

UNIVERSITY OF MUMBAI
No. UG/136 of 2016-17

CIRCULAR:-

A reference is invited to the syllabi relating to the Master of Engineering (Instrumentation and Control Engineering) degree course vide this office Circular No.UG/34 of 2013-14, dated 23rd May, 2013 and the Principals of affiliated Colleges in Engineering are hereby informed that the recommendation made by Ad-hoc Board of Studies in Electrical Engineering at its meeting held on 8th July, 2016 has been accepted by the Academic Council at its meeting held on 14th July, 2016 vide item No. 4.10 and that in accordance therewith, the revised syllabus as per Choice Based Credit System for Master of Engineering (Instrumentation and control Engineering) Sem. I to IV), which is available on the University's web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2016-17.

MUMBAI – 400 032
9th November, 2016


(Dr.M.A.Khan)
REGISTRAR

To,
The Principals of affiliated Colleges in Engineering.

A.C/ 4.10/14/07/2016.

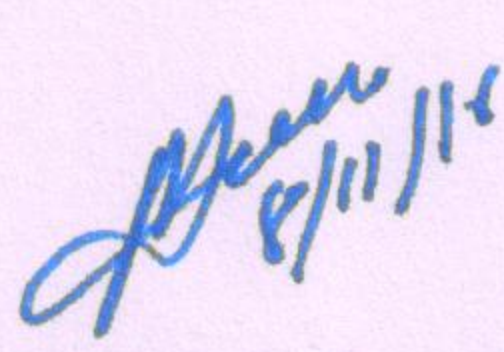
No. UG/136-A of 2016

MUMBAI-400 032

9th November, 2016

Copy forwarded with compliments for information to:-

1. The Dean, Faculty of Technology,
2. The Chairmen, Ad-hoc Board of the Studies in Electrical Engineering
3. The Director, Board of College and University Development,
4. The Controller of Examinations,
5. The Co-Ordinator, University Computerization Centre.


(Dr.M.A.Khan)
REGISTRAR

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UNIVERSITY OF MUMBAI



Revised Syllabus for the M.E. Instrumentation and Control

(As per Choice Based Credit and Grading System
with effect from the academic year 2016-2017)

From Co-ordinator'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) and 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 enables 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 Master of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Master of Engineering in the academic year 2017-2018.

Dr. Suresh K. Ukarande
Co-ordinator,
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 also 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 Chairman, Board of Studies in Electrical Engineering of University of Mumbai, happy to state here that, Program Educational Objectives (PEOs) were finalized for post-graduate program in Instrumentation and Control Engineering, more than ten senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs were finalized for post-graduate program in Instrumentation Engineering are listed below;

Program Educational Objectives (PEOs)

- To create the competent & skilled engineers to ensure them the careers and employment and in this way fulfill the requirement of Multinational industries.
- Expose them by giving an opportunity as an individual as well as team.
- Inculcate professional and ethical attitude and ability to relate automation issues to society at large.
- Facilitate strong base of basic scientific & engineering knowledge with professional ethics, lifelong learning attitude society globally.
- To give adequate knowledge of Advancements in the field of Automation, Processing and Control.
- To give the knowledge in the field of Sensors, transducers and Signal processing required in various field of Instrumentation such as Process Instrumentation, Biomedical Instrumentation, Optical Instrumentation and Nuclear Instrumentation.
- To familiarise the students with the advancements in Control engineering.

Program Outcomes (POs)

- Able to demonstrate & competent enough in basic knowledge in Mathematics, Engineering and Technology to obtain the solution of engineering problem.
- Have ability to formulate the engineering problem, design the setup for experimentation, analysis and interpretation of the result data, report preparation.
- Demonstrate the ability to work on basic engineering discipline as well as multi-disciplinary engineering teams to achieve the solution of engineering problem.
- Strong competency in using modern engineering tools like MATLAB / Simulink, LABVIEW/MultiSim for solution of control engineering problems.
- Able to use the acquired knowledge and professional skill and project as well as

- budget management towards betterment of the society.
- Understand the needs of the society worldwide in the context of his professional knowledge to ensure environmental safety and better sustainability.
 - Capable to apply ethical principles with committed professional ethics and duties towards the solution of complex engineering problems.
 - Motivate to work independently as well as a member of team or team leader in multi functionaries and diversified knowledge platforms.
 - Develop an effective inter personnel communication skill at large with public and professional bodies. They will be able to comprehend the data and accordingly will prepare technical design details, datasheets, reports, documentation etc.
 - Inculcate the lifelong learning in the purview of updates /upgrade in engineering and technology.
 - Investigate the complex engineering problems using acquired knowledge in instrumentation engineering to develop industrial level solutions in the interest of society.
 - Students will be able to apply their knowledge for the use of various Instruments and systems in the field of Instrumentation.
 - Students will be able to design basic circuits and systems required in various fields of Instrumentation such as Process Instrumentation, Biomedical Instrumentation, Optical Instrumentation and Nuclear Instrumentation.
 - Students will be able to apply latest control strategies on various applications.

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

**Program Structure for
M.E. Instrumentation and Control
University of Mumbai
(With Effect from 2016-17)**

Semester I

		Teaching Scheme (Contact Hours)			Credits Assigned				
Subject Code	Subject Name	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
ISEC101	Higher Mathematics for Control Engineering	04	-	-	04	-	-	04	
ISEC102	Advanced signal processing for Sensors	04	-	-	04	-	-	04	
ISEC103	Robust Control	04	-	-	04	-	-	04	
ISEDLO101X	Department Level Optional Course-I	04	-	-	04	-	-	04	
ILO101X	Institute Level Optional Course-I	03	-	-	03	-	-	03	
ISEL101	Laboratory-I	-	02	-	-	01	-	01	
ISEL102	Laboratory-II	-	02	-	-	01	-	01	
Total		19	04	-	19	02	-	21	
Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /Oral	Total
		Internal Assessment			End Sem.	Exam. Duration			
		Test1	Test 2	Avg.					
ISEC101	Higher Mathematics for Control Engineering	20	20	20	80	03	-	-	100
ISEC102	Advanced signal processing for Sensors	20	20	20	80	03	-	-	100
ISEC103	Robust Control	20	20	20	80	03	-	-	100
ISEDLO101X	Department Level Optional Course-I	20	20	20	80	03	-	-	100
ILO101X	Institute Level Optional Course-I	20	20	20	80	03	-	-	100
ISEL101	Laboratory-I	-	-	-	-	-	25	25	50
ISEL102	Laboratory-II	-	-	-	-	-	25	25	50
Total		100	100	100	400	-	50	50	600

**Program Structure for
M.E. Instrumentation and Control
University of Mumbai
(With Effect from 2016-17)**

Semester II

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
ISEC201	Electronic Systems Design	04	-	-	04	-	-	04	
ISEC202	State Estimation and Stochastic Processes	04	-	-	04	-	-	04	
ISEC203	Advanced Process Control and Automation	04	-	-	04	-	-	04	
ISEDLO202X	Department Level Optional Course-II	04	-	-	04	-	-	04	
ILO202X	Institute Level Optional Course-II	03	-	-	03	-	-	03	
ISEL201	Laboratory-III	-	02	-	-	01	-	01	
ISEL202	Laboratory-IV	-	02	-	-	01	-	01	
Total		19	04	-	19	02	-	21	
Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /Oral	Total
		Internal Assessment			End Sem.	Exam. Duration			
		Test1	Test 2	Avg.					
ISEC201	Electronic Systems Design	20	20	20	80	03	-	-	100
ISEC202	State Estimation and Stochastic Processes	20	20	20	80	03	-	-	100
ISEC203	Advanced Process Control and Automation	20	20	20	80	03	-	-	100
ISEDLO202X	Department Level Optional Course-II	20	20	20	80	03	-	-	100
ILO202X	Institute Level Optional Course-II	20	20	20	80	03	-	-	100
ISEL201	Laboratory-III	-	-	-	-	-	25	25	50
ISEL202	Laboratory-IV	-	-	-	-	-	25	25	50
Total		100	100	100	400	-	50	50	600

**Program Structure for
M.E. Instrumentation and Control
University of Mumbai
(With Effect from 2016-17)**

Semester III

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theor	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISES301	Special Topic Seminar	-	06	-	-	03	-	03
ISED301	Dissertation–I	-	24	-	-	12	-	12
Total		-	30	-	-	15	-	15
Subject Code	Subject Name	Examination Scheme						
		Theory				Term Work	Pract. /Oral	Total
		Internal Assessment			End Sem. Exam.			
		Test1	Test 2	Avg.				
ISES301	Special Topic Seminar	-	-	-	-	50	50	100
ISED301	Dissertation–I	-	-	-	-	100	-	100
Total		-	-	-	-	150	50	200

Semester IV

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theor	Pract.	Tut.	Theory	Pract.	Tut.	Total	
ISED401	Dissertation–II	-	30	-	-	15	-	15	
Total		-	30	-	-	15	-	15	
Subject Code	Subject Name	Examination Scheme							
		Theory				End Sem. Exam.	Term Work	Pract. /Oral	Total
		Internal Assessment							
		Test1	Test 2	Avg.					
ISED401	Dissertation–II	-	-	-	-	100	100	200	
Total		-	-	-	-	100	100	200	

Note:

- In case of Seminar, 01 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation I, 02 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation II, 02 Hour / week / student should be considered for the calculation of load of a teacher
- **End Semester Examination:** In all six questions to be set, each of 20 marks, out of these any four questions to be attempted by students. Each question will comprise of mixed questions from different units of the subjects.

Subject Code	Department Level Optional Course-I	Subject Code	Department Level Optional Course-II
ISEDLO1011	Advanced Biomedical Instrumentation	ISEDLO2021	Rehabilitation Engineering
ISEDLO1012	Advanced Measurement Techniques	ISEDLO2022	Advanced Fiber Optics and LASER Instrumentation
ISEDLO1013	Expert Systems	ISEDLO2023	Advanced Nuclear Instrumentation
ISEDLO1014	Robotics and Control	ISEDLO2024	MEMS and Nanotechnology

Subject Code	Institute Level Optional Course-I	Subject Code	Institute Level Optional Course-II
ILO1011	Product Lifecycle Management	ILO2021	Project Management
ILO1012	Reliability Engineering	ILO2022	Finance Management
ILO1013	Management Information System	ILO2023	Entrepreneurship Development and Management
ILO1014	Design of Experiments	ILO2024	Human Resource Management
ILO1015	Operation Research	ILO2025	Professional Ethics and Corporate Social Responsibility (CSR)
ILO1016	Cyber Security and Laws	ILO2026	Research Methodology
ILO1017	Disaster Management and Mitigation Measures	ILO2027	IPR and Patenting
ILO1018	Energy Audit and Management	ILO2028	Digital Business Management
		ILO2029	Environmental Management

Subject Code	Subject Name	Credits
ISEC101	Higher Mathematics for Control Engineering	04

Course Objectives:

- To introduce different methods of solving systems of linear equations
- Introduce concept of Linear Vector Spaces
- To present the concept of Orthogonality and Quadratics Forms

Course Outcomes:

- Demonstrate ability to solve systems of linear equations
- Demonstrate ability to work with Vector Spaces
- Demonstrate ability to get least square solutions to systems
- Demonstrate ability to effect linear transformation

Module	Detailed content	Hours
	Prerequisite: Knowledge about Matrices, Matrix, Elementary Operations, Determinants and Matrix Inverse	
1	Linear Equations in Linear Algebra: Systems of Linear Equations, Gaussian Elimination, Row Reduction , Echelon Forms , LU Factorization.	08
2	Euclidean Vector Spaces: Euclidean n-Space, Linear Transformation from R^n to R^m , Properties of Linear Transformations from R^n to R^m , Linear Transformation.	08
3	General Vector Spaces: Real Vector Spaces, Subspaces, Linear Independence, Basis and Dimension, Row Space, Column Space and Nullspace, Rank, Nullity and Change of basis.	08
4	Eigenvalues and Eigenvectors: Eigenvectors and Eigenvalues, The Characteristic Equation, Diagonalization, Eigenvectors and Linear Transformations, Complex Eigenvalues, Discrete Dynamical Systems.	08
5	Orthogonality and Least Squares: Inner Product, length and Orthogonality, Orthogonal Sets, Orthogonal Projections, The Gram-Schmidt Process, Least –Square Problems, Applications to Linear Models, Inner Product Spaces, Applications of Inner Product Spaces.	08
6	Symmetric Matrices and Quadratic Forms: Diagonalization of Symmetric Matrices, Quadratic Forms, Constrained Optimization, The Singular Value Decomposition, Application to Image Processing and Statistics.	08

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions

to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

References:

1. Athanasios Papoulis, "Probability, random Variable & Stochastic Processes" 3rd Edn, McGraw Hill, Inc 1995
2. Gantmacher, Feliks R."the theory of Matrices Vol.I and II" Chelsia Publishing Co.1959
3. Gantmacher F.R. "Application of Theory of Matrices"
4. Hoffman K. & R. Kunez, "Linear Algebra" 2nd Edn, Printice Hall 1971
5. Howard Anton, "Elementary Linear Algebra"- Wiley Student End, 2011

Subject Code	Subject Name	Credits
ISEC102	Advanced Signal Processing for Sensors	04

Course Objectives:

- To give students knowledge in the field of advanced signal processing system required for processing the signals from various sensors.
- To give knowledge regarding applications of various types of sensors used for high resolution measurement of various parameters.

Course Outcomes:

- The students will be able to understand the methodology and design of electronic circuits utilized for processing the signals for various sensors.

Module	Detailed content	Hours
	Prerequisite: Knowledge in the field of transducers and sensors, Basic concepts in electronic signal processing	
1	Classification of sensors and transducers: Input and output characteristics of various transducers, variable resistance transducer and its equivalent circuit, potentiometers, their construction and performance, variable inductance and variable capacitance transducers, their construction and performance, Piezoelectric transducer.	08
2	Design techniques for sensor signal conditioning: Sensor and signal conditioning for strain, force, pressure, flow and temperature measurement, Bridge configurations, Amplifying and linearizing bridge outputs, Driving bridge circuits. Ratio metric techniques.	10
3	High impedance sensors: Photodiodes and high impedance charge output sensors, Signal conditioning of high impedance sensors, Chemical and Biosensors.	08
4	Positioning, motion and temperature sensors: LVDT, Hall effect magnetic sensors, optical encoders Accelerometer, RTDs, thermistors, thermocouples, semiconductors temperature sensors and their signal conditioning.	08
5	Micro-sensors and smart sensors: Construction, characteristics, and applications.	06
6	Radioactivity detectors and Counting systems: Gas filled, Scintillation and Semiconductor detectors, Preamplifiers, Shaping amplifiers, Single Channel analyzer, Multi-channel analyzer.	08

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be

attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

References:

1. H.K.P Neubert “Instrument Transducers Oxford Herman University Press Eighth Impression 2008.
2. Ramon Pallas-Arenyand Johan G. Webster “Sensor and Signal Conditioning” John Wiley, New York 1991.
3. Dan Sheingold-Editor “Transducer Interfacing Handbook”, Analog Devices Inc 1980
4. “High Speed Design Technique” Analog Device Inc 1996
5. Jacoba Fraden “Handbook of Modern Sensors “2nd Edition, Springer-Verlag.New York 1996
6. Jerald G.Graeme “Photodiode Amplifiers And Op-Amp Solution”, Mc Graw Hill 1995
7. Harry L. Trietly, “Transducers in Mechanical and Electronic Design”, Marcel Dekker Inc 1986
8. Dan Shiengold, “Non Linear Circuits Handbook”, Analog Device Inc
9. Walt Kester-Editor, “System Application Guide”, Analog Devices Inc 1993
10. IMEGA, “Temperature Measurement Handbook”, Omega Instruments Inc
11. Henry Ott, “Noise Reduction Technique In Electronic Systems”, N.Y.John Wiley And Sons 1988
12. Ralph Morrison,”Grounding And Shielding Technique”, Fourth Edition,John Wiley,1998
13. G.F.Knoll ,“Radiation detection and measurement”, John Wiely and Sons, 2nd edition, 1998.

Subject Code	Subject Name	Credits
ISEC103	Robust Control	04

Course Objectives:

- To study the effect of disturbance, parametric uncertainties and model errors on the stability of the system.
- To study the robust control techniques such as a control based on Kharitonov theorem, internal model control and introduction to Quantitative feedback technique for the system with parametric uncertainties and external disturbances.
- To study the sliding mode control for asymptotic stability in presence of disturbances.

Course Outcomes:

- The students should be able to understand the robustness properties of the system against uncertainties.
- Students should be able to design the robust control that overcomes parametric uncertainties.
- Students should be able to design the internal model control for uncertain systems.
- Students should be able to understand concept of Quantitative feedback techniques.
- Students should be able to design the sliding mode control for uncertain systems.

Module	Detailed content	Hours
	Prerequisite: Regulators and Servo Mechanism, Concepts in State-space analysis, Controllability and Observability.	
1	Introduction to Sliding Mode Control: Main Concepts of Sliding Mode Control, Chattering Avoidance: Attenuation and Elimination, Concept of Equivalent Control, Sliding Mode Equations, The Matching Condition and Insensitivity Properties, Conventional Sliding Mode Controller Design	08
2	Conventional Sliding Modes: Introduction, Filippov Solution, Concept of Equivalent Control, State-Feedback Sliding Surface Design, Regular Form, Eigenvalue Placement, Quadratic Minimization, State-Feedback Relay, Control Law Design, Single-Input Nominal Systems, Single-Input Perturbed Systems, Relay Control for Multi-Input Systems.	10
3	Interval Polynomials: Kharitonov's Theorem: Kharitonov's Theorem for Real Polynomials, Kharitonov's Theorem for Complex Polynomials, Robust State Feedback Stabilization.	08
4	Internal Model Control (IMC): Introduction to Model-Based Control, Practical Open-Loop Controller Design, Generalization of the Open-Loop Control Design Procedure, Model Uncertainty and Disturbances, Development of the IMC Structure, IMC Background, The IMC Structure, The IMC Design Procedure, Effect of Model Uncertainty and Disturbances, Improving Disturbance Rejection Design	10
5	The IMC-Based PID Control: Background, The Equivalent Feedback Form to IMC, IMC-Based Feedback Design for Delay-Free Processes, IMC-Based Feedback Design for Processes with a Time Delay, Summary	08

	of IMC-Based PID Controller Design for Stable Processes, IMC-Based PID Controller Design for Unstable Processes	
6	Introduction to Quantitative Feedback Theory: Quantitative Feedback Theory (QFT), Why Feedback, QFT Overview, QFT Design Objective, Structured Parametric Uncertainty, Control System Performance Specifications, QFT Design Overview, QFT Basics, QFT Design, Insight to the QFT Technique, Open-Loop Plant, Closed-Loop Formulation, Benefits of QFT.	04

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

References:

1. S. P. Bhattacharyya, H. Chapellat, and L. H. Keel. "*Robust control: the parametric approach*," Upper Saddle River (1995).
2. Manfred Morari and Evangelos Zafriou, "*Robust process control*," Vol. 488. Englewood Cliffs, NJ, Prentice hall, 1989.
3. B. Wayne Bequette, "*Process Control: Modeling, Design and Simulation*," Prentice Hall Professional, 2003.
4. Constantine H. Houppis, Steven J. Rasmussen and Mario Garcia-Sanz, "*Quantitative feedback theory: fundamentals and applications*," CRC Press, 2005.
5. Oded Yaniv, "*Quantitative feedback design of linear and nonlinear control systems*," Vol.509. Springer Science & Business Media, 2013.
6. Yuri Shtessel, Christopher Edwards, Leonid Fridman and Arie Levant, "*Sliding mode control and observation*," New York, USA: Birkhuser, 2014.
7. Christopher Edwards and Sarah Spurgeon, "*Sliding mode control: theory and applications*," CRC Press, 1998.
8. Dorf, Richard C., and Robert H. Bishop, "*Modern control systems*," Prentice Hall, 2011

Subject Code	Subject Name	Credits
ISEDLO1011	Advanced Biomedical Instrumentation	04

Course Objectives:

- To introduce concepts of advanced biomedical instruments used in hospitals.
- To study the design considerations of various signal conditioning systems for measurement of Bio-signals like ECG, EEG and EMG.
- To study the concept behind various Advanced Medical imaging techniques.

Course Outcomes:

- The students should be able to understand the principle and working of various advanced biomedical instruments.
- The students should be able to design signal conditioning systems for bio-signal measurements.
- The students should be able to apply concepts of biomedical techniques for various applications.
- The students should be able to understand the concept and working of various advanced medical image acquisition and reconstruction techniques.

Module	Detailed content	Hours
	Prerequisite: Knowledge of Anatomy and Physiology of Human Systems, Knowledge of various Bio-signals and their basic Measurement techniques, Knowledge of basic principle of Medical Imaging Techniques	
1	Instrumentation for Bio-Potential Recording: Sensors, Bio-Potential Amplifiers like Chopper Amplifiers, Isolation Amplifiers and Advanced Instrumentation Amplifiers, Signal Conditioning Circuit designing for ECG, EEG and EMG, Multi-Channel Data Acquisition System.	10
2	Diathermy in Medicine: Electro Surgical Diathermy, Short Wave Diathermy, Microwave Diathermy and Ultrasound Diathermy, Lithotripsy.	06
3	Cardiac and Neuro-Assist Devices: Cardiac Pace Makers- constructional details and design, Internal and External Defibrillators with Design, Stimulation Electronics – Nerve and Muscle Stimulators.	08
4	Telemetry and Telemedicine: Introduction to Telemetry System, Types of Wireless, Power and Data Transmission System, Receiver and Transmitter specifications, Telemedicine.	08
5	Advanced Medical Imaging Systems: CT Scanning Systems – tube design, types of Gantry, Image Reconstruction Techniques in Tomography. MRI – Image Acquisition and Reconstruction Techniques. Nuclear Imaging – Scanners, Gamma Camera, Positron Emission Tomography (PET), Single Photon Emission Computer Tomography (SPECT).	10
6	Laser Application in Medicine: Types of Lasers, Properties of Lasers and Interaction of Lasers with tissues, Basic Endoscope System and its characteristics.	06

Assessment:**Internal:**

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

References:

1. Jacobsons and Webster, "Medicine and Clinical Engineering", PHI, 1981.
2. Carr and Brown, "Introduction of Biomedical Equipment Technology", PHI, 1981.
3. Jacob Kline, "Handbook of Bio Medical Engineering", Academic Press, 1988.
4. J B Gupta, "A course in Electronic and Electrical Measurement and Instrumentation", S K Kataria and Sons, 1999.
5. Steve Webb, "The Physics of Medical Imaging", Taylor & Francis, New York, 1988.
6. Norris, A.C., "Essential of Telemedicine and Telecare", Wiley, 2002.

Subject Code	Subject Name	Credits
ISEDLO1012	Advanced Measurement Techniques	04

Course Objectives:

To provide knowledge to the students regarding various methods used for high resolution measurement of various parameters like voltage, current, resistance, inductance, capacitance, time, frequency and phase difference.

Course Outcomes:

- Understand principles and methods used for measurement of various parameters.
- Make use of proper methods of measurement depending upon requirement of resolution, accuracy and speed of measurement.

Module	Detailed content	Hours
	Prerequisite: Basic knowledge of Electronic measurements, analog and digital circuits.	
1	High resolution measurement for electrical components: Analog and digital techniques for high resolution measurement of Resistance, Inductance, Capacitance. Various bridge circuits and auto balancing methods. Polar and Cartesian type impedance meters. Tan delta measurement.	12
2	High resolution time measurement: Philosophy of digital and microprocessor/microcontroller based instruments.; Time measurement techniques: Time standards; Measurement of time interval between events, order of events, Vernier technique, Very low time, period, phase, time constant measurements	08
3	Frequency measurement techniques: Frequency, ratio and product, high and low frequency measurements; Deviation meter and tachometer, Peak/valley recorder.; Programmable circuits: Programmable resistors, amplifiers, filters.; Programmable amplifiers as DACs	12
4	Applications of ADCs and DACs: Application of various types of ADCs and DACs in measurement techniques; DVM and its design; Voltage and current ratio measurements.	08
5	Sampling theory and applications: Modulation index meter, Sampling theory and its application in current, voltage, power and energy measurements.	08

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions

to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

References:

1. T. S. Rathore, “Digital Measurement Techniques”, Narosa Publishing House, 1996.
2. B. S. Sonde, “Monographs on System Design using Integrated Circuits”, Tata Mc-Graw Hill, 1974.
3. D. J. DeFatta, J. G. Lucas, “Digital Signal Processing”, J Wiley and Sons, 1988.

Subject Code	Subject Name	Credits
ISEDLO1013	Expert Systems	04

Course Objectives:

- To give knowledge to the students regarding Neural Networks and their applications in control engineering.
- To familiarize the students with concepts in Fuzzy Logic and their applications in control engineering.

Course Outcomes:

- Students will be able to understand concepts in Neural Networks and their applications in control engineering.
- Students will be able to understand concepts in Fuzzy logic and their applications in control engineering.

Module	Detailed content	Hours
	Prerequisite: Basic knowledge in computer science and Control Engineering	
1	Introduction to Neural Networks: Artificial Neural Networks: Basic properties of Neurons; Neuron Models; Feedforward networks - Perceptrons; Widrow-Hoff LMS algorithm; Multiplayer networks - Exact and approximate representation; Back propagation algorithm; variants of Back propagation; Unsupervised and Reinforcement learning; Symmetric Hopfield networks and Associative memory; Competitive learning and self organizing networks, Hybrid Learning; Computational complexity of ANNs.	10
2	Neural Networks Based Control: ANN based control: Introduction: Representation and identification; modeling the plant, control structures - supervised control, Model reference control, Internal model control, Predictive control : Examples - Inferential estimation of viscosity an chemical process; Auto - turning feedback control; industrial distillation tower.	08
3	Introduction to Fuzzy Logic: Fuzzy Controllers: Preliminaries - Fuzzy sets and Basic notions - Fuzzy relation calculations - Fuzzy members - Indices of Fuzziness - comparison of Fuzzy quantities - Methods of determination of membership functions.	08
4	Fuzzy Logic Based Control: Fuzzy Controllers: Preliminaries - Fuzzy sets in commercial products - basic construction of fuzzy controller - Analysis of static properties of fuzzy controller - Analysis of dynamic properties of fuzzy controller - simulation studies - case studies - fuzzy control for smart cars.	12
5	Neuro - Fuzzy and Fuzzy: Neural Controllers: Neuro - fuzzy systems; A unified approximate reasoning approach - Construction of role bases by self learning : System structure and learning algorithm - A hybrid neural network based Fuzzy controller with self learning teacher. Fuzzified CMAC and RBF network based self-learning controllers.	10

Assessment:**Internal:**

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

References:

1. Bose & Liang, “ Artificial Neural Networks “, Tata Mcgraw Hill, 1996
2. Kosco B, “ Neural Networks and Fuzzy Systems : A Dynamic Approach to Machine Intelligence, Prentice Hall of India, New Delhi, 1992.
3. Klir G.J. and Folger T.A., Fuzzy sets, “ Uncertainty and Information “ , Prentice Hall of India, New Delhi, 1994.
4. Simon Haykin - “ Neural Networks “, ISA, Research Triangle Park, 1995

Subject Code	Subject Name	Credits
ISEDLO1014	Robotics and Control	04

Course Objectives:

- To introduce robot terminologies and robotic sensors
- To educate on direct and inverse kinematics
- To introduce robot control techniques

Course Outcomes:

- Students would be able to understand the concepts behind various robotic sensors and manipulators.
- Students would be able to understand the kinematics and control strategies behind robot movement.
- Students would be able to apply robots for various applications.

Module	Detailed content	Hours
	Prerequisite: Knowledge of basic control strategies, Knowledge of working of basic controllers, Knowledge of basic programming languages like C, C++	
1	Robot Organization: Coordinate transformation, kinematics and inverse kinematics, Trajectory planning and remote manipulation.	08
2	Robot Hardware: Robot sensors, Proximity sensors, Range sensors, Visual sensors, Auditory sensors, Robot manipulators, Manipulator dynamics, Manipulator control, Wrists, End efforts, Robot grippers.	10
3	Robot and Artificial Intelligence: Principles of AI, Basics of learning, Planning movement, Basics of knowledge representations, Robot programming languages.	10
4	Robot Vision System: Principles of edge detection, Determining optical flow and shape, Image segmentation, Pattern recognition, Model directed scene analysis.	08
5	Robot Control System: Linear control schemes, joint actuators, decentralized PID control, Computed torque control, force control, hybrid position force control, Robot control using voice and infrared.	08
6	Robot Application: Overview of robot applications. Prosthetic devices. Robots in material handling, processing assembly and storage.	04

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered

in question papers of end semester examination.

References:

1. Koren, “Robotics for Engineers”, McGraw Hill International Company, Tokyo, 1995.
2. Vokopravotic, “Introduction to Robotics”, Springer, 1988.
3. Rathmill. K., “Robot Technology and Application”, Springer, 1985.
4. Charniak and McDarmott, “Introduction to Artificial Intelligence”, McGraw Hill, 1986.
5. K. S. Fu, R. C. Gonzally, C.S. G. Lee, “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Company, 1997.
6. Barru Leatham, Jones, “Elements of Industrial Robotics”, Pittmann Publishing, 1987.
7. Mikell P. Groover, Mitchell Weiss, Roger. N. Nagel, Nicholas G. Odrey, “Industrial Robotic Technology Programming and Applications”, McGraw Hill Book Company, 1986.

Subject Code	Subject Name	Credits
ILO1011	Product Life Cycle Management	03

Objectives:

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to...

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	12
02	Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	06
04	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	06
05	Integration of Environmental Aspects in Product Design: Sustainable	06

	Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
06	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	06

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314

Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265	Subject Name	Credits
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Code		
ILO1012	Reliability Engineering	03

Objectives:

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to...

- Understand and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	10
02	Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	10
03	System Reliability: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	Reliability Improvement: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	10
05	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

Assessment:**Internal:**

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

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

Subject Code	Subject Name	Credits
ILO1013	Management Information System	03

Objectives:

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development
- Define and analyze various MIS management responsibilities, including planning, budgeting, project management, and personnel management
- Discuss critical ethical and social issues in information systems

Outcomes: Learner will be able to...

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	7
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	9
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	6
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	10

Assessment:**Internal:**

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

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

Subject Code	Subject Name	Credits
ILO1014	Design of Experiments	03

Objectives:

- To understand the issues and principles of Design of Experiments (DOE).
- To list the guidelines for designing experiments.
- To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to...

- Plan data collection, to turn data into information and to make decisions that lead to appropriate action.
- Apply the methods taught to real life situations.
- Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	Introduction: Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	06
02	Fitting Regression Models: Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	08
03	Two-Level Factorial Designs: The 2^2 Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design, Split-Plot Designs.	07
04	Two-Level Fractional Factorial Designs: The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	07
05	Conducting Tests: Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	07
06	Taguchi Approach: Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	04

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question**

paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

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

Subject Code	Subject Name	Credits
ILO1015	Operations Research	03

Objectives:

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to...

- Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand.
- Understand the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems.
- Solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
- Understand the applications of, basic methods for, and challenges in integer programming
- Model a dynamic system as a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	Introduction to Operations Research: Introduction, Historical Background, Scope of Operations Research , Features of Operations Research, Phases of Operations Research, Types of Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools , Structure of the Mathematical Model, Limitations of Operations Research	02
02	Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, <i>Simplex Method</i> Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality , Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis	06
03	Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem	06
04	Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	06
05	Queuing models: queuing systems and structures, single server and multi-server	06

	models, Poisson input, exponential service, constant rate service, finite and infinite population	
06	Simulation: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation <i>Monte-Carlo Method:</i> Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	04
07	Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	04
08	Games Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	04
09	Inventory Models: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	04

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

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

Subject Code	Subject Name	Credits
ILO1016	Cyber Security and Laws	03

Objectives:

- To understand and identify different types cyber crime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Outcomes: Learner will be able to...

- Understand the concept of cyber crime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	Introduction to Cybercrime: Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	Cyber offenses & Cybercrime: How criminal plan the attacks, Social Engg, Cyber stalking, Cybercafé and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	10
03	Tools and Methods Used in Cyberline: Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	The Concept of Cyberspace : E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	Indian IT Act.: Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000,IT Act. 2008 and its Amendments	8
06	Information Security Standard compliances : SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions

to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
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4. Only Four question need to be solved.

REFERENCES:

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

Subject Code	Subject Name	Credits
ILO1017	Disaster Management and Mitigation Measures	03

Objectives:

- To understand the various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To understand role of individual and various organization during and after disaster
- To know warning systems, their implementation and based on this to initiate training to a laymen
- To understand application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to...

- Understand natural as well as manmade disaster and their extent and possible effects on the economy.
- Planning of national importance structures based upon the previous history.
- Understand government policies, acts and various organizational structure associated with an emergency.
- Know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	Introduction: Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion . Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	06
03	Disaster Management, Policy and Administration: Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster	06

	Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	
05	Financing Relief Measures: Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.	09
05	Preventive and Mitigation Measures: Pre-disaster, during disaster and post-disaster measures in some events in general, Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication. Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.

3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

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

Subject Code	Subject Name	Credits
ILO1018	Energy Audit and Management	03

Objectives:

- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to...

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	Energy Scenario: Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	Energy Audit Principles: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	Energy Management and Energy Conservation in Electrical System: Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	Energy Management and Energy Conservation in Thermal Systems: Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of	10

	insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	
05	Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

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

Subject Code	Subject Name	Credits
ISEL101	Laboratory-I	01

Expt. No.	Title
1	Linearizing circuit for “single element” varying bridge.
2	Kelvin sensing system to drive remote bridges.
3	Active low pass, band pass and high pass filters for transducer signal processing.
4	Use of high resolution ADC for transducer signal processing.
5	Simulation of boiler start-up process control using PLC
6	Simulation of paint manufacturing process using PLC
7	Study of SCADA (HMI) software

NOTE: Perform any six experiments from above list and two experiments from Department Elective Course.

Term work: Term work consists of performing 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners.

Subject Code	Subject Name	Credits
ISEL102	Laboratory-II	01

Expt. No.	Title
1	Experiments in MATLAB/Scilab for Computation of Eigen values, Eigen vectors, different types of norms etc.
2	QR Decomposition
3	LQ Decomposition
4	Gram Schmidt Orthogonalisation
5	Design the sliding mode control for SISO systems
6	Design the IMC controller for the — a) First order delay system b) First order NMP system
7	Design PID controller based on IMC controller
8	Design state feedback control for interval systems.

NOTE: Perform any six experiments from above list and two experiments from Department Elective Course.

Term work: Term work consists of performing 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners.

Subject Code	Subject Name	Credits
ISEC201	Electronic Systems Design	04

Course Objectives:

- To provide students with knowledge to design basic electronic systems.
- To make students aware of practical design considerations like noise reduction, grounding techniques, shielding and isolation which are required to design high performance electronic instrumentation systems.

Course Outcomes:

- Students will be able to understand practical design considerations such as Noise reduction, Shielding and grounding techniques, Isolation and Power management associated with design of electronic systems.
- Students will be able to design Analog, Digital and Mixed signal processing circuits required for electronic systems.

Module	Detailed content	Hours
	Prerequisite: Basic knowledge of analog and digital electronic circuits.	
1	Design of linear integrated circuits and their applications: Linear and log amplifiers, peak detect and milli volt rectifier circuits, analog switches and multiplexers, current and voltages references and their stability	08
2	Instrumentation and special operational amplifiers: Advanced instrumentation amplifier and various designs to improve dynamic range and reduce power dissipation. High speed OP-amps CMOS OP-amps Micro power amplifiers low noise and chopper stabilized OP-amps	08
3	Nonlinear integrated circuits: Comparators, voltage to frequency and frequency to voltage converters switched capacitor circuit's filters. Analog filters, Sample and hold circuits.	08
4	Converters: D.C to D.C converters. Mixed signal processing. High speed and high resolution DACs and A/D converters. Various techniques of A/D conversion. flash, successive approximation, multi slope ADC. Delta sigma ADC.	10
5	Noise reduction techniques: Design of mixed signal processing circuits, grounding and isolation techniques R.F shielding, Power supply noise reduction and filtering, Over voltage and ESD protection.	10
6	Power Management: Power management issues in low power portable systems, Linear and switch mode regulators.	04

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions

to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

References:

1. E.Allen Douglas R.Holberg, “CMOS Analog Circuit Design”, Philip Oxford , University Press
2004
2. Kevin M.Daugherty, “Analog To Digital Converter”, Tata McGraw Hill Inc 1995
3. Manual: High Speed Design Technique- Analog Devices Inc 1996
4. Dan Shiengold, “Non Linear Integrated Circuits Hand Book”, Analog Devices.
5. Ralph Morrison,”Grounding And Shielding Technique”, Fourth Edition,John Wiley,1998

Subject Code	Subject Name	Credits
ISEC202	State Estimation and Stochastic Processes	04

Course Objectives:

- To study the concept of Stochastic Processes, Monte Carlo Simulation and fractional calculus
- To study the concept of Kalman filtering

Course Outcomes:

- The students should be able to understand the Stochastic Properties of random variable in terms of pdf.
- Students should be able to understand the concept of stochastic processes
- Students should be able to understand concept of least square estimation
- Students should be able to realize the significance of Kalman filter and its applications to linear and nonlinear systems.

Module	Detailed content	Hours
	Prerequisite: Knowledge about concept of probability and Random Variable, Knowledge about concept of state and state space models of systems	
1	Random Variables: Introduction to Random Variables, Probability Distribution Function, Probability Density Function, Exponential Distribution, Gaussian Distribution, Binomial Distribution, Poisson Distribution, Two Dimensional Random Variables, Joint Probability, Marginal Density Function, Conditional Probability and Independence, Correlation, Covariance, Introduction to n-dimensional Random Variables.	12
2	Stochastic Processes: Definition, Statistics of Stochastic Processes, Types of Stochastic Processes, Random Walk, Markov Process, Brownian Motion, Poisson Process, Concept of Monte Carlo Simulation, Monte Carlo Simulation of Stochastic Processes such as Random Walk. Correlation functions, Power Spectrum, White Noise, Linear Systems with Stochastic input.	10
3	Parameter Estimation: Point Estimation, Optimal Estimates, Acceptable Estimates, Least Squares Estimation: The deterministic point of view (Gauss), Sequential Bayes Theorem, Linear Minimum Mean-square-error Estimation: Vector case sequential MMSE Estimation.	10
4	The Discrete-time Kalman Filter: Propagation of states and covariances, Derivation of the discrete-time Kalman filter, Kalman filter properties, Divergence issues	06
5	Nonlinear Kalman Filtering: The extended Kalman Filter, The Unscented Kalman Filter, General Unscented transformations, The Simplex unscented transformation, The spherical unscented transformation, Introduction to Particle filtering	06
6	Fractional Calculus: Introduction to Fractional Calculus, Functions for	04

	the Fractional Calculus, Riemann-Liouville fractional derivative (Left Hand Definition), Caputo definition of fractional derivative (Right Hand Definition), Fractional random walk, Application of fractional calculus to engineering systems.	
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Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

References:

1. Starks and Woods, "Probability and Random Processes with applications to Signal Processing, Phi, 2002.
2. Simon Haykins, "Adaptive filter theory", Pearson 2012
3. W.C. Van Etten, "Introduction to Random signals and noise", Wiley 2009
4. G.N. Saridis, "Stochastic Processes, Estimation and Control", Wiley 1995
5. Meditch. J., "Stochastic Linear Estimation and Control", Tata Macgraw Hills, 1969
6. Papoulis, "Probability, Random Variables and Stochastic Processes, Mc-Grawhill, 1995
7. Shantanu Das, "Functional Fractional Calculus" 2nd Edn, Springer Verlag, Germany, 2012
8. Dan Simon, "Optimal State Estimation" – Wiley 2006

Subject Code	Subject Name	Credits
ISEC203	Advanced Process Control and Automation	04

Course Objectives:

- To study the concepts of process modeling
- To study the effect of constraints and interaction between different loops
- To study the sizing of PLC and DCS.
- To study the knowledge about safety Instrumented System and advances in intrinsic safety.

Course Outcomes:

- The students should be able to design process and behavioral model of the process.
- The students should be able to select appropriate control configuration to minimize interaction between different loops
- The students should be able to design PLC and DCS based systems.
- The students should be able to calculate Safety Integrity Level for a given process.

Module	Detailed content	Hours
	Prerequisite: Basic knowledge of Process control and automation tools such as PLC, DCS and SCADA	
1	Process Dynamics and Control: Fundamentals of process modeling, Design for process modeling and behavioral model, Linearisation of model equations- Level process, evaporation and chemical reactor model. Dynamics of CSTR, Heat exchanger and evaporator.	07
2	Multivariable control: Constraint Control, SISO constraint control, Signal selectors, Relative gain analysis, steady state decoupling, dynamic decoupling.	06
3	Integrated Automation: Process and factory automation, PLC, DCS and SCADA- programming, selection and sizing, PLC networking, PLC-HMI interfacing, Installation and troubleshooting.	12
4	Buses and Networks: Introduction to networks in Industrial Automation, PLC Proprietary and open networks, hardware selection for Fieldbus systems, Fieldbus advantages and disadvantages, Limitations of open networks. Design and installation of Field Bus oriented Industrial Communication Networks- Foundation Fieldbus, Profibus PA, Devicenet, As-i segments in Hazardous and Non-Hazardous area.	10
5	Safety Instrumented System: Life cycle model of Safety Instrumented System, technologies, SIL calculation methods, SIL-calculation of PFD, RRF etc., Phases of SIS overall implementation and reliability.	08
6	Advanced intrinsic safety: Entity concept, FISCO, High power trunk, Dynamic arc recognition and termination technology with advantages and disadvantages.	05

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

References:

1. Myke King, "Process control-A practical approach", John Wiley, 1st edition, 2011.
2. Bela G Liptak, "Instrument Engineer's Handbook-Process software and digital networks", CRC press, ISA, 3rd edition, 2002.
3. Bela G Liptak, "Optimisation of Unit operation", ISA.
4. Bela G Liptak, "Instrument Engineer's Handbook-Process Control", Chilton Book Company, 3rd edition.
5. Gary Dunning, "Introduction to Programmable Logic controller", Thomas Learning, edition, 2001.
6. Thomas Hughes, "Programmable Logic Controller", ISA Publication.
7. Stuart A. Boyer, "SCADA supervisory control and data acquisition", ISA Publication.
8. George Stephanopoulos, "Chemical process control", PHI-1999
9. Paul Gruhn, Harry L cheddie, "Safety Instrumented System: Design, Analysis and justification", ISA, 2nd edition, 2006.
10. Ian Verhappen, Augusto Periria, "Foundation fieldbus", ISA, 2006

Subject Code	Subject Name	Credits
ISEDLO2021	Rehabilitation Engineering	04

Course Objectives:

- To develop an understanding of the principle and working of various rehabilitation aids.
- To give information about the application of various recent rehabilitation aids.
- To give information about rehabilitation medicine and Advocacy.

Course Outcomes:

- The students will be able to understand the principle and working of various rehabilitation aids.
- The students will be able to understand the design considerations of various rehabilitation aids.
- The students would be able to select which rehabilitation aid to apply for challenged people based on their medical conditions.
- The student would be aware of the various legal considerations while selecting a rehabilitation aid.

Module	Detailed content	Hours
	Prerequisite: Knowledge of Anatomy and Physiology of Human Systems, Knowledge of various basic stimulation techniques, Knowledge of basic concept of human-assist devices.	
1	Prosthetic and orthotic devices: Hand and arm replacement, different types of models for externally powered limb prosthetics, feedback in orthotic system, material for prosthetic and orthotic devices, mobility aids.	10
2	Auditory and speech assist devices: Types of deafness, hearing aids, application of DSP in hearing aids, cochlear implants	06
3	Visual aids: Retinal Implants, Types of retinal implants – Epi-retinal and sub-retinal, design and working, applications of retinal implants. Ultra sonic and laser canes, Intra ocular lens, Text voice converter, screen readers.	10
4	Medical stimulator: Muscle and nerve stimulator, Location for Stimulation, Functional Electrical Stimulation, Sensory Assist Devices.	10
5	Rehabilitation medicine: Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy.	08
6	Advocacy: Legal aspect available in choosing the device and provision available in education, job and in day-to-day life.	04

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered

in question papers of end semester examination.

References:

1. Rory A Cooper, "An Introduction to Rehabilitation Engineering", CRC press, 2006.
2. Joseph D.Bronzino, "The Biomedical Engineering Handbook", Third Edition, CRC Press, 2006
3. Levine.S.N.Editor, "Advances in Bio Medical Engineering and Medical Physics", Inter University Publication, New York 1968.
4. Albert M.Cook and Webster J.G, "Therapeutic Medical devices", Prentice Hall Inc., New Jersey, 1982.
5. Reswick.J, "What is Rehabilitation Engineering, Annual review of Rehabilitation-volume2", Springer-Verlag, New York 1982.

Subject Code	Subject Name	Credits
ISEDLO2022	Advanced Fiber Optics and LASER Instrumentation	04

Course Objectives:

- To expose the students to the concepts of instrumentation based on optical fibers and lasers along with their properties.
- To provide sufficient knowledge about the extensive utilization of optical fibers and lasers in Industries.

Course Outcomes:

- Understand the principle of optical fibers, its losses, sources and detectors and their importance.
- Understand the operation of lasers in detail.
- Master the various principles of optical fiber used for different parameter measurement.
- Perceive the significance of the intensive use of laser and optical fiber in Industrial applications.

Module	Detailed content	Hours
	Prerequisite: Awareness of light theory, Basics of fiber optics, Basics of Physics of Laser, Basics of measurement in Instrumentation.	
1	Optical Fibers and their properties: Ray theory, Principle of light propagation through a fiber, different types of fibers and their properties, Transmission characteristics of optical fiber, Absorption losses, Scattering losses, Dispersion losses, Non-linear phenomena.	08
2	Optical sources and Detectors: LED, LD, PIN, APD their characteristics, modulation circuits, optical detection principle, LED coupling to fiber	06
3	Fiber Optic Sensors: Principle of fiber optic sensors, classification, principle of intensity modulated sensors, phase modulated sensors, wavelength modulated sensors, distributed optical fiber sensing	08
4	Optical Fiber Measurement: Measurement of numerical aperture, refractive index profile, OTDR. concepts of temperature, flow, pressure and level measurement.	10
5	Laser Fundamentals: Fundamental characteristics of lasers, 3 and 4 level laser, its properties, modes, resonator configuration, Q switching and mode locking. Types of lasers: solid, liquid and gas.	08
6	Industrial & Biomedical Application of Lasers: Laser for measurement of distance, length velocity, acceleration, Material processing, Laser heating, welding, melting and trimming of materials. Laser instruments for surgery, Application of Laser for removal of tumors, brain surgery, oncology, plastic surgery.	08

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is

either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

References:

1. Gerd Keiser, "Optical Fiber Communication", McGraw Hill
2. John M Senior, "Optical Fiber Communications Principles and Practice", 3rd edition, Pearson
3. D.A.Krohn, "Fiber Optic Sensors- fundamentals and applications" 3rd edition, ISA
4. I. John and Harry, "Industrial lasers and their applications", McGraw Hill
5. John Crisp, "Introduction to Fibre Optics", an imprint of Elsevier Science, 1996
6. John F Ready, "Industrial applications of Lasers, Academic Press, 1978

Subject Code	Subject Name	Credits
ISEDLO2023	Advanced Nuclear Instrumentation	04

Course Objectives:

- To give students knowledge in the field of nuclear instrumentation, which is used for various hi-tech applications including field of nuclear research, nuclear reactors, accelerators and nuclear medical instruments?

Course Outcomes:

- The students should be able to understand design and working of advanced nuclear instruments used in nuclear research, nuclear reactors and other related nuclear field.
- Students will be able to apply the concepts for basic design of nuclear instruments.

Module	Detailed content	Hours
	Prerequisite: Basic concepts of Radioactivity, Measurement of Radioactivity.	
1	Nuclear instrumentation for research: Radiation detectors for high resolution nuclear pulse spectroscopy, HPGE, Ge(Li), Si(Li) detectors, high resolution Multi Channel Analyzers, Nuclear ADCs, Wilkinson, Gatti's sliding scale technique, various modes of Multi-Channel Analyzer, portable spectroscopy systems and their design. Timing spectroscopy, Time Pick-off circuits, TDCs, TACs, spectrum stabilization.	16
2	Instrumentation for reactors: Log and linear amplifiers, in core and out of core instrumentation, Neutron detector, BF3 detector, Fission counters, nuclear instrumentation for pressurized water reactors, boiling water reactors, self-powered detectors, fast Neutron detection and spectroscopy.	08
3	Detection of very low radio-activity: Liquid scintillation counting systems, noise reduction by coincidence detection. Counting interferences in LSC, Methods of quench corrections.	04
4	Instrumentation for accelerators: Various types of accelerators, detectors and electronics used.	04
5	Nuclear medical instrumentation: Functional imaging, design and construction of imaging systems gamma camera, PET SPET. Calibrations and testing of various nuclear instruments and systems.	12
6	Instrumentation for astrophysics experiments: Detection of cosmic events, detector arrays and trigger systems	04

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered

in question papers of end semester examination.

References:

1. G.F.Knoll ,“Radiation detection and measurement”, John Wiely and Sons, 4th edition, 2010.
2. P.W. Nicolson, “Nuclear electronics”, John Wiely,1998.
3. Gerald. J.Hine, James A Sorenson, “Instrumentation in nuclear Medicine”, Vol II, Academic press,1974
4. Ramesh Chandra, “Nuclear Medicine Physics”, Williams and Wilkins,1998.
5. Irving Kaplan “Nuclear Physics.”, Narosa Publishing House.1992

Subject Code	Subject Name	Credits
ISEDLO2024	MEMS and Nanotechnology	04

Course Objectives:

- To give students adequate knowledge regarding quantum mechanics to understand principles utilized in Nanotechnology and MEMS.
- To familiarize the students with advanced technologies used in fabrication of nano materials and MEMS.

Course Outcomes:

- Students will be able to understand concepts in quantum mechanics used in nanotechnology
- Students will be able to understand technologies used in fabrication of nano materials and MEMS.

Module	Detailed content	Hours
	Prerequisite: Basic knowledge in quantum mechanics and material science.	
1	Introduction: Introduction to nanotechnology and Nanomaterials, How It All Began: Synthesis of carbon buckyballs, List of stable carbon allotropes extended, fullerenes, metallofullerenes, solid C ₆₀ , bucky onions, nanotubes, nanocones.	04
2	Quantum Mechanics : Review of classical mechanics, de Broglie's hypothesis, Heisenberg uncertainty principle Pauli Exclusion Principle, Schrödinger's equation, Properties of the wave function, Application: quantum well, wire, dot, quantum cryptography Solid State Physics and Nanodevices-Structure and bonding, Application: carbon nanotube, Electronic band structure Electron statistics, Application: Optical transitions in solids, Semiconductor quantum dots, photonic crystals.	12
3	Nanomaterials - Fabrication, MEMS and NEMS nanotubes synthesis: Bottom-up vs. top-down approach, Epitaxial growth, Self-assembly, Modeling and Applications Production Techniques of Nanotubes Carbon arc bulk synthesis in presence and absence of catalysts High-purity material (Bucky paper) production using Pulsed Laser Vaporization (PLV) of pure and doped graphite High-pressure CO conversion (HIPCO) nanotube synthesis based on Boudoir Reaction Chemical Vapor Deposition (CVD).	08
4	Nanomaterials: Characterization and commercial processes of synthesis of nonmaterial, Nanoclay, Nanoinroganic materials, Nanocarbontubes CNT, Applications of nanomaterials in water treatment, polymers,	08

	catalysis etc Structural, XRD, TEM, SEM, STM, AFM.	
5	MEMS Technology: Introduction to Microelectromechanical Systems (MEMS), Microsensors and Microactuators, Micromachining, System modeling and Simulation, different types of MEMS sensors and actuators.	08
6	Micro Electromechanical Systems: MEMS: Micro-transducers Analysis, Design and Fabrication, Microprocessor-Based Controllers and Microelectronics, Micro-switches, Micro-actuators for Electromechanical systems.	08

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

References:

1. K. Eric Drexler, “Nanosystems: Molecular Machinery, Manufacturing, and Computation”, 1992 .
2. Mark Ratner & Daniel Ratner, “Nanotechnology: A Gentle Introduction to the Next Big Idea”, November 2002 Read reviews.
3. Nitaigour Premchand Mahalik, “MEMS”, Tata McGraw Hill, New Delhi, 2007.
4. K. K. Appukuttan, “Introduction to Mechatronics”, Oxford Higher Education, 2003.
5. Nitaigour Premchand Mahalik, “Machatronics”, Tata McGraw-Hill, 2003

Subject Code	Subject Name	Credits
ILO2021	Project Management	03

Objectives:

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to...

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	Project Management Foundation: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	Initiating Projects: How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	Project Planning and Scheduling: Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	Planning Projects: Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	Executing Projects: Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. Monitoring and Controlling Projects: Earned Value Management techniques for measuring	8

	value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. Project Contracting: Project procurement management, contracting and outsourcing,	
06	Project Leadership and Ethics: Introduction to project leadership, ethics in projects. Multicultural and virtual projects. Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

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

Subject Code	Subject Name	Credits
ILO2022	Finance Management	03

Objectives:

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to...

- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	Overview of Indian Financial System: Characteristics, Components and Functions of Financial System. Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market. Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation	05

	between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
06	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

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

Subject Code	Subject Name	Credits
ILO2023	Entrepreneurship Development and Management	03

Objectives:

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME

Outcomes: Learner will be able to...

- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
- Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	Indian Environment for Entrepreneurship: key regulations and legal aspects, MSME 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	08
05	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	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	05

Assessment:**Internal:**

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

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

Subject Code	Subject Name	Credits
ILO2024	Human Resource Management	03

Objectives:

- To introduce the students with basic concepts, techniques and practices of the human resource management.
- To provide opportunity of learning Human resource Management (HRM) processes, related with the functions, and challenges in the emerging perspective.
- To familiarize the students about the latest developments, trends & different aspects of HRM.
- To acquaint the student with the importance of behavioral skills, Inter- personal, inter- group in an organizational setting.
- To prepare the students as future organizational change facilitators, stable leaders and managers, using the knowledge and techniques of human resource management.

Outcomes: Learner will be able to...

- Gain knowledge and understand the concepts about the different aspects of the human resource management.
- Understand and tackle the changes and challenges in today's diverse, dynamic organizational setting and culture.
- Utilize the behavioral skill sets learnt, in working with different people, teams & groups within the national and global environment.
- Apply the acquired techniques, knowledge and integrate it within the engineering/ non engineering working environment emerging as future engineers and managers.

Module	Detailed Contents	Hrs
01	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.	5
02	Organizational Behavior (OB) : Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues, Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness, Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study	7
03	Organizational Structure & Design : Structure, size, technology, Environment	6

	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.	
04	Human resource Planning: Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. Training & Development: Identification of Training Needs, Training Methods	5
05	Emerging Trends in HR : Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment, Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	HR & MIS: Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries) Strategic HRM Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals Labor Laws & Industrial Relations Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

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

Subject Code	Subject Name	Credits
ILO2025	Professional Ethics and Corporate Social Responsibility (CSR)	03

Objectives:

- To understand professional ethics in business
- To recognize corporate social responsibility

Outcomes: Learner will be able to...

- Understand rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	Introduction to Corporate Social Responsibility: Potential Business 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	05
05	Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question**

paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

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.

Subject Code	Subject Name	Credits
ILO2026	Research Methodology	03

Objectives:

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to...

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Module	Detailed Contents	Hrs
01	Introduction and Basic Research Concepts: Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology, Need of Research in Business and Social Sciences , Objectives of Research, Issues and Problems in Research, Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	10
02	Types of Research: Basic Research, Applied Research, Descriptive Research, Analytical Research, Empirical Research, Qualitative and Quantitative Approaches	08
03	Research Design and Sample Design : Research Design – Meaning, Types and Significance, Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	08
04	Research Methodology : Meaning of Research Methodology, Stages in Scientific Research Process a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis 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	08
05	Formulating Research Problem: Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
06	Outcome of Research: Preparation of the report on conclusion reached, Validity Testing & Ethical Issues, Suggestions and Recommendation	04

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

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, (2nd ed), Singapore, Pearson Education

Subject Code	Subject Name	Credits
ILO2027	IPR and Patenting	03

Objectives:

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to...

- understand Intellectual Property assets
- assist individuals and organizations in capacity building
- work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	06
04	Basics of Patents: Definition of Patents, Conditions of patentability, 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	07
05	Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	07

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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4. Only Four question need to be solved.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. PrabhuddhaGanguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohdIqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. KompalBansal and PraishitBansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
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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, Priti Mathur, Anshul Rathi, 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

Subject Code	Subject Name	Credits
ILO2028	Product Life Cycle Management	03

Objectives:

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Outcomes: The learner will be able to

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Module	Detailed content	Hours
1	Introduction to Digital Business: Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	Overview of E-Commerce: E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	Digital Business Support services: ERP as e –business backbone, knowledge Tope Apps, Information and referral system, Application Development: Building Digital business Applications and Infrastructure	06
4	Managing E-Business- Managing Knowledge, Management skills for e-business, Managing Risks in e –business, Security Threats to e-business - Security Overview, Electronic Commerce Threats, Encryption, ryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	E-Business Strategy- E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	Materializing e-business: From Idea to Realization- Business plan preparation	08

	Case Studies and presentations	
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Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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4. Only Four question need to be solved.

REFERENCES:

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

Subject Code	Subject Name	Credits
ILO2029	Environmental Management	03

Objectives:

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Outcomes: Learner will be able to...

- Understand the concept of environmental management
- Understand ecosystem and interdependence, food chain etc.
- Understand and interpret environment related legislations

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

Assessment:

Internal:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to**

number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

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, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Subject Code	Subject Name	Credits
ISEL201	Laboratory-III	01

Experiment No.	Title
1	To develop a VI to simulate bottle filling system
2	To develop a VI to Simulate Continuous Stirred Tank Reactor
3	To develop a VI to simulate Traffic Control system
4	To develop a VI to simulate temperature controller using fuzzy controller
5	To design and simulate signal conditioning and processing circuits using Multisim.
6	Acquire data for monitoring and controlling purpose using DAQ cards.
7	Monte Carlo simulation of stochastic process.

Virtual Instrumentation based experiments should be based on basic programming of Lab VIEW and Common Design Techniques and patterns: Sequential programming, state machines, architectures, events, timing a design pattern and event programming, Data Management Techniques: Communicating among multiple loops: Variables, functional global variable, race condition, synchronizing data transfer, File I/O techniques: Low, high and advanced, Data Acquisition and interfacing instruments.

NOTE: Perform any six experiments from above list and two experiments from Department Elective Course.

Term work: Term work consists of performing 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners.

Subject Code	Subject Name	Credits
ISEL202	Laboratory-IV	01

Experiment No.	Title
1	Simulation of batch reactor control using PLC with GUI
2	Study of Ethernet network communication
3	Study of modbus communication
4	Simulation of furnace control using PLC with GUI
5	Simulation of Heat exchanger feedback control scheme using DCS
6	Simulation of cascade control scheme using DCS
7	Simulation of feedforward control scheme using DCS
8	Simulation of boiler level control using DCS

NOTE: Perform any six experiments from above list and two experiments from Department Elective Course.

Term work: Term work consists of performing 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners.

Subject Code	Subject Name	Credits
ISES301	SEMINAR	03

Guidelines for Seminar:

- Seminar should be based on thrust areas in Instrumentation Engineering.
- Students should undergo literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the topic and compile the report in standard format and present in front of Panel of Examiners appointed by the Head of the Department/Institute of respective Program.
- Seminar assessment should be based on following points:
 - Quality of Literature survey and Novelty in the topic.
 - Relevance to the specialization
 - Understanding of the topic
 - Quality of Written and Oral Presentation

IMPORTANT NOTE:

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be selected from approved panel of examiners for Seminar by University of Mumbai, OR faculty from Premier Educational Institutions/Research Organizations such as IIT, NIT, BARC, TIFR, DRDO, etc. OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries.
2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.
3. At least 4-5 hours of course on Research Methodology should be conducted which includes Literature Survey, Problems Identification, Analysis and Interpretation of Results and Technical Paper Writing in the beginning of 3rd Semester.

Subject Code	Subject Name	Credits
ISED301/401	DISSERTATION (I AND II)	12 + 15

Guidelines for Dissertation:

- Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt the solution to the problem by analytical/simulation / experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation-I:

- Dissertation-I should be assessed based on following points
 - Quality of Literature survey and Novelty in the problem
 - Clarity of Problem definition and Feasibility of problem solution
 - Relevance to the specialization
 - Clarity of objective and scope
- Dissertation-I should be assessed through a presentation by a panel of Internal examiners appointed by the Head of the Department/Institute of respective Program.

Guidelines for Assessment of Dissertation-II:

- Dissertation-II should be assessed based on following points
 - Quality of Literature survey and Novelty in the problem
 - Clarity of Problem definition and Feasibility of problem solution
 - Relevance to the specialization or current Research / Industrial trends
 - Clarity of objective and scope
 - Quality of work attempted
 - Validation of results
 - Quality of Written and Oral Presentation
- Dissertation-II should be assessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai.

Students should publish at least one paper based on the work in reputed International / National Conference / Refereed Journal.