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.