AC 14/7/2016, Item No. 4.64

UNIVERSITY OF MUMBAI

Bachelor of Engineering

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

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

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

Scheme for FE - Semester – I

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

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

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

Scheme for FE - Semester – II

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

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

University of Mumbai

As per AAU letter dated 20th Aug. 2019

No. UG/ 65 of 2019-20

CIRCULAR:-

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

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

(Dr. Ajay Deshmukh)
REGISTRAR

MUMBAI – 400 032
14th August, 2019

To

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

A.C/4.40/26/07/2019

****

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

Copy forwarded with Compliments for information to:-

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

(Dr. Ajay Deshmukh)
REGISTRAR

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

UNIVERSITY OF MUMBAI

Bachelor of Engineering

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

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

(Common for All Branches of Engineering)

Under

FACULTY OF SCIENCE &TECHNOLOGY

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

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

Semester I

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

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

*** Shall be conducted batch-wise**

Semester II

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

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

*** Shall be conducted batch-wise**

AC
Item No.

UNIVERSITY OF MUMBAI

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

FACULTY OF TECHNOLOGY

Instrumentation Engineering

Final Year with Effect from **AY 2019-20**

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

Program Structure for

BE Instrumentation Engineering
University of Mumbai
(With Effect from 2019-20)

Scheme for Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ISC701	Industrial Process Control	4	-	-	4	-	-	4
ISC702	Biomedical Instrumentation	4	-	-	4	-	-	4
ISC703	Industrial Automation	4	-	-	4	-	-	4
ISDLO703X	Department Level Optional Course III	4	-	-	4	-	-	4
ILO701X	Institute Level Optional Course I	3	-	-	3	-	-	3
ISL701	Industrial Process Control – Lab Practice	-	2	-	-	1	-	1
ISL702	Biomedical Instrumentation – Lab Practice	-	2	-	-	1	-	1
ISL703	Industrial Automation – Lab Practice	-	2	-	-	1	-	1
ISL704	Department Level Optional Course III – Lab Practice	-	2	-	-	1	-	1
ISL705	Project I	-	6	-	-	3	-	3
Total		**19**	**14**	**-**	**19**	**07**	**-**	**26**

Examination Scheme for Semester VII

Course Code	Course Name	Examination Scheme					Total Marks
		Theory		Term Work	Oral	Pract. & Oral	
		End Sem Exam (ESE)	Internal Assessment (IA)				
		Max Marks	Max Marks	Max Marks	Max Marks	Max Marks	
ISC701	Industrial Process Control	80	20	-	-	-	100
ISC702	Biomedical Instrumentation	80	20	-	-	-	100
ISC703	Industrial Automation	80	20	-	-	-	100
ISDLO703X	Department Level Optional Course III	80	20	-	-	-	100
ILO701X	Institute Level Optional Course I	80	20	-	-	-	100
ISL701	Industrial Process Control – Lab Practice	-	-	25	25	-	50
ISL702	Biomedical Instrumentation – Lab Practice	-	-	25	25	-	50
ISL703	Industrial Automation – Lab Practice	-	-	25	25	-	50
ISL704	Department Level Optional Course III – Lab Practice	-	-	25	25	-	50
ISL705	Project I	-	-	50	50	-	100
	Total	**400**	**100**	**150**	**150**	**-**	**800**

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC701	Industrial Process Control	4	-	-	4	-	-	4

Subject Code	Subject Name	Examination scheme							
		Theory Marks (100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment (20)			End Sem Exam				
		Test1	Test2	Avg.					
ISC701	Industrial Process Control	20	20	20	80	-	-	-	100

Subject Code	Subject Name	credits
ISC701	Industrial Process Control	4
Course objectives	1. To impart the knowledge of different industrial unit operations. 2. To make the students capable to design and develop instrumentation and control schemes for industrial processes. 3. To give them overview of various process industries, hazardous areas and their classification.	
Course Outcomes	The students will be able to: 1. Explain working and control of various heat transfer unit operations 2. Explain working and control of various heat and mass transfer unit operations 3. Explain the miscellaneous process equipment and their control 4. Describe the processes of various continuous process industries and instrumentation involved in them. 5. Describe the processes of various batch process industries and instrumentation involved in them. 6. Classify hazardous areas in the industry.	

Details of Syllabus:

Prerequisite: Temperature, flow, pressure sensors, fundamentals of process instrumentation and control, control schemes like feedback, feedforward, cascade, split range, selective etc., basics of unit operations.

Module	Content	Hrs	CO Mapping
1	**Control System for Heat transfer unit operations:** Introduction to unit operations and processes, concept of heat transfers and energy balance, heat transfer coefficient. **Heat exchanger control:** classification as per fluid flow arrangement and construction, feedback, feed-forward, bypass control schemes, fouling in heat exchangers. **Boiler control:** Types, working and operation of boilers, Terms related- Shrink and swell effect and excess oxygen, boiler efficiency, boiler performance terminology. Boiler controls- Drum level control- Single, two and three elements, and Combustion Control-Type 1, 2, 3 and 4, steam temperature control, boiler pressure control, furnace draft control, Burner Management System. **Evaporator control:** Evaporator terminologies, Types of Evaporator, mathematical model for evaporator, control systems for Evaporator – feedback, cascade, feed forward and selective control. **Furnace control:** Start- up heaters, fired re-boilers, process and safety controls.	13	CO1
2	**Control System for Heat and mass transfer unit operations:** **Distillation column:** Basic principle, Distillation equipment and its accessories. Batch and continuous distillation, Binary product distillation, multi-product distillation, side-draw product distillation column. Distillation column control strategies- Top and bottom product composition controls, Using chromatograph, Pressure controls, Vacuum distillation, Vapors recompression and pressure control, Feed controls- Column feed controls and Feed temperature control, economizer. **Dryer control:** Process of drying, types of dryer- Tray, Vacuum dryer, fluidized bed, Double drum dryer, rotary, turbo and spray, and their control strategies. **Crystallizers:** Process of crystallization, Super-saturation methods, types of crystallizer, control of evaporating crystallizer, cooling crystallizers, vacuum crystallizers. **Reactor control:** Reactor characteristics, runaway reaction, various schemes of temperature control of reactors.	12	CO2
3	**Miscellaneous process equipment:** **Compressor-** Classification, Phenomenon of Surge for centrifugal compressors, Methods of surge control for compressors. **Gas turbine-** Introduction, gas turbine layouts, closed cycle gas turbine, Engine controls.	05	CO3
4	**Continuous Process Industries:** **Refinery Industry:** Process flow diagram, separation, Treatment-Hydro-desulphurization unit, conversion methods- Fluid Catalytic Cracking, blending, sensors and control schemes.	07	CO4

	Iron and steel Industry: Process flow diagram, Sensors and Control schemes.		
5	**Batch Process Industries:** **Food processing:** Milk pasteurization. **Pharmaceutical industries**- Penicillin-G production, sensors and control schemes.	07	CO5
6	**Safety in Instrumentation control systems:** Area and material classification as per IEC and NEC standard, techniques used to reduce explosion hazards, intrinsic safety, and installation of intrinsically safe systems.	04	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Theory 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

   4 to 5 marks will be asked.

4. Remaining questions will be mixed in nature.

5. In question paper weight age of each module will be proportional to number of respective

   Lecture hours as mentioned in the syllabus.

Text Books:

1. W. L. McCabe and Julian Smith, "Unit operation and chemical engineering", Tata McGraw Hill, Sixth edition, 2001.
2. Bela G. Liptak, "Instrument engineers handbook - Process control", Chilton book company, third edition, 1995.
3. Bela G. Liptak, "Instrumentation in the processing industries", Chilton book company-first edition, 1973.

Reference Books:

1. Douglas M. Considine, "Process industrial instruments and controls handbook", McGraw Hill- 4th edition, 1993.
2. George T. Austin, "Shreve's chemical process industries", Mc-GrawHill- fifth edition, 1984.
3. George Stephenopoulos, "Chemical process control", PHI-1999.
4. David Lindsey, "Power Plant control and instrumentation – control of boilers HRSG", Institution of Engineering and Technology,
5. G.F. Gilman "Boiler Control Systems Engineering", ISA Publication, 2005,
6. A.M.Y.Razak, Industrial gas turbines Performance and operability", CRC Press Woodhead

Publishing Limited and CRC Press LLC, 2007.

Sub code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract.	Tut.	Total
ISC702	Biomedical Instrumentation	4	-	-	4	-	-	4

Sub code	Subject Name	Examination Scheme							
		Theory (out of 100)				Term Work	Pract. and oral	Oral	Total
		Internal Assessment (out of 20)			End sem Exam				
		Test 1	Test 2	Avg					
ISC702	Biomedical Instrumentation	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC702	Biomedical Instrumentation	4
Course Objectives	To make students understand the Identification, classification, and working principle of various Biomedical Instruments used for Bio-potential measurement To make students understand the application of the various biomedical instruments in diagnosis, therapeutic and imaging fields.	
Course Outcomes	The students will be able 1. To identify various Bio-potential with their specifications and perform their measurements. 2. To discuss various Physiological systems and to identify their parameters and related measurements. 3. To explain the principle and working of various cardiovascular parameters and their measurement techniques with applications. 4. To relate between the different life support instruments and to describe their applications. 5. To distinguish between the various medical imaging techniques based on the principles and concepts involved in them. 6. To describe the significance of electrical safety in biomedical measurement.	

Module	Topics	Hrs.	CO Mapping
1	**Bio-Potentials and their Measurement:** Structure of Cell, Origin of Bio-potential, electrical activity of cell and its characteristics and specifications. Measurement of RMP and AP. Electrode-Electrolyte interface and types of bio-potential electrodes.	06	CO1
2	**Physiological Systems and Related Measurement:** • Respiratory system- Physiology of respiration and measurements of respiratory related parameters. • Nervous system- Nerve cell, neuronal communication, nerve-muscle physiology, CNS, PNS. Generation of EEG and study of its characteristics. Normal and abnormal EEG, evoked potential and epilepsy. • Muscular system- Generation of EMG signal, specification and measurement. • Cardiovascular system- Structure of Heart, Electrical and Mechanical activity of Heart, ECG measurements and Cardiac arrhythmias. • Design of ECG amplifier.	12	CO2
3	**Cardiovascular Measurement:** • Blood Pressure- Direct and Indirect types. • Blood Flow- Electromagnetic and Ultrasonic types. • Blood Volume- Types of Plethysmography. (Impedance, Capacitive and Photoelectric) • Cardiac Output- Flicks method, Dye-dilution and Thermo-dilution type. • Heart sound measurement.	08	CO3
4	**Life support Instruments:** • Patient monitoring system - Bedside monitors, Central nurse station • Pacemaker- Types of Pacemaker, mode of pacing and its application. • Defibrillator- AC and DC Defibrillators and their application. • Heart Lung machine and its application during surgery. • Hemodialysis system and the precautions to be taken during dialysis. • Ventilator system and its important parameters for monitoring	10	CO4
5	**Imaging Techniques: *** • X-Ray machine and its application. CT Scan- CT Number, Block Diagram, scanning system and application. • Ultrasound Imaging- Modes of scanning and their application. • MRI- Concepts and image generation, block diagram and its application. • Introduction to Functional imaging.	10	CO5
6	**Significance of Electrical Safety:** Physiological effects of electrical current, Shock Hazards from electrical equipment and methods of accident prevention.	02	CO6

*** A Hospital Visit is recommended for Imaging Techniques.**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

1) Leslie Cromwell, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson Education, 1980.
2) John G. Webster, "Medical Instrumentation", John Wiley and Sons, 4th edition, 2010.
3) R. S. Khandpur, "Biomedical Instrumentation", TMH, 2004

Reference Books:

1) Richard Aston, "Principles of Biomedical Instrumentation and Instruments", PH, 1991.
2) Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", PHI/Pearson Education, 4th edition, 2001.
3) John E Hall, Gyton's Medical Physiology, 12th edition, 2011
4) L. E. Baker L. A. Geddes, "Principles of Applied Biomedical Instrumentation", John Wiley and Sons, 3rd Edition, 1991.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISC703	Industrial Automation	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4		-	4

Sub Code	Subject Name	Examination scheme							
		Theory (100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment(20)			End sem Exam				
		Test1	Test 2	Avg.					
ISC703	Industrial Automation	20	20	20	80	-	-	-	100

Subject Code	Subject Name	credits
ISC703	Industrial Automation	4
Course objective	• To impart knowledge about the fundamentals of automation and various automation systems used in industry. • To impart the knowledge about the architecture, working and applications of PLC, DCS and SCADA • To make the students understand the requirements of Safety Instrumented System (SIS).	
Course Outcome	The students will be able to 1. Describe automation, need, importance and applications in industry. 2. Identify components of PLC, and develop PLC ladder using instructions of PLC and design PLC based application by proper selection and sizing criteria 3. Explain evolution and architecture of DCS, hierarchical control in DCS, programming DCS through Function Block Diagram (FBD) method. 4. Describe SCADA architecture, communication in SCADA and develop any application based on SCADA along with GUI using SCADA software. 5. Explain database and alarm management system 6. Recognize the need of SIS and describe risk reduction methods.	

Details of Syllabus:

Prerequisite: Knowledge of Digital Electronics, Process Instrumentation and Control.

Module	Content	Hrs.	CO Mapping
1	**Automation Fundamentals** Automation, Need for automation and its importance, Types of automation, Automation applications, Expectations of automation. Process and factory automation. Types of plant and control – categories in industry, open loop and closed loop control functions, continuous processes, discrete processes, and mixed processes. Automation hierarchy – large control system hierarchy, data quantity & quality and hierarchical control. Control system architecture – evolution and current trends, comparison of different architectures.	04	**CO1**
2	**Programmable Logic Controller** **Hardware** Evolution of PLC, Definition, functions of PLC, Advantages, Architecture, working of PLC, Scan time, Types & Specifications. Safety PLC DI-DO-AI-AO examples and ratings, I/O modules, local and remote I/O expansion, special purpose modules, wiring diagrams of different I/O modules, communication modules, Memory & addressing- memory organization (system memory and application memory), I/O addressing, hardware to software interface. **Software** Development of Relay Logic Ladder Diagram, introduction to PLC Programming, programming devices, IEC standard PLC programming languages, LD programming-basic LD instructions, PLC Timers and Counters: Types and examples, data transfer & program control instructions, advanced PLC instructions, PID Control using PLC. **Case study:** PLC selection and configuration for any one process applications**.**	14	**CO2**
3	**Distributed Control System** (**DCS**) Introduction to DCS. Evolution of DCS, DCS flow sheet symbols, architecture of DCS. Controller, Input and output modules, Communication module, data highway, local I/O bus, Workstations, Specifications of DCS. Introduction of Hierarchical control of memory: Task listing, Higher and Lower computer level task. Supervisory computer tasks, DCS configuration, Supervisory computer functions, Control techniques, Supervisory Control Algorithm. DCS & Supervisory computer displays, advanced control Strategies, computer interface with DCS. DCS System integration with PLCs computer: HMI, Man machine interface sequencing, Supervisory control, and integration with PLC, personal computers and direct I/O, serial linkages, network linkages, link between networks. Introduction to DCS Programming, Function Block Diagram method for DCS programming.	12	**CO3**

4	**Supervisory Control and Data Acquisition (SCADA)** SCADA introduction, brief history of SCADA, elements of SCADA. Features of SCADA, MTU- functions of MTU, RTU- Functions of RTU, Protocol Detail, Specifications of SCADA SCADA as a real time system Communications in SCADA- types & methods used, components, Protocol structure and Mediums used for communications. SCADA Development for any one typical application. Programming for GUI development using SCADA software.	10	**CO4**
5	**Database and Alarm Management, MES, ERP** Database management, Philosophies of Alarm Management, Alarm reporting, types of alarms generated and acceptance of alarms. Manufacturing Execution System , Enterprise Resource Planning, Integration with enterprise system.	04	**CO5**
6	**Safety Instrumented System (SIS)** Need for safety instrumentation- risk and risk reduction methods, hazards analysis. Process control systems and SIS. Safety Integrity Levels (SIL) and availability. Introduction to the international functional safety standard IEC 61508.	04	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weight age of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. Samuel M. Herb, “Understanding Distributed Processor Systems for Control”, ISA Publication, 1999.
2. Thomas Hughes, “Programmable Logic Controller”, ISA Publication, 2001.
3. Stuart A. Boyer, “SCADA supervisory control and data acquisition”, ISA Publication, 2010.
4. Gruhn and Cheddie, “Safety Shutdown Systems” – ISA, 1998,

Reference Books:

1. Poppovik Bhatkar, “Distributed Computer Control for Industrial Automation”, Dekkar Publication, 1990.
2. S.K. Singh, “Computer Aided Process Control”, Prentice Hall of India, 2004.
3. Krishna Kant, “Computer Based Process Control”, Prentice Hall of India
4. N.E. Battikha, “The Management of Control System: Justification and Technical Auditing”, ISA.

5. Gary Dunning, “Introduction to Programmable Logic controller”, Thomas Learning, edition, 2001.
6. John. W. Webb, Ronald A Reis, “Programmable Logic Controllers – Principles and Applications”, 3rd edition, Prentice Hall Inc., New Jersey, 1995.
7. Bela G. Liptak “Instrument engineer’s handbook- Process control” Chilton book company- 3rd edition.
8. D.J. Smith & K.G.L. Simpson, “Functional Safety: A Straightforward Guide to IEC61508 and Related Standards”, -Butterworth-Heinemann Publications.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDLO7031	Image Processing	4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment(20)			End Sem Exam				
		Test1	Test2	Avg.					
ISDLO7031	Image Processing	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDLO7031	Image Processing	4
Course Objectives	1. To explain basic principles of Image processing. 2. To apply time and frequency domain transformation method on 2D Images 3. To study different Image enhancement techniques in spatial and frequency domain. 4. To study Image restoration techniques to reduce the noise and recover original Image. 5. To study Lossy and lossless Image compression by different methods. 6. To study Image morphology and segmentation techniques to represent images into more meaningful and easier to analyze.	
Course Outcomes	Students will be able to - 1. Describe general terminology of Image processing. 2. Examine Images and their analysis by various transformation techniques. 3. Apply basic Image enhancement operations on Images. 4. Evaluate mathematical tools such as Image morphology and Image segmentation to extract various Image components. 5. Discuss Image compression methods 6. Discuss Image degradation and restoration model.	

Details of Syllabus:

Prerequisite: Knowledge of Fundamentals of Engineering Mathematics, Basic Operation with Matrices, Signals and Systems and Digital Signal Processing.

Module	Contents	Hrs	CO mapping
1	**Introduction to Image processing**: -Concept of Digital Image, Fundamental steps in Image processing, Components of Image processing systems, Elements of visual perception, Image formation model, Sampling and Quantization of Image, Relationships between pixels like neighbours of pixel, Adjacency, Connectivity, Distance measures, Translation, Scaling , Rotation and Perspective projection of Image.	08	CO1

2	**Image Transformation**: -Orthogonal and Orthonormal Function, 2D Discrete Fourier transform and its properties, Fast Fourier transform of Image, Discrete Cosine and Sine transform (2D), Walsh-Hadamard transform, Haar transform, Slant transform, Karhunen-Loeve transform, Introduction to Wavelet transform and its application.	07	CO2
3	**Image Enhancement**: -Image enhancement in spatial domain, Basic gray level transformation like Image Negatives, Log transformations, Power Law transformations, Contrast stretching, Gray level and Bit plane slicing, Histogram processing, Enhancement using Arithmetic/Logic operation, Smoothing spatial filters, Sharpening spatial filters, Image enhancement in frequency domain, Smoothing frequency domain filters, Sharpening frequency domain filters, Homomorphic filtering.	10	CO3
4	**Morphological Image Processing**: Logic operations of Binary Images, Dilation and Erosion, Opening and Closing, Hit or Miss transformation, Boundary extraction, Region filling, Extraction of connected component, Thinning, Thickening, Skeletons. **Image Segmentation**: Point, Line and Edge detection, Edge linking and boundary detection (Hough Transform), Thresholding, Region based segmentation. **Image Registration**: Introduction, Geometric transformation, Plane to plane transformation, Image Mapping models, Mutual Information, Entropy, Registration using MI, Introduction to Stereo Imaging	10	CO4
5	**Image Compression**: -Need of Image compression, Data redundancy, Image compression model, Difference between Lossy and Lossless compression, Image compression technique(Huffman, Arithmetic, Run length, LZW coding),Predictive coding(DPCM),JPEG and MPEG compression standard.	08	CO5
6	**Image Restoration**: -Image degradation/Restoration model, Noise models, Probability density function of important noises (Gaussian, Rayleigh, Gamma, Exponential, Uniform, Salt and Pepper), Restoration in presence of noise by spatial filtering (Mean, Median, Midpoint filter), Periodic noise reduction in frequency domain filtering (Band reject, Band pass, Notch filter), Point spread function, Inverse filtering, Weiner filtering.	05	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4) Remaining questions will be mixed in nature.
5) In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books.

1. Richard E. Woods, Rafael C. Gonzalez, “Digital Image Processing”, Pearson,3rd edition, 2012.
2. Jain A.K, “Fundamentals of Digital Image Processing”, Pearson,1st edition, 2015.
3. B. Chanda, D. Dutta Majumder, “Digital Image Processing and Analysis”,PHI, 2nd edition, 2011.

Reference Books

1.M. Sonka, Hlavac, “Image Processing, Analysis, and Machine Vision” Cengage,4th edition, 2014.
2. Tamal Bose, “Digital Signal and Image Processing”, Wiley, 1st edition,2003.
3. William K. Pratt,“Digital Image Processing”, Wiley, 4th edition, 2007.
4. Jayaraman , Veerakumar, Esakkirajan, “Digital Image Processing”, McGraw Hill, 1st edition, 2009.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDLO7032	Digital Control System	4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg.					
ISDLO7032	Digital Control System	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDLO7032	Digital Control System	4
Course Objective	1. To equip the students with the basic knowledge of digital systems 2. To obtain the canonical forms of digital control systems 3. To test the stability and steady state performance of digital control system. 4. To design the controller and observer for digital control systems.	
Course Outcome	Students will be able to 1. Understand the advantages and examples of digital control systems. 2. Understand the basics of Discretization. 3. Represent digital control system as pulse transfer function. 4. Determine stability, and steady-state error of discrete time systems. 5. Represent given system in different canonical forms. 6. Design controller and observer with state space approach.	

Details of Syllabus:

Prerequisite: Knowledge of Linear algebra, Fourier Series, Matrix Algebra, and Nyquist stability criterion.

Module	Contents	Hrs	CO
1	**Introduction** Block diagram of Digital Control System, Advantages &limitations of Digital Control System, comparison of continuous data & discrete data control system, Examples of digital control system, data conversion and quantization, sampling period considerations, sampling as impulse modulation, sampled spectra &aliasing, Reconstruction of analog signals, zero order hold, first order hold.	12	CO1
2	**Principles of discretization**- impulse invariance, finite difference approximation of derivatives, rectangular rules for integration, Bilinear transformation, Mapping between s-plane and z-plane, Discrete PID controller.	06	CO2
3	**Representation of digital control system** Linear difference equations, pulse transfer function, input output model, examples of first order continuous and discrete time systems, Signal flow graph applied to digital control systems.	06	CO3
4	**Stability of digital control system in z-domain and Time domain analysis** Jury's method, R.H. criteria, Comparison of time response of continuous data and digital control system, steady state analysis of digital control system,	08	CO4

	Effect of sampling period on transient response characteristics.		
5	**State space analysis** Discrete time state equations in standard canonical forms, similarity transformation, state transition matrix, solution of discrete time state equation, Discretization of continuous state space model & its solution.	08	CO5
6	**Pole placement and observer designs** Concept of reachability, Controllability, Constructability & Observability, Design of controller via Pole placement method, dead beat controller design, concept of duality, state observer design.	10	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4) Remaining questions will be mixed in nature.
5) In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books.

1. M. Gopal, "Digital Contol and State Variable Methods", Tata McGraw Hill, 2nd Edition, March 2003.
2. K. Ogata, "Discrete Time Control Systems", Pearson Education Inc., 1995.
3. B.C. Kuo, "Digital Control Systems", Saunders College Publishing, 1992.

Reference Books

1. Richard J. Vaccaro, "Digital Control", McGraw Hill Inc., 1995.
2. Ashish Tewari, "Modern Control System Design with MATLAB", John Wiley, Feb. 2002.
3. Joe H. Chow, Dean K. Frederick, "Discrete Time Control Problems using MATLAB", Thomson Learning, 1st Edition, 2003.
4. Eronini Umez, "System Dynamics and Control", Thomson Learning, 1999.
5. Franklin Powel, "Digital Control of Dynamic Systems", Pearson Education, 3rd Edition, 2003.
6. Digital Control Systems vol. I & II - Isermann, Narosa publications

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
ISDLO7033	Advanced Microcontroller Systems	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4	-	-	4

Subject Code	Subject Name	Examination scheme							
		Theory Marks(100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment(20)			End Sem Exam				
		Test1	Test2	Avg.					
ISDLO7033	Advanced Microcontroller Systems	20	20	20	80	-	-	-	100

Subject Code	Subject Name	credits
ISDLO7033	Advanced Microcontroller Systems	4
Course objectives	1. To explain the fundamentals of PIC 18F Microcontroller and working of the system. 2. To discuss and explain the integrated hardware of the PIC 18F Microcontroller 3. To illustrate various programming tools and development of software using assembly and higher level language. 4. To examine and design, interfacing of PIC 18F Microcontroller with different peripheral devices such as LCD, keyboard, ADC, DAC etc. 5. To design applications using learned concepts of hardware, software and interfacing. 6. To describe the working of RTOS and related tasks	
Course Outcomes	The students will be able to: 1. Describe working of PIC 18F Microcontroller Architecture and Programming model. 2. Discuss programming tools and construct software programs in assembly or 'C' language. 3. Illustrate the knowledge of operation of integrated hardware components such as (CCP) module, ECCP module. Master Synchronous Serial Port (MSSP) Module, Enhanced Universal Synchronous, Asynchronous Receiver Transmitter (EUSART), Analog-To-Digital Converter (A/D) Module. 4. Investigate and construct circuits for interfacing of peripheral components with PIC 18F Microcontroller. 5. Design and develop sophisticated application based on PIC 18F Microcontroller such as Temperature controller, PID controller, RTC etc. 6. Describe the principle of working of RTOS and related tasks.	

Details of Syllabus:

Prerequisite: Knowledge of digital electronics, microcontrollers, programming skills

Module	Contents	Hrs	CO Mapping
1	**Introduction to PIC 18F Microcontroller** PIC 18F Microcontroller architecture, Hardware PIC 18F Microcontroller family, PIC18F architecture, features PIC18F4520, Block diagram, Oscillator configuration, power saving modes. Memory model, EEPROM and RAM, Program Memory. Hardware multiplier, Interrupt structure.	06	CO1
2	**PIC 18F Software** PIC18F addressing modes, Instruction set, Instruction format, Integrated Development Environment (IDE), Assembling, Debugging, and Executing a program using MPLAB IDE in assembly and embedded C. Data copy operation, Arithmetic operation, Branch and Skip operation, Logic operations, bit Operation, Stack and Subroutine, Code conversion programs and Software Design, Programming practice using assembly & C compiler.	10	CO2
3	**Integrated peripherals of PIC 18F Microcontroller** I/O ports, Timer, capture/compare/PWM (CCP) module, ECCP module. Master Synchronous Serial Port (MSSP) Module, Enhanced Universal Synchronous, Asynchronous Receiver Transmitter (EUSART), Analog-To-Digital Converter (A/D) Module, Comparator module.	08	CO3
4	**PIC 18F Interfacing** Interfacing to LCD, 7 segment display, Keyboard, ADC, DAC, relay, DC motor, Stepper Motor.	08	CO4
5	**Case Studies** PWM Generation, Digital encoder, PID Controller, Temperature controller, RTC, Speed Control of DC motors and similar system design	08	CO5
6	**Introduction to Real Time Operating System** Introduction to RTOS concept. Tasks and task states, task and data, Semaphores and shared data. Multitasking operating systems, Context switching, task tables, and kernels, Task swapping methods (Time slice, Pre-emption, Co-operative multitasking) Scheduler algorithms (Rate monotonic, Deadline monotonic scheduling) Priority inversion, Tasks, threads and processes, Exceptions, Example of any tiny RTOS.	08	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Theory 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

   4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective

   Lecture hours as mentioned in the syllabus.

Text Books:

1. Mazidi M.A., PIC 18F Microcontroller & Embedded systems, Pearson Education Second edition.
2. Ramesh Gaonkar, Fundamentals of Microcontrollers and application in Embedded system (With PIC 18 Microcontroller family) Penram International Publishing.
3. Steve Heath, Embedded Systems Design, Newnes publication, Second edition, ISBN 0 7506 5546

Reference Books:

1. John B. Peatman, Design with PIC Microcontroller, Pearson Education
2. Han-way Huang, PIC Microcontroller: An Introduction to Software & Hardware Interfacing, Thomson Delmar Learning, India Edition.
3. David Simon, Embedded Software Primer, Pearson Education, ISBN 81-7808-045-1.
4. Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, Wiley Student Edition.
5. Rajkamal, Embedded Systems, TMH, Second Edition.

Subject code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDLO 7034	Mechatronics	4	-	-	4	-	-	4

Subject code	Subject Name	Examination Scheme							
		Theory(out of 100)				Theory	Pract. And Oral	Oral	Total
		Internal Assessment (out of 20)			End Sem. Exam				
		Test 1	Test 2	Avg.					
ISDLO 7034	Mechatronics	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDLO7034	Mechatronics	4
Course Objectives	1. To present architecture of the mechatronics system design 2. To study on broad spectrum the characteristics of the mechanical and electrical actuators and their selection for mechatronic systems. 3. Development of process plan and templates for design of mechatronic systems.	
Course Outcomes	The students will be able to 1. Describe mechatronics system. 2. Apply the concept of system modeling 3. Identify the suitable sensor and actuator for a mechatronic system. 4. Explain feedback and intelligent controllers 5. Learn mechatronics system validation 6. Integrate the components in mechatronics system	

Details of Syllabus:

Prerequisites: Signal conditioning, controllers and signals and systems, communication protocols.

Module	Contents	Hrs.	CO Mapping
1	**Introduction to mechatronics systems:** Definition and evolution levels of mechatronics, integrated design issues in mechatronics, key elements of mechatronics, mechatronics design process- modeling and simulation, prototyping, deployment /life cycle, advanced approaches in mechatronics.	06	CO1
	Modeling and Simulation of physical systems: Simulation and block diagrams, Analogies and impedance diagrams, electrical system-bridge circuit system, transformer, mechanical	10	CO2

	translational and rotational systems-sliding block with friction, elevator cable system, mass-damper system, automobile suspension system, mechanical lever system, geared elevator system, electromechanical coupling- DC motor, fluid systems-three tank liquid system, hydraulic actuator and hydraulic pressure regulator.		
3	**Hardware components:** Sensors: motion and position measurement, force, torque and tactile sensors, ultrasonic and range sensors, fiber optic sensors, micro sensors. Actuators: Pneumatic and hydraulic-directional and pressure control valves, cylinders, servo proportional control valves, rotary actuators, Electrical actuation: A.C and DC motors, stepper motors, mechanical switches and solid state switches. Mechanical Actuation: types of motion, kinematic chain, cams, gears, ratchets and pawl, belt and chain drives, bearings, mechanical aspects of motor selection, piezoelectric actuators, magnetostrictive actuators, memory metal actuators, Programmable Logic Controller	10	CO3
4	**Intelligent control:** Automatic control methods, Artificial Neural Network(ANN) – Modeling, basic model of neuron, characteristics of ANN, perceptron, learning algorithms, fuzzy logic – propositional logic, membership function, fuzzy logic and fuzzy rule generation, defuzzification, time dependent and temporal fuzzy logic.	10	CO4
5	**Components based modular design and system validation:** Components based modular design view, system validation, validation methodology- integrated and design dependence, distributed local level, validation schemes, fusion technique	06	CO5
6	**Integration:** Advanced actuators, consumer mechatronic products, hydraulic fingers, surgical equipment, industrial robot, autonomous guided vehicle, drilling machine, 3D Plotter, Motion Control Systems-Printing machines, coil winding machines, machine tools, and robotics, IC, and PCB manufacturing.	06	CO6

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus where in sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Reference Books:

1. Devdas Shetty and Richard Kolk, “Mechatronics System Design”, Thomson Learning, 2nd reprint, 2001.
2. W. Bolton, “Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering”, Pearson Education Ltd, 4th edition, 2010.
3. Nitaigour Mahalik, “Mechatronics- Principles, Concepts and Applications”, Tata McGraw Hill .
4. Stamatios V.Kartalopoulos,“Understanding Neural Networks and fuzzy Logic”, PHI,3rd reprint, 2013.
5. Zhijun Li, Shuzhi Sam Ge, “Fundamentals in Modeling and Control of Mobile Manipulators", March 30, 2017, by CRC Press.
6. Sergey Edward Lyshevski, “Mechatronics and Control of Electromechanical Systems", May 30, 2017, by CRC Press.
7. Bodgan Wilamowski, J. David Irwin, “Control and Mechatronics", October 12, 2017, by CRC Press.
8. Takashi Yamaguchi, Mitsuo Hirata, Justin Chee Khiang Pang, "High-Speed Precision Motion Control", March 29, 2017, by CRC Press.
9. David Allan Bradley, Derek Seward, David Dawson, Stuart Burge, “Mechatronics and the Design of Intelligent Machines and Systems", November 17, 2000, by CRC Press.
10. Clarence W. de Silva, Farbod Khoshnoud, Maoqing Li, Saman K. Halgamuge, “Mechatronics: Fundamentals and Applications", November 17, 2015, by CRC Press.
11. Clarence W. de Silva,“Mechatronics: A Foundation Course", June 4, 2010 by CRC Press.
12. GENERAL CATALOGUE 2011 Motion & Drives, OMRON.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDLO 7035	Building Automation	4	-	-	4	-	-	4

Subject Code	Subject Name	Examination scheme							
		Theory Marks(100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment(20)			End Sem Exam				
		Test1	Test2	Avg.					
ISDLO 7035	Building Automation	20	20	20	80	-	-	-	100

Subject Code	Subject Name	credits
ISDLO7035	Building Automation	4
Course objectives	1. To brief students with origin and evolution of building automation. 2. To train them with architecture and operation of BAS. 3. To facilitate them for designing automation system for intelligent building. 4. Develop technique for preparation of various documents required for design requirement of safety building.	
Course Outcomes	The students will be able to: 1. Explain the concept of intelligent building and BAS. 2. Select the hardware and design of HVAC in building automation system. 3. Discuss the concept of energy management system. 4. Design and implement the safety system for building. 5. Design security and video management system for building. 6. Design and integrate the different system in BAS.	

Details of Syllabus:

Prerequisite: Fundamental of measurement and control, industrial automation, smart buildings.

Module	Contents	Hrs	CO Mapping
1	**Introduction to intelligent buildings:** Definitions of intelligent building, Intelligent architecture and structure, Facilities management vs. intelligent buildings, Technology systems and evolution of intelligent buildings. **Introduction to Building Automation System:** Features, Characteristics, Drawbacks of Building Automation system. Various Systems of Building Automation – Building Management System, Energy Management System, Security System, Safety System, Video Management System.	06	CO1

2	**HVAC system:** Introduction, HVAC, Sensors & Transducers – Temperature, Pressure, Level, Flow, RH. Meaning of Analog & Digital Signals, Valves and Actuators, Valve & Actuator Selection, Various Controllers, Concept of Controller IOs, Std Signals, Signal Compatibility between Controller & Field Devices. AHU – Concept, Components, Working Principle. AC Plant Room – Concept, Components, Refrigeration Cycle Working Principle, Chiller Sequencing, AC Plant Sequencing. Feedback Control Loops, Heat – Types, Heat Transfer Principles, Measurement of Heat Transfer. Psychrometry –Concept, ASHRAE Psychrometric Chart, Meaning of Various Terms – DBT, WBT, ST, RH, DPT, Sensible & Latent Cooling & Heating, Numericals. Job IO Summary Calculation, Controller Sizing, AI to DI Conversion, Cable Selection, Earthing – Meaning, Importance, Panel Earthing, EMI & Tackling EMI. Logic Examples, CL Programming.	12	CO2
3	**Energy Management System:** Concept, Energy Meters, Types, Meter Networking, Monitoring Energy Parameters, Analysis of Power Quality – Instantaneous Power, Active Power, Reactive Power, Power Factor, Voltage, Current. Effect of Power Quality on Energy Consumption, Energy Reports, Energy Conservation, Importance of Energy Saving.	06	CO3
4	**Safety Systems:** Introduction, Fire –Meaning, Fire Development Stages, Fire Sensors & Detectors, Detector Placement, Detectors Required For Various Applications. Fire Extinguishing Principles, Fire Extinguishers & Its Classification. Fire Alarm System – Controllers, Components, Features, Concept of Fire Loop & Fire Devices, 2-Wire & 4-Wire Loops, Working Principle, System Description, Pre-alarm, Alarm, Trouble, Fault, Differences, Cable Selection, Installation Guidelines Best Installation Practices, Logic Example. NFPA and IS2189 Stds, System Programming.	08	CO4
5	**Security Systems:** Introduction, Access Control – Concept, Generic Model, Components, Types, Features, Card Technologies, Protocols, Controllers, Concept of Antipassback, Biometrics, Issues With Biometrics, Cabling, Video Door phone, Intrusion Detection System – Sensors, Working Principle, Access Control System Programming. **Video Management:** Introduction, CCTV Cameras, CCD Camera Basics, Traditional	10	CO5

	CCTV System, Video Recording, Drawbacks, Digital Video Recording, Features, Functionalities, Digital Vs Analog Recording, Digital Video Management System – Introduction, Features, Advancements & Differences from Earlier Video Techniques, TCP/IP Networking Fundamentals, System Network Load Calculations, Network Design.		
6	**Integrated Systems:** Introduction, Integration of Building Management System, Energy Management System, Safety System, Security Systems & Video Management, Benefits of Integrated Systems, Challenges, Future Prospects of Integrated Systems.	06	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weight age of each module will be proportional to number of respective Lecture hours as mentioned in the syllabus.

Text Books:

1. Shengwei Wang, Intelligent Buildings and Building Automation, 2009.
2. Reinhold A. Carlson Robert A. Di Giandomenico, 'Understanding Building Automation Systems: Direct Digital Control, Energy Management, Life Safety, Security Access Control, Lighting, Building',1st edition (R.S. Means Company Ltd), (1991).

Reference Books:

1. Roger W. Haines, "HVAC system Design Handbook", fifth edition.
2. National Joint Apprenticeship & Training Committee, Building Automation System Integration With Open Protocols: System Integration With Open Protocols
3. John I. Levenhagen and Donald H. Spethmann, HVAC Controls and Systems (Mechanical Engineering) , 1992.
4. James E.Brumbaugh, "HVAC fundamentals", vol: 1 to 3.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
ILO7011	**Product Lifecycle Management (abbreviated as PLM)**	**3**	**-**	**3**	**-**	**3**

Course code	Course Name	Examination Scheme						
		Theory					Term Work	Total
		Internal Assessment			End Sem. Exam	Exam Duration (Hrs.)		
		Test 1	Test 2	Avg.				
ILO7011	Product Lifecycle Management	20	20	20	80	03	-	100

Course Objectives	• To familiarize the students with the need, benefits and components of PLM • To acquaint students with Product Data Management & PLM strategies • To give insights into new product development program and guidelines for designing and developing a product • To familiarize the students with Virtual Product Development
Course Outcomes	Student will be able to… • Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation. • Illustrate various approaches and techniques for designing and developing products. • Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc. • Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plan

Module	Contents	Hours
1	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	12
2	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent	09

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

Books Recommended:

Reference Books:

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

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining question will be randomly selected from all the modules.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
ILO7012	**Reliability Engineering (abbreviated as RE)**	**3**	**-**	**3**	**-**	**3**

Course code	Course Name	Examination Scheme						
		Theory					Term Work	Total
		Internal Assessment			End Sem. Exam	Exam Duration (Hrs.)		
		Test 1	Test 2	Avg.				
ILO7012	Reliability Engineering	20	20	20	80	03	-	100

Course Objectives	• To familiarize the students with various aspects of probability theory • To acquaint the students with reliability and its concepts • To introduce the students to methods of estimating the system reliability of simple and complex systems • To understand the various aspects of Maintainability, Availability and FMEA procedure
Course Outcomes	Student will be able to… • Understand and apply the concept of Probability to engineering problems • Apply various reliability concepts to calculate different reliability parameters • Estimate the system reliability of simple and complex systems • Carry out a Failure Mode Effect and Criticality Analysis

Module	Contents	Hours
1	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	10
2	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	10
3	**System Reliability** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
4	**Reliability Improvement** Redundancy Techniques: Element redundancy, Unit redundancy,	10

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

Books Recommended:

Reference Books:

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

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining question will be randomly selected from all the modules.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
ILO7013	**Management Information System (abbreviated as MIS)**	**3**	**-**	**3**	**-**	**3**

Course code	Course Name	Examination Scheme						
		Theory					Term Work	Total
		Internal Assessment			End Sem. Exam	Exam Duration (Hrs.)		
		Test 1	Test 2	Avg.				
ILO7013	Management Information System	20	20	20	80	03	-	100

Course Objectives	• The course is blend of Management and Technical field. • Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built • Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage • Identify the basic steps in systems development • Define and analyze various MIS management responsibilities, including planning, budgeting, project management, and personnel management • Discuss critical ethical and social issues in information systems
Course Outcomes	Student will be able to… • Explain how information systems Transform Business • Identify the impact information systems have on an organization • Describe IT infrastructure and its components and its current trends • Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making • Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Contents	Hours
1	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	7
2	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	9

3	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	6
4	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
5	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
6	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	10

Books Recommended:

Reference Books:

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

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining question will be randomly selected from all the modules.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
ILO7014	**Design of Experiments (abbreviated as DoE)**	**3**	**-**	**3**	**-**	**3**

Course code	Course Name	Examination Scheme						
		Theory					Term Work	Total
		Internal Assessment			End Sem. Exam	Exam Duration (Hrs.)		
		Test 1	Test 2	Avg.				
ILO7014	Design of Experiments	20	20	20	80	03	-	100

Course Objectives	1. To understand the issues and principles of Design of Experiments (DOE). 2. To list the guidelines for designing experiments. **3.** To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization
Course Outcomes	Student will be able to… • Plan data collection, to turn data into information and to make decisions that lead to appropriate action. • Apply the methods taught to real life situations. • Plan, analyze, and interpret the results of experiments

Module	Contents	Hours
1	**Introduction:** Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	6
2	**Fitting Regression Models:** Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	8
3	**Two-Level Factorial Designs:** The 2^2Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^kDesign, The Addition of Center Points to the 2^kDesign, Blocking in the 2^kFactorial Design, Split-Plot Designs.	7
4	**Two-Level Fractional Factorial Designs:** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	7
5	**Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	7
6	**Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	4

Books Recommended:

Reference Books:

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

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining question will be randomly selected from all the modules.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
ILO7015	**Operation Research (abbreviated as OR)**	**3**	**-**	**3**	**-**	**3**

Course code	Course Name	Examination Scheme						
		Theory					Term Work	Total
		Internal Assessment			End Sem. Exam	Exam Duration (Hrs.)		
		Test 1	Test 2	Avg.				
ILO7015	Operation Research	20	20	20	80	03	-	100

Course Objectives	• Formulate a real-world problem as a mathematical programming model. • Understand the mathematical tools that are needed to solve optimization problems. • Use mathematical software to solve the proposed models.
Course Outcomes	Student will be able to… • Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand. • Understand the relationship between a linear program and its dual, including strong duality and complementary slackness. • Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change. • Solve specialized linear programming problems like the transportation and assignment problems. • Solve network models like the shortest path, minimum spanning tree, and maximum flow problems. • Understand the applications of, basic methods for, and challenges in integer programming • Model a dynamic system as a queuing model and compute important performance measures

Module	Contents	Hours
1	**Introduction to Operations Research***:* Introduction, Historical Background, Scope of Operations Research , Features of Operations Research, Phases of Operations Research, Types of Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools , Structure of the Mathematical Model, Limitations of Operations Research	2
2	**Linear Programming***:* Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, *Simplex Method* Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, ***Duality***, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis	6
3	**Transportation Problem***:* Formulation, solution, unbalanced	6

	Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem***:* Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem	
4	**Integer Programming Problem***:* Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	6
5	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	6
6	**Simulation***:* Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation *Monte-Carlo Method:* Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	4
7	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	4
8	**Games Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	4
9	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	4

Books Recommended:

Reference Books:

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

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining question will be randomly selected from all the modules.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
ILO7016	**Cyber Security and Laws (abbreviated as CSL)**	**3**	**-**	**3**	**-**	**3**

Course code	Course Name	Examination Scheme						
		Theory					Term Work	Total
		Internal Assessment			End Sem. Exam	Exam Duration (Hrs.)		
		Test 1	Test 2	Avg.				
ILO7016	Cyber Security and Laws	20	20	20	80	03	-	100

Course Objectives	• To understand and identify different types cyber crime and cyber law • To recognized Indian IT Act 2008 and its latest amendments • To learn various types of security standards compliances
Course Outcomes	Student will be able to… • Understand the concept of cyber crime and its effect on outside world • Interpret and apply IT law in various legal issues • Distinguish different aspects of cyber law • Apply Information Security Standards compliance during software design and development

Module	Contents	Hours
1	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
2	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cybercafé and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	10
3	**Tools and Methods Used in Cyberline:** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
4	**The Concept of Cyberspace:** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to	8

	Electronic Banking , The Need for an Indian Cyber Law	
5	**Indian IT Act.:** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000,IT Act. 2008 and its Amendments	8
6	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Books Recommended:

Reference Books:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining question will be randomly selected from all the modules.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
ILO7017	**Disaster Management and Mitigation Measures (abbreviated as DMMM)**	**3**	**-**	**3**	**-**	**3**

Course code	Course Name	Examination Scheme						
		Theory					Term Work	Total
		Internal Assessment			End Sem. Exam	Exam Duration (Hrs.)		
		Test 1	Test 2	Avg.				
ILO7017	Disaster Management and Mitigation Measures	20	20	20	80	03	-	100

Course Objectives	• To understand the various types of disaster occurring around the world • To identify extent and damaging capacity of a disaster • To study and understand the means of losses and methods to overcome /minimize it. • To understand role of individual and various organization during and after disaster • To know warning systems, their implementation and based on this to initiate training to a laymen • To understand application of GIS in the field of disaster management • To understand the emergency government response structures before, during and after disaster
Course Outcomes	Student will be able to… • Understand natural as well as manmade disaster and their extent and possible effects on the economy. • Planning of national importance structures based upon the previous history. • Understand government policies, acts and various organizational structure associated with an emergency. • Know the simple do's and don'ts in such extreme events and act accordingly

Module	Contents	Hours
1	***Introduction: Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.***	03
2	***Natural Disaster and Manmade disasters: Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion . Manmade Disasters:***	06

	Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	
3	***Disaster Management, Policy and Administration: Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.***	06
4	***Institutional Framework for Disaster Management in India: Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.***	06
5	***Financing Relief Measures: Ways to raise finance for relief expenditure,*** ***Role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters.*** ***Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.*** ***International relief aid agencies and their role in extreme events.***	09
6	Preventive and Mitigation Measures: Pre-disaster, during disaster and post-disaster measures in some events in general, Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication. Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Books Recommended:

Reference Books:

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

7. Concepts and Techniques of GIS –C.P. Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

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

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining question will be randomly selected from all the modules.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
ILO7018	**Energy Audit and Management (abbreviated as EAM)**	**3**	**-**	**3**	**-**	**3**

Course code	Course Name	Examination Scheme						
		Theory					Term Work	Total
		Internal Assessment			End Sem. Exam	Exam Duration (Hrs.)		
		Test 1	Test 2	Avg.				
ILO7018	Energy Audit and Management	20	20	20	80	03	-	100

Course Objectives	• To understand the importance of energy security for sustainable development and the fundamentals of energy conservation. • To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management • To relate the data collected during performance evaluation of systems for identification of energy saving opportunities
Course Outcomes	Student will be able to… • To identify and describe present state of energy security and its importance. • To identify and describe the basic principles and methodologies adopted in energy audit of an utility. • To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. • To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities • To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Contents	Hours
1	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	4
2	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	8

3	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
4	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities	10
5	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	4
6	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	3

Books Recommended:

Reference Books:

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

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

Theory Examination:

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

2. Total four questions need to be solved.
3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining question will be randomly selected from all the modules.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
ILO7019	**Development Engineering (abbreviated as DE)**	**3**	**-**	**3**	**-**	**3**

Course code	Course Name	Examination Scheme						
		Theory					Term Work	Total
		Internal Assessment			End Sem. Exam	Exam Duration (Hrs.)		
		Test 1	Test 2	Avg.				
ILO7019	**Development Engineering**	20	20	20	80	03	-	100

Course Objectives	• To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural • To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas • An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals • To understand the Nature and Type of Human Values relevant to Planning Institutions
Course Outcomes	Student will be able to… • Apply knowledge for Rural Development • Apply knowledge for Management Issues. • Apply knowledge for Initiatives and Strategies. • Develop acumen for higher education and research. • Master the art of working in group of different nature. • Develop confidence to take up rural project activities independently.

Module	Contents	Hours
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development. Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
2	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local. Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	04
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring	06

	organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	
4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	10
6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

Books Recommended:

Reference Books:

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

Theory Examination:

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

2. Total four questions need to be solved.
3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining question will be randomly selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL701	Industrial Process Control-Lab Practice	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End Sem Exam	Term work	Pract. and Oral	Oral	Total
		Test 1	Test 2	Avg.					
ISL701	Industrial Process Control –Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	credits
ISL701	Industrial Process Control-Lab Practice	1
Course objectives	1. To impart the knowledge of different industrial unit operations. 2. To make them capable to design and develop instrumentation and control scheme for industrial processes. 3. To give them exposure to work in process industry. 4. To explain students about hazardous area and safety design system.	
Course Outcomes	The students will be able to 1. Explain working and control of various heat transfer unit operations 2. Explain working and control of various heat and mass transfer unit operations 3. Explain the miscellaneous process equipment and their control 4. Describe the processes of various continuous process industries and instrumentation involved in them. 5. Describe the processes of various batch process industries and instrumentation involved in them. 6. Classify hazardous areas in the industry.	

Syllabus: Same as that of Subject ISC701 Industrial Process Control.

List of Laboratory Experiments/Assignments:

Sr. No.	Detailed Content	CO Mapping
1	Demonstrate the operation and control scheme of Heat exchanger	CO1
2	Learn working of various Unit Operations (Boilers/furnace / Distillation column etc.) using online learning resources.	CO2
3	Demonstrate the reactor control system.	CO2
4	Demonstrate the operation & control scheme of a compressor.	CO3
5	Prepare a report on any one industry.	CO4 and CO5
6	Develop some charts on hazardous area classification.	CO6
7	Assignment/Exercise on heat transfer unit operations- heat exchanger, boilers	CO1
8	Assignment/Exercise on heat transfer unit operations-evaporator, furnace	CO1
9	Assignment/Exercise on heat and mass transfer unit operations-Distillation, dryers	CO2
10	Assignment/Exercise on heat and mass transfer unit operations-Crystallization, reactor	CO2
11	Assignment/Exercise on miscellaneous equipment	CO3
12	Assignment/Exercise on hazardous area classification	CO6
13	Assignment/Exercise on continuous process industries	CO4
14	Assignment/Exercise on batch process industries	CO5

Any other additional experiments/assignments based on syllabus which will help students to understand topic/concept.

- Industry visit is advised to understand the unit operations, industrial processes and their control.

Practical/Oral Examination:

Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum four experiments and four assignments.

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

Laboratory work (Experiments/assignments) : 10 Marks

Laboratory work (programs / journal) : 10 Marks

Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of

Laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL702	Biomedical Instrumentation - Lab Practice	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End Sem Exam	Term work	Pract. And oral	Oral	Total
		Test1	Test2	Avg.					
ISL702	Biomedical Instrumentation- Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	Credits
ISL702	Biomedical Instrumentation- Lab Practice	1
Course objective	1. To make students perform experiments based on the principle and working of various Biomedical Instruments used for Bio-potential measurements 2. To develop skills in the design of various biomedical instruments used in diagnosis and life-support.	
Course Outcome	Students will be able 1. To measure and identify various Bio-potentials with their specifications. 2. To observe and plot various Physiological parameters with their specifications. 3. To measure the various cardiovascular parameters by Designing the related circuitry. 4. To realise the circuitry of different life support instruments, like pacemaker, defibrillator. 5. To distinguish between the various medical imaging techniques by comparing, principle and concept involved in each of the technique. 6. To describe the significance of electrical safety in biomedical measurement.	

Syllabus: Same as that of Subject ISC702 Biomedical Instrumentation.

List of Suggested Laboratory Experiments:

Sr. No.	Detailed Content	CO Mapping
1	Demonstration and working of instruments like ECG and PCG.	CO1

2	Demonstration and working of instruments like EMG and EEG.	**CO1**
3	Study of electrodes for various biomedical applications.	**CO1**
4	To measure Blood pressure by indirect method.	**CO2**
5	To study Pacemaker and various waveforms or Design and implement pacemaker circuit.	**CO4**
6	To study Defibrillator and voltage waveforms or Design and implement Defibrillator circuit.	**CO4**
7	Design of ECG amplifier and testing of gain frequency response with weak input signal.	**CO3**
8	To design and implement ECG signal conditioning circuits with different parameter.	**CO3**
9	To design and implement EMG Quantification circuit.	**CO2**
10	To study Hemodialysis, Heart/Lung machine based models.	**CO4**
11	ECG simulation on PC / Microcontroller.	**CO3**
12	Study of working of pulse oxymeter / Heart rate meter.	**CO3**
13	To study respiration rate meter / respiration parameter measurement.	**CO2**
14	Study on Medical Imaging Techniques	**CO5**
15	Study on Electrical Safety	**CO6**

Any other additional experiment based on syllabus which will help students to understand topic/concept

Practical/Oral Examination:

Practical/Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum 08 experiments from the above given list and 02 assignments from imaging techniques module and electrical safety module.

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

Laboratory work (Experiments/Assignments) : 10 Marks

Laboratory work (programs / journal) : 10 Marks

Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL703	Industrial Automation-Lab Practice	-	02	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End sem exam	Term work	Pract. And oral	Oral	Total
		Test1	Test2	Avg.					
ISL703	Industrial Automation-Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	Credits
ISL703	Industrial Automation -Lab Practice	1
Course objective	1. To give the students fundamentals of automation and various automation systems used in industry such as PLC, DCS, and SCADA. 2. To impart the knowledge about the architecture, working of PLC, DCS and SCADA 3. To make the students capable to apply knowledge to identify hardware and software requirements of PLC, DCS and SCADA 4. To give the students a comprehension of the aspects related to Safety Instrumented system (SIS).	
Course Outcome	The students will be able to 1. Describe automation, need, importance and applications in industry. 2. Identify components of PLC, and develop PLC ladder using instructions of PLC and design PLC based application by proper selection and sizing criteria 3. Explain evolution and architecture of DCS, hierarchical control in DCS, programming DCS through Function Block Diagram (FBD) method. 4. Describe SCADA architecture, communication in SCADA and develop any application based on SCADA along with GUI using SCADA software. 5. Explain database and alarm management system 6. Recognize the need of SIS and describe risk reduction methods.	

Syllabus: Same as that of Subject ISC703 Industrial Automation.

List of Laboratory Experiments/Assignments:

Sr. No.	Detailed Content	CO Mapping
1.	Processing of sensor signals by the PLC to drive various end effectors such as pneumatic/electric/hydraulic.	**CO2**
2.	PLC programs for process control applications (minimum 4 nos)	**CO2**
3.	DCS programming using Function block diagram method	**CO3**
4.	GUI development for any one application using SCADA software.	**CO4**
5.	Assignment/Exercise based on Automation Fundamentals	**CO1**
6.	Assignment/Exercise based on DCS	**CO3**
7.	Assignment /Exercise based on SCADA	**CO4**
8.	Assignment/Exercise based on Database and Alarm management	**CO5**
9.	Assignment/Exercise based on Safety Instrumented System	**CO6**

Any other additional experiment based on syllabus which will help students to understand topic/concept

Practical/Oral Examination:

Practical/Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum 4 experiments and 4 assignments.

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

Laboratory work (Experiments/Assignments): 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL704	Image Processing-Lab Practice	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End sem Exam	Term work	Pract. and Oral	Oral	Total
		Test1	Test2	Avg.					
ISL704	Image Processing-Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	credits
ISL704	Image Processing-Lab Practice	1
Course objectives	1. Familiarize with computer simulation software for Image processing and its analysis and basic Image operations. 2. To Study the Fourier and Cosine transformation of images in the simulation platform and display the result 3. Write advanced image processing algorithms such as Image enhancement, Image restoration by using computer simulations. 4. Develop program for extract the features of images by segmentation and image morphology.	
Course Outcomes	Students will be able to - 1. Simulate various operations on Images. 2. Perform Discrete Fourier transform and Discrete Cosine transform on Image. 3. Perform Image enhancement techniques. 4. Perform morphological operations on images and display the result. 5. Implement Image compression techniques. 6. Implement restoration techniques on degraded images.	

Syllabus same as that of subject ISDLO7031 Image Processing

List of Laboratory Experiments:

Sr. No.	Detailed Contents	CO mapping
1	Basic Image operations such as Reading, Displaying, Writing, Flipping, Cropping Images. Introduction to M file, Basic Matrix operations.	**CO1**
2	Spatial transformation of images like Translation, Rotation and Scaling.	**CO1**
3	Compute and visualize 2-D DFT, DCT of Images.	**CO2**

4	Point processing operations like Image negative, brightness adjustment, contrast stretching, Threshold, Log transformation, Power law transformations, Gray level slicing with or without background.	**CO3**
5	Image Enhancement techniques by arithmetic and logic operations.	**CO3**
6	Generate and plot Image Histogram and Histogram Equalization.	**CO4**
7	Image Analysis and interpret the result by using Spatial filter.	**CO5**
8	Image smoothing and Sharpening in frequency domain.	**CO5**
9	Implementing Image acquisition and degradation process by different noises and	**CO5**
10	Edge detection by using Robert operator, Prewitt operator, Sobel operator and compare the result.	**CO6**
11	Morphological operation of Images like Dilation, Erosion, Opening, Closing, Boundary Detection.	**CO6**
12	Image segmentation such as point, line, edge detection.	**CO6**

Any other additional experiments based on syllabus which will help students to understand topic/concept.

Note: Students can use any Computer simulation software programing platform like MATLAB/SCILAB.

Oral Examination:

Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of Eight experiments.

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

Laboratory work (Experiments) : 10 Marks
Laboratory work (programs /journal) : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL704	Digital Control System-Lab Practice	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End sem Exam	Term work	Pract. and Oral	Oral	Total
		Test1	Test2	Avg.					
ISL704	Digital Control System- Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	Credits
ISL704	Digital Control System-Lab Practice	1
Course objective	1. The students should be able to determine response of ZOH and FOH 2. The students should be able to descretize continuous data system. 3. The students will be able to represent given system into different canonical form. 4. The students should able to determine state transition matrix 5. Students can be able to design controller and observer	
Course Outcome	Students will be able to - 1. Understand the difference in response with reconstruction due to ZOH and FOH . 2. Discretize the analog systems and signals with different methods 3. Design controller and observer for the given system. 4. Demonstrate their knowledge to obtain different canonical forms analytically and verify using simulation software. 5. Determine state transition matrix using simulation software and verify the results analytically 6. Measure and record the experimental data, analyze the results, and prepare a formal laboratory report.	

Syllabus same as that of subject ISDLO7032 Digital Control System

List of Laboratory Experiments:

Sr. No.	Detailed Contents	CO Mapping
1	To determine response of zero order hold and first order hold using simulation software	CO1
2	Mapping from S- plane to Z-plane analytically and verification using simulation software	CO2
3	Discretization of continuous data system using i) Step invariance method, ii) Impulse invariance method, and iii) Bilinear transformations, analytically and verification using simulation software	CO3
4	To represent given system in different canonical forms, analytically and verification using simulation software	CO4
5	To determine pulse transfer function of a given system analytically and its verification using simulation software	CO4,CO6
6	Determination of state transition matrix analytically and its verification using simulation software	CO5,CO6
7	To check controllability and observability of a given system analytically and verify the result using simulation software.	CO3,CO6
8	To design the controller by any method	CO3
9	To design an observer by any method	CO3

Any other additional experiments based on syllabus which will help students to understand topic/concept.

Note: Student can use simulation software such as MATLAB, MATHCAD, SCILAB or any other open source software.

Oral Examination:
Oral examination will be based on entire syllabus

Term Work:

Term work shall consist of Eight experiments.

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

Laboratory work (Experiments) : 10 Marks
Laboratory work (programs /journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL704	Advanced Microcontroller Systems- Lab Practice	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End Sem Exam	Term work	Pract and Oral	Oral	Total
		Test 1	Test 2	Avg.					
ISL704	Advanced Microcontroller Systems- Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	Credits
ISL704	**Advanced Microcontroller Systems- Lab Practice**	**1**
Course objectives	1. To explain the fundamentals of PIC 18F Microcontroller and working of the system. 2. To discuss and explain the integrated hardware of the PIC 18F Microcontroller 3. To illustrate various programming tools and development of software using assembly and higher level language. 4. To examine and design, interfacing of PIC 18F Microcontroller with different peripheral devices such as LCD, keyboard, ADC, DAC etc. 5. To design applications using learned concepts of hardware, software and interfacing. 6. To describe the working of RTOS and related tasks.	
Course Outcomes	The students will be able to: 1. Simulate, Analyze and develop programs using assembly language. 2. Simulate, Analyze and develop programs using embedded C 3. Develop program to use PIC18 integrated peripherals. 4. Design and Develop programs for interfacing of external peripheral components with PIC 18F Microcontroller. 5. Design and develop sophisticated application using the PIC18 integrated peripherals and external peripherals 6. Show the uses and features of RTOS	

Syllabus: Same as that of Subject ISDLO7033 Advanced Microcontroller Systems.

List of Laboratory Experiments/ Assignments:

Sr. No.	Detailed Content	CO Mapping
1.	To develop assembly program	**CO1**
2.	To develop embedded C program	**CO2**
3.	To develop a program for generating square wave on port pin with and without timer.	**CO3**
4.	To develop a program for interfacing 7 segments displays with PIC18	**CO4**
5.	To develop a program for interfacing LCD display with PIC18	**CO4**
6.	To develop a program for interfacing keyboard with PIC18	**CO4**
7.	To develop a program for Serial Communication with PC.	**CO3**

8.	To develop a program for interfacing DAC and its application.	**CO4**
9.	To develop a program for implementing RTC.	**CO3**
10.	To develop a program for Speed control of DC Motor	**CO5**
11.	To develop a program for temperature measurement.	**CO5**
12.	To develop a program for Stepper motor control	**CO5**
13.	To develop a program for implementing PID controller.	**CO5**
14.	Assignment on understanding operation of integrated peripherals	**CO5**
15.	Case study on various types of RTOS	**CO6**

Any other additional experiments/assignments based on syllabus which will help students to understand topic/concept.

Practical/Oral Examination:

Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum four experiments and four assignments.

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

Laboratory work (Experiments/assignments): 10 Marks

Laboratory work (programs / journal) : 10 Marks

Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of

Laboratory work and minimum passing in the term work.

Sub code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL704	Mechatronics	-	2	-	-	1	-	1

Sub code	Subject Name	Examination Scheme							
		Theory(out of 100)				Theory	Pract. And Oral	Oral	Total
		Internal Assessment (out of 20)			End Sem. Exam				
		Test 1	Test 2	Avg.					
ISL704	Mechatronics	-	-	-	-	25	-	25	50

Subject Code	Subject Name	Credits
ISL704	Mechatronics Lab	1
Course Objectives	1. To present architecture of the mechatronics system design 2. To study on broad spectrum the characteristics of the mechanical and electrical actuators and their selection for mechatronic systems. 3. Development of process plan and templates for design of mechatronic systems.	
Course Outcomes	The students will be able to 1. Apply the concept of system modeling 2. Calculate performance characteristics of sensors 3. Learn the working of actuators for a mechatronic system. 4. Design feedback and intelligent controllers 5. Describe mechatronics system validation 6. Integrate the components in mechatronics system	

Syllabus: Same as that of Subject ISDLO7034 Mechatronics.

List of Laboratory Experiments/ Assignments:

Sr. No.	Detailed Content	CO Mapping
1	Modeling and simulation of basic electrical, hydraulic and pneumatic systems using any virtual instrumentation software like LabVIEW.	CO1
2	Calculate static and dynamic characteristics of position/force/tactile sensors	CO2
3	Design of circuits with logic sequence using Electro pneumatic trainer kits.	CO3
4	Simulation of basic Hydraulic, Pneumatic and Electric circuits using any software	CO3

5	Electro pneumatic applications using PLC	CO3
6	Speed Control of AC & DC drives	CO3
7	Servo controller interfacing for DC motor	CO4
8	PID controller interfacing	CO4
9	Implementation of fuzzy controller for level or temperature control	CO4
10	Stepper motor interfacing with Micro controller (i) Full step resolution (ii) half step resolution	CO4
11	Assignment on Components based modular design and system validation	CO5
12	Computerized data logging system with control for process variables like pressure, flow and temperature.	CO6
13	Case study on any one mechatronics system	CO6

Any other additional experiments / case studies based on syllabus which will help students to understand topic/concept.

**Industry visit is advised to understand the Mechatronics subject.

Practical/Oral Examination:
Oral examination will be based on entire syllabus.

Term Work:
Term work shall consist of minimum seven experiments and 01 case study.

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

Laboratory work (Experiments/assignments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL704	Building Automation-Lab Practice	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End Sem Exam	Term work	Pract. and Oral	Oral	Total
		Test 1	Test 2	Avg.					
ISL704	Building Automation-Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	credits
ISL704	Building Automation Lab Practice	1
Course objectives	1. To brief students with origin and evolution of building automation. 2. To train them with architecture and operation of BAS. 3. To facilitate them for designing automation system for intelligent building. 4. Develop technique for preparation of various documents required for design requirement of safety building.	
Course Outcomes	The students will be able to: 1. Explain the concept of intelligent building and BAS. 2. Select the hardware and design of HVAC in building automation system. 3. Discuss the concept of energy management system. 4. Design and implement the safety system for building. 5. Design security and video management system for building. 6. Design and integrate the different system in BAS.	

Syllabus: Same as that of Subject ISDLO7035 Building Automation.

List of Laboratory Experiments/ Assignments:

Sr. No.	Detailed Content	CO Mapping
1	Assignment on intelligent building.	CO1
2	Assignment on BAS.	CO1
3	Assignment on HVAC.	CO2
4	Assignment on Direct Digital Control of an HVAC system.	CO2

5	Assignment on BACnet and its features.	CO2
6	Assignment on lighting- control systems.	CO3
7	Assignment on fire alarm systems.	CO4
8	Assignment on access Control System.	CO5
9	Assignment on CCTV systems.	CO5
10	Assignment on building system integration.	CO6
11	Case study – Intelligent building of hospital/hotel/airport.	CO1, CO2

Any other experiments/assignments based on syllabus which will help students to understand topic/concept.

- Visit to intelligent building of hotel/hospital/airport is advised to understand the Building Automation subject.

Practical/Oral Examination:

Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum four experiments and four assignments. The distribution of marks for term work shall be as follows:

Laboratory work (Experiments/assignments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL705	Project-I	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	6	-	-	3	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL705	Project-I	-	-	-	-	50	-	50	100

Term Work:

The final year students have already under gone project assignment in their third year in Mini Project I and II. In final year, group of maximum **four** students will be completing a comprehensive project work based on the courses studied. The project work may be internally assigned or externally assigned by the research institutes and industry etc. Each group will be assigned one faculty as a supervisor. This project work in final year may be extension of the Mini Project work done in third year.

The main intention of project work is to enable students to apply the knowledge and skills learned out of courses studied to solve/implement predefined practical problem. The project work may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be

- Learning additional skills
- Development of ability to define, design, analysis and implementation of the problem and lead to its accomplishment with proper planning
- Learn the behavioral science by working in a group
- The project area may be selected in which the student intend to do further education and/or may be either intend to have employment or self employment
- The topic of project should be different and/or may be advancement in the same topic of Mini Project
- The students may use this opportunity to learn different computational techniques as well as some model development. This they can achieve by making proper selection of project work.

The college should keep proper assessment record of the progress of project and at the end of the semester it should be assessed for awarding TW marks. The TW should be examined by approved internal faculty appointed by the head of the institute on the basis of following:

- Scope and objective of the project work.
- Extensive Literature survey.
- Progress of the work (Continuous assessment)
- Report in prescribed University format.

An approved external examiner and internal examiner appointed by the head of the institute together will assess during oral examination. The oral examination is a presentation by the group members on the project along with demonstration of the work done. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained.

AC 11/05/2017
Item No. 4.187A

UNIVERSITY OF MUMBAI

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

FACULTY OF TECHNOLOGY

Instrumentation 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

From Co-coordinator's Desk:

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), course objectives and course outcomes 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, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enable 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, 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. Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. **Choice Based Credit and Grading System** were implemented for First Year of Engineering (Undergraduate) from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year of Engineering (Undergraduate) in the academic year 2017-2018 and so on.

Dr. Suresh K. Ukarande
Coordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

The overall technical education in our country is changing rapidly in manifolds. Now it is very much challenging to maintain the quality of education with its rate of expansion. To meet present requirement a systematic approach is necessary to build the strong technical base with the quality. Accreditation will provide the quality assurance in higher education and to achieve recognition of the institution or program meeting certain specified standards. The main-focus of an accreditation process is to measure the program outcomes, essentially a range of skills and knowledge that a student will have at the time of graduation from the program that is being accredited. Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, as a Chairman, Board of Studies in Instrumentation Engineering of University of Mumbai, happy to state here that, Program Educational Objectives (PEOs) were finalized for undergraduate program in Instrumentation Engineering, more than ten senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs and POs of undergraduate program in Instrumentation Engineering are listed below;

Program Educational Objectives (PEOs)

- *Graduates will have successful career in industry or pursue higher studies to meet future challenges of technological development.*
- *Graduates will develop analytical and logical skills that enable them to analyze and design Instrumentation and Control Systems.*
- *Graduates will achieve professional skills to expose themselves by giving an opportunity as an individual as well as team.*
- *Graduates will undertake research activities in emerging multidisciplinary fields.*

Program Outcomes (POs)

- **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Dr. S. R. Deore,
Chairman,
Board of Studies in Electrical Engineering,
Member - Academic Council
University of Mumbai

Program Structure for

SE Instrumentation Engineering
University of Mumbai
(With Effect from 2017-18)

Scheme for Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ISC301	Applied Mathematics – III	4	-	1	4	--	1	5
ISC302	Analog Electronics	4	-	-	4	-	-	4
ISC303	Transducers – I	4	-	-	4	-	-	4
ISC304	Digital Electronics	4	-	-	4	-	-	4
ISC305	Electrical Networks and Measurement	4	-	1	4	-	1	5
ISL301	Object Oriented Programming and Methodology	-	4#	-	-	2	-	2
ISL302	Analog Electronics Lab practice	-	2	-	-	1	-	1
ISL303	Transducer-I Lab Practice	-	2	-	-	1	-	1
ISL304	Digital Electronics Lab practice	-	2	-	-	1	-	1
Total		**20**	**10**	**02**	**20**	**05**	**02**	**27**

Out of four hours, 2 hours theory shall be taught to entire class and 2 hours practical in batches

Examination Scheme for Semester III

Course Code	Course Name	Examination Scheme					Total Marks
		Theory		Term Work	Oral	Pract. & Oral	
		End Sem Exam (ESE)	Internal Assessment (IA)				
		Max Marks	Max Marks	Max Marks	Max Marks	Max Marks	
ISC301	Applied Mathematics-III	80	20	25	-	-	125
ISC302	Analog Electronics	80	20	-	-	-	100
ISC303	Transducer –I	80	20	-	-	-	100
ISC304	Digital Electronics	80	20	-	-	-	100
ISC305	Electrical Networks and Measurement	80	20	25	-	-	125
ISL301	Object Oriented Programming and Methodology	-	-	50	-	25	75
ISL302	Analog Electronics Lab Practice	-	-	25	-	25	50
ISL303	Transducer-I Lab Practice	-	-	25	-	25	50
ISL304	Digital Electronics Lab Practice	-	-	25	-	-	25
Total		400	100	175	-	75	750

Note: As per above Examination Scheme, the Minimum marks are as follows –

Max. Marks	Min. marks
80	32
50	20
25	10
20	8

Program Structure for

SE Instrumentation Engineering
University of Mumbai
(With Effect from 2017-18)

Scheme for Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ISC401	Applied Mathematics – IV	4	-	1	4	-	1	5
ISC402	Transducers –II	4	-	-	4	-	-	4
ISC403	Feedback Control system	4	-	-	4	-	-	4
ISC404	Analytical Instrumentation	3	-	-	3	-	-	3
ISC405	Signal Conditioning Circuit Design	4	-	-	4	-	-	4
ISL401	Application Software Practice	-	4#	-	-	2	-	2
ISL402	Transducer-II Lab Practice	-	2	-	-	1	-	1
ISL403	Feedback Control systems Lab Practice	-	2	-	-	1	-	1
ISL404	Analytical Instrumentation Lab Practice	-	2	-	-	1	-	1
ISL405	Signal Conditioning Circuit Design Lab Practice	-	2	-	-	1	-	1
Total		**19**	**12**	**01**	**19**	**06**	**01**	**26**

Out of four hours, 2 hours theory shall be taught to entire class and 2 hours practical in batches

Examination Scheme for Semester IV

Course Code	Course Name	Examination Scheme					Total Marks
		Theory		Term Work	Oral	Pract./ Oral	
		End sem Exam (ESE)	Internal Assessment (IA)				
		Max Marks	Max Marks	Max Marks	Max Marks	Max Marks	
ISC401	Applied Mathematics – IV	80	20	25	-	-	125
ISC402	Transducers –II	80	20	-	-	-	100
ISC403	Feedback Control System	80	20	-	-	-	100
ISC404	Analytical Instrumentation	80	20	-	-	-	100
ISC405	Signal Conditioning Circuit Design	80	20	-	-	-	100
ISL401	Application Software Practice	-	-	50	-	25	75
ISL402	Transducer-II Lab Practice	-	-	25	-	25	50
ISL403	Feedback Control Systems Lab Practice	-	-	25	25	-	50
ISL404	Analytical Instrumentation Lab Practice	-	-	25	25		50
ISL405	Signal Conditioning Circuit Design Lab Practice	-	-	25	-	25	50
Total		**400**	**100**	**175**	**50**	**75**	**800**

Note: As per above Examination Scheme, the Minimum marks are as follows –

Max. Marks	Min. marks
80	32
50	20
25	10
20	8

Course Code	Course Name	Teaching Scheme (Contact HOURS)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut	Total
ISC301	Applied Mathematics - III	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISC301	Applied Mathematics - III	20	20	20	80	25	-	-	125

Subject Code	Subject Name	credits
ISC301	Applied Mathematics - III	5
Course objectives	1. To build the strong foundation in Mathematics of students needed for the field of Instrumentation Engineering. 2. To provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems. 3. To prepare student to apply reasoning informed by the contextual knowledge to engineering practice. 4. To provide opportunity for students to work as part of teams on multi-disciplinary projects	
Course Outcomes	The students will be able to – 1. Demonstrate basic knowledge of Laplace Transform. 2. Obtain the time response of systems using inverse Laplace transform. 3. Find the Fourier series, Complex form of Fourier series, Fourier Integral and Fourier transform of the functions. 4. Study the differential vector algebra and its properties. 5. Study vector line integral and theorems in plane and surface. 6. Check for analytical functions and find the analytical function and study the mapping.	

Details of Syllabus:

Prerequisite: Knowledge of Matrix algebra, Differentiation, Integration, Probability, and Series expansion.

Module	Contents	Hrs.	CO mapping
1	**Laplace Transform** **Laplace Transform (LT) of Standard Functions:** Definition of Laplace transform, Condition of Existence of Laplace transform, Laplace transform of  (No Proof of formulas), Heaviside unit step function, Dirac-delta function (No Proof of formula), Laplace transform of Periodic function (Proof of formula) **Properties of Laplace Transform:** Linearity, first shifting theorem, second shifting theorem multiplication by t^n, Division by *t*, Laplace Transform of derivatives and integrals, change of scale, convolution theorem, Evaluation of integrals using Laplace transform. (No proof of any property)	8	CO1
2	**Inverse Laplace Transform:** Partial fraction method, Method of convolution, Laplace inverse by derivative **Applications of Laplace Transform:** Solution of ordinary differential equations, Solving RLC circuit differential equation using Laplace transform of first order and second order only (not framing of differential equation)	5	CO2
3	**Fourier Series** **Introduction:** orthogonal and orthonormal set of functions, Definition, Dirichlet's conditions, Euler's formulae **Fourier Series of Functions:** Exponential, trigonometric functions of any period =2L, even and odd functions, half range sine and cosine series Complex form of Fourier series, Fourier integral representation, Fourier Transform and Inverse Fourier transform of constant and Exponential function, Fourier sine and cosine transform of Exponential, sine and cosine function	12	CO3
4	**Vector Algebra** **Scalar and Vector Product**: Scalar and vector product of three and four vectors and their properties (Only introduction, No question to be asked) **Vector Differentiation:** Gradient of scalar point function, divergence and curl of vector point function **Properties:** Solenoidal and irrotational vector fields, conservative vector field	7	CO4
5	**Vector Integral:** Line integral Green's theorem in a plane (Verification question can be asked), Gauss' divergence theorem and Stokes' theorem (No question on Verification to be asked)	6	CO5

6	**Complex Variable** **Analytic Function:** Necessary and sufficient conditions (No Proof), Cauchy Reiman equation Cartesian form (No Proof) Cauchy Reiman Equation in polar form (with Proof), Milne Thomson Method and its application, Harmonic function, orthogonal trajectories **Mapping:** Conformal mapping, bilinear transformations, cross ratio, fixed points, bilinear transformation of straight lines and circles	10	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Term Work:

Term work shall consist of minimum three simulations and four tutorials from the above list.

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

Laboratory work (Tutorials)	: 10 Marks
Laboratory work (programs / journal)	: 10 Marks
Attendance	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Text books:

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

Reference Books:

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

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISC302	**Analog Electronics**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISC302	**Analog Electronics**	20	20	20	80	-	-	-	100

Subject Code	**Subject Name**	**Credits**
ISC302	**Analog Electronics**	**4**
Course Objectives	1. To familiarize the student with basic electronic devices and circuits. 2. To provide understanding of operation of diodes, bipolar and MOS transistors, DC biasing circuits, Transistors as switching device, Power circuits and systems. 3. To introduce the students the basic properties of OpAmp, analysis and design of electronic circuits using OpAmp	
Course Outcomes	Students will be able to **1.** Explain working of Diode and Zener diode and its applications **2.** Analyze, simulate, and design amplifiers using BJT biasing techniques, frequency response. **3.** Analyze circuits using MOSFET. 4. Explain power amplifiers and power supply. 5. Explain op-amp parameters 6. Design various circuits using operational amplifiers.	

Details of Syllabus:

Prerequisite: Knowledge of semiconductor theory.

Module	**Contents**	**Hrs.**	**CO mapping**
1	**P-N Junctions diode** PN Junction diode small signal model, p-n junction under forward bias and reverse bias conditions, Rectifier Circuits, Clipping and Clamping circuits, Zener diode and its applications.	**4**	**CO1**
2	**Bipolar Junction Transistors (BJTs)** Physical structure and operation modes, Active region operation of transistor, D.C. analysis of transistor circuits **Biasing the BJT**: Different type of biasing circuit and their analysis. Bias stability, Thermistor compensation, thermal runaway. Basic BJT amplifier configuration, Transistor as a switch. High frequency model of BJT amplifier. Effect of positive and negative feedback, advantages of negative feedback, Feedback Connection Type.	**11**	**CO2**
3	**Field Effect Transistor (FET)** Junction FET, its working and VI characteristic. Enhancement-type MOSFET: structure and physical operation,	**11**	**CO3**

	current voltage characteristics. Depletion-type MOSFET.JFET and MOSFET as an amplifier. Biasing in JFET and MOSFET amplifiers. Basic JFET and MOSFET amplifier configuration: common source,common gate and common drain types. High frequency model of FET, Low and High frequency response of common source amplifier.		
4	**Power Amplifiers** Class A large signal amplifiers, Harmonic distortion, Transformer coupled audio power amplifier, Class B amplifier, Class AB operation, Power BJTs, Regulated power supplies, Series voltage regulator.	**6**	**CO4**
5	**Operation Amplifier (Op-amps)** Ideal Op-amp. Op-amp characteristics, Op-amp feedback analysis.	**4**	**CO5**
6	**Applications of Op-amp.** Practical op-amp circuits: inverting amplifier, non -inverting amplifier, weighted Summation circuit, summation, subtractor, integrator, differentiator. Large signal operation of op-amps. Instrumentation amplifier. Active filters, Op-amp as V to I and I to V converter, logarithmic amplifiers, waveform generators, Schmitt triggers, comparators. Oscillators: Introduction, Condition for Oscillation, RC phase shift, Weinbridge, Hartley, Colpitts and Crystal controlled oscillator.	**12**	**CO6**

Internal Assessment:
Internal Assessment consists of two tests out of which, one should be compulsory class test (on Minimum 02 Modules) and the other is either a class test or assignment on live problems or Course project.

Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:
1. J. Millman and C. C. Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata McGraw-Hill Publishing Company, 1988.
2. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw-Hill.

Reference Books:
1. Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, Eighth edition, PHI publishers, 2004.
2. J. Millman and Taub, Pulse and Digital Circuits, Tata McGraw Hill.
3. Ramakant A. Gaikwad, Op-amp and Integrated circuits, Fourth edition, PHI Publication, 2002.
4. Sergio Franco, Design with Op-amp and Analog Integrated circuits, Tata McGraw Hill Edition, New Delhi.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISC303	**Transducers –I**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISC303	**Transducers-I**	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC303	**Transducers-I**	**4**
Course objectives	1. To explain the measurement systems, errors of measurement. 2. To provide an understanding of the operation of sensors and transducers. 3. To familiarize the student with the Identification, classification, construction, working principle and application of various transducers used for Displacement, level, temperature measurement.	
Course Outcomes	The students will be able to **1.** Explain the measurement systems, errors of measurement **2.** Explain the working principles of sensors and transducers. **3.** Discuss the working principle of displacement transducers and their applications. **4.** Discuss the working principle of transducers used for Temperature measurement, comparative study of various transducers. **5.** Explain the working principle of transducers used for level measurement, comparative study of various transducers and their applications. **6.** Identify various transducers in the industry and understand working of miscellaneous sensors.	

Details of Syllabus:

Prerequisite: Knowledge of basic measurement.

Module	Contents	Hrs.	CO Mapping
1	**Instrumentation System** Units and standards of measurement, Introduction, block diagram, functional elements of measurement system, static and dynamic characteristics of transducer, Measurement and calibration systems- Requirement. **Error**: definition, classification, statistical analysis of errors, Error correction methods.	4	**CO1**
2	**Sensor and Transducer:** Definition, working principle, classification (active, passive, primary, secondary, mechanical, electrical, analog, digital), selection criteria, sources of error for	4	**CO2**

	parameter under measurement, transducer specifications, test condition and operating conditions.		
3	**Displacement** **Resistance potentiometer:** (linear and logarithmic), piezo-resistive effect, ultrasonic transducer. LVDT, RVDT (transfer function, linearity, sensitivity, source, frequency dependence, phase null, and signal conditioning). Selection and properties of materials for LVDT, and general electromagnetic sensors. **Capacitance type transducers:** with applications, materials for capacitive, ultrasonic and elastic transducers**.** **Digital transducer:** translational and rotary encoders (absolute position and incremental position encoders), Optical and magnetic pickups. **Pneumatic transducer:** flapper- nozzle transducer**.** Comparative study for Displacement Transducers**.**	10	**CO3**
4	**Temperature transducers:** Modes of heat transfer, laws of conduction, convection and radiation, Temperature scales, classification of Temperature Sensors, Overview of Temperature Sensor Material. **Thermometers:** Classification of Thermometers, Construction and working of glass thermometers, liquid expansion thermometer, gas thermometer (filled system thermometer), bimetallic thermometer, solid state temperature sensor, Specifications of Thermometers. **Resistance temperature detector (RTD):** Principle, types, Configurations, construction and working of RTD, Material for RTD, Signal Measurement techniques for RTD, Comparative Response curves for RTD, 2 wire,3wire and 4 wire RTD Element, Lead wire Compensation in RTD, self-heating effect, Specifications, advantages, disadvantages and applications of RTD. **Thermistors**: Principle, types (NTC and PTC), characteristics, Construction and working of Thermistor, Materials, specifications of Thermistor, applications. **Thermocouples:** Principle, thermoelectric effect, Seebeck effect, Peltier effect, laws of thermocouple, types of thermocouple with characteristic curve, thermocouple table, Sensitivity, constructional Features of Thermocouples., Thermo couple specifications, electrical noise and noise reduction techniques, cold junction Compensation method, thermopile, thermocouple emf measurement method, Thermo well Material of construction and its specifications. **Pyrometers:** Principle, Construction and working of Radiation and optical pyrometers and its Applications. Comparative study for Temperature Transducers	12	**CO4**
5	**Level Transducers** Need for Level Measurement, Classification of Level Measurement Techniques. Construction and working of Dipstick, displacer, float system, bubbler, capacitive devices for level measurement, ultrasonic level gauge, DP cell, load cell, vibrating type, microwave, radar, radioactive type level gauges, LASER type transducers, fiber optic level sensors, solid level detectors, Intelligent level measuring instruments. Comparative study for Level Transducers	9	**CO5**

6	**Miscellaneous Transducers** Transducers for Position, speed, acceleration, vibration, sound, humidity, and moisture measurement, Hall effect Transducer, Optical sensors (LDR, Photo-diode, photo-transistor) leak detector, flame detector, smoke detector and Proximity sensors.	9	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be a compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. B.C Nakra, K.K. Chaudhary, Instrumentation, Measurement and Analysis, Tata McGraw-Hill Education, 01-Oct-2003 - Electronic instruments - 632 page
2. A. K. Sawhney, Puneet Sawhney,A course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Co. Rai, 1996 -
3. Rangan, Mani,Sharma.Instrumentation systems and Devices,2nd Ed.,Tata McGraw Hill.

Reference Books:

1. Doeblin E.D., Measurement system, Tata McGraw Hill., 4th ed, 2003.
2. Bela G. Liptak, Instrument Engineers' Handbook, Fourth Edition, Volume One: Process Measurement and Analysis, June 27, 2003.
3. Neubert Hermann K. P., Instrument Transducer, 2nd ed., Oxford University Press, New Delhi, 2003.
4. Johnson Curtis D., Process Control Instrumentation Technology, 8th Ed., 2005
5. S.P. Sukhatme, Heat Transfer, 3rd edition, University Press.
6. B.E. Jones, Instrument Technology.
7. Chortle Keith R., Fundamentals of Test, Measurement Instrument Instrumentation, ISA Publication.
8. Alan S Morris, Measurement and Instrumentation Principles; 3rd Edition
9. D. V. S. Murty, 'Transducers and Instrumentation', PHI, New Delhi, 2003

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISC304	**Digital Electronics**	Theory	Pract	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg.					
ISC304	**Digital Electronics**	20	20	20	80	-	-	-	100

Subject Code	**Subject Name**	**Credits**
ISC304	**Digital Electronics**	**4**
Course objectives	1. To provide an understanding of the principles of digital electronics and use of number systems 2. To give knowledge about combinational circuits, 3. To describe working and design methods of sequential circuits. 4. To familiarize with the basics of asynchronous sequential circuits and design techniques. 5. To provide understanding of memory devices and state machines. 6. To make the students understand basic logic families and their applications.	
Course Outcomes	Students will be able to- 1. Represent numerical values in various number systems and perform number conversions between different number systems. 2. Explain operation of logic gates using IEEE/ANSI standard symbols. Analyze and design, digital combinational circuits. 3. Analyze and design, sequential logic circuits. 4. Analyze and design, asynchronous sequential logic circuits. 5. Explain nomenclature and technology in memory devices. 6. Analyze logic families and their application to design the digital system.	

Details of Syllabus:

Prerequisite: Knowledge of number systems and boolean logic

Module	**Topic**	**Hrs.**	**CO Mapping**
1.	**NUMBER SYSTEMS:** Binary, Octal, Decimal, Hexadecimal-Number base conversions, complements, signed Binary numbers. Binary Arithmetic- Binary codes: Weighted, BCD, 8421, Gray code, Excess 3 code, ASCII, Error detecting code, code conversion from one code to another Boolean laws,De-Morgan's Theorem, Principle of Duality, Boolean expression, Boolean function, Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS), Minterm, Maxterm, Karnaugh map Minimization, Don't care conditions.	**08**	**CO1**
2.	**COMBINATIONAL CIRCUITS:** **LOGIC GATES:** AND, OR, NOT, NAND, NOR, Exclusive,	**12**	**CO2**

	OR and Exclusive NOR, Implementations of Logic Functions using gates, NAND, NOR implementations, Multi level gate implementations, Multi output gate implementations. Design of combinational circuits, Adders-Subtractors – Serial adder/ Subtractor - Parallel adder/ Subtractor, look ahead carry generator, BCD adder, Magnitude Comparator, Multiplexer/ Demultiplexer, encoder / decoder, parity checker, code converters. Implementation of combinational logic using MUX, DEMUX.		
3.	**SEQUENTIAL LOGIC CIRCUITS** Flip flops- SR, D and Master slave JK, T, Characteristic table and equation, Edge triggering, Level Triggering, Realization of one flip flop using other flip flops, Asynchronous / Ripple counters, Synchronous counters, Modulo n counter, shift registers, Universal shift register and its applications, Serial to parallel and parallel to serial converter.	**12**	**CO3**
4.	**ASYNCHRONOUS SEQUENTIAL CIRCUITS** Design of fundamental mode and pulse mode circuits – primitive state / flow table, Minimization of primitive state table, state assignment, Excitation table, Excitation map, cycles, Races, Hazards: Static –Dynamic, Hazards elimination.	**04**	**CO4**
5.	**MEMORY AND PROGRAMMABLE LOGIC DEVICES** Classification of memories, RAM organization, Read/Write operation, Memory cycle, Timing waveforms, Memory decoding, memory expansion, Static RAM Cell, Bipolar RAM cell, MOSFET RAM cell, Dynamic RAM cell, ROM organization, PROM / EPROM / EEPROM / EAPROM Programmable Logic Devices –Programmable Logic Array (PLA), Programmable Array Logic (PAL), Introduction to Complex Programmable Logic Device (CPLD), Field Programmable Gate Arrays (FPGA). Introduction to state machine.	**08**	**CO5**
6.	**LOGIC FAMILIES** Basics of digital integrated circuits, basic operational characteristics and parameters. TTL, Schottky clamped TTL, tri-state gate ECL, IIL, MOS devices CMOS comparison of logic families. PMOS, NMOS and E2 CMOS	**04**	**CO6**

Internal Assessment:
Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

TEXT BOOKS

1. M. Morris Mano, Digital Design, 3.ed., Prentice Hall of India Pvt. Ltd., New Delhi, 2003/Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003

2. John .M Yarbrough, Digital Logic Applications and Design, Thomson- Vikas publishing house, New Delhi, 2002.

REFERENCES

1. S. Salivahanan and S. Arivazhagan, Digital Circuits and Design, 2nd ed., Vikas Publishing House Pvt. Ltd, New Delhi, 2004
2. Charles H. Roth. "Fundamentals of Logic Design", Thomson Publication Company, 2003.
3. Donald P. Leach and Albert Paul Malvino, Digital Principles and Applications, 5 ed., Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.
4. R.P.Jain, Modern Digital Electronics, 3 ed., Tata McGraw–Hill publishing company limited, New Delhi, 2003.
5. Thomas L. Floyd, Digital Fundamentals, Pearson Education, Inc, New Delhi, 2003
6. Donald D. Givone, Digital Principles and Design, Tata Mc-Graw-Hill Publishing company limited, New Delhi, 2003.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISC305	**Electrical Networks and Measurement**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISC305	**Electrical Networks and Measurement**	20	20	20	80	25	-	-	125

Subject Code	**Subject Name**	**Credits**
ISC305	**Electrical Networks and Measurement**	**5**
Course objectives	1. To introduce the concept of circuit elements lumped circuits, circuit laws and reduction. 2. To study the concept of coupled circuits. 3. To study the transient response of series and parallel A.C. circuits. 4. To study two port model of circuit and circuit elements. 5. To introduce the concept of network synthesis. 6. To study basic analog instruments as well as digital instruments 7. To study the measurement of R-L-C	
Course Outcomes	Students will be able to - **1.** Analyze AC and DC circuits using different theorems. **2.** Analyze transient and steady-state response of passive electrical networks. **3.** Analyze network using poles and zeros and find their parameters like Z, Y, and ABCD. **4.** Synthesize the networks using canonical forms. **5.** Discuss construction and working principle and applications of analog and digital instruments **6.** Measure electrical parameter like R, L, C using electrical bridges.	

Details of Syllabus:

Prerequisite: Knowledge of DC and AC circuit analysis, Three-phase circuit and transformer.

Module	**Contents**	**Hrs**	**CO Mapping**
1	**Networks Theorems** Analysis of networks with dependent sources: mesh analysis, nodal analysis, super mesh and super node concept, source transformation technique, superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem. Solution of networks with AC sources, Analysis of coupled circuits (self-inductance, mutual inductance, and dot convention)	12	**CO1**
2	**Time and Frequency response of circuits** Voltage/current relations for R, L, C and their equations in time	06	**CO2**

	domain. Initial and final conditions, first and second order differential equations, steady state and transient response. Analysis of transient and steady state responses using Classical technique		
3	**Network Functions: poles and zeros** Network functions for one port and two port networks, driving point and transfer functions, ladder network, general network, poles and zeros of network functions, restrictions on Pole and zero locations for driving point functions and Transfer functions, time domain behavior from pole-zero plot. **Two-Port parameters** Open circuit, Short circuit, transmission and hybrid parameters, relationship between parameter sets, reciprocity and symmetry conditions, parallel connections, parallel connection of two port networks.	08	**CO3**
4	**Fundamentals of Network Synthesis.** Causality and stability, Hurwitz polynomials, positive real functions, synthesis of one port networks with two kinds of elements. Properties and synthesis of L-C, R-C, R-L driving point impedances, synthesis of R-L-C functions.	08	**CO4**
5	**Analog & Digital Meters** D'Arsonaval galvanometers, PMMC and PMMI instruments. Shunts and multipliers, Construction and working principle of: ammeters, voltmeters, ohmmeters, power factor meter, energy meter, Q meters, analog multimeters. Electronic Voltmeters, Digital Voltmeter and digital multimeter. CRO, Measurement of phase and frequency,DSO	08	**CO5**
6	**Measurement of R, L, C** Measurement of medium, low and high resistance, Megger.AC bridges, measurement of self and mutual inductances. Measurement of capacitance. Derivations and numerical related to all bridges.	06	**CO6**

Sr. No.	**Tutorials**	**CO Mapping**
1	Examples indicating concept of super mesh and super node.	**CO1**
2	Examples of indicating the application of Thevenin's and Norton's theorem for circuits with dependent sources.	**CO1**
3	Examples on evaluating the transient and steady-state conditions for a R-L-C series or parallel connections for different values of resistance.	**CO2**

4	Examples on evaluating the transient and steady-state conditions for a R-L, R-C circuits for DC conditions.	**CO2**
5	Examples for finding different parameters of two port networks	**CO3**
6	Examples on Hurwitz Polynomial. Necessary and sufficient condition for Positive real function.	**CO4**
7	Examples on realization of R-L, R-C, L-C functions.	**CO4**
8	Examples on synthesis of R-L-C function.	**CO4**
9	Testing /measurement of R-L-C using analog/digital multimeter	**CO5**
10	Applications of CRO (Measurements of phase and frequency).	**CO5**
511	Study of DVM.	**CO5**
12	Measurement of medium value resistance using bridge.	**CO6**
13	Measurement of Inductance using bridge.	**CO6**
14	Measurement of Capacitance using A.C. Bridges.	**CO6**

Term Work:
Term work shall consist of minimum three simulations and four tutorials from the above list.
The distribution of marks for term work shall be as follows:

Laboratory work (Tutorials) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment:
Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. Kuo Franklin F., Network analysis and synthesis, 1st ed., Wiley International, 1962.

2. Van Valkenburg M.E., Network analysis, 3rd ed., Eastern Economy Edition, 1983.
3. A. K. Sawhney, Puneet Sawhney,A course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Co. Rai, 1996.

Reference Books:

1. Roy Chaudhary D., Network and systems, Wiley Eastern Limited, 1991.
2. Hayt William, KemmerlyJr.Jack E., Engineering circuit Analysis, 6th ed., Tata McGraw Hill, New Delhi 2002.
3. Edminister Joseph A., NahviMohmood, Electric Circuits, 3rd ed., Tata McGraw Hill New Delhi 1999.
4. Shyammohan Sudhakar, Circuits and Networks Analysis and Synthesis, 13th reprint, Tata McGraw Hill, 2000
5. Bruce Carsion A., Circuits, Brooks/Cole Thomson Learning, 2000.
6. DavArtice M., Linear Circuits Analysis, PWS Publishing Company, 1998.
7. Alexander Charlesk, Mathew N.O., Sadlku, Fundamentals of Electric Circuits, McGraw Hill, 2000.

8. Cooper W.D., Helfrick A.D., Electronic Instrumentation and Measurement Techniques, Prentice Hall of India Limited, New Delhi.

9. Rathore-Narosa T. S., Digital Measurement Techniques.

10.Oliver and Cage, Modern Electronic Measurements and Instrumentation, MGH.

11. Bouwens A. J., Digital Instrumentation, MGH.

12.Technical Manuals of DSO: APLAB, Scientific, HP etc.

13.Technical Manuals for Virtual CRO.

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End Sem Exam	Term work	Pract. and Oral	Oral	Total
ISL301	**Object Oriented Programming and Methodology**	-	-	-	-	50	-	25	75

Subject Code	**Subject Name**	Teaching Scheme			Credits Assigned			
ISL301	**Object Oriented Programming and Methodology**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	4#	-	-	2	-	2

out of four hours two hours theory shall be taught to entire class and two hours practical in batches

Subject Code	**Subject Name**	**Credits**
ISL301	**Object Oriented Programming and Methodology**	**2**
Course Objectives	1. To learn the object-oriented programming concepts 2. To study various java programming constructs like multithreading, exception handling, packages etc. 3. To explain components of GUI based programming	
Course Outcomes	The students will be able to: 1. Apply fundamental programming constructs. 2. Illustrate the concept of packages, classes and objects. 3. Elaborate the concept of strings arrays and vectors. 4. Implement the concept of inheritance and interfaces. 5. Implement the notion of exception handling and multithreading. 6. Develop GUI based application	

Details of Syllabus:

Prerequisite: Structured Programming Approach

Module	**Contents**	**Hrs**	**CO Mapping**
1	**Introduction to Object Oriented Programming** **OO Concepts:** Object, Class, Encapsulation, Abstraction, Inheritance, Polymorphism. **Features of Java, JVM** **Basic Constructs/Notions:** Constants, variables and data types, Operators and Expressions, Revision of Branching and looping	02	CO1

2	**Classes, Object and Packages** Class, Object, Method. Constructor, Static members and methods Passing and returning Objects Method Overloading, Packages in Java, creating user defined packages, access specifiers.	05	CO2
3	**Array, String and Vector** Arrays, Strings, String Buffer, Wrapper classes, Vector	04	CO3
4	**Inheritance and Interface** Types of Inheritance, super keyword, Method Overriding, abstract class and abstract method, final keyword, Implementing interfaces, extending interfaces	03	CO4
5	**Exception Handling and Multithreading** Error vs Exception, try, catch, finally, throw, throws, creating own exception, Thread lifecycle, Thread class methods, creatingthreads, Synchronization	04	CO5
6	**GUI programming in JAVA** **Applet:** Applet life cycle, Creating applets, Graphics class methods, Font and Color class, parameter passing. **Event Handling:** Event classes and event listener **Introduction to AWT:** Working with windows, Using AWT controls- push Buttons, Label, Text Fields, Text Area, Check Box and Radio Buttons.	06	CO6

Text books:

1. Herbert Schildt, 'JAVA: The Complete Reference', Ninth Edition, Oracle Press.

2. Sachin Malhotra and Saurabh Chaudhary, "Programming in Java", Oxford University Press, 2010

Reference Books:

1. Ivor Horton, 'Beginning JAVA', Wiley India.

2. Dietal and Dietal, 'Java: How to Program', 8/e, PHI

3. 'JAVA Programming', Black Book, Dreamtech Press.

List of Laboratory Experiments/ Assignments:

Sr. No.	**Detailed Contents**	**CO mapping**
1.	Program on various ways to accept data through keyboard and unsigned right shift operator.	**CO1**
2.	Program on branching, looping, labelled break and labelled continue.	**CO1**
3.	Program to create class with members and methods, accept and display details for single object.	**CO2**
4.	Program on constructor and constructor overloading	**CO2**
5.	Program on method overloading	**CO2**

6.	Program on passing object as argument and returning object	**CO2**
7.	Program on creating user defined package	**CO2**
8.	Program on 1D array	**CO3**
9.	Program on 2D array	**CO3**
10.	Program on String	**CO3**
11.	Program on String Buffer	**CO3**
12.	Program on Vector	**CO3**
13.	Program on single and multilevel inheritance (Use super keyword)	**CO4**
14.	Program on abstract class	**CO4**
15.	Program on interface demonstrating concept of multiple inheritance	**CO4**
16.	Program on dynamic method dispatch using base class and interface reference.	**CO4**
17.	Program to demonstrate try, catch, throw, throws and finally.	**CO5**
18.	Program to demonstrate user defined exception	**CO5**
19.	Program on multithreading	**CO5**
20.	Program on concept of synchronization	**CO5**
21.	Program on Applet to demonstrate Graphics, Font and Color class.	**CO6**
22.	Program on passing parameters to applets	**CO6**
23.	Program to create GUI application without event handling using AWT controls	**CO6**
24.	Program to create GUI application with event handling using AWT controls	**CO6**
25.	Mini Project based on content of the syllabus. (Group of 2-3 students)	**CO1-CO6**

Term Work:

Students will submit term work in the form of journal that will include:

1. At least 20 programs and mini project
2. Two assignments covering whole syllabus
3. Class test based on the above syllabus.

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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

Total: 50 Marks (Total Marks) : 20 marks (Experiments),
10 marks (Mini Project),
05 marks (Assignments),
10 marks (Class Test),
05 marks (Attendance)

Practical and oral examination will be based on the suggested experiment list and the entire syllabus.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL302	**Analog Electronics Lab Practice**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	02	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assesment			End sem exam	Term work	Pract. And oral	Oral	Total
		Test1	Test2	Avg.					
ISL302	**Analog Electronics Lab Practice**	-	-	-	-	25	25	-	50

Subject Code	**Subject Name**	**Credits**
ISL302	**Analog Electronics Lab Practice**	**1**
Course objective	1. To familiarize the student with assembling circuits using basic electronic devices . 2. To demonstrate operation of diodes, bipolar and MOS transistors, 3. Demonstrate DC biasing circuits, Transistors as switching device, 4. Power circuits and systems. 5. To design and demonstrate Op-amp based circuits for linear and nonlinear applications	
Course Outcome	Students will be able to 1. Demonstrate operation of basic electronic devices such as Diode 2. Demonstrate operation of basic electronic devices BJT, Assemble circuits using BJT AND find frequency response 3. Demonstrate operation of MOSFET. 4. Demonstrate linear applications of operational amplifier. 5. Demonstrate non-linear applications of operational amplifier 6. Design various circuits like regulator.	

Syllabus: Same as that of Subject ISC302 Analog Electronics.

List of Laboratory Experiments:

Sr. No.	**Detailed Content**	**CO Mapping**
1	Clipping and clamping circuits using diode.	CO1
2	Plot input / output characteristics of BJT- CB, CE, and CC Configuration.	CO2
3	Design and analysis of biasing circuit and observing performance of BJT as a amplifier at various operating points.	CO2

4	BJT amplifier frequency response.	CO2
5	Demonstrate BJT as a switch and analysis of circuit	CO2
6	Study of input and transfer characteristics of FET.	CO3
7	FET amplifier frequency response.	CO3
8	Demonstrate use of Op-Amp as inverting and non-inverting amplifier	CO4
9	Clipper and Clamper circuits using Op-amp.	CO5
10	Precision rectifiers using Op-amp	CO5
11	Wein bridge oscillator using Op-amp	CO5
12	Demonstrate integrator and differentiator using Op-amp.	CO4
13	Adder and Subtractor using Op-amp	CO4
14	RC phase shift oscillator using Op-amp	CO5
15	Design and analysis of series regulator	CO6
16	Design and analysis of shunt regulator	CO6

Any other experiment based on syllabus which will help students to understand topic/concept

Practical/Oral Examination:
Practical/Oral examination will be based on entire syllabus.

Term Work:
Term work shall consist of minimum 10 experiments.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL303	**Transducer - I Lab Practice**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	02	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assesment			End sem exam	Term work	Pract. And oral	Oral	Total
		Test1	Test2	Avg.					
ISL303	**Transducer - I Lab Practice**	-	-	-	-	25	25	-	50

Subject Code	**Subject Name**	**Credits**
ISL303	**Transducer –I Lab Practice**	**1**
Course objective	**1.** To make students understand the Identification, construction, working principle of various transducers used for Displacement measurement, Temperature measurement, Level measurement and miscellaneous measurement. **2.** To experimentally verify the principle and characteristics of various transducers	
Course Outcome	The students will be able to **1.** Explain measurement techniques and measuring instruments. **2.** Classify sensors, Transducers, and their brief Performance specifications. **3.** Examine characteristics of various temperature transducers. **4.** Examine characteristics of various level transducers **5.** To demonstrate the performance characteristics of displacement transducers. **6.** To demonstrate the performance characteristics of miscellaneous transducers.	

Syllabus: Same as that of Subject ISC303 Transducers - I.

List of Laboratory Experiments:

Sr. No.	**Detailed Contents**	**CO mapping**
1.	Basic Measurements and Measuring Instruments.	CO1
2.	Temperature Measurement using various Thermometers.	CO2, CO3
3.	Plot characteristics of RTD	CO2, CO3
4.	Plot characteristics of various Thermocouples.	CO2, CO3
5.	Plot characteristics of Thermistors.	CO2, CO3
6.	Temperature Measurement with and without Thermo-well.	CO2, CO3
7.	Liquid Level Measurement using DP Cell.	CO2, CO4
8.	Liquid Level Measurement using Capacitance Type Level	CO2, CO4

	Sensor.	
9.	Liquid Level Measurement using Tubular Level Gauge and Ultrasonic Level Sensor.	CO2, CO4
10.	Displacement Transducer using LVDT.	CO2, CO5
11.	Plot Response curve for Flapper Nozzle system.	CO2, CO5
12.	Humidity measurement.	CO2, C06
13.	Application of Proximity sensor	CO2, C06
14	Application of optical sensors.	CO2, C06

Any other experiments based on syllabus which will help students to understand topic/concept.

Term Work:

Term work shall consist of minimum eight experiments.

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

Laboratory work (Experiments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance (Practical) : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work.

Practical/Oral Examination:

Practical/Oral examination will be based on entire syllabus.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL304	Digital Electronics Lab Practice	Theory	Pract	Tut.	Theory	Pract.	Tut.	Total
		-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End Sem Exam	Term work	Pract. and Oral	Oral	Total
		Test1	Test2	Avg.					
ISL304	Digital Electronics Lab Practice	-	-	-		25	-	-	25

Subject Code	Subject Name	Credits
ISL304	Digital Electronics Lab Practice	1
Course objectives	1. To provide students basic experimental experiences in the operation of various gates, combinational circuit. 2. To develop skills in the design of multiplexer, demultiplexer, counter, state machine design.	
Course Outcomes	Students will be able to – 1. Implement code converters. 2. Verifying truth tables of all logic gates using NAND and NOR gates. 3. Using gates for constructing half and full adder and subtractor and also realize with multiplexer. 4. Understand the basics of types of flip-flops and design them to implement other flip-flops. 5. Design and implement counters and shift registers. 6. Learn how to convert BCD to seven segment and design finite state machine.	

Syllabus: same as that of subject ISC304 Digital Electronics

List of Laboratory Experiments:

Sr. No.	Detailed Contents	CO mapping
1.	Implementation and conversion of gray/binary code.	CO1
2.	Implementation of all gates using NAND/NOR.	CO2
3.	Implementation of half/ full adder.	CO3
4.	Implementation of half/ full Subtractor	CO3
5.	Realise full adder using 2:1 Multiplexer	CO3
6.	Realise full Subtractor using 2:1 Multiplexer	CO3

7.	Implementation of various flip-flops	**CO4**
8.	Design and implement RS flip flop into other flip flops	**CO4**
9.	Design and implement JK flip flop into other flip flops	**CO4**
10.	Design and implement modulo-n counter	**CO5**
11.	Design and implement ring counter	**CO5**
12	Design and implement universal shift register	**CO5**
13	Implement BCD to seven segments	**CO6**
14.	Design finite state machine for a digital lock	**CO6**

Note:

1. Any other experiments based on syllabus which will help students to understand topic/concept.
2. **2.** It is advised to implement one or two practicals with VHDL.

Term Work:

Term work shall consist of minimum eight experiments.

The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (programs/ journal) : 10
Marks Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
ISC401	**Applied Mathematics - IV**	Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
		04	--	01	04	--	01	05

Subject Code	**Subject Name**	Examination Scheme							
		Theory Marks				Term Work	Pract.	Oral	Total
		Test 1	Test 2	Avg.	End Sem Exam				
ISC401	**Applied Mathematics - IV**	20	20	20	80	25	--	--	125

Subject Code	**Subject Name**	**credits**
ISC401	**Applied Mathematics - IV**	**5**
Course Objectives	1. To develop analytical insight of the student to prepare them for graduate's studies in Instrumentation Engineering 2. To enhance their ability to solve and analyse engineering problem. 3. To provide students with a strong mathematical foundation to acquire the professional competence knowledge and skills.	
Course Outcomes	The students will be able to: 1. Check the given set of vectors is the vector space. 2. Find eigenvalues and eigenvectors of matrix and can diagonalize the matrix. 3. Find the probability distribution, expectation, variance and moments for the given data. 4. Use binomial distribution and Poisson distribution and normal distribution for the data for required probability. 5. Apply Cauchy's integral formula and theorem and residue theorem to solve the integral problem. 6. Find the correlation coefficients and rank correlation coefficients and lines regression between the two data.	

Details of syllabus:

Pre-requisites:

Basics of Complex numbers, Analytic Function, Matrices, Symmetric, Orthogonal and Unitary matrices, Rank, Normal form, Solution of system of linear equations, L. I. & L. D. vectors, Basics of Probability.

Module	Contents	Hrs.	CO mapping
1	**Linear Algebra: Vector Spaces** Vectors in n-dimensional vector space: properties, dot product, cross product, norm and distance properties in n-dimensional vector space. Vector spaces over real field, properties of vector spaces over real field, subspaces. The Cauchy-Schwarz inequality, Orthogonal Subspaces, Gram-Schmidt process.	06	**CO1**
2	**Linear Algebra: Vector Matrix Theory** Characteristic equation, Eigen values and Eigen vectors, properties of Eigen values and Eigen vectors Cayley-Hamilton theorem, examples based on verification of Cayley- Hamilton theorem. Similarity of matrices, Diagonalisation of matrices. Functions of square matrix, derogatory and non-derogatory matrices.	10	**CO2**
3	**Random Variables** Discrete & continuous random variables, expectation, Variance, Probability mass function and Density Function, Probability distribution for random variables Moments, Moment Generating Function. Functions of one random variable and their distribution and density functions	10	**CO3**
4	**Probability distribution** Probability distribution: Binomial distribution, Poisson & normal distribution (For detailed study)	6	**CO4**
5	**Complex integration** Complex Integration: Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula. Taylor's and Laurent's Series Zeros, singularities, poles of f(z), residues, Cauchy's Residue theorem. Applications of Residue theorem to evaluate real Integrals of different types.	12	**CO5**
6	**Correlation & Regression** Karl Pearson's coefficient of correlation, covariance, Spearman's Rank correlation. Lines of Regression.	4	**CO6**

Text Books:

1. Higher Engineering Mathematics by Dr. B. S. Grewal 42th edition, Khanna Publication.
2. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.

Reference Books:

1. A Text Book of Applied Mathematics Vol. II by P. N. Wartilar & J. N. Wartikar, Pune,

Vidyarthi Griha Prakashan., Pune.

2. Advanced Engineering Mathematics by C. Ray Wylie & Louis Barrett. TMH International Edition.
3. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
4. Theory and Problems of Statistics by Murry R. Spieget, Schaum's outline series-McGraw Hill Publication.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISC402	Transducer - II	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg.					
ISC402	Transducer - II	20	20	20	80	-	-	-	100

Subject Code	Subject Name	credits
ISC402	Transducer II	4
Course Objectives	1. To make students understand the construction, working principle and application of various transducers used for flow measurement, strain measurement, pressure and vacuum measurement, force, torque and power measurement 2. To study electro-chemical sensors and transducers used for density and viscosity measurement	
Course Outcomes	The course would enable the students to: **1.** Explain working principle of strain gauges. **2.** Explain working principle of pressure transducers **3.** Learn transducers for vacuum measurement. **4.** Identify types of flow and use different transducers for flow measurement. **5.** Explain the terminologies of electrochemical sensors and their applications in industry. **6.** Identify sensors for power, density, humidity, pH measurement.	

Details of Syllabus:

Prerequisite: Knowledge of basic measurement techniques

Module	Contents	Hrs.	CO mapping
1	**Strain Measurement** Introduction, types of strain gauge, gauge factor calculation, materials for strain gauge, resistance strain gauge bridges, temperature compensation and applications of strain gauges	04	**CO1**
2	**Pressure Measurement** Pressure scales, units and relations, classification **Primary pressure sensors** - elastic elements like bourdon tube, diaphragm, bellows, properties and selection of elastic materials, Calibration using dead weight tester. **Electrical/Secondary Pressure Transducers**: Capacitive, piezo-electric and its material, variable reluctance, LVDT, strain gauge. **High Pressure Measurement**: Bulk modulus cell, Bridgeman type, capsule. **Differential pressure measurement**: Force balance, motion balance, DP Cell, semiconductor strain gauges.	12	**CO2**

	Pressure measurement using manometer: U-tube types, well type, inclined type, micro manometer		
3	**Vacuum Measurement** Units and relations, McLeod gauge, Pirani gauge, thermocouple gauge, hot and cold cathode ionization gauge, Knudsen gauge	04	**CO3**
4	**Flow Measurement** **Introduction to fluid flow**: properties of fluid, types of fluid, dimensionless numbers, types of fluid flow, continuity equation, Bernoulli's equation, hydrostatic law, Pascal's law, flow through pipes – major and minor losses, flow measurement through open channel-weirs and notches. Materials used for flow sensors, performance of materials, corrosion resistors, erosion, effect of vapour pressure **Head Type**: orifice, venturi, nozzle, pitot tube, annubar, characteristics of head type flow meters. **Variable Area Type**: Rotameter **Velocity and Inertia based flowmeters**: Turbine, electromagnetic, ultrasonic, positive displacement, anemometers, mass flow meters, solid flow measurements	16	**CO4**
5	**Electro-chemical Sensors** Terminology, equations, units. pH measurement-electrodes, measuring circuits, maintenance, temperature compensation, calibration. Conductivity measurement-probes and measuring circuits	04	**CO5**
6	**Miscellaneous Measurement** Force Measurement: strain gauge, LVDT, piezoelectric. Torque: Torsion bar, strain gauge. Power: Dynamometer, instantaneous power measurement, alternator power measurement. Density Measurement – Displacement and float type densitometers Hydrometers, Radiation and Ultrasonic densitometers Viscosity Measurement – Capillary tube viscometer, Efflux type viscometer, Variable area viscometer Introduction to Advances in sensors technology: Smart sensors, MEMS, Nano sensors, Semiconductor sensors, Optical fiber sensors.	08	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.

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

Text Books:

1. Nakra B.C., Chaudhary K.K., Instrumentation Measurement and Analysis, Tata Mc Graw Hill.
2. Sawhney A.K., Electrical and Electronic Measurement and Instrumentation, Dhanpatrai And Co.
3. Rangan, Mani, Sarma, “Instrumentation Systems and Devices”, 2nd ed., Tata Mc Graw Hill.

Reference Books:

1. Doeblin E.D., “Measurement system”, Tata Mc Graw Hill., 4th ed, 2003
2. Liptak B.G., “Instrument engineer’s handbook – Process measurement and analysis”.
3. Douglas M. Considine, “Process Instruments and controls”, Handbook, Mc Graw Hill.
4. Curtis Johnson, “Process Control Instrumentation Technology”, 8th ed, 2005
5. Andrew Williams, “Applied Instrumentation in process industry”, Vol-I, Gulf publishing company.
6. Bansal R.K., “Fluid Mechanics and Hydraulic Machines”, Laxmi publications.
7. David W. Spitzer, “Industrial Flow Measurement”, ISA Publication.
8. Sawhney A.K., “Mechanical Measurement”, Dhanpatrai And Co.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISC403	**Feedback Control System**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg.					
ISC403	**Feedback Control System**	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC403	**Feedback Control System**	4
Course Objectives	1. The students should be able to learn the type of System, dynamics of physical systems, classification of control system, analysis and design objective. 2. The students should learn how to represent system by transfer function and block diagram reduction method and Mason's gain formula. 3. The students should able to learn time response analysis and demonstrate their knowledge to frequency response. 4. Students can be able to learn stability analysis of system using Root locus, bode plot, polar plot, and Nyquist plot.	
Course Outcomes	Students will be able to - 1. Identify open and closed loop control system 2. Formulate mathematical model for physical systems. 3. Simplify representation of complex systems using reduction techniques. 4. Use standard test signals to identify performance characteristics of first and second-order systems. 5. Apply root locus technique for stability analysis. 6. Analyze performance characteristics of system using Frequency response methods.	

Details of Syllabus:

Prerequisite: Knowledge of Laplace and Inverse Laplace Transform.

Module	Contents	Hrs	CO mapping
1	**Introduction** Definition of control system and related terms, open loop and closed loop system, examples. Development of automatic control systems, classification of control system, examples	4	**CO1**
2	**Mathematical Models of Physical Systems** Definition of physical systems, principle of superposition and homogeneity, linear/non-linear, time variant/time invariant systems. Types of dynamic model, linear elements of electrical and mechanical systems, differential equations of physical systems-mechanical systems, electrical systems – RLC series, parallel circuits, Analogous systems.	8	**CO2**

3	**Transfer Function and Feedback Characteristics** Definition of transfer function, sinusoidal transfer function, transfer functions of physical systems, block diagram algebra, reduction rules, signal flow graphs-definition, construction, properties, and Mason's gain formula, sensitivity of closed loop and open loop systems, effect of feedback, effect of disturbances signals, regenerative feedback with examples	10	**CO3**
4	**Time Response Analysis** Standard test signals, pulse and impulse function, step function, ramp function, parabolic function, sinusoidal function, dynamic response, time response of first order system, time response of second order system, specifications, steady –state error, system types and error constants, design specifications of second order system-desired closed loop pole location and the dominant closed loop pole concept. Time response analysis of electrical RLC circuits – first and second order differential equations, steady-state, and transient response by using Laplace transform.	10	**CO4**
5	**Stability Analysis and Root Locus Method** Concept of stability, definitions, bounded input-bounded output stability, relative stability, necessary and sufficient conditions for stability, Routh's stability criterion, relative stability analysis, root locus technique, applications, concept, construction of root loci, root loci of different systems, electrical RLC circuits, etc.	08	**CO5**
6	**Frequency Response and Stability Analysis** Correlation between time and frequency response, polar plots, Bode plots, Nyquist stability criterion, frequency response specifications, stability analysis using-bode plots, polar plots, definition and significance of gain margin and phase margin, sensitivity analysis in frequency domain, Frequency response and analysis of electrical RLC circuits.	08	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4) Remaining questions will be mixed in nature.
5) In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books.

1. Nagrath I. G., Gopal M., *Control System Engineering*, New Age International (P) Ltd. Publishers, 2000
2. Kuo Benjamin C., "Automatic Control Systems",6th Edition, Prentice Hall of India, New Delhi, 1993.

Reference Books

1. Gopal M. "Control Systems Principles and Design", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1998.
2. Nise Norman S., "Control Systems Engineering", 3rd.Edition, John Wiley and Sons, Inc.-2000.
3. Lewis Paul H., Chang Yang, "Basic Control Systems Engineering", Prentice HallInternational, Inc. 1997.
4. Raymond T. Stefani, Bahram Shahian, late Clement J. Savant and, late Gene H. Hostetter, "Design of Feedback Control Systems", 4th Edition., Oxford, University Press, New Delhi, 2001.
5. Dhanesh N. Manik,"Control System", Cengage Learning India, 1stEdition, 2012.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract.	Tut.	**Total**
ISC404	**Analytical Instrumentation**	3	-	-	3	-	-	**3**

Subject Code	Subject Name	Examination Scheme							
		Theory				Term Work	Pract. and Oral	Oral	**Total**
		Internal Assessment (out of 20)			End sem Exam				
		Test 1	Test 2	Avg					
ISC404	**Analytical Instrumentation**	20	20	20	80	-	-	-	**100**

Subject Code	**Subject Name**	**Credits**
ISC404	**Analytical Instrumentation**	**3**
Course Objectives	1. Introduce the basic concept of qualitative and quantitative analysis of a given sample. 2.Study various spectroscopic techniques and its instrumentation. 3.Study the concept of separation science and its applications. 4.Study the concept of radiochemical analysis along with industrial analyzers.	
Course Outcomes	The students will be able to: **1)** Define and explain various fundamentals of spectroscopy, qualitative and quantitative analysis. **2)** Discuss the terms, principle, instrumentation, operation and applications of Molecular spectroscopic techniques. **3)** Differentiate between principle, instrumentation and operation of Atomic absorption and emission Spectroscopy. **4)** Explain the various Separation techniques and its instrumentation. **5)** Describe the principle and working of various Radiation detectors. **6)** Discuss the principle and working of various Gas analyzers.	

Details of Syllabus:

Prerequisite: Knowledge of sensors and analog electronic circuits.

Module	**Contents**	**Hrs**	**CO Mapping**

1	**Introduction:** Introduction to analytical Instrumentation. Compare classical analytical techniques with instrumental techniques. **Fundamentals of Spectroscopy:** Nature of Electromagnetic Radiation, Electromagnetic spectrum, Beer Lambert's Law statement and derivation. Deviations from Beer's law. Numerical on EMR and laws of photometry. Interaction of radiation with matter. Instrumentation of spectroscopic analytical system – Radiation sources, Wavelength selectors, Detectors, signal processors and readout modules.	06	CO1
2	**Molecular Spectroscopy:** Molecular Energy levels, correlation of energy levels with transitions. **Electronic transitions and Vibrational transitions –** Introduction to UV-VIS molecular spectroscopy – basics of single beam, double beam spectrophotometer and filter photometer, its instrumentation and applications. Basic principle of Fluorescence, Phosphorescence and Raman Spectroscopy, components and instrumentation of Fluorimeters, Phosphorimeters and Raman spectrometers. **Nuclear/Rotational transitions** – Nuclear Magnetic Resonance (NMR) spectroscopy, basic principle and numerical problems based on NMR principle, instrumentation and constructional details of NMR Spectrometer. Electron Spin Resonance (ESR) Spectroscopy – Basic principle and construction of ESR spectrometer.	10	CO2
3	**Atomic Spectroscopy:** Atomic Energy levels, Atomic absorption spectrometers- components, working and absorption spectra. Atomic Emission spectrometers – components, working and emission spectra, comparison between AAS and AES.	03	CO3
4	**Separation Science:** **Chromatography:** Fundamentals of chromatographic Separations, Classification, Gas chromatographic system with components, factors affecting separation, applications. Analysis of Gas Chromatogram. HPLC – Its principle and instrumentation. **Mass Spectrometers:** Basic principle, components and types of mass spectrometers, sample handling techniques for liquids and solids, resolution and numerical problems based on resolution. Interfacing Gas Chromatography and Mass spectrometry (GCMS).	09	CO4
5	**Radio Chemical Instrumentation:** Basics of Radioactivity, properties of radiations (α, β, γ). Half-life period and numerical problems based on half-life period. Radiation detectors – Ionization chamber, Proportional counter, Geiger Muller counter, Scintillation detector, Semiconductor detectors, Pulse height analyzers.	05	CO5

6	**Industrial Gas Analyzers:** Oxygen, Carbon dioxide(CO2), Carbon monoxide(CO) and NO_2 analyzers, Gas density analyzer.	03	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Theory 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 will be of 4 to 5 marks.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. Willard, Merritt, Dean, Settle, *Instrumental Methods of Analysis*, CBS Publishers & Distributors, New Delhi, 7th Edition.
2. Khandpur R. S., *Handbook of Analytical Instruments*, Tata McGraw–Hill Publications, 3rd Edition.

Reference Books:

1. Skoog, Holler, Niemen, *Thomson Principles of Instrumental Analysis*, Books-Cole Publications, 5th Edition.
2. Ewing Galen W., *Instrumental Methods of Chemical Analysis*, McGraw-Hill Book Company, 5th Edition.
3. Braun Robert D., *Introduction to Instrumental Analysis*, McGraw-Hill Book Company.
4. Sherman R.E., *Analytical Instrumentation*, ISA Publication.
5. B.R.Bairi, Balvindersingh, N.C.Rathod, P.V.Narurkar *Handbook nuclear medical Instruments*, McGraw-Hill Book Company.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISC405	**Signal Conditioning Circuit Design**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISC405	**Signal Conditioning Circuit Design**	20	20	20	80	-	-	-	100

Subject Code	**Subject Name**	**Credits**
ISC405	**Signal Conditioning Circuit Design**	4
Course objectives	1. To give the knowledge about the various components analog signal conditioning. 2. To impart knowledge of design considerations of analog signal conditioning of components. 3. To give the students knowledge about various components digital signal conditioning. 4. To make the students capable to apply knowledge to design various transducer signal conditioning circuits 5. To give the students knowledge about the adjustable power supply design	
Course Outcomes	The students will be able to: 1. Explain principle of analog signal conditioning circuits 2. Design analog signal conditioners 3. Design digital signal conditioners 4. Apply knowledge of signal conditioning circuits to design temperature and pressure transducers signal conditioning 5. Apply knowledge of signal conditioning circuits to design optical and miscellaneous transducers signal conditioning 6. Apply knowledge to design different power supplies.	

Details of Syllabus:

Prerequisite: Knowledge of various sensors and basic electronics.

Module	**Contents**	**Hrs**	**CO mapping**
1	**Principles of Analog Signal Conditioning:** Standard analog signals, Signal Level and bias changes, Linearization, signal conversion, filtering and impedance matching, concept of loading. Passive circuits – Divider Circuits, Bridge circuits (Current, Voltage, Balanced and Unbalanced), RC filters	06	**CO1**
2	**Analog signal conditioners and their design** Practical applications of Op amp based circuits with design:	12	**CO2**

	Differentiators, Integrator, Instrumentation amplifier using 3 op amps Half wave, full wave milivolt rectification, absolute value circuit, Log and antilog amplifier with temperature compensation, active filters, threshold detector, zero crossing detector, window detector, Phase locked loops (PLL), Voltage to Current converter and Current to Voltage Converter, 555 Timer: modes of operation with applications. Guidelines for analog signal conditioning design and design based problems		
3	**Components of Digital Signal Conditioning**: Block diagram of Digital signal conditioning, Characteristics of digital data: digitized value, sampled data system and linearization, sample and hold circuit, peak detector, ADC (Successive Approximation, Flash, Ramp, dual slope) and DAC (R/2R, Weighted resistors) their types and specifications, V to F and F to V converters.	10	**CO3**
4	**Thermal and Pressure Transducers Signal Conditioning Design**: Thermal sensor signal conditioning, design considerations and application for RTD, Thermistor, thermocouple and solid state temperature sensor. Pressure Transducer signal conditioning Design: design considerations and applications for various pressure sensors.	8	**CO4**
5	**Optical and Other Transducer Signal Conditioning Design**: Optical Sensor signal conditioning - photo-diode with photo-conducting and photovoltaic modes, photo-transistor and photomultiplier tube. Optical encoder signal conditioning for linear displacement, velocity and angular displacement applications. Other sensor signal conditioning: Potentiometer, LVDT, strain gauges, piezoelectric and capacitive transducers	6	**CO5**
6	**Power Supply Design**: Power supply design using 78xx series, 79xx series and adjustable voltage IC regulators like 723 and LM317. Switched Mode Power Supply (SMPS): Block diagram with advantages and disadvantages over conventional power supply.	6	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. Ramakant Gayakwad " Op-amp and Linear Integrated Circuits" , PHI Pearson Education.
2. C. D. Johnson, "Process Control Instrumentation Technology (VIII Edition)"

Reference Books:

1. Roy Choudhary, "Linear Integrated Circuits", Wiley Eastern, 1991.
2. Coughlin & Driscoll, "Op-amp and Linear ICs" 6 th Edition, PHI 2002.
3. C. D. Johnson, "Microprocessor Based Process Control" , PHI
4. Sergio Franco, "Design with op-amp analog ICs" McGraw Hill, 1988.
5. Robert G. Seippel, "Transducer Interfacing – Signal Conditioning for Process Control", Prentice Hill.
6. D. E. Pippenger and E. J. Tobanen, "Linear and Interface Circuits Applications", McGraw Hill, 1988.
7. Burr-Brown, "General Catalog", Tucson, Ariz:Burr-Brown, 1979.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL401	**Application Software Practice**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	4*	-	-	2	-	2

* Out of 4 hours 2 hours theory shall be taught to entire class followed by 2hours practical in batches

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End Sem Exam	Term work	Pract. and Oral	Oral	Total
		Test1	Test2	Avg.					
ISL401	**Application Software Practice**	-	-	-	-	50	25	-	75

Subject Code	**Subject Name**	**Credits**
ISL401	**Application Software Practice**	**2**
Course objectives	To study graphical programming language for creating simulation and custom applications that interact with real-world data or signals in fields of science and engineering.	
Course Outcomes	Students will be able to 1. Design logical operations, using Graphical programming language 2. Develop customized virtual instruments and represent them in required format with user friendly graphical programming software for LOOPS like FOR LOOP, WHILE LOOP etc. 3. Discuss Global variable, sequence structure etc. 4. Explain Visa programming 5. Discuss concepts of hardware used 6. Use the data acquisition card or simulated software module and make user interface in the field of engineering.	

Details of Syllabus:

Prerequisite: Knowledge of Mathematics and conversion, LOOPs, switch CASE of any other software like C program, simple concept of proportional process.

Module	**Contents**	**Hrs**	**CO mapping**
1	Graphical Programming Software basics: Components of virtual instrument, creating virtual files and sub-files, data types, debugging techniques.	03	**CO1**
2	Structures- FOR, WHILE, Case structure, Timing, formula nodes and math script, loops- shift registers Auto-indexing concept, feedback nodes. Arrays and clusters, Strings, File I/O.	07	**CO2**
3	Sequence structure -Local and global variables, Express virtual files	02	**CO3**
4	VISA programming, Understanding simple concepts of control using PID block, Plotting data -- graphs and charts,	06	**CO4**

5	Introduction to terms: Measurement system, sampling, calibration, measurement hardware- configuration.	02	**CO5**
6	Data Acquisition cards, Graphical Programming Software modules and tool sets, general applications of Graphical Programming Software.	04	**CO6**

List of Laboratory Experiments:

Sr. No.	Detailed Contents	CO mapping
1	To develop a VI to calculate speed, convert degree celcius to Fahrenheit	**CO1**
2	To develop a Sub VI to Perform Half adder and implement Full ADDER using Sub-VI	**CO1**
3	To develop VI using FOR and WHILE loop to add 10 numbers, calculate Factorial of a given number	**CO2**
4	To create VI to find roots of quadratic equation, user defined unit conversions etc using case structure.	**CO2**
5	To create VI student database using String control and Array and cluster functions.	**CO2**
6	To develop a VI for storing all the points of simulated signal using File I/Os	**CO1**
7	To create VI to simulate traffic light control, stirred tank heater etc. using Sequence structure	**CO3**
8	To create VI to simulate bottle filling plant using Sequence structure.	**CO3**
9	Build a VI to plot circle in XY graph, generate and plot random numbers on chart, different colors in an intensity graph etc with graph, chart properties and options.	**CO4**
10	Applications of Graphical Programming Software in digital electronics—binary to decimal conversion etc.	**CO1,CO2**
11	Applications of Graphical Programming Software in control — simulate first and second order system response, effect of damping factor etc.	**CO4**
12	Applications of Graphical Programming Software in process —tank level/temperature control, alarm annunciator, batch process control etc.	**CO5**
13	Measurement of AC/ DC voltage and current using DAQ cards.	**CO6**
14	Any one Mini project based on the above syllabus	**CO1 -CO6**

Note:

Any other experiments based on syllabus which will help students to understand topic/concept can also be included.
For this course use Graphical Programming Software like Lab View or Open Source Software

Term Work:
Term work shall consist of minimum 10 programs from the list of suggested programs and one Mini-project of your choice or from the list given above.

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

Laboratory work (Performing Experiments)	: 20 Marks
Laboratory work (programs/ journal)	: 10 Marks
Mini Project	: 15 Marks
Marks Attendance	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Practical /oral Examination:
Practical/Oral examination will be based on entire syllabus.

Reference Books:

1. Robert Bishop, "Learning with LabVIEW ^{TM} 7 express", Pearson Education, 2005.
2. Jovitha Jerome, "Virtual Instrumentation", PHI, 2010.
3. Gupta S, "Virtual Instrumentation Using LabVIEW", Tata McGraw Hill Publishing Company Limited.
4. LabVIEW users manual.
5. National instruments Product catalog.

Website: www.ni.com

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL402	**Transducer - II Lab Practice**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
						Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End Sem exam				
		Test1	Test2	Avg.					
ISL402	**Transducer - II Lab Practice**	-	-	-	-	25	25	-	50

Subject Code	**Subject Name**	**credits**
ISL402	**Transducer II Lab Practice**	**1**
Course Objectives	1. To make students understand the construction, working principle and application of various transducers used for flow measurement, strain measurement, pressure. 2. To study electro-chemical sensors and transducers used for density and viscosity measurement 3. To experimentally verify the principle and characteristics of various transducers	
Course Outcomes	Students will be able to - 1. Explain working principle of transducers used for strain measurement. 2. Explain working principle of transducers used pressure measurement. 3. Identify constant head type flow sensors such as orifice, venturi, tube, nozzle and pitot tube and study the applications. 4. Identify variable area and electromagnetic flow meters 5. Demonstrate the performance characteristics of various electrochemical sensors 6. Use miscellaneous sensors for density and viscosity measurement.	

Syllabus same as that of subject ISC402 Transducers-II

List of Laboratory Experiments:

Sr. No.	**Detailed Contents**	**CO mapping**
1.	Strain gauge characteristics and weight measurement	**CO1**
2.	Study use of semiconductor strain gauges for pressure measurement	**CO2**
3.	Study measurement of pressure using bellows, diaphragm, bourdon tube, manometer.	**CO2**
4.	Test and calibration of pressure gauges using dead weight tester.	**CO2**
5.	Measurement of flow using orifice/venturi tube/nozzle/pitot tube.	**CO3**
6.	Measurement of flow using rotameter.	**CO4**

7.	Measurement of flow using electromagnetic flow meter.	**CO4**
8.	Study and characterization of pH meter.	**CO5**
9.	Study and characterization of conductivity meter.	**CO5**
10.	Measurement of Density	**CO6**
11.	Viscosity measurement	**CO6**

Any other experiments based on syllabus which will help students to understand topic/concept.

Term Work:

Term work shall consist of minimum eight experiments.

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

Laboratory work (Experiments) : 10 Marks
Laboratory work (programs/ journal) : 10
Marks Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Practical /oral Examination:

Practical/Oral examination will be based on entire syllabus.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL403	**Feedback Control Systems Lab Practice**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End Sem Exam	Term work	Pract. and Oral	Oral	Total
		Test1	Test2	Avg.					
ISL403	**Feedback Control Systems Lab Practice**	-	-	-	-	25	-	25	50

Subject Code	**Subject Name**	**credits**
ISL403	**Feedback Control Systems Lab Practice**	1
Course objectives	1. The students should be able to examine steady-state and frequency response of the Type 0, 1, and 2 systems. 2. The students should be able to examine steady-state and frequency response of first and second order electrical systems. 3. The students should able to examine time response analysis of first and second order systems. 4. Students can be able to inspect stability analysis of system using Root locus, Bode plot, polar plot.	
Course Outcomes	Students will be able to - 1. Plot frequency response of first-order electrical system. 2. Plot time response of second-order electrical system and calculate the steady-state error. 3. Demonstrate their knowledge to obtain the transfer function and transient and steady-state response to test signals such as step, ramp, and parabolic. 4. Understand the effect of damping factor on system response. 5. Inspect the time response specifications of systems by using root-locus. 6. Inspect the frequency response specifications of systems by using bode-plot, Polar plot, Nyquist-plot techniques, and comment on the stability of system	

Syllabus same as that of subject ISC403 Feedback Control systems

List of Laboratory Experiments:

Sr. No.	Detailed Contents	**CO mapping**
1	To plot the effect of time constant on first – order systems response.	**CO1**
2	To plot the frequency response of first-order system	**CO1**
3	To plot the time response of second – order systems.	**CO2**
4	To examine steady state errors for Type 0, 1, 2 systems	**CO3**
5	To study the block diagram reduction technique by using simulation software.	**CO3**
6	To interpret the effect of damping factor on the performance of second order system.	**CO4**

7	To inspect the relative stability of systems by Root-Locus using Simulation Software	**CO5**
8	To inspect the stability of systems by Bode plot using Simulation Software	**CO6**
9	To determine the frequency response specifications from Polar plot of system	**CO6**
10	To inspect the stability of systems by Nyquist plot using Simulation Software	**CO6**

Any other experiments based on syllabus which will help students to understand topic/concept.

Note: Sr. 1 to 4 experiments should be performed using practical kit /bread-board and Sr. 5 to 10 by using simulation software like MATH CAD/MATLAB/SCILAB/OCTAVE or equivalent.

Term Work:

Term work shall consist of Eight experiments.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks
Laboratory work (programs /journal) : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Oral Examination:

Oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract.	Tut.	**Total**
ISL404	**Analytical Instrumentation Lab Practice**	-	2	-	-	1	-	**1**

Subject Code	Subject Name	Examination Scheme							
		Theory				Term Work	Pract. and Oral	Oral	**Total**
		Internal Assessment			End sem Exam				
		Test 1	Test 2	Avg					
ISL404	**Analytical Instrumentation Lab Practice**	-	-	-	-	25	-	25	**50**

Subject Code	**Subject Name**	**Credits**
ISL404	**Analytical Instrumentation Lab Practice**	**1**
Course Objectives	1. To make students perform experiments to understand concept and working of various Analytical Instruments. 2. To develop skills in analyzing the sample using various spectroscopic techniques.	
Course Outcomes	The students will be able to: 1) Illustrate the concept and working of various spectrometers using different samples. 2) Analyze the given sample in qualitative and quantitative manner, using spectral techniques. 3) Use specific techniques employed for monitoring different pollutants in air and water. 4) Demonstrate the working of various radiation detectors. 5) Experiment the working of instruments used for clinical analysis, and pharmaceutical laboratories. 6) Illustrate the concept of separation science.	

Syllabus: Same as that of Subject ISC404 Analytical Instrumentation.

List of Laboratory Experiments / Assignments:

Sr. No.	**Detailed Content**	**CO Mapping**
1.	To calculate the refractive index of a given sample using Refractometer.	CO1
2.	To examine the optical density of a given sample using Photoelectric Colorimeter.	CO2

3.	To identify the optical density of a given sample using Balance cell Colorimeter.	CO2
4.	To determine the absorbance and transmittances of a given sample using Single/double beam UV/VIS spectrometer.	CO2
5.	To examine the optical density of given electrophoresis strip using Densitometer.	CO1
6.	To identify the turbidity of given sample using Nephalo-turbidity meter.	CO3
7.	To determine the pH of a given solution using pH meter.	CO5
8.	To determine the conductivity of a given sample using conductivity meter.	CO5
9.	To determine the Na and K concentration in a given sample using Flame Photometer	CO1
10.	To examine the fluorescence phenomenon using Photo-fluorimeter.	CO1
11.	To demonstrate the radioactive radiations using Geiger Muller counter and Scintillation counter.	CO4
12.	To demonstrate the working of Gas chromatograph.	CO6

Any other experiment based on syllabus which will help students to understand topic/concept.

Note:

1. Minimum of eight experiments and two assignments can be performed during the semester for term work and oral examination.

2. Industry visit is advised to understand the concept of Analytical Instrumentation subject.

Practical/Oral Examination:
Oral examination will be based on entire syllabus.

Term work:
Term work shall consist of minimum 08 experiments from the above given list and 02 assignments on the entire syllabus.

The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Two Assignments and viva on practicals : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL405	**Signal Conditioning Circuit Design Lab Practice**	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End semExam	Term work	Pract. and Oral	Oral	Total
		Test 1	Test2	Avg.					
ISL405	**Signal Conditioning Circuit Design Lab Practice**	-	-	-	-	25	25	-	50

Subject Code	Subject Name	credits
ISL405	**Signal Conditioning Circuit Design Lab Practice**	1
Course objectives	1. To give the knowledge about the various components analog signal conditioning. 2. To impart knowledge of design considerations of analog signal conditioning of components. 3. To give the students knowledge about various components digital signal conditioning. 4. To make the students capable to apply knowledge to design various transducer signal conditioning circuits 5. To give the students knowledge about the adjustable power supply design	
Course Outcomes	The students will be able to 1. Explain working principle of signal conditioning circuits 2. Discuss the design considerations of analog signal conditioners used in transducer signal conditioning. 3. Discuss the design considerations of various digital signal conditioners used in transducer signal conditioning. 4. Apply knowledge of signal conditioning circuits to design temperature and pressure transducers signal conditioning 5. Apply knowledge of signal conditioning circuits to design optical and miscellaneous transducers signal conditioning 6. Apply knowledge to design different power supply.	

Syllabus: same as that of subject ISC405 Signal Conditioning Circuit Design

List of Laboratory Experiments:

Sr. No.	Detailed Content	CO Mapping
1	Demonstrate non-inverting buffer amplifier circuit	CO1

2	Design and demonstrate general signal conditioning circuit to convert sensor output to 0-5 V	**CO2**
3	Design and demonstrate general signal conditioning circuit to convert sensor output to 4-20 mA	**CO2**
4	Design and demonstrate signal conditioning circuit for low level signals in micro-volts' region	**CO2, CO4**
5	Design and demonstrate absolute value circuit for an application	**CO2**
6	Design and demonstrate signal conditioning circuit for weight measuring system using strain gauge	**CO5**
7	Design and demonstrate signal conditioning circuit for capacitive transducer	**CO5**
8	Design and demonstrate second order LPF and HPF for any application	**CO2**
9	Design signal conditioning circuit for RTD	**CO4, CO2**
10	Design signal conditioning circuit for optical sensor.	**CO2, CO5**
11	Design and demonstrate digital to Analog converter circuit	**CO3**
12	Design and demonstrate I to V and V to I converter circuit	**CO2**
13	Design and implement Astable and Monostable Multivibrator using IC 555.	**CO3**
14	Design adjustable voltage regulators using IC723/ LM317	**CO6**

Any other experiments based on syllabus which will help students to understand topic/ concept.

Term Work:

Term work shall consist of minimum eight experiments.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work.

Practical/Oral Examination:
Practical/Oral examination will be based on entire syllabus.

Program Structure for

TE Instrumentation Engineering
University of Mumbai
(With Effect from 2018-19)

Scheme for Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ISC501	Signals and Systems	4	-	-	4	-	-	4
ISC502	Applications of Microcontroller	4	-	-	4	-	-	4
ISC503	Control System Design	4	-	-	4	-	-	4
ISC504	Control System Components	4	-	-	4	-	-	4
ISDLO501X	Department Level Optional Course I	3	-	-	3	-	-	3
ISL501	Business Communication and Ethics	-	4#	-	-	2	-	2
ISL502	Applications of Microcontroller – Lab Practice	-	2	-	-	1	-	1
ISL503	Control System Design Lab Practice	-	2	-	-	1	-	1
ISL504	Control System Components – Lab Practice	-	2	-	-	1	-	1
ISL505	Department Level Optional Course I – Lab Practice	-	2	-	-	1	-	1
ISL506	Mini-project – I	-	2	-	-	1	-	1
Total		**19**	**14**	**-**	**19**	**07**	**-**	**26**

Out of four hours, 2 hours theory shall be taught to entire class and 2 hours practical in batches

Examination Scheme for Semester V

Course Code	Course Name	Examination Scheme					Total Marks
		Theory		Term Work	Oral	Pract. & Oral	
		End Sem Exam (ESE)	Internal Assessment (IA)				
		Max Marks	Max Marks	Max Marks	Max Marks	Max Marks	
ISC501	Signals and Systems	80	20	-	-	-	100
ISC502	Applications of Microcontroller	80	20	-	-	-	100
ISC503	Control System Design	80	20	-	-	-	100
ISC504	Control System Components	80	20	-	-	-	100
ISDLO501X	Department Level Optional Course I	80	20	-	-	-	100
ISL501	Business Communication and Ethics	-	-	50	-	-	50
ISL502	Applications of Microcontroller – Lab Practice	-	-	25	-	25	50
ISL503	Control System Design Lab Practice	-	-	25	25	-	50
ISL504	Control System Components – Lab Practice	-	-	25	-	25	50
ISL505	Department Level Optional Course I – Lab Practice	-	-	25	25	-	50
ISL506	Mini-project – I	-	-	25	25	-	50
Total		400	100	175	75	50	800

Program Structure for

TE Instrumentation Engineering
University of Mumbai
(With Effect from 2018-19)

Scheme for Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ISC601	Process Instrumentation System	4	-	-	4	-	-	4
ISC602	Industrial Data Communication	3	-	-	3	-	-	3
ISC603	Electrical machines and Drives	4	-	-	4	-	-	4
ISC604	Digital Signal Processing	4	-	-	4	-	-	4
ISC605	Advanced Control System	3	-	-	3	-	-	3
ISDL0602X	Department Level Optional Course II	3	-	-	3	-	-	3
ISL601	Process Instrumentation System – Lab Practice	-	2	-	-	1	-	1
ISL602	Industrial Data Communication – Lab Practice	-	2	-	-	1	-	1
ISL603	Electrical machines and Drives – Lab Practice	-	2	-	-	1	-	1
ISL604	Digital Signal Processing – Lab Practice	-	2	-	-	1	-	1
ISL605	Advanced Control System – Lab Practice	-	2	-	-	1	-	1
ISL 606	Mini-project - II	-	2	-	-	1	-	1
Total		**21**	**12**	**-**	**21**	**06**	**-**	**27**

Examination Scheme for Semester VI

Course Code	Course Name	Examination Scheme					Total Marks
		Theory		Term Work	Oral	Pract. & Oral	
		End Sem Exam (ESE)	Internal Assessment (IA)				
		Max Marks	Max Marks	Max Marks	Max Marks	Max Marks	
ISC601	Process Instrumentation System	80	20	-	-		100
ISC602	Industrial Data Communication	80	20	-	-		100
ISC603	Electrical machines and Drives	80	20	-	-		100
ISC604	Digital Signal Processing	80	20	-	-		100
ISC605	Advanced Control System	80	20	-	-		100
ISDL0602X	Department Level Optional Course II	80	20	-	-		100
ISL601	Process Instrumentation System – Lab Practice	-	-	25	25		50
ISL602	Industrial Data Communication – Lab Practice	-	-	25	-	-	25
ISL603	Electrical machines and Drives – Lab Practice	-	-	25	25	-	50
ISL604	Digital Signal Processing – Lab Practice	-	-	25	-	25	50
ISL605	Advanced Control System – Lab Practice	-	-	25	-	25	50
ISL 606	Mini-project - II	-	-	25#	-	-	25
Total		480	120	150	50	50	850

Mini-project based on internal oral and project report.

Program Structure for

BE Instrumentation Engineering
University of Mumbai
(With Effect from 2019-20)

Scheme for Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ISC701	Industrial Process Control	4	-	-	4	-	-	4
ISC702	Biomedical Instrumentation	4	-	-	4	-	-	4
ISC703	Industrial Automation	4	-	-	4	-	-	4
ISDLO703X	Department Level Optional Course III	4	-	-	4	-	-	4
ILO701X	Institute Level Optional Course I	3	-	-	3	-	-	3
ISL701	Industrial Process Control – Lab Practice	-	2	-	-	1	-	1
ISL702	Biomedical Instrumentation – Lab Practice	-	2	-	-	1	-	1
ISL703	Industrial Automation – Lab Practice	-	2	-	-	1	-	1
ISL704	Department Level Optional Course III – Lab Practice	-	2	-	-	1	-	1
ISL705	Project I	-	6	-	-	3	-	3
Total		**19**	**14**	**-**	**19**	**07**	**-**	**26**

Examination Scheme for Semester VII

Course Code	Course Name	Examination Scheme					Total Marks
		Theory		Term Work	Oral	Pract. & Oral	
		End Sem Exam (ESE)	Internal Assessment (IA)				
		Max Marks	Max Marks	Max Marks	Max Marks	Max Marks	
ISC701	Industrial Process Control	80	20	-	-	-	100
ISC702	Biomedical Instrumentation	80	20	-	-	-	100
ISC703	Industrial Automation	80	20	-	-	-	100
ISDLO703X	Department Level Optional Course III	80	20	-	-	-	100
ILO701X	Institute Level Optional Course I	80	20	-	-	-	100
ISL701	Industrial Process Control – Lab Practice	-	-	25	25	-	50
ISL702	Biomedical Instrumentation – Lab Practice	-	-	25	25	-	50
ISL703	Industrial Automation – Lab Practice	-	-	25	25	-	50
ISL704	Department Level Optional Course III – Lab Practice	-	-	25	25	-	50
ISL705	Project I	-	-	50	50	-	100
Total		400	100	150	150	-	800

Program Structure for

BE Instrumentation Engineering
University of Mumbai
(With Effect from 2019-20)

Scheme for Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ISC801	Instrumentation Project Documentation and Execution	4	-	-	4	-	-	4
ISC802	Instrument and System design	4	-	-	4	-	-	4
ISDLO804X	Department Level Optional Course IV	4	-	-	4	-	-	4
ILO802X	Institute Level Optional Course II	3	-	-	3	-	-	3
ISL801	Instrumentation Project Documentation and Execution	-	2	-	-	1	-	1
ISL802	Instrument and System design	-	2	-	-	1	-	1
ISL803	Department Level Optional Course IV – Lab Practice	-	2	-	-	1	-	1
ISL804	Project II	-	12	-	-	6	-	6
Total		**15**	**18**	**-**	**15**	**09**	**-**	**24**

Examination Scheme for Semester VIII

Course Code	Course Name	Examination Scheme					Total Marks
		Theory		Term Work	Oral	Pract. & Oral	
		End Sem Exam(ESE)	Internal Assessment (IA)				
		Max Marks	Max Marks	Max Marks	Max Marks	Max Marks	
ISC801	Instrumentation Project Documentation and Execution	80	20	-	-	-	100
ISC802	Instrument and System design	80	20	-	-	-	100
ISDLO804X	Department Level Optional Course IV	80	20	-	-	-	100
ILO802X	Institute Level Optional Course II	80	20	-	-	-	100
ISL801	Instrumentation Project Documentation and Execution	-	-	25	25	-	50
ISL802	Instrument and System design	-	-	25	25	-	50
ISL803	Department Level Optional Course IV– Lab Practice	-	-	25	25	-	50
ISL804	Project II	-	-	100	50	-	150
Total		320	80	175	125	-	700

Department Level Optional Courses:

Subject Code	Subject Name
ISDLO5011	Advanced Sensors
ISDLO5012	Optimization Techniques
ISDLO5013	Database Management System
ISDLO5014	Fiber Optic Instrumentation

Subject Code	Subject Name
ISDLO6021	Material Science
ISDLO6022	Computer Organization and Architecture
ISDLO6023	Bio-sensors and Signal Processing
ISDLO6024	Nuclear Instrumentation

Subject Code	Subject Name
ISDLO7031	Image Processing
ISDLO7032	Digital Control System
ISDLO7033	Advanced Microcontroller Systems
ISDLO7034	Mechatronics
ISDLO7035	Building Automation

Subject Code	Subject Name
ISDLO8041	Expert System
ISDLO8042	Optimal Control System
ISDLO8043	Internet of Things(IOT)
ISDLO8044	Power Plant Instrumentation
ISDLO8045	Functional Safety

Institute Level Optional Courses

Subject Code	Institute level Optional Course - I
ILO7011	Product Lifecycle Management
ILO7012	Reliability Engineering
ILO7013	Management Information System
ILO7014	Design of Experiments
ILO7015	Operation Research
ILO7016	Cyber Security and Laws
ILO7017	Disaster Management and Mitigation Measures
ILO7018	Energy Audit and Management
ILO7019	Development Engineering

Subject Code	Institute level Optional Course - II
ILO8021	Project Management
ILO8022	Finance Management
ILO8023	Entrepreneurship Development and Management
ILO8024	Human Resource Management
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)
ILO8026	Research Methodology
ILO8027	IPR and Patenting
ILO8028	Digital Business Management
ILO8029	Environmental Management

AC- 5.05.2018
Item No. 4.56

UNIVERSITY OF MUMBAI

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

FACULTY OF TECHNOLOGY

Instrumentation Engineering

Third Year with Effect from **AY 2018-19**

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

From Co-coordinator's Desk:

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), course objectives and course outcomes 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, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enable 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, 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. Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. **Choice Based Credit and Grading System** were implemented for First Year of Engineering (Undergraduate) from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year of Engineering (Undergraduate) in the academic year 2017-2018 and so on.

Dr. Suresh K. Ukarande
Coordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

The overall technical education in our country is changing rapidly in manifolds. Now it is very much challenging to maintain the quality of education with its rate of expansion. To meet present requirement a systematic approach is necessary to build the strong technical base with the quality. Accreditation will provide the quality assurance in higher education and to achieve recognition of the institution or program meeting certain specified standards. The main-focus of an accreditation process is to measure the program outcomes, essentially a range of skills and knowledge that a student will have at the time of graduation from the program that is being accredited. Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, as a Chairman, Board of Studies in Instrumentation Engineering of University of Mumbai, happy to state here that, Program Educational Objectives (PEOs) were finalized for undergraduate program in Instrumentation Engineering, more than ten senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs and POs of undergraduate program in Instrumentation Engineering are listed below;

Program Educational Objectives (PEOs)

- Graduates will have successful career in industry or pursue higher studies to meet future challenges of technological development.
- Graduates will develop analytical and logical skills that enable them to analyze and design Instrumentation and Control Systems.
- Graduates will achieve professional skills to expose themselves by giving an opportunity as an individual as well as team.
- Graduates will undertake research activities in emerging multidisciplinary fields.

Program Outcomes (POs)

- **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Dr. S. R. Deore,
Chairman,
Board of Studies in Electrical Engineering,
Member - Academic Council
University of Mumbai

Program Structure for
TE Instrumentation Engineering
University of Mumbai
(With Effect from 2018-19)

Scheme for Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ISC601	Process Instrumentation System	4	-	-	4	-	-	4
ISC602	Industrial Data Communication	3	-	-	3	-	-	3
ISC603	Electrical machines and Drives	4	-	-	4	-	-	4
ISC604	Digital Signal Processing	4	-	-	4	-	-	4
ISC605	Advanced Control System	3	-	-	3	-	-	3
ISDL0602X	Department Level Optional Course II	3	-	-	3	-	-	3
ISL601	Process Instrumentation System – Lab Practice	-	2	-	-	1	-	1
ISL602	Industrial Data Communication – Lab Practice	-	2	-	-	1	-	1
ISL603	Electrical machines and Drives – Lab Practice	-	2	-	-	1	-	1
ISL604	Digital Signal Processing – Lab Practice	-	2	-	-	1	-	1
ISL605	Advanced Control System – Lab Practice	-	2	-	-	1	-	1
ISL 606	Mini-project - II	-	2	-	-	1	-	1
Total		**21**	**12**	**-**	**21**	**06**	**-**	**27**

Subject code	Subject Name	Teaching scheme (Hrs)			Credit assigned			
ISC 601	Process Instrumentation System	Theory	Pract	Tut	Theory	Pract	Tut	Total
		4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract and Oral	Oral	Total
		Internal Assessment (out of 20)			End sem Exam				
		Test 1	Test 2	Avg.					
ISC 601	Process Instrumentation System	20	20	20	80	-	-	-	100

Subject Code	Subject Name	credits
ISC 601	Process Instrumentation System	4
Course objective	1. To make the students to familiar with different Process Dynamics & process control actions. 2. Students are expected to learn classification & working of Controllers & Tuning Methods. 3. Students are expected to understand various control schemes. 4. To familiarize concept of Multivariable Control & Discrete state process control Requirement.	
Course Outcome	The students will be able to 1. Understand & Learn Process Control Terminologies, Process Dynamics & their mathematical model. 2. Understand different types of control actions & their selection. 3. Learn Features & Classify controllers like electronic, pneumatic and hydraulic & their Tuning Techniques. 4. Learn various process control schemes & their applications and selection. 5. Understand Multivariable Control systems & their Interaction 6. Develop relay logic for various processes & symbols.	

Details of Syllabus:

Prerequisite: Measurement of physical parameters, sensors/transducers and basic control system.

	Process Instrumentation System		
Module	Content	Hrs	CO Mapping
1	**Introduction to Process Control** Process Control Terminology, Development of Typical Process Control loops like Pressure, Temperature, flow & Level. Process characteristics, control system parameters, Dynamic elements in a control loop, Dead time processes and smith predictor compensator. Inverse response behaviour of processes and compensator. Dynamic behaviour of first and second order systems. Interacting and non-interacting systems. Development	08	CO1

	of Mathematical Model for first & second order system with Example.		
2	**Process Control Actions** Types-Discontinuous, continuous (P, I, D) and composite control actions (PI, PD, and PID), Effects of control actions, selection criteria.	**06**	**CO2**
3	**Process Controllers and Tuning** Need for controller, General features, specifications, classification & working of Pneumatic, Hydraulic and Electronic controllers. Need for controller Tuning. Tuning Methods-Process reaction curve method, Ziegler-Nichols method, Cohen coon correction for quarter amplitude, Frequency response method, Relay based tuning. Concept of Auto Tuning. Introduction to Model based Controller.	**08**	**CO3**
4	**Control Schemes** Feedback, Feed forward, cascade, Ratio, split range, selective control, adaptive control, inferential control, and selection Guidelines.	**12**	**CO4**
5	**Multivariable Control** Introduction to SISO & MIMO systems, Block diagram analysis of multivariable systems, Interaction, relative gain analysis, Decoupler design	**06**	**CO5**
6	**Discrete-State process control** Need for Discrete state process control systems, process specification and event sequence description, Relay Logic symbols, Development of Relay ladder Logic diagram and case study examples.	**08**	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems.

Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weight age of each module will be proportional to number of respective Lecture hours as mentioned in the syllabus.

Books Recommended:

Text Books:

1. Curtis D. Johnson, “Process Control Instrumentation Technology”, PHI /Pearson Education 2002.
2. George Stephanopoulos, “Chemical process control”, PHI-1999.

Reference Books:

1. Bela G. Liptak, "Instrument Engineer's Hand Book – Process Control", Chilton Company, 3rd Edition, 1995.

2. M.Chidambaram, "Computer Control of Processes", Narosa, 2002.
3.Deshpande P.B and Ash R.H, "Elements of Process Control Applications", ISA Press, New York, 1995.
4.D. Patranabis, "Principles of Process Control", Second edition, TMH.
5.F.G. Shinsky, "Process Control System", TMH.
6.N.E. Battikha, "Condensed Handbook of Measurement and Control",3rd Edition., ISA Publication.
7.Donald P. Eckman, "Automatic Process Control", Wiley Eastern Ltd.
8.Franklyn W. Kirk, Nicholas R. Rimboi, "Instrumentation", First edition,1996, D.

Suggested E Books:

1. Instrumentation & Controls- Process control Fundamental by PA Control.Com
2. Dr. M.J.Willis, "Conventional process control schemes"
3. Tony R Kuphaldt,"Lessons in Industrial Instrumentation"
4. W.C.Dunn, "Fundamentals of Industrial Instrumentation"

Subject code	Subject Name	Teaching			Credits Assigned			
		Theory	Prac	Tut.	Th	Pract.	Tut.	Total
ISC602	Industrial Data Communication	3	-	-	3	-	-	3

Subject Code	Subject Name	Examination Scheme							
		Theory(out of100)							
		Internal Assessment(out			End sem Exam	Term Work	Pract and oral	Oral	Total
		Test1	Test 2	Avg.					
ISC 602	Industrial Data Communication	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC602	**Industrial Data Communication**	3
Course Objectives	1. To expose students to the basics of communication 2. To create awareness about the the OSI refrence model. 3. To acquaint the students with the different types of networks at various levels such as sensor level,device network and control network. 4. To provide sufficient knowledge about the HART. 5. To impart the fundamentals of foundation field bus.	
Course Outcomes	The students will be able to 1. Explain the importance of modulation in communication. 2. Examine the importance of OSI,TCP/IP model,various networking components. 3. Compare the different types of networks at various levels of field communication. 4. Use HART for communication 5. Establish Foundation fieldbus communication. 6. Investigate the various wireless devices.	

Details of syllabus:

Prerequisite: Awareness of transmitters, different process loops, Basics of communication system.

Module	Content	Hours	CO Mapping
1.	**Introduction to Communication System:** Elements of communication system, Noise in communication Systems. Amplitude Modulation: Introduction, Time and frequency domain analysis, Frequency Modulation, Phase Modulation, Effect of noise in FM. Digital Modulation, PAM,PPM,PWM,FSK,QPSK.	08	CO1
2.	**Introduction to Networks:** OSI reference model**,** TCP/IP model, Transmission media, UTP-STP cable, co-axial cable, N/W components: Repeaters, bridge, hub, switch, router, gateways. **Open Control N/W: RS232, RS422,EIA485** Modbus Structure, Implementation, GPIB. Proprietary Control N/W:Modbus Plus	05	CO2
3	**Networks at different levels:** Sensor level network: AS-i, CAN, Devicenet, Interbus and LON Device networks: Foundation Fieldbus H1-HART Profibus-PA Control Network: BACnet,control-net, FF-HSE, Profibus-DP, Ethernet, TCP/IP	08	CO3
4	**HART:** Architecture, Physical, Data Link, Application, Communication Technique, Normal and burst mode of communication, Troubleshooting, Benefits of HART	04	CO4
5	**Foundation Fieldbus:** Fieldbus requirement, features, advantages, fieldbus components, types, architecture–physical, data link, application layer, system and network management, wiring, segment functionality checking, installation in safe and hazardous area and troubleshooting, function block application process. **OPC Architecture**	06	CO5
6	**Wireless Technologies:** Satellite systems, Wireless LANs (WLANs), WiFi, VPAN, Zigbee, bluetooth GPRS and – their comparison, limitations and characteristics, Introduction to IOT and IIOT,RFID	05	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

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 4 to 5 marks will be asked.

4. Remaining questions will be mixed in nature.

5. In question paper weight age of each module will be proportional to number of respective Lecture hours as mentioned in the syllabus.

Text Books:

1. Deon Reynders,Steve Mackay,Edwin Wright, : "Practical Industrial Data Communications" ,1st edition ELSEVEIR,2005.
2. Lawrence M Thompson, : "Industrial Data Communication", 2nd edition , 1997.

Reference Books:

1. Daniel T Miklovic, "Real Time Control Networks", ISA 1993.
2. Bela G Liptak, "Process Software and Digital Networks",3rd edition2002.
3. Andrew S. Tanenbaum, "Computer Networks", 4th edition, PHI/Pearson Education,2002.
4. Behrouz A. Forouzan, "Data Communications and Networking", 2nd update edition, Tata McGraw Hill Publishing Company, New Delhi,2000.
5. Douglas E.Corner, "Computer Networks and Internets"2nd edition, Pearson Education Asia,5th Indian reprint, 2001.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISC603	Electrical Machines and Drives	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg.					
ISC603	Electrical Machines and Drives	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC603	Electrical Machines and Drives	4
Course Objective	1. To learn the basic concept and characteristics of Electrical motors. 2. To equip the students with the knowledge of semiconductor devices& their applications.	
Course Outcome	Students will be able to: 1. Explain working of DC motors and study their characteristics. 2. Describe the working principle of 3-phase I.M. 3. Discuss the constructional features of single-phase I.M. 4. Compare basic characteristics and ratings of power electronic devices. 5. Use controlled rectifiers, Inverters & choppers with different loads. 6. Illustrate working of AC & DC drives.	

Details of Syllabus:

Prerequisite: Knowledge of Faraday's laws, Lenz's law. Semiconductor devices such as diodes and transistors and their characteristics.

Module	Contents	Hrs	CO mapping
1	**DC Machines:** Types of DC motors, EMF equation generating & motoring action. Characteristics of DC motors. Speed control methods of DC motors. Applications of DC motors	08	**CO1**
2	**3-Phase Induction Motors:** Construction& working principle of3-phase IM. Slip, rotor frequency torque slip characteristic, power stages in IM	08	**CO2**
3	**Fractional HP Motors:** Construction & working principle of 1-phase I.M.split phase IM. Shaded pole IM Basic concepts of Stepper Motor, Servomotor	06	**CO3**
4	**Semiconductor Devices:**Introduction, characteristic, ratings & applications of power diode, power BJT, power MOSFET & IBGT Construction & characteristic, ratings of SCR, TRIAC Triggering methods of Thyristors using DIAC,UJT & PUT only.	08	**CO4**
5	**Applications of power semiconductor devices:** Controlled Rectifier: Principle of operation of 1-phase controlled converters, 1-phase half bridge & full bridge	12	**CO5**

	converter performance with R-L load. Basic operation of 3-phase converter AC power control with TRIAC-DIAC Inverter: Principle of operation of basic inverter, bridge inverter, PWM inverter DC-to-DC Converter: Basic operation of chopper, study of different types of chopper circuits like step up & step down chopper		
6	**Drives:** DC motor drives: 1-phase & 3-phase converter drives for continuous & discontinuous operation, chopper fed drive. AC motor drives and control: Control strategies of IM like stator voltage control & frequency control. Variable frequency VSI drives. Variable frequency CSI drives.	06	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

6) Question paper will comprise of 6 questions, each carrying 20 Marks.
7) Total 4 questions need to be solved.
8) Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
9) Remaining questions will be mixed in nature.
10) In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. Sawhney A.K., Electrical & Electronics Measurement and Instrumentation, Dhanapat Rai &Co. Pvt Ltd
2. Nagrath I.J., Kothari D.P., Electrical Machines, second edition,Tata McGraw Hill, New Delhi.
3. B.L.Theraja, Fundamentals of Electrical & Electronics, S.Chand, Technical.
4. V.K. Mehta , Rohit Mehta, Principles of Electrical Engg. & Electronics, S.Chand
5. P.S. Bhimbra, Power Electronics, Khanna publishers, 2004
6. M. H. Rashid, Power Electronics, 2nd Edition, PHI, 2005

Reference Books:

1. Say M.G.,The performance & Design of Alternating Current Machines, 3rd edition, Oxford University
2. P.C. Sen, Power Electronics, Tata McGraw Hill, 2005
3. Mohan Undeland Robbins, Power Electronics- Converters application & Design, Wiley Eastern,1996
4. Dubey, Dorald, Thyristorised Power Controller, Wiley Eastern Ltd.1993
5. S.K. Datta, Power Electronics & control, PHI 1986
6. S.K. Bhattacharya, Industrial Electronics & Control, TATA McGraw Hill, 2007
7. B.K.Bose, Modern power Electronics & AC Drives Pearson Education Inc.2002

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISC604	**Digital Signal Processing**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg.					
ISC604	**Digital Signal Processing**	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC604	**Digital Signal Processing**	**4**
Course Objectives	1. To introduce the basic concept of discrete time signal processing and Acquired knowledge about DSP and its fundamentals. 2. To familiarize with Fourier transform algorithms and convolution of DT sequences. 3. Ability to design IIR digital filter and realization of its structures using different forms. 4. To design FIR filter using different methods. 5. To understand the basic concept of DSP processor and Adaptive filtering for practical applications.	
Course Outcomes	Students will be able to - 1. Describe the basic concept of discrete time signal processing such as sampling, aliasing, concept of DSP. 2. Demonstrate an ability to apply Discrete Fourier Transform, Fast Fourier transform and convolution techniques to signals. 3. Apply the concepts of all-pass and minimum-phase systems to analyses the LTI system, Also realization of system by direct form I, II, Cascade, Parallel and Structure form. 4. Design FIR filter by different techniques. 5. Describe how IIR filters are designed and Implemented by different methods. 6. Explain DSP processors and adaptive filters such as LMS, RLS for various applications.	

Details of Syllabus:

Prerequisite: Knowledge of Fundamentals of Engineering Mathematics, Knowledge of Signals and Systems, Basic programming skill

Module	Contents	Hrs	CO mapping
1	**Introduction**:- Review of discrete time signals and systems, Basics of Z transform, Block diagram of DSP, Advantages and applications, Sampling theorem, Reconstruction of signals, Aliasing.	04	**CO1**
2	**Discrete Fourier Analysis**: - DFT and its property, Decimation in time FFT algorithms, Decimation in frequency FFT algorithms, convolution by DFT, Overlap add and Overlap save method, Goertzel algorithm, The chirp Z transform algorithm	12	**CO2**
3	**Analysis of Digital Filter**: - Classification of filter on their pole zero diagram. Frequency response of IIR filters frequency response analysis of all types of linear phase system. Difference between IIR and FIR Filters. Realization of systems: -Realization of IIR systems by Direct Form-I, Direct form-II, Cascade and Parallel. Realization of FIR systems by Direct form, cascade and linear phase system. Lattice structures.	06	**CO3**
4	**Design of digital FIR filters**:- Classification of filters, Ideal filter characteristics, Symmetric and asymmetric FIR filters, Minimum Phase and All pass filters,FIR filter design by window technique and frequency sampling method, Linear phase and Zero phase filters, Hilbert transform.	08	**CO4**
5	**Design of digital IIR filters**:- Comparison with FIR filters, Review of Analog filters, Butterworth, Chebyshev approximations, Frequency transformation, Design of digital IIR filters using Bilinear transformation method, Impulse Invariant transformation method, Pole zero placement method, Matched Z transform (MZT) method.	10	**CO5**
6	**Recent trends in DSP system design**: - Introduction, Architecture of TMS 320C54X, CPU, Arithmetic logic unit, Multiplier/Adder unit, Engineering applications of DSP processors. Introduction to adaptive filters: -Need of Adaptive filter and its application areas, Least mean square (LMS) filter, Recursive least square(RLS) filter.	08	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. Oppenheim, Schafer, "Discrete-Time Signal Processing", PHI,3rd edition, 2009.
2. John G. Proakis, "Digital Signal Processing",Pearson ,4th edition, 2007.
3. Sanjit K. Mitra, "Digital Signal Processing", McGraw Hill, 4nd edition, 2013.
4. Emmanuel Ifeachor, "Digital Signal Processing: A Practical Approach", PHI,2nd edition, 2001.
5. Vinay Ingale, "Digital signal processing using MATLAB", Cengage, 3rd edition, 2012.
6. Richard Lyons, "Understanding Digital Signal Processing" PHI, 1st edition, 2001.

Reference Books:

1. Thomas J. Cavicchi, "Digital Signal Processing" Wiley, 1st edition, 2009.
2. B. Venkataramani, M Bhaskar, "Digital Signal Processors", McGraw Hill, 2ndedition,2010.
3. Chi-Tsong Chen, "Digital Signal Processing: Spectral Computation", Oxford, 1stedition, 2007.
4. Dr.Shaila D. Apte, "Digital Signal Processing" Wiley, 2nd edition, 2009.
5. Robert A. Schilling," Introduction to Digital Signal Processing using MATLAB", Cengage, 2nd edition, 2012.
6. Ramesh Babu, "Digital Signal Processing" Scitech, 4thedition, 2011.
7. Monson H. Hayes, "Schaums Outline of Digital Signal Processing", McGraw Hill, 2ndedition,2010.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISC605	Advanced Control System	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg.					
ISC605	Advanced Control System	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC605	Advanced Control System	3
Course Objectives	To make students understand - 1. the concept of nonlinear control system, and different linearization methods to linearize the nonlinear system. 2. the concept of sliding mode control and its features. 3. the stability analysis of nonlinear control system through describing function and Lyapunov's method. 4. the concept of Internal Model Control and its application in control engineering 5. the importance of adaptive control system with their different types in control engineering as well as in process industries 6. the basic concept of Optimal Control.	
Course Outcomes	The Students will be able to - 1. Differentiate linear and nonlinear system, study characteristics of common physical nonlinearities. 2. Perform linearization of the nonlinear systems by using linearization techniques. 3. Construct phase-plane trajectories, study behavior of limit cycle and concept of sliding mode control. 4. Investigate the stability of nonlinear system by describing function method. 5. Investigate the stability of nonlinear system by Lyapunov's method 6. Design and develop the IMC structure for particular system with Uncertainty and Disturbances.	

Details of Syllabus:

Prerequisite: Knowledge of Linear algebra, Fourier Series, and Nyquist stability criterion.

Module	Contents	Hrs	CO mapping
1	**Nonlinear Control Systems** Definition of nonlinear systems, Difference between linear and nonlinear systems, characteristics of nonlinear systems, Common physical nonlinearities.	02	**CO1**
2	**Linearization Methods** Jacobian Linearization, Concept of relative degree, feedback linearization for systems with no internal dynamics.	02	**CO2**

3	**Phase plane Analysis** Basic concepts, phase trajectories, phase portrait, Constructing phase portraits by analytical method, Graphical Method -Delta Method Singular points and their classification, limit cycles and behaviour of limit cycles. Introduction to Sliding Mode Control**.**	08	**CO3**
4	**Describing Function Analysis** Describing Function Fundamentals, Describing Functions of saturation, dead zone, relay and their combinations, Stability analysis of nonlinear systems via describing function method.	08	**CO4**
5	**Lyapunov Stability Analysis** Stability of equilibria, Asymptotic stability, Lyapunov stability theorems, Stability analysis of linear systems, Construction of Lyapunov functions using Krasovskii method and variable gradient method.	08	**CO5**
6	**Internal Model Control** Introduction to Model-Based Control, Open loop controller Design, Model Uncertainty and Disturbances, Development of IMC structure, IMC-Based PID Controller Design	08	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4) Remaining questions will be mixed in nature.
5) In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. I. J. Nagrath and M. Gopal, Control System Engineering, 3rd Edition, New Age International (P) Ltd., Publishers - 2000.
2. K. Ogata, Modern Control Engineering, Prentice Hall of India, 4th edition, 2002.
3. Dr. K.P. Mohandas, "Modern Control Engineering", revised edition, Sanguine Publishers, Bangalore, 2006.

Reference Books:

1. Gene F. Franklin, J David Powell, Abbas Emami-Naeini, "Feedback Control of Dynamic Systems", 5th edition Pearson Educations.
2. Shankar Sastry, Marc Bodson, "Adaptive Control", Prentice Hall of India (P) Ltd., 1993.
3. John Doyle, Bruce Francis, Allen Tannenbaum, "Feedback Control Theory".
4. Pierre R. Belanger, "Control Engineering", Saunders college Publishing.

5. Norman Nise, “Control System Engineering”, 4th edition Wiley International Edition.
6. Christopher Edwards, Sarah K. Spurgeon, “Sliding Mode control: Theory and Application”, 1998.
7. Karl J. Astrom, B. Wittenmark, “Adaptive Control”, 2nd Edition, Pearson Education Asia, First Indian Reprint, 2001
8. Stanislaw H. Zak, “Systems and Control”, Indian Edition, Oxford University Press, 2003.
9. Donald E. Kirk, “Optimal Control Theory- An Introduction”,
10. M. Gopal, “Modern Control System Theory”, Wiley Eastern Ltd., New Delhi.

Sub code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pra	Tut.	Theory	Pract.	Tut.	Total
ISDLO6021	**Material Science**	3	-	-	3	-	-	3

Sub code	Subject Name	Examination Scheme							
		Theory Marks 100							
		Internal Assessment(20)			End sem Exam	Term Work	Pract and oral	Oral	Total
		Test1	Test2	Avg.					
ISDLO6021	**Material Science**	20	20	20	80	-	-	-	100

Subject Code	**Subject Name**	**Credits**
ISDLO 6021	**Material Science**	**3**
Course Objectives	1. To understand the fundamentals of Material Science and Metallurgy. 2. To create awareness about the different mechanical testing in industry. 3. To determine the mechanical properties of metal, non-metal and alloys.	
Course Outcomes	The students will be able to 1. Classify and brief the properties of materials. 2. Describe about the mechanical testing. 3. Explain structure of materials. 4. Acquire knowledge about heat treatment of steel 5. Examine micro-macro metals. 6. Analyze different non ferrous alloys	

Details of Syllabus :

Prerequisite: Knowledge of metals ,non-metals and basic physics.

Module	Content	Hrs.	CO Mapping
1	**Classification and properties of material** Metal, non-metal such as ceramic, plastic and polymers, composite material Structure of material: Structure, general relationship of structure level to various engineering properties, atomic structure, bonding in solid, atomic arrangement in solid, crystal structure of metal, space lattice, unit cell, indexing of lattice plane and direction, plastic deformation, mechanism, deformation of single crystal and polycrystalline metals, imperfection in crystal, dislocation theory of slippage, work hardening, strengthening mechanism in	06	**CO1**
2	**Mechanical Testing** Tension test, engineering and true stress-strain curves, evaluation of properties, ductility, brittleness and toughness. Types of engineering stress-strain curve, compression test. Hardness testings- Brinell hardness Test, Poldi hardness Test, Rockwell hardness Test, Vickers hardness Test. Durometers, micro hardness. Relation among the various hardness test and hardness to tensile	06	**CO2**
3	**Equilibrium diagrams:** Related terms and their definitions, construction, common types of equilibrium diagrams, rules of solid solubility, Gibb's phase rules and non-equilibrium cooling. Plane carbon steel, iron-carbon phase diagram, classification of iron carbon alloys, classification, properties & application of steel. Alloy steel: effects of alloying element, function and uses of alloying elements.	06	**CO3**
4	**Heat transfer of steel:** Principal of heat treatment, phase transformation in steel during heating, transformation of Austenite during cooling, time-temperature transformation diagram, critical cooling rate, continuous transformation diagram, Heat treatment Process: annealing, normalizing, hardening, tempering, and case hardening, Hardenability of steel, significance of hardenability, the jominy-end quench test, other hardening heat treatment such as hardening, tempering, annealing.	06	**CO4**

5	**Macro and micro examination of metals** Macro examination: Specimen preparation, Sulphar painting, flow lines, welded section, Micro examination: Grinding, polishing, etching, optical metallurgical microscopy. Cast Iron: Classification, grey and white cast iron, modular and ductile iron, malleable cast iron, alloyed cast iron, effects of various parameter on structure and properties of cast iron, Application and heat treatment of cast iron.	06	**CO5**
6	**Engineering non-ferrous alloys** Brass, Bronze, Tin, Aluminum, Silicon, Beryllium bronze, Copper nickel alloy, aluminum alloys, titanium and its alloy, solder and bearing material, Common applications and some specification of various non-ferrous alloys in field such as 1. Die casting industry, 2. Automobile 3. Aircraft industry	06	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weight age of each module will be proportional to number of respective Lecture hours as mentioned in the syllabus.

Text Books :

1. Davis H.E. Trcxell G.E. &Wickocil C.T., "Testing of Engg. Materials", McGrawHill Book Co. Inc.
2. Smith W. F.,:"Principles of material science", Addison Welsey Publishing Co. Inc
3. V. D. Kodgire,:" Material Science and Metallurgy for engineers", Everest publishing House, Pune
4. Van Valck L.H. ,:"Principle of material science and engineering", Addison Wesley Publication Co. Inc.
5. B. K. Agrawal ,:" Introduction to engineering materials", Tata Mcgraw Hill Co. Ltd

Reference Books :

1. ASM Handbook : Surface Engineering Volume 5.
2. TME Handbook : Material, Finishing and coating Volume 3.

Subject code	Subject Name	Teaching Scheme (Hrs)			Credit Assigned			
		Theory	**Pract**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ISDL06022	**Computer Organization and Architecture**	3	-	-	3	-	-	3

Subject code	Subject Name	Examination Scheme							
		Theory (out of 100)				Term Work	Pract. and oral	Oral	Total
		Internal Assessment (out of 20)			End sem Exam				
		Test 1	Test 2	Avg					
ISDL06022	**Computer Organization and Architecture**	20	20	20	80	-	-	-	**100**

Subject Code	**Subject Name**	**Credits**
ISDL06022	**Computer Organization and Architecture**	3
Course Objectives	1. To conceptualize the basics of organizational and architectural issues of a digital computer. 2. To analyse performance issues in processor and memory design of a digital computer. 3. To understand various data transfer techniques in digital computer. 4. To analyse processor performance improvement using instruction level parallelism.	
Course Outcomes	The students will be able to: 1. To describe basic structure and operation of a digital computer. 2. To design fixed-point and floating-point addition, subtraction, multiplication & division and other arithmetic unit algorithms. 3. To describe the different ways of communicating with I/O devices and standard I/O interfaces. 4. To analyze the hierarchical memory system including cache memories and virtual memory. 5. To describe pipelining and its Hazards 6. To Explain the Pentium processor Hardware design	

Details of Syllabus :

Module	Topics	Hrs.	CO Mapping
1	**Basic Structure of Computers**: Functional UNIT computer, Difference between CO & CA. System Bus, Data Types, Instruction Cycle, Instruction cycle with interrupt	04	CO1
2	**Computer Arithmetic Introduction:** Fixed Point Representation, Floating - Point Representation (IEEE-754) Addition and subtraction, Multiplication Algorithms (Booth Multiplication Algorithm), Division Algorithms, Floating Point Arithmetic operations.	08	CO2
3	**Micro Programmed Control:** Control Memory, micro code Sequencing, Micro program Examples, Functional description of Control Unit, Hard Wired Control unit, Micro programmed Control unit.	06	CO3
4	**The Memory System:** Basic Concepts of Semiconductor RAM Memories, Read-Only Memories, Memory hierarchy, Cache Memories organization, Virtual Memories, Introduction to RAID basic structure. Input-Output Organization: Peripheral Devices, Input-Output Interface, Direct Memory Access, Input-Output Processor (IOP), Serial Communication; Introduction to Interconnect (PCI) Bus.	09	CO4
5	**Pipeline And Vector Processing:** Flynn's taxonomy, Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline and Pipeline Hazards.	05	CO5
6	**Case Study :Pentium architecture** Overview, Bus operations , Pipelining, Branch Prediction , Instruction and Data Cache ,Floating Point Unit	04	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination:

1. Question paper will comprise of 1 compulsory question of 10 marks and 5 questions, each carrying 20 marks, out of which 3 questions need to be solved.
2. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books :

1. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, “Computer Organization”, Fifth Edition, Tata McGraw-Hill.
2. John P. Hayes, “Computer Architecture and Organization”, Third Edition.
3. William Stallings, “Computer Organization and Architecture: Designing for Performance”, Eighth Edition, Pearson.

Reference Books:

1. B. Govindarajulu, “Computer Architecture and Organization: Design Principles and Applications”, Second Edition, Tata McGraw-Hill.
2. Dr. M. Usha and T. S. Srikanth, “Computer System Architecture and Organization”, First Edition, Wiley-India.
3. Ramesh Gaonkar, “Microprocessor Architecture, Programming and Applications with the 8085”, Fifth Edition,Penram.
4. The Intel Family Of Microprocessors: Hardware and Software Principles and Applications Author: James L. Antonakos

Subject Code	Subject Name	Teaching Scheme (Hrs)			Credit Assigned			
ISDLO6023	**Bio-Sensors and Signal Processing**	**Theory**	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
		3	-	-	3	-	-	3

Sub Code	Subject Name	Examination Scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test 1	Test2	Avg.					
ISDLO6023	**Bio-Sensors and Signal Processing**	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDLO6023	**Bio-Sensors and Signal Processing**	**3**
Course objectives	1. To provide basic knowledge of various bio-sensors and their uses in biomedical applications. 2. To provide understanding of principle and operation of different types of bio-sensors like potentiometric, optical and amperiometric sensors. 3. To introduce the students to basic signal processing methods used in bio-signal measurement and analysis.	
Course Outcomes	Students would be able 1. To describe the basic concept behind bioelectric phenomena. 2. To classify the different types of bio-sensors and describe their characteristics. 3. To distinguish between the different biosensors used for physical and chemical measurands. 4. To explain the various types of transducers found in biosensors and their significance. 5. To explain about the various basic signal processing techniques used in bio-signal acquisition and analysis. 6. To apply the appropriate biosensor for different applications.	

Details of Syllabus :

Prerequisite: Knowledge about bio-signals and their specifications, Knowledge about the basic working principle of various transducers

Module	Contents	Hrs	CO Mapping
1	**Bioelectricity and Bio-electric Phenomena** Sensors / receptors in the human body, basic organization of nervous system-neural mechanism and circuit processing. Electrode theory, electrode-tissue interface, metal-electrolyte interface, electrode-skin interface, electrode impedance, electrical conductivity of electrode jellies and creams.	04	CO1
2	**Introduction to biological sensors** Sensor architecture and Classification of biosensors: Medically significant measurands, functional specifications of medical sensors; Bio-sensor characteristics: linearity, repeatability, hysteresis, drift; Bio-sensor models in the time & frequency domains.	04	CO2
3	**Physical and Chemical Biosensors** Bio-sensors for physical measurands: strain, force, pressure, acceleration, flow, volume, temperature and bio potentials. Bio-sensors for measurement of chemicals: Potentiometric sensors, ion selective electrodes, Amperometric sensors, Clark Electrode biosensors, Catalytic biosensors, Immuno-sensors.	09	CO3
4	**Transducers in Biosensors** Various types of transducers; principles and applications - Resistive, Capacitive, Inductive, Photoelectric, piezoelectric, mechanical and molecular electronics based transducers in biosensors. Chemiluminiscene - based biosensors, Liquid and solid ion exchange membrane electrode, Enzyme electrode, Principle of fiber optic cable, fiber optic sensors, Photo acoustic sensors in biomedical field.	09	CO4
5	**Bio-signal Acquisition and Processing** Measuring ultra-small signals, noise. Electrical signals produced by cells, Various types of signal processing techniques used for bio-signals.	05	CO5
6	**Applications of Biosensors** Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food, Low cost-biosensor for industrial processes for online monitoring; biosensors for environmental monitoring.	05	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on Minimum 02 Modules) and the other is either a class test or assignment on live problems or Course project.

Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.

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

Text Books:

1. Richard S.C. Cobbold, "Transducers for Biomedical Measurements: Principles and Applications", John Wiley & Sons, 1992.
2. A.P.F. Turner, I. Karube & G.S. Wilson, "Biosensors: Fundamentals & Applications", Oxford University Press, Oxford, 1987.
3. Rangan C.S., Sarma G.R., and Mani V.S.V., "Instrumentation devices and system", Tata McGraw Hill Publishing Company limited, New Delhi, 2006.
4. John G.Webster, "Medical Instrumentation: Application and Design", John willey and sons, 1999.
5. Jacob Kline, "Handbook of Bio Medical Engineering", Academic press Inc., Sandiego, 1988.

Reference Books:

1. Richard Aston: Principles of Biomedical Instrumentation and Measurement, Merril Publishing Co., Columbus, 1990.
2. Ernest O. Doeblin: Measurement Systems, Application and Design, McGraw-Hill, 1985.
3. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.

Subject code	Subject Name	Teaching Scheme		Credit Assigned		
		Theory	Pract. / Tut.	Theory	Pract. / Tut.	Total
ISDL06024	**Nuclear Instrumentation**	3	-	3	-	3

Sub Code	**Subject Name**	**Examination Scheme**							
		Theory(out of 100)				**Term work**	**Pract. and Oral**	**Oral**	**Total**
		Internal Assessment			**End sem Exam**				
		Test1	**Test2**	**Avg.**					
ISDLO6024	**Nuclear Instrumentation**	20	20	20	80	-	-	-	100

Subject Code	**Subject Name**	**Credits**
ISDL06024	**Nuclear Instrumentation**	**3**
Course Objectives	1. To introduce the basic concept of radioactivity, properties of alpha, beta and gamma rays and study various radiation detectors 2. To study the electronics and counting systems 3. To study applications of nuclear instrumentation in medicines, Industry and in Agriculture.	
Course Outcomes	Students would be able 1. To explain basics of radioactivity, properties of alpha, beta and gamma rays. 2. To compare construction and working of various radiation detectors. 3. To describe electronics and counting systems used in nuclear instrumentation to process nuclear detector signal. 4. To list various factors influencing resolution of gamma energy spectrum and specifications of nuclear ADC. 5. To apply nuclear radiation detectors in medicine 6. To apply nuclear instrumentation in industry.	

Pre-Requisites: Students should know the basics of digital, analog electronics and signal conditioning circuits which is required in understanding the working of nuclear instruments.

Module	Topics	Hrs.	CO
1	**Radioactivity** : General properties of Nucleus, Radioactivity, Nature of Nuclear Radiation's, Properties of Alpha, Beta and Gamma rays, Natural and artificial radio-activity. Radioactivity Laws, Half-life period, radioactive series, Isotopes and Isobars, Various effects-photoelectric, Compton scattering and pair production, stopping power and range of charged nuclear particles.	06	**CO1**
2	**Radiation Detectors** : Techniques for radiation detection, Detectors for Alpha, beta and gamma rays, Detector classification, Gas filled detectors - volt ampere characteristics, Ionization chamber, Proportional counter, Geiger Muller counter, Designing features, Scintillation detectors, Photomultiplier tube, dark currents, pulse resolving power, efficiency of detection, Solid state detectors (Lithium ion drifted – Si-Li, Ge-Li, Diffused junction, surface barrier detectors)	12	**CO2**
3	**Electronics and Counting systems:** Pre-amp, shaping amplifiers, Discriminators, Scalars and count rate meters, Pulse shaping, peak stretchers, photon counting system block diagram, single channel analyser SCA (pulse height analyser - PHA), Coincidence detection	04	**CO3**
4	**Nuclear Spectroscopy systems:** Factors influencing resolution of gamma energy spectrum, Energy resolution in radiation detectors, Multichannel analysers (MCA), Role of Nuclear ADC's – performance parameters.	04	**CO4**
5	**Radiation Monitors &Application in Medicines**: Radiation uptake studies – block diagram and design features. Gamma camera – design, block diagram, medical usage. Nuclear instrumentation for health care, Radiation Personnel Health Monitors like neutron monitors, Gamma Monitors, Tritium monitors, Iodine monitors and PARA (particulate activity radiation alarms).	06	**CO5**
6	**Industrial Applications**: Basic Nuclear Instrumentation system – block diagram, Personal monitors like Thermo Luminescence Detectors (TLD). Dosimeters, Tele-detectors. Nuclear Instrumentation for power reactor. Nuclear Instrumentation for Toxic fluid tank level measurement, weighing, thickness gauges, Agriculture applications like food irradiation, Underground Piping Leak detection, water content measurement etc.	04	**CO6**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory 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 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

4. G.F. Knoll, "Radiation Detection & Measurement", 2nd edition, John Wiley & Sons, 1998.
5. P.W. Nicholson, "Nuclear Electronics", John Wiley, 1998.
6. S.S. Kapoor & V.S. Ramamurthy, "Nuclear Radiation Detectors", Wiley Easter Limited, 1986.

Reference Books:

1. Gaur & Gupta, "Engineering Physics", Danpat Rai & Sons, 2001.
2. Irvin Kaplan, "Nuclear Physics", Narosa, 1987.
3. M.N. Avdhamule & P.G. Kshirsagar, "Engineering Physics", S.Chand & Co., 2001.
4. R.M. Singru, "Introduction to Experimental Nuclear Physics", Wiley Eastern Pvt. Ltd., 1974.
5. Hand Book of Nuclear Medical Instruments, Edited by B.R.Bairi, Balvinder Singh, N.C. Rathod, P.V. Narurkar, TMH Publishing New Delhi, 1974.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL601	Process Instrumentation System- Lab Practice	Theory	Pract	Tut	Theory	Pract	Tut	Total
		-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End sem exam	Term work	Pract. And oral	Oral	Total
		Test 1	Test 2	Avg					
ISL 601	Process Instrumentation System- Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	Credits
ISL 601	Process Instrumentation System- Lab Practice	1
Course objective	1. To make the students to familiar with different Process Dynamics & process control actions. 2. Students are expected to learn classification & working of Controllers & Tuning Methods. 3. Students are expected to understand various control schemes. 4. To familiarize concept of Multivariable Control & Discrete state process control Requirement.	
Course Outcome	The students will be able to 1. Understand & Learn Process Control Terminologies, Process Dynamics & their mathematical model. 2. Understand different types of control actions & their selection. 3. Learn Features & Classify controllers like electronic, pneumatic and hydraulic & their Tuning Techniques. 4. Learn various process control schemes & their applications and selection. 5. Understand Multivariable Control systems & their Interaction 6. The students will be able to develop relay logic for various processes & symbols.	

Syllabus: Same as that of Subject ISC601 Process Instrumentation System.

List of Laboratory Experiments:

Sr. No.	Detailed Content	CO Mapping
1	Study Features & operation of ON-OFF Controller & its Application.	**CO3**
2	Familiarization of various control actions (pure and composite) using PID controller with Real time Process OR Simulator.	**CO2**
3	Testing Features, specifications, wiring & operation of an electronic PID controller.	**CO3**
4	Tuning of an Electronic PID controller.	**CO3**
5	Analysis of Feedback Control using Level / Pressure / Flow / Temperature Control Loop.	**CO4**
6	Study Feed Forward Control system using Temperature control Loop.	**CO4**
7	Study of split range control system using Pressure Control set up.	**CO4**
8	Study of Ratio control system using Flow Control Loop.	**CO4**
9	Study of Cascade control system.	**CO4**
10	Study Dynamic behaviour of First Order Hydraulic system.	**CO1**
11	Study Dynamic behaviour of Second Order Hydraulic system.	**CO1**
12	Development & Implementation of Relay Ladder Logic for Discrete state process control system.	**CO6**
13	Assignment on Relative gain analysis.	**CO5**

Note:

*Factory / Industrial visit is suggested to understand the Practical knowledge of the subject.

Oral Examination:
Oral examination will be based on Laboratory work & Entire syllabus.

Term Work:
Term work shall consist of minimum eight experiments.

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

Laboratory work (Experiments)	: 10 Marks
Laboratory work (programs/assignments / journal)	: 10 Marks
Attendance (Class Room & Laboratory)	: 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work.

Sub code	Subjec tName	Teaching Scheme(Hrs)			CreditsAssigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL602	**Industrial Data Communication-Lab Practice**	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination Scheme							
		Theory(out of100)							
		Internal Assessment(out of20)			End sem Exam	Term Work	Pract and oral	Oral	Total
		Test1	Test 2	Avg.					
ISL602	**Industrial Data Communication-Lab Practice**	-	-	-	-	25	-	-	25

Subject Code	**Subject Name**	**Credits**
ISL602	**Industrial Data Communication-Lab Practice**	**1**
Course Objectives	1. To expose the students to the basics of communication 2. To create awareness about the the OSI refrence model . 3. To acquaint the students with the different types of networks at various levels such as sensor level,device network and control network. 4. To provide sufficient knowledge about the HART. 5. To impart the fundamentals of foundation field bus.	
Course Outcomes	The students will be able to 1. Explain the importance of modulation in communication. 2. Examine the importance of OSI,TCP/IP model,various networking components. 3. Compare the different types of networks at various levels of field communication. 4. Use HART for communication 5. Establish Foundation fieldbus communication. 6. Investigate the various wireless devices.	

Syllabus: Same as that of Subject ISC602 **Industrial Data Communication**.

List of Laboratory Experiments/ Assignments:

Sr. No.	Detailed Content	CO Mapping
1	To Study the various modulation techniques(AM,FM,PWM)	**CO1**
2	To Study the networking components	**CO2**
3	To understand LAN	**CO3**
4	To study HART Protocol.	**CO4**
5	To calibrate various transmitters using HART	**CO4**
6	To study the components of Foundation Field Bus.	**CO5**
7	To study Zigbee	**CO6**
8	Assignment on MODBUS protocol.	**CO3**
9	Assignment onEthernet.	**CO3**
10	Assignment on application of IOT	**CO6**

Any other additional experiments/assignments based on syllabus which will help students to understand topic/concept.

Term Work:

Term work shall consist of minimum four experiments and four assignments.

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

Laboratory work (Experiments/assignments) : 10 Marks

Laboratory work (programs / journal) : 10 Marks

Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of

Laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL603	**Electrical Machines and Drives – Lab Practice**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End sem Exam	Term work	Pract. and Oral	Oral	Total
		Test1	Test2	Avg					
ISL603	**Electrical Machines and Drives– Lab Practice**	-	-	-	-	25	-	25	50

Subject Code	**Subject Name**	**Credits**
ISL603	**Electrical Machines and Drives – Lab Practice**	1
Course Objectives	1. To learn operation & speed control methods of electric motors. 2. To learn operations of semiconductor devices & their applications.	
Course Outcomes	Students will be able to 1. Perform speed control of DC motor by different methods 2. Describe working principle of three-phase and single -phase induction motors. 3. Study the characteristics of semiconductor devices 4. Use semiconductor devices to build different circuits.. 5. Apply drives for speed control of DC motor. 6. Discuss the working of AC drive for I.M.	

Syllabus same as that of subject ISC603 Electrical Machines and Drives

List of Laboratory Experiments:

Sr. No.	**Detailed Contents**	**CO mapping**
1	Speed control methods of DC motor	**CO1**
2	Starting of 3-phase IM by DOL/Autotransformer/rotor resistance method	**CO2**
3	Study of different types of fractional horse power motor	**CO2**
4	Plot V-I characteristics of SCR	**CO3**
5	Plot V-I characteristics of Triac	**CO3**

6	Triac based AC power control circuit.	**CO3**
7	Half wave & full wave controlled rectifier	**CO4**
8	SCR Based Inverter	**CO4**
9	MOSFET/IGBT Based Inverter	**CO4**
10	DC motor speed control drive	**CO5**
11	AC drive for I.M.	**CO6**

**Any other additional experiments based on syllabus which will help students to understand topic/concept.

Oral Examination:

Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum Eight experiments.

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

Laboratory work (Experiments) : 10 Marks
Laboratory work (programs /journal) : 10 Marks
Attendance : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL604	**Digital Signal Processing- Lab Practice**	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
						Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL604	**Digital Signal Processing- Lab Practice**	-	-	-	-	25	25	-	50

Subject Code	**Subject Name**	**credits**
ISL604	**Digital Signal Processing- Lab Practice**	1
Course objectives	1. Study simulation software platform for digital signal processing and Plot different type of signals. 2. To understand the concept of linear, circular convolution, correlation and simulate it by computer software. 3. To understand Fourier transform and its algorithms such as FFT and IFFT and simulate it. 4. To design and implement filters both FIR and IIR using computer simulation. 5. To study DSP processors, adaptive filters and their applications.	
Course Outcomes	Students will be able to - 1. Verify sampling theorem using simulation software. 2. Demonstrate DT Fourier analysis, convolution and correlation concept using simulation software. 3. Perform Fast Fourier Transform of signals. 4. Design and implement FIR and IIR filters using computer simulation software platform. 5. Realize filters by direct form I, II, Cascade and Parallel form. 6. Study DSP processors, Adaptive filters and their applications.	

Syllabus same as that of subject ISC604 Digital Signal Processing

List of Laboratory Experiments:

Sr. No.	Detailed Contents	CO mapping
1	Generation of DT sinusoidal signal and verification of sampling theorem.	**CO1**
2	Finding the Impulse response of the system.	**CO2**
3	Program for finding linear convolution, Circular convolution, and linear convolution by using circular convolution technique.sequences.	**CO2**
4	Program for finding correlation (auto and cross).	**CO2**
5	Computation of N point DFT of a given sequence and to plot magnitude and	**CO3**

6	Computing circular convolution by DFT and IDFT of signals.	**CO3**
7	Implementation of FFT algorithms (DIT, DIF) etc.	**CO3**
8	Designing of FIR filter using windowing technique.	**CO4**
9	Design and Implement IIR filter to meet given specifications.	**CO4**
10	Assignment on Filter Implementation direct form I, II, Cascade, Parallel	**CO5**
11	Study of Adaptive filters such as LMS, RLS and its applications.	**CO6**
12	Study of DSP processor and its applications.	**CO6**

Any other additional experiments based on syllabus which will help students to understand topic/concept.

Oral Examination:
Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum Eight experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (programs /journal) : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL605	**Advanced Control System - Lab Practice**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End sem Exam	Term work	Pract. and Oral	Oral	Total
		Test1	Test2	Avg.					
ISL605	**Advanced Control System - Lab Practice**	-	-	-	-	25	25	-	50

Subject Code	Subject Name	credits
ISL605	**Advanced Control System- Lab Practice**	1
Course objectives	1. Students should be able to examine stability of limit cycle 2. The students should be able to examine stability of nonlinear system using DF techniques and Lyapunov's functions 3. The students should be able to design the IMC structure. 4. The students should able to examine the stability using sliding mode control 5. Students can be able to optimize the any particular system.	
Course Outcomes	Students will be able to 1. Construct the phase-plane trajectories using Delta Method. 2. Classify stability of limit cycle as per obtained response of the system 3. Derive DF for common nonlinearities and investigate stability of system with limit cycle. 4. Determine Lyapunov's function and also able to investigate the stability of nonlinear system 5. Design the IMC structure and apply same for stability analysis. 6. Design IMC based PID controller.	

Syllabus same as that of subject ISC605 Advanced Control System

List of Laboratory Experiments:

Sr. No.	Detailed Contents	CO mapping
1	Construct the trajectory for system represented by second order differential equation and for any initial condition by using Delta Method.	**CO1**
2	Study behaviour of limit cycle with the help of Vander Pol's equation.	**CO2**
3	Derivation of DF for nonlinearities – relay with saturation, relay with dead-zone, dead-zone and saturation etc.	**CO3**
4	Investigate the stability of system with nonlinearities – relay, saturation, dead-zone and existence of limit cycle using DF technique.	**CO3**
5	Verify Sylvester theorem for the definiteness of the Lyapunov Function.	**CO4**

6	Determine the stability of the system and construct the Lyapunov function for Linear Time invariant system	**CO4**
7	By using Krasovskii method determine the stability of the system and construct the Lyapunov function.	**CO4**
8	By using Variable Gradient method determine the stability of the nonlinear system	**CO4**
9	Effect of filter tuning parameter on step response of the first and second order systems	**CO5**
10	Design of IMC controller for a system subject to step input.	**CO5**
11	Design of IMC controller for a system subject to ramp input.	**CO5**
12	Design of IMC based PID controller.	**CO6**
13	Design of IMC controller for delay and non-minimum phase systems.	**CO5**

Any other additional experiments based on syllabus which will help students to understand topic/concept.

Oral Examination:
Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum eight experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (programs /journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL606	Mini Project-II	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL606	Mini Project-II	-	-	-	-	25#	-	-	25

Mini Project will be based on internal oral and project report.

Term Work:

The main intention of Mini Project is to make student enable to apply the knowledge and skills learned from the courses studied to solve/implement predefined challenging practical problems of interdisciplinary nature .The students undergo various laboratory/tutorial/simulation laboratory courses in which they do experimentation based on the curriculum requirement. The students should be encouraged to take challenging problems of interdisciplinary nature. The emphasis should be on

- Learning additional skills
- Development of ability to define and design the problem and lead to its accomplishment with proper planning.
- Learn the behavioral science by working in a group.

The group may be of maximum four (04) students. Each group will be assigned one faculty as a supervisor. The college should keep proper assessment record of progress of the project and at the end of the semester it should be assessed for awarding TW marks. The TW may be examined by approved internal faculty appointed by the head of the institute. The TW marks will be allocated based on the internal examination of demonstration in front of the examiner. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained about the completed task.

The students may use this opportunity to learn different design techniques in instrumentation, control and electronics. This can be achieved by making a proper selection of Mini Project.