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

From Co-Coordinator's Desk:

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

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

Choice Based Credit and Grading System enable a much-required shift in focus from teacher-centric to learner-centric education. Since the workload estimated is based on the investment of time in learning, not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes. Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. **Choice Based Credit and Grading System** were implemented for First Year of Engineering (Undergraduate) from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year of Engineering (Undergraduate) in the academic year 2017-2018 and so on.

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

Preamble:

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

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

Program Educational Objectives (PEOs)

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

Program Outcomes (POs)

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

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

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

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

Scheme for Semester VII

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

Examination Scheme for Semester VII

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

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

Scheme for Semester VIII

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

Examination Scheme for Semester VIII

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

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			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDLO7033	Advanced Microcontroller Systems	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:

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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:

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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.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC801	Instrumentation Project Documentation and Execution	4	-	-	4	-	-	4

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISC801	Instrumentation Project Documentation and Execution	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC801	Instrumentation Project Documentation and Execution	4
Course objective	1. To provide knowledge of Instrumentation Project & Detailed Engineering techniques in the EPC Consultancy. 2. To make the students capable of executing Project Deliverables and Engineering activities of Project Documentation.	
Course Outcome	The students will able to: 1. Interpret types of project and execute it by knowing relationship between customer, designer and constructor. 2. Use standards in instrumentation project. 3. Design engineering documents such as loop diagram, hook-up, JB schedule. 4. Develop and test system integration. 5. Schedule and evaluate activities like procurement, commissioning, installation. 6. Support and evaluate documentation software packages used in industry.	

Details of Syllabus:

Prerequisite: Knowledge of standards, basics of Sensor, transducer, process loops, control valve.

Module	Content	Hrs	CO Mapping
1	**The Project and Project Team:** Introduction, Types of project, constraint's predictability, structure, flow and deliverables, Need and techniques used for Project Planning and Scheduling, software used for Project Planning and Scheduling **The Project Team**: Customer, designer and constructor	10	CO1
2	**Standards used in instrumentation project:** ISA, ANSI, & ASTM, ASME, NFPA, NEMA, SAMA. **Engineering Documents Part-I:** Need for engineering document, general guidelines for development of document, project stage**,** purpose, scope, contents, references for document, team of creation and users. 1) Process Flow Diagram (PFD) and Material Balance Sheet (MBS) 2) Piping and Instrumentation diagrams (P&ID) – practical applications. 3) Instrument Index Sheet 4) Instrument specifications sheet- for temperature, pressure, level, flow instruments and control valves.	08	CO2
3	**Engineering Documents Part-II** 1) Loop diagrams- pneumatic, electronic and digital data types. 2) Instrument Location Plan 3) Cable and Tray Routing and Cable Schedule 4) JB Schedule 5) Air header schedule 6) Instrument Hook- up diagrams - for control valve, transmitters (DP in liquid service, dry gas service,) Thermocouple, Temperature switch line mounted, flow transmitter, connections for air supply and output. etc. 7) BOM for erection 8) Logic diagrams, 9) SAMA flow diagram	10	CO3
4	**Systems Integration:** Division of labour, control logic specification, HMI specification (development of mimic and graphic), System Architecture design, Network single line diagram generation, I/O address assignment (Partitioning)-Hardware & software address, Other tasks like -System testing, Safety Instrumented System (SIS), Safety Integrated Level (SIL), control room layout design, types of control system cabinet design.	07	CO4
5	**Procurement, Installation and Commissioning:** **Procurement:** Engineering Procurement procedure, PO format, preparation of tender documents, bids, technical bid evaluation. **Installation of instruments-** Installation standards (stanchion, impulse tubing, clamping) installation of instrument junction box, earthing system, cable laying (cable trays, cable types, cable glands), tubing, instrument installation guidelines (for pressure instruments, DP transmitter, temperature and flow instruments, control valve.) **Inspection**: Need for Inspection, General Inspection Guidelines	10	CO5

	Documents for Inspection- Factory acceptance test (FAT) ,Site acceptance test (SAT). **Commissioning:** Pre-commissioning Procedures, stages, check out procedure of control valve, DP transmitter etc. Calibration, testing of instruments, operation and maintenance manual.		
6	**Documentation Software Packages:** Advantages of using software packages for documentation. Overview of documentation software packages used in industry.	03	CO6

Internal Assessment:

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

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. Andrew Williams, "Applied instrumentation in the process industries", 2nd Edition, Vol. 2, Gulf publishing company, 1979.
2. Michael D. Whitt, "Successful Instrumentation and Control Systems Design", ISA Publication, 2012.
3. Installation of Instrumentation & Process control systems- EEUA Handbook, 1977.
4. D. N. Pawar, D. K. Nikam, Fundamentals of Project Planning and Engineering, 1st Edition, Penram International Publishing-2017.

Additional References :

- Specification forms- ISA-20-1981- ISA Publication
- Piping and Instrumentation Diagram Documentation Criteria- Process Industry
- Practices Instrumentation Design Criteria-ONGC, Mumbai
- Commissioning Procedures -ONGC, Mumbai

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC802	Instrument and System Design	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.					
ISC802	Instrument and System Design	20	20	20	80	-	-	-	100

Subject Code	Subject Name	credits
ISC802	Instrument and System Design	4
Course objectives	1. To impart knowledge of selection and design considerations of transducers along with its calibration techniques. 2. To make the students capable of sizing the control valve. 3. To impart the students' knowledge about the types, sizing of control panels and standards. 4. To make the students capable to design electronic product, control room layout and its environment. 5. To familiarize students with the concept of reliability engineering.	
Course Outcomes	The students will be able to: 1. Select, design and calibrate transducers 2. Select and size control valves and actuators. 3. Apply knowledge to size the control panels. 4. Apply knowledge to design electronic product and enclosure design 5. Describe the terms used in Reliability engineering. 6. Apply knowledge in designing control room layout and its environment.	

Details of Syllabus:

Prerequisite: Knowledge of sensors, control valves, PLC and DCS.

Module	Content	Hrs	CO Mapping
1	**Design of Transducers:** An overview of static and dynamic performance characteristics of instruments. Selection criteria, design considerations, calibration and installation for flow, temperature, pressure and level transducers.	08	CO1
2	**Design of Control Valve:** Review of flow equations. Valve selection and sizing for liquid service, gas or vapor service, flashing liquids, Newtonian fluids and mixed phase flow, Control valve noise estimation and Control valve cavitations. Actuator sizing. Selection criteria and design consideration of safety relief valves and rupture discs.	16	CO2

3	**Control Panel Design:** Panel selection-size, type, construction and IP classification, NEMA standard. GA Diagrams, Power wiring and distribution, Typical wiring diagrams for AI,DI,AO,DO,RTD, and T/C modules. Earthing scheme. Panel ventilation, cooling and illumination. Operating consoles- ergonomics. Wiring accessories- ferules, lugs, PVC ducts, spiral etc. Wire sizes and color coding. Packing, Pressurized panels- X, Y, and Z Purging for installation in hazardous areas. Ex-proof panels.	08	CO3
4	**Electronic product design:** System Engineering, ergonomics, phases involved in electronic product design. **Enclosure Design :** Packing and enclosures design guidelines, Grounding and shielding, front panel and cabinet design of an electronic product.	08	CO4
5	**Reliability engineering:** Reliability concepts, causes of failures, bath tub curve, Quality and reliability, MTTF, MTBF, and MTTR. Availability and Maintainability. Redundancy and redundant systems.	04	CO5
6	**Control Room Design:** Layout and environment, modern control room layout	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. Les Driskell, "Control valve sizing", ISA.
2. Kim R Fowler, "Electronic Instrument Design", Oxford University- 1996.
3. Bela G. Liptak, "Instrument Engineer's Hand Book – Process Control", Chilton Company, 3rd Edition, 1995.
4. Andrew Williams, "Applied instrumentation in the process industries", 2nd Edition, Vol. 1 & 3, Gulf publishing company,1979.

Reference Books:

1. Harshvardhan, “Measurement Principles and Practices”, Macmillan India Ltd-1993
2. Balaguruswamy E, “Reliability”, Tata McGraw-Hill Pub.co. New Delhi, 1999.
3. Mourad Samiha & ZorianYervant,” Principles of Testing Electronic Systems”, New York. John Wiley & Sons, 2000.
4. Lewis E E,” Introduction to Reliability Engineering (2nd)”, New York. John Wiley & Sons, 1996.
5. Anand M S,” Electronic Instruments and Instrumentation Technology”, New Delhi. Prentice Hall of India, 2004.
6. Ott H W,” Noise Reduction Techniques in Electronic System. ,” (2) John Wiley & Sons New York, 1988.
7. Manual on product design: IISc C.E.D.T.
8. C.L.Albert and D.A. Coggan,””Fundamentals of Industrial Control”,ISA, 1992.
9. R. W. Zape, “Valve selection hand book third edition”, Jaico publishing house,2003.
10. Curtis Johnson, “Process Control Instrumentation Technology”, PHI /Pearson Education 2002.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDLO8041	Expert System	4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment (20)			End sem Exam				
		Test 1	Test2	Avg.					
ISDLO8041	Expert System	20	20	20	80	-	-	-	100

Subject Code	Subject Name	credits
ISDLO801	Expert System	4
Course objective	1. To provide an understanding on the fundamentals of neural network and fuzzy systems. 2. To learn the different intelligent techniques for control 3. To gain knowledge in Expert systems 4. To gain knowledge in genetic algorithm.	
Course Outcome	The students will able to 1. Identify various networks and learning algorithms in artificial neural network (ANN). 2. Define Fuzzy set, rules and membership function and also defuzzification for a given problem. 3. Identify areas of application for Expert Systems. 4. Apply the concepts of ANN and Fuzzy Logic in solving engineering problems and implementing controllers. 5. Discuss various concepts of Genetic Algorithm 6. Identify various hybrid control strategies.	

Details of syllabus:

Prerequisite: Knowledge of control systems, optimization technique, expert system, Neural network and Genetic algorithm.

Module	Contents	Hrs	CO Mapping
1	**Introduction to Artificial Neural Network (ANN)** Neuron, nerve structure and synapse –Artificial Neuron and its model, activation functions, neural network architecture –Single Layer Perceptron– Multi Layer Perceptron – Back propagation algorithm (BPA). Supervised and Unsupervised learning. Associative Networks - Hopfield networks, Boltzmann machines.	09	CO1
2	**Introduction to Fuzzy Logic** Fuzzy set theory – Fuzzy sets – Operation on Fuzzy sets – Scalar cardinality, fuzzy cardinality, union and intersection, complement, equilibrium points, aggregation, projection, composition, decomposition, cylindrical extension, fuzzy relation – Fuzzy membership functions, De- fuzzification.	09	CO2
3	**Introduction to Expert System** What are Expert Systems, Features of Expert System, Basic activities of expert system and the areas in which they solve problems, Prospector systems-features, working. Knowledge representation in expert systems- using rules semantic nets, frames, Types of tools available for expert system building, Stages in the development of expert system tools. Building an Expert system.	09	CO3
4	**Neural Networks and Fuzzy Logic for Control** Familiarization of Neural Network Control and Fuzzy Tool Box. Development of PID control using ANN and Fuzzy Logic.	06	CO4
5	**Genetic Algorithm** Basic concept of Genetic algorithm – flow chart of GA – Genetic representations – encoding – Initialization and selection, Genetic operators– Mutation, Generational Cycle, applications – Concepts on search techniques – Tabu search, Ant-colony search and Particle Swarm Optimization (PSO).	09	CO5
6	**Hybrid Control Schemes** Neuro fuzzy systems –Adaptive neuro fuzzy inference system (ANFIS) – Optimization of membership function and rule base using Genetic Algorithm and PSO – Case study – Introduction to Support Vector Regression – Familiarization of ANFIS Tool Box.	06	CO6

Internal Assessment:

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

Theory Examination:

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

Text Books:

1. Stamatios V. Kartalopolous, .Understanding Neural Network and Fuzzy Logic., PHI Pvt Ltd.
2. Kishan Mehrotra, .Elements of ANN., 2nd Editon, Penram International Publishing (I) Pvt.Ltd.
3. Donald A. Waterman, "A Guide to Expert Systems", Addison-Wesley Publishing Company
4. David Goldberg. V "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2009

References:

1. Laurene. V, Fausett, "Fundamentals of Neural Networks, Architecture, Algorithms, and Applications", Pearson Education, 2008.
2. Timothy. J, Ross, "Fuzzy Logic with Engineering Applications", Wiley, Third Edition, 2010.
3. Zimmermann. H.J, "Fuzzy set theory-and its Applications"- Springer international edition, 2011.
4. Miller W.T, Sutton . R.S and Webrose . P.J, "Neural Networks for Control", MIT Press, 1996.
5. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill-2008.
6. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007. (Unit-III).
7. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007.
8. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2007
9. Deepak Khemani "Artificial Intelligence", Tata Mc Graw Hill Education 2013.
10. Laurance Fausett, Englewood Cliffs, N.J., 'Fundamentals of Neural Networks', Pearson Education,1992.
11. Timothy J. Ross, 'Fuzzy Logic with Engineering Applications', Tata McGraw Hill, 1997.
12. S.N.Sivanandam and S.N.Deepa, Principles of Soft computing, Wiley India Edition, 2nd Edition,2013
13. Simon Haykin, 'Neural Networks', Pearson Education, 2003.
14. John Yen & Reza Langari, 'Fuzzy Logic – Intelligence Control & Information', Pearson

Education,New Delhi, 2003.
15. M.Gen and R,Cheng, Genetic algorithms and optimization, Wiley Series in Engineering Design and Automation, 2000.
16. Hagan, Demuth, Beale, " Neural Network Design", Cengage Learning, 2012.
N.P.Padhy, " Artificial Intelligence and Intelligent Systems", Oxford, 2013.
17. William S.Levine, "Control System Advanced Methods," The Control Handbook CRC Press 2011.
18. http://nptel.ac.in

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISDLO8042	Optimal Control System	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg.					
ISDLO8042	Optimal Control System	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDLO8042	Optimal Control System	4
Course Objective	1. To make students understand the optimal control problems their types and how to solve them by calculus of variation and dynamic programming approaches. 2. To make student to understand the linear regulator and tracking systems, discrete time optimal control systems.	
Course Outcome	The students will be able to 1. Identify various optimal control problems with performance measure with minimum time, minimum fuel, minimum energy, terminal cost and general problems. 2. Describe the principle of calculus of variation, wherein to determine a function that minimizes a specified functional. 3. Derive the necessary conditions for optimal control problem, and optimal law for the linear regulator problem. 4. Apply variational calculus for solving discrete linear quadratic regulator and tracking problems. 5. Explain the method of dynamic programming leading to a functional equation that is amenable to solution by using simulation software. 6. Solve optimal control problems.	

Details of Syllabus:

Prerequisite: Knowledge of Linear algebra, Fourier Series, and differential calculus.

Module	Topic	Hrs	CO
1	**Introduction**: Formulation of optimal control problem, Performance measure, selecting a performance measure.	04	CO1
2	**Calculus of variation I** Fundamental concepts: functional, Linearity of functional, closeness, increment, variation, maxima and minima of functional, fundamental theorem of calculus of variation. Extremum of functional of single function: fixed and free end point problems, Extremum of functional of several independent function: fixed and free end point problems.	10	CO2

3	**Calculus of variation II** Constrained extremum of functions: elimination method, Lagrange multiplier method Constrained extremum of functionals: point constraint, differential equation constraints, isoperimetric constraints. The Variational approach to optimal control problems: necessary conditions for optimal control for different boundary conditions	10	CO3
4	**Linear Regulator and Tacking Systems:** Linear Quadratic Regulator(LQR): Finite time LQR and infinite time LQR Linear Quadratic Tracking Systems: Finite and infinite time Cases	06	CO4
5	**Discrete time Optimal control systems**: variational calculus for discrete time systems, Discrete time LQR and tracking systems	06	CO5
6	**Dynamic Programming**: Principle of optimality, application of principle of optimality to decision making, dynamic programming applied to routing problem, Hamilton-Jacobi-Bellman (HJB) equation, LQR system using HJB equation	12	CO6

Internal Assessment:

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

Theory Examination:

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

Text Books.

1. D. S. Naidu, Optimal Control System, CRC Press LLC - 2003,
2. D. E. Kirk, Optimal Control Theory - An Introduction, Dover Publication, New York – 1998.

Reference Books

1. B.D.O. Anderson and J.B. Moore. Optimal Control, Linear Quadratic Methods. Prentice-Hall Inc., Englewood Cliffs, NJ, 1989.
2. H. Kwakernaak and R. Sivan. Linear Optimal Control Systems. Wiley-Interscience, New York, 1972.
3. A. Sage. Optimum systems control. Prentice Hall, 2nd edition, 1977
4. F. L. Lewis and V. L. Syrmos. Optimal Control theory. Wiley Interscience, 2nd edition, 1995.
5. R. D. Robinett, D. G. Wilson, G. R. Eisler, and J. E. Hurtado. Applied dynamic programming for optimization of dynamical systems. Advances in Design and Control. SIAM,Philadelphia, 2005.
6. K. Ogata, Discrete Time Control System, Second Edition, PHI, Inc. 1995.

Course Code	Course Name	Teaching Scheme (Contact HOURS)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut	Total
ISDLO8043	Internet of Things (IOT)	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.					
ISDLO8043	Internet of Things (IOT)	20	20	20	80	-		-	100

Subject Code	Subject Name	credits
ISDLO8043	Internet of Things (IOT)	4
Course objective	1. To teach fundamentals of IoT 2. To study data and knowledge management and use of devices in IoT technology. 3. To understand IoT architecture and Integration of embedded devices with IoT 4. To understand concept of IoT. 5. To learn designing of industrial internet systems. 6. To study overview of Android/ IOS app development tools and Internet of Everything	
Course Outcome	Students will be able to- 1. Demonstrate the knowledge of operation of IoT architecture 2. Identify the various technologies for implementing IoT 3. Discuss various communication Technologies used in IoT 4. Discuss various communication models and protocols used in IoT 5. Discuss about the role of cloud computing in IoT 6. Illustrate the application of IoT in Industrial Automation and identify Real World Design Constraints.	

Details of Syllabus:

Module	Content	Hrs	CO Mapping
1	**Introduction to Internet of Things: An Overview** Introduction – Definition and characteristics of IoT, Physical design of IoT- Things in IoT, IoT protocol, Logical design of IoT – IoT functional blocks, IoT Communication Models, IoT communication APIs.	06	CO1
2	**IoT Enabling Technology** Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems. **IOT Levels and Deployment Templates.**	06	CO2

3	**Introduction to Communication Technologies** 802.15.4,ZigBee, BLE, WiFi, LORA,GSM basic protocol ,topologies, data rate, range, power, computations/bandwidth, QoS	12	CO3
4	**Communication Model and Protocols** M2M vs IOT ,Resource Management, Registration, Discovery Data Exchange Formats - XML & JSON , MQTT Protocol , RESTFul Architecture , HTTP REST Model , CoAP Protocol	12	CO4
5	**Basics of Cloud Computing** Cloud Based Architecture, Basics of Virtualization º Specific Characteristics that Define a Cloud , Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) Cloud Delivery Models , Public Cloud, Private Cloud, Hybrid Cloud and Community Cloud Deployment Models ,Benefits, Challenges and Risks of Cloud Computing Platforms and Cloud Services	06	CO5
6	**Case Studies of IOT** Home (Smart Lighting and Intrusion detection), Cities(Smart Parking, Garbage collection),Environment(Pollution detection, Forest Fire Detection), Power (Smart Grid) , Retail(Inventory Management) , Logistics(Fleet Tracking) Industry(Machine Diagnosis & Prognosis), Heath(Monitoring and Detection) , Agriculture(Green House Monitoring ,Animal Husbandry.	06	CO6

Internal Assessment:

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

Theory Examination:

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

Text Books:

1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.
2. Cloud Computing Black Book Edition-2014 by Jagannath Kallakurchi Wiley India

Reference Books:

1. Francis DaCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013
2. Wimer Hazenberg, Menno Huisman and Sara Cordoba Rubino, "Meta Products: Building the Internet of Things", BIS publishers.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
ISDLO8044	Power Plant Instrumentation	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.					
ISDL08044	Power Plant Instrumentation	20	20	20	80	-	-	-	100

Subject Code	Subject Name	credits
ISDLO8044	Power Plant Instrumentation	4
Course objectives	1. To create awareness of energy resources and its scenario in India and worldwide. 2. To study the concept of power generation using various resources. 3. To study the role of Instrumentation in various power plants. 4. To study and compare various power plants for optimal performance. 5. To acquire students the knowledge about hazards and safety in handling power plants.	
Course Outcomes	The students will be able to: 1. Identify the energy sources and explain power generation. 2. Describe operation and control of various equipment in thermal power plant. 3. Select the sites for hydroelectric power plants and explain its operation. 4. Explain the power generation and control of Nuclear power plant. 5. Describe the non-conventional energy resources. 6. Compare different types of power plants.	

Details of Syllabus:

Prerequisite: Knowledge of energy resources, types of power plants and power generation.

Module	Content	Hrs	CO Mapping
1	**Introduction:** Energy sources, their availability, worldwide energy production, energy scenario of India. Introduction to Power generation, load curve, load factor. Classification of energy generation resources.	04	CO1
2	**Thermal Power Plant**- Method of power generation, layout and energy conversion process. Types of Turbines & their control. Types of Boilers and their control. Types of Generators and their control, Condensers. Types of Pumps and Fans, variable speed pumps and Fans, Material handling system, study of all loops-water, steam, fuel etc. Schematics of Gas turbine and Diesel power plant. Application of DCS in power plants.	14	CO2
3	**Hydroelectric Power Plant**- Site selection, Hydrology, Estimation electric power to be developed, classification of Hydropower plants. Types of Turbines for hydroelectric power plant, pumped storage plants, storage reservoir plants.	06	CO3
4	**Nuclear Power Plant –** Concept of energy generation from nuclear fission, control of chain reaction. Schematics of Nuclear power plant, types of reactors, reactor control, safety measures.	08	CO4
5	**Non-conventional Energy Resources** – **Wind Energy:** Power in wind, Conversion of wind power, Aerodynamics of wind turbine, types of wind turbine and their modes of operation, power control of wind turbines, Betz limit, Pitch & Yaw control, wind mill, wind pumps, wind farms, different generator protections, safety. **Solar Energy:** Solar resource, solar energy conversion systems. Solar PV technology: Block diagram of PV system, advantages and limitations. Solar thermal energy system: Principle, solar collector and its types, solar concentrator and its types, safety. Introduction to Modern Biomass, Bio-fuels, Geothermal energy, Tidal energy and Ocean thermal energy.	12	CO5
6	Comparison of different types of power plant: thermal power plant, hydro electric power plant, wind, solar, nuclear power plant on the basis of: Performance, efficiency, site selection, Economics-capital and running, safety. Introduction to Hybrid Power Generation concept.	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. P. K. Nag, Power plant engineering, 3rd edition, 2010. McGraw Hill.
2. K. Krishnaswamy, M. Ponni Bala, ,Power Plant Instrumentation, 2011, Prentice Hall India.
3. R. K. Rajput, A Textbook of Power Plant Engineering, 2010, Laxmi Publications.

Reference Books:

1. Domkundwar, Power Plant Engg.
2. B. H. Khan, Non-conventional energy resources, McGraw Hill, New Delhi.
3. Chetan Singh Solanki, Renewable energy Technology, Prentice Hall Publication.
4. S. P. Sukhatme, Solar Energy, Tata McGraw Hill, New Delhi.
5. G. D. Rai, Nonconventional energy sources, Khanna Publication.
6. Dickinson & Cheremision off, Solar Energy Technology vol I & II.
7. Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi ,Wind Energy Handbook (2001), John Wiley & Sons, ISBN: 0471489972.
8. James Manwell, J. F. Manwell, J. G. McGowan, Wind Energy Explained: Theory, Design and Application (2002), John Wiley and Sons Ltd, ISBN: 0471499722
9. Z. Lubosny, Wind Turbine Operation in Electric Power Systems (2003), Springer-Verlag New York, Inc ; ISBN: 354040340X.
10. Z. Lubosny, Wind Turbine Operation in Electric Power Systems (2003), Springer-Verlag New York, Inc ; ISBN: 354040340X.
11. G.F. Gilman, Boiler Control Systems Engineering, 2005, ISA Publication.

Sub code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract	Tut.	Total
ISDLO8045	Functional Safety	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.					
ISDLO8045	Functional safety	20	20	20	80	--	-	--	100

Subject Code	Subject Name	Credits
ISDLO8045	Functional Safety	4
Course Objectives	To make the students aware of basic concepts of safety instrumented system, standards and risk analysis techniques.	
Course Outcomes	The students will be able to 1. Define the role of Safety instrumented system in the industry. 2. Describe steps involved in Safety life cycle 3. Explain process and safety control with SIS technologies. 4. Learn types of events and combined probability calculations. 5. Identify and analyse the hazards 6. Determine the Safety integrity level.	

Details of Syllabus:

Prerequisite: Digital Electronics, transducers and Process Control.

Module	Contents	Hrs.	CO Mapping
1	**Introduction :** Safety Instrumented System (SIS) - need, features, components, difference between basic process control system and SIS, Risk: how to measure risk, risk tolerance, Safety integrity level, safety instrumented functions. Standards and Regulation – HSE-PES, AIChE-CCPS, IEC-61508, IEC 61511 (2-16), ANSI/ISA-84.00.01-2004 (IEC 61511 Mod) & ANSI/ISA – 84.01-1996.9, NFPA 85.10, API RP 556,11 , API RP 14C,11, OSHA (29 CFR 1910.119 – Process Saftey Management of Highly Hazardous Chemicals)	06	CO1
2	**Safety life cycle:** Standards and safety life cycle, analysis phase, realisation phase, operations phase Allocation of Safety Functions to Protection Layers, Develop Safety Requirements Specifications, SIS Design and Engineering, Installation,	06	CO2

	Commissioning and Validation, Operations and Maintenance, Modification, De-commissioning.		
3	**Process Control** Active / Dynamic , Safety Control – Passive / Dormant, Demand Mode vs. Continuous Mode, Separation of Control and Safety Systems - HSE-PES, AIChE-CCPS, IEC-61508, Common Cause and Systematic or Functional Failures, **Protection Layers**: Prevention and mitigation layers, SIS Technologies: Pneumatic Systems, Relay Systems, Solid State Systems, Microprocessors / PLC (Software based) Systems	08	CO3
4	**Rules of Probability:** Assigning probability to an event, types of events and event combination, combining event probabilities, fault tree analysis, failure rate and probability, simplifications and approximations.	08	CO4
5	**Process Hazard Analysis:** Consequence analysis: Characterisation of potential events, dispersion, impacts, occupancy considerations, consequence analysis tools. Likelihood analysis: estimation and statistical analysis, fault propagation, event tree analysis and fault tree analysis, Quantitative layer of protection analysis: multiple initiating events, estimating initiating event frequencies and IPL failure probabilities HAZOP and SIL calculation and verification.	12	CO5
6	**Determining the Safety Integrity Level (SIL) :** Evaluating Risk, Safety Integrity Levels, SIL Determination Method : As Low As Reasonably Practical (ALARP), Risk matrix, Risk Graph, Layers of Protection Analysis (LOPA) .	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 weight age of each module will be proportional to number of respective Lecture hours as mentioned in the syllabus.

Reference Books:

1. Paul Gruhn and H Jarry L. Cheddie," Safety Instrumented systems: Design, Analysis and Justification", ISA , 2nd edition, 2006
2. Dr. Eric W Scharpf, Heidi J Hartmann, Harlod W Thomas, " Practical SIL target selection : Risk analysis per the IEC 61511 safety Lifecycle", exida,2012.
3. Ed Marszal, Eric W Scharpf , "Safety Integrity Level Selection", ISA.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
ILO8021	**Project Management (abbreviated as PM)**	**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.				
ILO8021	Project Management	20	20	20	80	03	-	100

Course Objectives	• To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques. • To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.
Course Outcomes	Student will be able to… • Apply selection criteria and select an appropriate project from different options. • Write work break down structure for a project and develop a schedule based on it. • Identify opportunities and threats to the project and decide an approach to deal with them strategically. • Use Earned value technique and determine & predict status of the project. • Capture lessons learned during project phases and document them for future reference

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

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

Books Recommended:

Reference Books:

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

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**
ILO8022	**Finance Management (abbreviated as FM)**	**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.				
ILO8022	Finance Management	20	20	20	80	03	-	100

Course Objectives	• Overview of Indian financial system, instruments and market • Basic concepts of value of money, returns and risks, corporate finance, working capital and its management • Knowledge about sources of finance, capital structure, dividend policy
Course Outcomes	Student will be able to… • Understand Indian finance system and corporate finance • Take investment, finance as well as dividend decisions

Module	Contents	Hours
1	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market. **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	6
2	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	6
3	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market	9

	Ratios; Limitations of Ratio Analysis.	
4	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10

Books Recommended:

Reference Books:

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

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**
ILO8023	**Entrepreneurship Development and Management (abbreviated as EDM)**	**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.				
ILO8023	Entrepreneurship Development and Management	20	20	20	80	03	-	100

Course Objectives	• To acquaint with entrepreneurship and management of business • Understand Indian environment for entrepreneurship • Idea of EDP, MSME
Course Outcomes	Student will be able to… • Understand the concept of business plan and ownerships • Interpret key regulations and legal aspects of entrepreneurship in India • Understand government policies for entrepreneurs

Module	Contents	Hours
1	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	4
2	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	9
3	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	5
4	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies	8

	of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
5	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	8
6	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	5

Books Recommended:

Reference Books:

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

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	**Course Name**	**Teaching Scheme**	**Credits Assigned**

Code		(Contact Hours)				
		Theory	Tutorial	Theory	Tutorial	Total
ILO8024	**Human Resource Management (abbreviated as HRM)**	**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.				
ILO8024	Human Resource Management	20	20	20	80	03	-	100

Course Objectives	• To introduce the students with basic concepts, techniques and practices of the human resource management. • To provide opportunity of learning Human resource Management (HRM) processes, related with the functions, and challenges in the emerging perspective. • To familiarize the students about the latest developments, trends & different aspects of HRM. • To acquaint the student with the importance of behavioral skills, Inter-personal, inter- group in an organizational setting. • To prepare the students as future organizational change facilitators, stable leaders and managers, using the knowledge and techniques of human resource management.
Course Outcomes	Learner will be able to… • Gain knowledge and understand the concepts about the different aspects of the human resource management. • Understand and tackle the changes and challenges in today's diverse, dynamic organizational setting and culture. • Utilize the behavioral skill sets learnt, in working with different people, teams & groups within the national and global environment. • Apply the acquired techniques, knowledge and integrate it within the engineering/ non engineering working environment emerging as future engineers and managers.

Module	Contents	Hours
1	**Introduction to HR:** Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	05
2	**Organizational Behavior (OB) :** Introduction to OB Origin, Nature and	07

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

Books Recommended:

Reference Books:

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

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**
ILO8025	**Professional Ethics and Corporate Social Responsibility (abbreviated as PECSR)**	**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.				
ILO8025	Professional Ethics and Corporate Social Responsibility	20	20	20	80	03	-	100

Course Objectives	• To understand professional ethics in business • To recognized corporate social responsibility
Course Outcomes	Student will be able to… • Understand rights and duties of business • Distinguish different aspects of corporate social responsibility • Demonstrate professional ethics • Understand legal aspects of corporate social responsibility

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

	Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	
5	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
6	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Books Recommended:

Reference Books:

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

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**
ILO8026	**Research Methodology (abbreviated as RM)**	**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.				
ILO8026	Research Methodology	20	20	20	80	03	-	100

Course Objectives	• To understand Research and Research Process • To acquaint students with identifying problems for research and develop research strategies • To familiarize students with the techniques of data collection, analysis of data and interpretation
Course Outcomes	Student will be able to… • Prepare a preliminary research design for projects in their subject matter areas • Accurately collect, analyze and report data • Present complex data or situations clearly • Review and analyze research findings

Module	Contents	Hours
1	**Introduction and Basic Research Concepts:** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology, Need of Research in Business and Social Sciences , Objectives of Research, **Issues** and Problems in Research, Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	10
2	**Types of Research:** Basic Research, Applied Research, Descriptive Research, Analytical Research, Empirical Research, Qualitative and Quantitative Approaches	08
3	**Research Design and Sample Design :** Research Design – Meaning, Types and Significance, Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	08
4	**Research Methodology :** Meaning of Research Methodology, Stages in Scientific Research Process **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis	08

	e. Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	
5	**Formulating Research Problem:** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
6	**Outcome of Research:** Preparation of the report on conclusion reached, Validity Testing & Ethical Issues, Suggestions and Recommendation	04

Books Recommended:

Reference Books:

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

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**
ILO8027	**IPR and Patenting (abbreviated as IPRP)**	**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.				
ILO8027	IPR and Patenting	20	20	20	80	03	-	100

Course Objectives	• To understand intellectual property rights protection system • To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures • To get acquaintance with Patent search and patent filing procedure and • applications
Course Outcomes	Student will be able to… • understand Intellectual Property assets • assist individuals and organizations in capacity building • work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Contents	Hours
1	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
2	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
3	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	06
4	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications	07

	(e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	
5	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
6	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Books Recommended:

Reference Books:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield,2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph&Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. PrabhuddhaGanguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar andmohdIqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. KompalBansal and PraishitBansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, PritiMathur, AnshulRathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005,Intellectual Property Rights for Engineers,IET

15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

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**
ILO8028	**Digital Business Management (abbreviated as DBM)**	**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.				
ILO8028	Digital Business Management	20	20	20	80	03	-	100

Course Objectives	• To familiarize with digital business concept • To acquaint with E-commerce • To give insights into E-business and its strategies
Course Outcomes	Student will be able to ….. • Identify drivers of digital business • Illustrate various approaches and techniques for E-business and management • Prepare E-business plan

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

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

Books Recommended:

Reference Books:

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

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**
ILO8029	**Environmental Management (abbreviated as EVM)**	**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.				
ILO8029	Environmental Management	20	20	20	80	03	-	100

Course Objectives	• Understand and identify environmental issues relevant to India and global concerns • Learn concepts of ecology • Familiarise environment related legislations
Course Outcomes	Student will be able to… • Understand the concept of environmental management • Understand ecosystem and interdependence, food chain etc. • Understand and interpret environment related legislations

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

Books Recommended:

Reference Books:

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

Assessment:

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Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL801	Instrumentation Project Documentation and Execution- Lab Practice	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Theory(out of 100)				Term work	Pract. And oral	Oral	Total
		Internal Assessment			End sem exam				
		Test1	Test2	Avg.					
ISL801	Instrumentation Project Documentation and Execution- Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	Credits
ISL801	Instrumentation Project Documentation and Execution	1
Course objective	1. To provide knowledge of types and execution of I&C type project 2. This Course aims to explain Project deliverables and engineering activities of project documentation. 3. To get acquainted with commercial software used for documentation.	
Course Outcome	The students will able to 1. Apply standards used in instrumentation project for preparation of deliverables. 2. Interpret, design and construct documents such as PFD , P&ID, Index sheet. 3. Apply ISA specification data sheet / loop standard, to prepare Instrument specification sheet and construct loop wiring diagram. 4. Interpret, design and construct Hook-up diagram, and develop skill to prepare different project schedule. 5. Select and apply procurement, installation procedure and pre-commissioning and commissioning activities with Inspection. 6. Select and support documentation software packages used in industry.	

Syllabus: Same as that of Subject ISC801 Instrumentation Project Documentation and Execution.

List of Laboratory Experiments/ Assignments:

Sr. No.	Detailed Content	CO Mapping
1	Summarize instrument/unit symbols and identification, tagging and line designation procedure from ISA/ANSII Standard	**CO1**
2	Apply symbols and identification standard for preparation of graphical document such as Process Flow Diagrams.	**CO2**
3	To develop of Piping & Instrumentation Diagram using PFD of Expt-2.	**CO2**
4	Prepare instrument index sheet for tags used in P&ID of Expt-3.	**CO2**
5	Prepare ISA specification forms (for temperature, pressure, level ,flow instruments, CV)	**CO3**
6	Develop loop wiring diagram of pneumatic and electronic loops.	**CO3**
7	Develop sample hook-up drawing and prepare BOM.	**CO4**
8	Study and Development of Detailed Engineering schedules.(Project schedule / Cable schedule / JB schedule / AH schedule)	**CO4**
9	Learn procedure to perform pre-commissioning activities.(Hydro Test / Loop checking / Trouble shooting /calibration of DPT or Control valve etc)	**CO5**
10	Survey of instrumentation software and study different features	**CO6**

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

Term Work:
Term work shall consist of Laboratory work which includes minimum study of eight experiments/ assignments / Creation of Documents
Other task: (Optional) Visit to any one Engineering consultants office /organizations to understand their Working Environment & submission of Report.

The distribution of marks for term work shall be as follows:
Laboratory work (Experiments/Assignments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance (Theory and Practical) : 05 Marks

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

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL 803	Expert System- Lab Practice	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Theory(out of 100)				Term work	Pract. And oral	Oral	Total
		Internal Assessment			End sem exam				
		Test1	Test2	Avg.					
ISL 803	Expert System- Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	Credits
ISL803	Expert System- Lab Practice	1
Course objective	1. To provide an understanding on the fundamentals of neural network and fuzzy systems. 2. To learn the different intelligent techniques for control 3. To gain knowledge in Expert systems 4. To gain knowledge in genetic algorithm.	
Course Outcome	The students will able to 1. Identify various networks and learning algorithms in artificial neural network. 2. Define Fuzzy set, rules and membership function and also defuzzification for a given problem. 3. Identify areas of application for Expert Systems. 4. Apply the concepts of ANN and Fuzzy Logic in solving engineering problems and implementing controllers. 5. Discuss various concepts of Genetic Algorithm 6. Identify various hybrid control strategies.	

Syllabus: Same as that of Subject ISDLO8041 Expert System.

List of Laboratory Experiments/ Assignments:

Sr. No.	Detailed Content	CO Mapping
1	Example for Perceptron learning	**CO1**
2	Multilayer Feedforward neural networks	**CO1**
3	Hopfield model for pattern storage task	**CO1**
4	Solution to travelling salesman problem using ANN	**CO1**
5	Temperature controller using Fuzzy logic	**CO2**
6	Washing machine control using Fuzzy logic	**CO2**
7	Design of PID control using ANN and Fuzzy Toolbox.	**CO4**
8	Assignment on Expert systems	**CO3**
9	Assignment on Expert Systems	**CO3**
10	Assignment on Genetic algorithm	**CO5**
11	Assignment on Hybrid control schemes	**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.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL803	Internet of Things- 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.					
ISL803	Internet of Things- Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	Credits
ISL803	Internet of Things- Lab Practice	1
Course objectives	1. To impart knowledge about fundamentals of IoT 2. To describe data and knowledge management and use of devices in IoT technology. 3. To give knowledge of IoT architecture and Integration of embedded devices with IoT 4. To explain the concept of IIoT. 5. To impart knowledge about designing of industrial internet systems. 6. To describe overview of Android/ IOS app development tools and Internet of Everything	
Course Outcomes	The students will be able to : 1. Use microcontroller based embedded platforms in IOT 2. Use microprocessor based embedded platforms in IOT 3. Use wireless peripherals for exchange of data. 4. Make use of Cloud platform to upload and analyse any sensor data 5. Use of Devices, Gateways and Data Management in IoT. 6. Use the knowledge and skills acquired during the course to build and test a complete, working IoT system involving prototyping, programming and data analysis.	

Syllabus: Same as that of Subject **ISDLO8043 Internet of Things**.

List of Suggested Laboratory Experiments:

Sr. No.	Detailed Content	CO Mapping
1	Introduction to Arduino platform and programming	CO1
2	Interfacing Arduino to Zigbee module	CO1,CO3
3	Interfacing Arduino to GSM module	CO1,CO3
4	Interfacing Arduino to Bluetooth Module	CO1,CO3
5	Introduction to Raspberry PI platform and python programming	CO2

6	Interfacing sensors to Raspberry PI	CO2
7	Communicate between Arduino and Raspberry PI using any wireless medium	CO1,CO2,CO3
8	Setup a cloud platform to log the data	CO4
9	Log Data using Raspberry PI and upload to the cloud platform	CO5
10	Design an IOT based 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 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) : 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
ISL803	Power Plant Instrumentation -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.					
ISL803	Power Plant Instrumentation- Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	Credits
ISL803	**Power Plant Instrumentation- Lab Practice**	**1**
Course objectives	To create awareness of energy resources and its scenario in India and worldwide. 1. To study the concept of power generation using various resources. 2. To study the role of Instrumentation in various power plants. 3. To study and compare various power plants for optimal performance. 4. To acquire students the knowledge about hazards and safety in handling power plants.	
Course Outcomes	The students will be able to: 1. Identify the energy sources and explain power generation. 2. Describe operation and control of various equipment in thermal power plant. 3. Select the sites for hydroelectric power plants and explain its operation. 4. Explain the power generation and control of Nuclear power plant. 5. Describe the non-conventional energy resources. 6. Compare different types of power plants.	

Syllabus: Same as that of Subject ISDLO8044 Power Plant Instrumentation.

List of Laboratory Experiments/ Assignments:

Sr. No.	Detailed Content	CO Mapping
1	Assignment on Energy Sources	**CO1**
2	Assignment on Thermal Power plant	**CO2**
3	Assignment on Hydroelectric power plant	**CO3**
4	Assignment on Nuclear Power plant	**CO4**
5	Assignment on Nonconventional Energy Resources	**CO5**
6	Assignment on Comparison of various power plants	**CO6**
7	Assignment on Introduction to Hybrid Power generation concept	**CO6**

Additional experiments/assignments based on syllabus which will help students to understand topic/concept can be considered.

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			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL803	Functional Safety- 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.					
ISL803	Functional Safety - Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	Credits
ISL803	**Functional Safety- Lab Practice**	**1**
Course objectives	To make the students aware of basic concepts of safety instrumented system, standards and risk analysis techniques.	
Course Outcomes	The students will be able to 1. Define the role of Safety instrumented system in the industry. 2. Describe steps involved in Safety life cycle 3. Explain process and safety control with SIS technologies. 4. Learn types of events and combined probability calculations. 5. Identify and analyse the hazards 6. Determine the Safety integrity level.	

Syllabus: Same as that of Subject ISDLO8045 Functional Safety.

List of Laboratory Experiments/ Assignments:

Sr. No.	Detailed Content	CO Mapping
1	Assignment on Introduction to Functional safety	CO1
2	Assignment on Safety Life cycle	CO2
3	Assignment on Protection layers and SIS technologies	CO3
4	Assignment on Rules of Probability- types of events, numerical	CO4
5	Assignment on Rules of Probability – numerical on event tree and fault tree analysis	CO4
6	Assignment on Consequence analysis	CO5
7	Assignment on Process hazard	CO5
8	Assignment on SIL determination methods	CO6
9	Assignment on Fault propagation modelling techniques using Excel	CO5
10	Assignment on SIL determination using Excel	CO6
11	Case study	CO1-CO6

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

- Industry visit is advised to understand the Functional Safety subject.

Practical/Oral Examination:

Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum eight 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
ISL804	Project-II	-	12	-	-	6	-	6

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.					
ISL804	Project-II	-	-	-	-	100	-	50	150

Term Work:

The final year students have already under gone project assignment in their seventh semester and in this semester the students are expected to continue the project work of stage I.

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:

1. Scope and objective of the project work.
2. Extensive Literature survey.
3. Progress of the work (Continuous assessment)
4. Design, implementation, and analysis of the project work.
5. Results, conclusions and future scope.
6. 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.