AC Item No.



## 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	Teac	hing sche	eme	Credit assigned			
	Instrumentation	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
160001	Project							
15C801	Documentation	4	-	-	4	-	-	4
	and Execution							

		Examination scheme								
Subject Code		]	Theory (ou	it of 100	)		Draat			
	Subject Name	Internal Assessment			End sem Exam	Term work	and Oral	Oral	Total	
		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 tec in the EPC Consultancy.	chniques
	2. To make the students capable of executing Project Deliverables and Engla activities of Project Documentation.	ineering
Course	The students will able to:	
Outcome	<ol> <li>Interpret types of project and execute it by knowing relationship between cu designer and constructor.</li> </ol>	ustomer,
	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	n.
	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
1	<b>The Project and Project Team:</b> 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 <b>The Project Team:</b> Customer designer and constructor	10	CO1
2	<ul> <li>Standards used in instrumentation project: ISA, ANSI, &amp; ASTM, ASME, NFPA, NEMA, SAMA.</li> <li>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.</li> <li>1) Process Flow Diagram (PFD) and Material Balance Sheet (MBS)</li> <li>2) Piping and Instrumentation diagrams (P&amp;ID) – practical applications.</li> <li>3) Instrument Index Sheet</li> <li>4) Instrument specifications sheet- for temperature, pressure, level, flow instruments and control valves.</li> </ul>	08	CO2
3	<ul> <li>Engineering Documents Part-II</li> <li>1) Loop diagrams- pneumatic, electronic and digital data types.</li> <li>2) Instrument Location Plan</li> <li>3) Cable and Tray Routing and Cable Schedule</li> <li>4) JB Schedule</li> <li>5) Air header schedule</li> <li>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.</li> <li>7) BOM for erection</li> <li>8) Logic diagrams,</li> <li>9) SAMA flow diagram</li> </ul>	10	CO3
4	<b>Systems Integration:</b> 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	<ul> <li>Procurement, Installation and Commissioning:</li> <li>Procurement: Engineering Procurement procedure, PO format, preparation of tender documents, bids, technical bid evaluation.</li> <li>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.)</li> </ul>	10	CO5

	Documents for Inspection- Factory acceptance test (FAT) ,Site acceptance test (SAT). <b>Commissioning:</b> 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:	03	CO6
	Advantages of using software packages for documentation. Overview		
	of documentation software packages used in industry.		

## **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", 2<sup>nd</sup> 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, 1<sup>st</sup> 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	Tea	ching Sch	eme	Credits Assigned					
ISC802	Instrument and	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total		
	System Design	4	-	-	4	-	-	4		

Subject Code	Subject Name	Examination scheme							
			Theory	Marks(100	)	Torm	Pract. and Oral	Oral	Total
		Intern	al Assess	ment(20)	End Sem	work			
		Test1	Test2	Avg.	Exam	WULK			
	Instrument								
ISC802	and System	20	20	20	80	-	-	-	100
	Design								

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

# **Details of Syllabus:**

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

Module	Content	Hrs	СО
			Mapping
1	<b>Design of Transducers:</b> 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	<b>Design of Control Valve:</b> 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:	08	CO3
	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.		
4	Electronic product design:	08	CO4
	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.		
5	Reliability engineering:	04	CO5
	Reliability concepts, causes of failures, bath tub curve, Quality and reliability,		
	MTTF, MTBF, and MTTR. Availability and Maintainability. Redundancy and		
	redundant systems.		
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.
- Bela G. Liptak, "Instrument Engineer's Hand Book Process Control", Chilton Company, 3<sup>rd</sup> Edition, 1995.
- **4.** Andrew Williams, "Applied instrumentation in the process industries", 2<sup>nd</sup> Edition, Vol. 1 & 3, Gulf publishing company,1979.

- 1. Harshvardhan, "Measurement Principles and Practices", Macmillan India Ltd-1993
- 2. Balaguruswamy E, "Reliability", Tata McGraw-Hill Pub.co. New Delhi, 1999.
- 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.
- 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	Tead	Teaching scheme			Credit assigned					
	Expert	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total			
15DL08041	System	4	-	-	4	-	-	4			

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

	J.	cicuits						
ISDLO801	Expert System	4						
Course objective	. To provide an understanding on the fundamentals of neural network							
	and fuzzy systems.							
	2. To learn the different intelligent techniques for control	To learn the different intelligent techniques for control						
	3. To gain knowledge in Expert systems							
	4. To gain knowledge in genetic algorithm.							
Course Outcome Th	ne students will able to							
	<ol> <li>Identify various networks and learning algorithms in artific network (ANN).</li> <li>Define Fuzzy set, rules and membership function and also defuzzification for a given problem.</li> <li>Identify areas of application for Expert Systems.</li> <li>Apply the concepts of ANN and Fuzzy Logic in solving er problems and implementing controllers.</li> <li>Discuss various concepts of Genetic Algorithm</li> <li>Identify various hybrid control strategies.</li> </ol>	cial neural						

**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	<b>Introduction to Fuzzy Logic</b> 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	<b>Introduction to Expert System</b> 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	<b>Genetic Algorithm</b> 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	<b>Hybrid Control Schemes</b> 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 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.
- 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	<b>Optimal Control System</b>	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4	-	-	4

	Subject Name	Examination scheme								
		1	Theory (	out of 1	.00)	Tamm	Pract.			
Sub Code		Internal Assessment			End Sem	1 erm work	and	Oral	Total	
		Test1	Test2	Avg.	Exam	WOLK	Oral			
ISDLO8042	Optimal Control System	20	20	20	80	-	-	-	100	

Subject Code	Subject Name	Credits
ISDLO8042	Optimal Control System	4
Course Objective	<ol> <li>To make students understand the optimal control problems their ty to solve them by calculus of variation and dynamic programming a</li> <li>To make student to understand the linear regulator and track discrete time optimal control systems.</li> </ol>	/pes and how pproaches. ing systems,
Course Outcome	<ol> <li>The students will be able to</li> <li>Identify various optimal control problems with performance mminimum time, minimum fuel, minimum energy, terminal cost problems.</li> <li>Describe the principle of calculus of variation, wherein to determine that minimizes a specified functional.</li> <li>Derive the necessary conditions for optimal control problem, and for the linear regulator problem.</li> <li>Apply variational calculus for solving discrete linear quadratic matching problems.</li> <li>Explain the method of dynamic programming leading to a function that is amenable to solution by using simulation software.</li> <li>Solve optimal control problems.</li> </ol>	neasure with and general ne a function l optimal law regulator and onal equation

**Details of Syllabus:** 

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

Module	Торіс	Hrs	CO
1	Introduction: Formulation of optimal control problem, Performance	04	CO1
	measure, selecting a performance measure.		
2	Calculus of variation I	10	CO2
	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.		

3	Calculus of variation II	10	CO3
	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		
4	Linear Regulator and Tacking Systems:	06	CO4
	Linear Quadratic Regulator(LQR): Finite time LQR and infinite time LQR		
	Linear Quadratic Tracking Systems: Finite and infinite time Cases		
5	Discrete time Optimal control systems: variational calculus for discrete	06	CO5
	time systems, Discrete time LQR and tracking systems		
6	Dynamic Programming: Principle of optimality, application of principle of	12	CO6
	optimality to decision making, dynamic programming applied to routing		
	problem, Hamilton-Jacobi-Bellman (HJB) equation, LQR system using HJB		
	equation		

#### **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	Teaching Scheme (Contact HOURS)			Credit As	signed	
	Internet of	Theory	Pract.	Tut.	Theory	TW/Pract.	Tut	Total
ISDLO8043	Things (IOT)	4	-	-	4	-	-	4

	Subject Name	Examination scheme									
		T	heory (o	ut of 10	0)		Droot				
Sub Code		Internal Assessment			End	Term	and	Oral	Total		
		Test1	Test2	Avg.	sem Exam	work	Oral	Urai	I Utal		
ISDLO8043	Internet of Things (IOT)	20	20	20	80	-		-	100		

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

## **Details of Syllabus:**

Module	Content	Hrs	СО
			Mapping
1	Introduction to Internet of Things: An Overview	06	CO1
	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.		
2	IoT Enabling Technology	06	CO2
	Wireless Sensor Networks, Cloud Computing, Big Data		
	Analytics, Communication Protocols, Embedded Systems.		
	IOT Levels and Deployment Templates.		

3	Introduction to Communication Technologies	12	CO3
	802.15.4,ZigBee, BLE, WiFi, LORA,GSM		
	basic protocol ,topologies, data rate, range, power,		
	computations/bandwidth, QoS		
4	<b>Communication Model and Protocols</b>	12	CO4
	M2M vs IOT ,Resource Management, Registration, Discovery		
	Data Exchange Formats - XML & JSON, MQTT Protocol,		
	RESTFul Architecture, HTTP REST Model, CoAP Protocol		
5	Basics of Cloud Computing	06	CO5
	Cloud Based Architecture, Basics of Virtualization ° 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		
6	Case Studies of IOT	06	CO6
	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.		

## **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)", 1<sup>st</sup>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", 1<sup>st</sup> 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 As			
ISDLO8044	Power Plant Instrumentation	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
	Instrumentation	4	-	-	4	-	-	4

Subject Code				Ι	Examinatio	n scheme			
	Subject Name		Theory	Marks(100	))	T	Pract.		
	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	Internal Assessment(20) End Sem				l erm work	and Oral	Oral	Total
		Test1	Test2	Avg.	Exam		01ui		
ISDL08044	Power Plant Instrumentation	20	20	20	80	-	-	-	100

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

### **Details of Syllabus:**

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

Module	Content	Hrs	CO Mapping
1	<b>Introduction:</b> 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	<b>Thermal Power Plant</b> - 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	<b>Hydroelectric Power Plant</b> - 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	<ul> <li>Nuclear Power Plant – Concept of energy generation from nuclear fission, control of chain reaction.</li> <li>Schematics of Nuclear power plant, types of reactors, reactor control, safety measures.</li> </ul>	08	CO4
5	<ul> <li>Non-conventional Energy Resources –</li> <li>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 &amp; Yaw control, wind mill, wind pumps, wind farms, different generator protections, safety.</li> <li>Solar Energy: Solar resource, solar energy conversion systems. Solar PV technology: Block diagram of PV system, advantages and limitations.</li> <li>Solar thermal energy system: Principle, solar collector and its types, solar concentrator and its types, safety.</li> <li>Introduction to Modern Biomass, Bio-fuels, Geothermal energy, Tidal energy and Ocean thermal energy.</li> </ul>	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, 3<sup>rd</sup> 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	Teachi	ng Scheme	(Hrs)	Credits Assigned			
	Name	Theory	Pract.	Tut.	Theory	Pract	Tut.	Total
ISDLO8045	Functional Safety	4	-	-	4			4

		Examination Scheme								
		ſ	Theory(o	ut of 100	))					
Sub code	Subject Name	Internal Assessment (out of 20)			End Term		Pract. and	Oral	Total	
		Test 1	Test 2	Avg.	Exam	WUIK	oral			
ISDL 08045	Functional safety	20	20	20	80				100	
15DLU0045	F unctional 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	n, 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.	СО
			Mapping
1	Introduction :	06	CO1
	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)		
2	Safety life cycle:	06	CO2
	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,		

	Commissioning and Validation, Operations and Maintenance, Modification,		
	De-commissioning.		
3	Process Control	08	CO3
	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		
4	Rules of Probability:	08	CO4
	Assigning probability to an event, types of events and event combination,		
	combining event probabilities, fault tree analysis, failure rate and probability,		
	simplifications and approximations.		
5	Process Hazard Analysis:	12	CO5
	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.		
6	Determining the Safety Integrity Level (SIL):	08	CO6
	Evaluating Risk, Safety Integrity Levels, SIL Determination Method : As Low		
	As Reasonably Practical ( ALARP ), Risk matrix, Risk Graph, Layers of		
	Protection Analysis (LOPA).		

#### **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:**

- Paul Gruhn and H Jarry L. Cheddie," Safety Instrumented systems: Design, Analysis and Justification", ISA, 2<sup>nd</sup> 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	Course Name	Teaching (Contac	g Scheme t Hours)	Credits Assigned		
Code		Theory	Tutorial	Theory	Tutorial	Total
ILO8021	Project Management (abbreviated as PM)	3	-	3	-	3

		Examination Scheme							
Course									
code	Course Name	Interna	al Assess	ment	End	Exam	Term	Total	
coue		Test 1	Tost 2	Ava	Sem.	Duration	Work	Total	
		Test I	Test 2	Avg.	Exam	(Hrs.)			
ILO8021	Project Management	20	20	20	80	03	-	100	

Course Objectives	<ul> <li>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.</li> <li>To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.</li> </ul>
Course Outcomes	<ul> <li>Student will be able to</li> <li>Apply selection criteria and select an appropriate project from different options.</li> <li>Write work break down structure for a project and develop a schedule based on it.</li> <li>Identify opportunities and threats to the project and decide an approach to deal with them strategically.</li> <li>Use Earned value technique and determine &amp; predict status of the project.</li> <li>Capture lessons learned during project phases and document them for future reference</li> </ul>

Module	Contents	Hours
1	Project Management Foundation: Definition of a project, Project Vs	5
	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).	
2	Initiating Projects: How to get a project started, Selecting project	6
	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.	
3	Project Planning and Scheduling: Work Breakdown structure (WBS)	8
	and linear responsibility chart, Interface Co-ordination and concurrent	
	engineering, Project cost estimation and budgeting, Top down and	

	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	6
	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	
5	<b>Executing Projects:</b> Planning monitoring and controlling cycle.	8
-	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 creen. Project audit	
	<b>Project Contracting</b> Project procurement management contracting and	
	outsourcing	
6	Project Leadership and Ethics: Introduction to project leadership	6
0	ethics in projects Multicultural and virtual projects	0
	<b>Closing the Project:</b> Customer acceptance: Reasons of project	
	termination Various types of project terminations (Extinction	
	Addition Integration Starvation) Process of project terminations	
	completing a final report: doing a lassons learned analysis:	
	completing a final report, doing a ressons rearried analysis,	
	acknowledging successes and failures, Project management templates	
	and other resources; Managing without authority; Areas of further study.	

## **Reference Books:**

- 1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7<sup>th</sup>Ed.
- 2. A Guide to the Project Management Body of Knowledge (PMBOK<sup>®</sup> Guide), 5<sup>th</sup> 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

- 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 (Contac	g Scheme t Hours)	Credits Assigned				
		Theory	Tutorial	Theory	Tutorial	Total		
ILO8022	Finance Management (abbreviated as FM)	3	-	3	-	3		

		Examination Scheme							
Course	Course Name								
Course		Internal Assessment			End	Exam	Term	Total	
coue		Test 1	Tost 2	Ava	Sem.	Duration	Work	Total	
		Test I	Test 2	Avg.	Exam	(Hrs.)			
ILO8022	Finance Management	20	20	20	80	03	-	100	

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

Module	Contents	Hours
1	Overview of Indian Financial System: Characteristics, Components	6
	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	
2	Concepts of Returns and Risks: Measurement of Historical Returns	6
	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.	
3	Overview of Corporate Finance: Objectives of Corporate Finance;	9
	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	

	Ratios; Limitations of Ratio Analysis.	
4	Capital Budgeting: Meaning and Importance of Capital Budgeting;	10
	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.	

## **Reference Books:**

- 1. Fundamentals of Financial Management, 13<sup>th</sup> Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
- 2. Analysis for Financial Management, 10<sup>th</sup> Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
- 3. Indian Financial System, 9<sup>th</sup> Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
- 4. Financial Management, 11<sup>th</sup> 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

- 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 (Contac	g Scheme t Hours)	Credits Assigned				
		Theory	Tutorial	Theory	Tutorial	Total		
ILO8023	Entrepreneurship Development and Management (abbreviated as EDM)	3	-	3	-	3		

Course		Examination Scheme							
	Course Name								
code		Internal Assessment			End	Exam	Term	Total	
coue		Test 1	Test 2	Avg.	Sem.	Duration	Work	TOtal	
					Exam	(Hrs.)			
	Entrepreneurship								
ILO8023	Development and	20	20	20	80	03	-	100	
	Management								

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

Module	Contents	Hours
1	Overview Of Entrepreneurship: Definitions, Roles and	4
	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	
2	<b>Business Plans And Importance Of Capital To Entrepreneurship:</b>	9
	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	
3	Women's Entrepreneurship Development, Social entrepreneurship-role	5
	and need, EDP cell, role of sustainability and sustainable development	
	for SMEs, case studies, exercises	
4	Indian Environment for Entrepreneurship: key regulations and legal	8
	aspects, MSMED Act 2006 and its implications, schemes and policies	

	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	<b>Effective Management of Business:</b> 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

### **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

- 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	<b>Teaching Scheme</b>	Credits Assigned			

Code		(Contac	t Hours)			
		Theory	Tutorial	Theory	Tutorial	Total
	Human Resource					
ILO8024	Management	3	-	3	-	3
	(abbreviated as HRM)					

Examination Scheme						
rm ,	Total					
ork	Totai					
	100					
ി (	rm ork -					

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, Interpersonal, inter- group in an organizational setting.
	• To prepare the students as future organizational change facilitators, stable
	resource management.
	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,
Course	dynamic organizational setting and culture.
Outcomes	• 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					
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.					
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 Bahavior Motivation: Theories of	
	Metivation and their Applications for Dehavioral Change (Mealew	
	Mouvation and their Applications for Benavioral Change (Masiow,	
	Herzberg, McGregor); Group Benavior 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,	06
	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.	
4	Human resource Planning: Recruitment and Selection process, Job-	05
	enrichment, Empowerment - Job-Satisfaction, employee morale.	
	Performance Appraisal Systems: Traditional & modern methods,	
	Performance Counseling, Career Planning, Training & Development:	
	Identification of Training Needs, Training Methods	
5	<b>Emerging Trends in HR</b> • Organizational development: Business	06
	Process Re-engineering (BPR) BPR as a tool for organizational	
	development managing processes & transformation in HR	
	Organizational Change Culture Environment Cross Cultural	
	Landership and Decision Making: Cross Cultural Communication and	
	diversity at work. Causes of diversity managing diversity with anasial	
	diversity at work, Causes of diversity, managing diversity with special	
	reference to nandicapped, women and ageing people, intra company	
	cultural difference in employee motivation.	10
6	<b>HR &amp; MIS:</b> Need, purpose, objective and role of information system in	10
	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	
	Evolution of IR, IR issues in organizations, overview of Eabor Eaws in	
	India; Industrial Disputes Act, Trade Unions Act, Shops and	

### **Reference Books:**

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

### Assessment:

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- 4: Remaining question will be randomly selected from all the modules.

University of Mumbai									
Course Code	Course Name	Teaching (Contac	g Scheme t Hours)	Credits Assigned					
		Theory	Tutorial	Theory	Tutorial	Total			
ILO8025	Professional Ethics and Corporate Social Responsibility (abbreviated as PECSR)	3	-	3	-	3			

		Examination Scheme								
Course		Theory								
code	Course Name	Internal Assessment			End	Exam	Term	Total		
coue		Test 1 Test	Tost 2	Test 2 Avg.	Sem.	Duration	Work	Total		
			Test Z		Exam	(Hrs.)				
	Professional									
ILO8025	Ethics and	20	20	20	80	03	_	100		
	Corporate Social	20		20	20	20	20	00	05	
	Responsibility									

Course	To understand professional ethics in business
Objectives	To recognized corporate social responsibility
	Student will be able to
Course	• Understand rights and duties of business
Outcomes	• 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;	04					
	Ethical Issues in Business; Moral Responsibility and Blame;						
	Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties						
	of Business						
2	Professional Ethics in the Marketplace: Perfect Competition;	08					
	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						
3	Professional Ethics of Consumer Protection: Markets and Consumer	06					
	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.						
4	Introduction to Corporate Social Responsibility: Potential Business	05					
	Benefits—Triple bottom line, Human resources, Risk management,						
	Supplier relations; Criticisms and concerns—Nature of business;						

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

## **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

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- 4: Remaining question will be randomly selected from all the modules.

University of Mumbai								
Course Code	Course Name	Teaching (Contac	g Scheme t Hours)	Credits Assigned				
		Theory	Tutorial	Theory	Tutorial	Total		
ILO8026	Research Methodology (abbreviated as RM)	3	-	3	-	3		

		Examination Scheme							
Course									
code	Course Name	Interna	al Assess	ment	End	Exam	Term	Total	
coue		Test 1	Tost 2	Ava	Sem.	Duration	Work	Total	
		Test I	Test 2	Avg.	Exam	(Hrs.)			
ILO8026	Research Methodology	20	20	20	80	03	-	100	

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

Module	Contents	Hours					
1	Introduction and Basic Research Concepts: Research – Definition;	10					
	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						
2	Types of Research: Basic Research, Applied Research, Descriptive	08					
	Research, Analytical Research, Empirical Research, Qualitative and						
	Quantitative Approaches						
3	Research Design and Sample Design : Research Design – Meaning,	08					
	Types and Significance, Sample Design – Meaning and Significance						
	Essentials of a good sampling Stages in Sample Design Sampling						
	methods/techniques Sampling Errors						
4	Research Methodology : Meaning of Research Methodology, Stages in	08					
	Scientific Research Process						
	a. Identification and Selection of Research Problem						
	<b>b.</b> Formulation of Research Problem						
	c. Review of Literature						
	<b>d.</b> Formulation of Hypothesis						

	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,	04
	Data Availability, Choice of data, Analysis of data, Generalization and	
	Interpretation of analysis	
6	Outcome of Research: Preparation of the report on conclusion reached,	04
	Validity Testing & Ethical Issues, Suggestions and Recommendation	

#### **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<sup>nd</sup>ed), Singapore, Pearson Education

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- 1. Question paper will comprise of 6 questions, each carrying 20 marks.
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- 4: Remaining question will be randomly selected from all the modules.

University of Mumbai						
Course	Course Name	Teaching (Contac	g Scheme t Hours)	Credits Assigned		
Code		Theory	Tutorial	Theory	Tutorial	Total
ILO8027	IPR and Patenting (abbreviated as IPRP)	3	-	3	-	3

Course	Course Name	Examination Scheme							
code		Internal Assessment			End	Exam	Term	Total	
coue		Test 1	Test 2	Avg.	Sem.	Duration	Work	Total	
					Exam	(Hrs.)			
ILO8027	IPR and Patenting	20	20	20	80	03	-	100	

Course	• To understand intellectual property rights protection system						
	• To promote the knowledge of Intellectual Property Laws of India as well						
	as International treaty procedures						
Objectives	• To get acquaintance with Patent search and patent filing procedure and						
	• applications						
	Student will be able to						
Course	understand Intellectual Property assets						
Outcomes	<ul> <li>assist individuals and organizations in capacity building</li> </ul>						
outcomes	• 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,	05
	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	
2	Enforcement of Intellectual Property Rights: Introduction, Magnitude	07
	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.	
3	Emerging Issues in IPR: Challenges for IP in digital economy, e-	06
	commerce, human genome, biodiversity and traditional knowledge etc.	
4	Basics of Patents: Definition of Patents, Conditions of patentability,	07
	Patentable and non-patentable inventions. Types of patent applications	

	(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,	08
	Australia scenario, Japan scenario, Chinese scenario, Multilateral	
	treaties where India is a member (TRIPS agreement, Paris convention	
	etc.)	
6	Procedure for Filing a Patent (National and International):	07
	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	

#### **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
- Cornish, William Rodolph&Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7<sup>th</sup> Edition, Sweet & Maxwell
- LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3<sup>rd</sup> 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

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University of Mumbai						
Course Code	Course Name	Teaching (Contac	g Scheme et Hours)	Credits Assigned		
		Theory	Tutorial	Theory	Tutorial	Total
ILO8028	Digital Business Management (abbreviated as DBM)	3	-	3	-	3

		Examination Scheme							
Course									
code	Course Name	Interna	al Assess	ment	End	Exam	Term	Total	
coue		Test 1	Test 2	Δνα	Sem.	Duration	Work	Total	
		1050 1	1051 2	Avg.	Exam	(Hrs.)			
ILO8028	Digital Business Management	20	20	20	80	03	-	100	

Course	To familiarize with digital business concept						
Objectives	• To acquaint with E-commerce						
Objectives	<ul> <li>To give insights into E-business and its strategies</li> </ul>						
	Student will be able to						
Course	• Identify drivers of digital business						
Outcomes	• 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	09							
	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,								
2	Overview of E-Commerce: E-Commerce- Meaning, Retailing in e-	06							
	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								
3	Digital Business Support services: ERP as e -business backbone,	06							
	knowledge Tope Apps, Information and referral system, Application								
	Development: Building Digital business Applications and Infrastructure								

4	Managing E-Business-Managing Knowledge, Management skills for	06
	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	
5	E-Business Strategy-E-business Strategic formulation- Analysis of	04
	Company's Internal and external environment, Selection of strategy,	
	E-business strategy into Action, challenges and E-Transition	
	(Process of Digital Transformation)	
6	M Materializing e-business: From Idea to Realization-Business plan	08
	preparation	
	Case Studies and presentations	

### **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, 6<sup>th</sup> 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, 2<sup>nd</sup> 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 2<sup>nd</sup> 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:<u>10.1787/9789264221796-en</u> OECD Publishing

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- 4: Remaining question will be randomly selected from all the modules.

University of Mumbai										
Course Code	Course Name	Teaching (Contac	g Scheme et Hours)	Credits Assigned						
		Theory	Tutorial	Theory	Tutorial	Total				
ILO8029	Environmental Management (abbreviated as EVM)	3	-	3	-	3				

	Course Name	Examination Scheme							
Course									
Course		Internal Assessment			End	Exam	Term	Total	
coue		Test 1	Test 2	Ava	Sem.	Duration	Work	Total	
		1050 1	1051 2	Avg.	Exam	(Hrs.)			
ILO8029	Environmental Management	20	20	20	80	03	-	100	

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

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

### **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, 3<sup>rd</sup> Ed. Access Publishing.2015

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- 4: Remaining question will be randomly selected from all the modules.

Subject code	Subject Name	Теа	ching sch	eme	Credit assigned			
	Instrumentation Project	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL801	Documentation and Execution- Lab Practice	-	2	-	-	1	-	1

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

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

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

### List of Laboratory Experiments/ Assignments:

Sr.	Detailed Content	CO Mapping
No.		
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	Subject	Teaching scheme			Credit assigned				
code	Name								
TOT 000	Expert	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
ISL 803	System- Lab								
	Practice	-	2	-	-	1	-	1	

		Examination scheme								
		Theory(out of 100)					<b>D</b> (			
Sub Code	Subject Name	Interi	nal Asses	ssment	End sem exam	Term work	Pract. And oral	Oral	Total	
		Test1	Test2	Avg.						
	Expert					25		25		
ISL 803	System- Lab	-	-	-	-	25	-	25	50	
	Practice									

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

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.

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Subject code	Subject Name	Te	aching schem	ne	Credit assigned			
ISL803	Internet of Things- Lab	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
151.005	Practice	-	02	-	-	1	-	1

Sub Code	Subject Name	Examination scheme								
		Inter	mal Assessi	ment	End	Term work	Pract. And oral	Oral	Total	
		Test1	Test2	Avg.	Sem Exam					
	Internet of									
ISL803	Things- Lab	-	-	-	-	25	-	25	50	
	Practice									

Subject Code	Subject Name							
ISL803	Internet of Things- Lab Practice							
Course objectives	<ol> <li>To impart knowledge about fundamentals of IoT</li> <li>To describe data and knowledge management and use of device technology.</li> <li>To give knowledge of IoT architecture and Integration of embed devices with IoT</li> <li>To explain the concept of IIoT.</li> <li>To impart knowledge about designing of industrial internet syst</li> <li>To describe overview of Android/ IOS app development tools a of Everything</li> </ol>	es in IoT dded ems. nd Internet						
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 d							

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
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6	Interfacing sensors to Raspberry PI	CO2
7	Communicate between Arduino and Raspberry PI using any wireless	CO1,CO2,CO3
	medium	
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	Теа	aching Sch	eme	Credits Assigned				
ISL803	Power Plant Instrumentation	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
	-Lab Practice	-	2	-	-	1	-	1	

Sub Code		Examination scheme								
	Subject Name	Internal Assessment			End Sem	Term	Pract.	Oral	Total	
		Test 1	Test 2	Avg.	Exam	work	Oral	01ui	Totui	
ISL803	Power Plant Instrumentatio n- Lab Practice	-	-	-	-	25	-	25	50	

Subject Code	Subject Name	Credits						
ISL803	Power Plant Instrumentation- Lab Practice1							
Course objectives	<ul> <li>To create awareness of energy resources and its scenario in India an</li> <li>1. To study the concept of power generation using various res</li> <li>2. To study the role of Instrumentation in various power plant</li> <li>3. To study and compare various power plants for optimal per</li> <li>4. To acquire students the knowledge about hazards and safety</li> </ul>	nd worldwide. ources. s. formance. y in handling power plants.						
	The students will be able to:							
	1. Identify the energy sources and explain power generation.							
Course Outcomes	2. Describe operation and control of various equipment in the	rmal power plant.						
Course Outcomes	3. Select the sites for hydroelectric power plants and explain i	ts 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
110.		
1	Assignment on Energy Sources	C01
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	Te	aching schem	ıe		Credit a	ssigned	
ISL803	Functional Safety- Lab	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
131.003	Practice	-	02	-	-	1	-	1

Sub Code	Subject Name	Examination scheme									
		Inter	nal Assess	ment	End	Term	Pract. And oral	Oral	Total		
		Test1	Test2	Avg.	Sem Exam	work					
	Functional										
ISL803	Safety - Lab	-	-	-	-	25	-	25	50		
	Practice										

Subject Code	Subject Name	Credits					
ISL803	Functional Safety- Lab Practice1						
Course objectives	<b>s</b> To make the students aware of basic concepts of safety instrumented system, stand analysis techniques.						
Course Outcomes	The students will be able to1. Define the role of Safety instrumented syst2. Describe steps involved in Safety life cycle3. Explain process and safety control with SI4. Learn types of events and combined proba5. Identify and analyse the hazards6. Determine the Safety integrity level	em in the industry. e S technologies. bility calculations.					

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.

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#### **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	Subject	Teaching scheme			Credit assigned				
code ISL804	Name Project-II	Theory Pract. Tut.			Theory	Pract.	Tut.	Total	
	U U	-	12	-	-	6	-	6	

Sub Code	Subject Name	Examination schemeTheory (out of 100)TermPractOralTotal							
		Internal Assessment End			End	work	. and		
		Test1	Test1 Test2 Avg. sem				Oral		
					Exam				
<b>ISL804</b>	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.