AC 14/7/2016, Item No. 4.64

UNIVERSITY OF MUMBAI

Bachelor of Engineering

First Year Engineering (Semester I & II), Revised course (REV-2016)from Academic Year 2061 -17,(Common for All Branches of Engineering)

(As per Choice Based Credit and Grading System with effect from the A. Y. 2016 - 17)

First Year Engineering (Semester I & II), Revised course from Academic Year 2016 -17, (REV- 2016) (Common for all Branches of Engineering)

Scheme for FE - Semester – I

Sub. Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End sem. exam				
		Test 1	Test 2	Average of Test 1 & Test 2					
FEC101	Applied Mathematics-I	20	20	20	80	25	-	-	125
FEC102	Applied Physics-I	15	15	15	60	25	-	-	100
FEC103	Applied Chemistry –I	15	15	15	60	25	-	-	100
FEC104	Engineering Mechanics	20	20	20	80	25	-	25	150
FEC105	Basic Electrical Engineering	20	20	20	80	25	-	25	150
FEC106	Environmental studies	15	15	15	60	-	-	-	75
FEL101	Basic Workshop Practice-I	-	-	-	-	50	-	-	50
				105	420	175		50	750

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC101	Applied Mathematics-I	04	-	01	04		01	05
FEC102	Applied Physics-I	03	01	-	03	0.5	-	3.5
FEC103	Applied Chemistry -I	03	01	-	03	0.5	-	3.5
FEC104	Engineering Mechanics	05	02	-	05	01	-	06
FEC105	Basic Electrical Engineering	04	02	-	04	01	-	05
FEC106	Environmental studies	02	-	-	02	-	-	02
FEL101	Basic Workshop Practice-I	-	04	-	-	02	-	02
		21	10	01	21	05	01	27

First Year Engineering (Semester I & II), Revised course from Academic Year 2016 -17, (REV- 2016) (Common for all Branches of Engineering)

Scheme for FE - Semester – II

Sub. Code	Subject Name	Examination Scheme							
		Theory marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End sem. exam				
		Test 1	Test 2	Average of Test 1 & Test 2					
FEC201	Applied Mathematics-II	20	20	20	80	25	-	-	125
FEC202	Applied Physics-II	15	15	15	60	25	-	-	100
FEC203	Applied Chemistry -II	15	15	15	60	25	-	-	100
FEC204	Engineering Drawing	15	15	15	60	25	50	-	150
FEC205	Structured Programming Approach	20	20	20	80	25	25	-	150
FEC206	Communication Skills	10	10	10	40	25	-	-	75
FEL201	Basic Workshop Practice-II	-	-	-	-	50	-	-	50
				95	380	200	75		750

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC201	Applied Mathematics-II	04	-	01	04		01	05
FEC202	Applied Physics-II	03	01	-	03	0.5	-	3.5
FEC203	Applied Chemistry -II	03	01	-	03	0.5		3.5
FEC204	Engineering Drawing	03	04	-	03	02	-	05
FEC205	Structured Programming Approach	04	02	-	04	01	-	05
FEC206	Communication Skills	02	02	-	02	01	-	03
FEL201	Basic Workshop Practice -II	-	04	-	-	02	-	02
		19	14	01	19	07	01	27

University of Mumbai

As per AAU letter ... dated 20th Aug. 2019

No. UG/ 65 of 2019-20

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/131 of 2016-17 dated 9th November, 2016 relating to the revised syllabus as per (CBCS) for Bachelor of Engineering (First Year Engineering (Sem. I to II).

They are hereby informed that the recommendations made by the faculty members of Engineering at its meeting held on 8th May,2019 have been accepted by the Academic Council at its meeting held on 26th July, 2019 **vide** item No. 4.40 and that in accordance therewith, the Revised Syllabus and Scheme for 2019 of **First Year Engineering** (Sem. I & II) as per AICTE model curriculum from the academic year 2019-20. (The same is available on the University's website www.mu.ac.in).

(Dr. Ajay Deshmukh)
REGISTRAR

MUMBAI – 400 032
14th August, 2019

To

The Principals of the affiliated Colleges, and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.40/26/07/2019

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No. UG/ 65 -A of 2019-20 MUMBAI-400 032 14th August, 2019

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Director, Board of Examinations and Evaluation,
3) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. Ajay Deshmukh)
REGISTRAR

AC: Item No. 4.40
Date: 26TH July, 2019

UNIVERSITY OF MUMBAI

Bachelor of Engineering

First Year Engineering (Semester I & II), Revised course

(REV- 2019'C' Scheme) from Academic Year 2019 – 20

(Common for All Branches of Engineering)

Under

FACULTY OF SCIENCE &TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Program Structure for First Year Engineering
Semester I & II
UNIVERSITY OF MUMBAI
(With Effect from 2019-2020)

Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
FEC101	Engineering Mathematics-I	3	--	1*	3	--	1	4
FEC102	Engineering Physics-I	2		--	2		--	2
FEC103	Engineering Chemistry-I	2	--	--	2	--	--	2
FEC104	Engineering Mechanics	3	--	--	3	--	--	3
FEC105	Basic Electrical Engineering	3	--	--	3	--	--	3
FEL101	Engineering Physics-I	--	1	--	--	0.5	--	0.5
FEL102	Engineering Chemistry-I	--	1	--	--	0.5	--	0.5
FEL103	Engineering Mechanics	--	2	--	--	1	--	1
FEL104	Basic Electrical Engineering	--	2	--	--	1	--	1
FEL105	Basic Workshop practice-I	--	2	--	--	1	--	1
Total		13	08	01	13	04	01	18

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC101	Engineering Mathematics-I	20	20	20	80	3	25	--	125
FEC102	Engineering Physics-I	15	15	15	60	2	--	--	75
FEC103	Engineering Chemistry-I	15	15	15	60	2	--	--	75
FEC104	Engineering Mechanics	20	20	20	80	3	--	--	100
FEC105	Basic Electrical Engineering	20	20	20	80	3	--	--	100
FEL101	Engineering Physics-I	--	--	--	--	--	25	--	25
FEL102	Engineering Chemistry-I	--	--	--	--	--	25	--	25
FEL103	Engineering Mechanics	--	--	--	--	--	25	25	50
FEL104	Basic Electrical Engineering	--	--	--	--	--	25	25	50
FEL105	Basic Workshop practice-I	--	--	--	--	--	50	--	50
Total		--	--	90	360	--	175	50	675

*** Shall be conducted batch-wise**

Semester II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
FEC201	Engineering Mathematics-II	3	--	1*	3	--	1	4
FEC202	Engineering Physics-II	2	--	--	2	--	--	2
FEC203	Engineering Chemistry-II	2	--	--	2	--	--	2
FEC204	Engineering Graphics	2	--	--	2	--	--	2
FEC205	C programming	2	--	--	2	--	--	2
FEC206	Professional Communication and Ethics- I	2	--	--	2	--	--	2
FEL201	Engineering Physics-II	--	1	--	--	0.5	--	0.5
FEL202	Engineering Chemistry-II	--	1	--	--	0.5	--	0.5
FEL203	Engineering Graphics	--	4	--	--	2	--	2
FEL204	C programming	--	2	--	--	1	--	1
FEL205	Professional Communication and Ethics- I	--	2	--	--	1	--	1
FEL206	Basic Workshop practice-II	--	2	--	--	1	--	1
Total		**13**	**12**	**01**	**13**	**06**	**01**	**20**

Course Code	Course Name	Examination Scheme								
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC201	Engineering Mathematics-II	20	20	20	80	3	25	--	125
FEC202	Engineering Physics-II	15	15	15	60	2	--	--	75
FEC203	Engineering Chemistry-II	15	15	15	60	2	--	--	75
FEC204	Engineering Graphics	15	15	15	60	3	--	--	75
FEC205	C programming	15	15	15	60	2	--	--	75
FEC206	Professional Communication and Ethics- I	10	10	10	40	2	--	--	50
FEL201	Engineering Physics-II	--	--	--	--	--	25	--	25
FEL202	Engineering Chemistry-II	--	--	--	--	--	25	--	25
FEL203	Engineering Graphics	--	--	--	--	--	25	50	75
FEL204	C programming	--	--	--	--	--	25	25	50
FEL205	Professional Communication and Ethics- I	--	--	--	--	--	25	--	25
FEL206	Basic Workshop practice-II	--	--	--	--	--	50	--	50
Total		--	--	**90**	**360**	--	**200**	**75**	**725**

*** Shall be conducted batch-wise**

UNIVERSITY OF MUMBAI

No. UG/43 of 2018-19

CIRCULAR:-

Attention of the Principals of the affiliated Colleges and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/243 of 2010, dated 12th August, 2010 relating to syllabus of the Bachelor of Engineering (B.E.) degree course.

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Electronics Engineering at its meeting held on 9th April, 2018 have been accepted by the Academic Council at its meeting held on 5th May, 2018 **vide** item No. 4.54 and that in accordance therewith, the revised syllabus as per the (CBCS) for the T.E. & B.E. in Electronics Engineering (Sem - V to VIII) has been brought into force with effect from the academic year 2018-19 and 2019-2020, accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
25th June, 2018

(Dr. Dinesh Kamble)
I/c REGISTRAR

To

The Principals of the affiliated Colleges & Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.54/05/05/2018

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No. UG/ 43 -A of 2018 MUMBAI-400 032 25th June, 2018

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Electronics Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-Ordinator, University Computerization Centre,

(Dr. Dinesh Kamble)
I/c REGISTRAR

AC19.04.2017
Item No. X.XX

UNIVERSITYOFMUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Electronics Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

Engineering education in India is expanding and is set to increase manifold. Themajor challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards.The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Electronics Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Electronics Engineering. The Program Educational Objectives finalized for the undergraduate program in Electronics Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process
4. To prepare the Learner for a successful career in Indian and Multinational Organisations

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr.Sudhakar S. Mande
Chairman, Board of Studies in Electronics Engineering, University of Mumbai

B.E. (Electronics Engineering) – Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX701	Instrumentation System Design	04	--	---	04	---	---	04
ELX702	Power Electronics	04	--	---	04	---	---	04
ELX703	Digital signal processing	04	--	---	04	---	---	04
ELXDLO703X	Department Level Optional course III	04	--	---	04	---	---	04
ILO701X	Institute Level Optional Course I#	03	---	---	03	---	---	03
ELXL701	Instrumentation System Design Lab.		02			01	---	01
ELXL702	Power Electronics Lab.		02			01	---	01
ELXL703	Digital signal processing Lab.		02			01	---	01
ELXL704	Project-I	---	06	---	---	03	---	03
ELXLDLO703 X	Dept. Level Optional course III Lab.		02			01	---	01
	TOTAL	**19**	**14**	**---**	**19**	**07**	**---**	**26**

Course Code	Course Name	Examination Scheme – Semester VII							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX701	Instrumentation System Design	20	20	20	80	03	---	---	100
ELX 702	Power Electronics	20	20	20	80	03	---	---	100
ELX 703	Digital signal processing	20	20	20	80	03	---	---	100
ELXDLO703X	Department Level Optional courses III*	20	20	20	80	03	---	---	100
ILO701X	Institute Level Optional Subject	20	20	20	80	03	---	---	100
ELXL701	Instrumentation System Design Lab.						25	25	50
ELXL702	Power Electronics Lab.						25	25	50
ELXL703	Digital signal processing Lab.						25	25	50
ELXL704	Project-I	---	---	---	---	---	50	50	100
ELXLDLO703 X	Dept. Level Optional courses III Lab.						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**150**	**150**	**800**

B.E. (Electronics Engineering) – Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX801	Internet of Things	04	--	---	04	---	---	04
ELX 802	Analog and Mixed VLSI Design	04	--	---	04	---	---	04
ELXDLO804X	Department Level Optional course IV	04	--	---	04	---	---	04
ILO802X	Institute Level Optional course II#	03	---	---	03	---	---	03
ELXL801	Internet of Things Lab.		02			01	---	01
ELXL802	Analog and Mixed VLSI Design Lab.		02			01	---	01
ELXL803	Project-II	---	12	---	---	06	---	06
ELXLDLO804X	Department Level Optional Courses IV Lab.		02			01	---	01
	TOTAL	**15**	**18**	**---**	**15**	**9**	**---**	**24**

Course Code	Course Name	Examination Scheme – Semester VIII							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX801	Internet of Things	20	20	20	80	03	---	---	100
ELX 802	Analog and Mixed VLSI Design	20	20	20	80	03	---	---	100
ELXDLO804X	Department Level Optional course IV	20	20	20	80	03	---	---	100
ILO802X	Institute Level Optional course II	20	20	20	80	03	---	---	100
ELXL801	Internet of Things Lab.						25	25	50
ELXL802	Analog and Mixed VLSI Design Lab.						25	25	50
ELXL803	Project-II	---	---	---	---	---	100	50	150
ELXLDLO804X	Department Level Optional Courses IV Lab.						25	25	50
Total		**80**	**80**	**80**	**320**	**15**	**150**	**150**	**700**

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I#
ELXDLO7031	Neural Network and Fuzzy Logic	ILO7011	Product Lifecycle Management
ELXDLO7032	Advance Networking Technologies	ILO7012	Reliability Engineering
ELXDLO7033	Robotics	ILO7013	Management Information System
ELXDLO7034	Integrated Circuit Technology	ILO7014	Design of Experiments
		ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II#
ELXDLO8041	Advanced Power Electronics	ILO8021	Project Management
ELXDLO8042	MEMS Technology	ILO8022	Finance Management
ELXDLO8043	Virtual Instrumentation	ILO8023	Entrepreneurship Development and Management
ELXDLO8044	Digital Image Processing	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

B.E. (Electronics Engineering)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX701	Instrumentation System Design	04	--	---	04	---	---	04
ELX702	Power Electronics	04	--	---	04	---	---	04
ELX703	Digital signal processing	04	--	---	04	---	---	04
ELXDLO703X	Department Level Optional course III	04	--	---	04	---	---	04
ILO701X	Institute Level Optional Course I#	03	---	---	03	---	---	03
ELXL701	Instrumentation System Design Lab.		02			01	---	01
ELXL702	Power Electronics Lab.		02			01	---	01
ELXL703	Digital signal processing Lab.		02			01	---	01
ELXL704	Project-I	---	06	---	---	03	---	03
ELXLDLO703X	Dept. Level Optional course III Lab.		02			01	---	01
	TOTAL	**19**	**14**	**---**	**19**	**07**	**---**	**26**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX801	Internet of Things	04	--	---	04	---	---	04
ELX 802	Analog and Mixed VLSI Design	04	--	---	04	---	---	04
ELXDLO804X	Department Level Optional course IV	04	--	---	04	---	---	04
ILO802X	Institute Level Optional course II#	03	---	---	03	---	---	03
ELX801	Internet of Things Lab.		02			01	---	01
ELXL802	Analog and Mixed VLSI Design Lab.		02			01	---	01
ELXL803	Project-II	---	12	---	---	06	---	06
ELXLDLO804X	Department Level Optional Courses IV Lab.		02			01	---	01
	TOTAL	**15**	**18**	**---**	**15**	**9**	---	**24**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 701	Instrumentation System Design	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELX 701	Instrumentation System Design (ISD)	20	20	20	80	---	---	100

Rationale :- For optimum operation & satisfactory performance of any industrial process control system, it is necessary to have a reliably engineered system with a thorough knowledge of the process conditions & requirements as per the system or design specifications. This subject introduces various nuances in the design of instrumentation systems, which is itself a synergy of sensors, transducers, actuators, process control & electronic systems to achieve the desired operation of a plant or the proper control of an industrial process. Students are exposed to principles of designing which enable them to design, build & implement such electronically controlled systems for measurement, signal conditioning & final control.

Course Objectives :-

1. To learn basic functions & working of pneumatic, hydraulic & electrical components used in process control

2. To understand principles of process parameter conversion & transmission in various forms

3. To gain familiarity with control system components & their applications in process control

4. To study various types of controllers used in process control & their tuning for different applications

5. To be aware of recent advances & technological developments in industrial instrumentation & process control

Course Outcomes :-

At the end of the course, students should gain the ability to :-

- **ELX 701.1 :-** Demonstrate the needs of advancement in instrumentation systems
- **ELX 701.2 :-** Select the proper components for pneumatic & hydraulic systems
- **ELX 701.3 :-** Choose the transmitter / controller for given process application
- **ELX 701.4 :-** Analyze the controller parameters for discrete or continuous type
- **ELX 701.5 :-** Design the controller (electronic) for a given process or application

Module No.	Topics	Hours
1	**ACTUATORS & PROCESS CONTROL VALVES**	08
1.1	Electrical actuators – relays, solenoids & electrical motors (DC, AC & stepper motor)	
1.2	Pneumatic actuators – basic pneumatic system, pneumatic compressors (piston, vane, screw) flapper nozzle, single & double acting cylinder, rotary actuator, filter-regulator-lubricator (FRL)	
1.3	Hydraulic actuator – hydraulic pumps, control valves types (globe, ball, needle, butterfly, gate, diaphragm & pinch), cavitation & flashing with their remedies, pressure drop across valve & leakage, valve noise, flow characteristics on load changes, control valves parameters, control valves sizing, valve calibration, digital control valves, selecting control valves & applications	
2	**DESIGN OF SIGNAL CONDITIONING CIRCUITS**	08
2.1	Principles of analog & digital signal conditioning – signal level & bias change, linearization, conversion, filtering & impedance matching, concept of loading, comparators & converters	
2.2	Design of operational amplifier based circuits in instrumentation – analysis of voltage divider circuits, bridge circuits, RC filters, inverting & non-inverting amplifier, instrumentation amplifier, V to I & I to V converter, integrator, differentiator & linearization (with numerical examples)	
2.3	Transmitters – Introduction to telemetry & its basic block diagram, 2 wire, 3 wire & 4 wire transmitters, 4 mA to 20 mA current transmitter, electronic transmitters for temperature, level, pressure & flow, current to pressure (I to P) & pressure to current (P to I) converters	
3	**PROCESS CONTROLLER PRINCIPLES**	08
3.1	Discontinuous controller – two position mode, multi-position mode & floating mode	
3.2	Continuous controller – single mode (P, I & D) & composite mode (PD, PI & PID), split range, auto select, ratio & cascaded controllers, selection criterion of controller for a process mode	
3.3	Tuning of PID controller – process loop tuning, open loop transient response method, Ziegler – Nichols tuning method, frequency response methods (numerical examples on PID tuning)	
4	**PROGRAMMABLE LOGIC CONTROLLERS (PLC)**	10
4.1	Discrete state process controller – discrete state variables, process specifications & event sequence description	
4.2	Relay controller & ladder diagram – introduction to relay ladder diagram logic, ladder diagram elements & ladder diagram programming examples	

4.3	PLC – relay sequencers, programmable logic controller design, PLC operation, programming the PLC, PLC software functions (application examples on relay ladder logic programming)	
5	**DIGITAL BASED PROCESS CONTROL**	**08**
5.1	Data acquisition system (DAS) – objectives, signal conditioning of inputs, single channel DAS, multi-channel DAS, computer based DAS, data logger, difference between DAS & data logger	
5.2	Computer aided process control – architecture, human machine interface (HMI), supervisory control & data acquisition (SCADA), standard interfaces (RS-232C, RS-422A & RS-485)	
5.3	Supervisory control system (SCS), introduction to the Fieldbus & Profibus process controlled networks, overview of distributed control system (DCS), features & advantages of DCS	
6	**CALIBRATION STANDARDS & ADVANCES IN INSTRUMENTATION**	**06**
6.1	PC & microcomputer based instrumentation, virtual instrumentation & LabVIEW introduction	
6.2	Calibration of instrumentation systems, representation of instrumentation control process with SAMA & ISA symbols, ISO/IEC 17025 General requirements for calibration standards	
6.3	Instrumentation standards, ISA S82.01 – Safety Standard for Electrical and Electronic Test, Measuring, Controlling Related Equipment, ISA S84.01 – Application of Safety Instrumented Systems for the Process Industries, ANSI/NEMA 250 – Enclosures for Electrical Equipment	
1 – 6	**TOTAL**	**48**

Recommended Books :-

1. Curtis D. Johnson, Process Control Instrumentation Technology, 7th edition, PHI
2. S. K. Singh, Industrial Instrumentation & Control, 3rd edition, McGraw Hill
3. B.C. Nakra & K. K. Chaudhary, Instrumentation Measurement & Analysis, 3rd edition, McGraw Hill
4. Andrew Parr, Pneumatics & Hydraulics, 2nd edition, Jaico Publishing Co.
5. B. G. Liptak, Handbook of Process Control & Instrumentation, 4th edition, CRC Press
6. William C. Dunn, Fundamentals of Industrial Instrumentation & Process Control, 1st edition, McGraw Hill

Internal Assessment (IA) :-Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Q.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX702	Power Electronics	04	02	--	04	--	--	04

Subject Code	Subject Name	ExaminationScheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELX702	Power Electronics	20	20	20	80	03	--	--	--	100

\Course Pre-requisite:

1. ENAS
2. EDC-1
3. EDC-2

Course Objectives:

1. To teach power electronic devices and their characteristics.
2. To highlight power electronics based rectifiers, inverters and choppers.

Course Outcomes:

After successful completion of the course students will be able to:

1. Discuss trade-offs involved in power semiconductor devices.
2. Design of triggering, commutation and protection circuits for SCRs.
3. Analyse different types of single-phase rectifiers and DC-DC converters.
4. Analyse different types of DC-AC converters (inverters).
5. Analyse different types of AC Voltage Controllers and Cycloconvertors.

Module No.	Unit No.	Contents	Hrs.
1		**Power semiconductor devices**	8
	1.1	Principle of operation of SCR, static and dynamic characteristics, gate Characteristics,	
	1.2	Principle of operation, characteristics, ratings and applications of: TRIAC, DIAC, MOSFET and power BJT. IGBT: basic structure, principle of operation, equivalent circuit, latch-up in IGBT's and V-I characteristics.	
2		**SCR: Triggering, commutation and Protection Circuits**	8
	2.1	Methods of turning ON SCR (types of gate signal), firing circuits (using R, RC, UJT, Ramp and pedestal, inverse cosine),	
	2.2	Design of commutation circuits,	
	2.3	Protection of SCR	
3		**Single-phase Controlled Rectifiers**	8
	3.1	Introduction to uncontrolled rectifiers, Half wave controlled rectifiers with R, RL load, effect of free-wheeling diode	
	3.2	Full wave fully controlled rectifiers (centre-tapped, bridge configurations), full-wave half controlled (semi-converters) with R, RL load, effect of freewheeling diode and effect of source inductance.	
	3.3	Calculation of performance parameters, input performance parameters (input power factor, input displacement factor (DF), input current distortion factors (CDF), input current harmonic factor (HF/THD), Crest Factor (CF)), output performance parameters.	
4		**Inverters**	10
	4.1	Introduction to basic and improved series/parallel inverters, limitations.	
	4.2	Introduction, principle of operation, performance parameters of Single phase half / full bridge voltage source inverters with R and R-L load,	
	4.3	Voltage control of single phase inverters using PWM techniques, harmonic neutralization of inverters, applications	
5		**DC-DC converters**	8
	5.1	Basic principle of step up and step down DC-DC converters, DC-DC switching mode regulators: Buck, Boost, Buck-Boost, Cuk Regulators (CCM mode only)	
	5.2	Voltage commutated, current commutated and load commutated DC-DC	

		converters	
	5.3	Applications in SMPS, Battery charging systems.	
6		**AC Voltage Controllers and Cycloconvertors**	**6**
	6.1	Principle of On-Off control, principle of phase control, single phase bidirectional control with R and RL load	
	6.2	Introduction, single phase and three phase Cyclo-converters, applications	
		Total	**48**

Recommended Books:

1. M. H. Rashid, "*Power Electronics*", Prentice-Hall of India
2. Ned Mohan, "*Power Electronics*", Undeland, Robbins, John Wiley Publication
3. P. S. Bhimbra, "Power Electronics", Khanna Publishers, 2012
4. M.D. Singh and K. B. Khanchandani, "*Power Electronics*", Tata McGraw Hill
5. Ramamurthy, " *Thyristors and Their Applications*"
6. P. C. Sen, "*Modern Power Electronics*", Wheeler Publication
7. S. Shrivastava, "Power Electronics", Nandu Publication, Mumbai.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1	Test 2	Ave. of Test 1 and Test 2					
EXC703	Digital Signal Processing	20	20	20	80	--	--	--	100

Prerequisite Courses: Signals and Systems

Course Objectives:

1. To teach the design techniques and performance analysis techniques of digital filters
2. To introduce the students to advanced signal processing techniques, digital signal processors and applications

Course Outcomes:

After successful completion of this course students will be able to

1. Demonstrate an understanding of the discrete-time Fourier transform and the concept of digital frequency.
2. Design FIR and IIR digital filters to meet arbitrary specifications and Develop algorithms for implementation
3. Understand the effect of hardware limitations on performance of digital filters
4. Use advanced signal processing techniques and digital signal processors in various applications

Module No.	Unit No.	Topics	Hrs.
1.0		**Discrete Fourier Transform and Fast Fourier Transform**	10
	1.1	Definition and Properties of DFT,IDFT, circular convolution of sequences using DFT and IDFT, Relation between Z-transform and DFT Filtering of long data sequences: Overlap Save and Overlap Add Method Computation of DFT	
	1.2	Fast Fourier transforms(FFT),Radix-2decimationintime and decimation in frequency FFT algorithms, inverse FFT, and Introduction to composite FFT	
2.0		**IIR Digital Filters**	10
	2.1	Types of IIR Filters (Low Pass, High Pass, Band Pass, Band stop and All Pass) Analog filter approximations: Butterworth, Chebyshev I and II	
	2.2	MappingofS-planetoZ-plane,impulseinvariancemethod,bilineartransformation method, Design of IIR digital filters from analog filters with examples	
	2.3	Analog and digital frequency transformations with design examples	
3.0		**FIR Digital Filters**	10
	3.1	Characteristics of FIR digital filters, Minimum Phase, Maximum Phase, Mixed Phase and Linear Phase Filters Frequency response, location of the zero sof linear phase FIR filters	

	3.2	Design of FIR filter susing window techniques (Rectangular, Hamming, Hanning,Blackmann, Barlet) Design of FIR filter susing Frequency Sampling technique Comparison of IIR and FIR filters	
4.0		**Finite Word Length Effects in Digital Filters**	06
	4.1	Quantization, truncation and rounding, Effects due to truncation and rounding, Input quantization error, Product quantization error, Co-efficient quantization error, Zero-input limit cycle oscillations, Overflow limit cycle oscillations, Scaling	
	4.2	Quantization in Floating Point realization of IIR digital filtersFinite word length effects in FIR digital filters	
5.0		**Multirate DSPand FilterBanks**	06
	5.1	Introduction and concept of Multirate Processing, Block Diagram of Decimator and Interpolator, Decimation and Interpolation by Integer numbers Multistage Approach to Sampling rate converters	
	5.2	Sample rate conversion using Polyphase filter structure, Type I and Type II Polyphase Decomposition	
6.0		**DSP Processors and Applications**	06
	6.1	Introduction to General Purpose and Special Purpose DSP processors, fixed point and floating point DSP processor, Computer architecture for signal processing, Harvard Architecture, Pipelining, multiplier and accumulator(MAC), Special Instructions, Replication, On-chip memory, Extended Parallelism	
	6.2	General purpose digital signal processors, Selecting digital signal processors, Special purpose DSP hardware	
	6.3	Applications of DSP: Radar Signal Processing and Speech Processing	
Total			**48**

Text Books:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, "*Digital Signal Processing*", A Practical Approach by, Pearson Education
2. Tarun Kumar Rawat, " *Digital Signal Processing*", Oxford University Press, 2015

Reference Books:

1. ProakisJ., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education
2. Sanjit K. Mitra , Digital Signal Processing – A Computer Based Approach – edition 4e
3. McGraw Hill Education (India) Private Limited
4. OppenheimA.,SchaferR.,BuckJ.,"*DiscreteTimeSignalProcessing*",2ndEdition, Pearson Education..
5. B. VenkataRamaniand, M. Bhaskar, "*Digital Signal Processors, Architecture, Programming andApplications*", Tata McGraw Hill, 2004.
6. L.R.RabinerandB.Gold,"*TheoryandApplicationsofDigitalSignalProcessi*ng",Prentice-HallofIndia, 2006.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5markswill be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7031	NEURAL NETWORKS & FUZZY LOGIC	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO7031	NEURAL NETWORKS & FUZZY LOGIC	20	20	20	80	-	--	--	100

Pre-requisite

- Knowledge of linear algebra, multivariate calculus, and probability theory
- Knowledge of a programming language (MATLAB /C/C ++ recommended)

Course Objectives:

- To study basics of biological Neural Network.
- To understand the different types of Artificial Neural Networks
- To know the applications of ANN .
- To study fuzzy logic and fuzzy systems.

Course outcomes:

At the end of completing the course of Neural Networks & Fuzzy Logic, a student will be able to:

1. Choose between different types of neural networks
2. Design a neural network for a particular application
3. Understand the applications of neural networks
4. Appreciate the need for fuzzy logic and control

Module	Contents	Hours
1	**Introduction:**1.1 Biological neurons, McCulloch and Pitts models *of* neuron, Types of activation function, Network architectures, Knowledge representation, Hebb net 1.2 Learning processes: Supervised learning, Unsupervised learning and Reinforcement learning 1.3 Learning Rules : Hebbian Learning Rule, Perceptron Learning Rule, Delta Learning Rule, Widrow-Hoff Learning Rule, Correlation Learning Rule, Winner-Take-All Learning Rule 1.4 Applications and scope of Neural Networks	**10**
2	**Supervised Learning Networks :** 2.1 Perception Networks – continuous & discrete, Perceptron convergence theorem, Adaline, Madaline, Method of steepest descent, – least mean square algorithm, Linear & non-linear separable classes & Pattern classes, 2.2 Back Propagation Network, 2.3 Radial Basis Function Network.	**12**
3	**Unsupervised learning network:** 3.1 Fixed weights competitive nets, 3.2 Kohonen Self-organizing Feature Maps, Learning Vector Quantization, 3.3 Adaptive Resonance Theory – 1	**06**
4	**Associative memory networks:** 4.1 Introduction, Training algorithms for Pattern Association, 4.2 Auto-associative Memory Network, Hetero-associative Memory Network, Bidirectional Associative Memory, 4.3 Discrete Hopfield Networks.	**08**
5	Fuzzy Logic: 5.1 Fuzzy Sets, Fuzzy Relations and Tolerance and Equivalence 5.2 Fuzzification and Defuzzification 5.3 Fuzzy Controllers	**12**

	TOTAL	**48**

Text- Books:

- Dr. S. N. Sivanandam, Mrs S.N. Deepa, *"Principles of Soft computing"*, Wiley Publication.
- Jacek M. Zurada, *"Introduction to Artificial Neural Systems,* Jaico publishing house.

Reference books :

- Simon Haykin, "*Neural Network* a - *Comprehensive Foundation",* Pearson Education.
- S. Rajsekaran, Vijaylakshmi Pai, *"Neural Networks, Fuzzy Logic, and Genetic Algorithms"*, PHI.
- Thimothy J. Ross, "*Fuzzy Logic with Engineering Applications",* Wiley Publication.
- Christopher M Bishop, *"Neural Networks For Pattern Recognition"* ,Oxford Publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of total 6 questions, each of 20 marks.
2. Only 4 questions need to be solved.
3. Question number 1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.
5. No question should be asked from pre-requisite module

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7032	Advanced Networking Technologies	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO7032	Advanced Networking Technologies	20	20	20	80	-	--	--	100

Course Pre-requisite: ELX405 Principles of Communication Engineering
ELX602 Computer Communication Network
ELXDLO-2 Wireless Communication

Course Objectives:
The objectives of this course are to:
1. Understand the characteristic features of Various Wireless networks
2. Understand Optical networking and significance of DWDM.
3. Introduce the need for network security and safeguards
4. Understand the principles of network management

Course Outcomes:

On successful completion of the course the students will be able to:

1. Appreciate the need for Wireless networks and study the IEEE 802.11 Standards
2. Comprehend the significance of Asynchronous Transfer Mode(ATM)
3. Understand the features of emerging wireless Networks: Bluetooth Networks,ZIGBEE, WSN
4. Analyze the importance of Optical networking
5. Demonstrate knowledge of network design and security and management
6. Understand the concept of Cloud Computing and its applications.

Module No.	Unit No.	Topics	Hrs.
1.		**Wireless LAN and WAN technologies**	**08**
	1.1	Introduction to Wireless networks : Infrastructure networks, Ad-hoc networks, IEEE 802.11 architecture and services, Medium Access Control sub-layers, CSMA/CA Physical Layer, 802.11 Security considerations .	
	1.2	Asynchronous Transfer Mode (ATM): Architecture, ATM logical connections, ATM	

		cells , ATM Functional Layers, Congestion control and Quality of service	
2.		**Emerging Wireless Technologies**	**10**
	2.1	**Wireless Personnel Area Network(WPAN):** WPAN 802.15.1 architecture ,Bluetooth Protocol Stack, Bluetooth Link Types, Bluetooth Security, Network Connection Establishment in Bluetooth, Network Topology in Bluetooth, Bluetooth Usage Models	
	2.2	802.15.3- Ultra Wide Band , 802.15.4- Zigbee , RFID	
	2.3	**Wireless Sensor Networks: Introduction and Applications,** Wireless Sensor Network Model, Sensor Network Protocol Stack,	
3.0		**Optical Networking**	**08**
	3.1	SONET : SONET/SDH, Architecture, Signal, SONET devices, connections, SONET layers, SONET frames, STS Multiplexing, SONET Networks	
	3.2	DWDM: Frame format, DWDM architecture ,Optical Amplifier , Optical cross connect Performance and design considerations	
4.0		**Network Design, Security and Management**	**10**
	4.1	3 tier Network design layers: Application layer, Access layer, Backbone layers, Ubiquitous computing and Hierarchical computing	
	4.2	Network Security: Security goal, Security threats, security safeguards, firewall types and design.	
	4.3	Network management definitions, functional areas (FCAPS), SNMP,RMON	
5.0		**Routing in the Internet:**	**06**
	5.1	Intra and inter domain Routing, Unicast Routing Protocols: RIP, OSPF, BGP	
	5.2	Multicast Routing Protocols ,Drawbacks of traditional Routing methods	
6.0		**Cloud computing:**	**06**
	6.1	Cloud Computing Evolution, Definition, SPI framework of Cloud Computing, Cloud service delivery models,	
	6.2	Cloud deployment models, key drivers to adoption of cloud, impact of cloud computing on users, examples of cloud service providers: Amazon, Google, Microsoft, Salesforce etc.	
		Total	**48**

Recommended Text Books:

1. Behrouz A. Forouzan, "Data communication and networking ", McGraw Hill Education, Fourth Edition.
2. Darren L. Spohn , "Data Network Design" , McGraw Hill Education ,Third edition
3. William Stallings, "Data and Computer communications", Pearson Education, 10th Edition.
4. Tim Mather , Subra Kumaraswamy & Shahed Latif, "Cloud security & Privacy: an enterprise Perspective", O'Reilly Media Inc.Publishers

Reference Books:

1. William Stallings, "Wireless Communications and Networks", Pearson Ed., 2nd Edition.

2. Vijay Garg ,"Wireless Communication and networking" , Morgan Kaufmann Publishers
3. Carr and Snyder, " Data communication and network security" , McGraw Hill ,1ST edition.
4. Upena Dalal & Manoj Shukla , " Wireless Communication and Networks", Oxford Press
5. Deven Shah , Ambavade, "Advanced Communication Networking"
6. Beherouz A Forouzan , "TCP /IP Protocol Suite" , Tata McGraw Hill Education ,4th edition.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7033	Robotics	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO7033	Robotics	20	20	20	80	-	--	--	100

Pre-requisite: Applied Mathematics III, Applied Mathematics IV ,Linear Control Systems

Course Objectives:

1. To study basics of robotics
2. To familiarize students with kinematics & dynamics of robots
3 To familiarize students with Trajectory & task planning of robots.
4 To familiarize students with robot vision

Course outcomes:

At the end of completing the course of Robotics, a student will be able to:

1. understand the basic concepts of robotics
2. perform the kinematic and the dynamic analysis of robots
3. perform trajectory and task planning of robots
4. describe importance of visionary system in robotic manipulation

Module	Contents	Hours
1	**Fundamentals of Robotics:** 1.1 Robot Classification, Robot Components, Robot Specification, Joints, Coordinates, Coordinate frames, Workspace, Languages, Applications.	**04**
2	**Kinematics of Robots:** 2.1 Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation 2.2 Denavit-Hatenberg representation of forward kinematics, Forward and inverse kinematic solutions of three and four axis robot	**10**
3	**Velocity Kinematics & Dynamics:** 3.1 **Differential motions and velocities :** Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian, Singularities, 3.2 **Dynamic Analysis of Forces :** Lagrangian mechanics, Newton Euler formulation, Dynamic equations of two axis robot	**10**
4	**Trajectory planning:** 4.1 Basics of Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories	**08**
5	**Robot Vision:** 5.1 Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform, Camera Calibration	**08**
6	**Task Planning:** 6.1 Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-motion Planning, Simulation of Planer motion, Source and goal scenes, Task planner simulation.	**08**
	TOTAL	**48**

Text- Books :

- Robert Shilling, “Fundamentals of Robotics - Analysis and contro”l, Prentice Hall of India, 2009
- Saeed Benjamin Niku, “Introduction to Robotics – Analysis, Control, Applications”, Wiley India Pvt. Ltd., Second Edition, 2011

Reference books :

- John J. Craig, “Introduction to Robotics – Mechanics & Control”, Third Edition, Pearson Education, India, 2009
- Mark W. Spong , Seth Hutchinson, M. Vidyasagar, “Robot Modeling & Control ”, Wiley India Pvt. Ltd., 2006
- Mikell P. Groover et.al, ”Industrial Robots-Technology, Programming & applications”, McGraw Hill , New York, 2008

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7034	IC Technology	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELXDLO7034	IC Technology	20	20	20	80	--	--	--	100

Course Pre-requisite:

- ELX302:Electronic Devices and Circuits I
- ELX303:Digital Circuit Design
- ELX603:VLSI Design

Course Objectives:

1. To provide knowledge of IC fabrication processes and advanced IC technologies.
2. To disseminate knowledge about novel VLSI devices and materials.

Course Outcomes:

After successful completion of the course student will be able to

1. Demonstrate a clear understanding of various MOS fabrication processes & CMOS fabrication flow.
2. Design layout of MOS based Circuits.
3. Demonstrate a clear understanding of Semiconductor Measurements & Testing.
4. Understand advanced technologies, Novel Devices and materials in Modern VLSI Technology.

Module No.	Unit No.	Topics	Hrs.
1. 0		**Crystal Growth, Wafer preparation and fabrication for VLSI Technology**	8
	1.1	**Semiconductor Manufacturing:** Semiconductor technology trend, Clean rooms, Wafer cleaning and Gettering.	
	1.2	**Semiconductor Substrate:** Crystal structure, Crystal defects, Czochralski growth, Float Zone growth, Bridgman growth of GaAs, Wafer Preparation and specifications	
2.0		**Fabrication Processes Part 1**	12
	2.1	**Epitaxy:** Classification, Molecular Beam Epitaxy	
	2.2	**Silicon Oxidation:** Thermal oxidation process, Kinetics of growth, Properties of	
		Silicon Dioxide, Oxide Quality.	
	2.3	**Device Isolation:** LOCOS, Shallow Trench Isolation (STI).	
	2.4	**Deposition: Physical Vapor Deposition-**Evaporation and Sputtering, **Chemical Vapor Deposition:** APCVD, LPCVD,PECVD	
	2.4	**Diffusion:** Nature of diffusion, Diffusion in a concentration gradient, diffusion Equation, diffusion systems, problems in diffusion.	
	2.5	**Ion Implantation:** Penetration range-Nuclear& Electronic stopping and Range, implantation damage, Annealing-Rapid thermal annealing, ion implantation systems.	
3.0		**Fabrication Process Part 2**	12
	3.1	**Etching &Lithography:** **Etching:** Basic concepts and Classification **Lithography:** Introduction to Lithography process, Types of Photoresist, Types of Lithography: Electron beam, Ion beam and X-ray lithography	
	3.2	**Metallization and Contacts:** Introduction to Metallization, Schottky contacts and Ohmic contacts.	
	3.3	**CMOS Process Flow:** N well, P-well and Twin tub, CMOS Latch Up	
	3.4	Design rules, Layout of MOS based circuits (gates and combinational logic), Buried	

		and Butting Contact	
4.0		**Measurement and Testing**	06
	4.1	**Semiconductor Measurements:** Conductivity type, Resistivity, Hall Effect Measurements, Drift Mobility,	
	4.2	**Testing:** Technology trends affecting testing, VLSI testing process and test	
		equipment, test economics and product quality	
		VLSI Technologies	05
	5.1	**SOI Technology:** SOI fabrication using SIMOX, Bonded SOI and Smart Cut ,PD SOI and FD SOI Device structure and their features	
	5.2	**Advanced Technologies:** low κ and high κ, BiCMOS, HκMG Stack, Strained Silicon.	
	5.3	**GaAs Technologies:** MESFET Technology, MMIC technologies, MODFET	
		Novel Devices and Materials	
	6.1	**Multigate Devices*:***Various multigate device configurations-double gate, triple gate (FinFET) and Gate All Around (Nanowire). **Nanowire:** Concept, VLS method of fabrication, Nanowire FET, Types: Horizontal and Vertical Nanowires, III-V compound Materials in Nanowires.	05
	6.2	**2-D Materials and FET:**Graphene& CNT FET, MOS2 and Black Phosphorous.	
		Total	**48**

Recommended Books:

1. James D. Plummer, Michael D. Deal and Peter B. Griffin, "*Silicon VLSI Technology*", Pearson, Indian Edition.

2. Stephen A. Campbell, "*The Science and Engineering of Microelectronic Fabrication"*, Oxford University Press, 2nd Edition.

3. Sorab K. Gandhi, "*VLSI Fabrication Principles*", Wiley, Student Edition.
4. G. S. May and S. M. Sze, "*Fundamentals of Semiconductor Fabrication*", Wiley, First Edition.

5. Kerry Bernstein and N. J. Rohrer, "*SOI Circuit Design Concepts",* Kluwer Academic Publishers, 1st edition.

6. Jean-Pierre Colinge, "*FinFETs and Other Multigate Transistors",* Springer, 1st edition
7. M. S. Tyagi, "*Introduction to Semiconductor Materials and Devices*", John Wiley and Sons, 1st edition.
8. James E. Morris and KrzysztolIniewski, "*Nanoelectronic Device ApplicationsHandbook*", CRC Press
9. Glenn R. Blackwell, "*The electronic packaging*", CRC Press
10. Michael L. Bushnell and Vishwani D. Agrawal, "*Essentials of Electronic Testing fordigital, memory and mixed-signal VLSI circuits*", Springer

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Course Code	Course Name	Credits
ILO7011	Product Life Cycle Management	03

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09

03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:**Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	**Life Cycle Assessment and Life Cycle Cost Analysis:**Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", TataMcGrawHill,2006,ISBN:0070636265

Course Code	Course Name	Credits
ILO7012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.	08

	System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

<u>Assessment</u>:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud	6

	computing model.	
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO7014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08

03	**Two-Level Factorial Designs and Analysis** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs and Analysis** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Conducting Tests** 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Phillip J Ross, “Taguchi Technique for Quality Engineering,” McGrawHill
7. Madhav S Phadke, “ Quality Engineering using Robust Design,” Prentice Hall

Course Code	Course Name	Credits
ILO7015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem,	14

	Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation ofMobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed byMobile Devices, Registry Settings for Mobile Devices, AuthenticationService Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law	8

	,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings*, Cryptography and Network Security,* Pearson Publication

8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO7017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	**Natural Disaster and Manmade disasters:** 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	**Disaster Management, Policy and Administration** 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.	06

	3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
04	**Institutional Framework for Disaster Management in India:** 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	**Financing Relief Measures:** 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 7018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control;	10

	Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL701	Instrumentation System Design Laboratory	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXL701	Instrumentation System Design Laboratory	---	---	---	---	25	25	50

<u>Term Work</u> :-

At least 06 experiments covering entire syllabus of ELX 701 (Instrumentation System Design) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments :-

1. Study of pneumatic single acting & double acting cylinder
2. Study of hydraulic process control valves
3. Design of stepper motor interface & controller
4. Design of instrumentation amplifier for variable voltage gain
5. Design of signal conditioning circuits for LDR / thermistor / RTD / strain gauge
6. Design of linearization circuits for transducers
7. Design of temperature P+I+D controller
8. Tuning of P+I+D controller using MATLAB / Simulink
9. Implementation of PLC ladder diagram for given application
10. Study of SCADA & HMI
11. Designing of data acquisition system (DAS)
12. Simulating a simple process using LabVIEW

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL702	Power Electronics	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXL702	Power Electronics	---	---	---	---	25	25	50

Term Work :-

At least 06 experiments covering entire syllabus of ELX 702 (Power Electronics) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested List of Experiments

1. Characteristics of SCR, DIAC, TRAIC.
2. Characteristics of IGBT, MOSFET and Power BJT.
3. Firing circuit for SCR using UJT.
4. Study of Half wave and Full wave rectifiers using diodes.
5. Study of Half wave and Full wave controlled rectifiers.
6. Buck converter, Boost converter and Buck-Boost converter.
7. Study of Cycloconverter.
8. Simulation of single phase Half wave and Full wave rectifier circuit.
9. Simulation of controlled rectifier with R and RL load.
10. Simulation of controlled rectifier with (i) Source Inductance (ii) Freewheeling diode.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL703	Digital Signal Processing	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXL703	Digital Signal Processing	---	---	---	---	25	25	50

Instructions

1. Minimum 6 experiments and one course project must be submitted by each student.
2. Simulation tools like Matlab/Scilab can be used.
3. Processor based experiments/mini projects can be included.
   The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

Tentative List of Experiments:

1. Study of Convolution, Series and Parallel Systems
2. Generation of Basic Signals
3. Computation of DFT and it's inverse
4. Computation of FFT and comparison of frequency response of DFT and FFT
5. Computation of DFT
6. IIR Butterworth filter design using IIT technique
7. IIR Chebyshev filter design using BLT technique
8. Design of FIR filter using hamming and hanning window, low pass and high pass filter

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDOLO7031	NEURAL NETWORKS & FUZZY LOGIC	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXDOLO7031	NEURAL NETWORKS & FUZZY LOGIC	---	---	---	---	25	25	50

Term Work:

The term work shall consist of

1. At least ***six experiments*** using MATLAB Or C/C++ or Java covering the whole of syllabus, duly recorded and graded.
2. ***One seminar and Two assignments*** to be included covering at least 60% of the syllabus.

The distribution of marks for term work shall be as follows:

The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced *The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.*

Suggested List of experiments: using C/C++ or Matlab or java

- Activation functions
- McCulloch Pitts Neuron Model
- Hebbian learning
- Single layer perceptron neural network
- Multi-layer perceptron neural network

- Error Back propagation neural network
- Kohonen Self-organizing Feature Maps
- Associative memory network
- Fuzzy relations
- Defuzzification methods

Suggested List of seminar :

- Classification of upper case and lower case letters.
- Classification of numbers 0-9.
- BPN for training a hidden layer.
- Implement a heteroassociative memory network to implement any pattern.
- Implement discrete Hopfield network for letters A-E.
- Implement BAM for a pattern of 5X3 array.
- Fuzzy Logic controller design – washing machine / vehicle speed control.

Oral Examination:

Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXLDLO7032	Advanced Networking Technologies Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXLDLO7032	Advanced Networking Technologies Laboratory	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation** on any one of the suggested topics The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

Suggested Experiments:

1. Evaluation of home/campus network
2. GSM-GPS protocol implementation
3. Bluetooth protocol implementation
4. ZigBee protocol implementation
5. Wi-Fi protocol implementation
6. Study of NMAP
7. Study of SNMP
8. Study of Ethernet.

Suggested topics for presentation:

1. MANET
2. VOFR
3. VOIP
4. X.25
5. Body area network
6. RFID
7. Web Security
8. Compression Techniques
9. Security attacks
10. NAT
11. College campus network

12. Fiber Optics types, advantages disadvantages
13. WSN

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXLDLO7033	Robotics	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXLDLO7033	Robotics	-	-	-	-	25	--	25	50

Term Work:

The term work shall consist of

3. At least ***eight experiments*** using MATLAB / Scilab covering the whole of syllabus, duly recorded and graded.
4. ***Two assignments*** to be included covering at least 60% of the syllabus.

The distribution of marks for term work shall be as follows:

The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced *The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.*

Suggested List of experiments: using Matlab / Scilab

- Forward kinematics
- Inverse kinematic
- Dynamic analysis
- Joint-space trajectory
- Cartesian-space trajectory
- Template matching
- Iterative processing
- Segmentation

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXLDLO7034	IC Technology	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXLDLO7034	IC Technology	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation** on any one of the suggested topics. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

Suggested Experiments:

Following list of experiments covers the complete syllabus prescribed in IC Technology course. It is formulated in such a way that it allows student to explore various process, layout and device simulation tools. Detail analysis of observations should be recorded in the project book. Tools to be used are Microwind, SUPREME, Electric, Visual TCAD, Mentor Graphics Pyxis and tools available on nanohub. Linux based operating system is preferred to do simulations.

1. Draw and simulate layout for the CMOS inverter. Carry out static as well as transient simulation. Analyze CMOS inverter for i) $(W/L)_{pmos}>(W/L)_{nmos}$ ii) $(W/L)_{pmos}=(W/L)_{nmos}$ iii) $(W/L)_{pmos}<(W/L)_{nmos}$. Do parasitic extraction. Feed these parasitic in circuit simulator and do layout versus schematic verification.

2. Draw and simulate layout for the following circuits. Size them with respect to reference inverter.

   a. CMOS NAND
   b. CMOS NOR

Also observe the effect of different types of design rules on above circuits and tabulate the comparative results.

3. Draw and simulate layout for the given equation (each student will get different equation [y= $\overline{A.B + C.D}$]) with the following design style

   a. Static CMOS
   b. Transmission gate
   c. Dynamic Logic

4. Draw and simulate layout for 6T SRAM cell. Size the SRAM cell for 1) lowest area 2) high reliability

5. Draw and simulate layout for the following circuits.

a. SR latch

b. D flip Flop

6. Simulate oxidation process with Deal-Grove model for different conditions (e.g. oxidation type, orientation, time, temperature, thickness etc.) and comment on the results obtained.

7. Simulate diffusion process for different conditions (e.g. source, time, temperature, dopant etc.) and comment on the results obtained.

8. Simulate Si PN junction for various structure and environmental conditions and comment on the results obtained. Repeat the entire simulation for Ge diode.

9. Simulate MOS capacitor (Classical Simulation) for single gate device for a typical value of fixed charge density and interface trap charge density in gate insulator. Do the AC analysis and comment on the results obtained.

10. Simulate MOS capacitor (Quantum Simulation) for single gate device for a typical value of fixed charge density and interface trap charge density in gate insulator. Do the AC analysis and comment on the results obtained.

Suggested topics for presentation:

Presentation on any Novel device or process.

B.E. (Electronics Engineering) – Semester VIII

`Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 801	Internet of Things	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX 801	Internet of Things	20	20	20	80	-	--	--	100

Course Pre-requisite: ELX 501 :- Micro-controllers and Applications
ELX 601:- Embedded System and RTOS
ELX602:- Computer Communication Network
ELXDLO-2 Wireless Communication

Course Objectives:

The objectives of this course are to:

1. Understand the design features of Internet of Things(IoT)
2. Understand importance of data handling in IoT Way.
3. Introduce multiple way of data communication and networking.
4. Understand design issue in IoT

Course Outcomes:

On successful completion of the course the students will be able to:

1. Understand the concepts of Internet of Things
2. Analyze basic web connectivity in IoT
3. Understand Data handling in IoT
4. Design basic applications based on IoT using specific components

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to IoT**	08
	1.1	**Introduction;-**Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Sources of IoT, and M2MCommunication.	
	1.2	**Iot and M2m:-** IoT/M2M System layers and Design Standardization, Difference between IoT and M2M	
2.		**Network & Communication aspects**	10

	2.1	**Design Principles & Web Connectivity:-** Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and WebSockets (Publish –Subscribe),MQTT, AMQP, CoAP Protocols	
	2.2	**Internet Connectivity: -** Internet connectivity, Internet based communication, IP addressing in IoT, Media Access Control, Application Layer Protocols. LPWAN Fundamentals :LORA ,NBIoT,CAT LTE M1,SIGFOX	
3.0		**IoT Platforms and Design Methodology**	**08**
	3.1	**Defining Specifications About:-** Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration, (case studies)	
	3.2	**IoT Levels:-**IoT Levels and Deployment Templates	
4.0		**Data Handling in IoT**	**10**
	4.1	**Data Acquiring, Organizing, Processing:-** Data acquiring and storage, Organizing the data, Transactions, Business Processes, Integration and Enterprise Systems, Analytics.	
	4.2	**Data Collection and Storage:-** Cloud Computing Paradigm for Data Collection, storage and computing, Cloud Service Models, Xively Cloud for IoT (AWS ,Google APP engine ,Dweet.IO, Firebase)	
5.0		**Components of IoT**	**06**
	5.1	**Exemplary Devices:-** Raspberry Pi, R-Pi Interfaces, Programming R-Pi, Sensor Technology, Sensor Data Communication Protocols, RFID, WSN Technology, Intel Galileo	
6.0		**IoT Case Studies**	**06**
	6.1	Design Layers, complexity, IoT Applications in Premises, Supply Chain and Customer Monitoring.	
	6.2	Home Automation, Smart Cities, Environment, Agriculture, IoT Printer	
		Total	**48**

Recommended Text Books:

5. ArshdeepBahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach, Universities Press.
6. Raj Kamal, " Internet of Things: Architecture and Design Principles", McGraw Hill Education ,First edition
7. David Hanes ,Gonzalo salgueiro"IoT Fundamentals Networking Technologies,Protocols and Use Cases for Internet of Things", Cisco Press, Kindle 2017 Edition
8. Andrew Minteer ,"Analytics for the Internet of Things(IoT)",Kindle Edition

Reference Books:

1. Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things", Paperback, First Edition
2. Yashavant Kanetkar , Shrirang Korde :Paperback "21 Internet of Things (IOT) Experiments"
    a. BPB Publications

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of thesyllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	T/W Practical	Tutorial	Total
ELX802	Analog and Mixed VLSI Design	04	02	-	04	-	-	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				Exam Duration (Hrs)	Term work	Practical	Oral	Total
		Internal Assessment Marks			End Sem Exam (Marks)					
		Test 1	Test 2	Average						
ELX802	Analog and Mixed VLSI Design	20	20	20	80	03	-	-	-	100

Course Pre-requisite:

- ELX302: Electronic Devices and Circuits I
- ELX303: Digital Circuit Design
- ELX402: Electronic Devices and Circuits II
- ELX504: Design With Linear Integrated Circuits
- ELX603: VLSI Design
- ELX DLO-3: IC Technology

Course Objectives:

1. To teach analysis and design of building blocks of CMOS Analog VLSI Circuits.
2. To highlight the issues associated with the CMOS analog VLSI circuit design.
3. To emphasize upon the issues related to mixed signal layout design.

Course Outcomes:

After successful completion of the course student will be able to

1. Discuss tradeoffs involved in analog VLSI Circuits.
2. Analyze building blocks of CMOS analog VLSI circuits.
3. Design building blocks of CMOS analog VLSI circuits
4. Carry out verifications of issues involved in analog and mixed signal circuits

Module No	Unit No	Topics	Hrs
1. 0		**Analog building blocks**	8
	1.1	Need for CMOS analog and mixed signal designs, MOS Transistor as sampling switch, active resistances, current source and sinks,current mirror.	
	1.2	**Voltage References:** Band Gap References, General Considerations, Supply-independent biasing, Temperature independent references, PTAT	

		current generation and Constant Gm biasing	
2.0		**Amplifier Fundamentals**	
	2.1	**Single Stage Amplifiers**: Basic concepts, Gain Bandwidth (GBW), Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascade stage.	12
	2.2	**Differential Amplifiers:** Single ended and differential operation, Basic differential pair, large signal and small signal behaviours, Common-mode response, Differential pair with MOS loads.	
	2.3	**Noise:** Statistical Characteristics of Noise, Types of Noise, Representation of Noise in circuits, Noise in Single stage amplifiers (CS, CD, CG stages), noise in differential pairs, noise bandwidth, noise figure, noise temperature.	
3.0		**MOS Operational Amplifiers**	
	3.1	**Stability and Frequency Compensation:** General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op- amps	8
	3.2	**Op-amp Design:** General Considerations, performance parameters, One-stage op- amps, Two-stage op-amps, Gain Boosting, Common-mode feedback, Input range limitations(ICMR), Slew Rate, Power supply rejection, Noise in op-amps. Design of single ended and double ended two stage Op-amps	
4.0		**Mixed Signal Circuits**	
	4.1	**Basic Concepts:** AMS design flow, ASIC, Full custom design, Semi-custom design, System on Chip, System in package, Hardware software co-design, and mixed signal layout issues.	8
	4.2	**Oscillators:** General considerations, Ring oscillators, LC oscillators, VCO,	
	4.3	**Phase-Locked Loop:** Simple PLL, Charge pump PLL, Non-ideal effects in PLL, Delay locked loops and applications of PLL in integrated circuits	
5.0		**Data Converter Fundamentals**	
	5.1	**Switch Capacitor Circuits:** MOSFETs as switches, Speed considerations, Precision Considerations, Charge injection cancellation, Unity gain buffer, Non- inverting amplifier and integrator.	4
	5.2	Basic CMOS comparator Design, Adaptive biasing, Analog multipliers.	
6.0		**Data Converter Fundamentals and Architectures**	
	6.1	**Fundamentals:** Analog versus discrete time signals, converting analog signals to data signals, sample and hold characteristics. DAC specifications, ADC specifications.	8
	6.2	**DAC architectures:** Digital input code, resistors string, R-2R ladder networks, current steering, charge scaling DACs, Cyclic DAC, pipeline DAC **ADC architectures:** Flash, Two Step Flash, Pipeline ADC, Integrating ADCs, Successive approximation ADCs	
		Total	**48**

Recommended Books:

1. B Razavi, "*Design of Analog CMOS Integrated Circuits*", Tata McGraw Hill, 1st Edition.
2. R. Jacaob Baker, Harry W. Li, David E. Boyce, "*CMOS Circuit Design, Layout, and Simulation*", Wiley, Student Edition
3. P. E. Allen and D. R. Holberg, "*CMOS Analog Circuit Design*", Oxford University Press, 3rd Edition.
4. Gray, Meyer, Lewis, Hurst, "*Analysis and design of Analog Integrated Circuits*", Willey, 5th Edition

Internal Assessment (IA)

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX DLO8041	Advanced Power Electronics	04	02	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELX DLO8041	Advanced Power Electronics	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

4. Power Electronics.
5. Linear Control System.
6. BEE

Course Objectives:

3. To enhance the ideas of students for more complex power electronic system.
4. To teach the analytical methods in power electronic systems.
5. To expose the students to various applications of power electronics in electronics equipment, drives and non-conventional energy systems.

Course Outcomes:

After successful completion of the course students will be able to:

1. Thoroughly understand the modern methods of analysis and control of power electronic systems.
2. Carry out the theoretical analysis of the power electronic systems from the 'Systems Theory' point of view.
3. Appreciate the ubiquity of power electronic systems in engineering fields.
4. Simulate and analyse power electronic systems.

Module No.	Unit No.	Contents	Hrs.
1		**Three-phase Rectifiers**	**8**
	1.1	3-phase half-wave and full-wave controlled rectifiers with R and RL load, Effect of source inductance,	
	1.2	Distortion in line current, calculation of performance parameters.	
2		**Three-phase inverters and control**	**8**
	2.1	Three phase bridge inverters (120° and 180° conduction mode) with R and RL load	
	2.2	PWM for 3-phase voltage source inverters, Space Vector Modulation (SVM) technique for 3-phase voltage source inverters, hysteresis control.	
3		**DC-DC Converters**	**10**
	3.1	Average model, linearized and transfer function models, state-space average models of basic buck, boost and buck-boost converters.	
	3.2	Feedback control of these converters (PI and PID).	
4		**Power Electronic Applications in DC Drives**	**8**
	4.1	Introduction to DC motors, speed control of DC motor, drives with semi converters, full converters and dual converters.	
	4.2	Chopper-based drive.	
	4.3	Electric braking of DC motors.	
5		**Power Electronic Applications in AC Drives**	**10**
	5.1	Introduction to three-phase induction motor, speed control methods for three-phase induction motor : i) Stator voltage ii) Variable frequency iii) Rotor resistance iv) V/f control v) Slip power recovery schemes	
6		**Power Electronic Applications**	**4**
	6.1	Induction heating, dielectric heating, solid state relays,	

	6.2	Energy conversion interface in renewable energy system.	
Total			**48**

Recommended Books:

1. M. Rashid, Power Electronics: Circuits, Devices, and Applications, PHI, 3rd Edition.
2. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, Springer, 2nd Edition.
3. Mohan, Undeland and Robbins, Power Electronics: Converters, Applications and Design, Wiley (Student Edition), 2nd Edition.
4. P. S. Bimbhra, Power Electronics, Khanna Publishers, 2012.
5. M. D. Singh, K. B. Khanchandani, Power Electronics, Tata McGraw Hill, 2nd Edition.
6. J. P. Agrawal, Power Electronics Systems: Theory and Design, Pearson Education, 2002.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX DLO8042	MEMS Technology	04	02	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELX DLO8042	MEMS Technology	20	20	20	80	03	--	--	--	100

Course Pre –requisite: VLSI Design an IC Technology

Course Objectives:

1. To provide knowledge of MEMS processing steps and processing modules
2. To provide knowledge of MEMS Materials with respect to applications.
3. To demonstrate the use of semiconductor based processing modules used in the fabrication of variety of sensors and actuators (e.g. pressure sensors, accelerometers, etc.) at the micro-scale.
4. To provide an understanding of basic design and operation of MEMS sensors, actuators and structures.

Course Outcomes:

1. Understand the underlying fundamental principles of MEMS devices including physical operation and material properties.
2. Design and simulate MEMS devices using standard simulation tools.
3. Develop different concepts of micro system sensors and actuators for real-world applications.
4. Understand the rudiments of Micro-fabrication techniques.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to MEMS**	4
	1.1	Introduction to MEMS, Comparison with Micro Electronics Technology,	
	1.2	Real world examples (Air-Bag, DMD, Pressure Sensors), MEMS Challenges, MEMS Sensors in Internet of Things (IoT), Bio-medical applications	
2		**MEMS Materials and Their Properties**	8
	2.1	Materials (eg. Si, SiO_2, SiN, SiC, Cr, Au, Al, Ti, SU8, PMMA, Pt)	
	2.2	Important properties: Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure.	
3		**MEMS Sensors, Actuators and Structures**	8
	3.1	MEMS Sensing (Capacitive, Piezo electric Piezo resistive)	
	3.2	Micro Actuation Techniques (Thermal, Piezo electric, Electro static, Shape Memory Alloys, **LORENTZ FORCE ACTUATION**), Micro Grippers, Micro Gears, Micro Motors, Micro Valves, Micro Pumps.	
4		**MEMS Fab Processes**	10
	4.1	MEMS Processes & Process parameters: Bulk & Surface Micromachining, High Aspect Ratio Micro	
	4.2	Machining (LIGA, Laser), X-Ray Lithography, Photolithography, PVD techniques, Wet, Dry, Plasma	
	4.3	etching, DRIE, Etch Stop Techniques. Die, Wire & Wafer Bonding, Dicing, Packaging(with Metal	
5		**MEMS Devices**	12
	5.1	Architecture, working and basic behaviour of Cantilevers, Micro heaters, Accelerometers, Pressure Sensor types, Micromirrors in DMD, Inkjet printer-head. Steps involved in Fabricating above devices	
6		**MEMS Device Characterization**	6

	6.1	Piezo-resistance, TCR, Stiffness, Adhesion, Vibration, Resonant frequency, & importance of these measurements in studying device behavior	
	6.2	MEMS Failure Mechanisms and Reliability.	
		Total	**48**

Recommended Books:

1.	MEMS and MICROSYSTEMS Design and Manufacture by Tai Ran Hsu : McGraw Hill Education
2.	An Introduction to Micro-electromechanical Systems Engineering; 2nd Ed - by N. Maluf, K Williams; Publisher: Artech House Inc
3.	Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill
4.	Practical MEMS - by Ville Kaajakari; Publisher: Small Gear Publishing
5.	Micro-system Design - by S. Senturia; Publisher: Springer
6.	Analysis and Design Principles of MEMS Devices - MinhangBao; Publisher: Elsevier Science
7.	Fundamentals of Micro-fabrication - by M. Madou; Publisher: CRC Press; 2 edition
8.	Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4.Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8043	Virtual Instrumentation	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXDLO8043	Virtual Instrumentation	20	20	20	80	-	-	100

Rationale :- Virtual instrumentation combines mainstream commercial technologies such as the PC, with flexible software and a wide variety of measurement hardware, so one can create user-defined systems that meet their exact application needs. Virtual instrumentation has led to a simpler way of looking at measurement systems. Instead of using several stand-alone instruments for multiple measurement types and performing rudimentary analysis by hand, engineers now can quickly and cost-effectively create a system equipped with analysis software and a single measurement device that has the capabilities of a multitude of instruments for various applications & measurements.

Course Objectives :-

1. To understand virtual instrumentation (VI) & to realize its architecture

2. To familiarize with VI software & learn programming in VI

3. To study various instruments interfacing & data acquisition methods

4. To understand various analysis tools & develop programs for different measurement applications

Course Outcomes :-

At the end of the course, students should gain the ability to :-

- **CO-1 :-** Explain the concepts of virtual instrumentation
- **CO-2 :-** Select the proper data acquisition hardware
- **CO-3 :-** Configure the data acquisition hardware using LabVIEW
- **CO-4 :-** Use LabVIEW to interface related hardware like transducers
- **CO-5 :-** Design virtual instruments for practical applications

Module No.	Topics	Hours
1	**INTRODUCTION TO VIRTUAL INSTRUMENTATION (VI)**	06
1.1	Historical perspective – Need for VI – Advantages of VI – Definition of VI – Block diagram & architecture of VI – Data flow techniques – Graphical programming in data flow – Comparison with conventional programming	
2	**PROGRAMMING TECHNIQUES**	08
2.1	VI & sub-VI – Loops & charts – Arrays – Clusters – Graphs – Case & sequence structures – Formula nodes – Local & global variables – String & files inputs	
3	**APPLICATION DEVELOPMENT SOFTWARE (LabVIEW)**	10
3.1	Creating virtual instrument in LabVIEW – Implementing dataflow programming in LabVIEW – VI, sub-VI & modular code creation in LabVIEW – Arrays & file I/O in LabVIEW – Textual math integration in LabVIEW – Interfacing external instruments to PC using LabVIEW	
4	**DATA ACQUISITION BASICS**	08
4.1	Digital I/O – Counters & timers – PC hardware structure – Timing – Interrupts – DMA – Software & hardware installation – IEEE GPIB 488 concepts – Embedded system buses – PCI – EISA – CPCI	
5	**COMMON INSTRUMENT INTERFACES**	08
5.1	Current loop – RS 232C / RS 485 – Interface basics – USB – PCMCIA – VXI – SCXI – PXI – Networking basics for office & industrial application VISA & IVI – Image acquisition & process – Motion control – Digital multimeter (DMM) – Waveform generator	
6	**USING ANALYSIS TOOLS & APPLICATION OF VI**	08
6.1	Fourier transform – Power spectrum – Correlation method – Windowing & filtering – Pressure control system – Flow control system – Level control system – Temperature control system – Motion control employing stepper motor – PID controller toolbox	
1 – 6	**TOTAL**	48

Recommended Books :-

1. Dr. Sumathi S. & Surekha P, LabVIEW Based Advanced Instrumentation System, PHI, 2nd edition (2007)
2. Gary Johnson, LabVIEW Graphical Programming, McGraw Hill, 2nd edition (2006)
3. Lisa K. Wells & Jeffrey Travis, LabVIEW for Everyone, PHI, 3rd edition (2009)

4. Robert H. Bishop, Learning with LabVIEW 7 Express, Pearson Education, 1st edition (2005)
5. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI, 2nd edition (2010)

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each carrying 20 marks.

2. The students need to solve total 4 questions.

3. Q.1 will be compulsory and based on entire syllabus.

4. Remaining questions (Q.2 to Q.6) will be set from all modules.

5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	**Practical**	**Tutorial**	**Theory**	**TW/Practical**	**Tutorial**	**Total**
ELXDLO 8044	Digital Image Processing	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXDLO 8044	Digital Image Processing	20	20	20	80	-	-	100

Course Pre-requisite:

- Applied Mathematics
- Signals and Systems

Course Objectives:

1. To learn the fundamental concepts of Digital Image Processing through basic spatial and frequency domain techniques.
2. To learn Image Compression and Decompression Techniques and compression standards.

Course Outcomes:

After successful completion of the course student will be able to

1. Understand the fundamentals of Digital Image representation and simple pixel relations.
2. Explain spatial domain and frequency domain techniques for digital image enhancement.
3. Perform segmentation and morphological operations.
4. Apply compression and decompression techniques to different digital images.

Module No.	Unit No.	Topics	Hrs.
1		**Digital Image Processing Fundamentals**	04
	1.1	**Introduction:** Background, Representation of a Digital Image, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System	
	1.2	**Digital Image Fundamentals:** Elements of Visual Perception, A Simple Image Model, Two dimensional Sampling and Quantization, Tonal and Spatial Resolutions, Some Basic Relationships between Pixels, Image File Formats : BMP, TIFF and JPEG. Color Models (RGB, HSI, YUV)	
2		**Image Enhancement in Spatial Domain**	08
	2.1	Enhancement in the spatial domain: Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging, Spatial domain filters: Smoothing Filters, Sharpening Filters,High boost filter	
3		**Image Segmentation and Representation**	08
	3.1	Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based Segmentation, Split and Merge Technique	
	3.2	Image Representation and Description, Chain Code, Polygonal Representation, Shape Number, Two Dimensional Moments.	
4		**Binary Image Processing**	06
	4.1	Binary Morphological Operators, Dilation and Erosion, Opening and Closing, Hit-or-Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening, Medial Axis Transform, Connected Component Labeling	
5		**Image Transforms and frequency domain processing**	12
	5.1	Introduction to 2 Dimensional Fourier Transform, Discrete Fourier Transform, Properties of the Two-Dimensional Fourier Transform, Fast Fourier Transform(FFT), Computation of 2 DFFT	
	5.2	Discrete Hadamard Transform(DHT), Fast Hadamard Transform(FHT), Discrete	

		Cosine Transform(DCT), Introduction to Discrete Wavelet Transform (DWT)	
	5.3	Enhancement in the frequency domain: Frequency Domain Filtering Lowpass Filtering, Highpass Filtering, Homomorphic Filtering, Generation of Spatial Masks from Frequency Domain Specifications	
6		**Image Compression:**	10
	6.1	Fundamentals :Coding Redundancy, Interpixel Redundancy, Psycho visual	
		Redundancy	
	6.2	Image Compression Models :The Source Encoder and Decoder, Lossless	
		Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman	
		Coding, Differential PCM,	
	6.3	Lossy Compression Techniques: Predictive Coding, Delta modulation, Improved Gray Scale Quantization, Transform Coding, JPEG, MPEG-1. , Fidelity Criteria.	
Total			**48**

Text Books:

1. Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, Third Edition, 2009,
2. Anil K. Jain, "Fundamentals and Digital Image Processing", Prentice Hall of India Private Ltd, Third Edition

Reference Books:

1. S. Jayaraman, E.Esakkirajan and T.Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd, 2009,
2. Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, and Machine Vision", Second Edition, Thomson Learning, 2001
3. William K. Pratt, "Digital Image Processing", Third Edition, John Wiley & Sons, Inc., 2001

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Q.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

e Code	Course Name	Credits
ILO8021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM,	8

	GANTT chart. Introduction to Project Management Information System (PMIS).	
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
ILO8022	**Finance Management**	**03**

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis;	09

	Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	Enterprepreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc.,	08

	Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-	7

	making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals	10

	Labor Laws & Industrial Relations Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	**Professional Ethics and Corporat Social Responsibility (CSR)**	**03**

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship	08

	Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	Research Methodology	03

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	09
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	07

03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2^{nd}ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method	07

	of getting a patent	
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignments on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books

9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO8028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06

3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	Environmental Management	03

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL 801	Internet of Things Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL 801	Internet of Things Laboratory	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation on case study.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested Experiments:
(Programming using C, Embedded C, Pyhton is to be encouraged)

1. Minimum two Experiments using any hardware platform (Arduino/Raspberry Pi/BeagleBone/Galileo) for data handling and storage.
2. Minimum three experiments using any hardware platform (Arduino/Raspberry Pi/BeagleBone/Galileo) for interfacing various sensors and communicating data using Internet using various Protocols.
3. Minimum two experiments using any hardware platform (Arduino/Raspberry Pi/BeagleBone/Galileo) and wireless communication protocol (802.11 and 802.14.5 IEEE standard)
4. Minimum one experiment using Cloud Storage.

Suggested topics for Case Study:
Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering design issues, hardware and software details and applications.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL 802	Analog and Mixed VLSI Design	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL 802	Analog and Mixed VLSI Design	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation on case study.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested Experiments:

Use of Online Tools to study analog VLSI circuits

2. Analysis of MOSFETs for analog performance
3. Design and simulate various types of current mirror circuits
4. Design and simulate various common source amplifier circuits
5. Design and simulate various types of single stage amplifiers
6. Design and simulate differential amplifier
7. Design and simulate operational tran-sconductance amplifier
8. Design and simulate switch capacitor circuits
9. Design and simulate various types of oscillators
10. Design and simulate mixed mode circuit
11. Generate layout for the simple and cascode current mirror
12. Generate layout for common source amplifier
13. Generate layout for the differential amplifier

14. Generate layout for the Oscillator

15. Generate layout for Phase Detector

Suggested topics for Case Study:
Faculty members can suggest topics pertaining above syllabus and ask students to submit proper report covering the latest advances in the field of Mixed VLSI Design.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8041	Advanced Power Electronics Lab.	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO 8041	Advanced Power Electronics Lab.	-	-	-	-	25	--	25	50

Course Objectives:
Lab session includes **seven experiments plus one presentation on case study.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested Experiments:
1. Single Phase Full Controlled Bridge Rectifier.
2. Speed control of Separately excited DC motor using Armature Voltage Control
3. Speed control of 3-phase Induction Motor using V/F control.
4. Simulation of 3-phase fully controlled Bridge rectifier with R and RL load.
5. Simulation of 1-phase fully controlled Bridge rectifier and study of various parameters.
6. Simulation of 1-phase Inverter and study of various Performance parameters.
7. Simulation of SVM Inverter.
8. Simulation of Closed loop dc-dc converter
9. Study High Frequency Induction heating & Dielectric heating.
10. Study of operation and control of solid state relays.

Suggested topics for Case Study:
Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering design issues, hardware and software details and applications.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8042	MEMS Technology Lab.	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO 8042	MEMS Technology Lab.	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation on case study.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested Experiments:

1. Design electro-statically actuated cantilever
2. Design bimorph cantilever which act as pressure sensor.
3. Dynamic analysis of Beam
4. Find the tip deflection of the cantilever with different types of load
5. Find the tip deflection of the cantilever in sweep analysis
6. Model and simulate Electro-mechanical actuator. Do dc and transient analysis
7. Design the geometry of MEMS and find performance characteristics such as resonant frequency, deflection per voltage or temperature
8. Simulate the harvested electrical power from mechanical vibrations using piezoelectric cantilever beam
9. Model and simulate of accelerometer
10. Case study of MEMS based device

Suggested topics for Case Study:

Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering fabrication issues, materials, characterization and applications of the MEMS devices.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO8043	Virtual Instrumentation Laboratory	--	02	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Exam			
		Test I	Test II	Average				
ELXDLO8043	Virtual Instrumentation Laboratory	--	--	--	--	25	25	50

Term Work :-

At least 6 experiments covering entire syllabus of ELXDLO8043 (Virtual Instrumentation) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. One presentation on a case study based on the topic in Virtual Instrumentation need to be submitted. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

Suggested List of Experiments :-

1. Verification of arithmetic operations
2. Verification of Boolean Expressions / half-adder & full-adder
3. Implementation of array functions
4. Program to convert Celsius into Fahrenheit & vice-versa
5. Program for implementing seven segment display
6. Program for calculating body mass index (BMI) using cluster

7. Program to control temperature using thermistor / RTD & DAQ
8. Program to control liquid flow using DAQ
9. Program to control liquid level using DAQ
10. Program to control pressure using DAQ
11. Program for DC motor speed control using PID toolbox

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO8044	Digital Image Processing	--	02	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Exam			
		Test I	Test II	Average				
ELXDLO8044	Digital Image Processing	--	--	--	--	25	25	50

Term Work :-

At least 7 experiments covering entire syllabus of ELXDLO8044 (Digital Image Processing) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. One presentation on a case study based on the topic in Digital Image Processing need to be submitted. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL704 ELXL803	Project I Project II	-	06 12	--	-	03 06	--	09

Objectives:

1. To acquaint with the process of undertaking literature survey/industrial visit and identifying the problem
2. To familiarize the process of problem solving in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research Outcomes

Outcome:

Learner will be able to:

1. Do literature survey/industrial visit and identify the problem
2. Apply basic engineering fundamental in the domain of practical applications
3. Cultivate the habit of working in a team
4. Attempt a problem solution in a right approach
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare report as per the standard guidelines.

Students should do literature survey/visit industry/analyse current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by experimental/simulation methods. The solution is to be validated with proper justification and the report needs to be compiled in standard format.

Guidelines for Assessment of Project I

Project I should be assessed based on following points

a) Quality of problem selected
b) Clarity of Problem definition and Feasibility of problem solution
c) Relevance to the specialization
d) Clarity of objective and scope
e) Breadth and depth of literature survey

Project I should be assessed through a presentation by the student project group to a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Project II

Project II should be assessed based on following points

a) Quality of problem selected
b) Clarity of Problem definition and Feasibility of problem solution
c) Relevance to the specialization / Industrial trends
d) Clarity of objective and scope
e) Quality of work attempted
f) Validation of results
g) Quality of Written and Oral Presentation

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines. Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the University of Mumbai Students should be motivated to publish a paper in Conferences/students competitions based on the work

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Item No. 4.178

UNIVERSITYOFMUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Electronics Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
With effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

Quality of education is one of the major factors to contribute to the growth of a nation and subsequently quality of education is largely decided by the syllabi of the Educational Programme and its proper implementation. In order to make B.E (Electronics) Engineering programme of University of Mumbai rich in quality, revision of the syllabi is being undertaken as per the guidelines of University of Mumbai. While deciding the core courses and department level optional courses, inputs from various stake holders were taken into account. The exposure to the latest technology and tools used all over the world is given by properly selecting courses and their hierarchy in the programme curriculum. Thus this syllabus is made to groom the postgraduate students to be made competent in all respect with best possible efforts put in by the experts in framing detailed contents of individual courses.

I, as Chairman, Board of Studies in Electronics Engineering University of Mumbai, am happy to state here that, heads of the department and senior faculty from various institutes took timely and valuable initiative to frame the Program Educational Objectives as listed below as per National Board of Accreditation (NBA) guidelines.

1. To provide students with a strong foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze engineering problems and to prepare them for graduate studies.
2. To prepare students to demonstrate an ability to identify, formulate and solve electronics engineering problems.
3. To prepare students to demonstrate ability to design electrical and electronics systems and conduct experiments, analyze and interpret data.
4. To prepare students to demonstrate for successful career in industry to meet needs of Indian and multi-national companies.
5. To develop the ability among students to synthesize data and technical concepts from applications to product design.
6. To provide opportunity for students to work as part of teams on multidisciplinary projects.
7. To promote awareness among students for the life-long learning and to introduce them to professional ethics and codes of professional practice.

These are the suggested and expected main objectives and individual affiliated institute may add further in the list. In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that small step taken in right direction will definitely help in providing quality education to the stake holders.

At the end I must outset extend my gratitude to all experts who contributed to make curriculum competent at par with latest technological development in the field of electronics engineering.

Dr.Sudhakar S. Mande

Chairman, Board of Studies in Electronics Engineering, University of Mumbai

S.E. (Electronics Engineering) – Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX301	Applied Mathematics III	04	---	01@	04	---	01	05
ELX302	Electronic Devices and Circuits I	04	---	---	04	---	---	04
ELX303	Digital Circuit Design	04	---	---	04	---	---	04
ELX304	Electrical Network Analysis and Synthesis	04	---	---	04	---	---	04
ELX305	Electronics Instruments and Measurement	04	---	---	04	---	---	04
ELXL301	Electronic Devices and Circuits I Laboratory		02	---	---	01	---	01
ELXL302	Digital Circuit Design Laboratory		02	---	---	01	---	01
ELXL303	Electrical Network and Measurement Laboratory		02	---	---	01	---	01
ELXL304	Object Oriented Programming Methodology Laboratory		02+02#	---	---	02	---	02
	Total	**20**	**10**	**01**	**20**	**05**	**01**	**26**

@1 hour tutorial classwise

#02 hours classwise and 02 hours batchwise

Course Code	Course Name	Examination Scheme – Semester III							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX301	Applied Mathematics III	20	20	20	80	03	25	---	125
ELX302	Electronic Devices and Circuits I	20	20	20	80	03	---	---	100
ELX303	Digital Circuit Design	20	20	20	80	03	---	---	100
ELX304	Electrical Network Analysis and Synthesis	20	20	20	80	03	---	---	100
ELX305	Electronic Instruments and Measurements	20	20	20	80	03	---	---	100
ELXL301	Electronic Devices and Circuits I Laboratory						25	25	50
ELXL302	Digital Circuit Design Laboratory						25	25	50
ELXL303	Electrical Network and Measurement Laboratory						25	---	25
ELXL304	Object Oriented Programming Methodology Laboratory						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**125**	**75**	**700**

S.E. (Electronics Engineering) – Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX401	Applied Mathematics IV	04	---	01@	04	---	01	04
ELX402	Electronic Devices and Circuits II	04	---	---	04	---	---	04
ELX 403	Microprocessors and Applications	04	---	---	04	---	---	04
ELX 404	Digital System Design	04	---	---	04	---	---	04
ELX 405	Principles of Communication Engineering	04	---	---	04	---	---	04
ELX 406	Linear Control Systems	04	---	---	04	---	---	04
ELXL 401	Electronic Devices and Circuits II Laboratory		02	---	---	01	---	01
ELXL 402	Microprocessors and Applications Laboratory		02	---	---	01	---	01
ELXL 403	Digital System Design Laboratory		02	---	---	01	---	01
ELXL 404	Principles of Communication Engineering Laboratory		02	---	---	01	---	01
	Total	**24**	**08**	**---**	**24**	**04**	**01**	**29**

@1 hour tutorial classwise

Course Code	Course Name	Examination Scheme – Semester IV							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX401	Applied Mathematics IV	20	20	20	80	3	25	---	125
ELX 402	Electronic Devices and Circuits II	20	20	20	80	3	---	---	100
ELX 403	Microprocessors and Applications	20	20	20	80	3	---	---	100
ELX 404	Digital System Design	20	20	20	80	3	---	---	100
ELX 405	Principles of Communication Engineering	20	20	20	80	3	---	---	100
ELX 406	Linear Control Systems	20	20	20	80	3	---	---	100
ELXL401	Electronic Devices and Circuits II Laboratory						25	25	50
ELXL402	Microprocessors and Applications Laboratory						25	25	50
ELXL 403	Digital System Design Laboratory						25	25	50
ELXL404	Principles of Communication Engineering Laboratory						25	--	50
Total		**120**	**120**	**120**	**480**	**18**	**125**	**75**	**800**

T.E. (Electronics Engineering) – Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX501	Micro-controllers and Applications	04	--	--	04	--	--	04
ELX 502	Digital Communication	04	--	--	04	--		04
ELX 503	Engineering Electromagnetics	04	--	@01	04	--	01	05
ELX 504	Design with Linear Integrated Circuits	04	--	--	04	--	--	04
ELXDLO501X	Department Level optional courses I	04		--	04		--	04
ELXL501	Micro-controllers and Applications Laboratory		02			01	--	01
ELXL502	Digital Communication Laboratory		02			01	--	01
ELXL503	Design with Linear Integrated Circuits Laboratory		02			01	--	01
ELX 505	Business Communication & Ethics		02+02#		---	02	--	02
ELX DLOl50X	Department Level optional course-I Laboratory		02			01	--	01
	TOTAL	**20**	**12**	**01**	**20**	**06**	**01**	**27**

@1 hour to be taken as classwise

\# 2 hours classwise and 2 hours batchwise

Course Code	Course Name	Examination Scheme – Semester V							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX501	Micro-controllers and Applications	20	20	20	80	03	---	---	100
ELX502	Digital Communication	20	20	20	80	03	---	---	100
ELX503	Engineering Electromagnetics	20	20	20	80	03	25	---	125
ELX504	Design with Linear Integrated Circuits	20	20	20	80	03	---	---	100
ELXDLO501X	Department Level Elective-I	20	20	20	80	03	---	---	100
ELXL501	Micro-controllers and Applications Laboratory						25	25	50
ELXL502	Digital Communication Lab.						25	---	25
ELXL503	Design with Linear Integrated Circuits Laboratory						25	25	50
ELXL504	Business Communication & Ethics	---	---	---	---	---	50	---	50
ELXLDLO501X	Department Elective I laboratory						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**175**	**75**	**750**

Course Code	Department Level Optional Course I
ELXDLO5011	Data Base and Management System
ELXDLO5012	Digital Control system
ELXDLO5013	ASIC Verification
ELXDLO5014	Biomedical Instrumentation

T.E. (Electronics Engineering) – Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX601	Embedded System and RTOS	04		---	04	---	---	04
ELX602	Computer Communication Network	04		---	04	---	---	04
ELX 603	VLSI Design	04		---	04	---	---	04
ELX 604	Signals and systems	04		@01	04	---	01	05
ELXDLO502X	Department Level Optional courses II	04	--	---	04	---	---	04
ELXL601	Embedded System and RTOS Laboratory		02			01	---	01
ELXL602	Computer Communication Network Laboratory		02			01		01
ELXL603	VLSI Design Laboratory		02			01	---	01
ELXLDLO502X	Department Level Optional courses II Laboratory		02			01	---	01
	TOTAL	**20**	**10**	**01**	**20**	**04**	**01**	**25**

@ 1 hour classwise

Course Code	Course Name	Examination Scheme – Semester VI							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX601	Embedded System and RTOS	20	20	20	80	03	---	---	100
ELX602	Computer Communication Network	20	20	20	80	03	---	---	100
ELX603	VLSI Design	20	20	20	80	03	---	---	100
ELX604	Signals and systems	20	20	20	80	03	25	25	150
ELXDLO602X	Department Level Optional courses II*	20	20	20	80	03	---	---	100
ELXL601	Embedded System and RTOS Laboratory						25	25	50
ELXL602	Computer Communication Network Laboratory						25	25	50
ELXL603	VLSI Design Laboratory						25	25	50
ELXLDLO602X	Department Level Optional Courses II Laboratory						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**125**	**100**	**750**

Course Code	Department Level Optional Course II
ELXDLO6021	Microwave Engineering
ELXDLO6022	Electronics Product Design
ELXDLO6023	Wireless Communication
ELXDLO6024	Computer Organization and Architecture

B.E. (Electronics Engineering) – Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX701	Instrumentation System Design	04		---	04	---	---	04
ELX702	Power Electronics	04		---	04	---	---	04
ELX703	Digital signal processing	04		---	04	---	---	04
ELXDLO703X	Department Level Optional course III	04		---	04	---	---	04
ILO701X	Institute Level Optional Course I#	03		---	03	---	---	03
ELXL701	Instrumentation System Design Laboratory		02			01	---	01
ELXL702	Power Electronics Laboratory		02			01	---	01
ELXL703	Digital signal processing Laboratory		02			01	---	01
ELXL704	Project-I	---	06	---	---	03	---	03
ELXLDLO703X	Department Level Optional course III Laboratory		02			01	---	01
	TOTAL	**19**	**14**	**---**	**19**	**07**	**---**	**26**

Course Code	Course Name	Examination Scheme – Semester VII							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX701	Instrumentation System Design	20	20	20	80	03	---	---	100
ELX 702	Power Electronics	20	20	20	80	03	---	---	100
ELX 703	Digital signal processing	20	20	20	80	03	---	---	100
ELXDLO703X	Department Level Optional courses III*	20	20	20	80	03	---	---	100
ILO701X	Institute Level Optional Course #I	20	20	20	80	03	---	---	100
ELXL701	Instrumentation System Design Laboratory						25	25	50
ELXL702	Power Electronics Laboratory						25	25	50
ELXL703	Digital signal processing Laboratory						25	25	50
ELXL704	Project-I	---	---	---	---	---	50	50	100
ELXLDLO703X	Department Level Optional courses III Laboratory						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**150**	**150**	**800**

#Common to all branches

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I#
ELXDLO7031	Neural Network and Fuzzy Logic	ILO7011	Product Lifecycle Management
ELXDLO7032	Advance Networking Technologies	ILO7012	Reliability Engineering
ELXDLO7033	Robotics	ILO7013	Management Information System
ELXDLO7034	Integrated Circuit Technology	ILO7014	Design of Experiments
		ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management
		ILO7019	Development Engineering

B.E. (Electronics Engineering) – Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX801	Internet of Things	04		---	04	---	---	04
ELX 802	Analog and Mixed VLSI Design	04		---	04	---	---	04
ELXDLO804X	Department Level Optional course IV	04		---	04	---	---	04
ILO802X	Institute Level Optional course II#	03		---	03	---	---	03
ELX801	Internet of Things Laboratory		02			01	---	01
ELXL802	Analog and Mixed VLSI Design Laboratory		02			01	---	01
ELXL803	Project-II		12	---	---	06	---	06
ELXLDLO804X	Department Level Optional Courses IV Laboratory		02			01	---	01
	TOTAL	**15**	**18**	**---**	**15**	**09**	---	**24**

Course Code	Course Name	Examination Scheme – Semester VII							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX801	Internet of Things	20	20	20	80	03	---	---	100
ELX 802	Analog and Mixed VLSI Design	20	20	20	80	03	---	---	100
ELXDLO804X	Department Level Optional course IV	20	20	20	80	03	---	---	100
ILO802X	Institute Level Optional course II#	20	20	20	80	03	---	---	100
ELXL801	Internet of Things Laboratory						25	25	50
ELXL802	Analog and Mixed VLSI Design Laboratory						25	25	50
ELX803	Project-II	---	---	---	---	---	100	50	150
ELXLDLO804X	Department Level Optional Courses IV Laboratory						25	25	50
Total		**80**	**80**	**80**	**320**	**15**	**150**	**150**	**700**

#Common to all branches

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II#
ELXDLO8041	Advanced Power Electronics	ILO8021	Project Management
ELXDLO8042	MEMS Technology	ILO8022	Finance Management
ELXDLO8043	Virtual Instrumentation	ILO8023	Entrepreneurship Development and Management
ELXDLO8044	Digital Image Processing	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

S.E. (Electronics Engineering) – Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX301	Applied Mathematics III	04	---	01@	04	---	01	05
ELX302	Electronic Devices and Circuits I	04	---	---	04	---	---	04
ELX303	Digital Circuit Design	04	---	---	04	---	---	04
ELX304	Electrical Network Analysis and Synthesis	04	---	---	04	---	---	04
ELX305	Electronic Instruments and Measurements	04	---	---	04	---	---	04
ELXL301	Electronic Devices and Circuits I Laboratory		02	---	---	01	---	01
ELXL302	Digital Circuit Design Laboratory		02	---	---	01	---	01
ELXL303	Electrical Network and Measurement Laboratory		02	---	---	01	---	01
ELXL304	Object Oriented Programming Methodology Laboratory		02+02#	---	---	01	---	02
	Total	**20**	**08**	**02**	**20**	**04**	**01**	**26**

@1 hour tutorial classwise

#02 hours classwise and 02hours batchwise

Course Code	Course Name	Examination Scheme – Semester III							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX301	Applied Mathematics III	20	20	20	80	03	25	---	125
ELX302	Electronic Devices and Circuits I	20	20	20	80	03	--	---	100
ELX303	Digital Circuit Design	20	20	20	80	03	---	---	100
ELX304	Electrical Network Analysis and Synthesis	20	20	20	80	03	---	---	100
ELX305	Electronic Instruments and Measurements	20	20	20	80	03	---	---	100
ELXL301	Electronic Devices and Circuits I Laboratory						25	25	50
ELXL302	Digital Circuit Design Laboratory						25	25	50
ELXL303	Electrical Network and Measurement Laboratory						25	--	50
ELXL304	Object Oriented Programming Methodology Laboratory						25	25	25
Total		**100**	**100**	**100**	**400**	**15**	**125**	**75**	**700**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX301	Applied Mathematics III	04	--	01	04	--	01	05

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX301	Applied Mathematics III	20	20	20	80	25	--	125

Prerequisite:

FEC 101: Applied Mathematics I
FEC 201: Applied Mathematics II

Course objectives:

1. To build the strong foundation in Mathematics of students needed for the field of Electronics and Telecommunication Engineering
2. To provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.
3. To prepare student to apply reasoning informed by the contextual knowledge to engineering practice.
4. To prepare students to work as part of teams on multi-disciplinary projects.

Course outcomes:

1. Students will be able demonstrate basic knowledge of Laplace Transform. Fourier series, Bessel Functions, Vector Algebra and Complex Variable.
2. Students will be able to identify and model the problems in the field of Electronics and Telecommunication Engineering with feasible and practical solution.
3. Students will be able to apply the application of Mathematics in Electronics and Telecommunication Engineering.

Module No	Unit No.	Topic	No of Contact Hour
1	**Laplace Transform**		7
	1.1	**Laplace Transform (LT) of Standard Functions:** Definition of Laplace transform, Condition of Existence of Laplace transform, Laplace transform of $e^{at}, Sin(at), \cos(at), \sinh(at), \cosh(at), t^n$ Heaviside unit step function, Dirac-delta function, Laplace transform of Periodic function	
	1.2	**Properties of Laplace Transform:** Linearity, first shifting theorem, second shifting theorem, multiplication by t^n,Division by *t*, Laplace Transform of derivatives and integrals, change of scale, convolution theorem, Evaluation of integrals using Laplace transform.	
2	**Inverse Laplace Transform & its Applications**		6
	2.1	Partial fraction method, Method of convolution, Laplace inverse by derivative	
	2.2	**Applications of Laplace Transform:** Solution of ordinary differential equations, Solving RLC circuit differential equation of first order and second order with boundary condition using Laplace transform (framing of differential equation is not included)	
3	**Fourier Series**		11
	3.1	**Introduction:** Orthogonal and orthonormal set of functions, Introduction of Dirichlet's conditions, Euler's formulae	
	3.2	**Fourier Series of Functions:** Exponential, trigonometric functions of any period =2L, even and odd functions, half range sine and cosine series	
	3.3	Complex form of Fourier series, Fourier integral representation, Fourier Transform and Inverse Fourier transform of constant and exponential function.	
4	**Vector Algebra & Vector Differentiation**		7
	4.1	**Review of Scalar and Vector Product**: Scalar and vector product of three and four vectors, Vector differentiation, Gradient of scalar point function, Divergence and Curl of vector point function	
	4.2	**Properties:** Solenoidal and irrotational vector fields, conservative vector field	
5	**Vector Integral**		6
	5.1	Line integral	
	5.2	Green's theorem in a plane, Gauss' divergence theorem and Stokes' theorem	
6	**Complex Variable & Bessel Functions**		11
	6.1	**Analytic Function:** Necessary and sufficient conditions (No Proof), Cauchy Reiman equation Cartesian form (No Proof) Cauchy Reiman Equation in polar form (with Proof), Milne Thomson Method and it application, Harmonic function, orthogonal trajectories	
	6.2	**Mapping:** Conformal mapping, Bilinear transformations, cross ratio, fixed points	

	6.3	**Bessel Functions:** Bessel's differential equation, Properties of Bessel function of order +1/2 and -1/2, Generating function, expression of cos(xsin θ), sin (x sin θ) in term of Besselfunctions	
		Total	**48**

Text books:

1. H.K. Das, "*Advanced engineering mathematics*", S . Chand, 2008
2. A. Datta, *"Mathematical Methods in Science and Engineering",* 2012
3. B.S. Grewal, *"Higher Engineering Mathematics",* Khanna Publication

Reference Books:

1. B. V. Ramana, *"Higher Engineering Mathematics",* Tata Mc-Graw Hill Publication
2. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, *"Advanced Engineering Mathematics",* John Wiley & Sons, Inc
4. Murry R. Spieget, *"Vector Analysis",* Schaum's outline series, Mc-Graw Hill Publication

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Term Work/ Tutorial:
At least 08 assignments covering entire syllabus must be given during the "**class wise tutorial'**. The assignments should be students centric and an attempt should be made to make assignments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per "**credit and grading system"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX302	Electronic Device and Circuits I	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX302	Electronic Device and Circuits I	20	20	20	80	-	-	100

Course Objectives:

1. To deliver the knowledge about physics of basic semiconductor devices and circuits.
2. To enhance comprehension capabilities of students through understanding of electronic devices and circuits
3. To introduce and motivate students to the use of advanced microelectronic devices
4. To analyze and design electronic circuits using semiconductor devices.

Course Outcomes:

1. Students will be able to explain working of semiconductor devices.
2. Students will be able to analyze characteristics of semiconductor devices.
3. Students will be able to perform DC and AC analysis of Electronics circuits.
4. Students will be able to compare various biasing circuits as well as various configurations of BJT,JFET and MOSFETs.
5. Students will be able to select best circuit for the given specifications/application.
6. Students will be able to design electronics circuits for given specifications.

Module No.	Unit No.	Topics	Hours
1		**PN junction Diode Analysis and applications.**	08
	1.1	PN junction Diode: Basic Structure, Energy Band Diagrams, Zero Applied Bias, Forward bias, Reverse bias, PN junction current, drift and diffusion current, junction capacitance, , DC load line, small signal model , Applied Bias, Reverse Applied Bias, temperature effects.	
	1.2	Clippers and Clampers	
2		**Bipolar Junction Transistor**	12
	2.1	BJT operations, voltages and currents, BJT characteristics (CE, CB, CC configurations) , early effect	
	2.2	DC Circuit Analysis: DC load line and region of Operation, Common Bipolar Transistor Configurations, biasing circuits, bias stability and compensation, analysis and design of biasing circuits.	
	2.3	AC Analysis of BJT Amplifiers : AC load line, small signal models (h-parameter model, re model, Hybrid-pi model), graphical analysis, ac equivalent circuits and analysis to obtain voltage gain, current gain, input impedance, output impedance of CE,CB and CC amplifiers	
3		**Field Effect Devices**	10
	3.1	JFET: Construction, operation and characteristics. MOSFET: Construction, operation and characteristics of D-MOSFET and E-MOSFET.	
	3.2	DC Circuit Analysis : DC load line and region of operation, Common-MOSFETs configurations, Analysis and Design of Biasing Circuits	
	3.3	AC Analysis: AC load line, Small-Signal model of MOSFET and its equivalent Circuit, Small-Signal Analysis MOSFET Amplifiers (Common-Source, Source Follower, Common Gate)	
4		**Special semiconductor devices – I**	06
	4.1	Construction, working and characteristics of : Zener diode, Schottkey diode, Varactor diode, Tunnel diode, Solar Cells, Photodiodes, LEDs	
5		**Rectifiers and Regulators**	06
	5.1	Rectifiers: working and analysis of Half wave, Full wave and Bridge	
	5.2	Filters: C,L,LC, pi	
	5.3	Regulators: Zener shunt regulator, Series and shunt regulator using single transistor and Zener	
6		**Design of electronic circuits**	06
	6.1	Design of single stage CE amplifier	
	6.2	Design of single stage CS MOSFET amplifier	
	6.3	Design of full wave rectifier with LC and pi filter.	
		Total Hours	**48**

Text Books:
1. Millman and Halkies, “Integrated Electronics”, TATA McGraw Hill.
2. Donald A. Neamen, “Electronic Circuit Analysis and Design”, TATA McGraw Hill, 2nd Edition

Reference Books:
1. Boylestad," Electronic Devices and Circuit Theory", Pearson
2. David A. Bell, “Electronic Devices and Circuits”, Oxford, Fifth Edition.
3. Muhammad H. Rashid, “Microelectronics Circuits Analysis and Design”, Cengage
4. S. Salivahanan, N. Suresh Kumar,“Electronic Devices and Circuits”, Tata McGraw Hill,
5. Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar,”
6. Microelectronic Circuits Theory and Applications”, International Version, OXFORD International Students Edition, Fifth Edition.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX303	Digital Circuit Design	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX303	Digital Circuit Design	20	20	20	80	-	-	100

Course Objective:

1. To understand various number representations and conversion between different representation in digital electronic circuits.
2. To introduce the students to various logic gates, SOP,, POS and their minimization techniques.
3. To analyze logic processes and implementation of logical operations using combinational logic circuits.
4. To explain and describe various logic families and provide information on different IC's.
5. To understand, analyze and design sequential circuits.

Course Outcomes:

1. Students will be able to perform various logical and arithmetic operations various number systems as well as conversion of one representation to another.
2. Students will be able to apply Boolean algebra for the implementation and minimization of logic functions.
3. Students will be analyze, design and implement combinational logic circuits.
4. Students will be able to differentiate between logic families TTL and CMOS.
5. Students will be able to analyze, design and implement sequential logic circuits.

Module No.	Topics	Hrs.
1	**Number Systems and Codes:**	06
	Review of Number System, Binary Code, Binary Coded Decimal, Octal Code, Hexadecimal Code and their conversions, Binary Arithmetic: One's and two's complements,Excess-3 Code, Gray Code, Weighted code, Parity Code: Hamming Code	
2	**Logic Gates and Boolean Algebra:**	08
	Digital logic gates, Realization using NAND, NOR gates, Boolean Algebra, De Morgan's Theorem, SOP and POS representation, K Map up to four variables and Quine-McClusky method upto four variables	
3	**Combinational Logic Circuits and Hazards**	12
	Arithmetic Circuits: Adders/Subtractors:Half adder, Full adder, Half Subtractor, Full Subtractor, Ripple carry adder, Carry Look ahead adder and BCD adder, Magnitude Comparator	
	Multiplexer and De-multiplexer: Multiplexer, cascading of Multiplexer, Boolean Function implementation using single multiplexer and basic gates, De-multiplexer, encoder and decoder, Parity Circuits, ALU	
	Hazards: Timing hazards static and dynamic	
4	**Logic Families:**	06
	Basics of standard TTL (Two input NAND gate operation), CMOS (Inverter, Two input NAND gate, Two input NOR gate), Interfacing of TTL to CMOS and CMOS to TTL, ECL, Working and characteristics of logic families	
5	**Sequential Logic Principles:**	08
	Latches and Flip flops: Difference between latches and flip flops, RS, JK, Master slave flip flops, T & D flip flops with various triggering methods, Conversion of flip flops, Applications of latches and flip flops in switch debouncing, bus holder circuits, Flip flops timing considerations and Metastability	
6	**Counters and Registers:**	08
	Asynchronous and Synchronous, Up/Down, Johnson Counter, MOD N, BCD counter using Decade counter, Ring counters, Shift registers, Universal Shift Register	
Total		**48**

Text Books:

1. R. P. Jain, Modern Digital Electronics, Tata McGraw Hill Education, Third Edition 2003.
2. John F. Warkerly, Digital Design Principles and Practices, Pearson Education, Fourth Edition, 2008.

Reference Books:

1. A. Anand Kumar, Fundamentals of Digital Circuits, PHI, Fourth Edition, 2016.
2. Morris Mano / Michael D. Ciletti , Digital Design, Pearson Education, Fourth Edition, 2008.
3. Donald P. Leach / Albert Paul Malvino / Gautam Saha, Digital Principles and Applications, The McGraw Hill, Seventh Edition, 2011.
4. Thomas L. Floyd, Digital Fundamentals, Pearson Prentice Hall, Eleventh Global Edition, 2015.
5. Charles H. Roth, Fundamentals of Logic Design, Jaico Publishing House, First Edition, 2004.
6. Norman Balabanian/ Bradley Carlson, Digital Logic Design Principles, John Wiley & Sons, First Edition, 2011.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX304	Electrical Network Analysis and Synthesis	04	--	--	04	--	--	05

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX304	Electrical Network Analysis and Synthesis	20	20	20	80	-	-	100

Course Pre-requisites:

- FEC105**:** Basic Electrical Engineering
- Partial fraction expansion, matrices, calculus and Laplace Transforms.

Course Objectives:

1. To make the students understand DC and AC electrical networks and analyze the Networks in time and frequency domain.
2. To understand synthesis of electrical networks and study various filters.

Course Outcome:

1. Students will be able to apply their understanding of network theorems in analyzing complex circuits.
2. Students will be able to evaluate the time and frequency response of electrical circuits and thereby understand the behaviour of electrical networks.
3. Students will be able to evaluate the inter-relationship among various circuit parameters and solve complex networks using these parameters.
4. Students will be able to synthesize electrical networks for a given network function and design simple filters.

Module No.	Unit No.	Topics	Hours
1		**Analysis of DC Circuits**	06
	1.1	**DC Circuit Analysis:** Analysis of DC circuits with dependent sources using generalized loop, node matrix analysis.	
	1.2	**Application of Network Theorems to DC Circuits**: Superposition, Thevenin, Norton, Maximum Power Transfer and Millman theorems.	
2		**Analysis of AC Circuits**	08
	2.1	**Analysis of Steady State AC circuits:** Analysis of AC circuits with independent sources using generalized loop, node matrix analysis.	
	2.2	**Application of Network Theorems to AC Circuits**: Superposition, Thevenin, Norton, Maximum Power Transfer and Millman theorems.	
	2.3	**Analysis of Coupled Circuits:** Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit, solution using loop analysis.	
3		**Time and Frequency Domain Analysis of Electrical Networks**	12
	3.1	**Time domain analysis of R-L and R-C circuits:** Forced and natural responses, time constant, initial and final values.	
	3.2	**Solution using first order equation for standard input signals:** Transient and steady state time response, solution using universal formula.	
	3.3	**Frequency domain analysis of RLC circuits:** S-domain representation, Concept of complex frequency, applications of Laplace Transform in solving electrical networks, Driving point and Transfer Function, Poles and Zeros, calculation of residues by analytical and graphical method.	
4		**Two Port Networks**	08
	4.1	**Parameters:** Open Circuit, Short Circuit, Transmission and Hybrid parameters, relationships among parameters, reciprocity and symmetry conditions	
	4.2	**Series/parallel connection:** T and Pi representations, interconnection of Two-Port networks.	
5		**Synthesis of RLC Circuits**	08
	5.1	**Positive Real Functions:** Concept of positive real function, testing for Hurwitz polynomials, testing for necessary and sufficient conditions for positive real functions.	
	5.2	**Synthesis of RC, RL, LC circuits:** Concepts of synthesis of RC, RL, LC driving point functions.	
6		**Filters**	06
	6.1	**Basic filter circuits:** Low pass, high pass, band pass and band stop filters, transfer function, frequency response, cut-off frequency, bandwidth, quality factor, attenuation constant, phase shift, characteristic impedance.	
	6.2	**Design and analysis of filters:** Constant K filters	

Text Books:

1. *Circuits and Networks: Analysis and Synthesis,* A. Sudhakar and S.P. Shyammohan, Tata McGraw-Hill Publishing Company Ltd.
2. *Engineering Circuit Analysis,* William Hayt and Jack Kemmerly, McGraw-Hill.

Reference Books:

1. *Networks and Systems*, D.Roy Choudhury, New Age International Publications.
2. *Network Analysis and Synthesis*, Franklin F. Kuo, Wiley.
3. *Network Analysis*, M.E.VanValkenburg, 3/E, PHI.
4. *Shaum's Outline of Theory and Problems of Basic Circuit Analysis*, John O'Malley, McGraw-Hill.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- The students need to solve total 4 questions.
- Question No. 1 will be compulsory and based on the entire syllabus.
- Remaining questions (Question No. 2 to 6) will be set from all the modules.
- Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX305	Electronic Instruments and Measurements	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX305	Electronic Instruments and Measurements	20	20	20	80	-	-	100

Course Objectives

1 To impart in-depth knowledge of measurement methods & instruments of electrical quantities

2 To explain the design aspect & performance criterion for measuring instruments

3 To understand the working principle of transducers

Course Outcomes

1 Students will be able to describe the static & dynamic characteristics of an instrument, components of general instrumentation system & different types of errors in the measurement process

2 Students will be analyze various test & measuring instruments including AC and DC bridges to determine the unknown quantity under measurement

3 Students will be able to use cathode ray oscilloscope (CRO) to perform wide range of simple to complex measurement functions for voltage, current, frequency, phase & component testing

4 Students will be able to select choice of transducer for practical & real-life applications based on their principle of operation, working, construction & characteristics

Module No	Unit No	Topic	Hours
1		**Principles of Measurements**	06
	1.1	**Principles of Measurements & Instrumentation** :- Components of a generalized measurement system, applications of instrument systems & revision of SI electrical units (units of current, charge, EMF, potential difference, voltage, resistance, conductance, magnetic flux & flux density, inductance & capacitance)	
	1.2	**Performance Characteristics** :- Static characteristics (accuracy, precision, linearity, drift, sensitivity, calibration, repeatability, reproducibility, resolution, hysteresis & dead band zone) & dynamic characteristics (speed of response, fidelity, lag & dynamic error)	
	1.3	**Errors in Measurement :-** Errors in measurement, classification of errors, remedies to eliminate or to minimize errors, statistical analysis of errors	
2		**Measurement of R, L and C**	08
	2.1	**Measurement of Resistance :-** Measurement of low, medium & high resistances by using Wheatstone bridges, Kelvin's Double bridge & mega-ohm meter (megger)	
	2.2	**Measurement of Inductance & Capacitance :-** Inductance & capacitance comparison bridge, Maxwell's bridge, Hay's bridge, Schering's bridge, Wien's bridge & LCR Q Meter	
3		**Oscilloscopes**	10
	3.1	**Cathode Ray Oscilloscope** :- Block diagram based study of CRO, control & specifications, sweep mode, role of delay line, single & dual beam, dual-trace CRO, chop & alternate modes	
	3.2	**Measurement using Oscilloscope :-** Measurement of voltage, frequency, rise time, fall time & phase difference, Lissajous figures in detecting phase & frequency difference	
	3.3	**Digital Storage Oscilloscope :-** Features like roll, refresh, storage mode & sampling rate, applications of DSO	
4		**Analog and Digital Instruments**	08
	4.1	**Digital Instruments :-** DVM (ramp, dual-slope, integrating & successive approximation), Digital multimeter, Digital frequency meter, Digital phase meter, Digital time measurement	
	4.2	**Signal Generators :-** Low frequency signal generator, function generator, pulse generator, RF signal generator & sweep frequency generators	
	4.3	**Wave Analyzer :-** Basic wave analyzer, frequency selective & heterodyne	

		wave analyser, harmonic distortion analyzer & spectrum analyzer	
5		**Transducers for Displacement and Temperature Measurement**	**08**
	5.1	**Basics of Transducers / Sensors :-** Characteristics of transducers & sensors, requirements of transducers, classification of transducers, criteria for selection of transducers	
	5.2	**Temperature :-** Resistance temperature detector (RTD), thermistor, thermocouple, their range & applications, comparison of RTD, thermistor & thermocouple	
	5.3	**Displacement :-** Potentiometers, linear variable differential transformer (LVDT), resistance strain gauges, capacitance sensors	
6		**Transducers for Pressure, Level and Flow Measurements**	**08**
	6.1	**Pressure :-** Pressure gauges, elastic pressure transducers, dead weight tester, vacuum pressure measurement – McLeod gauge & Pirani gauge	
	6.2	**Level :-** Side glass tube method, float type methods, capacitance type methods, ultrasonic type transducers, optical level detectors	
	6.3	**Flow :-** Restriction type flow meter – orifice & venturi, rotameter, magnetic type flow meter, turbine flow meter, rotameters	
		Total	**48**

Text books:

1. David A. Bell, Electronic Instrumentation & Measurements, Oxford Publishing, 2nd edition
2. H. S. Kalsi, Electronic Instrumentation, McGraw Hill, 4th edition

Reference Books:

1. C. S. Rangan, G.R. Sarma, V.S.V. Mani, Instrumentation Devices and Systems, Tata McGraw Hill, 9th edition.
2. A. K. Sawhney, Electrical & Electronic Instruments & Measurement, Dhanpat Rai & Sons, 11th edition
3. S. K. Singh, Industrial Instrumentation & Control, McGraw Hill, 3rd edition

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL301	Electronic Device and Circuits I Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL301	Electronic Device and Circuits ILaboratory	--	--	--	--	25	25	50

Term Work:

At least 6 experiments covering entire syllabus of ELX 302 (Electronic Devices and Circuits I) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a ***Mini Project*** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments, however Instructor is free to design his/her own experiments as per the guidelines

Laboratory Experiments

1. To study passive(R,L,C) and active (BJT,MOSFTET) components
2. To study equipment (CRO, Function Generator,Power supply).
3. To perform characteristics of PN junction diode.
4. To perform Clippers and Clampers.
5. To perform analysis and design Fixed bias,voltage divider bias for CE amplifier.
6. To perform CE amplifier as voltage amplifier (Calculate Av,Ai,Ri,Ro).
7. To perform CS MOSFET amplifier as voltage amplifier and measurment of its performance parametes.
8. To perform Half wave/Full wave/Bridge rectifier with LC/pi filter.
9. To perform Zener as a shunt voltage regulator.
10. To design Half wave/Full wave/Bridge rectifier with LC/pi filter.

11. To design single stage CE Amplifier.
12. To design single stage CS Amplifier.

Guidelines for Simulation Experiments

1. SPICE simulation of and implementation for junction analysis
2. SPICE simulation of and implementation for BJT characteristics
3. SPICE simulation of and implementation for JFET characteristics
4. SPICE simulation of for MOSFET characteristics
5. SPICE simulation of Half wave/Full wave/Bridge rectifier with LC/pi filter.
6. SPICE simulation of CE amplifier
7. SPICE simulation of CS MOSFET amplifier.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL302	Digital Circuit Design Laboratory	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL302	Digital Circuit Design Laboratory	--	--	--	--	25	25	50

Term Work:

At least 6 experiments covering entire syllabus of ELX 303 (Digital Circuit Design) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a ***Mini Project*** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments, however Instructor is free to design his/her own experiments as per the guidelines

Laboratory Experiments

1. Verify different logic gates.
2. Simplification of Boolean functions.
3. Verify Universal gates NAND and NOR and design EXOR and EXNOR gates using Universal gates.
4. Implement Half adder, Full adder, Half subtractor and Full subtractor circuits.
5. Implement BCD adder using four bit binary adder IC-7483.
6. Flip flops conversion JK to D, JK to T and D to TFF.
7. Implement logic equations using Multiplexer.
8. Design synchronous MOD N counter using IC-7490.
9. Verify encoder and decoder operations.
10. Implement digital circuits to perform binary to gray and gray to binary operations.
11. Verify truth table of different types of flip flops.
12. Verify different counter operations.
13. Verify operations of shift registers.
14. Implement parity checker circuit.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL303	Electrical Networks and Measurements Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL303	Electrical Network and Measurement Laboratory	--	--	--	--	25	--	25

Term Work:

At least 5 experiments covering entire syllabus of ELX 305 (Electronic Instruments and Measurements) should be set to have well predefined inference and conclusion and minimum of five tutorials covering entire syllabus of ELX304 (Electrical Network Analysis and Synthesis) with each tutorial shall have a minimum of four numerical problems solved and duly assessed. Simulation based tutorials shall be based using any circuit simulation tool like Spice/LTspice are encouraged. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

Suggested List of Experiments for ELX305

1.To experimentally determine static characteristics of instruments & perform error analysis
2.To measure low & medium resistances using Kelvin's Bridge & Kelvin's Double Bridge
3.To measure high resistances using mega-ohm-meter (megger)
4.Study of CRO & understand various front panel controls
5.Study of function / signal generator & understand various front panel controls
6.Study of spectrum / wave analyser & understand various front panel controls
7.Study of linear variable differential transducer (LVDT)
8.Study of strain gauges
9.Study of thermistor characteristics
10.Study of RTD characteristics

Suggested topics (but not limited to) for tutorial for ELX304 are as follows:
1. Find Open circuit parameters, Short circuit parameters, Hybrid parameters of 2 port network.
2. Obtain the Frequency response of Low pass and High pass filters.
3. Find the time response of R-L and R-C circuits and obtain the time constants.
4. Study of dependent sources – Voltage controlled voltage source and Current controlled current source.
5. Verification of Superposition theorem and Thevenin's theorem in AC circuits.
6. Time response of a 2nd order system.

7. Calculation of driving point functions for various circuit topologies.
8. Simulation of initial/final conditions (switching) of RLC circuit with DC source on any circuit simulation platform.
9. Simulation of initial/final conditions (switching) of RLC circuit with AC source on any circuit simulation platform.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL304	Object Oriented Programming Methodology Laboratory	02 Classwise	02 Batchwise	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL304	Object Oriented Programming Methodology Laboratory	--	--	--	--	25	25	50

Prerequisite:
FEC205: Structured Programming Approach

Course Objective:
1.To learn the object oriented programming concepts.
2.To study various java programming concept like multithreading, exception handling, packages etc.
3.To explain components of GUI based programming.

Course Outcomes: At the end of the course Student should be able:
1.To apply fundamental programming constructs.
2.To illustrate the concept of packages, classes and objects.
3.To elaborate the concept of strings, arrays and vectors.
4.To implement the concept of inheritance and interfaces.
5.To implement the notion of exception handling and multithreading.
6.To develop GUI based application.

Module No	Unit No	Topic	Hours
1		**Introduction to Object Oriented Programming**	02
	1.1	OOP Concepts: Object, Class, Encapsulation, Abstraction, Inheritance, Polymorphism	
	1.2	Features of Java, JVM	
	1.3	3 Basic Constructs/Notions: Constants, variables and data types, Operators and Expressions, Revision of Branching and looping	
2		**Classes, Object and Packages**	05
	2.1	Class, Object, Method	
	2.2	Constructor, Static members and methods	
	2.3	Passing and returning Objects	
	2.4	Method Overloading	
	2.5	Packages in java, creating user defined packages, access specifiers.	
3		**Array, String and Vector**	04
	3.1	Arrays, Strings, String Buffer	
	3.2	Wrapper classes, Vector	
4		**Inheritance and Interface**	03
	4.1	Types of Inheritance, super keyword, Method Overriding, abstract class and abstract method, final keyword	
	4.2	Implementing interfaces, extending interfaces	
5		**Exception Handling and Multithreading**	04
	5.1	Error vs Exception, try, catch, finally, throw, throws, creating own exception	
	5.2	Thread lifecycle, Thread class methods, creating threads, Synchronization	
6		**GUI programming in JAVA**	
	6.1	Applet: Applet life cycle, Creating applets, Graphics class methods, Font and Color class, parameter passing.	
	6.2	Event Handling: Event classes and event listener	

	6.3	Introduction to AWT: Working with windows, Using AWT controls- push Buttons, Label, Text Fields, Text Area, Check Box, and Radio Buttons.	**08**
	6.4	Programming using JDBC: Introduction to JDBC, JDBC Drivers & Architecture.	
		Total	**26**

Text books:

1. Herbert Schildt, 'JAVA: The Complete Reference', Ninth Edition, Oracle Press.
2. Sachin Malhotra and Saurabh Chaudhary, "Programming in Java", Oxford University Press, 2010

Reference Books:

1. Ivor Horton, 'Beginning JAVA', Wiley India.
2. DietalandDietal, 'Java: How to Program', 8/e,PHI
3. 'JAVA Programming', Black Book, Dreamtech Press.
4. 'Learn to Master Java programming', Staredusolutions

Digital Material:

1. www.nptelvideos.in
2. www.w3schools.com
3. http://spoken-tutorial.org
4. www.staredusolutions.org

Suggested List of Programming Assignments/Laboratory Work:

1.Program on various ways to accept data through keyboard and unsigned right shift operator.
2.Program on branching, looping, labelled break and labelled continue.
3.Program to create class with members and methods, accept and display details for single object.
4.Program on constructor and constructor overloading
5.Program on method overloading
6.Program on passing object as argument and returning object
7.Program on creating user defined package
8.Program on 1D array
9.Program on 2D array
10.Program on String
11.Program on StringBuffer
12.Program on Vector
13.Program on single and multilevel inheritance (Use super keyword)
14.Program on abstract class
15.Program on interface demonstrating concept of multiple inheritance
16.Program on dynamic method dispatch using base class and interface reference.
17.Program to demonstrate try, catch, throw, throws and finally.
18.Program to demonstrate user defined exception
19.Program on multithreading
20.Program on concept of synchronization
21.Program on Applet to demonstrate Graphics, Font and Color class.

22. Program on passing parameters to applets
23. Program to create GUI application without event handling using AWT controls
24. Program to create GUI application with event handling using AWT controls
25. Mini Project based on content of the syllabus. (Group of 2-3 students)

Term Work:
At least 10-12 experiments covering entire syllabus of ELXL304 (Object Oriented Programming Methodology) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a **Mini Project** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

S.E. (Electronics Engineering) – Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX401	Applied Mathematics IV	04	---	01@	04	---	01	05
ELX 402	Electronic Devices and Circuits II	04	---	---	04	---	---	04
ELX 403	Microprocessors and Applications	04	---	---	04	---	---	04
ELX 404	Digital System Design	04	---	---	04	---	---	04
ELX 405	Principles of Communication Engineering	04	---	---	04	---	---	04
ELX 406	Linear Control Systems	04	---	---	04	---	---	04
ELXL 401	Electronic Devices and Circuits II Lab.		02	---	---	01	---	01
ELXL 402	Microprocessors and Applications Lab.		02	---	---	01	---	01
ELXL 403	Digital System Design Lab.		02	---	---	01	---	01
ELXL 404	Principles of Communication Engineering Lab.		02	---	---	01	---	01
	Total	**24**	**08**	**01**	**24**	**04**	**01**	**29**

@1 hour tutorial classwise

Course Code	Course Name	Examination Scheme – Semester IV							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX401	Applied Mathematics IV	20	20	20	80	3	25	---	125
ELX 402	Electronic Devices and Circuits II	20	20	20	80	3	---	---	100
ELX 403	Microprocessors and Applications	20	20	20	80	3	---	---	100
ELX 404	Digital System Design	20	20	20	80	3	---	---	100
ELX 405	Principles of Communication Engineering	20	20	20	80	3	---	---	100
ELX 406	Linear Control Systems	20	20	20	80	3	---	---	100
ELXL401	Electronic Devices and Circuits II Laboratory						25	25	50
ELXL402	Microprocessors and Applications Laboratory						25	25	50
ELXL 403	Digital System Design Laboratory						25	25	50
ELXL404	Principles of Communication Engineering Laboratory						25	--	50
Total		**120**	**120**	**120**	**480**	**18**	**100**	**75**	**800**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ELX401	Applied Mathematics IV	04	--	01	04	--	01	05

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX401	Applied Mathematics IV	20	20	20	80	25	--	100

Prerequisite:

FEC 101: Applied Mathematics I
FEC 201: Applied Mathematics II
ELX 301: Applied Mathematics III

Course objectives:

1. To build the strong foundation in Mathematics of students needed for the field of Electronics and Telecommunication Engineering
2. To provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.
3. To prepare student to apply reasoning informed by the contextual knowledge to engineering practice.
4. To prepare students to work as part of teams on multi-disciplinary projects.

Course outcomes:

1 Students will demonstrate basic knowledge of Calculus of variation, Vector Spaces, Matrix Theory, Random Variables, Probability Distributions, Correlation and Complex Integration.

2 Students will demonstrate an ability to identify and Model the problems in the field of Electronics and Telecommunication and solve it.

3 Students will be able to apply the application of Mathematics in Telecommunication Engineering.

Module No.	Unit No.	Topics	Hrs.
1		**Calculus of Variation:**	**06**
	1.1	Euler's Langrange equation, solution of Euler's Langrange equation (only results for different cases for Function) independent of a variable, independent of another variable, independent of differentiation of a variable and independent of both variables	
	1.2	Isoperimetric problems, several dependent variables	
	1.3	Functions involving higher order derivatives: Rayleigh-Ritz method	
2		**Linear Algebra: Vector Spaces**	**06**
	2.1	Vectors in n-dimensional vector space: properties, dot product, cross product, norm and distance properties in n-dimensional vector space.	
	2.2	Vector spaces over real field, properties of vector spaces over real field, subspaces.	
	2.3	The Cauchy-Schwarz inequality, Orthogonal Subspaces, Gram-Schmidt process.	
3		**Linear Algebra: Matrix Theory**	**10**
	3.1	Characteristic equation, Eigen values and Eigen vectors, properties of Eigen values and Eigen vectors	
	3.2	Cayley-Hamilton theorem (without proof), examples based on verification of Cayley- Hamilton theorem.	
	3.3	Similarity of matrices, Diagonalisation of matrices.	
	3.4	Functions of square matrix, derogatory and non-derogatory matrices.	
4		**Probability**	**10**
	4.1	Baye's Theorem (without proof)	
	4.2	Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function, expectation, variance.	
	4.3	Moments, Moment Generating Function.	
	4.4	Probability distribution: Binomial distribution, Poisson & normal distribution (For detailed study)	
5		**Correlation**	**04**
	5.1	Karl Pearson's coefficient of correlation,Covariance,Spearman's Rank correlation,	
	5.2	Lines of Regression.	
6		**Complex integration**	**12**
	6.1	Complex Integration:Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula.	
	6.2	Taylor's and Laurent's Series	
	6.3	Zeros, singularities, poles of f(z), residues, Cauchy's Residue theorem.	
	6.4	Applications of Residue theorem to evaluate real Integrals of different types.	
		Total	**48**

Text books:

1. H.K. Das, "*Advanced engineering mathematics*", S . Chand, 2008
2. A. Datta, *"Mathematical Methods in Science and Engineering",* 2012
3. B.S. Grewal, *"Higher Engineering Mathematics",* Khanna Publication
4. P.N.Wartilar&J.N.Wartikar, "*A Text Book of Applied Mathematics*" Vol.I and II,VidyarthiGrihaPrakashan., Pune.

Reference Books:

1. B. V. Ramana, *"Higher Engineering Mathematics",* Tata Mc-Graw Hill Publication
2. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, *"Advanced Engineering Mathematics",* John Wiley & Sons, Inc
4. Seymour Lipschutz ,"*Beginning Linear Algebra*" Schaum's outline series, Mc-Graw Hill Publication
5. Seymour Lipschutz, "*Probability*" Schaum's outline series, Mc-Graw Hill Publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Term Work/ Tutorial:

At least 08 assignments covering entire syllabus must be given during the "**class wise tutorial'**. The assignments should be students centric and an attempt should be made to make assignments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per "**credit and grading system"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ELX402	Electronic Devices &Circuits-II	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX402	Electronic Devices & Circuits-II	20	20	20	80	--	--	100

Prerequisite:

- **FEC105:** Basic Electrical & Electronics Engineering
- **ELX302:** Electronic Device and Circuits I

Course Objectives:

1. To enhance comprehension capabilities of students through understanding of electronic devices and circuits
2. To perform DC and AC analysis of single stage and multistage amplifiers
3. To introduce and motivate students to the use of advanced microelectronic devices
4. To design electronic circuits using semiconductor devices.

Course Outcome:

1. Students will be able to Ability to understand amplifiers through frequency response.
2. Students will be able to perform DC and Ac analysis of single stage and multistage amplifiers, oscillators, differential amplifiers and power amplifiers.
3. Students will be able to derive expression for performance parameters in terms of circuit and device parameters.
4. Student will be able to select appropriate circuit for given specifications/applications.
5. Students will be able to explain working and construction details of special, semiconductor devices.

Module No.	Topics	Hours
1	**Frequency response of amplifiers.**	**8**
1.1	High frequency equivalent circuit of BJT and MOSFET, Miller's theorem, effect of Miller's capacitance, unity gain bandwidth	
1.2	Effect of coupling, bypass and load capacitors on single stage BJT and MOSFET amplifiers.	
2	**Frequency Response of Multistage Amplifiers.**	**6**
2.1	Effect of parasitic capacitances on BJT and MOSFET amplifiers. Low, mid and high frequency response of multistage amplifiers (CE-CE, CE-CB, CS-CS, CS-CG)	
3	**Feedback Amplifiers and Oscillators**	**8**
3.1	Types of Negative Feedback block diagram representation, Effect of negative feedback on Input impedance, Output impedance, Gain and Bandwidth with derivation, feedback topologies (Introduction only).	
3.2	Positive feedback and principle of oscillations, RC oscillators: Phase shift oscillators, Wien bridge oscillators, LC Oscillators: Hartley, Colpitts and clapp, Tunned Oscillator, Twin T Oscillator, Crystal Oscillator (BJT circuit analysis).	
4	**Differential Amplifiers**	**10**
4.1	MOSFET current sources, Cascode current mirror, advanced MOSFET active load, small signal analysis: MOSFET active load	
4.2	Basic MOSFET differential amplifier, DC characteristics, transfer characteristics, differential and common mode input impedances.	
4.3	MOSFET differential amplifier with active load, MOSFET differential amplifier with cascode active load,	
5	**Power Amplifiers**	**8**
	Power BJTs, Heat sinks, Power BJTs, Power MOSFETs, Heat Sinks, Class A, Class B, Class C and Class AB operation, Power efficiency, Class AB output stage with diode biasing, VBE multiplier biasing, input buffer transistors, Darlington configuration.	
6	**Special Semiconductor Devices - II**	**8**
	PNPN diode, SCR, DIAC, TRIAC, UJT, IGBT, HEMT, Gunn diode, IMPATT diode, HBT	
	Total Hours	**48**

Text Books:

1. Millman and Halkies, “Integrated Electronics”, TATA McGraw Hill.
2. Donald A. Neamen, “Electronic Circuit Analysis and Design”, TATA McGraw Hill, 2nd Edition

Reference Books:

1. Boylestad," Electronic Devices and Circuit Theory", Pearson
2. David A. Bell, “Electronic Devices and Circuits”, Oxford, Fifth Edition.
3. Muhammad H. Rashid, “Microelectronics Circuits Analysis and Design”, Cengage
4. S. Salivahanan, N. Suresh Kumar,“Electronic Devices and Circuits”, Tata McGraw Hill,
5. Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar,” Microelectronic Circuits Theory and Applications”, International Version, OXFORD International Students Edition, Fifth Edition.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ELX403	Microprocessors & Applications	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX403	Microprocessors and Applications	20	20	20	80	--	--	100

Prerequisite*:*

- **ELX303**:Digital Circuit Design

Course Objectives:

1. To develop background knowledge and core expertise in microprocessor.
2. To study the concepts and basic architecture of 8086 and Co-processor 8087.
3. To know the importance of different peripheral devices and their interfacing to 8086.
4. To know the design aspects of basic microprocessor.
5. To write assembly language programs in microprocessor for various applications.

Course Outcomes:

1.Students will be able to understand and explain 16-bit microprocessor architecture.
2.Students will be able to understand and write programmes for 8086 microprocessor.
3.Students will be able to use various peripheral devices to design Single Board Computer(SBC).
4.Students will be able to understand and explain 32-bit microprocessor architecture.

Module No.	Topics	Hrs.
1.	**Intel 8086 Architecture:** Major features of 8086 processor, 8086 CPU Architecture and the pipelined operation, Programmer's Model, Memory Segmentation and 8086 pin description in detail.	05
2.	**Instruction Set of 8086 and Programming:** Addressing modes of 8086, Instruction Set of 8086 microprocessor in detail, Assembler directives,Procedures and Macros, Programming 8086 in assembly language, Mixed mode Programming with C-language and assembly language.	07
3.	**8086 Interrupts:** Interrupt types in 8086, Dedicated interrupts, Software interrupts, Programming examples related to INT 21H (DOS Interrupts).	05
4.	**Designing the 8086 CPU module:** Generating the 8086 System Clock and Reset Signals using 8284 clock generator, 8086 Minimum and Maximum Mode CPU Modules, Minimum and Maximum Mode Timing Diagrams, Memory interfacing.	07
5.	**Single Board Computer Design:** 8086 – 8087 coprocessor interfacing. Functional Block Diagram and description, Operating Modes, Control Word Formats and Applications of the Peripheral Controllers - 8255-PPI,8259- PIC and 8237-DMAC. Keyboard and Seven Segment Display Interface using 8255. System design using peripheral controllers.	12
6.	**Introduction to 32-bit Intel Pentium Architecture:** Features of Pentium Processor, Pentium Superscalar architecture, Pipelining, Branch Prediction, Instruction and Data cache.	12
	Total	48

Text Books:

1)8086/8088 family: Design Programming and Interfacing: By John Uffenbeck (Pearson Education)
2)Microprocessor and Interfacing: By Douglas Hall (TMH Publication)
3)The Intel Microprocessor family: Hardware and Software principles and Applications: By James L. Antonakos (Cengage Learning)

Reference Books:

1) 8086 Microprocessor Programming and Interfacing the PC: By Kenneth Ayala (West Publication)
2) Pentium Processor System Architecture: By Don Anderson & Tom Shanley (Mindshare, Inc.) (Addison-Wesley Publisher)
3) The INTEL Microprocessors, Architecture, Programming and Interfacing: By Barry B. Brey (PearsonPublishers, 8^{th} Edition)
4) Microcomputer Systems: 8086/8088 family Architecture, Programming and Design: By Liu & Gibson (PHI Publication).

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX404	Digital System Design	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX404	Digital System Design	20	20	20	80	--	--	100

Prerequisite:

- **ELX303**: Digital Circuit Design

Course Objectives:

1. To perform analysis of synchronous sequential circuits.
2. To perform the design of synchronous and asynchronous counters using intuitive approaches.
3. To apply fundamental design procedure for synchronous sequential circuits; consisting of the steps as construction of initial state transition table/diagram, perform state reduction and state assignment, develop flip-flop excitations, and design of registers and counters.
4. To understand the basics of Hardware Description language. .
5. To make VHDL implementations on the structured design of synchronous sequential circuits.
6. To apply algorithmic state machines (ASMs) approach for large-size digital system design; consisting of the steps as development of ASM charts and ASM blocks, make state assignment on ASMs, and perform data path and control path designs.

Course Outcome:

1. Students will be able to design and implement synchronous sequential logic circuits.
2. Students will be able to analyze various types of digital logic circuits.
3. Students will be able to understand engineering concepts in the design of digital circuits.
4. Students will be able to understand the role of hardware description languages in digital circuit implementation.
5. Students will be able to describe simple hardware functions using a hardware description language.
6. Students will be able to understand the purpose of and steps involved in digital circuit implementation using Field-Programmable Gate Arrays.

Module No.	Topics	Hrs.
1	**Sequential logic design** Mealy and Moore models, state machine notations, clocked synchronous state machine analysis, construction of state diagram, sequence detector (word problem), state reduction techniques (inspection, partition and implication chart method), clocked synchronous state machine design, design examples like a few simple machines and traffic light controller, vending machine.	**09**
2	**Algorithmic State Machine (ASM) Chart and Register Transfer Luanguage(RTL)** Standard symbols for ASM Chart, Realization techniques for sequential/logic functions using ASM Chart, Top Down Design Example, Generalized ASM output, ASM Chart representation of control unit, RTL, Construction of data unit using RTL Description, Timing of connection and transfer, sequencing of control, Combinational logic and conditional transfer, Graphical and RTL Bus notation, Design examples of waveform controllable generator ,pulse width adjustor using ASM chart, design data unit and control unit for sequential circuits using RTL Description.	**08**
3	**Sequential logic design practices** Synchronous counter design and applications, MSI asynchronous counters (IC 7490, 7493), MSI synchronous counters (IC 74161, 74163, 74168, 74169) and applications, decoding binary counter states, MSI shift registers, Synchronous design methodology, impediments in synchronous design, synchronizer failure and metastability.	**09**
4	**Introduction to VHDL** Introduction to Hardware Description Language, Core features of VHDL, data types, concurrent and sequential statements, data flow, behavioral, structural architectures, subprograms, Examples like Adder, subtractor, Multiplexers, De-multiplexers, encoder, decoder.	**08**
5	**Design of Sequential circuits using VHDL** VHDL code for flip flop, counters, registers, Moore, Mealy type FSMs, Serial adders, sequence detector.	**08**
6	**Programmable Logic Devices** ROM, RAM, SRAM, PLA, PAL, CPLD and FPGA architecture. Numerical based on PLA and PAL.	**06**
	Total	**48**

Text Books:

1. Digital Logic Applications and Design – John M. Yarbrough, Thomson Publications, 2006
2. Digital Design, Morris Mano Second Edition, PHI, 2002
3. Volnei A. Pedroni, “Circuit Design with VHDL” MIT Press (2004)

Reference Books:

1. Digital Design Principles and Practices, 3rd ed. by Wakerly. Prentice Hall, 2000
2. Digital Design – Morris Mano, M.D.Ciletti, 4th Edition, PHI
3. Digital Circuits and Logic Design – Samuel C. Lee , PHI
4. William I.Flectcher, “An Engineering Approach to Digital Design”, PrenticeHall of India.
5. Parag K Lala, “Digital System design using PLD”, BS Publications, 2003.
6. Charles H. Roth Jr., “Fundamentals of Logic design”, Thomson Learning, 2004.
7. Stephen Brown, Zvonko Vranesic, “Fundamentals of Digital Logic Design” McGraw Hill, 2nd edition Charles H.Roth Jr “Fundamentals of Logic Design” Thomson Learning 2004

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX405	Principles of Communication Engineering	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX405	Principles of Communication Engineering	20	20	20	80	--	--	100

Prerequisite:

- Applied Mathematics-III
- Applied Mathematics-IV

Course Objectives:

1. Understand the need for various analog modulation techniques
2. Analyse the characteristics of the receivers
3. Understand pulse modulation methods
4. Identify the necessity of multiplexing

Course Outcomes:

1. Students will be able to comprehend the need for various components in analog communication systems
2. Students will be able to analyse various analog modulation methods
3. Students will be able to design modulators, demodulators for amplitude and frequency modulated systems.
4. Students will be able to assess the characteristics of pulse modulation techniques.
5. Recognize the need for multiplexing techniques.

Module No.	Unit No.	Topics	Hrs
1		**Introduction to Electronic Communication**	06
	1.1	**Introduction:** Electromagnetic frequency spectrum, concepts of wave propagation-ground wave, sky wave and space wave	
	1.2	**Elements of communication systems:** Information sources, communication channels, noise, sources of noises, need for modulation, bandwidth and power trade-off.	
	1.3	**1.3 Representation of the signals:** Fourier series, Fourier transform, two sided spectrum	
2		**Amplitude Modulation and demodulation**	10
	2.1	**Amplitude Modulation :** Types of Analog Modulation, Principles of Amplitude Modulation , AM for a Complex Modulating Signal, AM Power Distribution, AM Current Distribution, Limitations of AM , AM modulators and Demodulator	
	2.2	**Types of AM**: Modulation & Demodulation Techniques: DSB-SC, SSB-SC , , Vestigial-Sideband (VSB) Modulation , Comparison of AM, DSBSC, SSB and VSB	
	2.3	**2.3** Applications of AM	
3		**Angle modulation and demodulation**	08
	3.1	Frequency Modulation: Principles of Angle Modulation, Theory of FM—Basic Concepts, Spectrum Analysis of FM Wave, Narrowband and Wideband FM, Noise triangle,Pre-emphasis, de-emphasis FM Generation: Direct methods and Indirect method,FM Detection: Frequency discriminator and Phase discriminator methods	
	3.2	**Phase Modulation** : Theory of Phase Modulation, Relationship between FM and PM, Advantages and Disadvantages of Angle Modulation, Comparison of AM, FM and PM	
	3.3	3 Applications of FM and PM	
4		**Radio Transmitters and Receivers**	08
	4.1	Radio receivers: Receiver Characteristics : Sensitivity, Selectivity, Fidelity, Image frequency rejection ratio, TRF Receivers and its characteristics , Concept of Heterodyning , Superheterodyne Receiver , choice of Intermediate frequency	
	4.2	**AM Transmitters and Receivers**: AM Radio Transmitters, AM Radio Receivers, Practical diode detector, Automatic Gain control(AGC), Types of AGC.	
	4.3	**FM Transmitters and Receivers**: FM Transmitters, FM Receivers , Automatic Frequency control(AFC) , Importance of Limiter,Communication Receivers	
5		**Pulse-Modulation and demodulation**	08
	5.1	**Introduction to digital transmission of signals**: comparison of Digital Analog Transmissions, Concept of regenerative Repeater	
	5.2	**Sampling and quantization**: Sampling Theorem, Aliasing error, Natural Sampling , Flat top sampling, Quantization of Signals	
	5.3	**Pulse Modulation Techniques** :Generation and detection of Pulse	

		Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM)	
6		**PCM and Multiplexing**	08
	6.1	**PCM**: Pulse-Code Modulation (PCM), Noise Performance of PCM Systems, Differential PCM (DPCM), Adaptive Differential PCM (ADPCM), Delta Modulation, Adaptive Delta Modulation, Continuous Variable Slope DM (CVSDM), Comparison of PCM Techniques	
	6.2	Multiplexing in Telecommunications Networks, Synchronous and Asynchronous TDM, Single-Channel PCM Transmission System, T1 Digital Carrier System, FDM	
		Total	48

Text Books:

1.Kennedy and Davis “Electronics communication system ”,Tata McGraw Hill
2.T L Singal , Analog and Digital communication, Tata McGraw Hill
3.R P Singh &Sapre , Analog and Digital communication, Tata McGraw Hill 2nd Ed.

Reference books :

1.Wayne Tomasi “Electronics communication systems” Pearson Education, Third Edition, 2001.
2.Taub and Schilling “Principles of communication systems”, Tata McGraw Hill
3.Roy Blake, “Electronics communication system”, Thomson learning, Second Edition.
4.B.P. Lathi “Modern Digital and analog Communication system” Third Edition, OXFORD
5.Robert J. Schoenbeck “Electronics communications modulation and transmission”
6.Lean W couch “Digital and Analog communication system”, Pearson Education, Sixth Edition
7.Roddy Coolen, “Electronic Communications” PHI

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both thetest will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX406	Linear Control System	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX406	Linear Control System	20	20	20	80	--	--	100

Prerequisites Topics:
Differential Equations; Laplace transforms and Matrices.

Course Objectives:

1. To teach fundamental concepts of Control systems and mathematical modelling of the system.
2. To teach the concepts of time response and frequency response analysis of Control Systems.
3. To teach the concepts of state variable models as applicable to linear time invariant systems
4. To teach concepts of controllers and compensators

Course Outcomes:
1. Students will be able to understand the basic concepts of control system and identify control systems in real life applications.
2. Students will be able to derive the mathematical model of different types of control systems and represent them in various forms
3. Students will be able to analyze systems using time domain analysis techniques
4. Students will be able to apply concepts of frequency domain techniques in stability analysis of control systems
5. Students will be able to create state variable models of systems andanalyze their controllability, observability and time response
6. Students will be able to identify controllers and compensators in different controllers.

Module No.	Topics	Hrs.
1	**Models for Control System**	08
	1.1 Introduction: Open loop and closed loop systems; feedback and feed-forward control structure; examples of control systems.	
	1.2 Mathematical Modelling: Types of models; Impulse response model; State Variable model and Transfer function model for Electrical, Mechanical and Thermal systems	
	1.3 Manipulations: Block Diagram Representation of complex systems, Block diagram reduction, Signal flow graph and the Mason's gain rule for determining overall transfer function of Single Input, Single output systems	
2	**Time Response Analysis**	08
	2.1 Dynamic Response: Standard test signals; Transient and steady state behaviour of first and second order systems	
	2.2. Performance Specifications for a second order system and derivations for rise time, settling time, peak time, peak overshoot and steady state error	
	2.3. Steady State errors in feedbackcontrol systems and their types, Error constants and type of system.	
3	**State Variable Models**	10
	3.1 State variable models: State variable models of electrical systems	
	3.2 State transition equation: Concept of state transition matrix; Properties of state transition matrix; Solution of homogeneous systems; solution of nonhomogeneous systems.	
	3.3 Controllability and Observability: Concept of controllability; Controllability analysis of LTI systems; Concept of observability; Observability analysis of LTI systems using Kalman approach.	
4	**Stability Analysis in Time Domain**	06
	4.1 Concepts of Stability: Concept of absolute, relative and robust stability; Routh stability criterion.	
	4.2 Root Locus Analysis: Root-locus concepts; General rules for constructing root-locus; Root-locus analysis of control systems.	
5	**Stability Analysis in Frequency Domain**	
	5.1 Introduction: Frequency domain specifications, Response peak and peak resonating frequency; Relationship between time and frequency domain specifications of system; Stability margins.	10
	5.2 Bode plot: Magnitude and phase plot; Method of plotting Bode plot; Stability margins on the Bode plots; Stability analysis using Bode plot.	
	5.3 Nyquist Criterion: Polar plots, Nyquist stability criterions; Nyquist plot; Gain and phase margins.	
6	**Compensators and Controllers**	06
	6.1 Compensators: Types of compensation; Need of compensation; Lag compensator; Lead compensator.	
	6.2 Controllers: Concept of ON/OFF controllers; Concept of P, PI, PD and PID Controllers.	
	6.3 Advances in Control Systems: Introduction to Robust Control, Adaptive Control and Model Predictive control.	
	Total	**48**

Text Books

1. K. Ogata, Modern Control Engineering, Pearson Education India, Fifth Edition, 2015.
2. I. J. Nagrath, M. Gopal, Control Systems Engineering, New Age International, Fifth Edition, 2012.

Reference Books

1. M. Gopal, Control Systems: Principle and design, Tata McGraw Hill, First Edition, 1998
2. Richard C. Dorf and Robert H. Bishop, Modern Control System, Pearson, Eleventh Edition, 2013.
3. Norman S. Nise, Control Systems Engineering, John Wiley and Sons, Fifth Edition, 2010.
4. Farid Golnaraghi and Benjamin C. Kuo, Automatic Control Systems, Wiley, Ninth Edition, 2014.
5. S.P. Eugene Xavier and Joseph Cyril Babu, Principles of Control Systems, S. Chand, First Edition

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both thetest will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL401	Electronic Devices and Circuits II Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL401	Electronic Devices and Circuits II Laboratory	--	--	--	--	25	25	50

Term Work:

At least 6 experiments covering entire syllabus of ELX 402 (Electronic Devices and Circuits II) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a ***Mini Project*** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments, however Instructor is free to design own experiments as per the guidelines

Laboratory Experiments

1. To perform frequency response of single stage CE amplifier.
2. To perform frequency response of single stage CS MOSFET amplifier..
3. To perform frequency response of Cascode amplifier.
4. To perform frequency response of two stage RC coupled CE amplifier
5. To perform RC phase shift oscillator
6. To perform Wein Bridge oscillator.
7. To perform Hartley oscillator.
8. To perform Colpitts oscillator
9. To perform Crystal oscilator.
10. To perform Class B push pull amplifier
11. To perform Class AB amplifier

Guidelines for Simulation Experiments:

1. SPICE simulation ofs of frequency response of single stage CE amplifier

2. SPICE simulation of of frequency response of single stage CS MOSFET amplifier..
3. SPICE simulation of of frequency response of Cascode amplifier.
4. SPICE simulation of of frequency response of two stage RC coupled CE amplifier
5. SPICE simulation of RC phase shift oscillator
6. SPICE simulation of Wein Bridge oscillator.
7. SPICE simulation of Hartley oscillator.
8. SPICE simulation of Colpitts oscillator
9. SPICE simulation of Crystal oscilator.
10. SPICE simulation of Class B push pull amplifier
11. SPICE simulation of Class AB amplifier

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL402	Microprocessors and Applications Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL402	Microprocessors and Applications Laboratory	--	--	--	--	25	25	50

Term Work:

At least 6 experiments covering entire syllabus of ELX 403 (Microprocessors and Applications) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a ***Mini Project*** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments, however Instructor is free to design own experiments as per the guidelines

1. Write a program to arrange block of data in (i) Ascending and (ii) Descending order.
2. Write a program to find out any power of a number.
3. Write a programmable delay.
4. Write a program to find out largest number in an array.
5. Experiment on String instructions (e.g Reversing of string &Palindrome).
6. Write a program to multiply 32 bit numbers.
7. Menu driven programming.
8. Write a program for code conversion.
9. Programming the 8255 to read or write to port (any one application).
10. Programming the 8259 to demonstrate rotating priority, Specific priorityetc.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL403	Digital System Design Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL403	Digital System design Laboratory	--	--	--	--	25	25	50

Term Work:

At least 6 experiments covering entire syllabus of ELX 404 (Digital System Design) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a ***Mini Project*** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments, however Instructor is free to design own experiments as per the guidelines

Experiments based on Hardware:

1. Implementation of Counter using IC 7490, IC 7493
2. Implementation of Synchronous Counter using MSI counter ICs
3. Implementation of Universal Shift Register using IC 74194
4. Design and implement Moore Machine
5. Design and implement Mealy Machine
6. Serial Adder using a Melay/Moore Machine.
7. Design Sequence Detector using FF

Suggested experiments based on software:

1. Implement basic digital logic gates and simulate with HDL.

2. Implement basic Flip Flops and simulate with HDL.
4. Design and implement full adder logic with HDL and simulate the same.
5. Design and implement multiplexer with HDL and simulate the same.
6. Design and implement multiplexer with HDL and simulate the same.
7. Design and implement decoder (74138) with HDL and simulate the same.
8. Design and implement 4-bit counter with HDL and simulate the same.
9. Design and implement shift register with HDL and simulate the same.
10. Design and simulate the Finite State Machine (FSM) design by HDL.
11. Design and simulate the ALU design by HDL.

Additional suggested experiments (optional)

Implementation of any of above using **CPLD/FPGA**

Course Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL404	Principles of Communication Engineering Laboratory	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL404	Principles of Communication Engineering Laboratory	--	--	--	--	25	--	25

Term Work:

At least 6 experiments covering entire syllabus of ELX 405 (Principles of Communication Engineering) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a ***Mini Project*** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments, however Instructor is free to design own experiments as per the guidelines

1. Amplitude Modulation and demodulation
2. DSB-SC Balanced Modulator
3. Frequency Modulation and Demodulation
4. Super-heterodyne radio receiver
5. Pulse Amplitude Modulation
6. Verification of Sampling Theorem
7. Pulse Width Modulation
8. Pulse Position Modulation
9. Pulse Code Modulation
10. Delta Modulation
11. Adaptive Delta Modulation
12. Time Division Multiplexing

University of Mumbai

No. UG/ 46 of 2021

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, Directors of the recognized Institutions in Science & Technology Faculty is invited to the syllabus directly uploaded by the Academic Authority Unit which was accepted by the Academic Council at its meeting held on 11th May, 2017 **vide** item No.4.178 relating to the revised syllabus as per the (CBCGS) for Bachelor of Engineering (Electronics Engineering) Second Year w.e.f. AY 2017-18, Third Year w.e.f. AY 2018-19 and Final Year w.e.f. AY 2019-20 (Rev – 2016) from Academic Year 2016-17.

They are hereby informed that the recommendations made by Chairman, the Ad-hoc Board of Studies in Electronics Engineering at its meeting held on 26th May, 2020 and subsequently made by the Board of Deans at its meeting held on 26th June, 2020 vide item No. 14(6) have been accepted by the Academic Council at its meeting held on 23rd July, 2020 **vide** item No. 4.122 and that in accordance therewith, the scheme (Sem. III to VIII) and revised syllabus (Rec-2019 'C' Scheme) for the B.E. in Electronics Engineering (Sem.III & IV) has been brought into force with effect from the academic year 2020-21. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
21st January, 2021

(Dr. B.N.Gaikwad)
I/c REGISTRAR

To

The Principals of the affiliated Colleges, and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.122/23/07/2020

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No. UG/ 46 -A of 2021 MUMBAI-400 032 21st January, 2021

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Electronics Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. B.N.Gaikwad)
I/c REGISTRAR

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC-23/07/2020
Item No4122

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B E in Electronics Engineering**
2	Eligibility for Admission	First Year Engineering passed in line with the Ordinance 0.6242
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	Ordinance 0.6242
5	No. of Years / Semesters	8 Semesters
6	Level	Certificate/Diploma/UG/PG **(Strike out which is not applicable)**
7	Pattern	**Semester/~~Yearly~~** **(Strike out which is not applicable)**
8	Status	New/~~Revised~~ **(Strike out which is not applicable)**
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date:23rd July 2020

Signature
AMajumdar
Dr. Anuradha Majumdar

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Majumdar
Dean
Faculty of Science and Technology
University of Mumbai

AC- 23/07/2020
Item No. : 122

UNIVERSITY OF MUMBAI

Program: Bachelor of Engineering
in
Electronics Engineering

Second Year with Effect from AY 2020-21
Third Year with Effect from AY 2021-22
Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20
Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC-23/07/2020
Item No. 122

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B E in Electronics Engineering**
2	Eligibility for Admission	**First Year Engineering passed in line with the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 Semesters**
6	Level	~~Certificate/Diploma~~/**UG**/~~PG~~ **(Strike out which is not applicable)**
7	Pattern	**Semester**/~~Yearly~~ **(Strike out which is not applicable)**
8	Status	**New**/~~Revised~~ **(Strike out which is not applicable)**
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date:23rd July 2020 Signature:

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this, the Faculty of Science and Technology (in particular Engineering), of University of Mumbai, has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes, understand the depth and approach of the course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process. However, content of courses is to be taught in 12-13 weeks and the remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.
There was a concern that the earlier revised curriculum was more focused on providing information and knowledge across various domains of the said program, which led to heavily loading students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of the entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum, skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of the curriculum proposed in the present revision is in line with the AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and implementation of online contents from NPTEL/ SWAYAM Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time, in particular Revised syllabus of 'C 'scheme, wherever possible, additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In earlier revisions of the curriculum in the years 2012 and 2016, in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum, overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HOD's/ Faculties of all the institutes are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses and on successful completion, they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

Technical education in the country is undergoing a paradigm shift in current days. Think tank at national level are deliberating on the issues, which are of utmost importance and posed challenge to all the spheres of technical education. Eventually, impact of these developments was visible and as well adopted on bigger scale by almost all universities across the country. These are primarily an adoption of CBCS (Choice base Credit System) and OBE (Outcome based Education) with student centric and learning centric approach. Education sector in the country, as well, facing critical challenges, such as, the quality of graduates, employability, basic skills, ability to take challenges, work ability in the fields, adoption to the situation, leadership qualities, communication skills and ethical behaviour. On other hand, the aspirants for admission to engineering programs are on decline over the years. An overall admission status across the country is almost 50%; posing threat with more than half the vacancies in various colleges and make their survival difficult. In light of these, an All India Council for Technical Education (AICTE), the national regulator, took initiatives and enforced certain policies for betterment, in timely manner. Few of them are highlighted here, these are design of model curriculum for all prevailing streams, mandatory induction program for new entrants, introduction of skill based and inter/cross discipline courses, mandatory industry internships, creation of digital contents, mandate for use of ICT in teaching learning, virtual laboratory and so on.

To keep the pace with these developments in Technical education, it is mandatory for the Institutes & Universities to adopt these initiatives in phased manner, either partially or in toto. Hence, the ongoing curriculum revision process has a crucial role to play. The BoS of Electronics Engineering under the faculty of Science & Technology, under the gamut of Mumbai University has initiated a step towards adoption of these initiatives. We, the members of Electronics Engineering Board of Studies of Mumbai University feel privileged to present the revised version of curriculum for Electronics Engineering program to be implemented from academic year 2020-21. Some of the highlights of the revision are;

i. Curriculum has been framed with reduced credits and weekly contact hours, thereby providing free slots to the students to brain storm, debate, explore and apply the engineering principles. The leisure provided through this revision shall favour to inculcate innovation and research attitude amongst the students.
ii. New skill based courses have been incorporated in curriculum keeping in view AICTE model curriculum.
iii. Skill based Lab courses have been introduced, which shall change the thought process and enhance the programming skills and logical thinking of the students
iv. Mini-project with assigned credits shall provide an opportunity to work in a group, balancing the group dynamics, develop leadership qualities, facilitate decision making and enhance problem solving ability with focus towards socio-economic development of the country. In addition, it shall be direct application of theoretical knowledge in practice, thereby, nurture learners to become industry ready and enlighten students for Research, Innovation and Entrepreneurship thereby to nurture start-up ecosystem with better means.
v. An usage of ICT through NPTEL/SWAYAM and other Digital initiatives of Govt. of India shall be encouraged, facilitating the students for self learning and achieve the Graduate Attribute (GA) specified by National Board of accreditation (NBA) i.e. lifelong learning.

Thus, this revision of curriculum aimed at creating deep impact on the teaching learning methodology to be adopted by affiliated Institutes, thereby nurturing the students fraternity in a multifaceted directions and create competent technical manpower with legitimate skills. In times to come, these graduates shall shoulder the responsibilities of proliferation of future technologies and support in a big way for 'Make in India' initiative, a reality. In the process, BoS, Electronics Engineering got whole hearted support from all stakeholders including faculty, Heads of department of affiliating institutes, experts faculty who detailed out the course contents, alumni, industry experts and university official providing all procedural support time to time. We put on record their involvement and sincerely thank one and all for contribution and support extended for this noble cause.

Boards of Studies in Electronics Engineering

Sr. No.	Name	Designation	Sr. No.	Name	Designation
1	Dr. R. N. Awale	Chairman	5	Dr. Rajani Mangala	Member
2	Dr. Jyothi Digge	Member	6	Dr. Vikas Gupta	Member
3	Dr. V. A. Vyawahare	Member	7	Dr. D. J. Pete	Member
4	Dr. Srija Unnikrishnan	Member	8	Dr. Vivek Agarwal	Member

Program Structure for Second Year Electronics Engineering

UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

SEMESTER III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical And Oral	Tutorial	Total
ELC301	Engineering Mathematics - III	3	--	1	3	--	1	**4**
ELC302	Electronics Devices and Circuits - I	3	--	--	3	--	--	**3**
ELC303	Digital Logic Circuits	3	--	--	3	--	--	**3**
ELC304	Electrical Networks Analysis and Synthesis	3	--	1	3	--	1	**4**
ELC305	Electronic Instruments and Measurements	3	--	--	3	--	--	**3**
ELL301	Electronics Devices and Circuits - I Lab	--	2	--	--	1	--	**1**
ELL302	Digital Logic Circuits Lab	--	2	--	--	1	--	**1**
ELL303	Electronic Instruments and Measurements Lab	--	2	--	--	1	--	**1**
ELL304	Skill base Lab OOPM: *(C++ and Java)*	--	4	--	--	2	--	**2**
ELM301	Mini Project – 1A	--	$4^{\$}$	--	--	2	--	**2**
Total		**15**	**14**	**2**	**15**	**07**	**2**	**24**

$ indicates work-load of Learner (Not of Faculty), for Mini Project

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Practical & Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ELC301	Engineering Mathematics - III	20	20	20	80	3	25	--	125
ELC302	Electronics Devices and Circuits - I	20	20	20	80	3	--	--	100
ELC303	Digital Logic Circuits	20	20	20	80	3	--	--	100
ELC304	Electrical Networks Analysis and Synthesis	20	20	20	80	3	25	--	125
ELC305	Electronic Instruments and Measurements	20	20	20	80	3	--	--	100
ELL301	Electronics Devices and Circuits - I Lab	--	--	--	--	--	25	25	50
ELL302	Digital Logic Circuits Lab	--	--	--	--	--	25	25	50
ELL303	Electronic Instruments and Measurements Lab	--	--	--	--	--	25	25	50
ELL304	Skill base Lab - OOPM: *(C++ and Java)*	--	--	--	--	--	50	--	50
ELM301	Mini Project - 1A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**200**	**100**	**800**

Note:

1. Students group and load of faculty per week.

   Mini Project 1 and 2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   Faculty Load: 1 hour per week per four groups

   Major Project 1 and 2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   Faculty Load: In Semester VII– ½ hour per week per project group
   In Semester VIII – 1 hour per week per project group

2. Out of 4 hours/week allotted for the mini-projects 1-A and 1-B, an expert lecture of at least one hour per week from industry/institute or a field visit to nearby domain specific industry should be arranged.

3. Mini-projects 2-A and 2-B should be based on DLOs.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tutorial	Theory	TW/Pract.	Tutorial	Total
ELC301	Engineering Mathematics - III	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Avg of Test 1 & 2					
ELC301	Engineering Mathematics - III	20	20	20	80	25	--	--	125

Pre-requisite:

Engineering Mathematics-I, Engineering Mathematics-II, Scalar and Vector Product: Scalar and vector product of three and four vectors,

Course Objectives: The course is aimed

1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, and its applications.
2. To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills
3. To familiarize the concept of complex variables, C-R equations, harmonic functions, its conjugate and mapping in complex plane.
4. To understand the basics of Linear Algebra and its applications
5. To use concepts of vector calculus to analyze and model engineering problems.

Course Outcomes: On successful completion of course learner will be able to;

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Find orthogonal trajectories and analytic function by using basic concepts of complex variables.
5. Illustrate the use of matrix algebra to solve the engineering problems.
6. Apply the concepts of vector calculus in real life problems.

Module No	Contents	Hrs.
01	**Laplace Transform** 1.1 Definition of Laplace transform Condition of Existence of Laplace transform. 1.2 Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n, n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of integrals by using Laplace Transformation. **Self-learning Topics:** Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function.	**7**
02	**Inverse Laplace Transform** 2.1. Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives. 2.2 Partial fractions method to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof). **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	6
03	**Fourier Series** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof). 3.2 Fourier series of periodic function with period 2π and $2l$. 3.3 Fourier series of even and odd functions. 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, Orthogonal and orthonormal set of functions. Fourier Transform.	7
04	**Complex Variables** 4.1 Function *f*(z)of complex variable, limit, continuity and differentiability of *f*(z)Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof). 4.2 Cauchy-Riemann equations in Cartesian coordinates (without proof). 4.3 Milne-Thomson method to determine analytic function *f*(z)when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations.	7

05	**Linear Algebra: Matrix Theory** 5.1 Characteristic equation, Eigen values and Eigen vectors, Example based on properties of Eigen values and Eigen vectors.(Without Proof). 5.2 Cayley-Hamilton theorem (Without proof), Examples based on verification of Cayley-Hamilton theorem and compute inverse of Matrix. 5.3 Similarity of matrices, Diagonalization of matrices. Functions of square matrix **Self-learning Topics:** Application of Matrix Theory in machine learning and google page rank algorithms, derogatory and non-derogatory matrices**.**	6
06	**Vector Differentiation and Integra**l 6.1 **Vector differentiation**: Basics of Gradient, Divergence and Curl (Without Proof). 6.2 **Properties of vector field:** Solenoidal and irrotational (conservative) vector fields. 6.3 **Vector integral:** Line Integral, Green's theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation. **Self-learning Topics:** Gauss' divergence Theorem and applications of Vector calculus.	6
	Total	**39**

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and secondclass test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:

1. Advanced Engineering Mathematics,H.K. Das, S. Chand, Publications
2. Higher Engineering Mathematics, B. V. Ramana, Tata Mc-Graw Hill Publication
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
4. Advanced Engineering Mathematics,Wylie and Barret, Tata Mc-Graw Hill.
5. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series
6. Vector Analysis Murry R. Spiegel, Schaum's outline series, Mc-Graw Hill Publication
7. Beginning Linear Algebra, Seymour Lipschutz, Schaum's outline series, Mc-Graw HillPublication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELC302	Electronic Devices & Circuits - I	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours	-	-	-
		Test 1	Test 2	Avg of Test 1 and Test 2		-	-	-	-
ELC 302	Electronic Devices & Circuits - I	20	20	20	80	03	--	--	100

Course Objectives:

1. To deliver the knowledge about physics of basic semiconductor devices and circuits.
2. To enhance comprehension capabilities of students through understanding of electronic devices and circuits
3. To introduce and motivate students to the use of advanced microelectronic devices
4. To analyze and design electronic circuits using semiconductor devices.

Course Outcomes:

After successful completion of the course students will be able to:

1. Explain working of semiconductor devices.
2. Analyze characteristics of semiconductor devices.
3. Perform DC and AC analysis of Electronics circuits.
4. Compare various biasing circuits as well as various configurations of BJT and MOSFETs.
5. Select best circuit for the given specifications/application.
6. Design electronics circuits for given specifications.

Module No.	Unit No.	Contents	Hrs.
1		**PN Junction Diode**	06
	1.1	Fermi level concepts, Basic Diode Structure, Energy Band Diagrams, Zero Applied Bias, Forward bias, Reverse bias, PN junction current, drift and diffusion current, junction capacitance.	
	1.2	DC load line, small signal model, Applied Bias, Reverse Applied Bias, temperature effects.	
2		**Diode applications and Special semiconductor devices**	04
	2.1	Clippers and Clampers, Zener as voltage regulator.	
	2.2	Construction, Working and Characteristics of :Schottky diode, Solar Cells, Photodiodes, LEDs.	
3		**Bipolar Junction Transistor**	10
	3.1	BJT operations, voltages and currents, BJT characteristics (CE, CB, CC configurations), early effect.	
	3.2	DC Circuit Analysis: DC load line and region of Operation, Common Bipolar Transistor Configurations, biasing circuits, bias stability and compensation, analysis and design of biasing circuits.	
	3.3	AC Analysis of BJT Amplifiers: AC load line, small signal models: h-parameter model, re model, Hybrid-pi model. Ac equivalent circuits and analysis to obtain voltage gain, current gain, input impedance, output impedance of CE, CB and CC amplifiers using Hybrid-pi model only.	
4		**Field Effect Devices**	10
	4.1	JFET: Construction, operation and characteristics. MOSFET: Construction, operation and characteristics of D-MOSFET and EMOSFET.	
	4.2	DC Circuit Analysis: DC load line and region of operation, Common-MOSFETs configurations, Analysis and Design of Biasing Circuits	
	4.3	AC Analysis: AC load line, Small-Signal model of MOSFET and its equivalent Circuit, Small-Signal Analysis MOSFET Amplifiers (Common-Source, Source Follower, Common Gate)	
5		**Rectifiers and Filters**	04
	5.1	Rectifiers: Working and analysis of Full wave and Bridge	
	5.2	Filters: C, L, LC, pi.	
6		**Design of Electronic Circuits**	05
	6.1	Design of single stage CE amplifier	
	6.2	Design of single stage CS MOSFET amplifier	
	6.3	Design of full wave rectifier with LC and pi filter.	
		Total	**39**

Text Books:

1. Donald A. Neamen, "Electronic Circuit Analysis and Design", TATA McGraw Hill, 2nd Edition
2. Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar, "Microelectronic Circuits Theory and Applications", International Version, OXFORD International Students Edition, Fifth Edition.

Reference Books:

1. Boylestad," Electronic Devices and Circuit Theory", Pearson
2. David A. Bell, “Electronic Devices and Circuits”, Oxford, Fifth Edition.
3. Muhammad H. Rashid, “Microelectronics Circuits Analysis and Design”, Cengage
4. S. Salivahanan, N. Suresh Kumar,“Electronic Devices and Circuits”, Tata McGraw Hill
5. Millman and Halkies, “Integrated Electronics”, TATA McGraw Hill.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and oral	Tutorial	Theory	Practical and oral	Tutorial	Total
ELC303	Digital Logic Circuits	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours		--	--
		Test 1	Test 2	Avg of Test 1 and Test 2	--	--	--	--	--
ELC303	Digital Logic Circuits	20	20	20	80	03	--	--	100

Course Pre-requisite:

Basic Electrical & Electronics Engineering

Course Objectives:

1. To understand various number system & amp; codes and to introduce the students to various logic gates, SOP, POS form and their minimization techniques.
2. To teach the working of combinational circuits, their applications and implementation of combinational logic circuits using MSI chips.
3. To teach the elements of sequential logic design, analysis and design of sequential circuits.
4. To understand various counters and shift registers and its design using MSI chips.
5. To explain and describe various logic families and Programmable Logic Devices.
6. To train students in writing program with Verilog hardware description languages.

Course Outcome:

After successful completion of the course students will be able to;

1. Perform code conversion and able to apply Boolean algebra for the implementation and minimization of logic functions.
2. Analyse, design and implement Combinational logic circuits.
3. Analyse, design and implement Sequential logic circuits.
4. Design and implement various counter using flip flops and MSI chips.
5. Understand TTL & amp; CMOS logic families, PLDs , CPLD and FPGA.
6. Understand basics of Verilog Hardware Description Language and its programming with combinational and sequential logic circuits.

Module No.	Unit No.	Contents	Hrs.
1		**Fundamentals of Digital Design**	**7**
	1.1	**Number Systems and Codes:** Review of Number System, Binary Code, Binary Coded Decimal, Octal Code,Hexadecimal Code and their conversions, Binary Arithmetic: One's and two's complements,	
	1.2	**Codes :**Excess-3 Code, Gray Code, Weighted code, Parity Code: Hamming Code	
	1.3	**Logic Gates and Boolean Algebra:** Digital logic gates, Realization using NAND, NOR gates, Boolean Algebra, De Morgan's Theorem, SOP and POS representation, K Map up to four variables	
2		**Combinational Circuits using basic gates as well as MSI devices**	6
	2.1	**Arithmetic Circuits:** Half adder, Full adder, Ripple carry adder, Carry Look ahead adder, Half Subtractor, Full Subtractor, multiplexer, cascading of Multiplexer , demultiplexer, decoder, Comparator (Multiplexer and demultiplexer gate level upto 4:1).	
	2.2	**MSI devices :** IC7483, IC74151, IC74138, IC7485.	
3		**Elements of Sequential Logic Design**	6
	3.1	**Sequential Logic:** Latches and Flip-Flops. RS, JK, Master slave flip flops, T & D flip flops with various triggering methods, Conversion of flip flops,	
	3.2	**Counters:** Asynchronous, Synchronous Counters, Up Down Counters, Mod Counters, Ring Counter,Twisted ring counter, Shift Registers, Universal Shift Register.	
4		**Sequential Logic Design**	7
	4.1	**Sequential Logic Design:**Mealy and Moore Machines, Clocked synchronous state machine analysis, State reduction techniques (inspection, partition and implication chart method) and state assignment,sequence detector, Clocked synchronous state machine design.	
	4.2	**Sequential logic design practices :**MSI counters (7490, 7492, ,7493,74163, 74169) and applications, MSI Shift registers (74194) and their applications.	
5		**Logic Families and Programmable Logic Devices**	6
	5.1	**Logic Families:** Types of logic families (TTL and CMOS), characteristic parameters (propagation delays, power dissipation, Noise Margin, Fan-out and Fan-in), transfer characteristics of TTL NAND,(Operation of TTL NAND gate), CMOS Logic :- CMOS inverter,CMOS NAND and CMOS NOR, Interfacing CMOS to TTL and TTL to CMOS.	
	5.2	**Programmable Logic Devices**: Concepts of PAL and PLA. Simple logic implementation using PAL and PLA. Introduction to CPLD and FPGA architectures, Numerical based on PLA and PAL.	
6		**Introduction to Verilog HDL**	7
	6.1	**Basics**: Introduction to Hardware Description Language and its core features, synthesis in digital design, logic value system, data types, constants, parameters, wires and registers. **Verilog Constructs:** Continuous & procedural assignment statements, logical, arithmetic, relational, shift operator, always, if, case, loop statements, Gate level modelling, Module instantiation statements.	
	6.2	**Modelling Examples:** Combinational logic eg. Arithmetic circuits, Multiplexer, Demultiplexer, decoder, Sequential logic eg. flip flop, counters.	
		Total	**39**

Text Books:

1. R. P. Jain, Modern Digital Electronics, Tata McGraw Hill Education, Third Edition 2003.
2. Morris Mano, Digital Design, Pearson Education, Asia 2002.
3. J. Bhaskar, A Verilog HDL Primer, Third Edition, Star Galaxy Publishing, 2018.

Reference Books:

1. Digital Logic Applications and Design – John M. Yarbrough, Thomson Publications, 2006
2. John F. Warkerly, Digital Design Principles and Practices, Pearson Education, Fourth Edition, 2008.
3. Stephen Brown and ZvonkoVranesic, Fundamentals of digital logic design with Verilog design, McGraw Hill, 3rd Edition.
4. Digital Circuits and Logic Design – Samuel C. Lee , PHI
5. William I.Flectcher, "An Engineering Approach to Digital Design", PrenticeHall of India.
6. Parag K Lala, "Digital System design using PLD", BS Publications, 2003.
7. Charles H. Roth Jr., "Fundamentals of Logic design", Thomson Learning, 2004.

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.

Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and oral	Tutorial	Total
ELC304	Electrical Network Analysis & Synthesis	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC304	Electrical Network Analysis & Synthesis	20	20	20	80	03	25	--	125

Course Pre-requisite:

1. Basic Electrical Engineering
2. Engineering Mathematics I and II

Course Objectives:

1. To learn electrical networks and its analysis in time and frequency domain.
2. To understand synthesis of electrical networks.
3. To understand various types of filters.

Course Outcomes:

After successful completion of the course students will be able to;

1. Explain basic electrical circuits with nodal and mesh analysis and apply network theorems.
2. Apply Laplace Transform for steady state and transient analysis.
3. Determine different network functions and solve complex circuits using network parameters.
4. Realize electrical networks for given network functions using synthesis concepts.
5. Design various types of filters.

Module No.	Unit No.	Contents	Hrs.
1		**Analysis of Circuits**	10
	1.1	**Analysis of DC circuits with dependent sourcesusing**: generalized loop, node matrix analysis, Superposition, Thevenin, Norton's and Maximum Power Transfer theorems.	
	1.2	**Analysis of Coupled Circuits:** Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit, solution using loop analysis.	
2		**Time and Frequency Domain Analysis of Electrical Networks**	8
	2.1	**Time Domain Analysis of Electrical Networks:** Forced and natural response,Initial and final conditions in network elements, Solution of first and second order differential equations for series and parallel R-L, R-C, R-L-C circuits, Transient and steady state response.	
	2.2	**Frequency Domain Analysis of Electrical Networks:** S-domain representation, Concept of complex frequency, Applications of Laplace Transform in solving electrical networks.	
3		**Two Port Networks**	9
	3.1	**Network Functions:**Driving point and Transfer Function, Poles and Zeros, Analysis of ladder networks.	
	3.2	**Two Port Parameters:** Open circuit, Short circuit, Transmission and Hybrid parameters, relationships among parameters, reciprocity and symmetry conditions.	
	3.3	**Series/parallel connection:** T and Pi representations, interconnection of Two-Port networks.	
4		**Synthesis of Electrical Networks**	7
	4.1	**Realizability Concept:** Hurwitz polynomial, Concept of positive real function, testing for necessary and sufficient conditions for positive real functions.	
	4.2	**Synthesis of RC, RL, LC circuits:** Concepts of synthesis of RC, RL, LC driving point functions, Foster and Cauer forms.	
5		**Introduction to filters**	5
	5.1	**Basic filter circuits:** Low pass, high pass, band pass and band stop filters, cut-off frequency, bandwidth, quality factor, attenuation constant, phase shift, characteristic impedance.	
	5.2	**Design and analysis of filters:** Constant K filters	
		Total	**39**

Text Books:

1. Network Analysis, M. E. Van Valkenburg/T.S. Rathore, Pearson Education, 3rd Edition (2019).
2. Engineering Circuit Analysis, William H. Hayt, Jack Kemmerly, Jamie Phillips, Steven Durbin McGraw Hill, 9th Edition (2018).
3. Networks and Systems, Ashfaq Husain, Khanna Book Publishing Co. (P) Ltd.; 2nd Edition (2019).
4. Circuits and Networks: Analysis and Synthesis, A. Sudhakar and S.P. Shyammohan McGraw Hill Education (India) Private Limited; 5th edition (2015).

Reference Books:

1. Circuit Theory Analysis and Synthesis, A. Chakrabarti, DhanpatRai& Co., Seventh - Revised edition (2018)
2. MahmoodNahvi and Joseph A. Edminister, "Schaum's Outline of Electrical Circuits",McGraw-Hill Education, 7th Edition (2017).
3. Problems and Solutions of Electrical Circuit Analysis, R.K. Mehta & A.K. Mal, CBS Publishers and Distributors Pvt Ltd (2015).
4. Networks and systems, D. Roy Choudhary, New Age International Publishers, 2nd Edition (2013).

Term Work:

This shall consist of at least 10 tutorials based on the entire syllabus.Each tutorial shall have a minimum of four numerical problems solved and duly graded.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub- questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELC305	Electronic Instruments and Measurements	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC305	Electronic Instruments and Measurements	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. FEC105-Basic Electrical Engineering
2. FEC101-Engineering Mathematics-I
3. FEC201-Engineering Mathematics-II

Course Objectives:

1. To develop understanding of fundamental principles of electronic measurements.
2. To disseminate basic methods for measurements of electrical quantities.
3. Toimpart knowledge of analog and digital instrumentation.

Course Outcomes:
After successful completion of the course students will be able to:

1. Recall and define instrument characteristics as well as interpret errors in measurements.
2. Understand and Measure various variables or value of unknown element.
3. Illustrate digital instruments like digital voltmeter, signal generator, wave analyzer.
4. Explain various components of oscilloscopes.
5. Choose appropriate transducer for measurement of distance, temperature and pressure.
6. Develop a calibration scheme for given instrument.

Module No.	Unit No.	Contents	Hrs.
1		**Fundamental Principles of Measurement**	04
	1.1	Measurement units (SI units of current, charge, EMF, potential difference, voltage, resistance, conductance, magnetic flux & flux density, inductance & capacitance). Components of a general measurement system (instrument).	
	1.2	Instrument characteristics: Static (accuracy, precision, linearity, drift, sensitivity, resolution, hysteresis, dead band). Dynamic (Speed of response, fidelity, lag and dynamic error)	
	1.3	Errors in Measurement: Classification of Errors, methods to eliminate or minimize the errors. Statistical analysis of Errors.	
2		**Measurement of Resistance, Inductance and Capacitance**	08
	2.1	The concept of measurement with bridge, measurement of low, medium and high resistances using Wheatstone bridge, Kelvin double bridge and mega-ohm bridge (Megger). Numerical problems (computation of sensitivity, resolution, range, errors)	
	2.2	Measurement of Inductance, Capacitance and Frequency: Maxwell bridge, Anderson bridge, Hay's bridge, Schering bridge, Wien's bridge. LCR-Q meter. Numerical problems (computation of sensitivity, resolution, range, errors)	
3		**Electronic Instruments**	08
	3.1	Digital DC Voltmeters (DVM): Ramp, dual slope, integrating, successive approximation. AC Voltmeters: Rectifier, average responding, peak responding, true RMS meter. Digital multimeter (DMM), Digital phase meter.	
	3.2	Signal Generators: Low frequency signal generator, function generator, pulse generator, sweep frequency generator.	
	3.3	Wave analyzer: Basic wave analyzer, frequency selective and heterodyne. Harmonic distortion analyzer, spectrum analyzer.	
4		**Oscilloscopes**	08
	4.1	Cathode Ray Oscilloscope: Block diagram of CRO, deflection generator, horizontal sweep generator, delay line, single and dual beam, dual trace CRO, chop and alternate modes	
	4.2	Measurements using Oscilloscope: Measurement of voltage, frequency and phase. Lissagous figures and their use in phase and frequency measurement.	
	4.3	Digital Storage Oscilloscope: Basic DSO operation, sampling rate, auto-set.	
5		**Sensor and Transducers**	08
	5.1	Basics of Sensors and Transducers: Definitions, difference, characteristics, classification and criteria for selection.	
	5.2	Transducers for measurement of- temperature: RTD, thermister, thermocouple, comparison of all three; displacement: Potentiometer, capacitive transducers, LVDT, strain gauge; pressure: load cell, dead weight tester; level: ultrasonic and optical.	
6		**Instrument Calibration**	03
	6.1	Principles and characteristics of calibration. Need of calibration.	
	6.2	Calibration of potentiometer. Use of potentiometer for calibration of voltmeter. DMM as standard instrument for calibration.	
		Total	**39**

Text Books:

1. David Bell, “Electronic Instrumentation and Measurements”, Oxford Publishing, 2nd edition, 2003.
2. A. D. Helfrick, W. D. Cooper, “Modern Electronics Instrumentation and Measurement Techniques”, NJ. Prentice Hall, 2002.
3. H. S. Kalsi, “Electronic Instrumentation”, Tata McGraw Hill, 2nd edition, 2004.

Reference Books:

1. C. S. Rangan, G. R. Sarma, V. S. V. Mani, “Instrumentation: Devices and Systems”, Tata McGraw Hill, 2nd edition, 2004.
2. A. K. Sawhney, “Electrical and Electronic Instruments and Measurements”, DhanpatRai& Sons, Delhi, 2015.
3. D. Prensky, “Electronic Instrumentation”, Prentice Hall Publication.
4. S. K. Singh, “Industrial Instrumentation and Control”, Tata McGraw Hill, 3rd Edition, 2017.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL301	Electronic Devices & Circuits - I Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL301	Electronic Devices & Circuits - I Lab	--	--	--	--	--	25	25	50

Term Work:

At least 10 experiments covering entire syllabus of ELC302 (Electronic Devices and Circuits I) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiments must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Title
1	To study passive(R,L,C) and active (BJT,MOSFTET) components.
2	To study equipment (CRO, Function Generator, Power supply).
3	To perform characteristics of PN junction diode.
4	To perform Clippers and Clampers.
5	To perform analysis and design Fixed bias, voltage divider bias for CE amplifier.
6	To perform CE amplifier as voltage amplifier (Calculate Av, Ai, Ri, Ro).

7	To perform CS MOSFET amplifier as voltage amplifier and measurement of its performance parameters.
8	To perform Full wave/Bridge rectifier with LC/pi filter.
9	To perform Zener as a shunt voltage regulator.
10	To design Full wave/Bridge rectifier with LC/pi filter.
11	To design single stage CE Amplifier.
12	To design single stage CS Amplifier.

Suggested Simulation Experiments:

Sr. No.	**Experiment Title**
1	SPICE/NGSPICE simulation of and implementation for junction analysis
2	SPICE/NGSPICE simulation of and implementation for BJT characteristics
3	SPICE/NGSPICE simulation of and implementation for JFET characteristics
4	SPICE/NGSPICE simulation of for MOSFET characteristics
5	SPICE/NGSPICE simulation of Full wave/Bridge rectifier with LC/pi filters.
6	SPICE/NGSPICE simulation of CE amplifier
7	SPICE/NGSPICE simulation of CS MOSFET amplifier.

(Expected percentage of H/w and software experiments should be 60% & 40% respoectively)

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL302	Digital Logic Circuits Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical &Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL302	Digital Logic Circuits Lab	--	--	--	--	--	25	25	50

Term Work:
At least 10 experiments covering entire syllabus of ELC 303 (Digital Logic Circuits) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Course Objective:-
1. To learn the functionality of basic logic gates.
2. To Construct combinational circuits and verify their functionalities.
3. To learn the functionality of flip flops and their conversion.
4. To Design and implement synchronous and asynchronous counters, Shift registers using MSI.
5. To simulate various combinational and sequential circuits and analyze the results using Verilog HDL.

Suggested List of Experiments:

Sr. No.	Hardware Experiment Title
1	To verify different logic gates and implement basic gates using universal gates
2	To implement Boolean function in SOP and POS form
3	To implement half adder, full adder, half Subtractor, full Subtractor
4	To implement BCD adder using binary adder IC 7483

5	To implement logic equations using Multiplexer IC 74151
6	To verify truth table of SR,JK,T and D flip flops
7	To perform Flip flop conversion JK to D, JK to T and D to T flip flop
8	To implement MOD N counter using IC 7490/7492/7493
9	To implement Synchronous counter using IC 74163/74169 **OR** To implement universal shift register using IC 74194

Simulation/Software Experiments

Sr. No.	**Software Experiment Title**
1	To design and simulate Full adder/full subtractor using Verilog HDL
2	To design and simulate Multiplexer/Demultiplexer using Verilog HDL
3	To design and simulate decoder 74138 using Verilog HDL
4	To simulate basic flip flops using Verilog HDL
5	To design and simulate 4 bit counter / up-down counter using Verilog HDL
6	To design and simulate Shift register using Verilog HDL

(Additional suggested experiments (optional) *Implementation of any of above using* ***FPGA/CPLD)***

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELL303	Electronic Instruments and Measurements Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical/Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL303	Electronic Instruments and Measurements Lab	--	--	--	--	--	25	25	50

Course Outcomes:

After successful completion of the course students will be able to:

1. Demonstrate the instrument characteristics as well as interpret errors in measurements.
2. Measure various variables or value (R, L and C) of unknown element.
3. Illustrate digital instruments like digital voltmeter, signal generator, wave analyzer.
4. Explain various functions of oscilloscopes.
5. Choose appropriate transducer for measurement of distance, temperature and pressure.
6. Develop a calibration scheme for given instrument.

Term Work:

At least 10 experiments covering entire syllabus of ELC303 (**Electronic Instruments and Measurements**) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments:

Sr. No.	Hardware Experiment Title
1	Study of DSO for measurements of voltage, frequency and phase.
2	Measurement of resistance using wheat-stone /kelvin bridge.
3	Measurement of inductance and Q-factor using Hay's bridge.
4	Measurement of capacitance using Schering bridge.
5	Measurement of frequency using Wien bridge.
6	Study characteristics and use of LVDT.
7	Measurement of temperature using RTD/Thermister.
8	Measurement of displacement using strain gauge.
9	Calibration of potentiometer.
10	Calibration of voltmeter using potentiometer/DMM.

Simulation/Software Experiments

Sr. No.	Software Experiment Title
1	Simulation of the zeroth, first order and second order Instrument to understand its dynamic characteristics.
2	Simulation of measurement of rms , average with error indication
3	Simulation of the Working of multichannel oscilloscope and demonstrate the different modes
4	Simulation of measurement of various physical parameters such as Temperature, distance or pressure.
5	Simulation of DAS
6	Simulation of the calibration method and its performance evaluation

Preferably open source software should be used for implementation.

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently..

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELL304	Skill base Lab - OOPM: *(C++ and Java)*	--	02* + 02	--	--	02	--	02
* *Theory class to be conducted for full class*								

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ELL304	Skill base Lab - OOPM: *(C++ and Java)*	--	--	--	--	--	50	--	50

Course Pre-requisites:

- Fundamentals of C-Programming

Course Objectives:

1. To understand Object Oriented Programming basics and its features.
2. To understand and apply Object Oriented Programming (OOP) principles using C++
3. Able to implement Methods, Constructors, Arrays, Multithreading and Applet in java
4. Able to use a programming language to resolve problems.

Course Outcomes:

After successful completion of the course student will be able to;

1. Use C++ in programming.
2. Use different control structures.
3. Understand fundamental features of an object oriented language: object classes and interfaces, exceptions and libraries of object collections.
4. Understand Java Programming.
5. To develop a program that efficiently implements the features and packaging concept of java in laboratory.
6. To implement Exception Handling and Applets using Java.

Module No.	Unit No.	Topics	Hrs.
1		**C++ Overview**	08
	1.1	Need of Object-Oriented Programming (OOP), Object Oriented Programming Paradigm, Basic Concepts of Object-Oriented Programming, Benefits of OOP and C++ as object orientedprogramminglanguage.	
	1.2	C++ programming Basics, Data Types, Structures, Enumerations, control structures, Arrays and Strings, Class, Object, class and data abstraction, class scope and accessing class members, separating interface from implementation, controlling access to members.	
2		**C++ Control Structures**	06
	2.1	**Branching -** If statement, If-else Statement, Decision. **Looping –** while, do-while, for loop **Nested control structure-** Switch statement, Continue statement, Break statement.	
	2.2	**Array-** Concepts, Declaration, Definition, Accessing array element, One dimensional and Multidimensional array.	
3		**Object-Oriented Programming using C++**	10
	3.1	**Operator Overloading-** concept of overloading, operator overloading, Overloading Unary Operators, Overloading Binary Operators, Data Conversion, Type casting (implicit and explicit), Pitfalls of Operator Overloading and Conversion, Keywords explicit and mutable. **Function-** Function prototype, accessing function and utility function, Constructors and destructors, Copy Constructor, Objects and Memory requirements, Static Class members, data abstraction and information hiding, inline function. **Constructor-** Definition, Types of Constructor, Constructor Overloading, Destructor.	
	3.2	**Inheritance-** Introduction, Types of Inheritance, Inheritance, Public and Private Inheritance, Multiple Inheritance, Ambiguity in Multiple Inheritance, Visibility Modes Public, Private, Protected and Friend, Aggregation, Classes Within Classes. Deriving a class from Base Class, Constructor and destructor in Derived Class, Overriding Member Functions, Class Hierarchies, **Polymorphism-** concept, relationship among objects in inheritance hierarchy, Runtime & Compile Time Polymorphism, abstract classes, Virtual Base Class.	
4		**Introduction to Java**	06
	4.1	Programming paradigms- Introduction to programming paradigms, Introduction to four main Programming paradigms like procedural, object oriented, functional, and logic & rule based.Difference between C++ and Java.	
	4.2	Java History, Java Features, Java Virtual Machine, Data Types and Size (Signed vs. Unsigned, User Defined vs. Primitive Data Types, Explicit Pointer type), Programming Language JDK Environment and Tools.	
5		**Inheritance, Polymorphism, Encapsulation using Java**	10
	5.1	**Classes and Methods**: class fundamentals, declaring objects, assigning object reference variables, adding methods to a class, returning a value, constructors, this keyword, garbage collection, finalize() method, overloading methods, argument passing, object as parameter, returning objects, access control, static, final, nested and inner classes, command line arguments, variable-length Arguments. **String:** String Class and Methods in Java.	

	5.2	**Inheritances:** Member access and inheritance, super class references, Using super, multilevel hierarchy, constructor call sequence, method overriding, dynamic method dispatch, abstract classes, Object class. **Packages and Interfaces:** defining a package, finding packages and CLASSPATH, access protection, importing packages, interfaces (defining, implementation, nesting, applying), variables in interfaces, extending interfaces, instance of operator.	
6		**Exception Handling and Applets in Java**	08
	6.1	**Exception Handling:** fundamental, exception types, uncaught exceptions, try, catch, throw, throws, finally, multiple catch clauses, nested try statements, built-in exceptions, custom exceptions (creating your own exception subclasses). **Managing I/O:** Streams, Byte Streams and Character Streams, Predefined Streams, Reading console Input, Writing Console Output, and Print Writer class. **Threading:** Introduction, thread life cycle, Thread States: new, runnable, Running, Blocked and terminated, Thread naming, thread join method, Daemon thread	
	6.2	**Applet:** Applet Fundamental, Applet Architecture, Applet Life Cycle, Applet Skeleton, Requesting Repainting, status window, HTML Applet tag, passing parameters to Applets, Applet and Application Program.	
		Total	**48**

Textbooks:

1. BjarneStroustrup, "The C++ Programming language", Third edition, Pearson Education, 2000.
2. Deitel, "C++ How to Program", 4th Edition, Pearson Education, 2005.
3. D. T. Editorial Services, "Java 8 Programming Black Book", Dreamtech Press, Edition, 2015.
4. YashwantKanitkar, "Let Us Java", BPB Publications, 4nd Edition, 2019.

Reference Books:

1. Herbert Schidt, "The Complete Reference", Tata McGraw-Hill Publishing Company Limited, 10th Edition, 2017.
2. Harvey M. Deitel, Paul J. Deitel, Java: How to Program, 8th Edition, PHI , 2009.
3. Grady Booch, James Rumbaugh, Ivar Jacobson, "The Unified Modeling Languageser Guide", Pearson Education.
4. SachinMalhotra, SaurabhChaudhary "Programming in Java", Oxford University Press, 2010

Software Tools:

1. Raptor-Flowchart Simulation:http://raptor.martincarlisle.com/
2. Eclipse: https://eclipse.org/
3. Netbeans:https://netbeans.org/downloads/
4. CodeBlock:http://www.codeblocks.org/
5. J-Edit/J-Editor/Blue J

Online Repository:

1. Google Drive
2. GitHub
3. Code Guru

Suggested list of Experiments:

Sr. No	Write C++ Program to
1	Add Two Numbers
2	Print Number Entered by User
3	Swap Two Numbers
4	Check Whether Number is Even or Odd
5	Find Largest Number Among Three Numbers
6	Create a simple class and object.
7	Create an object of a class and access class attributes
8	Create class methods
9	Create a class to read and add two distance
10	Create a class for student to get and print details of a student.
11	Demonstrate example of friend function with class
12	Implement inheritance.

Sr. No.	Write JAVA Program to
1	Display addition of number
2	Accept marks from user, if Marks greater than 40,declare the student as “Pass” else “Fail””
3	Accept 3 numbers from user. Compare them and declare the largest number (Using if-else statement).
4	Display sum of first 10 even numbers using do-while loop.
5	Display Multiplication table of 15 using while loop.
6	Display basic calculator using Switch Statement.
7	Display the sum of elements of arrays.
8	Accept and display the string entered and execute at least 5 different string functions on it.
9	Read and display the numbers as command line Arguments and display the addition of them
10	Define a class, describe its constructor, overload the Constructors and instantiate its object.
11	Illustrate method of overloading
12	Demonstrate Parameterized Constructor
13	Implement Multiple Inheritance using interface
14	Create thread by implementing 'runnable' interface or creating 'Thread Class.
15	Demonstrate Hello World Applet Example

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term Work:

At least **16** experiments (**08 experiments** each on **C++** and **JAVA**) covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every experiments and are graded from time to time.

The grades will be converted to marks as per "**Choice Based Credit and Grading System**" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course code	Course Name	Credits
ELM 301	Mini Project - 1A	02

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELM 301	Mini Project - 1A	--	--	--	--	--	25	25	50

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcomes:

Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.

- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book: 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalisation of problem and proposed solution
  - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project:

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on the following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Program Structure for Second Year Electronics Engineering

UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

SEMESTER IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELC401	**Engineering Mathematics - IV**	3	--	1	3	--	1	**4**
ELC402	**Electronics Devices and Circuits - II**	3	--	--	3	--	--	**3**
ELC403	**Microcontroller Applications**	3	--	--	3	--	--	**3**
ELC404	**Principles of Communication Engg**	3	--	1	3	--	1	**4**
ELC405	**Signals and Systems**	3	--	--	3	--	--	**3**
ELL401	**Electronics Devices and Circuits - II Lab**	--	2	--	--	1	--	**1**
ELL402	**Microcontroller Applications Lab**	--	2	--	--	1	--	**1**
ELL403	**Analog Communication Lab**	--	2	--	--	1	--	**1**
ELL404	**Skill Base Lab : *Python Programming***	--	4	--	--	2	--	**2**
ELM401	**Mini Project - 1B**	--	4$	--	--	2	--	**2**
Total		**15**	**14**	**2**	**15**	**07**	**2**	**24**

$ indicates workload of Learner (Not for Faculty), for Mini Project

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Practical and oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (inHrs)			
		Test 1	Test 2	Avg.					
ELC401	**Engineering Mathematics - IV**	20	20	20	80	3	25	--	**125**
ELC402	**Electronics Devices and Circuits -II**	20	20	20	80	3	--	--	**100**
ELC403	**Microcontroller Applications**	20	20	20	80	3	--	--	**100**
ELC404	**Principles of Communication Engg**	20	20	20	80	3	--	--	**100**
ELC405	**Signals and Systems**	20	20	20	80	3	25	--	**125**
ELL401	**Electronics Devices and Circuits - II Lab**	--	--	--	--	--	25	25	**50**
ELL402	**Microcontroller Applications Lab**	--	--	--	--	--	25	25	**50**
ELL403	**Analog Communication Lab**	--	--	--	--	--	25	25	**50**
ELL404	**Skill Base Lab : *Python Programming***	--	--	--	--	--	50	--	**50**
ELM401	**Mini Project - 1B**	--	--	--	--	--	25	25	**50**
Total		**--**	**--**	**100**	**400**	**--**	**200**	**100**	**800**

Note:

1. Studentsgroupandloadoffacultyperweek.

   MiniProject 1 and2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   Faculty Load:1 hour per week per four groups

   MajorProject 1 and 2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   Faculty Load: In Semester VII – ½ hour per week per project group
   In Semester VIII – 1 hour per week per project group

2. Out of 4 hours/week allotted for the mini-projects 1-A and 1-B, an expert lecture of at least one hour per week from industry/institute or a field visit to nearby domain specific industry should be arranged.

3. Mini-projects 2-A and 2-B should be based on DLOs.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELC401	Engineering Mathematics - IV	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC401	Engineering Mathematics - IV	20	20	20	80	03	25	--	125

Pre-requisite:

Engineering Mathematics - I, Engineering Mathematics - II,
Engineering Mathematics - III, Binomial Distribution.

Course Objectives: The course is aimed;

1. To studythe line and contour integrals and expansion of complex valued function in a power series.
2. To understand the basic techniques of statistics for data analysis, Machine learning and AI.
3. To study the probability distributions and expectations.
4. To acquaint with the concepts of vector spaces used in the field of machine learning and engineering problems.
5. To familiarize withthe concepts of Quadratic forms and Singular value decomposition.
6. To learn the concepts of Calculus of Variations.

Course Outcomes:

On successful completion of course, learner will be able to;

1. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
2. Demonstrate the use of Correlation and Regression to the engineering problems in data science, machine learning and AI.
3. Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
4. Apply the concept of vector spaces and orthogonalization process in Engineering Problems.
5. Use the concept of Quadratic forms and Singular value decomposition in various Engineering applications.
6. Find the extremals of the functional using the concept of Calculus of variation.

Module No.	Detailed Contents	Hrs.
01	**Complex Integration** 1.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 1.2 Taylor's and Laurent's series (without proof). 1.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof). **Self-learning Topics:** Application of Residue Theorem to evaluate realintegrations, Z-Transform.	7
02	**Statistical Techniques** 2.1 Karl Pearson's Coefficient of correlation (r) . 2.2 Spearman's Rank correlation coefficient (R) (repeated and non-repeated ranks) 2.3 Lines of regression. 2.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	6
03	**Probability Distributions** 3.1. Baye's Theorem, Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function. 3.2 Expectation, mean and variance. 3.3 Probability distribution: Poisson & normal distribution. **Self-learning Topics:** Moments, Moment Generating Function, Applications of Probability Distributions in Engineering.	7
04	**Linear Algebra: Vector Spaces** 4.1 Vectors in n-dimensional vector space, norm, dot product, The Cauchy Schwarz inequality (with proof), Unit vector. 4.2 Orthogonal projection, Orthonormal basis, Gram-Schmidt process for vectors. 4.3 Vector spaces over real field, subspaces. **Self-Learning Topics**:- Linear combinations, linear Dependence andIndependence, QR decomposition.	6

05	**Linear Algebra: Quadratic Forms** 5.1 Quadratic forms over real field, Linear Transformation of Quadratic form, Reduction of Quadratic form to diagonal form using congruent transformation. 5.2 Rank, Index and Signature of quadratic form, Sylvester's law of inertia, Value-class of a quadratic form-Definite, Semidefinite and Indefinite. 5.3 Reduction of Quadratic form to a canonical form using congruent transformations. 5.4 Singular Value Decomposition. **Self-learning Topics:** Orthogonal Transformations**,** Applications of Quadratic forms and SVD in Engineering.	7
06	**Calculus of Variations:** 6.1 Euler- Lagrange equation(Without Proof), When F does not contain y, When F does not contain x, When F contains x,y,y'. 6.2 Isoperimetric problems-Lagrange Method. 6.3 Functions involving higher order derivatives: Rayleigh-Ritz Method. **Self-Learning Topics:-**Brachistochrone Problem, Variational Problem,Hamilton Principle, Principle of Least action,Several dependent variables.	6
	Total	**39**

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and secondclass test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:

1. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
2. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
3. Advanced engineering mathematics H.K. Das, S. Chand, Publications.
4. Higher Engineering Mathematics B. V. Ramana, Tata Mc-Graw Hill Publication
5. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
6. Advanced Engineering Mathematics Wylie and Barret, Tata Mc-Graw Hill.
7. Beginning Linear Algebra Seymour Lipschutz Schaum's Outline series, Mc-Graw Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELC402	Electronic Devices & Circuits - II	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC402	Electronic Devices & Circuits - II	20	20	20	80	03	--	--	100

Pre-requisite :

- **ELC302:** Electronic Devices and Circuits - I

Course Objectives:

1. To enhance comprehension capabilities of students through understanding of electronic devices and circuits.
2. To perform DC and AC analysis of single stage and multistage amplifiers.
3. To design electronic circuits using semiconductor devices.

Course Outcomes:

After successful completion of the course students will be able to:

1. Students will be able to understand performance of amplifiers with the help of frequency response.
2. Students will be able to perform DC and AC analysis of single stage and multistage amplifiers, oscillators differential amplifiers and power amplifiers.
3. Students will be able to derive expression for performance parameters in terms of circuit and device parameters.
4. Student will be able to select appropriate circuit for given specifications/applications.

Module No.	Unit No.	Contents	Hrs.
1		**Frequency Response of Amplifiers**	7
	1.1	Low frequency response and analysis: Effect of coupling, bypass and load capacitances on single stage MOSFET amplifiers.	
	1.2	High frequency response and analysis: Effect of parasitic capacitances on MOSFET amplifiers. High frequency equivalent circuit of MOSFET, Miller's theorem, effect of Miller's capacitance, unity gain bandwidth.	
2		**Frequency Response of Multistage Amplifiers**	7
	2.1	Types of coupling. Low, mid and high frequency response and analysis of multistage amplifiers (CS-CS, CS-CG).	
3		**Feedback Amplifiers**	5
	3.1	Types of negative feedback, block diagram representation, Effect of negative feedback on Input impedance, Output impedance, Gain and Bandwidth with derivation, feedback topologies (Introduction only).	
	3.2	Analysis of voltage series negative feedback with appropriate circuits.	
4		**Oscillators**	4
	4.1	Positive feedback and principle of oscillations, RC oscillators: Phase shift oscillators, Wien bridge oscillators, LC Oscillators: Hartley and Colpitts. Crystal Oscillator (MOSFET circuit analysis).	
5		**Differential Amplifiers**	8
	5.1	MOSFET current sources, Cascode current mirror, advanced MOSFET active load, small signal analysis: MOSFET active load.	
	5.2	Basic MOSFET differential amplifier, DC characteristics, transfer characteristics, differential and common mode input impedances. MOSFET differential amplifier with active load.	
6		**Power Amplifiers**	8
	6.1	Power MOSFETs, Heat Sinks, Class A, Class B, Class C and Class AB operation, Power efficiency.	
	6.2	Class AB output stage with diode biasing, VBE multiplier biasing, input buffer transistors, Darlington configuration.	
		Total	**39**

Text Books:

1. Donald A. Neamen, "Electronic Circuit Analysis and Design", TATA McGraw Hill, 2nd Edition.
2. Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar," Microelectronic Circuits Theory and Applications", International Version, OXFORD International Students Edition, Fifth Edition.

Reference Books:

1. Robert Boylestad," Electronic Devices and Circuit Theory", Pearson.
2. David A. Bell, "Electronic Devices and Circuits", Oxford, Fifth Edition.
3. Muhammad H. Rashid, "Microelectronics Circuits Analysis and Design", Cengage
4. S. Salivahanan, N. Suresh Kumar,"Electronic Devices and Circuits", Tata McGraw Hill.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will beasked.
4. Remaining questions will be selected from all themodules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELC403	Microcontroller Applications	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC403	Microcontroller Applications	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. ELC302: Electronics Devices and Circuits –I
2. ELC303: Digital Logic Circuits

Course Objectives:

1. To study the Architecture, Memory and hardware features of the 8051 microcontroller.
2. To study Assembly and C language programming for 8051.
3. To study interfacing of various I/O devices.
4. To build a microcontroller-based system.

Course Outcomes:

After successful completion of the course students will be able to:

1. To explain fundamental concepts of microcontrollers.
2. To develop programming skills for microcontrollers using Assembly and C concepts
3. To interface various devices to the microcontroller
4. To design and implement microcontroller-based systems.

Module No.	Unit No.	Contents	Hrs.
1		**8051 Microcontroller Architecture**	06
	1.1	Introduction to the concepts of Microprocessors and Microcontrollers	
	1.2	Prerequisites: Concept of Buses, Read/write operations, T state, Machine cycle and Instruction cycle	
	1.3	8051 Architecture	
	1..4	8051 Memory organisation	
	1.5	RISC and CISC Concepts, Harvard and Von Neumann Architectures	
	1.6	Overview of various available Microcontrollers	
	1.7	Applications of Microcontrollers	
2		**8051 Assembly language programming**	06
	2.1	Addressing modes of 8051.	
	2.2	Assembler Directives	
	2.3	Instruction Set: Data transfer instructions, Arithmetic instructions, Logical instructions, Branching instructions.	
3		**8051 Internal Hardware**	07
	3.1	I/O ports and programming	
	3.2	Timers/Counters and programming	
	3.3	Serial port and programming	
	3.4	Interrupts and programming	
	3.5	Low power modes of the 8051	
4		**8051 programming in Embedded C**	06
	4.1	Embedded C-programming concepts: Data types, Modifiers, Qualifiers, Functions, Macros, Interrupt service routines.	
	4.2	Embedded C programming for 8051 (including programming I/O ports, Timers/Counters, Serial port and Interrupts)	
5		**8051 Interfacing –Part 1**	07
	5.1	Interfacing external memory to 8051	
	5.2	Display interfacing: 7-segment LED display, 16x2 generic alphanumeric LCD display.	
	5.3	Keyboard interfacing: 4x4 matrix keyboard	
		(Interfacing examples must be done using Assembly language & Embedded C)	
6		**8051 Interfacing –Part 2**	07
	6.1	Analog devices interfacing: 8-bit ADC, 8-bit DAC, temperature sensor (LM35)	
	6.2	Motor interfacing: Relay, DC motor (speed control using PWM), Stepper motor and Servo motor.	
	6.3	8051 Microcontroller based system design (including Sensors and Actuators)	
	(Interfacing examples must be done using Assembly language & Embedded C)		
		Total	**39**

Text Books:

1. M.A.Mazidi, J.C.Mazidi, Rolin D. McKinlay,“The 8051 Microcontroller and Embedded Systems Using Assembly and C”, Pearson Education, Second Edition, 2007.
2. Kenneth J. Ayala, “The 8051 Microcontroller”, Cengage Learning India Pvt. Ltd, Third Edition, 2005.

Reference Books:

1. Raj Kamal, “Microcontrollers: Architecture, Programming, Interfacing and System Design”, Pearson Education, 2009.
2. Manish K Patel, “The 8051 Microcontroller Based Embedded Systems”, McGraw Hill, 2014.
3. Ajay V Deshmukh, “Microcontroller Theory And Applications “, Tata Mcgraw Hill, 2017

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Term Work	Practical or Oral	Total
ELC404	Principles of Communication Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC404	Principles of Communication Engineering	20	20	20	80	3	--	--	100

Prerequisite:

- **Engineering Mathematics - III**
- **Engineering Mathematics - IV**

Course Objectives:

1. Understand the need for various analog modulation techniques
2. Analyze the characteristics of the receivers
3. Understand pulse modulation methods
4. Identify the necessity of multiplexing

Course Outcomes:

After successful completion of the course students will be able to:

1. describe the various elements of communication system.
2. recognize the need for multiplexing techniques.
3. analyze the performance of different analog modulation methods.
4. illustrate generation and detection of amplitude and frequency modulated systems.
5. characterize pulse modulation techniques.

Module No.	Unit No.	Topics	Hrs
1		**Introduction to Electronic Communication**	04
	1.1	**Introduction:** Electromagnetic frequency spectrum, concepts of wave propagation-ground wave, sky wave and space wave	
	1.2	**Elements of communication systems:** Information sources, communication channels, noise, sources of noises, need for modulation, bandwidth and power trade-off.	
2		**Amplitude Modulation and demodulation**	10
	2.1	**Amplitude Modulation:** Types of Analog Modulation, Principles of Amplitude Modulation, AM for a Complex Modulating Signal, AM Power Distribution, AM Current Distribution, Limitations of AM, AM modulators and Demodulator	
	2.2	**Types of AM**: Modulation & Demodulation Techniques: DSB-SC, SSB-SC, Comparison of AM, DSBSC and SSB	
	2.3	**Applications of AM:**AM Radio broadcasting, TV broadcasting of video	
3		**Angle modulation and demodulation**	09
	3.1	**Frequency Modulation:** Principles of Angle Modulation, Theory of FM— Basic Concepts, Spectrum Analysis of FM Wave, Narrowband and Wideband FM, Noise triangle, Pre-emphasis, de-emphasis FM Generation: Direct methods and Indirect method, FM Detection: Frequency discriminator and Phase discriminator methods	
	3.2	**Phase Modulation**: Theory of Phase Modulation, Relationship between FM and PM, Advantages and Disadvantages of Angle Modulation, Comparison of AM, FM and PM	
	3.3	**Applications of FM:** FM Radio broadcasting, TV broadcasting of sound	
4		**Radio Transmitters and Receivers**	06
	4.1	**Radio receivers:** Receiver Characteristics: Sensitivity, Selectivity, Fidelity, Image frequency rejection ratio, TRF Receivers and its characteristics, Concept of Heterodyning, Superheterodyne Receiver, choice of Intermediate frequency	
	4.2	**AM and FM Transmitters and Receivers**: AM and FM Radio Transmitters, AM and FM Radio Receivers, Practical diode detector, Automatic Gain Control (AGC), Types of AGC, Automatic Frequency Control (AFC) and Importance of Limiter	
5		**Pulse-Modulation and Multiplexing**	10
	5.1	**Introduction to digital transmission of signals**: comparison of Digital Analog Transmissions, Concept of regenerative Repeater	
	5.2	**Sampling and quantization**: Sampling Theorem, Aliasing error, Natural Sampling, Flat top sampling, Quantization of Signals	
	5.3	**Pulse Modulation Techniques**: Generation and detection of Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM)	
	5.4	**PCM and Multiplexing**: Pulse-Code Modulation (PCM), Significance of Companding for voice signals, Delta Modulation, Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM)	
		Total	**39**

Text Books:

1. Kennedy and Davis, “Electronics Communication System”, Tata McGrawHill, Fourth Edition
2. T L Singal, “Analog and Digital Communication”, Tata McGrawHill
3. B.P. Lathi, “Modern Digital and analog Communication System”, OXFORD, Fourth Edition

Reference Books:

1. Wayne Tomasi, “Electronics Communication Systems”, Pearson Education, Fifth Edition
2. Taub and Schilling, “Principles of Communication Systems”, Tata McGraw Hill, Fourth Edition
3. Roy Blake, “Electronics Communication System”, Thomson learning, Second Edition
4. R P Singh & Sapre, “Analog and Digital communication”, Tata McGraw Hill, Third Edition
5. Robert J. Schoenbeck, “Electronics communications modulation and transmission”, Second Edition
6. Lean W Couch, “Digital and Analog communication system”, Pearson Education, Sixth Edition
7. Roddy Coolen, “Electronic Communications”, PHI, Fourth Edition

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20marks.
2. The students need to solve total 4questions.
3. Question No. 1 will be compulsory and based on entiresyllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
ELC405	Signals and Systems	Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
		03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC405	Signals and Systems	20	20	20	80	03	25	--	125

Course Pre-requisites:

- Basic knowledge of - Integration, Differentiation, Complex Numbers, Partial Fractions
- Basics of Laplace transform, Fourier transform and Z transform (Engineering Mathematics - I, II & III)

Course Objectives:

1. To introduce the mathematical concepts of continuous and discrete time signals and systems.
2. To acquaint the students with various time domain and frequency domain methods for analysis of signals and systems.

Course Outcomes:

After successful completion of the course students will be able to:

1. Identify and differentiate between continuous and discrete time signals and systems.
2. Develop input output relationship for LTI systems.
3. Apply the concept of Laplace transform and understand conversion from time domain to frequency domain for continuous time systems.
4. Apply the concept of Z transform and comprehend conversion from time domain to frequency domain for discrete time systems.
5. Analyse continuous time signals using Fourier series.
6. Analyse discrete time signals using Fourier Transform.

Module No.	Unit No.	CONTENTS	Hrs.
1		**Continuous and Discrete Time Signals and Systems**	8
	1.1	Mathematical Representation and Classification of Continuous Time CT) and Discrete Time (DT) Signals Arithmetic Operations on Signals, Time Shifting, Time Scaling, Time Reversal of Signals, Sampling Theorem and Aliasing	
	1.2	Mathematical Representation and Classification of CT systems	
	1.3	Mathematical Representation and Classification of DT systems	
2		**Time Domain Analysis of Continuous And Discrete Signals and Systems**	7
	2.1	Properties of Linear Time Invariant (LTI) systems, Impulse and Step Response	
	2.2	Use of Convolution Integral and Convolution Sum and Correlation for Analysis of LTI Systems	
	2.3	Properties of Convolution Integral/Sum	
3		**Frequency Domain Analysis of Continuous Time System using Laplace Transform**	6
	3.1	Need of Laplace Transform, Review of Laplace Transform, Concept of ROC, Properties, Inverse Laplace Transform, Poles and Zeros	
	3.2	Analysis and characterization of LTI system using Laplace transform: impulse and step response, causality, stability, stability of causal system	
4		**Frequency Domain Analysis of Discrete Time System using Z Transform**	6
	4.1	Need for Z Transform, Definition, Properties of Unilateral and Bilateral Z Transform, Mapping with s Plane, Relationship with Laplace Transform	
	4.2	Z Transform of Standard Signals, ROC, Poles and Zeros of Transfer Function, Inverse Z Transform	
	4.3	Analysis and Characterization of LTI System Using Z Transform: Impulse and Step Response, Causality, Stability in z-Domain.	
5		**Frequency Domain Analysis of Continuous Time Signals**	6
	5.1	Fourier Series of Continuous Time Signals ,Properties of Fourier series	
	5.2	Fourier Transform, Properties of Fourier Transform, Fourier Transform of Standard Signals, Relationship Between Fourier and Laplace Transform	
6		**Frequency Domain Analysis of Discrete Time Signals**	6
	6.1	Concept of Discrete Time Fourier Series, Properties of DTFS , Discrete Time Fourier Transform and Determination of Magnitude and Phase Functions using DTFT	
	6.2	Relation between Z transform and DTFT	
		Total	**39**

Text Books:

1. Tarun Kumar Rawat, "Signals and Systems", Oxford University Press, 2016.
2. A. Nagoor Kani, "Signals and Systems", Tata McGraw-Hill Education, 2014.

Reference Books:

1. John Proakis and Dimitris Monolakis, "Digital Signal Processing", Pearson Publications, 4th Edition, 2006.
2. Alan V. Oppenheim, AlanS. Willsky, and S.Hamid Nawab, "Signals and Systems", 2nd Edition, PHI learning, 2010
3. B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2nd Edition, 2006.

Internal Assessment (IA):

Two tests must be conducted, which should cover at least 80% of the syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus, wherein sub questions of 2 to 5 marks will be asked.
4. The remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELL401	Electronic Devices & Circuits - II Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical / Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL401	Electronic Devices & Circuits - II Lab	--	--	--	--	--	25	25	50

Term Work:

At least 10 experiments covering entire syllabus of **ELC 402** (Electronic Devices and Circuits-II) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Hardware Experiment Name
1	To implement single stage MOSFET amplifier (CS) and study its frequency response
2	To implement Cascode amplifier and study its frequency response.
3	To determine input and output impedance of amplifier with and without feedback.
4	To Implement two stage RC coupled CE amplifier and plot frequency response.
5	To perform an experiment to study performance of RC phase shift oscillator.

6	To perform an experiment to study performance of Hartley oscillator.
7	To perform an experiment to study performance of Colpitts oscillator.
8	To perform an experiment to study performance of Crystal oscillator.
9	To perform an experiment to study Class B push pull amplifier.
10	To perform an experiment to study Class AB amplifier.

Suggested Simulation Experiments:

Sr. No.	Simulation Experiment Name
1	SPICE simulation of frequency response of single stage CS MOSFET amplifier.
2	SPICE simulation of frequency response of Cascade amplifier.
3	SPICE simulation of frequency response of two stage RC coupled CS amplifier.
4	SPICE simulation of RC phase shift oscillator.
5	SPICE simulation of Wein Bridge oscillator.
6	SPICE simulation of Hartley oscillator.
7	SPICE simulation of Colpitts oscillator.
8	SPICE simulation of Crystal oscillator.
9	SPICE simulation of Class B push pull amplifier.
10	SPICE simulation of Class AB amplifier.

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELL402	Microcontroller Applications Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL402	Microcontroller Applications Lab	--	--	--	--	--	25	25	50

Prerequisite: C Programming

Course Objectives:
1. To study Assembly and C language programming for 8051.
2. To study interfacing of various I/O devices.

Course Outcomes:

After successful completion of the course students will be able to:
1. To develop programming skills for microcontrollers using Assembly and C concepts
2. To interface various devices to the Microcontroller

Term Work:

At least 10 experiments covering entire syllabus of **Microcontroller Applications (ELC403) s**hould be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment title
1	Arithmetic Operations
2	Logical Operations
3	Branching operations
4	I/O port programming
5	Applications of Timers
6	Serial port programming
7	Interrupts programming
8	Seven Segment Display Interfacing
9	LCD Interfacing
10	Interfacing a Matrix keyboard
11	Interfacing a Relay
12	Sensor interfacing using an ADC
13	Generation of different waveforms using DAC
14	Speed Control of DC Motor (using PWM)
15	Stepper Motor Interfacing
Atleast 05 exeperiments must be performed using Embeded C and experiments should have mix i.e. Hardware and simulation ones.	

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELL403	Principles of Communication Engineering Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL403	Principles of Communication Engineering Lab	--	--	--	--	--	25	25	50

Term Work:

At least 10 experiments covering entire syllabus of ***ELC 404*** (Principles of Communication Engg.) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of experiments/Tutorials:

Sr. No.	Tutorial/Experiment Title
1	Tutorial on Signal Representations- Fourier Series
2	Tutorial on Signal Representations- Fourier Transforms
3	Amplitude Modulation and demodulation
4	DSB-SC BalancedModulator
5	Frequency Modulation and Demodulation

6	Super-heterodyne radio receiver
7	Pulse Amplitude Modulation, Pulse Width Modulation and Pulse Position Modulation
8	Verification of SamplingTheorem
9	Pulse Code Modulation
10	Delta Modulation and Adaptive Delta Modulation

List of Simulation/Software Experiments

Sr. No.	Simulation Experiments Name
1	Simulation of Generation of Signals
2	Simulation of Fourier Transform
3	Simulation of PSD of a Signal
4	Simulation of Multiplexing (TDM/FDM)
5	Simulation of Amplitude Modulation and Demodulation
6	Simulation of Frequency Modulation and Demodulation
7	Simulation of Phase Modulation and Demodulation

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL 404	Skill-Base Lab: *Python Programming*	--	$01^{\$} + 03$	--	--	02	--	02

$ One-hour theory per week for the complete class. (For simplifying its implementation, 2hrs. theory on alternate weeks can be conducted)

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELL404	Skill-Base Lab: *Python Programming*	--	--	--	--	--	50	--	50

Course pre-requisite:

ECL 304 – Skill Lab: C++ and Java Programming

Course Objectives:

1. Describe the core syntax and semantics of Python programming language.
2. Explore file handling in Python
3. Infer the Object-oriented Programming concepts in Python
4. Formulate GUI Programming and Databases operations in Python
5. Develop applications using variety of libraries and functions

Course Outcomes:

After successful completion of the course student will be able to;

1. Describe syntax and semantics in Python
2. Illustrate different file handling operations
3. Interpret object-oriented programming in Python
4. Design GUI Applications in Python
5. Express proficiency in the handling Python libraries for data science
6. Develop machine learning applications using Python.

Module No.	Unit No.	Content	Hrs.
1		**Introduction to Python**	06
	1.1	Introduction to Python, Installation and resources, Identifiers and Keywords, Comments, Indentation and Multi-lining, Variables (Local and Global), data types, Arithmetic, Comparative, Logical and Identity Operators, Bitwise Operators, Expressions, Print statement and Formats, Input Statements in python.	
	1.2	Strings, Lists, Tuples, Dictionaries, Sets, Accessing Elements, Properties, Operations and methods on these data structures.	
	1.3	Decision Flow Control Statement: if and else statement, Nested If statement, Loop Statement: While Loop, do and while loop, for loop statement, Continue, Break and pass Statement, Conditional Statements.	
2		**Functions and File I/O Handling**	06
	2.1	Functions: Built-in-functions, library functions, Defining and calling the functions, Return statements, Passing the arguments, Lambda Functions, Recursive functions, Modules and importing packages in python code.	
	2.2	File Input/Output: Files I/O operations, Read / Write Operations, File Opening Modes, with keywords, Moving within a file, Manipulating files and directories, OS and SYS modules.	
3		**Object Oriented Programming**	08
	3.1	Classes and Objects, Public and Private Members, Class Declaration and Object Creation, Object Initialization, Class Variables and methods, Accessing Object and Class Attributes.	
	3.2	Intricacies of Classes and Objects, Inheritance, Constructor in Inheritance, Exception Handling, Link list, Stack, Queues.	
4		**Graphical User Interface and Image processing**	08
	4.1	Graphical User Interface using Tkinter Library module, creating simple GUI; Buttons, Labels, entry fields, widget attributes.	
	4.2	Database: Sqilite database connection, Create, Append, update, delete records from database using GUI.	
	4.3	Basic Image Processing using OpenCV library, simple image manipulation using image module.	
5		**Numpy, Pandas, Matplotlib, Seaborn, Scipy**	10
	5.1	Introduction to Numpy, Creating and Printing Ndarray, Class and Attributes of Ndarray, Basic operation, Copy and view, Mathematical Functions of Numpy.	
	5.2	Introduction to Pandas, Understanding Dataframe, View and Select Data, Missing Values, Data Operations, File read and write operation.	
	5.3	Introduction to Matplotlib library, Line properties, Plots and subplots, Types of Plots, Introduction to Seaborn.	
	5.4	Introduction to Scipy, Scipy Sub packages – Integration and Optimization, Eigen	

		values and Eigen Vectors, Statistic, Weave and IO.	
6		**Python Applications**	10
	6.1	GUI based applications	
	6.2	Applications in Image Processing, Networking	
	6.3	Machine Learning, Linear Regression, Logistic Regression	
	6.4	Classification using K nearest neighbor	
	6.5	Support Vector Machines	
Total			48

Text Books:

1. Yashvant Kanetkar, "Let us Python: Python is Future, Embrace it fast", BPB Publications; 1st edition (8 July 2019).
2. Dusty Phillips, "Python 3 object-oriented Programming", Second Edition PACKT Publisher, August 2015.
3. John Grayson, "Python and Tkinter Programming", Manning Publications (1 March 1999).
4. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
5. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication
6. Introduction to computing and problem solving using python, E Balagurusamy, McGraw Hill Education

Reference books:

1. Eric Matthes, "Python Crash Course A hands-on, Project Based Introduction to programming" No Starch Press; 1st edition (8 December 2015).
2. Paul Barry, "Head First Python" O′Reilly; 2nd edition (16 December 2016)
3. Zed A. Shaw, "Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly
4. Beautiful World of Computers and Code", Addison Wesley; 3rd edition (1 October 2013).
5. Andreas C. Mueller, "Introduction to Machine Learning with Python", O'Reilly; 1st edition (7 October 2016)
6. David Beazley, Brian K. Jones, "Python Cookbook: Recipes for Mastering Python 3", O'Reilly Media; 3rd edition (10 May 2013).
7. Bhaskar Chaudhary, "Tkinter GUI Application Development Blueprints: Master GUI
8. Programming in Tkinter as you design, implement, and deliver 10 real world application", Packt Publishing (November 30, 2015)

Software Tools:

- Python IDE: https://www.python.org/downloads/
- Anaconda Environment: https://www.anaconda.com/distribution/

Online Repository:

1. Github
2. Python 3 Documentation: https://docs.python.org/3/
3. "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/
4. http://spoken-tutorial.org
5. Python 3 Tkinter library Documentation: https://docs.python.org/3/library/tk.html
6. Numpy Documentation: https://numpy.org/doc/
7. Pandas Documentation: https://pandas.pydata.org/docs/
8. Matplotlib Documentation: https://matplotlib.org/3.2.1/contents.html
9. Scipy Documentation: https://www.scipy.org/docs.html
10. Machine Learning Algorithm Documentation: https://scikit-learn.org/stable/
11. https://nptel.ac.in/courses/106/106/106106182/

Sr. No.	Problem Statement	Module No.
1	1. Write python programs to understand expressions, variables, quotes, basic math operations, list, tuples, dictionaries, arrays etc. 2. Write Python program to implement byte array, range, set and different STRING Functions (len, count, lower, sorted etc) 3. Write Python program to implement control structures. 4. Assume a suitable value for distance between two cities (in km). 5. Write a program to convert and print this distance in meters, feet, inches and centimeter. 6. Write a program to carry out the following operations on the given set 7. s = {10, 2, -3, 4, 5, 88} a) Number of items in sets s b) Maximum element in sets s c) Minimum element in sets s d) Sum of all elements in sets s e) Obtain a new sorted set from s, set s remaining unchanged f) Report whether 100 is an element of sets s g) Report whether -3 is not an element of sets s.	Module 1
2	1. Write python program to understand different File handling operations 2. Create 3 lists – a list of names, a list of ages and a list of salaries. 3. Generate and print a list of tuples containing name, age and salary from the 3 lists. From this list generate 3 tuples – one containing all names, another containing all ages and third containing all salaries.	Module 2
3	1. Write Python program to implement classes, object, Static method and inner class 2. If any integer is given as in input through the keyboard, write a program to find whether it is odd or even number. 3. If ages of Ram, Shyam, and Ajay are given as an input through the keyboard, write a program to determine the youngest of the three. 4. Write a program that prints square root and cube root of numbers from 1 to 10, up to 4	Module 3

	decimal places. Ensure that the output is displayed in separate lines, with number center-justified and square and cube roots right-justified. 5. Write a program to find the factorial value of any number enteredthrough the keyboard. 6. Write a program that defines a function count_lower_upper( ) that accepts a string and calculates the number of uppercase and lowercase alphabets in it. It should return these values as a dictionary. Call this function for some sample strings. 7. A 5-digit positive integer is entered through the keyboard, write arecursive function to calculate sum of digits of 5-digit number.	
4	1. Write Python program to create, append, update, delete records from database using GUI. 2. Write Python program to obtain histogram of any image 3. Write Python Program to split color image in R,G,B and obtain a. individual histograms. 4. Write Python program for histogram equalization 5. Write Python Program for edge detection 6. Write Python Program for image segmentation 7. Write Python program to implement GUI Canvas application using Tkinter 8. Write Python program to implement GUI Frame application using Tkinter	Module 4
5	1. Write Python program to study define, edit arrays and perform arithmetic operations. 2. Write python program to study selection, indexing, merging, joining, concatenation in data frames 3. Evaluate the dataset containing the GDPs of different countries to: a) Find and print the name of the country with the highest GDP b) Find and print the name of the country with the lowest GDP c) Print text and input values iteratively d) Print the entire list of the countries with their GDPs e) Print the highest GDP value, lowest GDP value, mean GDP value, standardized GDP value, and the sum of all the GDPs 4. Analyze the Federal Aviation Authority (FAA) dataset using Pandas to do the following: a) View: aircraft make name, state name, aircraft model name, text information, flight phase, event description type, fatal flag b) Clean the dataset and replace the fatal flag NaN with “No”. c) Find the aircraft types and their occurrences in the dataset d) Remove all the observations where aircraft names are not available e) Display the observations where fatal flag is “Yes” 5. Analyze the “auto mpg data” and draw a pair plot using seabornlibrary for mpg, weight, and origin. (a) Origin: This dataset was taken from the StatLib library maintained at Carnegie Mellon University. • Number of Instances: 398 • Number of Attributes: 9 including the class attribute • Attribute Information: • mpg: continuous • cylinders: multi-valued discrete • displacement: continuous	Module 5

	• horsepower: continuous • weight: continuous • acceleration: continuous • model year: multi-valued discrete • origin: multi-valued discrete • car name: string (unique for each instance) 6. Write python program to use SciPy to solve a linear algebraproblem. 7. There is a test with 30 questions worth 150 marks. The test has twotypes of questions: 1. True or false – carries 4 marks each 2. Multiple-choice – carries 9 marks each. Find the number of true or false and multiple-choice questions.	
6	1. Write python program to study linear regression 2. Write python program to study multiple linear regression 3. Write python program to study logistic regression 4. Write python program to study Support Vector Machine 5. Write python program to study decision tree algorithm 6. Write python program to study two-way communication between client and server.	Module 6

Suggested list of course projects:

- Speed typing Test using Python
- Music player in Python
- Calculator app using tkinter
- Train announcement system using python
- Dice rolling simulator
- Expense tracker
- Contact book using python
- Develop classification model using freely available datasets
- Develop python application for sentiment analysis

Note:

Suggested List of Experimentsand problem statements are indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term Work:

At least 12 experiments and 1 course project should be performed. Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades will be converted to marks as per "Credit and Grading System" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Credits
ELM 401	Mini Project - 1B	02

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="8">Examination Scheme</th></tr>
<tr><th colspan="5">Theory Marks</th><th>Term Work</th><th>Practical/ Oral</th><th>Total</th></tr>
<tr><th colspan="3">Internal Assessment</th><th>End Sem. Exam</th><th>Exam duration Hours</th><th></th><th></th><th></th></tr>
<tr><th>Test 1</th><th>Test 2</th><th>Avg. of Test 1 and Test 2</th><th></th><th></th><th></th><th></th><th></th></tr>
<tr><td>ELM 401</td><td>Mini Project - 1B</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>25</td><td>25</td><td>50</td></tr>
</table>

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcomes:

Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.

- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
  - Marks awarded by guide/supervisor based on log book: 10
  - Marks awarded by review committee : 10
  - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
  - First shall be for finalisation of problem
  - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
  - First review is based on readiness of building working prototype to be conducted.
  - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalisation of problem and proposed solution
  - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project:

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on the following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

UNIVERSITY OF MUMBAI

Scheme

for

Bachelor of Engineering

in

Electronics Engineering

Second Year with Effect from AY 2020-21
Third Year with Effect from AY 2021-22
Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20
Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Program Structure for Second Year Electronics Engineering

UNIVERSITY OF MUMBAI

(With Effect from 2020-2021)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract	Tut	Total
ELC301	Engineering Mathematics - III	3	-	1	3	-	1	**4**
ELC302	Electronics Devices and circuits - I	3	-	-	3	-	-	**3**
ELC303	Digital Logic Circuits	3	-	-	3	-	-	**3**
ELC304	Electrical Networks Analysis and Synthesis	3	-	1	3	-	1	**4**
ELC305	Electronic Instruments and Measurements	3	-	-	3	-	-	**3**
ELL301	Electronics Devices and Circuits - I Lab	-	2	-	-	1	-	**1**
ELL302	Digital Logic Circuits Lab	-	2	-	-	1	-	**1**
ELL303	Electronic Instruments and Measurements Lab	-	2	-	-	1	-	**1**
ELL304	Skill-base Lab - OOPM: (C++ and Java)	-	4	-	-	2	-	**2**
ELM301	Mini Project - 1A	-	4$	-	-	2	-	**2**
Total		**15**	**14**	**2**	**15**	**07**	**2**	**24**

$ indicates workload of learner(Not faculty), for mini-project

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Pract/Oral	Total
		Test 1	Test 2	Av					
ELC301	Engineering Mathematics - III	20	20	20	80	03	25	-	**125**
ELC302	Electronics Devices and Circuits - I	20	20	20	80	03	-	-	**100**
ELC303	Digital Logic Circuits	20	20	20	80	03	-	-	**100**
ELC304	Electrical Networks Analysis and Synthesis	20	20	20	80	03	25	-	**120**
ELC305	Electronic Instruments and Measurements	20	20	20	80	03	-	-	**100**
ELL301	Electronics Devices and Circuits - I Lab	-	-	-	-	-	25	25	**50**
ELL302	Digital Logic Circuits Lab	-	-	-	-	-	25	25	**50**
ELL303	Electronic Instruments and Measurements Lab	-	-	--	-	-	25	25	**50**
ELL304	Skill base Lab - OOPM: *(C++ and Java)*	-	-	-	-	-	50	-	**50**
ELM301	Mini Project - 1A	-	-	-	-	-	25	25	**50**
	Total	**-**	**-**	**100**	**400**	**-**	**200**	**100**	**800**

Program Structure for Second Year Electronics Engineering

UNIVERSITY OF MUMBAI

(With Effect from 2020-2021)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract	Tut	Total
ELC401	Engineering Mathematics - IV	3	-	1	3	-	1	**4**
ELC402	Electronics Devices and Circuits - II	3	-	-	3	-	-	**3**
ELC403	Microcontroller Applications	3	-	-	3	-	-	**3**
ELC404	Analog Communication	3	-	-	3	-	-	**3**
ELC405	Signals and Systems	3	-	1	3	-	1	**4**
ELL401	Electronics Devices and Circuits - II Lab	-	2	-	-	1	-	**1**
ELL402	Microcontroller Applications Lab	-	2	-	-	1	-	**1**
ELL403	Analog Communication Lab	-	2	-	-	1	-	**1**
ELL404	Skill base Lab: *Python Learning*	-	4	-	-	2	-	**2**
ELM401	Mini Project – 1B	-	4$	-	-	2	-	**2**
	Total	**15**	**14**	**2**	**15**	**7**	**2**	**24**

$ indicates workload of learner(Not faculty), for mini project

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Pract/ Oral	Total
		Test 1	Test 2	Av					
ELC401	Engineering Mathematics - IV	20	20	20	80	03	25	-	**125**
ELC402	Electronics Devices and Circuits - II	20	20	20	80	03	-	-	**100**
ELC403	Microcontroller Applications	20	20	20	80	03	-	-	**100**
ELC404	Analog Communication	20	20	20	80	03	-	-	**100**
ELC405	Signals and Systems	20	20	20	80	03	25	-	**125**
ELL401	Electronics Devices and Circuits - II Lab	-	-	-	-	-	25	25	**50**
ELL402	Microcontroller Applications Lab	-	-	-	--	-	25	25	**50**
ELL403	Analog Communication Lab	-	-	--	-	-	25	25	**50**
ELL404	Skill base Lab: *Python Learning*	-	-	-	-	-	50	-	**50**
ELM401	Mini Project – 1B	-	-	-	-	-	25	25	**50**
	Total	**-**	**-**	**100**	**400**	**-**	**200**	**100**	**800**

Program Structure for Third Year Electronics Engineering

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract	Tut	Total
ELC501	Principles of Control System	3	-	-	3	-	-	**3**
ELC502	Digital Signal Processing	3	-	-	3	-	-	**3**
ELC503	Linear Integrated Circuits	3	-	-	3	-	-	**3**
ELC504	Digital Communication	3	-	-	3	-	-	**3**
ELDO501	Department Optional Course - I	3	-	-	3	-	-	**3**
ELL501	Principles of Control System Lab	-	2	-	-	1	-	**1**
ELL502	Linear Integrated Circuits Lab	-	2	-	-	1	-	**1**
ELL503	Digital Communication Lab	-	2	-	-	1	-	**1**
ELL504	Business Communication and Ethics	-	2*+2	-	-	2	-	**2**
ELM501	Mini Project – 2 A	-	4$	-	-	2	-	**2**
Total		**15**	**14**	**-**	**15**	**7**	**-**	**22**

**Theory class; $ indicates workload of learner (Not faculty), for mini-project*

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Pract/ Oral	Total
		Test 1	Test 2	Av					
ELC501	Principles of Control System	20	20	20	80	03	-	-	**100**
ELC502	Digital Signal Processing	20	20	20	80	03	-	-	**100**
ELC503	Linear Integrated Circuits	20	20	20	80	03	-	-	**100**
ELC504	Digital Communication	20	20	20	80	03	-	-	**100**
ELDO501	Department Optional Course - I	20	20	20	80	03	-	-	**100**
ELL501	Principles of Control System Lab	-	-	-	-	-	25	25	**50**
ELL502	Linear Integrated Circuits Lab	-	-	-	-	-	25	25	**50**
ELL503	Digital Communication Lab	-	-	-	-	-	25	25	**50**
ELL504	Business Communication and Ethics	-	-	-	-	-	50	-	**50**
ELM501	Mini Project – 2 A						25	25	**50**
	Total			**100**	**400**	**-**	**150**	**100**	**750**

Department Level Optional Couse - I (ELDO 501):

1. Data Structures	3. Neural Network and Fuzzy Logic
2. Biomedical Instrumentation	4. Computer Organization Architecture

Program Structure for Third Year Electronics Engineering

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract	Tut	Total
ELC601	Basic VLSI Design	3	-	-	3	-	-	**3**
ELC602	Electromagnetic Engineering	3	-	-	3	-	-	**3**
ELC603	Computer Communication Networks	3	-	-	3	-	-	**3**
ELC604	Embedded Systems and Real Time Operating Systems	3	-	-	3	-	-	**3**
ELDO601	Department Optional Course – II	3	-	-	3	-	-	**3**
ELL601	Basic VLSI Design Lab	-	2			1		**1**
ELL602	CCN Lab	-	2	-	-	1	-	**1**
ELL603	Embedded Systems and Real Time Operating Systems Lab	-	2	-	-	1	-	**1**
ELL604	Database Management Systems Lab	-	4	-	-	2	-	**2**
ELM601	Mini Project – 2 B	-	4$	-	-	2	-	**2**
Total		**15**	**14**	**-**	**15**	**7**	**-**	**22**

$ indicates workload of learner(Not faculty), for mini-project

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Pract/ Oral	Total
		Test 1	Test 2	Av					
ELC601	Basic VLSI Design	20	20	20	80	03	-	-	**100**
ELC602	Electromagnetic Engineering	20	20	20	80	03	-	-	**100**
ELC603	Computer Communication Networks	20	20	20	80	03	-	-	**100**
ELC604	Embedded Systems and Real Time Operating Systems	20	20	20	80	03	-	-	**100**
ELDO601	Department Optional Course – II	20	20	20	80	03	-	-	**100**
ELL601	Basic VLSI Design Lab	-	-	-	-	-	25	25	**50**
ELL602	CCN Lab	-	-	-	-	-	25	25	**50**
ELL603	Embedded Systems and Real Time Operating Systems Lab	-	-	-	-	-	25	25	**50**
ELL604	Database Management Systems Lab	-	-	-	-	-	50	-	**50**
ELM601	Mini Project – 2B						25	25	**50**
	Total			**100**	**400**	**-**	**150**	**100**	**750**

Department Level Optional Couse - II (ELDO 601):

1. Digital Control System	3. Machine Learning
2. Digital Image Processing and Machine Vision	4. Digital Design with Reconfigurable Architecture

Program Structure for Final Year Electronics Engineering

UNIVERSITY OF MUMBAI

(With Effect from 2022-2023)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract	Tut	Total
ELC701	Power Electronics	3	-	-	3	-	-	**3**
ELC702	Internet of Things	3	-	-	3	-	-	**3**
ELDO701	Department Optional Course - III	3	-	-	3	-	-	**3**
ELDO702	Department Optional Course - IV	3	-	-	3	-	-	**3**
ELIO701	Institute Optional Course - I	3	-	-	3	-	-	**3**
ELL701	Power Electronics Lab	-	2			1		**1**
ELL702	Internet of Things Lab	-	2	-	-	1	-	**1**
ELL703	Department Optional Course - III Lab	-	2	-	-	1	-	**1**
ELP701	Major Project - I	-	6	-	-	3	-	**3**
	Total	**15**	**12**	**-**	**15**	**6**	**-**	**21**

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Pract/ Oral	Total
		Test 1	Test 2	Av					
ELC701	Power Electronics	20	20	20	80	03	-	-	**100**
ELC702	Internet of Things	20	20	20	80	03	-	-	**100**
ELDO701	Department Optional Course - III	20	20	20	80	03	-	-	**100**
ELDO702	Department Optional Course - IV	20	20	20	80	03	-	-	**100**
ELIO701	Institute Optional Course - I	20	20	20	80	03	-	-	**100**
ELL701	Power Electronics Lab	-	-	-	-	-	25	25	**50**
ELL702	Internet of Things Lab	-	-	-	-	-	25	25	**50**
ELL703	Department Optional Course - III Lab	-	-	-	-	-	25	25	**50**
ELP701	Major Project - I	-	-	-	-	-	50	-	**50**
	Total			**100**	**400**	**-**	**125**	**75**	**700**

Department Level Optional Courses:

Department Level Optional Course -III (ELDO701)	Department Level Optional Course -IV (ELDO702)
1. Mixed Signal VLSI Design	1. Wireless Communication
2. Embedded GPU	2. Cloud Computing
3. Artificial Intelligence	3. Robotics
4. Advanced Networking Technologies	4. Data Science and applications

Program Structure for Final Year Electronics Engineering

UNIVERSITY OF MUMBAI

(With Effect from 2022-2023)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract	Tut	Total
ELC801	Industrial Automation	3	-	-	3	-	-	**3**
ELDO801	Department Optional Course - V	3	-	-	3	-	-	**3**
ELDO802	Department Optional Course – VI	3	-	-	3	-	-	**3**
ELIO801	Institute Optional Course - II	3	-	-	3	-	-	**3**
ELL801	Industrial Automation Lab	-	2	-	-	1	-	**1**
ELL802	Department Optional Course – V Lab	-	2	-	-	1	-	**1**
ELP801	Major Project - II	-	12	-	-	6	-	**6**
	Total	**12**	**16**	**-**	**12**	**8**	**-**	**20**

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Pract/ Oral	Total
		Test 1	Test 2	Av					
ELC801	Industrial Automation	20	20	20	80	03	-	-	**100**
ELDO801	Department Optional Course - V	20	20	20	80	03	-	-	**100**
ELDO802	Department Optional Course – VI	20	20	20	80	03	-	-	**100**
ELIO801	Institute Optional Course - II	20	20	20	80	03	-	-	**100**
ELL801	Industrial Automation Lab	-	-	-	-	-	25	25	**50**
ELL802	Department Optional Course – V Lab	-	-	-	-	-	25	25	**50**
ELP801	Major Project - II	-	-	-	-	-	50	100	**150**
	Total			**80**	**320**	**-**	**100**	**150**	**650**

Department Level Optional Courses:

Department Level Optional Course -V (ELDO801)	Department Level Optional Course -VI (ELDO802)
1. Microelectromechanical Systems (MEMS)	1. Next Generation Networks
2. Web Design	2. Industrial Internet of Things
3. Advanced Power Electronics	3. System on Chip
4. Virtual Instrumentation	4. Integrated Circuit Technology

Note:

1. Students group and load of faculty per week.

   Mini Project 1 and 2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   Faculty Load: 1 hour per week per four groups

   Major Project 1 and 2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   Faculty Load: In Semester VII– ½ hour per week per project group
   In Semester VIII – 1 hour per week per project group

2. Out of 4 hours/week allotted for the mini-projects 1-A and 1-B, an expert lecture of at least one hour per week from industry/institute or a field visit to nearby domain specific industry should be arranged.

3. Mini-projects 2-A and 2-B should be based on DLOs.

UNIVERSITY OF MUMBAI

No. UG/43 of 2018-19

CIRCULAR:-

Attention of the Principals of the affiliated Colleges and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/243 of 2010, dated 12th August, 2010 relating to syllabus of the Bachelor of Engineering (B.E.) degree course.

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Electronics Engineering at its meeting held on 9th April, 2018 have been accepted by the Academic Council at its meeting held on 5th May, 2018 **vide** item No. 4.54 and that in accordance therewith, the revised syllabus as per the (CBCS) for the T.E. & B.E. in Electronics Engineering (Sem - V to VIII) has been brought into force with effect from the academic year 2018-19 and 2019-2020, accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
25th June, 2018

(Dr. Dinesh Kamble)
I/c REGISTRAR

To

The Principals of the affiliated Colleges & Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.54/05/05/2018

****

No. UG/ 43 -A of 2018 MUMBAI-400 032 25th June, 2018

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Electronics Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-Ordinator, University Computerization Centre,

(Dr. Dinesh Kamble)
I/c REGISTRAR

AC19.04.2017
Item No. X.XX

UNIVERSITYOFMUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Electronics Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

Engineering education in India is expanding and is set to increase manifold. Themajor challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards.The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Electronics Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Electronics Engineering. The Program Educational Objectives finalized for the undergraduate program in Electronics Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process
4. To prepare the Learner for a successful career in Indian and Multinational Organisations

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr.Sudhakar S. Mande

Chairman, Board of Studies in Electronics Engineering, University of Mumbai

T.E. (Electronics Engineering) – Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX501	Microcontrollers and Applications	04	--	---	04	---	---	04
ELX 502	Digital Communication	04	-	--	04	---	---	04
ELX 503	Engineering Electromagnetics	04	-	@01	04	---	01	05
ELX 504	Design with Linear Integrated Circuits	04	02	---	04	---	---	04
ELX 505	Business Communication & Ethics	02	02#		---	02	---	02
ELXDLO501X	Department Level optional courses I	04	02	---	04		---	04
ELXL501	Microcontrollers and Applications Lab.					01	---	01
ELXL502	Digital Communication Lab.					01	---	01
ELXL503	Design with Linear Integrated Circuits Lab.					01	---	01
ELX DLOI50X	Department Level optional course-I Lab					01	---	01
	TOTAL	**20**	**08**	**04**	**20**	**06**	**01**	**27**

1 hour tutorial class-wise #02 hours batch-wise

Course Code	Course Name	Examination Scheme – Semester V							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX501	Micro-controllers and Applications	20	20	20	80	03	---	---	100
ELX 502	Digital Communication	20	20	20	80	03	---	---	100
ELX 503	Engineering Electromagnetics	20	20	20	80	03	25	---	125
ELX 504	Design with Linear Integrated Circuits	20	20	20	80	03	---	---	100
ELX 505	Business Communication & Ethics	---	---	---	---	---	50	---	50
ELX DLO501X	Department Level Elective-I	20	20	20	80	03	---	---	100
ELXL501	Micro-controllers and Applications Lab.						25	25	50
ELXL 502	Digital Communication Lab.						25	---	25
ELXL 503	Design with Linear Integrated Circuits Lab.						25	25	50
ELXL DLO501X	Department Elective I lab						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**175**	**75**	**750**

Course Code	Department Level Optional Course I
ELXDLO5011	Database and Management System
ELXDLO5012	Digital Control system
ELXDLO5013	ASIC Verification
ELXDLO5014	Biomedical Instrumentation

T.E. (Electronics Engineering) – Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX601	Embedded System and RTOS	04	--	---	04	---	---	04
ELX 602	Computer Communication Network	04	--	---	04	---	---	04
ELX 603	VLSI Design	04	--	---	04	---	---	04
ELX 604	Signals and systems	04	--	@01	04	---	01	05
ELXDLO502X	Department Level Optional courses II	04	--	---	04	---	---	04
ELXL601	Embedded System and RTOS Lab.	--	02	--	--	01	---	01
ELXL 602	Computer Communication Network Lab.	--	02	--	--	01	--	01
ELXL 603	VLSI Design Lab.	--	02	--		01	---	01
ELXLDLO601X	Department Level Optional courses IILab.	--	02	--		01	---	01
TOTAL		**20**	**08**	**01**	**20**	**04**	**01**	**25**

Course Code	Course Name	Examination Scheme – Semester VI							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX601	Embedded System and RTOS	20	20	20	80	03	---	---	100
ELX 602	Computer Communication Network	20	20	20	80	03	---	---	100
ELX 603	VLSI Design	20	20	20	80	03	---	---	100
ELX 604	Signals and systems	20	20	20	80	03	25	25	100
ELXDLO602X	Department Level Optional courses II*	20	20	20	80	03	---	---	100
ELXL601	Embedded System and RTOS Lab.						25	25	50
ELXL 602	Computer Communication Network Lab.						25	25	50
ELXL 603	VLSI Design Lab.						25	25	50
ELXLDLO602X	Department Level Optional Courses II*Lab.						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**125**	**125**	**750**

Course Code	Department Level Optional Course II
ELXDLO6021	Microwave Engineering
ELXDLO6022	Electronics Product Design
ELXDLO6023	Wireless Communication
ELXDLO6024	Computer Organization and Architecture

B.E. (Electronics Engineering) – Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX701	Instrumentation System Design	04	--	---	04	---	---	04
ELX702	Power Electronics	04	--	---	04	---	---	04
ELX703	Digital signal processing	04	--	---	04	---	---	04
ELXDLO703X	Department Level Optional course III	04	--	---	04	---	---	04
ILO701X	Institute Level Optional Course I#	03	---	---	03	---	---	03
ELXL701	Instrumentation System Design Lab.		02			01	---	01
ELXL702	Power Electronics Lab.		02			01	---	01
ELXL703	Digital signal processing Lab.		02			01	---	01
ELXL704	Project-I	---	06	---	---	03	---	03
ELXLDLO703 X	Dept. Level Optional course III Lab.		02			01	---	01
	TOTAL	**19**	**14**	**---**	**19**	**07**	**---**	**26**

Course Code	Course Name	Examination Scheme – Semester VII							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX701	Instrumentation System Design	20	20	20	80	03	---	---	100
ELX 702	Power Electronics	20	20	20	80	03	---	---	100
ELX 703	Digital signal processing	20	20	20	80	03	---	---	100
ELXDLO703X	Department Level Optional courses III*	20	20	20	80	03	---	---	100
ILO701X	Institute Level Optional Subject	20	20	20	80	03	---	---	100
ELXL701	Instrumentation System Design Lab.						25	25	50
ELXL702	Power Electronics Lab.						25	25	50
ELXL703	Digital signal processing Lab.						25	25	50
ELXL704	Project-I	---	---	---	---	---	50	50	100
ELXLDLO703 X	Dept. Level Optional courses III Lab.						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**150**	**150**	**800**

B.E. (Electronics Engineering) – Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX801	Internet of Things	04	--	---	04	---	---	04
ELX 802	Analog and Mixed VLSI Design	04	--	---	04	---	---	04
ELXDLO804X	Department Level Optional course IV	04	--	---	04	---	---	04
ILO802X	Institute Level Optional course II#	03	---	---	03	---	---	03
ELXL801	Internet of Things Lab.		02			01	---	01
ELXL802	Analog and Mixed VLSI Design Lab.		02			01	---	01
ELXL803	Project-II	---	12	---	---	06	---	06
ELXLDLO804X	Department Level Optional Courses IV Lab.		02			01	---	01
	TOTAL	**15**	**18**	**---**	**15**	**9**	**---**	**24**

Course Code	Course Name	Examination Scheme – Semester VIII							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX801	Internet of Things	20	20	20	80	03	---	---	100
ELX 802	Analog and Mixed VLSI Design	20	20	20	80	03	---	---	100
ELXDLO804X	Department Level Optional course IV	20	20	20	80	03	---	---	100
ILO802X	Institute Level Optional course II	20	20	20	80	03	---	---	100
ELXL801	Internet of Things Lab.						25	25	50
ELXL802	Analog and Mixed VLSI Design Lab.						25	25	50
ELXL803	Project-II	---	---	---	---	---	100	50	150
ELXLDLO804X	Department Level Optional Courses IV Lab.						25	25	50
Total		**80**	**80**	**80**	**320**	**15**	**150**	**150**	**700**

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I#
ELXDLO7031	Neural Network and Fuzzy Logic	ILO7011	Product Lifecycle Management
ELXDLO7032	Advance Networking Technologies	ILO7012	Reliability Engineering
ELXDLO7033	Robotics	ILO7013	Management Information System
ELXDLO7034	Integrated Circuit Technology	ILO7014	Design of Experiments
		ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II#
ELXDLO8041	Advanced Power Electronics	ILO8021	Project Management
ELXDLO8042	MEMS Technology	ILO8022	Finance Management
ELXDLO8043	Virtual Instrumentation	ILO8023	Entrepreneurship Development and Management
ELXDLO8044	Digital Image Processing	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX 501	Microcontrollers and Applications	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ELX 501	Microcontrollers &Applications	20	20	20	80	03	--	--	-	--	100

Course Code	Course Name	Credits
ELX 501	**Microcontrollers and Applications**	04
Course Objectives	To study 8-bit microcontroller architecture for system design along with exposure to advanced 32-bit architecture.	
Course Outcomes	1. Explain 8051 microcontroller architecture. 2. Develop assembly language programmes for 8051 microcontroller. 3. Design and implement 8051 based systems. 4. Explain advanced features of Cortex-M3 architecture.	

Module		Contents	Time
1.		**8051 Microcontroller Architecture**	04
	1.1	Introduction to microcontroller.	
	1.2	Overview of MCS51 family.	
	1.3	8051 architectural features.	
	1.4	Memory organisation.	
2.		**8051 Microcontroller assembly language programming**	10
	2.1	Addressing modes of 8051.	
	2.2	Instruction Set: Data transfer, Arithmetic, Logical, Branching.	
	2.3	Assembly Language Programming.	
3.		**8051 Internal Hardware & Programming**	10
	3.1	I/O port structure and programming.	
	3.2	Interrupts and programming.	
	3.3	Timer/Counter and programming.	
	3.4	Serial port and programming.	
4.		**8051 Interfacing & Applications**	12
	4.1	Display interfacing: 7-segment LED display, 16x2 generic alphanumeric	

		LCD display.	
	4.2	Keyboard interfacing: 4x4 matrix keyboard.	
	4.3	Analog devices interfacing: 8-bit ADC/DAC, temperature sensor (LM35).	
	4.4	Motor interfacing: Relay, dc motor, stepper motor and servo motor.	
5.		**ARM CORTEX-M3 Architecture**	**12**
	5.1	Comparison of CISC & RISC architectures, overview of ARM family.	
	5.2	ARM Cortex-M3 architecture, Programmer's model: Operation Modes and States, registers, special registers, Application Program Status Register-Integer status flags, Q status flag, GE bits.	
	5.3	Memory system: Features and memory map	
	5.4	Exceptions and Interrupts-Nested vectored interrupt controller	
		Total	**48**

Text books:

1.M. A. Mazidi, J. C. Mazidi, Rolin D. McKinlay,"The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, 2ndEdition.

2.Joseph Yiu,"The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors", Elsevier, 2014, 3rd Edition.

Reference Books:

1.Kenneth J. Ayala,"The 8051 Microcontroller", Cengage Learning India Pvt. Ltd, 3rdEdition.

2.David Seal, "ARM Architecture", Reference Manual (2nd Edition), Publisher Addison Wesley.

3.Andrew Sloss, Dominic Symes, Chris Wright,"ARMSystem Developers Guide: Designing and Optimising System Software", Publisher Elsevier Inc. 2004.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total of 4 questions.
3. Question No.1 will be compulsory and based on the entire syllabus.
4. Remaining question (Q.2 to Q.6) will be set from all the modules.
5. Weightage of marks, commensurate with the time allocated to the respective module.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 502	Digital Communication	4	--	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX 502	Digital Communication	20	20	20	80	-	--	--	100

Course Pre-requisite: ELX405 Principles of Communication Engineering

Course Objectives:

The objectives of this course are to:

1. Understand the typical subsystems of a digital communication system
2. Understand the significance of the trade-off between SNR and Bandwidth
3. Understand the effect of ISI in Baseband transmission of a digital signal.
4. Analyze various Digital modulation techniques
5. Identify the necessity of Source encoding and Channel encoding in Digital communication

Course Outcomes:

On successful completion of the course the students will be able to:

1. Comprehend the advantages of digital communication over analog communication and explain need for various subsystems in Digital communication systems
2. Realize the implications of Shannon-Hartley Capacity theorem while designing the efficient Source encoding technique.
3. Understand the impact of Inter Symbol Interference in Baseband transmission and methods to mitigate its effect
4. Analyze various Digital modulation methods and assess them based on parameters such as spectral efficiency , Power efficiency, Probability of error in detection
5. Explain the concept and need for designing efficient Forward Error Correcting codes.
6. Realize the areas of application of Digital communication.

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to Digital communication system:**	06
	1.1	A typical Digital communication system, Advantages and disadvantages of Digital transmission, significance of digitization: PCM encoding of voice and image signals.	
	1.2	**Concept of Probability Theory in Communication Systems:** Random variables, Mean and Variance of Random variables and sum of random variables ,Definition with examples,	
	1.3	**Useful PDFs & CDFs** :Gaussian, Rayleigh pdf & Rician Distribution, Binomial Distribution, Poisson Distribution, Central-Limit Theorem, Binary Synchronous Channel(BSC), development of Optimal receiver	
2.		**Information Theory and Source Coding**	06
	2.1	Measure of Information, Entropy, Information rate, Channel capacity, Shannon – Hartley Capacity Theorem and its Implications.	
	2.2	Shannon-Fano encoding, Huffman encoding , Code Efficiency & Redundancy.	
3.		**Pulse Shaping for Optimum Transmission:**	08
	3.1	Line codes and their desirable properties, PSD of digital data	
	3.2	Baseband PAM transmission: Concept of Inter symbol interference(ISI),Raised Cosine filter , Nyquist Bandwidth. Concept of equalizer to overcome ISI	
	3.3	Correlative coding: Duo-binary encoding and modified duo-binary encoding	
4.0		**Digital Modulation Techniques**	14
	4.1	Concept of Binary and M-ary transmission, Coherent and Non- Coherent reception, Power spectral density of Pass-band signal, Signal space Representation and Euclidian distance	
	4.2	Pass Band Amplitude modulation & Demodulation: BASK , M-ary PAM ,Digital Phase Modulation & Demodulation: BPSK, OQPSK, QPSK, M-ary PSK, QAM , Digital Frequency Modulation &Demodulation :BFSK, MSK , M-ary FSK	
	4.3	Comparison of all techniques based on Spectral efficiency, Power efficiency, Probability of error in detection	
	4.4	**Optimal Reception of Digital Data**: A baseband signal receiver and its Probability of error, The Optimum receiver, Matched filter, & its properties.	
5.0		**Error Control codes:**	10
	5.1	Need for channel encoding, Concept of Error detection and correction , Forward Error	

		correction	
	5.2	**Linear block codes** : Hamming Distance, Hamming Weight, Systematic codes ,Syndrome Testing	
	5.3	**Cyclic codes**; Generator polynomial for Cyclic codes, Systematic cyclic codes, Feedback shift register for Polynomial division	
	5.4	**Convolution codes**: Convolution encoder , Impulse response of encoder, State diagram, trellis diagram Representations	
6.0		**Applications of Digital communication**	06
	6.1	**Satellite communication system** : Satellite communication System model, Transponder ,Satellite Orbits : LEO, MEO, GEO , Link analysis	
	6.2	**Optical Communication system** : Advantages of Optical communication ,Signal transmission in Optical fibres, Optical sources and Optical Detectors, Optical Digital Communication system.	
		Total	**48**

Recommended Text Books:

1. Simon Haykin, "*Communication System*", John Wiley And Sons ,4th Ed
2. Taub Schilling & Saha, "*Principles Of Communication Systems*", Tata Mc-Graw Hill, Third Ed
3. B P Lathi & Zhi Ding ,"*Modern Digital and Analog communication systems" -4E,* Oxford University Press , Indian Ed.
4. R N Mutagi, "*Digital Communication"*, Oxford University Press, 2nd Ed.

Reference Books:

1. Bernad Sklar,- "Digital communication", Pearson Education, 2nd Ed.
2. Simon Haykin, "Digital communication", John wiley and sons
3. PROAKIS & SALEHI, "Communication system Engineering", Pearson Education.
4. Anil K.Maini & Varsha Agarwal, "Satellite communications", Wiley publication.
5. Amitabha Bhattacharya, "*Digital Communication*", Tata Mcgraw Hill

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX503	Electromagnetic Engineering	20	20	20	80	--	--	--	100

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX503	Electromagnetic Engineering	20	20	20	80	--	--	--	100

Course Objectives:

1. To study correlation between electrostatics, steady magnetic field and time varying fields using Maxwell's equations for different media.
2. To calculate energy transported by means of electromagnetic waves from one point to another and to study polarization of waves.
3. To solve electromagnetic problems using different numerical methods.
4. To extend the students' understanding about the propagation of the waves of different types.
5. To understand the radiation concepts.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Analyze the behaviour of electromagnetic waves in different media.
2. Evaluate various parameters of transmission lines and radiating systems.
3. Apply computational techniques to analyze electromagnetic field distribution.
4. Understand different mechanisms of radio wave propagation.

Module No.	Unit No.	Topics	Hrs.
1.0		**Basic Laws of Electromagnetic and Maxwell's Equations**	10
	1.1	Coulomb's law, Gauss's law, Bio-Savart's law, Ampere's law, Poisson's and Laplace equations	
	1.2	**Maxwell's Equations:** Integral and differential form for static and time varying fields and its interpretations	
	1.3	Boundary conditions for Static electric and magnetic fields	
2.0		**Electromagnetic Waves**	12
	2.1	Wave Equation and its solution in partially conducting media(lossy dielectric), perfect dielectrics, free space and good conductors, Skin Effect and concept of Skin depth	
	2.2	**Polarization of wave:** Linear, Circular and Elliptical	
	2.3	**Electromagnetic Power:** Poynting Vector and Power Flow in free space, dielectric and conducting media	
	2.4	**Propagation in different media:** Behavior of waves for normal and oblique incidence in dielectrics and conducting media, propagation in dispersive media	

3.0		**Computational Electromagnetics**	06
	3.1	**Finite Difference Method (FDM):** Neumann type and mixed boundary conditions, Iterative solution of finite difference equations, solutions using band matrix method	
	3.2	**Finite Element Method (FEM)**: triangular mesh configuration, finite element discretization, element governing equations, assembling all equations and solving resulting equations	
	3.3	**Method of Moment (MOM):** Field calculations of conducting wire	
4.0		**Fundamentals of Radiating Systems**	06
	4.1	Concept of retarded potentials, Lorentz Condition	
	4.2	Radiation from an alternating current element, half-wave dipole and quarter-wave monopole	
	4.3	**Antenna Parameters:** Radiation Patterns, beam-width, Radiation intensity, directivity, power gain, band-width, radiation resistance and efficiency, effective length and effective area	
5.0		**Radio wave propagation**	06
	5.1	**Types of wave propagation:** Ground, space, and surface wave propagation	
	5.2	**Space wave propagation:** Effect of imperfection of earth, curvature of earth, effect of interference zone, Line of sight propagation, troposphere propagation and fading	
	5.3	**Sky wave propagation:** Reflection and refraction of waves, structure of Ionosphere	
	5.4	**Measures of ionosphere propagation:** Critical frequency, Angle of incidence, Maximum usable frequency, Skip distance, Virtual height	
6.0		**Transmission Lines**	08
	6.1	Transmission Line parameters and equivalent circuit Transmission line equation and solution	
	6.2	**Secondary Parameters:** Propagation constant, characteristic impedance, reflection and transmission coefficient, Input Impedance, SWR, introduction to Smith chart	
		Total	**48**

Recommended Books:

1. W.H. Hayt, and J.A. Buck, "*Engineering Electromagnetics*", McGraw Hill Publications, 7th Edition, 2006
2. R.K. Shevgaonkar, "*Electromagnetic Waves*", TATA McGraw Hill Companies, 3rd Edition, 2009
3. Edward C. Jordan and Keth G. Balmin, "*Electromagnetic Waves and Radiating Systems*", Pearson Publications, 2nd Edition, 2006
4. Matthew N.D. Sadiku, "*Principles of Electromagnetics*", Oxford International Student 4th Edition, 2007
5. J.D. Kraus, R.J. Marhefka, and A.S. Khan, "*Antennas & Wave Propagation*", McGraw Hill Publications, 4th Edition, 2011

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pract	Tutorial	Total
ELX504	Design with Linear Integrated Circuits	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Prac.	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELX504	Design with Linear Integrated Circuits	20	20	20	80	--	--	--	100

Course Pre-requisite:

- Electronic Devices and Circuits I and II

Course Objectives:

1. To teach fundamental principles of standard linear integrated circuits.
2. To develop a overall approach for students from selection of integrated circuit, study its specification, the functionality, design and practical applications

Course Outcomes:

After successful completion of the course student will be able to

1. demonstrate an understanding of fundamentals of integrated circuits.
2. analyze the various applications and circuits based on particular linear integrated circuit.
3. select and use an appropriate integrated circuit to build a given application.
4. design an application with the use of integrated circuit

Module No.	Unit No.	Topics	Hrs.
1	**Fundamentals of Operational Amplifier**		04
	1.1	Ideal Op Amp, characteristics of op-amp, op-amp parameters, high frequency effects on op-amp gain and phase, slew rate limitation, practical determination of op-amp parameters, single supply versus dual supply op-amp	
	1.2	Operational amplifier open loop and closed loop configurations, Inverting and non-inverting amplifier	
2	**Applications of Operational Amplifier**		12
	2.1	**Amplifiers:** Adder, subtractor, integrator, differentiator, current amplifier, difference amplifier, instrumentation amplifier and application of Op-Amp in Transducer Measurement System with detail design Procedure. Single supply dc biasing techniques for inverting, non inverting and differential amplifiers.	
	2.2	**Converters:** Current to voltage converters, voltage to current converters, generalized impedance converter	
	2.3	**Active Filters:** First order filters, Second order active finite and infinite gain low pass, high pass, band pass and band reject filters.	
	2.4	**Sine Wave Oscillators:** RC phase shift oscillator, Wien bridge oscillator,	

		Quadrature oscillator.	
3	**Non-Linear Applications of Operational Amplifier**		10
	3.1	**Comparators:** Inverting comparator, non-inverting comparator, zero crossing detector, window detector and level detector.	
	3.2	**Schmitt Triggers:** Inverting Schmitt trigger, non-inverting Schmitt trigger with adjustable threshold levels.	
	3.3	**Waveform Generators:** Square wave generator and triangular wave generator with duty cycle modulation**.**	
	3.4	**Precision Rectifiers:** Half wave and full wave precision rectifiers and their applications.	
	3.5	Peak Detectors, Sample & Hold Circuits, voltage to frequency converter, frequency to voltage converter, logarithmic converters and antilog converters	
4	**Data Converters**		06
	4.1	**Analog to Digital**: Performance parameters of ADC, Single Ramp ADC, ADC using DAC, Dual Slope ADC, Successive Approximation ADC, Flash ADC, ADC0808/0809 and its interfacing	
	4.2	**Digital to Analog**: Performance parameters of DAC, Binary weighted register DAC, R/2R ladder DAC, Inverted R/2R ladder DAC, DAC0808 and its interfacing	
5	**Special Purpose Integrated Circuits**		08
	5.1	Functional block diagram, working, design and applications of Timer 555.	
	5.2	Functional block diagram, working and applications of VCO 566, PLL 565, multiplier 534, waveform generator XR 2206, power amplifier LM380.	
6	**Voltage Regulators**		08
	6.1	Functional block diagram, working and design of three terminal fixed (78XX, 79XX series) and three terminal adjustable (LM 317, LM 337) voltage regulators.	
	6.2	Functional block diagram, working and design of general purpose 723 (LVLC, LVHC, HVLC and HVHC) with current limit and current fold-back protection, Switching regulator topologies, Functional block diagram and working of LT1070 monolithic switching regulator.	
		Total	**48**

Recommended Books:

1. Sergio Franco, "*Design with operational amplifiers and analog integrated circuits*", Tata McGraw Hill, 3rd Edition.
2. William D. Stanley, "*Operational Amplifiers with Linear Integrated Circuits* ", Pearson, 4th Edition
3. D. Roy Choudhury and S. B. Jain, "*Linear Integrated Circuits*", New Age International Publishers, 4th Edition.
4. David A. Bell, "*Operation Amplifiers and Linear Integrated Circuits*", Oxford University Press, Indian Edition.
5. Ramakant A. Gayakwad, "*Op-Amps and Linear Integrated Circuits*", Pearson Prentice Hall, 4th Edition.
6. R. P. Jain, "*Modern Digital Electronics*," Tata McGraw Hill, 3rd Edition.
7. Ron Mancini, "*Op Amps for Everyone*", Newnes, 2nd Edition.
8. J. Millman and A. Grabel, "*Microelectronics*", Tata McGraw Hill, 2nd Edition.
9. R. F. Coughlin and F. F. Driscoll, "*Operation Amplifiers and Linear Integrated Circuits*", Prentice Hall, 6th Edition.
10. J. G. Graeme, G. E. Tobey and L. P. Huelsman, "*Operational Amplifiers- Design & Applications*", NewYork: McGraw-Hill, Burr-Brown Research Corporation.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final internal assessment.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory preferably objective type and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO5011	Database Management System	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELX DLO5011	Database Management System	20	20	20	80	--	--	--	100

Prerequisite:

Basic knowledge of Data structure.

Course objectives:

1. Learn and practice data modelling using the entity-relationship and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.
3. Apply normalization techniques to normalize the database
4. Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.

Course outcomes: On successful completion of course learner will be able to:

1. Understand the fundamentals of a database systems
2. Design and draw ER and EER diagram for the real life problem.
3. Convert conceptual model to relational model and formulate relational algebra queries.
4. Design and querying database using SQL.
5. Analyze and apply concepts of normalization to relational database design.
6. Understand the concept of transaction, concurrency and recovery.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction Database Concepts:**	**4**
	1.1	Introduction, Characteristics of databases File system v/s Database system Users of Database system	4

	1.2	Data Independence DBMS system architecture Database Administrator	
2.0		**Entity–Relationship Data Model**	8
	2.1	The Entity-Relationship (ER) Model: Entity types : Weak and strong entity sets, Entity sets, Types of Attributes, Keys, Relationship constraints : Cardinality and Participation, Extended Entity-Relationship (EER) Model : Generalization, Specialization and Aggregation	
3.0		**Relational Model and relational Algebra**	8
	3.1	Introduction to the Relational Model, relational schema and concept of keys. Mapping the ER and EER Model to the Relational Model	
	3.2	Relational Algebra – unary and set operations , Relational Algebra Queries.	
4.0		**Structured Query Language (SQL)**	12
	4.1	Overview of SQL Data Definition Commands, Data Manipulation commands, Data Control commands, Transaction Control Commands.	
	4.2	Set and string operations, aggregate function - group by, having.Views in SQL, joins , Nested and complex queries, Integrity constraints :- key constraints, Domain Constraints, Referential integrity , check constraints	
	4.3	Triggers	
5.0		**Relational–Database Design**	8
	5.1	Pitfalls in Relational-Database designs , Concept of normalization Function Dependencies , First Normal Form, 2nd , 3rd , BCNF, multi valued dependencies , 4NF.	
6.0		**Transactions Management and Concurrency**	12
	6.1	Transaction concept, Transaction states, ACID properties Concurrent Executions, Serializability – Conflict and View, Concurrency Control: Lock-based, Timestamp-based protocols.	

	6.2	Recovery System: Failure Classification, Log based recovery, ARIES, Checkpoint, Shadow paging. Deadlock handling	
		Total	**52**

Text Books:

1. G. K. Gupta "Database Management Systems", McGraw – Hill.
2. Korth, Slberchatz,Sudarshan, "Database System Concepts", 6th Edition, McGraw – Hill
3. Elmasri and Navathe, "Fundamentals of Database Systems", 5th Edition, Pearson education.
4. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.

Reference Books:

1. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
2. Gillenson, Paulraj Ponniah, " Introduction to Database Management", Wiley Publication.
3. Sharaman Shah, "Oracle for Professional", SPD.
4. Raghu Ramkrishnan and Johannes Gehrke, " Database Management Systems ",TMH.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO5012	Digital Control Systems	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme								
		Theory					Term work	Pract.	Oral	Total
		Internal Assessment			End sem	Duration (hrs)				
		Test 1	Test 2	Avg						
ELX DLO5012	Digital Control Systems	20	20	20	80	03	--	--	--	100

Course Pre-requisite: ELX301: Mathematics III , ELX401: Mathematics IV, ELX406: Linear Control Systems

Course Objectives:

1. To introduce the discrete-time systems theory.
2. To introduce Z-transform methods in digital systems design.
3. To introduce modern state-space methods in digital systems design.

Course Outcomes : At the end of the course, the learner will have the ability to

1. Justify the need for digital control systems as well as understand sampling and reconstruction of analog signals.
2. Model the digital systems using various discretization methods and understand the concept of Pulse Transfer Function.
3. Analyze the digital control systems using classical techniques.
4. Analyze the digital control systems using modern state-space techniques.
5. Understand the concept of controllability and design the state feedback controllers.
6. Understand the concept of observability and design the state observers.

Module		Contents	Time
1.		**Basics of discrete-time signals and discretization**	06
	1.1	Why digital control system? Advantages and limitations, comparison of continuous and discrete data control, block diagram of digital control system.	
	1.2	Impulse sampling. Nyquist-Shannon sampling theorem, reconstruction of discrete-time signals (ideal filter)	
	1.3	Realizable reconstruction methods (ZOH and FOH). Transfer function of ZOH and FOH.	
2.		**Modelling of Digital Control System**	10
	2.1	Discretization Approaches: Impulse invariance, step invariance, bilinear transformation, finite difference approximation of derivative.	
	2.2	Z-transform revision and its equivalence with starred Laplace transform.	
	2.3	The pulse transfer function (PTF) and general procedures to obtain PTF.	
3.		**Stability Analysis and Controller Design via Conventional Methods**	12
	3.1	Mapping between s-plane and z-plane, stability analysis of digital systems	

		in z-plane. Effects of sampling frequency on stability.	
	3.2	Transient and steady-state analysis of time response, digital controller design using root-locus method.	
	3.3	Digital controller design using bode plots, digital PID controller.	
	3.4	Realization of digital controllers: direct programming, standard programming, series programming, parallel programming, ladder programming,	
4.		**State Space Analysis of Discrete-time Systems**	08
	4.1	Revision of continuous-time state-space models. Solution of continuous-time state-space equation. Discretization of continuous-time state-space solution and discrete-time state-space model.	
	4.2	Various canonical state-space forms for discrete-time systems and transformations between state-space representations.	
	4.3	Solution of discrete-time state-space equation. Computation of state-transition matrix (z-transforms, Caley-Hamilton theorem, Diagonalization).	
5.		**Controllability and State Feedback Controller Design**	06
	5.1	Concept of controllability. Distinction between reachability and controllability in discrete-time systems.	
	5.2	Digital controller design using pole-placement methods. (Similarity transforms, Ackerman's formula).	
6.		**Observability and Observer Design**	06
	6.1	Concept of observability. Distinction between detectability and observability in discrete-time systems.	
	6.2	Observer design (prediction observer and current observer). Output feedback controller design. Introduction to separation principle.	
	6.3	Dead-beat controller design, dead-beat observer design.	
Total			**48**

Text books:

1. **Ogata Katsuhiko**, "Discrete-time Control Systems", Pearson, 2nd Edition, 1995.
2. **M. Gopal**, "Digital Control and State Variable Methods", Tata McGrow-Hill, 3rd Edition, 2003.

Reference Books:

1. **Gene Franklin, J. David Powell, Michael Workman**, "Digital Control of Dynamic Systems", Addison Wesley, 3rd Edition, 1998.
2. **B. C. Kuo**, "Digital Control Systems", Oxford University press, 2nd edition, 2007.
3. **Chi-Tsong Chen**, "Linear System Theory and Design", Oxford University Press, USA, 1998.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO5013	ASIC Verification	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme								
		Theory					Term work	Pract.	Oral	Total
		Internal Assessment			End sem	Duration (hrs)				
		Test 1	Test 2	Avg						
ELX DLO5013	ASIC Verification	20	20	20	80	03	--	--	--	100

Course Pre-requisite: EXC303: Digital Circuits and Design, ELXL304: Object Oriented Programming Methodology Laboratory, ELX 404: Digital System Design

Course Objectives

1. To introduce the learner System Verilog concepts for verification.
2. To introduce the learner advanced verification features such as practical use of classes, randomization, checking and coverage.
3. To highlight the significance of verification in VLSI industry.

Course Outcomes

At the end of the course, the learner will have the ability to

1. Demonstrate an understanding of programmable devices and verification methodologies.
2. Exploit new constructs in SV and advanced ASIC verification techniques.
3. Create test benches for digital designs in system verilog.
4. Carry out verification of design successfully using simulators

Module		Contents	Time
1.		**Programmable Devices and Verilog**	08
	1.1	**Programmable Devices:** Architecture of FPGA, CPLD with an example of Virtex-7 and Spartan -6 family devices	
	1.2	**Verilog HDL:** Data types, expressions, assignments, behavioural, gate and switch level modelling, tasks and functions	
2.		**Verification Basics and Data Types**	12
	2.1	**Verification Basics:** Technology challenges, Verification methodology options, Test bench creation, test bench migration, Verification languages, Verification IP reuse, Verification approaches, Layered Testbench, Verification plans	
	2.2	**Data Types:** Built in, Fixed size array, dynamic array, queues, associative array, linked list, array methods, choosing a storage type, creating new types with typedef, creating user defined structures, type conversion, enumerated types, constants, strings, expression width	
3.		**Procedural statements, test bench and Basic OOP**	12
	3.1	**Procedural Statements and Routines:** Procedural statements, tasks, functions and void functions, task and function overview, routine arguments, returning from a	

		routine, local data storage, time values **Connecting the Test bench and Design:** Separating the test bench and design, the interface construct, stimulus timing, interface driving and sampling, connecting it all together, top level scope, program-module interactions	
	3.2	**Basic OOP:** Class, Creating new objects, Object deal location, using objects, variables, class methods, defining methods outside class, scoping rules, using one class inside another, understanding dynamic objects, copying objects, public vs. local, building a test bench	
4.		**Randomization and IPC**	**10**
	4.1	**Randomization:** Randomization in system Verilog, constraint details, solution probabilities, controlling multiple constraint blocks, valid constraints, In-line constraints, The pre-randomize and post-randomize functions, Random number functions, Constraints tips and techniques	
	4.2	**Threads and Inter process Communication:** working with threads, disabling threads, inter process communication, events, semaphores, mailboxes, building a test bench with threads and IPC	
5.		**Assertions and Functional Coverage**	**06**
	5.1	**System Verilog Assertions:** Assertions in verification methodology, Understanding sequences and properties	
	5.2	**Functional Coverage:** Coverage types, strategies, examples, anatomy of a cover group, triggering a cover group, data sampling, cross coverage, generic cover groups, coverage options	
		Total	**48**

Text books:

1. **Chris Spear**, “System Verilog for Verification: A guide to learning the testbench language features”, Springer, 3rd Edition.
2. **Janick Bergeron**, “Writing Testbenches Using System Verilog”, Springer 2006.
3. **Stuart Sutherland, Simon Davidmann, and Peter Flake**, “System Verilog for Design: A guide to using system verilog for hardware design and modeling”, Springer, 2nd Edition.

Reference Books:

1. Ben Cohen, Srinivasan Venkataramanan, Ajeetha Kumari and Lisa Piper, “SystemVerilog Assertions Handbook”, VhdlCohen Publishing, 3rd edition
2. S Prakash Rashinkar, Peter Paterson and Leena Singh, “System on Chip Verification Methodologies and Techniques”, Kluwer Academic, 1st Edition.
3. System Verilog Language Reference manual
4. Samir Palnitkar, ”Verilog HDL: A guide to Digital Design and Synthesis” second edition,Pearson – IEEE 1364-2001 compliant.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO5014	Biomedical Instrumentation	04	02	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELX DLO5014	Biomedical Instrumentation	20	20	20	80	03	--	--	--	--	100

Course Objectives

1. Introduce the learners to basic physiology and function of various systems in human body.
2. Introduce the learners to Diagnostic, Pathology, Life supportive equipment and latest imaging modalities in hospitals and healthcare industry.
3. Motivate learners to take up live projects with medical applications which will benefit the society at large.

Course Outcomes

- Have basic knowledge about the basic structure and functions of parts of cell, generation of action potential and various bioelectric potentials.
- Builds foundation of knowledge of physiological processes such as respiratory, cardiovascular, nervous and muscular systems in human body.
- Compare various methods used for measurement of various cardiac parameters such as blood pressure, blood flow, blood volume, cardiac output and heart sounds.
- Know the basic principle of analytical instruments and will have an over view of pathology laboratory equipments such as colorimeter, spectrophotometer, blood cell counter and auto-analyser.
- Have knowledge of life support equipments such as pacemaker, defibrillator, Heart lung machine, Haemodialysis machine and baby incubator along with safety limits of micro and macro shocks and understand the importance of electrical safety in hospital equipments.

  Have knowledge of imaging modalities such as X-ray, CT, MRI and Ultrasound.

Module		Contents	Time
1.		**Bio-Potential measurements**	06
	1.1	**Human Cell** Structure of Cell, Origin of Bio-potentials, Generation of Action Potentials,.	
	1.2	**Electrodes** Electrode-Electrolyte interface and types of bio-potential electrodes	
2.		**Physiological Systems and Related Measurement**	12
	2.1	**Cardiovascular system** Structure of Heart, Electrical and Mechanical activity of Heart, ECG measurements and Cardiac arrhythmias, Design of ECG amplifier, Heart sounds measurement.	

	2.2	**Nervous system** CNS and PNS: Nerve cell, Neuronal Communication, Generation of EEG and its measurement. Normal and abnormal EEG, Evoked potential. Electroencephalography: EEG measurements, Electrode-placement and Block diagram of EEG machine	
	2.3	**Respiratory system** Physiology of respiration and measurements of respiratory related parameters like respiration rate, Lung Volumes and capacities	
	2.4	**Muscular system** Typical Muscle fibre Action potential Electromyography: EMG measurement and block diagram.	
3.		**Cardio-Vascular measurements**	**08**
	3.1	Blood Pressure- Direct and Indirect types.	
	3.2	Blood Flow- Electromagnetic and Ultrasonic type.	
	3.3	Blood Volume- Plethysmography: Impedance, Capacitive and Photoelectric type	
	3.4	Cardiac Output- Fick's method, Dye-dilution and Thermo-dilution type.	
4.		**Analytical equipment**	**05**
	4.1	Beer Lambert's law, Principle of photometry.	
	4.2	Photo-colorimeter : Optical diagram	
	4.3	Spectrophotometer : Optical diagram	
	4.5	Blood cell counter : Coulter's counter	
	4.6	Auto-analyser : Schematic diagram	
5.		**Life-saving and Support equipment**	**09**
	5.1	Pacemaker- Types of Pacemaker, Modes of pacing and its applications.	
	5.2	Defibrillator-Types of fibrillations, Modes of operation, DC Defibrillators and their applications.	
	5.3	Heart-Lung machine: System-flow diagram and its Application during surgery.	
	5.4	Haemodialysis machine: Principle of operation and System-flow diagram.	
	5.5	Baby Incubator and its applications	
	5.6	**Patient safety** Physiological effects of electrical current, Shock Hazards from electrical equipments and methods of accident prevention	
6.		**Imaging techniques**	**08**
	6.1	X-Ray- Generation, X-ray tube and its control, X-ray machine and its applications	
	6.2	CT Scan- CT Number, Block Diagram, scanning system and applications.	
	6.3	MRI- Concepts and image generation, block diagram and its applications	
	6.4	Ultrasound Imaging- Modes of scanning and their applications	
		Total	**48**

Text books:

1. Handbook of Biomedical Instrumentation: R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)

Reference Books:

1. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
2. Various Instruments Manuals.
3. Various internet resources.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

Question paper will comprise of 6 questions, each carrying 20 marks.
The Learners need to solve total 4 questions.
Question No.1 will be compulsory and based on entire syllabus.
Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
ELXL 501	Microcontrollers & Applications Laboratory	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ELXL501	Microcontrollers &Applications Laboratory	--	--	--	--	--	25	--	--	25	50

Assessment:

Term Work:

At least **SIX** experiments based on the entire syllabus of **ELX 501 (Microcontrollers and Applications)** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time. Term work must include a mini project in addition to the number of experiments. The course mini-project is to be undertaken in a group of two to three students.**

The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

The final certification and acceptance of term work ensures satisfactory performance of laboratory work, mini project and minimum passing marks in term work. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced. Practical and Oral exam will be based on the entire syllabus.

Suggested experiments:

- Maximum three experiments in X – 51 assembly programming involving arithmetic, logical, Boolean, code-conversion etc operations.
- Minimum three experiments on interfacing of X – 51 based system with peripheral IC's (ADCs, DACs etc) peripheral actuators (relays, motors etc.) sensors (temperature, pressure etc.).

Suggested mini projects:

- Interfacing single LED/seven-segment display(SSD)/multiple-SSD with refreshing along-with some additional functional feature.
- Interfacing dot matrix LED for message display/ rolling message display.

- Interfacing IR emitter/receiver pair for time-period/speed calculations.
- Interfacing single key/4 – key/4 X 4 matrix keyboard with some additional functional feature.
- Motors – continuous, stepper, servo interfacing with speed(RPM) indication.
- Multi-function alarm clock using buzzer and LCD.
- Interfacing DAC and generating various waveforms.
- Ambient temperature indicator using LM 35 and 8-bit ADC 0808.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL 502	Digital Communication Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL 502	Digital Communication Laboratory	-	-	-	-	25	--	25	50

Laboratory Experiments:

Lab session includes Seven experiments and a Case study(Power point Presentation) on any one of the suggested topics.

1. The experiments will be based on the syllabus contents.

2. Minimum Seven experiments need to be conducted, out of which at least THREE should be software-based

(Scilab, MATLAB, LabVIEW, etc).

3. Each student (in groups of 3/4) has to present a Case study (Power point Presentation) as a part of the laboratory work.

The topics for Presentation / Case-study may be chosen to be any relevant topic on emerging technology.

("Beyond the scope of the syllabus".) Power point presentation should contain minimum of 15 slides and students should submit a report , (PPT+REPORT carry minimum of 10 marks

The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced.

Suggested experiments based on Laboratory setups:

1. Line codes
2. Binary modulation techniques: BASK,BPSK,BFSK
3. M-ary modulation techniques: QPSK ,QAM
4. MSK

Suggested experiments based on software:

1. Simulation of PDF& CDF of Raleigh / Normal/ Binomial Distributions
2. Simulation of Eye pattern for PAM signal
3. Source encoding: Huffman coding for Binary symbols

4. Simulation of Shannon-Hartley equation to find the upper limit on the Channel Capacity
5. Channel Encoding: Linear Block code : code generation, Syndrome
6. Cyclic code-code generation, Syndrome
7. Channel encoding: Convolutional code-code generation from generator sequences
8. Simulation of BPSK/QPSK/BFSK Modulation
9. Simulation of Duo-binary encoder-decoder
10. Plot and compare BER curves for Binary/ M-ary modulation schemes
11. Simulation of error performance of a QPSK/BPSK/MSK Modulator

Suggested topics for presentation:

1. DTH
2. Digital Multiplexing
3. Satellite Launching vehicles: PSLV, GSLV
4. Digital TV
5. Digital Satellite system: VSAT
6. RFID

Any other related and advanced topics.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL504	Design With Linear Integrated Circuits Laboratory	-	2	--	-	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELXL504	Design With Linear Integrated Circuits Laboratory	--	--	--	--	25	25		50

Term Work:

At least Six experiments based on the entire syllabus of Course ELX504 **(Design with Linear Integrated Circuits)** should be set to have well predefined inference and conclusion. Few computation/simulation based experiments are encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time**. The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

A mini project based on the following topic or additional real time applications are encouraged. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments:

1. Experiment on op amp parameters
2. Experiment on design of application using op amp (Linear)
3. Experiment on implementation of op amp application e.g. oscillator
4. Experiment on non linear application (e.g. comparator) of op amp
5. Experiment on non linear application (e.g. peak detector) of op amp
6. Experiment on ADC interfacing
7. Experiment on DAC interfacing
8. Experiment on IC 555

9. Experiment on voltage regulator (Design)
10. Experiment on implementation of instrumentation system (e.g. data acquisition).
    The topic for the mini project in the course based on the syllabus of ELX505(Design with Linear Integrated Circuits)need to be application oriented.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO5011	Database Management Systems Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg						
ELXL DLO5011	Database Management Systems Laboratory	--	--	--	--	25	--	25		50

At least **eight experiments** based on the entire syllabus of **ELXDLO5011 (Data Base Management System)** should be set to have well-defined inference and conclusion. The experiments should be student-centric, and attempt should be made to make experiments more meaningful, interesting and innovative. Experiment must be graded from time to time. Additionally, each student (in group of 2/3) must perform a Mini Project as a part of the laboratory and report of mini project should present in laboratory journal. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced.

Suggested List of Experiments

Expt. No.	Title of the Experiments
1	To analyse the sampling and reconstruction of analog signal.
2	To study various discretization approaches (Impulse Invariance, Step Invariance, Bilinear Transformation)
3	Study of time domain transient and steady-state performance and performance specifications.
4	Digital controller design using Root-locus method.
5	Modelling of discrete-time systems in state-space and conversion to various canonical forms.
6	Discrete-time system simulation in Simulink.
7	Study digital PID controller and its implementation in MATLAB and Simulink.
8	Controllability and Observability of discrete-time systems.

9	Pole placement controller design for discrete-time systems.
10	Design of deadbeat controller and observer.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO5013	ASIC Verification	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg						
ELXL DLO5013	ASIC Verification	--	--	--	--	25	--	25		50

At least **eight** experiments based on the entire syllabus of **ELXDLO5013 (ASIC Verification)** should be set to have well-defined inference and conclusion. The experiments should be student-centric and attempt should be made to make experiments more meaningful, interesting and innovative. Experiment must be graded from time to time. Additionally, each student (in group of 2/3) has to perform a Mini Project as a part of the laboratory and report of mini project should present in laboratory journal. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced.

List of Experiments:

1. Implementation of 4:1 Multiplexer in Verilog with
   a. Gate level Modeling
   b. Structural/ Dataflow Modeling
   c. Behavioral Modeling
2. Implementation of D flip flop (Asynchronous/ Synchronous/latch) using Verilog.
3. Experiment to practice creating dynamic arrays, associative arrays, and queues (Test a synchronous 8-bit x64K (512kBit) RAM).
4. Write a test plan and test bench for ALU Design.
5. Experiment to practice Procedural Statements and Routines using tasks, functions and do-while loops.
6. Create Interfaces to connect the Test bench and Design.
7. Threads & IPC: Implement the following counters
   i. UP counter
   ii. DOWN counter
   iii. Divide by 2 count As threads. Use Fork join, fork join_none, fork_joinany.
8. Threads & IPC - create dynamic processes (threads) and get familiar with interprocess communication using events, semaphore and mailb
9. Functional Coverage - write cover groups and get familiar with the coverage repor
   Verification of FIFO

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO5013	**Biomedical Instrumentation**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg						
ELXL DLO5013	**Biomedical Instrumentation**	--	--	--	--	25	--	25		50

At least **eight** experiments based on the entire syllabus of **ELXDLO5014 (Biomedical Instrumentation)** should be set to have well-defined inference and conclusion. The experiments should be student-centric and attempt should be made to make experiments more meaningful, interesting and innovative. Experiment must be graded from time to time. Additionally, each student (in group of 2/3) has to perform a Mini Project as a part of the laboratory and report of mini project should present in laboratory journal. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced.

Suggested List of Experiments

Expt. No.	Title of the Experiments
1	Study of X-ray Tubes
2	Design of active notch filter for line frequency
3	Design of general purpose amplifier for Bio potential measurement.
4	Design of Pacemaker using 555 timer.
5	Demonstration of Blood pressure measurement.
6	Demonstration of Electrocardiogram recording.
7	Demonstration of Electroencephalogram recording.
8	Demonstration of Electromyogram recording.
9	Demonstration of Photo-Colorimeter.
10	Demonstration of Spectrophotometer.

11	Demonstration of Auto-analyser.
12	Demonstration of Blood Cell counter.
13	Demonstration of D C Defibrillator (proto type).
14	Demonstration of Baby Incubator.
15	Demonstration of X Ray machine.
16	Demonstration of CT scanner.
17	Demonstration of MRI machine.
18	Demonstration of Ultrasound machine.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX 601	Embedded Systems& Real Time Operating System	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELX 601	Embedded Systems& Real Time Operating System	20	20	20	80	03	--	--	--	--	100

Course Objectives

To study concepts involved in embedded hardware and software for systems realisation.

Course Outcomes At the end of the course, the learner will have the ability to

1. Identify and describe various characteristic features and applications of embedded systems.
2. Analyse and identify hardware for embedded systems implementation.
3. Analyse and identify various software issues involved in Embedded systems for real time requirements.
4. Analyse and explain the design life-cycle for embedded system implementation.

Module		Contents	Time
1.		**Introduction to Embedded Systems**	**04**
	1.1	Characteristics and Design metrics of Embedded system.	
	1.2	Real time systems:Need for Real-time systems, Hard-Soft Real-time systems.	
	1.3	Challenges in Embedded system Design: Power, Speed and Code density.	
		Embedded Hardware	**12**
2.	2.1	Embedded cores, Types of memories, Sensors (Optical encoders, Resistive) and Actuators (Solenoid valves, Relay/switch, Opto-couplers)	
	2.2	Power supply considerations in Embedded systems: Low power features-Idle & Power down mode, Sleep mode, Brown-out detection.	
	2.3	Communication Interfaces: Comparative study of serial communication interfaces (RS-232, RS-485), I2C, CAN, USB (v2.0), Bluetooth, Zig-Bee. Selection criteria of above interfaces. **(Frame formats of above protocols are not expected)**	
3.		**Embedded Software**	**14**
	3.1	Program Modelling concepts: DFG,FSM,UML	
	3.2	Embedded C-programming concepts (from Embedded system point of view): Data types, Modifiers, Qualifiers, Functions, Macros, Interrupt service routine, Device drivers.	
	3.3	Real-time Operating system: Need of RTOS in Embedded system software and comparison with GPOS, Foreground/Background processes, Interrupt latency, Task, Task states, Multi-tasking, Context switching, Task scheduling, Scheduling algorithms-Rate Monotonic Scheduling, Earliest Deadline First (with numericals), Inter-process communication: Semaphore, Mailbox, Message queues, Event timers, Task synchronisation- Shared data, Priority inversion, Deadlock. Memory Management	
	3.4	Introduction to μCOS II RTOS: Study of Kernel structure of μCOS II, μCOS II functions for Initialisation, Task creation, Inter-task communication and Resource management, Memory management	**08**
4.		**System Integration , Testing and Debugging Methodology**	**04**
	4.1	Embedded Product Design Life-Cycle (EDLC)	
	4.2	Hardware-Software Co-design	
	4.3	Testing & Debugging: Boundary-scan/JTAG interface concepts, Black-Box testing, White-Box testing, Hardware emulation, Logic analyser.	
5.		**Case Studies**	**06**
	5.1	Soft Real-time: Automatic Chocolate Vending machine using μCOS II RTOS- Requirements study, Specification study using UML, Hardware architecture, Software architecture	
	5.2	Hard Real-time: Car Cruise-Control using μCOS II RTOS- Requirements study, specification study using UML, Hardware architecture, Software Architecture	

Text books:

1.Dr. K.V. K. K. Prasad, “Embedded Real Time System: Concepts, Design and Programming”, Dreamtech, New Delhi, Edition 2014.
2.Jean J. Labrosse,“MicroC / OS-II The Real-Time Kernel”, CMP Books, 2011, Edition 2nd.
3. Rajkamal, “Embedded Systems: Architecture, Programming and Design”, McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd.
4. SriramIyer, Pankaj Gupta,“Embedded Real Time Systems Programming”, Tata McGraw Hill Publishing Company ltd., 2003.

Reference Books:

1.DavidSimon,“An Embedded Software Primer”, Pearson, 2009.
2.Jonathan W. Valvano, “Embedded Microcomputer Systems – Real Time Interfacing”, Publisher - Cengage Learning, 2012 Edition 3rd.
3.AndrewSloss, DomnicSymes, Chris Wright,“ARM System Developers Guide Designing and Optimising System Software”, Elsevier, 2004
4.FrankVahid, Tony Givargis,“Embedded System Design – A Unified Hardware/Software Introduction”, John Wiley & Sons Inc., 2002.
5.Shibu K V, “Introduction to Embedded Systems”, Tata McGraw Hill Education Private Limited, New Delhi, 2009.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total of 4 questions.
3. Question No.1 will be compulsory and based on the entire syllabus.
4. Remaining question (Q.2 to Q.6) will be set from all the modules.
5. Weightage of marks, commensurate with the time allocated to the respective module.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 602	Computer Communication and Networks	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX 602	Computer Communication and Networks	20	20	20	80	-	--	--	100

Course Pre-requisite: ELX405 Principles of Communication Engineering
ELX502 Digital Communication

Course Objectives:

The objectives of this course are to:

1. Introduce networking architecture and protocols
2. Understand the various layers and protocols in the TCP/IP model
3. Recognize different addressing schemes, connecting devices and routing protocols
4. Select the required protocol from the application layer protocols

Course Outcomes:

On successful completion of the course the students will be able to:

1. Demonstrate understanding of networking concepts and required protocols
2. Analyze the various layers and protocols of the layered architecture
3. Evaluate different addressing schemes, connecting devices and routing protocols
4. Appreciate the application layer protocols

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to Network Architectures, Protocol Layers, and Service models**	06
	1.1	Uses of computer networks. Topologies, LAN, MAN, WAN, Network topologies, **Addressing :** Physical / Logical /Port addressing, Protocols and Standards.	
	1.2	**Protocol Architecture:** Need of layered protocol architecture, Layers details of OSI, , Protocol Layers and Their Service Models	
	1.3	TCP/IP Model: Protocol suite, Comparison of OSI and TCP/IP	
2.		**Physical Layer**	08
	2.1	**Transmission Media:** Guided media like Coaxial, fiber, twisted pair, and Wireless media, Transmission Impairments. Interconnecting Devices: Hub, Bridges, Switches, Router, Gateway	
	2.2	**Data communication model :** DTE, DCE, RS-232D Interface , Null Modem , **Multiplexing :** FDM , Synchronous TDM , Statistical TDM, ADSL , xDSL, Cable Modem	
3.		**Data Link Control**	08
	3.1	**Data link services:** Framing, Flow control, Error control, ARQ methods, Piggybacking	
	3.2	**High Level Data Link Control (HDLC):** HDLC configurations, Frame formats, Typical frame exchanges.	
	3.3	**Medium Access Control Protocols**: ALOHA, Slotted ALOHA, CSMA, CSMA/CD	
4.		**Network Layer**	14
	4.1	**Switching**: Switched Communication networks, Circuit switching Networks, , Circuit switching Concepts, Packet switching Principles: Virtual circuit switching and Datagram switching	
	4.2	**Routing in Packet Switching Networks:** Characteristics, Routing strategies, Link state Routing versus Distance vector Routing. Least-Cost Routing Algorithms: Dijkstra's Algorithm, Bellman Ford Algorithm.	
	4.3	**Internet Protocol:** Principles of Internetworking: Requirements, Connectionless Operation Internet Protocol Operation: IP packet, IP addressing, subnet addressing , IPv4, ICMP, ARP, RARP IPv6 (IPv6 Datagram format, comparison with IPv4, and transition from IPv4 to IPv6)	
5.		**Transport Layer & Application Layer**	08
	5.1	**Connection –oriented Transport Protocol Mechanisms: Transmission Control Protocol (TCP):** TCP Services, TCP Header format, TCP three way handshake, TCP state transition diagram.	

		User datagram Protocol (UDP)	
	5.2	**Congestion:** Effects of congestion, Congestion control methods, Traffic management, Congestion control in Packet switching Networks	
	5.3	**Application layer Protocols** : HTTP, FTP, DNS,SMTP, SSH	
6.		**LANs.** High speed Ethernet	04
	6.1	LAN Protocol architecture , LAN topologies, Hub, Bridges, Virtual LANs **Traditional Ethernet and IEEE 802.3 LAN Standard**: Ethernet protocol, Frame structure, Physical layers,	
	6.2	**High Speed Ethernet** : Fast Ethernet, Gigabit Ethernet & 10- Gigabit Ethernet	
		Total	**48**

Recommended Text Books

1. William Stallings, "Data and Computer communications", Pearson Education, 10th Edition.
2. Behrouz A. Forouzan, "Data communication and networking ", McGraw Hill Education, Fourth Edition.
3. Alberto Leon Garcia, "Communication Networks" , McGraw Hill Education, Second Edition

Reference books :

1. S. Tanenbaum, "Computer Networks", Pearson Education, Fourth Edition.
2. J. F. Kurose and K. W. Ross ,"Computer Networking: A Top-Down Approach", Addison Wesley, 5th Edition.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 603	VLSI Design	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX 603	VLSI Design	20	20	20	80	-	--	--	100

Prerequisite Subject:

- ELX302: Electronics Devices and Circuits- I
- ELX304: Digital Circuit Design
- ELX404: Digital System Design
- ELX504: Design with Linear Integrated Circuits

Course Objectives:

1. To study MOS based circuit realization using different design styles
2. To highlight the fundamental issues in data path and system level design

Course Outcomes: After successful completion of the course student will be able to …

1. Demonstrate a clear understanding of choice of technology, scaling, MOS models and system level design issues.
2. Design and analyze MOS based inverters.
3. Design MOS based circuits with different design styles.
4. Design semiconductor memories, adders and multipliers.

Unit No.	Details	Teaching Hours
1	**Technology Trend :** **1.1 Technology Comparison:** Comparison of BJT and MOS technology **1.2 MOSFET Scaling:** Types of scaling, Level 1 and Level 2 MOSFET Models, MOSFET capacitances	06
2	**MOSFET Inverters:** **2.1 Types of MOS inverters:** Active and passive load and their comparison. **2.2 Circuit Analysis of MOS Inverters:** Static Analysis resistive and CMOS inverter: Calculation of all critical voltages and noise margins. Design of symmetric CMOS inverter. Dynamic Analysis of CMOS inverter: Calculation of rise time, fall time and propagation delay **2.3Logic Circuit Design:** Analysis and design of 2-I/P NAND,NOR and complex Boolean function using equivalent CMOS inverter for simultaneous switching.	10
3	**MOS Circuit Design Styles:**	10

	3.1 Design Styles: Static CMOS, pass transistor logic, transmission gate, Pseudo NMOS, C^2MOS, Dynamic, Domino,NORA and Zipper. **3.2Circuit Realization:** Basic gates,SR Latch, JK FF, D FF, 1 Bit Shift Register, MUX using above design styles.	
4	**Semiconductor Memories:** **4.1 SRAM:** 6T SRAM, operation, design strategy, leakage currents, read/write circuits, sense amplifier. **4.2DRAM**: 1T_DRAM, operation modes, leakage currents, refresh operation, physical design. 4.3 **ROM Array**: NAND and NOR PROM, Nonvolatile read/write memories-classification and programming techniques	08
5	**Data Path Design:** **5.1 Adder:** CLA adder, MODL, Manchester carry chainand high speed adders like carryskip, carry select and carry save. **5.2 Multipliers and shifter:** Array multiplier and barrel shifter	04
6	**VLSI Clocking and System Design:** **6.1Clocking:** CMOS clocking styles, Clock generation, stabilization and distribution **6.2Low Power CMOS Circuits:** Various components of power dissipation in CMOS, Limits on low power design, low power design through voltage scaling **6.3I/O pads and Power Distribution:** ESD protection, input circuits, output circuits, simultaneous switching noise, power distribution scheme **6.4Interconnect:** Interconnect delay model, interconnect scaling and crosstalk.	10

Text and Reference Books

1.Sung-Mo Kang and Yusuf Leblebici, "*CMOS Digital Integrated Circuits Analysis and Design*", Tata McGraw Hill, 3rd Edition.

2. John P. Uyemura, "Introduction to VLSI CIRCUITS AND SYSTEMS",Wiley India Pvt. Ltd.

3. Jan M. Rabaey, Anantha Chandrakasan and BorivojeNikolic, "*Digital Integrated Circuits: A Design Perspective*", Pearson Education, 2nd Edition.

4. Etienne Sicard and Sonia Delmas Bendhia, "*Basics of CMOS Cell Design*", Tata McGraw Hill, First Edition.

5. Neil H. E. Weste, David Harris and Ayan Banerjee, "*CMOS VLSI Design: A Circuits and Systems Perspective*", Pearson Education, 3rd Edition.

6. Debaprasad Das, "*VLSI Design*", Oxford, 1st Edition.

7. Kaushik Roy and Sharat C. Prasad, "*Low-Power CMOS VLSI Circuit Design*", Wiley, Student Edition.

8. David A Hodges, Horace G Jackson and Resve A Saleh, "Analysis and Design of Digital Integrated Cicuits", TMH, 3rd Edition

Additional Study Material & e-Books

1.Douglas A Pucknell, Kamran Eshraghian , "Basic VLSI Design", Prentice Hall of India Private Ltd.

2.Samir Palnitkar, " A Guide to Digital Design and Synthesis", Pearson Education

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX604	Signals and Systems	04	--	#01	04	--	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX604	Signals and Systems	20	20	20	80	25	-	-	125

#Class wise

Course Objectives:
1. To provide a comprehensive coverage of continuous time and discrete time Signals and Systems.
2. To introduce various time domain and frequency domain methods for analysis of Signals and systems.

Course Outcomes:
After successful completion of this course student will be able to
1. Differentiate between continuous time and discrete time Signals and Systems.
2. Understand various transforms for time domain to frequency domain conversion
3. Apply frequency domain techniques for analysis of LTI systems
4. Apply frequency domain techniques for analysis of continuous and discrete signals

Module No.	Unit No.	Topics	Hrs.
1.		**Continuous and Discrete Time Signals**	**8**
	1.1	Mathematical Representation and Classification of CT and DT signals, Orthogonality of signals	
	1.2	Arithmetic operations on the signals, Time Shifting, Time scaling, Time Reversal of signals	
	1.3	Sampling and Reconstruction, Aliasing effect	
2		**Continuous and Discrete Systems**	**8**
	2.1	Mathematical Representation and classification of CT and DT systems	
	2.2	Properties of LTI systems, impulse and step response.	
	2.3	Use of convolution integral, convolution sum and correlation for analysis of LTI systems	
	2.4	Properties of convolution integral and convolution sum	
3		**Frequency Domain Analysis of Continuous Time System using Laplace Transform**	**6**
	3.1	Concept of Complex frequency, Region of Convergence for Causal, Non-causal and Anti-causal systems, Poles and Zero of transfer function	
	3.2	Unilateral Laplace Transform	
	3.3	Analysis and characterization of LTI system using Laplace Transform: Impulse and Step Response, Causality, Stability, Stability of Causal system	
4		**Frequency Domain Analysis of Discrete Time System using Z Transform**	**12**
	4.1	Need for Z transform, definition, properties of unilateral and bilateral Z Transform, mapping with s plane, relationship with Laplace transform	
	4.2	Z transform of standard signals, ROC, poles and zeros of transfer function, Inverse Z transform	
	4.3	Analysis and characterization of LTI system using Z transform: impulse and step response, causality, stability, stability of causal system	
	4.4	System realization-Direct, Direct Canonic, Cascade and Parallel forms	
5		**Frequency Domainc Analysis of Continuous Signals**	6
	5.1	Frequency Domain Analysis of periodic non-sinusoidal signals	
	5.2	Frequency Domain Analysis of aperiodic Signals-Introduction, Properties of Fourier Transform, Fourier Transform based amplitude and phase response of standard signals, Relationship with Laplace and Z transform, Energy Spectral	
6		**Frequency Domain Analysis of Discrete Signals**	8
	6.1	Discrete Time Fourier Series, Evaluation of DTFS coefficients, Magnitude and Phase Spectrum of Discrete time periodic signals, Power Spectral Density	
	6.2	Discrete Time Fourier Transform – Concept of discrete time signal in frequency domain, definition of DTFT, determination of magnitude and phase functions using DTFT	
		Total	**48**

Text Books:

1. Tarun Kumar Rawat, "*Signals and Systems*", Oxford University*Press 2016.*
2. A. NagoorKani, *"Signals and Systems"*, Tata McGraw-Hill Education

Reference Books:

1. John Proakis and DimitrisMonolakis, "*Digital Signal Processing*", Pearson Publication, 4th Edition
2. Alan V. Oppenheim, AlanS. Willsky, and S.Hamid Nawab, "*Signals and Systems*", 2nd Edition, PHIlearning,2010.
3. B. P. Lathi, "Linear Systems and Signals", Oxford University Press,

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX DLO6021	Microwave Engineering	04	--	#01	04	--	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX6021	Microwave Engineering	20	20	20	80	25	-	-	125

Prerequisites: Knowledge of basic Engineering Electromagnetics

Course Objectives:

1. To introduce the students to various concepts of Microwave Engineering.
2. To teach the students the working principles and applications of different microwave devices.

Course Outcomes (CO):

After successful completion of the course, students will be able to:

1. Understand the importance and applications of microwaves.
2. Explain the process of generation and amplification of microwaves.
3. Analyse the electromagnetic field distribution in various microwave components.
4. Measure various microwave parameters.

Module	Contents	Hours
1	**Introduction to microwave communication** 1.1 Microwave spectrum and bands 1.2 Limitations of conventional circuit theory concepts at microwave frequencies 1.3 Applications of microwaves 1.4 Limitations of conventional vacuum tubes at microwave frequencies	4
2	**Generation and amplification of microwaves** 2.1 **Two cavity Klystron amplifiers:** Construction , Process of velocity modulation and bunching , Apple gate diagram Output power and efficiency , Applications 2.2 **Reflex Klystron:** Construction ,Process of velocity modulation and bunching	12

	Apple gate diagram , Output power and efficiency Applications 2.3 **Cylindrical Magnetron** Construction and working principle Hull cut-off magnetic equation , Cyclotron angular frequency Applications 2.4 **Traveling wave tube**: construction and working principle applications 2.5 numerical examples based on the above topics	
3	**Waveguides:** 3.1 Rectangular and circular waveguides 3.2 solution of Maxwell's equation for distribution of fields in the waveguides 3.3 characteristic equation 3.4 Dominant and degenerate modes 3.5 group and phase velocities 3.6 cut-off frequency 3.7 numerical examples based on the above topics	10
4	**Waveguide components and analysis**: 4.1 Definition and significance of s-parameters 4.2 Properties of s-parameters 4.3 Construction, working principle and s-matrix representation of cavity resonators, waveguide attenuators, waveguide phase shifters, waveguide multiport junctions, E-plane and H-plane Tees, Magic Tee, Hybrid Ring, direction couplers 4.4 Microwave ferrite components: Faraday rotation isolator, Circulator, Gyrator Numerical examples based on the above topics	12
5	Microwave solid state devices: 5.1Principle of operation and characteristics of: Gunn Diode, TRAPATT and IMPATT diodes, Microwave Transistors 5.2 Introduction to Strip Lines	5
6	Microwave Measurement: Measurement of 6.1 Power 6.2 Attenuation 6.3 Frequency 6.4 VSWR 6.5 Cavity Q 6.6 Impedance	5

Text Books:

1. " Microwave Devices and Circuits" by Samuel Liao, PHI
2. "Microwave circuits and Passive Devices" by M L Sisodia, G S Raghuvanshi, New Age International(P) Ltd

Reference Books:

1. " Electronic Communication Systems" by Kennedy, Davis, 4e TMH
2. " Microwave Engineering: Passive Circuits" by Peter Rizzi, PHI
3. " Foundations for Microwave Engineering" by Robert E Collin, 2e, John Wiley
4. " Basic Microwave Techniques & Laboratory Manual" by M L Sisodia, G S Raghuvanshi, 2001 New Age International(P) Ltd
5. Microwave Engineering, Annapurna Das, TMH\

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX DLO6022	Electronic Product Design	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELX DLO6022	Electronic Product Design (EPD)	20	20	20	80	---	---	100

Rationale :- The aim of this course is to enable students to gain practical experience & nurture their creativity in electronic product design & the objective is to provide students with a clear understanding of the practical design problems of the electronic products at an introductory level. With this course, students are expected to become familiar with the concept of designing a product as per the requirements (non-technical) & given specifications (technical), component tolerances, production constraints, safety requirements & EMC standards.

Course Objectives:-

1. To understand the stages of product (hardware / software) design & development

2. To learn different considerations of analog, digital & mixed circuit design

3. To be acquainted with methods of PCB design & different tools used for the same

4. To be aware of the importance of testing in product design cycle

5. To gain knowledge about various processes & importance of documentation

Course Outcomes :-

At the end of the course, students should gain the ability to :-

- **CO-1 :-** Design electronic products using user-centered designing processes
- **CO-2 :-** Identify & recognize essential design & production procedures of electronic products
- **CO-3 :-** Implement a prototype for meeting a particular requirement / specification
- **CO-4 :-** Demonstrate problem solving & troubleshooting skills in electronic product design
- **CO-5 :-** Prepare the relevant set of design documentation & present it as a case study

Module No.	Topics	Hours
1	**INTRODUCTION TO ELECTRONIC PRODUCT DESIGN** Man-machine dialog & industrial design, user-centered design, elements of successful design, cognition, ergonomics, packaging & factors; design for manufacture, assembly & disassembly wiring, temperature, vibration & shock; safety, noise, energy coupling, grounding, earthing, filtering & shielding	06
2	**HARDWARE DESIGN & TESTING METHODS** Design process, identifying the requirements, formulating specifications, design specifications, system partitioning, functional design, architectural design, functional model v/s architectural model, prototyping, performance & efficiency measures, formulating a test plan, writing all the specifications, test procedures & test cases, design reviews, module debug & testing – black box testing, white box testing, grey box testing	10
3	**SOFTWARE DESIGN & TESTING METHODS** Types of software, the waterfall model of software development, models, metrics & software limitations, risk abatement & failure prevention, software bugs & testing, good programming practice, user interface, embedded & real-time software	10
4	**PRINTED CIRCUIT BOARD (PCB) DESIGNING** Fundamental definitions, standards, routing topology configuration, layer stack up assignment, grounding methodologies, aspect ratio, image planes, functional partitioning, critical frequency & bypassing, decoupling; design techniques for ESD protection, guard-band & guard-rings	08
5	**PRODUCT DEBUGGING & TESTING** Steps of debugging, the techniques for troubleshooting, characterization, electromechanical components, passive components, active components, active devices, operational amplifier, analog-to-digital conversion, digital components, inspection & testing of components, process of simulation, prototyping & testing, integration, validation & verification, EMI & EMC issues	08
6	**THE DOCUMENTATION PROCESS** Definition, needs & types of documentation, records, accountability & liability, audience, steps in preparation, presentation & preservation of documents, methods of documentation, visual techniques, layout of documentation, bills of materials, manuals – instructional or operating manual, service and maintenance manual, fault finding tree, software documentation practices	06
1 – 6	**TOTAL**	**48**

Recommended Books :-

1. R. G. Kaduskar & V. B. Baru, Electronic Product Design, 3rd edition, Wiley India
2. Kim Fowler, Electronic Instrument Design, 2nd edition, Oxford University Press
3. Robert J. Herrick, PCB Design Techniques for EMC Compliance, 2nd edition, IEEE Press
4. G. C. Loveday, Electronic Testing & Fault Diagnosis, 4th edition, A. H. Wheeler Publishing
5. James K. Peckol, Embedded Systems – A Contemporary Design Tool, 1st edition, Wiley Publication
6. J. C. Whitaker, The Electronics Handbook, CRC Press

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Q.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX DLO6023	Wireless Communication	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX DLO6023	Wireless Communication	20	20	20	80	-	--	--	100

Course Objectives:

The objectives of this course are to:

1. To introduce the Concepts of basic Cellular communication systems , mobile Radio propagation
2. To understand the various Cellular processes such as handoff strategies, interference, Trunking theory
3. To study the features and services of 2G cellular technologies: GSM and CDMA
4. To study the features of evolving technological advances in 2G, 3G & 4G Cellular systems.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Understand the concepts of basic cellular system, frequency reuse, channel assignment
2. Understand the fundamentals radio propagation , Path loss and comprehend the effect of Fading .
3. Acquire the Knowledge about multiple access technologies and different of different spread spectrum techniques.
4. Acquire the Knowledge about overall GSM cellular concept and analyse its services and features
5. Comprehend the features of CDMA technology
6. Analyse the evolution of cellular technology from 2G to 4G Cellular systems .

Module No.	Unit No.	Topics	Hrs.
1.		**Concept of Cellular Communication**	**08**
	1.1	Introduction to cellular communications, Frequency reuse, Channel assignment strategies	
	1.2	**Cellular Processes:** Call setup, Handoff strategies, interference and system capacity, Co-channel Interference reduction with the use of Directional Antenna	
	1.3	**Traffic Theory:** Trunking and Grade of service, Improving Coverage and capacity in Cellular systems: Cell splitting, Sectoring, Micro-cell Zone concept	
2.		**Mobile Radio Propagation**	**08**

	2.1	Introduction to Radio wave propagation, Free space propagation model, the three basic Propagation mechanisms, The Ground Reflection (two-ray) model, Practical Link budget design using Path-Loss models:Log-distance Path –loss model.	
	2.2	Small scale Multipath Propagation: Factors influencing small scale fading, Doppler shift, Parameters of mobile multipath channels,	
	2.3	Types of small scale fading, Fading effects due to Doppler spread, Fading effects due to Multipath Time delay spread, Raleigh and Rician distributions	
3.0		Multiple access techniques & Spread spectrum Modulation	**08**
	3.1	Multiplexing and Multiple Access:Time Division Multiple Access, Frequency Division Multiple Access, Spread-spectrum multiple-access:Code Division Multiple Access	
	3.2	Spread spectrum Modulation :Need for and concept of spread spectrum modulation, PN-sequence generation, properties of PN-sequence, Gold sequence generation, Direct-sequence SS, Frequency-hopping SS,	
4.0		**GSM**	**12**
	4.1	GSM network architecture, Signalling protocol architecture, Identifiers, Physical and Logical Channels, Frame structure, Speech coding, Authentication and security, Call procedure, Hand-off procedure, Services and features	
5.0		**IS-95**	**06**
	5.1	Frequency and channel specifications of IS-95, Forward and Reverse CDMA channel, Packet and Frame formats, Mobility and Resource management	
6.0		**Evolution from 2G to 4G**	**06**
	6.1	GPRS, EDGE technologies, 2.5G CDMA-One cellular network, W-CDMA (UMTS), CDMA2000, LTE, Introduction to 5G Networks	
		Total	**48**

Recommended Books:

6. Theodore Rappaport, "Wireless Communications: Principles and Practice, 2nd Edition, Pearson Publication
7. ITI Saha Misra, "Wireless Communication and Networks: 3G and Beyond", Publication
8. Vijay Garg, "IS-95 CDMA and cdma 2000: Cellular/PCS System Implementation", Pearson Publication.

Reference Books:
1. T.L Singal , "Wireless Communication", Tata McGraw Hill ,2010
2. Upena Dalal , "Wireless Communication", Oxford University Press, 2009
3. Andreas F Molisch, "Wireless Communication", John Wiley, India 2006.
4. Vijay Garg, "Wireless communication and Networking", Pearson Publication

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO6024	Computer Organization and Architecture	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELX DLO6024	Computer Organization and Architecture	20	20	20	80	03	--	--	--	--	100

Course Objectives	1. To introduce the learner to the design aspects which can lead to maximized performance of a Computer. 2. To introduce the learner to various concepts related to Parallel Processing 3.To highlight the various architectural enhancements in modern processors.
Course Outcomes	At the end of the course, the learner will have the ability to 1. Define the performance metrics of a Computer 2.Explain the design considerations of Processor, Memory and I/O in Computer systems 3. Explain the advantages and limitations of Parallelism in systems 4. Explain the various architectural enhancements in modern processors

Module		Contents	Time
1.		**Introduction to Computer Organization**	**[06]**
	1.1	Fundamental Units of a Computer	01
	1.2	Introduction to Buses	01
	1.3	Number Representation methods- Integer and Floating-point, Booth's Multiplier, Restoring and Non-Restoring Division	03
	1.4	Basic Measures of Computer Performance - Clock Speed, CPI, MIPs and MFlops	01
2.		**Processor Organization and Architecture**	**10**
	2.1	CPU Architecture , Register Organization, Instruction cycle, Instruction Formats	04
	2.2	Control Unit Design- Hardwired and Micro-programmed Control: Vertical and Horizontal Micro-Instructions, Nano-programming	04
	2.3	Comparison between CISC and RISC architectures	02
3.		**Memory Organization**	**12**
	3.1	Classification of Memories-Primary and Secondary Memories, RAM (SRAM and DRAM) and ROM (EPROM , EEPROM), Memory Inter-leaving	02
	3.2	Memory Hierarchy, Cache Memory Concepts, Mapping Techniques, Write Policies, Cache Coherency (* Numerical Problems expected)	06
	3.3	Virtual Memory Management-Concept, Segmentation , Paging, Page Replacement policies	04
4.		**Input/Output Organization**	**06**
	4.1	Types of I/O devices and Access methods, Types of Buses , Bus Arbitration	03
	4.2	Expansion Bus Concept, PCI Bus	03
5.		**Parallelism**	**06**
	5.1	Introduction to Parallel Processing Concepts, Flynn's classification, Amdahl's law	02
	5.2	Pipelining - Concept, Speedup, Efficiency , Throughput, Types of Pipeline hazards and solutions (* Numerical Problems expected)	04
6.		**Architectural Enhancements**	**08**
		Superscalar Architectures, Out-of-Order Execution, Multi-core processors, Clusters, Non-Uniform Memory Access (NUMA) systems, Vector Computation , GPU	08

Text books:

1.William Stallings, "*Computer Organization and Architecture: Designing for Performance*", Eighth Edition, Pearson.

2. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGraw Hill, 2002.

Reference Books:

1. J.P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998.

2. B. Govindarajulu, "*Computer Architecture and Organization: Design Principles and Applications*", Second Edition, Tata McGraw-Hill.

3. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface", Morgan Kaufmann,1998.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

Question paper will comprise of 6 questions, each carrying 20 marks.

The Learner need to solve total 4 questions.

Question No.1 will be compulsory and based on entire syllabus. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL 601	Embedded Systems& Real Time Operating System Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELXL 601	Embedded Systems& Real Time Operating System Laboratory	--	--	--	--	--	25	--	--	25	50

Assessment:

Term Work:

At least **SIX** experiments based on the entire syllabus of **ELX 601 (Embedded System & Real Time Operating System)** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time. Term work must include a mini project in addition to the number of experiments. The course mini-project is to be undertaken in a group of two to three students.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

The final certification and acceptance of term work ensures satisfactory performance of laboratory work, mini project and minimum passing marks in term work.

Practical and Oral exam will be based on the entire syllabus.

Suggested Experiments:

- Simulation experiments using KeilC–cross complier to: evaluate basic C program for X-51 assembly; evaluating various C data types; evaluating and understanding iterative C constructs translated into x51's assembly; evaluating and understanding interrupt implementation.
- Simulate and understand working of µCOS-II functions using example programs from recommended text,"MicroC / OS-II The Real-Time Kernel", by Jean J. Labrosse.
- Porting of µCOS-II on X-51/AVR/CORTEX M3 platform.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL 602	Computer Communication and Networks Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL 602	Computer Communication and Networks Laboratory	-	-	-	-	25	--	25	50

Laboratory Experiments:

Lab session includes Seven experiments and a Case study(Power point Presentation) on any one of the suggested topics.

1. The experiments will be based on the syllabus contents.

2. Minimum **Seven experiments** need to be conducted, out of which **at least Four Experiments** should be software-based (C/C++ , Scilab, MATLAB, LabVIEW, etc).

3. Each student (in groups of 3/4) has to present a Case study (Power point Presentation) as a part of the laboratory work. The topics for Presentation / Case-study may be chosen to be any relevant topic on emerging technology. (“Beyond the scope of the syllabus”.)

Power point presentation should contain minimum of 15 slides and students should submit a report (PPT+Report)carry minimum of 10 marks . The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested List of experiments:

1. Study of transmission media and interconnecting devices of communication networks.
2. Implementation of serial transmission using RS232
3. Implementing bit stuffing algorithm of HDLC using C/C++
4. Implementation of Routing protocols using C/C++
5. Study of NS2 simulation software
6. Implementation of TCP/UDP session using NS2
7. Implementation of ARQ methods using NS2
8. Study of WIRESHARK and analyzing Packet using WIRESHARK
9. Study and implementation of IP commands
10. Study of GNS software and implementation of routing protocols using GNS

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL 603	VLSI Design Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELXL 603	VLSI Design Laboratory	--	--	--	--	--	25	--	--	25	50

Assessment:

Term Work:

At least **SIX** experiments based on the entire syllabus of **ELX 603 (VLSI Design)** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time. Term work must include a mini project in addition to the number of experiments. The course mini-project is to be undertaken in a group of two to three students.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

The final certification and acceptance of term work ensures satisfactory performance of laboratory work, mini project and minimum passing marks in term work.

Practical and Oral exam will be based on the entire syllabus.

Suggested Experiments:

MOSFET Scaling using circuit simulation software like Ngspice

Static and transient performance analysis of various inverter circuits

Implementation of NAND and NOR gate using various logic design styles

Design and verification of CMOS Inverter for given static and transient performance

Implementation of ROM, SRAM, DRAM

Interconnect analysis

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO6021	Microwave Engineering Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELXL DLO6021	Microwave Engineering Laboratory	--	--	--	--	--	25	--	--	25	50

Assessment:

Term Work:

At least **SIX** experiments based on the entire syllabus of **ELXDLO 6021 (Microwave Engineering)** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time. Term work must include a mini project in addition to the number of experiments. The course mini-project is to be undertaken in a group of two to three students.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

The final certification and acceptance of term work ensures satisfactory performance of laboratory work, mini project and minimum passing marks in term work.

Practical and Oral exam will be based on the entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO6022	Electronic Product Design	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELXL DLO6022	Electronic Product Design	--	--	--	--	--	25	--	--	25	50

At least **Six** experiments based on the entire syllabus of **ELXDLO6022 (**Electronic Product Design**)** should be set to have well-defined inference and conclusion. The experiments should be student-centric and attempt should be made to make experiments more meaningful, interesting and innovative. Experiment must be graded from time to time. Additionally, each student (in group of 2/3) has to perform a Mini Project as a part of the laboratory and report of mini project should present in laboratory journal. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Lab session includes **six experiments plus one presentation on case study.**

Suggested Experiments:

1. Experiment based on Ground and Supply bounce
2. PCB design steps involved in product design
3. Simulation based on use of Simulator software
4. Working of an Emulator in Design step
5. Role of Pattern Generator in Design step
6. Debugging of the digital circuit based on Logic Analyzer
7. Application of the Spectrum analyzer
8. Demonstration of usefulness of the Arbitrary waveform generator
9. Setup for EMI and EMC test
10. Experiment based on calibration of the product.

Suggested topics for Case Study:

Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering design issues, hardware and software details and applications.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL DLO6023	Wireless Communication Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL DLO6023	Wireless Communication Laboratory	-	-	-	-	25	--	25	50

Laboratory Experiments:

Lab session includes seven experiments and a Case study(Power point Presentation)on any one of the suggested topics.

Note:

1. The experiments will be based on the syllabus contents.

2. Minimum seven experiments need to be conducted.(Scilab, MATLAB, LabVIEW, NS2/NS3 etc can be used for simulation).

3. Each student (in groups of 3/4) has to present a Case study (Power point Presentation) as a part of the laboratory work.

The topics for Presentation / Case-study may be chosen to be any relevant topic on emerging technology.

("Beyond the scope of the syllabus".)

Power point presentation should contain minimum of 15 slides and students should submit a report , (PPT+Report) carry minimum of 10 marks The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ELXL DLO6024	Computer Organization and Architecture	**--**	**02**	**--**	**--**	**01**	**--**	**01**

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELXL DLO6024	Computer Organization and Architecture	**--**	**--**	**--**	**--**	**--**	**25**	**--**	**--**	**25**	**50**

At least **six** experiments based on the entire syllabus of **ELX DLO6024 (Computer Organization and Architecture)** should be set to have well-defined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be student-centric and attempt should be made to make experiments more meaningful, interesting and innovative. Additionally, a **Seminar on IEEE/ACM paper** focussing on key areas of research in Computer Architecture/Organization to be part of the term-work which is duly graded. **Suggested List of Experiments:**

Expt. No.	Title of the Experiments
1	Implementation of Booth's Algorithm (using VHDL)
2	To create a control store for micro-programmed control unit (using VHDL)
3	Using a cache simulator , calculate the cache miss-rate for various mapping schemes
4	Implement various page replacement policies (LRU, FIFO,LFU)
5	Program to detect the type of hazard (RAW,WAR,WAW)for a set of instructions
6	Using a performance analyzer tool, extract various performance metrics

AC- 29/06/2021
Item No. – 6.13

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Electronics Engineering

Second Year with Effect from AY2020-21
Third Year with Effect from AY2021-22
Final Year with Effect from AY 2022-23

(REV-2019‘C’ Scheme) from Academic Year2019–20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC – 29/06/2021
Item No. – 6.13

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Third Year BE in Electronics Engineering**
2	Eligibility for Admission	**Second Year Engineering passed in line with the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 Semesters**
6	Level	~~Certificate/Diploma~~/UG/~~PG~~ **(Strike out which is not applicable)**
7	Pattern	**Semester**/~~Yearly~~ **(Strike out which is not applicable)**
8	Status	**Revised**/~~New~~ **(Strike out which is not applicable)**
9	To be implemented from Academic Year	**With effect from Academic Year: 2021-2022**

Date: Signature:

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc. There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

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Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self-learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Faculty of Science and Technology
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Preface

Technical education in the country is undergoing a paradigm shift in current days. Think tank at national level are deliberating on the issues, which are of utmost importance and posed challenge to all the spheres of technical education. Eventually, impact of these developments was visible and as well adopted on bigger scale by almost all universities across the country. These are primarily an adoption of CBCS (Choice base Credit System) and OBE (Outcome based Education) with student centric and learning centric approach. Education sector in the country, as well, facing critical challenges, such as, the quality of graduates, employability, basic skills, ability to take challenges, work ability in the fields, adoption to the situation, leadership qualities, communication skills and ethical behavior. On other hand, the aspirants for admission to engineering programs are on decline over the years. An overall admission status across the country is almost 50%; posing threat with more than half the vacancies in various colleges and make their survival difficult. In light of these, an All India Council for Technical Education (AICTE), the national regulator, took initiatives and enforced certain policies for betterment, in timely manner. Few of them are highlighted here, these are design of model curriculum for all prevailing streams, mandatory induction program for new entrants, introduction of skill based and inter/cross discipline courses, mandatory industry internships, creation of digital contents, mandate for use of ICT in teaching learning, virtual laboratory and so on.

To keep the pace with these developments in Technical education, it is mandatory for the Institutes & Universities to adopt these initiatives in phased manner, either partially or in toto. Hence, the ongoing curriculum revision process has a crucial role to play. The BoS of Electronics Engineering under the faculty of Science & Technology, under the gamut of Mumbai University has initiated a step towards adoption of these initiatives. We, the members of Electronics Engineering Board of Studies of Mumbai University feel privileged to present the revised version of curriculum for Electronics Engineering program to be implemented from academic year 2020-21. Some of the highlights of the revision are;

i. Curriculum has been framed with reduced credits and weekly contact hours, thereby providing free slots to the students to brain storm, debate, explore and apply the engineering principles. The leisure provided through this revision shall favour to inculcate innovation and research attitude amongst the students.
ii. New skill based courses have been incorporated in curriculum keeping in view AICTE model curriculum.
iii. Skill based Lab courses have been introduced, which shall change the thought process and enhance the programming skills and logical thinking of the students
iv. Mini-project with assigned credits shall provide an opportunity to work in a group, balancing the group dynamics, develop leadership qualities, facilitate decision making and enhance problem solving ability with focus towards socio-economic development of the country. In addition, it shall be direct application of theoretical knowledge in practice, thereby, nurture learners to become industry ready and enlighten students for Research, Innovation and Entrepreneurship thereby to nurture start-up ecosystem with better means.
v. Usage of ICT through NPTEL/SWAYAM and other Digital initiatives of Govt. of India shall be encouraged, facilitating the students for self-learning and achieve the Graduate Attribute (GA) specified by National Board of accreditation (NBA) i.e. lifelong learning.

Thus, this revision of curriculum aimed at creating deep impact on the teaching learning methodology to be adopted by affiliated Institutes, thereby nurturing the student fraternity in multifaceted directions and create competent technical manpower with legitimate skills. In times to come, these graduates shall shoulder the responsibilities of proliferation of future technologies and support in a big way for 'Make in India' initiative, a reality. In the process,

BoS, Electronics Engineering got whole hearted support from all stakeholders including faculty, Heads of department of affiliating institutes, experts faculty who detailed out the course contents, alumni, industry experts and university official providing all procedural support time to time. We put on record their involvement and sincerely thank one and all for contribution and support extended for this noble cause.

Boards of Studies in Electronics Engineering

Sr. No.	Name	Designation	Sr. No.	Name	Designation
1	Dr. R. N. Awale	Chairman	5	Dr. Rajani Mangala	Member
2	Dr. Jyothi Digge	Member	6	Dr. Vikas Gupta	Member
3	Dr. V. A. Vyawahare	Member	7	Dr. D. J. Pete	Member
4	Dr. Srija Unnikrishnan	Member	8	Dr. Vivek Agarwal	Member

Program Structure for Third Year Electronics Engineering

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract	Tut	Total
ELC501	Principles of Control System	3	--	--	3	--	--	**3**
ELC502	Digital Signal Processing	3		--	3		--	**3**
ELC503	Linear Integrated Circuits	3	--	--	3	--	--	**3**
ELC504	Digital Communication	3	--	--	3	--		**3**
ELDO501	Department Optional Course - I	3	--	--	3	--	--	**3**
ELL501	Principles of Control System Lab	--	2	--	--	1	--	**1**
ELL502	Linear Integrated Circuits Lab	--	2	--	--	1	--	**1**
ELL503	Digital Communication Lab	--	2	--	--	1	--	**1**
ELL504	Professional Communication & Ethics-II	--	2*+2	--	--	2	--	**2**
ELM501	Mini Project–2 A	--	$4^{\$}$	--	--	2	--	**2**
Total		**15**	**14**	**--**	**15**	**07**	**--**	**22**

** Theory class; $ indicates workload of Learner (Not Faculty), for Mini Project*

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)	TW	Pract/ Oral	Total
		Test 1	Test 2	Avg.					
ELC501	Principles of Control System	20	20	20	80	3	--	--	100
ELC502	Digital Signal Processing	20	20	20	80	3	--	--	100
ELC503	Linear Integrated Circuits	20	20	20	80	3	--	--	100
ELC504	Digital Communication	20	20	20	80	3	--	--	100
ELDO501	Department Optional Course - I	20	20	20	80	3	--	--	100
ELL501	Principles of Control System Lab	--	--	--	--	--	25	25	50
ELL502	Linear Integrated Circuits Lab	--	--	--	--	--	25	25	50
ELL503	Digital Communication Lab	--	--	--	--	--	25	25	50
ELL504	Professional Communication & Ethics-II	--	--	--	--	--	50	--	50
ELM501	Mini Project–2 A	--	--	--	--	--	25	25	50
Total				**100**	**400**	--	**150**	**100**	**750**

Department Level Optional Course - I (ELDO 501):

1. Data Structures	3. Neural Network and Fuzzy Logic
2. Biomedical Instrumentation	4. Computer Organization Architecture

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELC501	Principles of Control System	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC501	Principles of Control System	20	20	20	80	3	--	--	100

Course Objectives:

1. To develop the understanding of fundamental principles of control systems.
2. To disseminate the basic methods for time-domain and frequency-domain analysis of control systems.
3. To develop the concept of stability and its assessment for linear-time-invariant systems.
4. To introduce the design of controllers in frequency-domain and state-space.

Course Outcomes:

After successful completion of the course students will be able to:

1. **Derive** the mathematical models of physical systems.
2. **Sketch** various plots in time and frequency domain and **analyse** the system using the plots.
3. **Evaluate** the stability of control systems in time and frequency domain.
4. **Design** performance specification based controller for a given system.
5. **Analyse** the control systems using state-space methods and **design** state feedback controllers.
6. **Design** performance specification based controller for a given system.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to the Control Problem**	**06**
	1.1	Examples of control systems; introduction to the control problem; open loop and closed loop systems; feed-forward control structure.	
	1.2	Differential equation models of physical systems, deriving models of physical systems (electrical, mechanical, thermal, Op-amp circuits) Types of models; Impulse response model; Transfer function model for Electrical, Mechanical and Thermal systems	
	1.3	Block diagram and Signal Flow Graph (SFG) representation of control systems; Block diagram reductions; Mason's gain formula.	
2		**Time Response Analysis**	**06**
	2.1	Standard test input signals; time response of first and second order systems for standard test inputs; Application of initial and final value theorem. Performance specifications for second order system (no derivation); Error constants and type of the system.	
	2.2	Concept of stability; Routh-Hurwitz Criteria; Relative stability analysis; Root-Locus technique and construction of root-loci.	
3		**Frequency Response Analysis**	**08**
	3.1	Introduction to frequency response; Frequency response plots: Polar plot and Bode plot; Performance specifications in frequency domain.	
	3.2	Stability margins in frequency domain; Mapping contours in s-plane; The Nyquist criterion; Relative stability using Nyquist criterion.	
4		**Introduction to Controller Design**	**10**
	4.1	Characteristics of feedback: Sensitivity to parametric variation; Disturbance rejection; Steady-state accuracy.	
	4.2	Feedback controller design using Root-locus; Reshaping the root-locus; Cascade lead, lag and lag-lead compensator.	
	4.3	Feedback control design using Bode plot; Reshaping the bode plot; Cascade lead, lag and lag-lead compensator.	
5		**State-space Analysis**	**07**
	5.1	Concept of state variables; State-space model; Canonical forms; Conversion between canonical forms using similarity transforms.	
	5.2	Solution of state-space equation; Eigen-values and eigenvectors; Stability in state-space; Concept of controllability and observability.	
6		**Controller Design in State-space**	
	6.1	State-feedback controller design: Pole-placement method; Ackerman's formula.	**02**
		Total	**39**

Text Books:

1. M. Gopal, "Control Systems: Principles and Design", 3rd edition, Tata McGraw Hill, 2008.
2. Richard Dorf, Robert Bishop, "Modern Control Systems", 11th edition, Pearson Education, 2008.

Reference Books:

1. Golnaraghi Farid, B. C. Kuo, "Automatic Control Systems", 10th edition, McGraw Hill, 2017.
2. K. Ogata, "Modern Control Engineering", 6th edition, Prentice Hall, 2010.
3. I.J. Nagrath, M. Gopal, "Control System Engineering", New Age International, 2009.
4. Norman Nise, "Control Systems Engineering", Wiley, 8th edition, 2019.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will consist of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELC502	Digital Signal Processing	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC502	Digital Signal Processing	20	20	20	80	3	--	--	100

Prerequisite:

ELC405: Signals and Systems

Course Objectives:

1. To introduce Fourier domain analysis of signals and systems and their efficient implementation.
2. To expose students to various design techniques for FIR/IIR filters.
3. To unveil the students to advances in signal processing techniques, digital signal processors and real-world applications.

Course Outcomes:

After successful completion of the course students will be able to:

1. Analyze discrete time systems in frequency domain using Discrete Fourier Transform.
2. Design IIR digital filters to meet given filter specifications and implement the same using lattice structure.
3. Design FIR digital filters to meet given filter specifications and implement the same using lattice structure.
4. Understand Architecture of DSP processors and examine the effect of hardware limitations on performance of digital filters.
5. Investigate the need of multi-rate digital signal processing and implement multi-rate systems.
6. Apply DSP techniques in real life problems.

Module No.	Unit No.	Contents	Hrs.
1		**Discrete Fourier Transform and Fast Fourier Transform**	10
	1.1	Definition and Properti0es of DFT, IDFT, circular convolution of sequences using DFT and IDFT, Relation between Z-transform and DFT, Filtering of long data sequences using Overlap Save and Overlap Add Method	
	1.2	Fast Fourier transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, Inverse FFT	
2		**Design of Infinite Impulse Response (IIR) Filters**	8
	2.1	Analog filter approximations: Butterworth, Chebyshev, Inverse Chebyshev and Elliptic filters	
	2.2	Mapping of S-plane to Z-plane, Impulse invariance method, Bilinear transformation method, Design of IIR digital filters from analog filters with examples (Butterworth, Chebyshev)	
	2.3	Realization of IIR filters using Lattice structures	
3		**Design of Finite Impulse Response(FIR) Filters**	7
	3.1	Characteristics of FIR digital filters, Minimum Phase, Maximum Phase, Mixed Phase and Linear Phase Filters, Frequency response and location of zeros for linear phase FIR filters	
	3.2	Effect of truncation on ideal filter impulse response, Design of FIR filters using window techniques (Rectangular, Hamming, Hanning, Blackmann, Bartlet), Design of FIR filters using Frequency Sampling Technique	
	3.3	Realization of FIR filters using Lattice structures	
4		**DSP Processors and Finite Word Length Effects**	6
	4.1	Introduction to General Purpose and Special Purpose DSP processors, Fixed point and floating-point DSP processors, Architecture of TMS320CXX processor	
	4.2	Quantization, truncation and rounding, Effects due to truncation and rounding, Input quantization error, Product quantization error, Coefficient quantization error, Limit cycle oscillations, Finite word length effects in FIR/IIR digital filters	
5		**Multirate DSP and Filter Banks**	5
	5.1	Introduction and concept of Multirate Processing, Decimator and Interpolator, Decimation and Interpolation by Integer numbers, Multistage Approach to Sampling rate converters	
	5.2	Sample rate conversion using Polyphase filter structure, Type I and Type II Polyphase Decomposition	
6		**DSP Applications**	3
	6.1	Application of DSP in Radar Signal Processing	
	6.2	Application of DSP in Speech Signal Processing: Echo cancellation	
	6.3	Application of DSP in Biomedical Signal Processing: Denoising of ECG Signal	
Total			**39**

Text Books:

1. Proakis J., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education, 2007
2. Tarun Kumar Rawat, "*Digital Signal Processing*", Oxford University Press, 2015

Reference Books:

1. L .R. Rabiner and B. Gold, "*Theory and Applications of Digital Signal Processi*ng", Prentice-Hall of India, 2006.
2. Oppenheim A., Schafer R., Buck J., "*Discrete Time Signal Processing*", 2nd Edition, Pearson Education
3. Johnson J. R., "*Introduction to Digital Signal Processing*", Prentice Hall
4. Emmanuel C. Ifeachor, Barrie W. Jervis, "*Digital Signal Processing: A Practical Approach*", Pearson Education, 2001
5. Sanjit K. Mitra, Digital Signal Processing – A Computer Based Approach – edition 4e McGraw Hill Education (India) Private Limited
6. B. Venkata Ramani and M. Bhaskar, "*Digital Signal Processors, Architecture, Programming and Applications*", Tata McGraw Hill, 2011.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Students are encouraged to explore more applications which can be assessed by the faculty.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELC503	Linear Integrated Circuits	03		--	03		--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal Assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELC503	Linear Integrated Circuits	20	20	20	80	03				100

Course Pre-requisite:

1. Electronic Devices and Circuits I
2. Electronic Devices and Circuits II

Course Objectives:

1. To teach fundamental principles of standard linear integrated circuits.
2. To develop a overall approach for students from selection of integrated circuit, study its specification, the functionality, design and practical applications

Course Outcomes:

After successful completion of the course students will be able to:

1. Demonstrate an understanding of fundamentals of integrated circuits.
2. Analyze the various applications and circuits based on particular linear integrated circuit.
3. Select and use an appropriate integrated circuit to build a given application.
4. Design an application with the use of integrated circuit
5. Design a real life application using certain linear Integrated Circuits
6. Design of power supply with proper selection of the regulator IC.

Module No.	Unit No.	Contents	Hrs.
1		**Module 1 Fundamentals of Operational Amplifier**	04
	1.1	Block diagram of op-amp, Characteristics of op-amp, op-amp parameters, high frequency effects on op-amp gain and phase, slew rate limitation, single supply versus dual supply op-amp	
	1.2	Configurations of op-amp: - open loop and closed loop configuration, Inverting amplifier and Non inverting amplifier	
2		**Module 2:-Linear Applications of Operational Amplifier**	08
	2.1	Adder, Subtractor, Difference amplifier, Integrator, Differentiator, Three Op-amp Instrumentation amplifier, V-I converter, I-V converter	
	2.2	Active Filters: - Transfer function, Design of First order and Second order of LPF, HPF, BPF and BRF	
	2.3	Oscillators: - RC phase shift and Wein bridge oscillators	
3		**Module 3:-Non-linear Applications of Operational Amplifier**	08
	3.1	Voltage Comparators, Applications of comparator as zero crossing detector, window comparator, level detector, Schmitt triggers, Half wave and full wave Precision rectifiers, Peak detectors, Sample & Hold circuit, Log and Antilog amplifier	
	3.2	Waveform generators: - Square wave and Triangular wane generator circuit	
4		**Module 4: - Data Converters**	05
	4.1	Analog to Digital: - Performance parameters, Simple ramp, Dual slop, Successive approximation and Flash ADC	
	4.2	Digital to Analog: - Performance parameters, Binary weighted and R/2R ladder	
5		**Module 5: - Special Purpose Integrated Circuits**	07
	5.1	Monolithic Timer: -NE555, functional block diagram, working, design and applications.	
	5.2	Functional block diagram, working, functional block diagram, working, design and applications. Voltage controlled oscillator 566, PLL 565, Function generator XR 2206, Power amplifier LM 380	
6		**Module 6:- Voltage Regulators**	07
	6.1	Functional block diagram of Voltage Regulators, Design of fixed voltage Regulators (78XX and 79XX), three terminal adjustable voltage regulators (LM 317 and LM 337)	
	6.2	Functional block diagram, working and design of IC 723 with current limit and current foldback protection, Switching regulator topologies	
		Total	**39**

Recommended Books:

1. Sergio Franco, "*Design with operational amplifiers and analog integrated circuits*", Tata McGraw Hill, 3rd Edition.
2. William D. Stanley, "*Operational Amplifiers with Linear Integrated Circuits* ", Pearson, 4th Edition
3. D. Roy Choudhury and S. B. Jain, "*Linear Integrated Circuits*", New Age International Publishers, 4th Edition.
4. David A. Bell, "*Operation Amplifiers and Linear Integrated Circuits*", Oxford University

Press, Indian Edition.
5. Ramakant A. Gayakwad, "*Op-Amps and Linear Integrated Circuits*", Pearson Prentice Hall, 4th Edition.
6. Ron Mancini, "*Op Amps for Everyone*", Newnes, 2nd Edition.
7. J. Millman and A. Grabel, "*Microelectronics*", Tata McGraw Hill, 2nd Edition.
8. R. F. Coughlin and F. F. Driscoll, "*Operation Amplifiers and Linear Integrated Circuits*", Prentice Hall, 6th Edition.
9. J. G. Graeme, G. E. Tobey and L. P. Huelsman, "*Operational Amplifiers- Design & Applications*", NewYork: McGraw-Hill, Burr-Brown Research Corporation.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final internal assessment.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory preferably objective type and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELC504	Digital Communication	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELC504	Digital Communication	20	20	20	80	03	--	--	--	100

Course Pre-requisite: ELX404 Principles of Communication Engineering
ELX405 Signals & Systems

Course Objectives:

1. Understand the typical subsystems of a digital communication system.
2. Understand the significance of the trade-off between SNR and Bandwidth.
3. Understand the effect of ISI in Baseband transmission of a digital signal.
4. Analyze various Digital modulation techniques.
5. Identify the necessity of Source encoding and Channel encoding in Digital Communication.

Course Outcomes:

After successful completion of the course students will be able to:

1. Comprehend the advantages of digital communication over analog communication and explain need for various subsystems in Digital communication systems
2. Realize the implications of Shannon-Hartley Capacity theorem while designing the efficient Source encoding technique.
3. Understand the impact of Inter Symbol Interference in Baseband transmission and methods to mitigate its effect.
4. Analyze various Digital modulation methods and assess them based on parameters such as spectral efficiency, Power efficiency, Probability of error in detection.
5. Explain the concept and need for designing efficient Forward Error Correcting codes.
6. Understand the Optimum reception of Digital signals.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Digital communication system and Probability Theory**	07
	1.1	Introduction to Digital communication system, significance of AWGN Channel, pulse dispersion in the channel.	
	1.2	Concept of Probability Theory in Communication Systems: Introduction to probability and sample space, Bayes' rule, conditional probability and statistical independence, relation between probability and probability density, PDF, CDF, Random variables, Mean and Variance of Random variables and sum of random variables, Definition with examples.	
	1.3	Gaussian, Rayleigh PDF & Rician Distribution, Binomial Distribution, Poisson Distribution, Central-Limit Theorem.	
2		**Information Theory and Source Coding**	05
	2.1	Measure of Information, Entropy, Information rate, Channel capacity, Shannon – Hartley Capacity Theorem and its Implications.	
	2.2	Shannon-Fano encoding, Huffman encoding, Code Efficiency and Redundancy examples and applications of source coding.	
3		**Pulse Shaping for Optimum Transmission**	04
	3.1	Line codes and their desirable properties, PSD of digital data	
	3.2	Baseband PAM transmission: Concept of Inter symbol interference (ISI), Raised Cosine filter, Nyquist Bandwidth. Concept of equalizer to overcome ISI.	
4		**Digital Modulation Techniques**	10
	4.1	Concept of Binary and M-ary transmission, Coherent and Non- Coherent reception, Power spectral density of Pass-band signal, Signal space Representation and Euclidian distance.	
	4.2	Pass Band Amplitude modulation and Demodulation: BASK, M-ary PAM, Digital Phase Modulation & Demodulation: BPSK, OQPSK, QPSK, M-ary PSK, QAM, Digital Frequency Modulation and Demodulation: BFSK, MSK, M-ary FSK, Introduction to spread spectrum modulation, OFDM.	
	4.3	Comparison of all techniques based on Spectral efficiency, Power efficiency, Probability of error in detection.	
5		**Error Control codes**	9
	5.1	Need for channel encoding, Concept of Error detection and correction, Forward Error correction.	
	5.2	Linear block codes: Hamming Distance, Hamming Weight, Systematic codes, Syndrome Testing.	
	5.3	Cyclic codes; Generator polynomial for Cyclic codes, Systematic cyclic codes, Feedback shift register for Polynomial division.	
	5.4	Convolution codes: Convolution encoder, Impulse response of encoder, State diagram, trellis diagram Representations.	
6		**Optimum Reception of Digital Signal**	04
	6.1	A baseband signal receiver and its Probability of error.	
	6.2	The Optimum receiver and Filter.	
	6.3	Matched filter and its probability of error.	
		Total	**39**

Text Books:

1. Haykin Simon, *"Digital Communication Systems*," John Wiley and Sons, New Delhi, Forth Edition, 2014.
2. H. Taub, D. Schlling, and G. Saha, "*Principles of Communication Systems,*" Tata Mc-Graw Hill, New Delhi, Third Edition, 2012.
3. Lathi B P, and Ding Z., "*Modern Digital and Analog Communication Systems*," Oxford University Press, Forth Edition, 2009.
4. R N Mutagi, *"Digital Communication"*, Oxford University Press, 2nd Ed.

Reference Books:

1. John G. Proakis, "*Digital Communications*", McGraw Hill , 5th Ed
2. Sklar B, and Ray P. K., *"Digital Communication: Fundamentals and applications,"*Pearson, Dorling Kindersley (India), Delhi, Second Edition, 2009.
3. T L Singal, "*Analog and Digital Communication*," Tata Mc-Graw Hill, New Delhi, First Edition, 2012.
4. P Ramakrishna Rao, *"Digital Communication*," Tata Mc-Graw Hill, New Delhi, First Edition, 2011.
5. Amitabha Bhattacharya, "*Digital Communication*", Tata McGraw Hill

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELDO501	Data structures	03	-	--	03	-	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELDO501	Data structures	20	20	20	80	03	--	--	---	100

Course Prerequisite: C Programming

Course Objectives:
1. To understand basic linear and non-linear data structures.
2. To implement various operations on Arrays, linked list, stack, queue, binary tree, and graph.
3. To study different sorting and searching techniques.
4. To analyze efficient data structures to solve real world problems.

Course Outcomes:

After successful completion of the course students will be able to:
1. Understand various linear data structures.
2. Perform operations on linear data structures.
3. Comprehend various nonlinear data structures.
4. Implement various operations on nonlinear data structures.
5. Analyze appropriate sorting and searching techniques for a given problem.
6. Apply appropriate data structure and algorithms for solving real world problems.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Data Structures** Introduction to Data Structures, Types of Data Structures – Linear and Nonlinear, Operations on Data Structures, Concept of array, Static arrays vs Dynamic Arrays, structures.	04
2		**Stack and Queues** Introduction, Basic Stack Operations, Representation of a Stack using Array, Applications of Stack – Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation. Queue, Operations on Queue, Representation of a Queue using array, Circular Queue, concept of priority Queue, Applications of Queue-Round Robin Algorithm.	08
3		**Linked List** Introduction, Representation of Linked List, Linked List v/s Array, Types of Linked List - Singly Linked List (SLL), Operations on Singly Linked List : Insertion , Deletion ,reversal of SLL, Print SLL . Implementation of Stack and Queue using Singly Linked List. Introduction to Doubly Linked List and Circular Linked List	08
4		**Trees** Introduction, Tree Terminologies, Binary Tree, Types of Binary Tree, Representation of Binary Trees, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree, Applications of Binary Tree – Expression Tree, Huffman Encoding.	08
5		**Graphs** Introduction, Graph Terminologies, Representation of graph (Adjacency matrix and adjacency list), Graph Traversals – Depth First Search (DFS) and Breadth First Search (BFS), Application – Topological Sorting.	03
6		**Searching and Sorting** Introduction to Searching: Linear search, Binary search Sorting: Internal VS. External Sorting, Sorting Techniques: Bubble, Insertion, selection, Quick Sort, Merge Sort, Comparison of sorting Techniques, Hashing Techniques, Different Hash functions, Collision & Collision resolution techniques: Linear and Quadratic probing, Double hashing.	08
		Total	**39**

Text Books:

1. Tenenbaum, A. M., "Data structures using C", Pearson Education India, 1990.
2. Tremblay, J. P., & Sorenson, P. G., "An introduction to data structures with applications", McGraw-Hill, Inc, 1984.
3. Thareja, R., "Data structures using C", Oxford University Pres, 2014.
4. Gilberg, R. F., Forouzan, B. A., "Data Structures", United States, Cengage Learning, 2004.
5. Balagurusamy, E., "Data Structures Using C", McGraw-Hill Education (India), 2013.

Reference Books:

1. Bhasin, H., "Algorithms: Design and Analysis", Oxford University Press, 2015.
2. DATA STRUCTURES USING C, 2E. Tata McGraw-Hill Education, 2006.
3. Rajasekaran, S., Sahni, S., Horowitz, E., "Computer Algorithms", United States, Silicon Press, 2008.
4. Lipschutz, S., "Data Structures", McGraw Hill Education (India) Private Limited. Schaum's Outlines, 2014.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will consist of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELDO501	Biomedical Instrumentation	03	-	--	03	-	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELDO501	Biomedical Instrumentation	20	20	20	80	03		--		100

Course Pre-requisite:
1. Knowledge of Instrumentation and Measurement
2. Display devices and measurement tools
3. Knowledge of Human anatomy

Course Objectives:
1. To introduce the fundamentals of Biomedical Instrumentation Systems
2. To explore the human body parameter measurement setups
3. To make the students understand the basic concepts of diagnostic, therapeutic and imaging systems.

Course Outcomes:
After successful completion of the course students will be able to:
1. Get basic technical competence in the field of Medical Instrumentation and understand the importance of electrical safety in hospital equipment.
2. Explain the concept of bio potential generation and measurement using electrodes with their types.
3. Build foundation of knowledge of analytical Instruments in Biomedical field
4. Acquire knowledge about the Diagnostic Equipment like ECG, EEG, EMG machines
5. Describe the working principle of patient monitoring and assistive systems
6. Distinguish between various imaging modalities such as X-ray, CT, MRI etc. based on their principles.

Module No.	Unit No.	Contents	Hrs.
1		**Module 1 - Fundamentals of Biomedical Instrumentation:**	6
	1.1	Basics of Medical Instrumentation, Recording Systems & Biomedical Recorders, Types of biomedical equipment – Analytical, Diagnostic, Therapeutic and Surgical equipment	
	1.2	Calibration of medical devices and testing of biomedical equipment, Electrical classification of Biomedical Equipment Patient Monitoring Systems, Patient safety	
2		**Module 2 - Measurement of bio potentials**	6
	2.1	Basics of Cardiovascular and Nervous systems, Bio-potential generation, Electrodes for ECG, EEG, EMG	
	2.2	Electrode-tissue interfaces, electrode-electrolyte and electrolyte-skin interfaces, Skin contact impedance	
3		**Module 3 - Analytic Instruments**	6
	3.1	Principle and working of - Pulse Oximeter, Plethysmographs, Blood Flow Meters	
	3.2	Introduction to Spectro photometers, Electrodes for pH, pO2 and pCO2 measurement, Blood gas analysers –, Blood cell counters, Radio Immuno Assay and ELISA techniques.	
4		**Module 4 - Diagnostic Equipment**	7
	4.1	Electrocardiography (ECG) –ECG in diagnosis –Lead systems – Artifacts – ECG Machine. Heart sounds – Phonocardiography (PCG)	
	4.2	Electro encephalography (EEG), EEG Machine, Artifacts, Electromyography (EMG)–Electro neurography (ENG), Principles and applications	
5		**Module 5 - Patient monitoring and Assistive system**	7
	5.1	Bed-side monitors, Central station monitors, Computerized arrhythmia monitors	
	5.2	Cardiac Pacemakers, Defibrillators, Ventilators	
6		**Module 6 - Imaging Equipment**	7
	6.1	Construction and working of X ray, CT, MRI imaging	
	6.2	Basic working principle of PET, SPECT, Ultrasound imaging	
		Total	**39**

Text Books:

1. R S. Khandpur, "Handbook of Biomedical Instrumentation", 2004 (TMH Pub).
2. Leslie Cromwell, "Biomedical Instrumentation and Measurements‖", Pearson Education, 1980.
3. J G. Webster, "Medical Instrumentation, Application and Design", (John Wiley).

Reference Books:

1. Carr –Brown "Introduction to Biomedical Equipment Technology",(PHI Pub)
2. L. A. Geddes & L. E. Baker, "Principles of Applied Biomedical Instrumentation", Wiley India Pvt. Ltd.
3. Richard Aston, "Principles of Biomedical Instrumentation and Measurements", Merril

Publishing Co.
4. Chanderlekha Goswami, "Handbook of Biomedical Instrumentation", Manglam Publications.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDO501	Neural Network and Fuzzy Logic	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Prac tical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELDO501	Neural Network and Fuzzy Logic	20	20	20	80	03	--	--	---	100

Course Pre-requisite:

1. Knowledge of linear algebra, multivariate calculus, and probability theory
2. Knowledge of a programming language (PYTHON/C/C ++/ MATLAB recommended)

Course Objectives:

1. To study basics of biological Neural Network.
2. To understand the different types of Artificial Neural Networks.
3. To identify the applications of ANN.
4. To study fuzzy logic and fuzzy systems

Course Outcomes:

After successful completion of the course students will be able to:

1. **Understand** learning rules of ANN.
2. **Apply** the concepts of supervised and unsupervised neural networks
3. **Explain** the importance of feedback networks
4. **Understand** Associative memory networks
5. **Appreciate** the need for fuzzy logic and control
6. **Illustrate** neural networks practical applications

Module No.	Unit No.	Contents	Hrs.
1		**Introduction**	**05**
	1.1	Biological neurons, McCulloch -Pitts neuron model, Types of activation function, Network architectures, Knowledge representation. Linear & non-linear separable classes & Pattern classes.	
	1.2	Learning processes: Supervised learning, Unsupervised learning and Reinforcement learning	
	1.3	Learning Rules: Hebbian Learning Rule, Perceptron Learning Rule, Delta Learning Rule, Widrow-Hoff Learning Rule, Correlation Learning Rule, Winner Take-All Learning Rule.	
	1.4	Applications and scope of Neural Networks.	
2		**Supervised Learning Networks**	**08**
	2.1	Perception Networks – continuous & discrete, Perceptron convergence theorem, Adaline, Madaline, Method of steepest descent and least mean square algorithm.	
	2.2	Back Propagation Network.	
	2.3	Radial Basis Function Network.	
3		**Unsupervised Learning Networks**	**08**
	3.1	Fixed weights competitive nets.	
	3.2	Kohonen Self-organizing Feature Maps, Learning Vector Quantization.	
	3.3	Adaptive Resonance Theory – 1.	
4		**Associative Memory Networks**	**06**
	4.1	Introduction, Training algorithms for Pattern Association	
	4.2	Auto-associative Memory Network, Hetero-associative Memory Network, Bidirectional Associative Memory.	
	4.3	Discrete Hopfield Networks.	
5		**Fuzzy Logic**	**08**
	5.1	Fuzzy Sets, Fuzzy Relations and Tolerance and Equivalence.	
	5.2	Fuzzification and Defuzzification	
	5.3	Fuzzy Controllers.	
6		**Case studies on ANN**	**04**
	6.1	Handwritten Digit Recognition, Process Identification, Expert Systems for Low Back Pain Diagnosis.	
		Total	**39**

Text Books:

1. Jacek M. Zurada, "Introduction to Artificial Neural Systems," Jaico Publishing House.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications," 3rd edition, Wiley India.
3. S. N. Sivanandam and S. N. Deepa, "Principles of Soft Computing," 3rd edition,Wiley India.

Reference Books:

1. Simon Haykin, "Neural Networks A Comprehensive Foundation", 3rd edition Pearson Education.
2. S Rajasekaran and G A Vijayalakshmi Pai, "Neural Networks and Fuzzy Logic and Genetic Algorithms ", PHI Learning.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Note: *Students are encouraged to explore more applications which can be assessed by the faculty.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELDO501	Computer Organization and Architecture	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELDO501	Computer Organization and Architecture	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

1. Digital Electronics
2. Fundamental concepts of processing

Course Objectives:

1. To introduce the learner to the design aspects this can lead to maximized performance of a Computer.
2. To introduce the learner to various concepts related to Parallel Processing
3. To highlight the various architectural enhancements in modern processors.

Course Outcomes:
After successful completion of the course students will be able to:

1. Define the performance metrics of a Computer
2. Distinguish between CISC and RISC Design Philosophies
3. Explain the design considerations of Processor, Memory and I/O in Computer systems
4. Analyze the advantages and limitations of Parallelism in systems
5. Apply the principles of pipelining to improve performance
6. Evaluate the various architectural enhancements in modern processors

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Computer Organization**	**05**
	1.1	Fundamental Units of a Computer	
	1.2	Introduction to Buses	
	1.3	Number Representation methods- Integer and Floating-point, Booth's Multiplier, Restoring and Non-Restoring Division	
	1.4	Basic Measures of Computer Performance - Clock Speed, CPI, MIPs and MFlops	
2		**Processor Organization and Architecture**	**08**
	2.1	CPU Architecture, Register Organization, Instruction cycle, Instruction Formats, Addressing Modes	
	2.2	Control Unit Design- Hardwired and Micro-programmed Control: Vertical and Horizontal Micro-Instructions, Nano-programming	
	2.3	Comparison between CISC and RISC architectures	
3		**Memory Organization**	**10**
	3.1	Classification of Memories-Primary and Secondary Memories, RAM (SRAM and DRAM) and ROM (EPROM, EEPROM), Memory Inter- leaving	
	3.2	Memory Hierarchy, Cache Memory Concepts, Mapping Techniques, Write Policies, Cache Coherency	
	3.3	Virtual Memory Management-Concept, Segmentation, Paging, Page Replacement policies	
4		**Input/Output Organization**	**04**
	4.1	Types of I/O devices and Access methods, Types of Buses, Bus Arbitration	
	4.2	Direct Memory Access (DMA)	
5		**Parallelism**	**06**
	5.1	Introduction to Parallel Processing Concepts, Flynn's classification, Amdahl's law	
	5.2	Pipelining - Concept, Speedup, Efficiency, Throughput, Types of Pipeline hazards and solutions	
6		**Architectural Enhancements**	**06**
		Superscalar Architectures, Out-of-Order Execution, Multi-core processors, Clusters, GPU, Processing-in -Memory (PIM)	
		Total	**39**

Text Books:

1. William Stallings, "*Computer Organization and Architecture: Designing for Performance*", Eighth Edition, Pearson.
2. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGraw Hill, 2002.

Reference Books:

1. J.P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998.
2. B. Govindarajulu, "*Computer Architecture and Organization: Design Principles and Applications*", Second Edition, Tata McGraw-Hill.
3. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface", Morgan Kaufmann, 1998.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL501	Principles of Control System Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL501	Principles of Control System Lab						25	25	50

Term Work:

At least 10 experiments covering the entire syllabus of ELL501 (Principles of Control System) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiments must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exams will be based on the entire syllabus.

Course Outcomes:

After successful completion of the course students will be able to:

1. **Analyse** a control system in time and frequency domain.
2. **Design** a performance specification based controller in time and frequency domain.
3. **Develop** and tune PID controller for given control system.
4. **Evaluate** controllability and observability of a control system.
5. **Design** a state feedback controller according to given specifications.

Suggested List of Experiments

(Expected percentage of H/w and software experiments should be 60% & 40% respectively)

Sr. No.	Experiment Title
1	To study the time response of a first-order and second-order system to standard input signals.
2	To study the frequency response of a second-order system to standard input signals.
3	To solve a differential equation model using simulation software.
4	To study the steady-state errors for type-0, 1 and 2 systems.
5	To design a controller according to given performance specifications using root-locus.
6	To design a controller according to given performance specifications using bode plot.
7	To design appropriate lag, lead or lag-lead compensator using bode plot.
8	To perform stability analysis of several control systems using Nyquist plots.
9	To study similarity transforms for state-space canonical forms.
10	To study controllability and observability of control systems.
11	To design a state feedback controller using pole-placement and ackerman’s formula.
12	To introduce the PID controller and its tuning.

(Experiments can be performed online using simulation software as well as hardware. Free simulation software like Scilab can be used to perform the experiments.)

Note:
Suggested List of Experiments is indicative. However, flexibility lies with individual course instructors to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Teachers are encouraged to develop a strong understanding of the subject using case studies like the one shown in [1] and [2].

[1] M. Gunasekaran and R. Potluri. Low-cost undergraduate control systems experiments using microcontroller-based control of a dc motor. IEEE Transactions on Education, 55(4):508 – 516, Nov. 2012

[2] Control Systems Laboratory Manual, EE380, IIT Kanpur.
https://www.iitk.ac.in/ee/data/Teaching_labs/Control_System/EE380_labmanual.pdf

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELL502	Linear Integrated Circuits Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL502	Linear Integrated Circuits Lab	--	--	--	--	--	25	25	50

Course Pre-requisite:

- Electronic Devices and Circuits I and II

Course Objectives:

1. To teach fundamental principles of standard linear integrated circuits.
2. To develop a overall approach for students from selection of integrated circuit, study its specification, the functionality, design and practical applications

Course Outcomes:

After successful completion of the course student will be able to

1. Demonstrate an understanding of fundamentals of integrated circuits.
2. Analyze the various applications and circuits based on particular linear integrated circuit.
3. Select and use an appropriate integrated circuit to build a given application.
4. Design an application with the use of integrated circuit
5. Demonstrate use of ADC and DAC to sense and control physical quantities
6. Design the Power supply for the given specifications.

Term Work: At least six experiments based on the entire syllabus of Subject **(Linear Integrated Circuits)** should be set to have well predefined inference and conclusion. Few computation/simulation based experiments are encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time**. The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and**

averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

(Expected percentage of H/w and software experiments should be 60% & 40% respectively)

Sr. No.	Experiment Name
1	Experiment on op amp parameters
2	Experiment on design of application using op amp (Linear)
3	Experiment on implementation of op amp application e.g. oscillator
4	Experiment on non-linear application (e.g. comparator, Astable and mono-stable Multi-vibrator) of op amp
5	Experiment on non-linear application (e.g. peak detector, Precision Rectifier) of op amp
6	Experiment on ADC interfacing
7	Experiment on DAC interfacing
8	Experiments on IC 555 (Astable and mono-stable Multi-vibrator)
9	Experiment on voltage regulator Design of LVLC, LVHC,HVLC
10	Experiment on voltage regulator Design of HVLC, HVHC
11	Experiment on voltage regulator Design for Fold-back current limiting circuit.
12	Experiment based on VCO 566 and PLL565
13	Experiment on implementation of instrumentation system (e.g. data acquisition).

Note:

Suggested List of Experiments is indicative. However, flexibility lies with the individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL503	Digital Communication Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELL503	Digital Communication Lab	--	--	--	--	--	25	25	--	50

Term Work:

Lab session includes Ten experiments
The experiments will be based on the syllabus contents.

1. Minimum 10 experiments need to be conducted, out of which at least four experiments should be software-based *(Scilab, MATLAB, LabVIEW, Python, Octave etc)*. The experiments should be set to have well predefined inference and conclusion.
2. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus

Suggested List of Experiments

Sr. No.	Experiment Name
1	Line codes
2	Binary modulation techniques: BASK,BPSK,BFSK
3	M-ary modulation techniques: QPSK ,QAM
4	Minimum shift Keying
5	PDF& CDF of Raleigh / Normal/ Binomial Distributions
6	Eye pattern, Power factor for PAM signal
7	Source encoding: Huffman coding for Binary symbols
8	Shannon-Hartley equation to find the upper limit on the Channel Capacity
9	Linear Block code : code generation, Syndrome
10	Cyclic code-code generation, Syndrome
11	Convolutional code-code generation from generator sequences
12	Generation of FHSS and DSSS signal
13	Error performance and Quality factor of QPSK/BPSK/MSK Modulation

Note:
Suggested List of Experiments is indicative. However, flexibility lies with the individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL504	Professional Communication and Ethics-II	--	2*+ 2 Hours (Batch-wise)	--	--	02	--	02

****Theory class to be conducted for full class.***

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL504	Professional Communication and Ethics - II	--	--	--	--	--	25	--	25	50

Course Objectives:

Learners should be able to:

1. Discern and develop an effective style of writing important technical/business documents.
2. Investigate possible resources and plan a successful job campaign.
3. Understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
4. Develop creative and impactful presentation skills.
5. Analyse personal traits, interests, values, aptitude and skills.
6. Understand the importance of integrity and develop a personal code of ethics

Course Outcomes:

After successful completion of the course students will be able to:

1. Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.
2. Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
3. Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
4. Deliver persuasive and professional presentations.
5. Develop creative thinking and interpersonal skills required for effective professional communication.
6. Apply codes of ethical conduct, personal integrity and norms of organizational behavior.

Module No.	Unit No.	Contents	Hrs.
1		**ADVANCED TECHNICAL WRITING: PROJECT/PROBLEM BASED LEARNING (PBL)**	06
	1.1	**Purpose and Classification of Reports** Classification on the basis of: Subject Matter (Technology, Accounting, Finance, Marketing, etc.), Time Interval (Periodic, One-time, Special), Function (Informational, Analytical, etc.), Physical Factors (Memorandum, Letter, Short & Long)	
	1.2	**Parts of a Long Formal Report** Prefatory Parts (Front Matter), Report Proper (Main Body), Appended Parts (Back Matter)	
	1.3	**Language and Style of Reports** Tense, Person & Voice of Reports, Numbering Style of Chapters, Sections, Figures, Tables and Equations, Referencing Styles in APA & MLA Format, Proof-reading through Plagiarism Checkers	
	1.4	**Definition, Purpose & Types of Proposals** Solicited (in conformance with RFP) & Unsolicited Proposals, Types (Short and Long proposals)	
	1.5	**Parts of a Proposal** Elements, Scope and Limitations, Conclusion	
	1.6	**Technical Paper Writing** Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References), Language and Formatting, Referencing in IEEE Format	
2		**EMPLOYMENT SKILLS**	06
	2.1	**Cover Letter & Resume** Parts and Content of a Cover Letter, Difference between Bio-data, Resume & CV, Essential Parts of a Resume, Types of Resume (Chronological, Functional & Combination)	
	2.2	**Statement of Purpose** Importance of SOP, Tips for Writing an Effective SOP	
	2.3	**Verbal Aptitude Test** Modelled on CAT, GRE, GMAT exams	
	2.4	**Group Discussions** Purpose of a GD, Parameters of Evaluating a GD, Types of GDs (Normal, Case-based & Role Plays), GD Etiquette	
	2.5	**Personal Interviews** Planning and Preparation, Types of Questions, Types of Interviews (Structured, Stress, Behavioral, Problem Solving & Case-based), Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	
3		**BUSINESS MEETINGS**	02
	3.1	**Conducting Business Meetings** Types of Meetings, Roles and Responsibilities of Chairperson, Secretary and Members, Meeting Etiquette	
	3.2	**Documentation** Notice, Agenda, Minutes	
4		**TECHNICAL/ BUSINESS PRESENTATIONS**	02
	4.1	**Effective Presentation Strategies**	

		Defining Purpose, Analyzing Audience, Location and Event, Gathering, Selecting &Arranging Material, Structuring a Presentation, Making Effective Slides, Types of Presentations Aids, Closing a Presentation, Platform Skills	
	4.2	**Group Presentations** Sharing Responsibility in a Team, Building the contents and visuals together, Transition Phases	
5		**INTERPERSONAL SKILLS**	08
	5.1	**Interpersonal Skills** Emotional Intelligence, Leadership & Motivation, Conflict Management & Negotiation, Time Management, Assertiveness, Decision Making	
	5.2	**Start-up Skills** Financial Literacy, Risk Assessment, Data Analysis (e.g. Consumer Behavior, Market Trends, etc.)	
6		**CORPORATE ETHICS**	02
	6.1	**Intellectual Property Rights** Copyrights, Trademarks, Patents, Industrial Designs, Geographical Indications Integrated Circuits, Trade Secrets (Undisclosed Information)	
	6.2	**Case Studies** Cases related to Business/ Corporate Ethics	
		Total	**26**

LIST OF ASSIGNMENTS FOR TERMWORK:

(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

1. Cover Letter and Resume
2. Short Proposal
3. Meeting Documentation
4. Writing a Technical Paper/ Analyzing a Published Technical Paper
5. Writing a SOP
6. IPR
7. Interpersonal Skills
8. Aptitude test (Verbal Ability)

Note:

1. *The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).*
2. *The group size for the final report presentation should not be less than 5 students or exceed 7 students.*
3. *There will be an end–semester presentation based on the book report.*

GUIDELINES FOR INTERNAL ASSESSMENT

Term Work:

Term work shall consist of minimum 8 experiments.

The distribution of marks for term work shall be as follows:

Assignment	: 10 Marks
Attendance	: 5 Marks
Presentation slides	: 5 Marks
Book Report (hard copy)	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal oral:

Oral Examination will be based on a GD & the Project/Book Report presentation.

Group Discussion	:10 marks
Project Presentation	:10 Marks
Group Dynamics	:5 Marks

Text books and Reference books:

1. Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition*. Boston, MA: McGraw-Hill.
2. Bovée, C. L., &Thill, J. V. (2021). *Business communication today*. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011), *Personal development for life and work*. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow, England: Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
8. Sanjay Kumar &Pushp Lata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Subject Code	Subject Name	Credits Assigned
ECM501	Mini project - 2A	02

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="8">Examination Scheme</th></tr>
<tr><th colspan="5">Theory Marks</th><th rowspan="3">Term Work</th><th rowspan="3">Practical/ Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal Assessment</th><th rowspan="2">End Sem Exam</th><th rowspan="2">Exam duration Hours</th></tr>
<tr><th>Test 1</th><th>Test 2</th><th>Avg. of Test 1 and Test 2</th></tr>
<tr><td>ECM501</td><td>Mini Project - 2A</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>25</td><td>25</td><td>50</td></tr>
</table>

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcomes:

Learner will be able to;

1. Identify problems based on societal /research needs.
2. Apply knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/experimental/simulations.
5. Analyze the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices.
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Major focus of Mini-project 2 shall be towards exploration and applicability of knowledge acquired in the domain areas of DLOs available for the year.

- Student shall give special consideration to identify and provide solutions to the burning societal and/or environmental issues which may affect the mankind to larger extend.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.

A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self- learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case-to-case basis.

Guidelines for Assessment of Mini Project:

The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester. In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below;

Marks awarded by guide/supervisor based on logbook:		***10***
Marks awarded by review committee	***:***	***10***
Quality of Project report	***:***	***05***

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

In **first semester** entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.

- First on identification and finalization of problem
- Second on proposed solution for the problem.

In **second semester** expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.

- First review shall base on readiness of building working prototype.
- Second review shall be based on poster presentation-cum-demonstration of working model in last month of the said semester.

Half-year project:

In this case students' group shall complete project in all aspects, in a semester, including;

- Identification of need/problem
- Proposed acceptable solution for the identified problem
- Procurement of components/systems, if any,
- Building a working prototype and testing

The group shall be evaluated twice during the semester by review committee, mainly look for the progress as;

- First review focus shall be towards identification & selection of problem and probable solution proposal.
- Second review shall be for implementation and testing of solution. (Innovative/out of box solution)

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria:

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Innovativeness and out of box thinking
6. Cost effectiveness and Societal impact
7. Functional working model as per stated requirements
8. Effective use of skillsets acquired through curriculum including DLOs
9. Effective use of standard engineering practices & norms
10. Contribution of an individual as team member/Leader
11. Feasibility to deploy the solution on large scale
12. Clarity in written and oral communication

In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini-

project.
In case of **half year project** all criteria's in generic may be considered for performance evaluation of students in mini-project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

Report should be prepared as per the guidelines issued by the University of Mumbai. Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations, having experience of more than five years approved by head of the Institute.

Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed by team of external & internal examiner at the end of semester/year. Performance shall be evaluated based on;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Implementation of working model
5. Effective use of diversified skill-set
6. Effective use of standard engineering practices & norms
7. Contribution of an individuals as a member/Leader
8. Clarity in written and oral communication

Program Structure for Third Year Electronics Engineering

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract.	Tut	Total
ELC601	Basic VLSI Design	3	--	--	3	--	--	**3**
ELC602	Electromagnetic Engineering	3		--	3		--	**3**
ELC603	Computer Communication Networks	3	--	--	3	--	--	**3**
ELC604	Embedded Systems and Real Time Operating Systems	3	--	--	3	--	--	**3**
ELDO601	Department Optional Course - II	3	--	--	3	--	--	**3**
ELL601	Basic VLSI Design Lab	--	2	--	--	1	--	**1**
ELL602	Computer Communication Networks Lab	--	2	--	--	1	--	**1**
ELL603	Embedded Systems and Real Time Operating Systems Lab	--	2	--	--	1	--	**1**
ELL604	Database Management Systems Lab	--	4	--	--	2	--	**2**
ELM601	Mini Project–2 B	--	4$	--	--	2	--	**2**
Total		**15**	**14**	**--**	**15**	**07**	**--**	**22**

$ indicates workload of Learner (Not Faculty), for Mini Project

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)	TW	Pract/ Oral	Total
		Test 1	Test 2	Avg.					
ELC601	Basic VLSI Design	20	20	20	80	3	--	--	100
ELC602	Electromagnetic Engineering	20	20	20	80	3	--	--	100
ELC603	Computer Communication Networks	20	20	20	80	3	--	--	100
ELC604	Embedded Systems and Real Time Operating Systems	20	20	20	80	3	--	--	100
ELDO601	Department Optional Course - II	20	20	20	80	3	--	--	100
ELL601	Basic VLSI Design Lab	--	--	--	--	--	25	25	50
ELL602	Computer Communication Networks Lab	--	--	--	--	--	25	25	50
ELL603	Embedded Systems and Real Time Operating Systems Lab	--	--	--	--	--	25	25	50
ELL604	Database Management Systems Lab	--	--	--	--	--	50	--	50
ELM601	Mini Project–2 B	--	--	--	--	--	25	25	50
Total				**100**	**400**	**--**	**150**	**100**	**750**

Department Level Optional Course - I (ELDO 601):

1. Digital Control System	3. Machine Learning
2. Digital Image Processing and Machine Vision	4. Digital Design with Reconfigurable Architecture

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELC601	Basic VLSI Design	03	-	--	03	-	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELC601	Basic VLSI Design	20	20	20	80	03		--		100

Course Pre-requisite:
1. Electronics Devices and circuits – I (ELC302)
2. Digital Logic Circuits(ELC303)
3. Electronics Devices and Circuits – II (ELC402)

Course Objectives:

1. To understand VLSI Design flow and technology trends.
2. To realize MOS based circuits using different design styles.
3. To study semiconductor memories using MOS logic.
4. To study adder, multiplier and shifter circuits for realizing data path design.

Course Outcomes:
After successful completion of the course students will be able to:

1. Demonstrate a clear understanding of VLSI Design flow, technology trends, scaling and MOSFET models.
2. Design and analyze MOS based inverters.
3. Understand different MOS circuit design styles.
4. Apply design styles for realization of Combinational and Sequential Circuits
5. Understand various semiconductor memories using MOS logic
6. Design adder, multiplier and shifter circuits using MOS logic

Module No.	Unit No.	Contents	Hrs.
1		**VLSI Design flow and Technology Trends**	06
	1.1	VLSI Design Flow: Full custom and Semicustom IC design flow	
	1.2	MOSFET Scaling: Types of scaling, comparison of MOSFET Model levels, MOSFET capacitances, interconnect scaling and crosstalk	
	1.3	Technology Comparison: Comparison of BJT and MOS technologies	
2		**MOSFET Inverters**	08
	2.1	Introduction to MOS inverters: Active and passive load nMOS inverters, CMOS inverter and their comparison	
	2.2	Static Analysis of Resistive nMOS and CMOS Inverters: Calculation of critical voltages and noise margins	
	2.3	Design of symmetric CMOS inverter	
	2.4	Dynamic Analysis of CMOS inverter: Calculation of rise time, fall time and propagation delay	
	2.5	Various components of power dissipation in CMOS circuits	
3		**MOS Circuit Design Styles**	05
	3.1	Static: Static CMOS, Pass transistor, Transmission gate, Pseudo NMOS design styles	
	3.2	Dynamic: C^2MOS, Dynamic, Domino, NORA and Zipper design styles	
4		**Combinational and Sequential Circuit Realization**	08
	4.1	Analysis and design of 2-I/P NAND, 2-I/P NOR and complex Boolean function realisation using equivalent CMOS inverter for simultaneous switching	
	4.2	Complex Boolean function realisation using various design styles	
	4.3	Basic gates and MUX realisation using pass transistor and transmission gate logic	
	4.4	SR Latch, JK FF, D FF, 1 Bit Shift Register realisation using CMOS logic	
5		**Semiconductor Memories**	07
	5.1	SRAM: 6T SRAM operation, design strategy, read/write circuits, sense amplifier	
	5.2	DRAM: 1T DRAM, operation modes, leakage currents, refresh operation, physical design	
	5.3	ROM Array: NAND and NOR based ROM array	
	5.4	Non-volatile read/write memories: Programming techniques for flash memory, Introduction to advances in non-volatile memories: MRAM, ReRAM	
6		**Data Path Design**	05
	6.1	Adder: CLA adder, MODL, Manchester carry chain High-speed adders: carry skip, carry select and carry save	
	6.2	Multipliers and shifter: Array multiplier and barrel shifter	
		Total	**39**

Text Books:

1. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design" Tata McGraw Hill, Revised 4th Edition.
2. John P. Uyemura, "Introduction to VLSI Circuits and Systems", Wiley India Pvt. Ltd.

Reference Books:

1. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", Pearson Education, 2nd Edition
2. Douglas A Pucknell, Kamran Eshraghian, "Basic VLSI Design", Prentice Hall of India Private Ltd.
3. Ivan Sutherlan and Bob Sproull, "Logical Effort: Designing Fast CMOS Circuits"
4. Etienne Sicard and Sonia Delmas Bendhia, "Basics of CMOS Cell Design", Tata McGraw Hill
5. Neil H. E. Weste, David Harris and Ayan Banerjee, "CMOS VLSI Design: A Circuits and Systems Perspective", Pearson Education
6. David Hodges, Horace Jackson, Resve Saleh, "Analysis and Design of Digital Integrated Circuits", McGraw-Hill, Inc.
7. Ashok K. Sharma, "Advanced Semiconductor Memories: Architectures, Designs, and Applications", Wiley Publication
8. Denny D.Tang, Chi-Feng Pai, "Magnetic Memory Technology: Spin-Transfer-Torque MRAM and Beyond", Wiley online Library
9. Daniele Ielmini, Rainer Waser, "Resistive Switching: From Fundamentals of Nanoionic Redox Processes to Memristive Device Applications", Wiley online Library

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELC602	Electromagnetic Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC602	Electromagnetic Engineering	20	20	20	80	3	--	--	100

Course Pre-requisites:
1. Vector Algebra (ELC301)
2. Engineering Physics
3. Electrical Network Analysis (ELC304)
4. Principles of Communication Engineering (ELC404)

Course Objectives:
1. To provide the basic skills required to understand, develop, and design various engineering applications involving electromagnetic fields.
2. To lay the foundations of electromagnetism and its practice in modern communications.
3. To provide an introduction to electromagnetic wave transmission through guided media.
4. To provide exposure to global safety standards in electromagnetic interference.

Course Outcomes:

After successful completion of the course students will be able to:
1. Apply vector calculus to static electric and magnetic fields in different engineering situations.
2. Analyze Maxwell's equation in different forms (differential and integral) and apply them to diverse engineering problems.
3. Analyze the phenomena of electromagnetic wave propagation in different media and in applications of microwave engineering.
4. Analyze the nature of electromagnetic wave propagation through transmission lines.
5. Evaluate and analyze different antenna structures and their applications.
6. Examine the sources of EMI and identify methods to ensure compatibility as per existing standards for electrical and electronic systems.

Module No.	Unit No.	Contents	Hrs.
1		**Basic Laws of Electromagnetic**	09
	1.1	Qualitative interpretation of Gradient, Divergence and Curl; Coulomb's Law & Electric Field Intensity, Derivation of electric field intensity due to point, line and surface charges; Electric flux density, Gauss's Law and divergence theorem; Relationship between Electric field & Potential.	
	1.2	Current and current Density, Continuity equation; Electric boundary conditions; Poisson's and Laplace's equation.	
	1.3	Biot-Savart's Law, Ampere's Circuital Law, magnetic field intensity of infinite current element; Magnetic flux density, Concept of magnetic scalar and vectors potentials; Magnetic boundary conditions.	
2		**Maxwell's Equations**	06
	2.1	Faraday's law, concept of transformer and motional electromotive forces; Displacement current, Ampere's Law for time-varying fields, Maxwell's equations in differential and integral form; Concept of time varying potentials, Lorentz gauge conditions.	
	2.2	Concept of phasors and time harmonic fields.	
3		**Electromagnetic Waves**	06
	3.1	Derivation of electromagnetic wave equation, General representation of EM waves.	
	3.2	Wave Propagation in Free Space, Lossy and Lossless Dielectrics and in Good Conductors, Skin Effect, Wave Polarization, Poynting's Theorem; Introduction to microwaves as an EM wave application.	
4		**Transmission Lines**	06
	4.1	Transmission line parameters, Transmission line equations; Input impedance, reflection coefficient, standing wave ratio and power.	
	4.2	Smith Chart, Applications of Smith Chart in finding VSWR, reflection coefficient, admittance calculations and impedance calculations over length of line. Applications of Microstrip Lines.	
5		**Introduction to Antennas**	08
	5.1	Introduction to antennas and radiation mechanism; Basic antenna parameters: Radiation pattern, radiation power density, radiation intensity, HPBW, FNBW, directivity, Antenna radiation efficiency, Gain, bandwidth, polarization, input impedance, effective length, near and far field regions; FRIIS transmission equation.	
	5.2	Far-field radiating fields, radiation resistance and directivity of an infinitesimal dipole; Comparison between small dipole, finite length dipole and a half wavelength dipole; Introduction to antenna arrays; linear array of two isotropic point sources, principle of pattern multiplication; Qualitative introduction to horn antennas, reflector antennas and microstrip antennas.	
6		**Introduction to EMI/EMC**	04
		Definition of EMI/EMC, introduction to sources and characteristics of EMI, EMI control techniques like grounding, shielding and filtering. EMC requirements for electronic systems, a review of MIL-standards, FCC and CISPR requirements.	
		Total	**39**

Text Books:

1. William H Hayt, John A Buck, Jaleel M. Akhtar, "Engineering Electromagnetics", 9th ed., McGraw-Hill Higher Education, 2020.
2. Matthew N. O. Sadiku, S. V. Kulkarni, "Principles of Electromagnetics", 6th ed., Oxford University Press, 2015.
3. R. K. Shevgaonkar, "Electromagnetic Waves", Tata McGraw Hill, 2005.
4. C. A. Balanis, "Antenna Theory: Analysis and Design", 4th ed., John Wiley & Sons, NJ, 2015.
5. W. Prasad Kodali, "Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies and Computer Models", 2nd ed., Wiley-IEEE Press, 2001.
6. Clayton R. Paul, "Introduction to Electromagnetic Compatibility", John Wiley & Sons, 2nd ed., 2006.

Reference Books:

1. John D. Kraus, Daniel A. Fleisch, "Electromagnetics: With Applications", 5th ed., Tata McGraw Hill, 2010.
2. Joseph Edminister, Mahmood Nahvi, "Schaum's Outline of Electromagnetics", 5th ed., McGraw Hill, 2018.
3. J. D. Kraus, R. J. Marhefka, A.S. Khan, "Antennas & Wave Propagation", McGraw Hill Publications, 5th ed., 2017.
4. R. E. Collin, "Antennas and Radio Wave Propagation", International Student Edition, McGraw Hill, 1985.
5. Henry Ott, "Electromagnetic Compatibility Engineering", Wiley, 2009.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	TW/Practical	Total
ELC 603	Computer Communication and Networks	3	--	--	3	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELC603	Computer Communication and Networks	20	20	20	80	-	--	--	100

Course Pre-requisite: ELC 404 Principles of Communication Engineering
ELC 504 Digital Communication

Course Objectives:
The objectives of this course are to:

1. Introduce networking architecture and protocols.
2. Understand the various layers and protocols in the TCP/IP model.
3. Recognize different addressing schemes, connecting devices and routing protocols.
4. Select the required protocol from the application layer protocols.

Course Outcomes:
On successful completion of the course the students will be able to:

1. **Demonstrate** understanding of networking concepts and required protocols.
2. **Analyze** the various layers and protocols of the layered architecture.
3. **Evaluate** different addressing schemes, connecting devices and routing protocols.
4. **Analyze** various routing protocols in Network layer.
5. **Understand** the various protocols in Transport layer
6. **Comprehend** the different protocols in application layer

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to Network Architectures, Protocol Layers, and Service models**	04
	1.1	Introduction to computer networks and it's uses. LAN, MAN, WAN Network topologies **Addressing:** Physical / Logical /Port addressing, Protocols and Standards.	
	1.2	**Protocol Architecture:** Need of layered protocol architecture, Layers details of OSI, Protocol Layers and Their Service Models	
	1.3	**TCP/IP Model:** Protocol suite, Comparison of OSI and TCP/IP	
2.		**Physical Layer**	06
	2.1	**Transmission Media:** Guided media like Coaxial, fiber, twisted pair, and Wireless media, Transmission Impairments. Interconnecting Devices: Hub, Bridges, Switches, Router, Gateway	
	2.2	**Introduction to LAN:** LAN Protocol architecture **Traditional Ethernet and IEEE 802.3 LAN Standard**: Ethernet protocol, Frame structure, Physical layers: LLC, MAC layers	
	2.3	**Multiplexing:** Synchronous TDM, Statistical TDM, ADSL	
3.		**Data Link Control**	10
	3.1	**Data link services:** Framing, Flow control, Error control, ARQ methods, Piggybacking	
	3.2	**High Level Data Link Control (HDLC):** HDLC configurations, Frame formats, Typical frame exchanges.	
	3.3	**Medium Access Control Protocols**: ALOHA, Slotted ALOHA, CSMA, CSMA/CD	
4.0		**Network Layer**	10
	4.1	**Switching**: Switched communication networks, Circuit switching networks, Circuit switching Concepts –Crossbar switch, Time Slot Interchange (TSI), TDM bus switching, Packet switching principles: Virtual circuit switching and Datagram switching	
	4.2	**Routing in Packet Switching Networks:** Characteristics, Routing strategies, Link state Routing, Distance vector Routing. Least-Cost Routing Algorithms: Dijkstra's Algorithm, Bellman Ford Algorithm.	
	4.3	**Internet Protocol:** **Principles of Internetworking:** Requirements, Connectionless Operation **Internet Protocol Operation:** IP packet, IP addressing - classful and classless, subnet and supernet addressing, IPv4, IPv6 (IPv6 Datagram format, comparison with IPv4, and transition from IPv4 to IPv6)	
5.0		**Transport Layer**	06
	5.1	**Connection –oriented Transport Protocol Mechanisms: Transmission Control Protocol (TCP):** TCP Services, TCP Header format, TCP three way handshake, TCP state transition diagram. **Connectionless transport mechanisms: User Datagram Protocol (UDP) -** header	
	5.2	**Congestion:** Effects of congestion, Congestion control methods, Congestion control in Packet switching Networks	
6.0		**Application layer**	03
		HTTP, FTP, DNS, SMTP, Internet Telephony and Streaming Multimedia	
Total			**39**

Recommended Text Books

1. William Stallings, “Data and Computer communications”, Pearson Education, 10th Edition.
2. Behrouz A. Forouzan, “Data communication and networking “, McGraw Hill Education, Fourth Edition.
3. Alberto Leon Garcia, “Communication Networks”, McGraw Hill Education, Second Edition

Reference books:

1. S. Tanenbaum, “Computer Networks”, Pearson Education, Fourth Edition.
2. Computer Networking: A Top-Down Approach, by J. F. Kurose and K. W. Ross, Addison Wesley, 5th Edition.
3. Bhushan Trivedi, “Data Communication and Network”, Oxford Publication Press, 1st edition.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4. Remaining question will be selected from all the modules.

Note: *Students are encouraged to explore more applications which can be assessed by the faculty.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELC604	Embedded Systems and Real Time Operating Systems	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELC604	Embedded Systems and Real Time Operating Systems	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

1. Digital Electronics
2. Basics of Microcontrollers

Course Objectives:

1. To study concepts involved in Embedded Hardware and Software for System realisation.
2. To learn the concepts of modern microcontroller cores like the ARM-Cortex
3. To learn Real-time programming to design time-constrained embedded systems

Course Outcomes:

After successful completion of the course students will be able to:

1. Identify and describe various characteristic features and applications of embedded systems.
2. Analyze and select hardware for embedded system implementation.
3. Evaluate various communication protocols for embedded system implementation.
4. Compare GPOS and RTOS and investigate the concepts of RTOS.
5. Evaluate and use various tools for testing and debugging embedded systems
6. Design a system for different requirements based on life-cycle for the embedded system, keeping oneself aware of ethics and environmental issues.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Embedded Systems**	**03**
	1.1	Definition, Characteristics, Classification, Applications	
	1.2	Design metrics of Embedded system and Challenges in optimization of metrics	
2		**Embedded Hardware Elements**	**13**
	2.1	Features of Embedded cores- µC, ASIC, ASSP, SoC, FPGA, RISC and CISC cores. Types of memories.	
	2.2	Case Study: ARM Cortex-M3 Features, Architecture, Programmer's model, Special Registers, Operating Modes and States, MPU, Memory map and NVIC.	
	2.3	Low power - Need and techniques. Case study of Low Power modes in Cortex-M3.	
	2.4	Communication Interfaces: Comparative study of Serial communication Interfaces -RS-232, RS-485, SPI, I2C, CAN, USB (v2.0), Bluetooth, Zig-Bee. (Frame formats of above protocols are not expected)	
	2.5	Selection Criteria of Sensors and Actuators	
3		**Embedded Software**	**12**
	3.1	Program Modelling concepts: DFG, CDFG, FSM.	
	3.2	Real-time Operating system: Need of RTOS in Embedded system software and comparison with GPOS. Task, Task states, Multi-tasking, Task scheduling, and algorithms-Preemptive SJF, Round-Robin, Priority, Rate Monotonic Scheduling, Earliest Deadline First Inter-process communication: Message queues, Mailbox, Event timers. Task synchronization: Need, Issues- Deadlock, Race condition, live Lock, Solutions using Mutex, Semaphores. Shared Data problem, Priority inversion.	
4		**Introduction to FreeRTOS**	**03**
		FreeRTOS Task Management features, Resource Management features, Task Synchronization features, Event Management features, Calculation of CPU Utilization of an RTOS, Interrupt Management features, Time Management features.	
5		**Testing and Debugging Methodology**	**02**
	5.1	Testing & Debugging: Hardware testing tools, Boundary-scan/JTAG interface concepts, Emulator.	
	5.2	Software Testing tools, Simulator, Debugger. White-Box and Black-Box testing.	
6		**System Integration (Case Studies)**	**06**
	6.1	Embedded Product Design Life-Cycle (EDLC)- Waterfall Model	
	6.2	Hardware-Software Co-design	
	6.3	Case studies for Automatic Chocolate Vending Machine, Washing Machine, Smart Card, highlighting i) Specification requirements (choice of components), ii) Hardware architecture iii) Software architecture	
		Total	**39**

Note: *Referring to data sheets while selecting Embedded Hardware components must be encouraged.*

Text Books:

1. Dr. K.V. K. K. Prasad, "Embedded Real Time System: Concepts, Design and Programming", Dreamtech, New Delhi, Edition 2014.
2. Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd.
3. SriramIyer, Pankaj Gupta," Embedded Real Time Systems Programming", Tata McGraw Hill Publishing Company ltd., 2003.
4. Joseph Yiu,"The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors", Elsevier, 2014, 3rd Edition.
5. www.freertos.org

Reference Books:

1. David Simon, "An Embedded Software Primer", Pearson, 2009.
2. Jonathan W. Valvano, "Embedded Microcomputer Systems – Real Time Interfacing", Publisher - Cengage Learning, 2012 Edition 3rd.
3. Andrew Sloss, Domnic Symes, Chris Wright, "ARM System Developers Guide Designing and Optimising System Software", Elsevier, 2004
4. Frank Vahid, Tony Givargis, "Embedded System Design – A Unified Hardware/Software Introduction", John Wiley & Sons Inc., 2002.
5. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi, 2009.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4. Remaining questions will be selected from all the module

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDO601	Digital Control Systems	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELDO601	Digital Control Systems	20	20	20	80	03	--	--	100

Course Objectives:

1. To develop the understanding of fundamental principles of digital control systems.
2. To disseminate the concept of stability and its assessment for discrete-time linear systems.
3. To introduce Z-transform methods and digital controller design.
4. To develop modern state-space methods in digital control systems design.

Course Outcomes:

After successful completion of the course students will be able to:

1. **Employ** sampling and reconstruction of analog signals.
2. **Derive** discrete-time models of physical systems.
3. **Evaluate** the stability of digital control systems in time and frequency domain.
4. **Design** performance specification based digital controller for a given system.
5. **Analyse** the digital control systems using state-space methods and **design** digital state feedback controllers.

Module No.	Unit No.	Contents	Hrs.
1		**Fundamentals of discrete-time signals and discretization**	06
	1.1	Why study digital control systems? Advantages and limitations, comparison of continuous and discrete data control, block diagram of digital control system.	
	1.2	Impulse sampling, Nyquist-Shannon sampling theorem, reconstruction discrete-time signals (Ideal filter).	
	1.3	Realizable reconstruction methods (ZOH and FOH), transfer functions of ZOH and FOH.	
2		**Modelling of Digital Control Systems**	06
	2.1	Discretization approaches: Impulse invariance, step invariance, bilinear transformation, finite-difference approximation of derivative.	
	2.2	Starred Laplace transform, Pulse transfer function and general procedures to obtain pulse transfer function.	
3		**Stability Analysis and Digital Controller Design**	10
	3.1	Mapping between s-plane and z-plane. stability analysis of digital systems in z-plane.	
	3.2	Transient and steady-state analysis of time response.	
	3.3	Digital controller design using the root-locus method; digital PID controller; deadbeat controller.	
	3.4	Realization of digital controllers: direct programming, standard programming, series programming, parallel programming ladder programming.	
4		**State-space Analysis of Discrete-time Systems**	09
	4.1	Discretization of continuous-time state-space solution and discrete-time state-space model. Representation of difference equation to state-space.	
	4.2	Canonical forms for state-space representation and similarity transformations.	
	4.3	Solution of discrete-time state-space equation. Computation of state-transition matrix (z-transform, Caley-Hamilton theorem, Diagonalization)	
5		**Controller Design in State-space**	08
	5.1	Concept of controllability, distinction between reachability and controllability, digital controller design using pole-placement methods (similarity transform, Ackerman's formula)	
	5.2	Concept of observability, distinction between detectability and observability in discrete-time systems.	
	5.3	Observer design (prediction and current observer), output feedback controller, introduction to separation principle.	
		Total	**39**

Text Books:

1. Katsuhiko Ogata, “Discrete-time Control Systems”, 2nd edition, Pearson Education, 1995.
2. M. Gopal, “Digital Control and State Variable Methods”, Tata McGraw Hill, 4th edition, 2012.

Reference Books:

1. Gene Franklin, J David Powell, Michael Workman, “Digital Control of Dynamic Systems”, Addison Wesley, 3rd edition, 1998.
2. B. C. Kuo, “Digital Control Systems”, Oxford University Press, 2nd edition, 2010.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will consist of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Note: Students are encouraged to take case study of real life applications.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDO601	Digital Image Processing and Machine Vision	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELDO601	Digital Image Processing and Machine Vision	20	20	20	80	3	--	--	100

Pre-requisites:
A student has to understood following subjects before learning this subject:

1. Engineering Mathematics – III (ELC301)
2. Engineering Mathematics – IV (ELC401)
3. Digital Signal Processing (ELC502)

Course Objectives:

1. To learn the fundamental concepts of image processing for image enhancement.
2. To learn image compression, segmentation techniques with practical applications.
3. To provide basic concepts of machine vision and application development.

Course Outcomes:

After successful completion of the course students will be able to:

1. Represent and interpret image in its numeric and graphical form.
2. Perform different image enhancement approaches for improving image quality.
3. Elucidate the mathematical modelling of image segmentation.
4. Apply the concept of image compression.
5. Understand machine vision system elements.
6. Develop a machine vision system based on requirement.

Module No.	Unit No.	Contents	Hrs.
1		**Digital Image Processing Fundamentals**	04
	1.1	Introduction: Background, Representation of a Digital Image, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System.	
	1.2	Digital Image Fundamentals: Elements of Visual Perception, A Simple Image Model, Two dimensional Sampling and Quantization, Tonal and Spatial Resolutions, Image File Formats: BMP, TIFF and JPEG. RGB Color model.	
2		**Enhancement in Spatial and Frequency Domain**	09
	2.1	Enhancement in the spatial domain: Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging.	
	2.2	Spatial domain filters: Smoothing Filters, Sharpening Filters, High boost filter, 2D-DFT/FFT of an image, Frequency domain image enhancement techniques.	
3		**Image Segmentation and Morphological Operations**	10
	3.1	Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based image segmentation, split and merge techniques. Image Representation and Description, Chain Code, Polygonal Representation.	
	3.2	Binary Morphological Operators, Dilation and Erosion, Opening and Closing, Hit-or-Miss Transformation, Thinning and Thickening.	
4		**Image Compression**	05
		Fundamentals: Coding Redundancy, Inter-pixel Redundancy, Psycho visual Redundancy Lossless Compression Techniques: Run Length Coding, Huffman Coding, Lossy Compression Techniques: Predictive Coding, Improved Gray Scale Quantization, Transform Coding, JPEG Standard.	
5		**Machine Vision Basics**	04
		Introduction, definition, Active vision system, Machine vision components, hardware's and algorithms, Image Feature Extraction.	
6		**Machine Vision Applications in Industry**	07
		Machine Vision for Industrial Applications, Low Angle Metal Surface (Crosshead) Inspection, Machine Vision System for Quality Grading of Painted Slates, Inspecting Glass Bottles and Jars, Stemware Inspection System, Glass Thickness Measurement Using Morphology, Inspecting Food Products.	
		Total	**39**

Text Books:

1. Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, Third Edition.
2. Anil K. Jain, "Fundamentals and Digital Image Processing", Prentice Hall of India Private Ltd, Third Edition.
3. Bruce G. Batchelor (Ed.), "Machine Vision Handbook", Springer, 1st Edition.
4. Peter Corke, "Robotics, Vision and Control", Springer, 1st Edition.

Reference Books:

1. S. Jayaraman, E.Esakkirajan and T. Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd, 2009.
2. Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, and Machine Vision", Second Edition, Thomson Learning, 2001.
3. Zeuch, Nello, "Understanding and Applying Machine Vision", CRC Press; 2nd edition.
4. Bershold Klaus, Paul Holm, "Robot vision", The MIT press.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will consist of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EDLO601	Machine Learning	03	-	--	03	-	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
EDLO601	Machine Learning	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

1. Linear algebra, multivariate calculus, and probability theory
2. Neural Networks
3. Knowledge of a programming language (PYTHON/C/C ++/ MATLAB recommended)

Course Objectives:

1. Apply Machine Learning techniques in real life applications.
2. Understanding nature of problems solved with Machine Learning.
3. Understand learning process by human and Machine learning algorithms.

Course Outcomes:

After successful completion of the course students will be able to:

1. **Develop** Machine Learning Techniques which can be used in real world scenario.
2. **Comprehend** regression, classification that are used in machine learning.
3. **Apply** different Dimensionality reduction and clustering methods that are used in machine learning.
4. **Analyze** Dimensionality reduction techniques.
5. **Uunderstand** the working of Probabilistic models
6. **Demonstrate** understanding to real life problems

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Machine Learning**	4
	1.1	What is Machine Learning? Why Machine Learning?	
	1.2	Examples of Machine Learning Problems, Structure of Learning, Issues in Machine Learning	
	1.3	Applications of Machine Learning	
	1.4	How to choose Right Algorithm, Steps in Developing a Machine Learning Application	
	1.5	Machine learning Models: Geometric Models, Logical Models, Probabilistic Models. Features: Feature types, Feature Construction and Transformation, Feature Selection	
2		**Classification and Regression**	8
	2.1	Binary Classification, assessing classification performance, Multi-class Classification	
	2.2	Linear regression, Logistic regression, Multi-class regression , Assessing performance of Regression- Error measures	
3		**Supervised Learning**	8
	3.1	Using Decision Trees, Constructing Decision Trees, Ranking and Probability estimation Trees, Classification and Regression Trees (CART)	
	3.2	Bayesian Logistic Regression, Naive Bay's classifier, Bayesian Belief Networks	
4		**Unsupervised learning**	8
	4.1	Dimensionality Reduction: Dimensionality Reduction Techniques, Principal Component Analysis (PCA)	
	4.2	K-means Clustering, Hierarchical Clustering, Expectation Maximization Algorithm, Supervised Learning after Clustering	
5		**Learning Models**	8
	5.1	Support Vector Machines, Maximum Margin Linear Separator	
	5.2	Quadratic Programming Solution to finding maximum margin separators, Kernels for learning non-linear functions	
6		**Case Studies In Machine Learning**	3
		Retail store sales prediction, Credit card Fraud detection (anomaly detection), healthcare, Telecommunications- Customer churn prediction	
		Total	**39**

Text Books:

1. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press.
2. Hastie, Tibshirani, Friedman, "Introduction to Statistical Machine Learning with Applications in R", Springer, 2nd Edition, 2012
3. Peter Harrington, "Machine Learning In Action", DreamTech Press.

Reference Books:

1. Ethem Alpaydin, "Introduction to Machine Learning", PHI 2nd Edition, 2013
2. C. M. Bishop, "Pattern Recognition and Machine Learning", Springer, 1st Edition, 2013

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Note: **Students are encouraged to explore more applications which can be assessed by the faculty.*

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELDO601	Digital Design with Reconfigurable Architecture	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELDO 601	Digital Design with Reconfigurable Architecture	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

Digital Logic Circuits (ELC303)

Course Objectives:

1. To understand, analyze & design finite state machines (FSM)
2. To train students in writing VHDL code of combinational & sequential circuits
3. To prepare students to design FSM using hardware description languages (HDL)
4. To motivate students to use reconfigurable devices for digital systems.

Course Outcomes:

After successful completion of the course students will be able to:

1. Analyze & design FSM.
2. Understand fundamentals of HDL and its use for designing combinational circuits.
3. Apply the concept of HDL for designing sequential circuits.
4. Develop FSM by using the fundamentals of HDL.
5. Design of complex digital systems.
6. Understand and distinguish FPGA and CPLD architecture.

Module No.	Unit No.	Contents	Hrs.
1		**State Machines Design**	8
	1.1	Mealy and Moore machines, Clocked synchronous state machine design, State reduction techniques, State assignment, Clocked synchronous state machine analysis.	
	1.2	Design examples on overlapping and non-overlapping sequence detector, Odd/even parity checker for serial data, vending machines.	
2		**Introduction to VHDL**	8
	2.1	Core features of VHDL, Data types, Concurrent and Sequential statements, Data flow, Behavioral and Structural architectures, Subprograms: Function and Procedure.	
	2.2	Design examples of combinational circuits like Multiplexers, De-multiplexers, Adder, Subtractor, Priority Encoder	
3		**Design of sequential circuit using VHDL**	6
	3.1	Design examples for Flip flops, Synchronous counters, Asynchronous counters, Shift registers	
4		**Design of Finite State Machines (FSM) using VHDL**	6
	4.1	VHDL code for Moore, Mealy type FSMs, Serial adders, Traffic light controller, Vending machines.	
5		**System Design using VHDL**	6
	5.1	Parallel Multiplication, Booth Multiplication, MAC unit, ALU, Memory: ROM and RAM	
6		**Simulation, Synthesis and Implementation**	5
	6.1	Functional simulation, Timing simulation, Logic synthesis, RTL.	
	6.2	CPLD, SRAM based FPGA architecture, Spartan II.	
		Total	**39**

Text Books:

1. M. Morris Mano,"Digital Design", 5th Edition, Pearson Education India, 2012.
2. John Wakerley, "Digital Design Principles & Practices" Pearson Publication, 3rd edition.
3. Volnei A. Pedroni, "Circuit Design with VHDL" MIT Press, 2004.
4. Wayne Wolf, "FPGA Based System Design" Pearson Education.
5. W. I. Fletcher, "Engineering Approach to Digital Design" PHI publications.

Reference Books:

1. R. P. Jain, "Modern Digital Electronics", 4th Edition, McGraw Hill Education, 2016.
2. Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital Logic Design" McGraw Hill, 2nd edition.
3. John M. Yarbrough, Digital Logic Applications and Design, Thomson Publications, 2006.
4. P. J. Ashenden, "The students guide to VHDL" Elsevier,1999.
5. Xilinx online resources – www.xilnix.com

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL601	Basic VLSI Design Lab		02	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Practical & Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELL601	Basic VLSI Design Lab	-	-	-	-	-	25	--	25	50

Course Objectives:

1. To acquire SPICE coding / circuit simulators skills for realizing MOS based circuits
2. To compare and analyze performance of various MOS Inverters
3. To implement MOS based combinational and sequential circuits

Course Outcomes:

After successful completion of the course students will be able to:

1. Develop circuits using SPICE / circuit simulators.
2. Design and analyze MOS based inverters.
3. Verify different MOS circuit design styles.
4. Validate functionality of Combinational and Sequential Circuits using different design styles.
5. Examine various semiconductor memories using MOS logic.
6. Enhance skills of building adder, multiplier and shifter circuits using MOS logic.

Term Work:

At least 10 experiments covering entire syllabus of ELC601 (Basic VLSI Design) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Use of different types of circuit simulators / industry standard simulators is encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Title of the Experiment
1	To write SPICE code for obtaining Transfer Characteristics (Id-Vg) and Output characteristics (Id-Vd) of enhancement and depletion type nMOS and pMOS transistors and extract parameter like subthreshold leakage current (I_L), threshold voltage (V_{T0}) and Subthreshold Swing (SS).
2	To study the impact of MOSFET scaling on the device performance.
3	To study the impact of MOSFET Model parameters in Level1 / Level2 on the drain characteristics.
4	To study the Voltage Transfer Characteristics (VTC) of resistive Load nMOS inverter and calculate high and low noise margins by extracting critical voltages. Also study the impact of variation of load resistance on VTC and hence on the noise margin.
5	To study the effect of Kr or transistor sizing on the VTC of CMOS inverter using SPICE simulation.
6	To analyse the transient performance of CMOS inverter.
7	To compare performance of different types of inverters by plotting their VTCs using SPICE code.
8	To realise the complex Boolean function using different design styles.
9	To realise Basic gates / MUX circuits using Pass transistor /Transmission gate logic.
10	To realise SR Latch, JK FF, D FF using MOS logic.
11	To realise SRAM /DRAM using MOS logic.
12	To realise adder / multiplier / shifter circuits.

Experiments can be performed using simulation tools such as NGSPICE, LTSPICE, DSCH2, etc.

Note:
Suggested List of Experiments is indicative. However, flexibility lies with individual course instructor to design and introduce new, innovative, problem based learning and challenging experiments, from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL602	Computer Communication Networks Lab	--	--	--	--	--	25	25	50

Course Prerequisite : ELC 404 Principles of Communication Engineering
ELC 504 Digital Communication

Course Objectives:

1. Introduce networking architecture and protocols.
2. Understand the various layers and protocols in the TCP/IP model.
3. Recognize different addressing schemes, connecting devices and routing protocols.
4. Select the required protocol from the application layer protocols.

Course Outcomes:

After successful completion of the course students will be able to:

1. **Demonstrate** understanding of networking concepts and required protocols.
2. **Analyze** the various layers and protocols of the layered architecture.
3. **Evaluate** different addressing schemes, connecting devices and routing protocols.
4. **Analyze** various routing protocols in Network layer.
5. **Understand** the various protocols in Transport layer
6. **Comprehend** the different protocols in application layer

Term Work:

Lab session includes Seven experiments and a case study (Power Point Presentation) on any one of the suggested topics.

1. The experiments will be based on the syllabus contents.
2. Minimum Seven experiments need to be conducted, out of which at least Four experiments should be software-based (C/C++, Scilab, MATLAB, LabVIEW, etc).
3. Each student (in groups of 3/4) must present a Case study (Power point Presentation) as a part of the laboratory work.
4. The topics for Presentation / Case-study may be chosen to be any relevant topic on emerging technology. ("Beyond the scope of the syllabus".)

Power point presentation should contain minimum of 15 slides and students should submit a report, (PPT+REPORT) carry minimum of 10 marks. The term work assessment can be carried out based on the different tools and the rubric decided by the concerned faculty members and need to be conveyed to the students well in advance.

At least 07 experiments covering entire syllabus of ELL602 (CCN Lab) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged.

Each student (in groups of 3/4) must present a Case study (Power point Presentation) as a part of the laboratory work. The topics for Presentation / Case-study may be chosen to be any relevant topic on emerging technology (“Beyond the scope of the syllabus”). Power point presentation should contain minimum of 15 slides and students should submit a report, (PPT+REPORT) carry minimum of 10 marks.

The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

(Expected percentage of H/w and software experiments should be 60% & 40% respectively)

Sr. No.	Experiment Title
1	Study of transmission media and interconnecting devices of communication networks.
2	Implementation of serial transmission using RS232.
3	Implementing bit stuffing algorithm of HDLC using C/C++.
4	Implementation of Routing protocols using C/C++.
5	Study of NS2 simulation software.
6	Implementation of TCP/UDP session using NS2.
7	Implementation of ARQ methods using NS2.
8	Study of WIRESHARK and analyzing Packet using WIRESHARK.
9	Study and implementation of IP commands.
10	Study of GNS software and implementation of routing protocols using GNS.

All the experiments can be performed using simulation softwares. (Free simulation software Scilab can be used)

Note:
Suggested List of Experiments is indicative. However, flexibility lies with the individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL603	Embedded Systems and Real Time Operating Systems Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL603	Embedded Systems and Real Time Operating Systems Lab	--	--	--	--	--	25	25	50

Prerequisite: Basics of Microcontroller programming
C programming

Course Objectives: To design and write efficient code for single-tasking and multi-tasking embedded systems

Course Outcomes:

After successful completion of the course students will be able to:

1. Interface various sensors and actuators to embedded cores.
2. Write code using RTOS for multi-tasking Embedded systems
3. Design applications using different embedded cores

Term Work:

At least 10 experiments covering entire syllabus of **Embedded Systems and Real Time Operating Systems (ELC604) s**hould be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

1. Students must perform the experiments using Simulation as well as in Hardware.
2. Experiments must include a minimum of 3 experiments using FreeRTOS

List of Experiments

Sr. No.	Experiment Name
1	Interfacing of LEDs /switches with any embedded core. (8051/ARM/STM32, etc)
2	Interfacing of Temperature sensor with any embedded core. (8051/ARM/STM32, etc)
3	Interfacing of LCD/ Seven segment display with any embedded core. (8051/ARM/STM32, etc)
4	Interfacing of Ultrasonic/Humidity sensor with any embedded core. (8051/ARM/STM32, etc)
5	Interfacing of a relay with any embedded core. (8051/ARM/STM32, etc)
6	Interfacing of a DC motor (speed and Direction control) with any embedded core. (8051/ARM/STM32,etc)
7	Interfacing of a stepper motor (to move by a particular angle) with any embedded core. (8051/ARM/STM32, etc)
8	Implement power management in any embedded core of your choice
9	Implement the I2C communication to connect to DS1307 RTC
10	Porting of FreeRTOS to Arduino/STM32.
11	Write a Program to Create Multiple Tasks and understand the Multitasking capabilities of RTOS (FreeRTOS).
12	Write a Program to illustrate the Queue Management Features of FreeRTOS.
13	Write a Program to illustrate the Event Management Features of FreeRTOS.
14	Write a Program to illustrate the use of Binary and Counting Semaphore for Task Synchronization using FreeRTOS.
15	Build a Multitasking Real-Time Applications using the above IPC Mechanisms (Message Queue, EventGroup, Semaphores) with FreeRTOS on Arduino/STM32.

Note:
Suggested List of Experiments is indicative. However, flexibility lies with individual course instructors to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELL604	Database Management Systems Lab	--	02*+02	--	--	02	--	02

** Theory class to be conducted for full class*

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL604	Database Management Systems Lab	--	--	--	--	--	50	--	50

Course Pre-requisites: Any programming language

Course Objectives:

1. To identify, define problem statements and construct conceptual data model for real life applications.
2. To build Relational Model from conceptual model(ER/EER).
3. To apply SQL to store and retrieve data efficiently.
4. To demonstrate notions of normalization for database design.

After successfully implementation of the case studies student will acquire following skills:

1. Identify the need of database, and define the problem statement for real life applications.
2. Create relational model for real life applications
3. Formulate query using SQL for efficient retrieval of data.

Syllabus: In order to perform the case studies given below, students must refer the following modules.

Module No	Topics
1	**Database System Concepts and Architecture**
	Introduction, Characteristics of Databases, File system v/s Database system, Data abstraction and Data Independence, DBMS system architecture, Database Administrator (DBA), Role of DBA
2	**The Entity-Relationship Model**
	Conceptual Modeling of a database, The Entity-Relationship (ER) Model, Entity Type, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Weak entity Types, Generalization, Specialization and Aggregation, Extended Entity-Relationship (EER) Model.
3	**Relational Model & Relational Algebra**
	Introduction to Relational Model, Relational Model Constraints and Relational Database Schemas, Concept of Keys: Primary Kay, Secondary key, Foreign Key, Mapping the ER and EER Model to the Relational Model, Introduction to Relational Algebra, Relational Algebra expressions for Unary Relational Operations, Set Theory operations, Binary Relational operation Relational Algebra Queries
4	**Structured Query Language (SQL) & Indexing**
	Overview of SQL, Data Definition Commands, Set operations, aggregate function, null values, Data Manipulation commands, Data Control commands, Complex Retrieval Queries using Group By, Recursive Queries, nested queries. Integrity constraints in SQL. Database Programming with JDBC, Security and authorization: Grant & Revoke in SQL Functions and Procedures in SQL and cursors. Indexing: Basic Concepts, Ordered Indices, Index Definition in SQL
5	**Relational Database Design**
	Design guidelines for relational Schema, Functional Dependencies, Database tables and normalization, The need for normalization, The normalization process, Improving the design, Definition of Normal Forms- 1NF, 2NF, 3NF & The Boyce-Codd Normal Form (BCNF).
6	**Transactions Management and Concurrency and Recovery**
	Transaction concept, Transaction states, ACID properties, Transaction Control Commands, Concurrent Executions, Serializability-Conflict and View, Concurrency Control: Lock-based, Timestamp-based protocols, Recovery System: Log based recovery, Deadlock handling

Term Work:

The case study may be chosen on any relevant topic which needs a database as backend. Suggested case studies are as follows:

1) Company Database Management System
2) University Database Management System
3) Hospital Management System
4) Student Management System
5) Library Management System

Selected case study may be divided into the following set of experiments.

1. Identify the case study and detail statement of problem. Design an Entity-Relationship(ER) / Extended Entity-Relationship (EER) Model & Mapping ER/EER to Relational schema.
2. Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified case study.
3. Apply DML commands for the specified system & perform simple queries, string manipulation operations and aggregate functions.
4. Implement various join operations, nested and complex queries.
5. Implementation of views and triggers.
6. Implement procedure and functions
7. Use of database connectivity like JDBC.
8. Deploy the application.

Assignments:

1. Perform Normalization: 1NF, 2NF, 3NF.
2. Privileged database user creation.

Suggested Books:

1. Korth, Slberchatz, Sudarshan, "Database System Concepts", 6th Edition, McGraw – Hill
2. Elmasri and Navathe, "Fundamentals of Database Systems", 5th Edition, Pearson
3. Peter Rob and Carlos Coronel, "Database Systems Design: mplementation and Management", Thomson Learning, 5th Edition.
4. Raghu Ramkrishnan and Johannes Gehrke, "Database Management Systems", TMH

Course code	Course Name	Credits
ELM 601	**Mini Project 2B**	**02**

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome:
Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyze the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project

of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.

- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalization of problem
    - Second shall be on finalization of proposed solution of problem.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalization of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication