AC
Item No.

UNIVERSITY OF MUMBAI

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

FACULTY OF TECHNOLOGY

Instrumentation Engineering

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

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

From Co-coordinator's Desk:

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

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

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

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

Preamble:

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

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

Program Educational Objectives (PEOs)

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

Program Outcomes (POs)

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

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

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

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:

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			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) Internal Assessment			End sem Exam	Term work	Pract. and Oral	Oral	Total
		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.