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).

(Dr. Dinesh Kamble)
I/c REGISTRAR

MUMBAI – 400 032
25th June, 2018

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

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 DLOl50X	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
ELXLDLO703X	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
ELXLDLO703X	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	Dura-tion (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, 2nd Edition.

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									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract / Oral	Total
		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									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		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									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		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									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		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