Dr. BabasahebAmbedkar Technological University Lonere.

ELECTRICAL ENGINEERING DEPARTMENT

Structure and syllabus

Of

Final Year B. Tech.

(Instrumentation Engineering)

With effect from August 2018

VII Semester

Course Code	Course Name	Teaching Scheme			Evaluation Scheme					Credits
		L	P	T	Int	MSE	ESE	TW	Pr/OR	
IEL701	Process Instrumentation	3	0	1	20	20	60	-	-	4
IEL702	Distributed Control System	3	0		20	20	60	-	-	3
IEL703	Elective-IX	3	0	0	20	20	60	-	-	3
IEL704	Elective-X	3	0	0	20	20	60	-	-	3
IEP705	Process Instrumentation Lab	0	2	0	-	-	-	25	25	1
IEP706	Distributed Control System Lab	0	2	0	-	-	-	25	25	1
IEP707	Seminar	0	2	0	-	-	-	25	25	1
IEP708	Project Phase-I	0	8	0	-	-	-	25	25	4
IET709	Industrial Training	0	0	0	-	-	-	25	25	2
	TOTAL	12	08	02	80	80	240	125	125	22

Elective-IX- 1. Fiber Optics Communication 2. Industrial drives 3. Digital Control 4. Clinical Engineering

Elective-X 1.Power Plant Instrumentation 2.Internet of things 3. Analytical Instrumentation 4. Embedded Systems

VIII Semester

Course Code	Course Name	Teaching Scheme			Evaluation Scheme					Credits
		L	P	T	Int	MSE	ESE	TW	Pr/OR	
IEL801	Process Modeling and Optimization	3	0	1	20	20	60	-	-	4
IEL802	Project Engineering in Instrumentation	3	0	1	20	20	60	-	-	4
IEL803	Elective-XI	3	0	0	20	20	60	-	-	3
IEL804	Elective-XII	3	0	0	20	20	60	-	-	3
IEP805	Process Modeling and Optimization Lab	0	2	0	-	-	-	25	25	1
IEP806	PLC and SCADA Lab	0	2	0	-	-	-	25	25	1
IEP807	Project Phase-II	0	12	0	-	-	-	50	50	6
	TOTAL	16	08	02	80	80	240	100	100	22

Elective-XI: 1. Automotive Instrumentation 2. Robotics 3. Biomedical Medical Image Processing
4. Agriculture and Environmental Instrumentation

Elective-XII: 1. Smart materials and systems 2. Building Automation 3. Batch Process Control
4. Data Analytics and Decision Support systems

SEMESTER VII

IEL 701. Process Instrumentation

Teaching scheme:
Theory: 3 hrs
Tutorial: 1 hr
Total credit: 4

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course objective	1. Design aspects of sensors and actuators for typical pilot plant 2. Design advance controllers strategies 3. Integrate various process loop components	
Course outcomes	1. Apply the principles and practices for system design and development to plantoperations. 2. Apply various control techniques to processes. 3. Design multivariate control scheme	
Unit	Contents	Contact Hrs
1	**Study of pilot plants** Process flow diagram, design aspects for boiler, heat exchanger, evaporator, distillation column and spray dryer	7
2	**Selection criteria of process loop components** Design aspects and selection criteria for field instruments,development of instrumentation scheme for boiler, heat exchanger, evaporator, distillation column, spray dryer.	7
3	**Loop component design** Valve sizing as per standard ANSI/ISA-S-75.01,valve capacity & testing by ANSI/ISA-S-75.02, orifice plate design as per ISO 5167standard	7
4	**Process characteristics** Types of processes (dead time, single & multi capacity, self & non-self-regulating, interacting & non-interacting, Linear & non-linear), process gain, process reaction curve, process time constant & constant step analysis method for finding time constant, dead time, dynamic elements in control loops, PID control of processes, process simulator	7
5	**Analysisof some common loops** Flow, pressure, level, temperature, pH etc. configuration of PID controller for specific loop.	7
6	**Multi Loop & multivariate process control systems** Feedback, feed forward control, cascade control, ratio control, selective control, split-range control, interaction & decoupling, relative process gain matrices (RPG) & applications, statistical process controls.	7
	Text/Reference Books: 1. Bela G Liptak, "Instrument Engineers Handbook: Process Control", Chilton, 3rd ed., 2. F. G. Shinskey, "Feedback controllers: Tuning, Applications& Design", McGraw-Hill, 3. William Andrews, "Applied Instrumentation in process industries ", Gulf, Second ed., 4. Control Valve Handbook, Fisher Control International Inc., 3rded.,2001. 5. G. Stephanopolous, "Chemical Process Control", Prentice Hall of India, 1984. 6. Distillation column control ISA Publication 7. ISA Handbook of Control Valves 8. Douglas M. Considine, "Process Instrumentation and control Handbook", McGraw. 9. Krishna Kant,"Computer based Industrial Control, Prentice Hall of India, 10. F. G. Shinskey/'Process Control Systems", McGraw-Hill, 1996.	

IEL 702. Distributed Control System.

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite	Modern Control Systems	
Course objective	To understand architecture of Distributed Control Systems. To design distributed computing system.	
Course outcomes	Design and develop Distributed computing System. Apply distributed system using expert system. Develop real time distributed control system.	
Unit		Contact Hrs
1	Architecture of computer control systems- controlled architecture-Distributed control architecture Data Highway system.	7
2	Distributed Computing System: Distributed processing, Digital control system-computer control, self tuning and adaptive algorithms	7
3	Supervising Control systems, multi layer hierarchical structure, system decomposition, open loop co-ordination strategies, model reality differences	7
4	closed loop co-ordinate strategies, integrated system, Optimization of parameter (ISOPE), double interactive systems. Real time control systems: Design techniques and tools-MASCOT, Structured development of real time system	7
5	Fault tolerance in mixed hardware-software systems- fault detection, measures-fault detection mechanism-Damage confident and assessment. Expert system in real time control-Knowledge based process management, Representation of knowledge, reasoning in real time, application of knowledge based systems for process management	7
6	Real time task management, Task scheduling, dispatch, task co-operations and communications, distributed data, distributed control	7
	REFERENCE BOOKS: 1. Distributed Computer control systems by SS Lamba, Y D Singh. TMH publications, New Delhi.	

IEL 703. 1. Fiber Optics communication.

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	Identify various sensors, Fiber optic and its specifications. Understand principle of working of Fiber Optic used to measure Temperature, Displacement, Level, and various miscellaneous other sensors Understand applications of Fiber Optics in industry.	
Unit	Contents	Contact Hrs
1	Optical Fiber and Their properties: Ray theory, wave guiding principles, Theory of optical wave propagation, Types and classification of optical fibers, optical fiber mode, single mode fiber, special fiber, fiber materials, fiber fabrication, transmission characteristics of fiber, absorption losses, scattering losses, dispersion, polarization, non-linear phenomena.	8
2	Optical Sources and Detectors, Power Launching and Coupling: Laser theory, Laser diodes, LED, PN diode, Pin diode, avalanche diode, solid, liquid, gas and semiconductor laser their characteristics modulation circuits, optical detection principles, quantum efficiency and detector noise, Source to fiber power launching, fiber alignment and fiber to fiber joints, splices, connectors, coupling losses, lensing schemes for coupling improvement, LED coupling to single mode fiber.	6
3	Optical Fiber Measurements: Measurement of attenuation, dispersion, refractive index profile of fiber and cut off wavelength, numerical aperture, OTDR, Measurement of flow, pressure, Temperature, displacement, acceleration and fluid level vibration measurement.	6
4	Fiber Optic Sensing Principles and Techniques: Classification and principle of fiber optic sensors, fiber grating and fiber Bragg grating technology and distributed optical fiber sensing.	6
5	Optical Amplification and Integrated Optics: Beam splitter, directional coupler, opto isolators, multimode interference coupler(MMIC) optical modulators, fiber modulator optical amplifiers, optical switches, frequency translators, optoelectronic integration	6
6	Holography and Laser instruments in medical application and Remote Sensing: Basic principle, methods, Holographic interferometry. Application of laser in medical application, laser in industrial application. Components of Remote sensing, Active and passive Remote Sensingplatforms, Electro-magnetic radiation(EMR),EMR spectrum	
	Text/Reference Books: 1. "Fiber optics – communication", Gerd Keiser. 2. "Integrated circuits and semiconductor devices theory and application" DebooBurrous, McGraw Hill Second Edition.	

IEL 703. 2. Industrial Drives

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	To select a suitable drive for a particular application. To develop basic design of an electric drive system, analyze its steady state stability.	
Unit	Contents	Contact Hrs
1	Basic introduction to electrical drives, Electric drive system – dynamic and steady state stability	
2	Components of electrical drives, electric machine, power converter, controllers, dynamics of electrical drive, torque equation, equivalent values of drive parameters, components of load torques types of load, four quadrant operation of motor, steady state stability, load equalization, classes of motor duty, determination of motor rating	
3	DC motor drives- dc motors & their performance (shunt, series, compound, permanent magnet motor, universal motor, dc servomotor), braking, regenerative, dynamic braking, plugging, transient analysis of separately excited motor, converter ratings and closed loop control, transfer function of self , separately excited DC motors, linear transfer function model of power converters, sensing and feedback elements, current and speed loops, P, PI, and PID controllers, response comparison, simulation of converter and chopper fed drive	
4	Induction motor drives, stator voltage control of induction motor, torque-slip characteristics, operation with different types of loads, operation with unbalanced source voltages and single phasing, analysis of induction motor fed from non-sinusoidal voltage supply, stator frequency control, variable frequency operation, V/F control, controlled current and controlled slip operation, effect of harmonics and control of harmonics.	
5	PWM inverter drives for induction motors, multi quadrant drives, rotor resistance control, slip torque characteristic, torque equations, constant torque operation, slip power recovery scheme, torque equation, torque slip characteristics, power factor, methods of improving power factor, limited sub synchronous speed operation, super synchronous operation.	
6	Synchronous motor drives, speed control of synchronous motors, adjustable frequency operation of synchronous motors, principles of synchronous motor control, voltage source inverter drive with open loop control, self-controlled synchronous motor with electronic communication, self-controlled synchronous motor with electronic communication, self-controlled synchronous motor drive using load commutated thyristor inverter.	
	Text/Reference Books: 1. R. Krishanan, Electrical Motor Drives, PHI 2. G. K. Dubey, Power semiconductor controlled drives, Prentice Hall 3. G. K. Dubey, Fundamentals of Electrical drives, Narosa 4. S. A. Nasar, Boldea, Electrical Drives, CRC Press	

IEL. 703.3. Digital Control

Teaching scheme:
Theory: 3 hrs
Tutorial: 1 hr
Total credit: 4

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome		
Unit	Contents	Contact Hrs
1	Introduction to digital control: Configuration of basic digital control system, discrete transfer function, discrete model sampled data systems using z-transform, transfer function model, signal analysis and dynamic response, zero-order hold equivalent, introduction to first order hold equivalent, transformation between =s, =z, =w plane, z-domain description of sampled continuous time systems.	
2	Controller design using transform techniques: root locus and frequency domain analysis compensator design.	
3	State space theory: Control system analysis using state variable method, vector and matrices, state variable representation, conversion of state variable to transfer function and vice-versa, conversion of transfer function to canonical state variable models, system realization, and solution of state equations.	
4	State space design: Design using state space methods- controllability and observability, control law design, pole placement, pole placement design using computer aided control system design (CACSD)	
5	Observer design: Observer design, Deadbeat controller design, delayed system, controller design for delayed systems.	
6	Stability analysis and Jury's stability criterion, Lyapunov stability analysis to linear systems and discrete systems, Stability improvement by state feedback.	
	Text/Reference Books: 1. K. Ogata, Discrete Control System 2. M. Gopal, Digital Control and state variable methods, Tata McGraw Hill	

IEL. 703.4. Clinical Engineering

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite	Electrical measurement and instrumentation, physics, basic electrical engineering	
Course outcome	Application of mathematics, science and engineering to biomedical instrumentation. Design aspects of clinical laboratory instruments and analysis. Select and use latest hardware tools for various biomedical systems design.	
Unit	Contents	Contact Hrs
1	Respiratory instrumentation: Natural process of breathing, O_2 and CO_2 transport, regulation of breathing, ventilator terms, spirometer, airflow measurement, oxygenators-bubble type, membrane type, gas analyzers, ventilators.	8
2	Clinical Lab instrumentation: Blood and its composition and function, electron microscope, blood cell counters, electrophoresis, pulse oximetry, hemoglobin and glucose measurement, auto analyzer.	6
3	Operation room instrumentation: Electrosurgical unit, anesthesia machine, operation table, autoclave, elements of intensive care unit, bedside monitor, drug delivery system, lithotripsy, ICU layout, introduction to telemetry and telemedicine.	6
4	Electrical safety: Significance of electrical danger, physiological effects of electrical current, ground shock hazards, methods of accident prevention, safety standards, and electrical safety analyzer.	6
5	Skeletal system, overview of biomechanics, GAIT analysis, orthotics and prosthetic devices, overview of various orthotics and prosthetic devices materials, wheelchair types, materials used in wheelchair, joysticks used in wheelchair, artificial organ- artificial kidney.	6
6	Imaging systems: X-rays, image intensifiers, CT scanner, ultrasound scanner, nuclear methods, thermography, MRI, fusion imaging, artifacts, introduction to image processing.	7
	Ref Books: 1. Carr and Brown, Englewood Cliffs, Introduction to biomedical equipment technology, Prentice Hall 2. John G. Webster, Medical instrumentation application and design, John Willey & Sons Pvt. Ltd.	

IEL. 704.1. Power Plant Instrumentation

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	Understanding of Instrumentation used in power plant. Ability to demonstrate the standards used in power plants. Understanding the impact of power plant operation in environmental and societal context	
Unit	Contents	Contact Hrs
1	Introduction to Power Plant Power plant terminologies and key terms, power plant classification: thermal, hydro, nuclear, co-generation, comparison of various power plants based on technology, usage, efficiency, and limitations.	
2	Boiler Ancillaries: Various ancillaries used in steam generation units, viz. water treatment, electro-staticprecipitator, soot blower, economizer, de-aerator, super heater, chemical dosing systems, air pre-heater, coal and ash handling systems, fuel storage and distribution, bag house filters.	
3	Boiler Control: Types of boilers, various control such as: combustion control, air to fuel ratio control, element drum level control, steam temperature and pressure control, O2/CO2 in flue gases, furnace draft, boiler interlocks, sequence event recorder, supervisory control, data acquisition controls, burner management systems and controllers, start-up and shut-down procedures, boiler safety standards, boiler inspection procedures, Boiler load calculation, boiler efficiency calculation.	
4	Turbine Instrumentation: Turbine instrumentation and control, start-up and shut-down, thermal stress control, turbine supervisory instrumentation, condition monitoring, generator, power distribution instrumentation.	
5	Nuclear Power Plant Instrumentation: Classification of nuclear reactors, nuclear reactor control loops, fuel cycle, control and safety instrumentation, reliability aspects and various modes of operations.	
6	Non-conventional energy sources and Power Distribution Schemes: Wind power, solar power, tidal power, diesel generator controls, substation automation and smart grid, energy harvesting.	
	Text/Reference Books: 1. Sam. G. Dukelow, "The Control of Boilers", ISA Press, New York. 2. David Lindsley, "Boiler Control Systems", McGraw Hill, New York.	

IEL 704.2. Internet of Things

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	System Design knowledge of Internet of Things. Understanding the design architecture of IOT. Choice of protocols and deployment in solutions Overview and Design Perspective of IOT based products /services. Ensuring IOT with Security and Privacy as applicable	
Unit	Contents	Contact Hrs
1	Introduction to Internet of Things: Overview of Internet of Things- the Edge, Cloud and the Application Development, Anatomy of the Thing, Industrial Internet of Things (MOT - Industry 4.0), Quality Assurance, Predictive Maintenance, Real Time Diagnostics, Design and Development for IOT, Understanding System Design for IOT, Design Model for IOT	
2	System Design of Connected Devices : Embedded Devices, Embedded Hardware, Connected Sensors and Actuators, Controllers, Battery Life Conservation and designing with Energy Efficient Devices, SoCs, Single Chip Controllerswith integrated Processing and Network Core with Hardware Crypto Engines.	
3	Understanding Internet Protocols: Simplified OSI Model, Network Topologies, Standards, Types of Internet Networking - Ethernet, WiFi, Local Networking, Bluetooth, Bluetooth Low Energy (BLE), Zigbee,6LoWPAN, Sub 1 GHz, RFID,NFC, Proprietary Protocols, Simplicity, Networking Design - Push, Pull and Polling, Network APIs.	
4	System Design Perspective for IOT - Products vs Services, Value Propositions for IOT, Services In IOT, Design views of Good Products, Understanding Context, IOT Specific Challenges and Opportunities	
5	Advances Design Concepts for IOT - Software UX Design Considerations, Machine Learning and Predictive Analysis, Interactions, Inter-usability and Inter-operability considerations, Understanding Security in IOT Design, Design requirements of IOT Security Issues and challenges, Privacy, Overview of Social Engineering.	
6	Domain specific IOT and their challenges: Illustrated domains-home automation, smart cities, environment, energy, retail, logistics, health and life style.Case Study of Rapid Internet Connectivity with Cloud Service Providers with CC3200 Controller.	
	Text/Reference Books: *1.* Foundational Elements of an IOT Solution - The Edge, Cloud and Application Development, Joe Biron& Jonathan Follett, Oreilly, First Edition, March 2016 *2.* Designing Connected Products, 1st Edition, Elizabeth Goodman, Alfred Lui, Martin Charlier, Ann Light, Claire Rowland *3.* The Internet of Things (A Look at Real World Use Cases and Concerns), Kindle Edition, 2016, Lucas Darnell	

IEL 704.3. Analytical Instrumentation

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	Summarize and classify capabilities and limitations of analytical instruments Justify use of an analytical instrument in solving real world problem Familiarize with current literature, research in analytical instrumentation	
Unit	Contents	Contact Hrs
1	Introduction to chemical instrumental analysis, advantages over classical methods, classification: Spectral, electro analytical and separative methods, Interaction of radiation with matter, Laws of photometry (Beer and Lambert's Law), Deviation from Beer's law, working of filters, Prism and grating monochromators, concept of design of analytical instrument	
2	Colorimeters, online colorimeter for process applications, turbidity meter, UV-visible spectrometers and its types with its optical system design, IR spectrometers, X-Ray spectroscopy	
3	Emission Spectra, Quantitive measurements, Flame Photometer and its applications, concept of design atomic absorption spectrometer, spectrum interpretation, interferences, applications of atomic absorption spectrophotometer.	
4	Classification of Chrmatographic methods, gas chromatography, process gas Chromatograph, Liquid Chromatography, high performance liquid chromatography (HPLC)	
5	Different types of gas analyzers for measurement of oxygen, NO2, Ammonia, carbon dioxide and hydrocarbons, real world applications : environmental monitoring system, real time gas leakage monitoring working principle and applications of laboratory instruments : centrifuge, oven, stirrers	
6	Working principle, analyzers and detector types of mass spectrometer, applications	
	Text/Reference Books: 1. Willard, Merritt, John AurieDean, "Instrumental Methods of Analysis", CBS Publishers & Distributors, New Delhi, Seventh ed., 1988. 2. R. S. Khandpur, "Handbook of Analytical Instruments", Tata McGraw-Hill Publications, Second ed., 2006.	

IEL 704.4. Embedded Systems

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	Ability to understand and analyze, linear and digital electronic circuits	
Unit	Contents	Contact Hrs
1	Introduction to Embedded systems, the build process for embedded systems, Structural units in Embedded processor, selection of processor & memory devices, DMA, Memory management methods, timer and counting devices, watchdog timer, real time clock, in circuit emulator, target hardware debugging.	8
2	Embedded networking: Introduction, I/O Device ports and buses, serial bus communication protocols, RS 232 standard, RS 422, RS 485, CAN Bus, Serial Peripheral Interface (SPI), Inter Integrated Circuits (I^2C), need for device drivers.	6
3	Embedded Product Development Life Cycle: objectives, different phases of ELDC, Modelling of ELDC, issues I Hardware- software co-design Data flow graph, state machine model, sequential program model, concurrent Model, object oriented model.	6
4	OS Concepts and types, tasks & task states, process, threads, inter process communication, task synchronization, semaphores, and role of OS in real time systems, scheduling resource allocation, interrupt handling.	6
5	Introduction to basic concept of RTOS, multiprocessing and multitasking, preemptive and non- preemptive scheduling, task communication shared memory, message passing, inter process communication- synchronization between processes semaphores, mailbox, pipes, priority inversion, priority inheritance, comparisons of real time operating systems: Vx Works, uc/OS-II, RT Linux.	6
6	Case study of washing machine- automotive application- smart card system application.	
	Text/Reference Books: 1. Rajkamal, Embedded system- architecture, programming, design, McGraw Hill 2. Peckol, Embedded system design, John Wiley & Sons. 3. Lyla B Das, Embedded Systems-an integrated approach, Pearson.	

IEP 705. Process Instrumentation Lab

Teaching scheme:
Lab work : 2hrs
Total credit: 1

Examination Scheme:
Continuous Assessment (T/W): 25 Marks
Pr/oral: 25 Marks

Pre requisite	Process Control Engineering	
Course Objective		
Course Outcome		
Expt No	Title of Expt	
1	Identification of FOPDT and SOPDT process using time domain and frequency domain techniques.	
2	Design of different PID controller for FOPDT and SOPDT process using different standard technique and evaluate qualitative & quantitative performance.	
3	Design and Verification of Combinational & Sequential Circuits Using PLC	
4	Design of PID Controller for a Level Process/Temperature/Flow/Pressure process stations and evaluate servo/regulatory responses.	
5	Study the effect of different PID Controller Parameters using real time process trainer.	
6	Pressure to Current & Current to Pressure Convertor using real time process trainer.	
7	Design of Timer and Counter Using PLC.	
8	Design of PLC programming for practical applications.	
9	Design of Cascade and Feed forward-feedback Controller using simulation software.	
10	Verification of Control Valve Characteristics using pneumatic and electronic control value trainer.	
11	Development of P&I design using Distributed control system (DCS)	
12		

IEP 706. Distributed control System Lab.

Teaching scheme:
Lab work : 2hrs
Total credit: 1

Examination Scheme:
Continuous Assessment (T/W): 25 Marks
Pr/oral: 25 Marks

Pre requisite		
Course Objective	1. Understand different architectures for DCS 2. Configure different blocks in DCS 3. Design and implement DCS based control scheme I for a typical plant	
Course Outcome	1. Understanding of different architectures and blocks in DCS. 2. Designing and implementing a DCS based control for a plant 3. Understanding DCS as tools.	
Expt No	Title of Expt	
1	Study of various architectures of Distributed Control System	
2	Study of various modules installed/commissioned in DCS	
3	Start-up procedure for DCS and software aspects for the implementation	
4	Configuration and commissioning of Digital I/O's for a typical system	
5	Configuration and commissioning of Analog I/O's for a typical system	
6	Configuration and commissioning of control block for a typical system	
7	Configuration and commissioning of logical, timer, counter modules for a typical system	
8	Configuration and implementation of field bus components	
9	Design and deploy communication with external devices/systems using modbus	
10	Development of GUI for a typical plant	
11	Development of a alarm, and historian system for a typical process	
12	Implementation of the logic, GUI, and trends for a typical plant	

IEP 707. Seminar

Teaching scheme:
Lab work : 2hrs
Total credit: 1

Examination Scheme:
Continuous Assessment (T/W): 25 Marks
Pr/oral: 25 Marks

Course Objective	. Exhibit self- learning capabilities to assimilate and practice emerging theories and technologies. . Reveal teamwork and effective communication skills	
Course Outcome	1. Ability to understand of contemporary / emerging technology for various processes and systems. 2. An ability to share knowledge effectively in oral and written form and formulate documents	
Course Contents:	Seminar topic would be an emerging technology/ research/ product, study and finalization of the topic, sharing of knowledge with peers and discussion, documentation in the form of report.	

IEP 708. Project Phase-I

Teaching scheme:
Lab work : 8hrs
Total credit: 4

Examination Scheme:
Continuous Assessment (T/W): 25 Marks
Pr/oral: 25 Marks

Course Objective	1. Exhibit self- learning capabilities to assimilate and practice emerging theories and technologies. 2. To understand emerging technology in various industries and appreciate multidisciplinary research	
Course Outcome	1. Ability to work effectively in a various team (may be multidisciplinary teams). 2. Identify, formulate and solve a problem of Instrumentation and Control Engineering. 3. Understand the impact of Instrumentation and Control solutions in a global, economic , environmental and societal context	
Course Contents:	1. To familiarize the students about the standards and practices used in industry/ research organization/In-house research. The study leads towards finalization of the problem statement for project work, which is helpful to establish a link between industry and academia for low cost solution, identification of current need of the society as well as industrial research	

SEMESTER VIII

IEL 801. Process Modelling & Optimization

Teaching scheme:
Theory: 3 hrs
Tutorial: 1 hr
Total credit: 4

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	An ability to apply knowledge of mathematics and science to obtain model of a system. An ability to identify, formulate and solve a problem of optimization of a given plant. Understanding of different nonlinear control systems	
Unit	Contents	Contact Hrs
1	Modeling of systems: Thermal system, hydraulic system, reactor system	
2	Objective function formulation: Investment cost, equipment cost, operational and capitalized costs in objective functions, time value of money, profitability, application of these concepts to thermal insulation, rate of production, thermal system, hydraulic system, reactor system.	
3	Objective function formulation: Investment cost, equipment cost, operational and capitalized costs in objective functions, time value of money, profitability, application of these concepts to thermal insulation, rate of production, thermal system, hydraulic system, reactor system.	
4	Optimization techniques and applications: Single and multivariate optimization, line programming, sequential quadratic programming and reduce gradient optimization techniques and applications, introduction to geometric programming and dynamic programming.	
5	Advanced controllers: Model based controllers (self-tuning & model reference adaptive controller), optimal controller using Kalman filter, model predictive controller.	
6	Intelligent controllers: Expert systems &expert controllers (AI based), fuzzy controllers, artificial neural networks & ANN controller, neuro-fuzzy control system, neuro-MPC.	
	Text/Reference Books: 1. Singiresu S. Rao, "Engineering Optimization Theory and Practices", John Wiley &Sons, 4th ed., 2009 2. F. G. Shinskey/'Process Control Systems", McGraw-Hill, 3rd ed. 1996	

IEL 802. Project Engineering in Instrumentation

Teaching scheme:
Theory: 3 hrs
Tutorial: 1 hr
Total credit: 4

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	In a position to select the appropriate instrument for a given process measurement problem. In a position to identify and classify the use of instruments in process industries according to the safety practices in industry. In a position to prepare a instruments specification and understand the procedure and process involved in project documentation	
Unit	Contents	Contact Hrs
1	Selection and Application: Selection and application of temperature, pressure, flow and level measuring instruments.	
2	Standards and Calibration: Introduction to standards and calibration, calibration of temperature, pressure and flow measuring devices.	
3	EMC: Introduction, interference coupling mechanism, basics of circuit layout and grounding, concepts of interfaces, filtering and shielding.	
4	Safety: Introduction, electrical hazards, hazardous areas and classification, non-hazardous areas, enclosures-NEMA types, fuses and circuit breakers. Protection methods: Purging, explosion proofing and intrinsic safety.	
5	Specifications: Specification of instruments, preparation of project documentation, process flow sheet, instrument index sheet, instrument specifications sheet, panel drawing and specifications, instrument specifications.	
6	Project procedure, schedules, vendor drawing, tender documentation, selection of measurement method and control panels.	
	Text/Reference Books: 1. Noltingk B.E., Instrumentation Reference Book, 2nd Edition, Butterworth Heinemann, 1995. 2. Liptak B. G, Process Measurement and Analysis, 4th Edition, Chilton Book Company, Radnor, Pennsylvania, 2003. 3. Andrew W.G, Applied Instrumentation in Process Industries - A survey, Vol I &Vol II, Gulf Publishing Company, Houston, 2001 4. Spitzer D. W., Industrial Flow measurement, ISA press, 3rd Edition, 2005.	

IEL 803.1. Automotive Instrumentation

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	Ability to understand electronic control unit. Acquire knowledge of various automotive standards and Protocols. Design aspects of measurement and control strategies in automotive application.	
Unit	Contents	Contact Hrs
1	Introduction of automobile system: Current trends in automobiles with emphasis on increasing role of electronics and software, overview of generic automotive control ECU functioning, overview of typical automotive subsystems and components, AUTOSAR.	
2	Engine management systems: Basic sensor arrangement, types of sensors such as oxygen sensors, crank angle position sensors, Fuel metering/ vehicle speed sensors, flow sensor, temperature, air mass flow sensors, throttle position sensor, solenoids etc., algorithms for engine control including open loop and closed loop control system, electronic ignition, EGR for exhaust emission control.	
3	Vehicle power train and motion control: Electronic transmission control, adaptive power Steering, adaptive cruise control, safety and comfort systems, anti-lock braking, traction control and electronic stability, active suspension control.	
4	Active and passive safety system: Body electronics including lighting control, remote keyless entry, immobilizers etc., electronic instrument clusters and dashboard electronics, aspects of hardware design for automotive including electro-magnetic interference suppression, electromagnetic compatibility etc., (ABS) antilock braking system, (ESP) electronic stability program, air bags.	
5	Automotive standards and protocols: Automotive standards like CAN protocol, Lin protocol, flex ray, OBD-II, CAN FD, automotive Ethernet etc. Automotive standards like MISRA, functional safety standards (ISO 26262).	
6	System design and energy management: BMS (battery management system), FCM (fuel control module),principles of system design, assembly process of automotives and instrumentation systems.	
	Text/Reference Books: 1. William B. Ribbens, "Understanding Automotive Electronics", 6th ed., 2003. 2. Young A.P., Griffiths, "Automotive Electrical Equipment", ELBS & New Press, 1999. 3. Tom Weather Jr. &Cland c. Hunter, "Automotive computers and control system", Prentice Hall Inc., New Jersey. 4. Crouse W.H., "Automobile Electrical Equipment", McGraw Hill Co. Inc., New York,1995.	

IEL 803.2 Robotics

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	Acquired comprehensive knowledge of robotics in the design, analysis and control point of view. Understand the various parts of robots and fields of robotics. Apply various kinematics, inverse kinematics of robots and various formulations of Robot dynamics.	
Unit	Contents	Contact Hrs
1	Basic Concepts: Definition and origin of robotics, different types of robotics, various generations of robots, degrees of freedom, Asimov's laws of robotics, dynamic stabilization of robots.	
2	Power Sources: Hydraulic, pneumatic and electric drives, determination of HP of motor and gearing ratio, variable speed arrangements, path determination, micro machines in robotics.	
3	Manipulators, Actuators and Grippers: Construction of manipulators - manipulator dynamics and force control, electronic and pneumatic manipulator control circuits, end effectors, various types of grippers - design considerations.	
4	Kinematics and Path Planning: Solution of inverse kinematics problem, multiple solution jacobian work envelop, hill climbing techniques, introduction to robot programming languages.	
5	Sensors and Intelligent Robots: Introduction to robotic sensors, vision systems, Range detectors, assembly aid devices, force and torque sensors, machine vision, ranging, laser, acoustic, magnetic, fiber optic and tactile sensors.	
6	Case Studies: Multiple robots, machine interface, robots in manufacturing and non- manufacturing applications, robot cell design, selection of robot.	
	Text/Reference Books: 1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., "Industrial Robotics", McGraw-Hill, Singapore, 1996. 2. Ghosh, "Control in Robotics and Automation: Sensor Based Integration", Allied Publishers, Chennai, 1998.	

IEL 803.3. Bio Medical Image Processing

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	Utilize knowledge of mathematics, Science and Engineering to Biomedical Instrumentation. Design different biological signal amplifiers and its analysis. Usage of latest hardware and software tools for various biomedical systems design. Identify, formulate and solve a given problem of Biomedical Instrumentation.	
Unit	Contents	Contact Hrs
1	Bio-potential measurement: Cell structure, basic cell functions, origin of bio-potentials, electrical activity of cells, biological control concept, electrode-electrolyte interface, half-cell potential, polarizable and non-polarizable electrode, electrode circuit model, body surface recording electrodes for electric simulations of tissue, various biomedical transducers.	
2	Cardio-vascular system: Structure of heart, rhythmicity, pacemaker cell, ECG theory, ECG electrodes, electrocardiograph, vector cardiograph, ECG analysis, Bio-signal amplifiers and signal processing, basic requirement, op-amp circuit, transient protection, interference reduction circuits, active filters, rate measurement, averaging and integrator circuits, Examples of physiological signals and systems including feedback systems.	
3	Central nervous systems and muscular system: Receptors, sensory pathways and motor systems, processing sensory information, neural, neuromuscular, sensory muscular and sensory measurements, biofeedback, evoked response, electroencephalography (EEG), EEG amplifier, separation of alpha, beta, theta and delta waves from EEG. Classification of muscles - muscle contraction mechanism, myoelectric voltages, electromyography (EMG), noise removal and signal compensation for reducing ECG artifacts in an EMG recording.	
4	Cardiovascular measurements, therapeutic devices and life saving devices Heart sound, phonocardiography, PCG analysis to diagnose heart valve disorder, blood pressure measurement (invasive and noninvasive), blood flow meter-magnetic and ultrasound, cardiac output measurement, plethysmography, Short wave diathermy, microwave diathermy, ultrasound therapy unit, transcutaneous electrical nerve stimulators, radiotherapy, Pacemakers and defibrillators, heart lung machine.	
5	Auditory and vision system: Mechanism of hearing, sound conduction system, basic audiometer, pure tone audiometer, audiometer system Bekesy, evoked response audiometer system, hearing aids.Anatomy of eye, visual acuity, slit lamp, tonometer, ophthalmoscope, perimeter, LASER applications in ophthalmology - diabetic retinopathy, glaucoma and retinal hole and detachment treatment.	
6	Biomaterials: Structure and property relationships in materials, biocompatibility, metallic, ceramics, polymers,composite materials, biodegradable polymeric material, biologic biomaterials, and interactions of materials with the human body: concepts and applications.	
	Text/Reference Books: 1. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical InstrumentationandMeasurements", Pearson Education. 2. R. S. Khandpur, "Handbook of Biomedical Instrumentation", TMH.	

IEL 803.4.Agriculture and Environmental Instrumentation

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	To provide a window of applications of instrumentation and automation in agriculture and food processing industries. Additionally students know about the various processes involved in Food Processing	
Unit		Contact Hrs
1	**Introduction**: Necessity of instrumentation and control for food processing and agriculture sensor requirement, remote sensing, biosensors in Agriculture, standards for food quality **Instrumentation for food quality assurance**: Instrumental measurements and sensory parameters.	6
2	**Inline measurement for the control of food processing operations**: color measurements of food, food composition analysis using infrared, microwave measurements of product variables, pressure and temperature measurement in food process control, level and flow measurement in food process control, ultrasonic instrumentation in food industry. Instrumental techniques in the quality control.	8
3	**Major Processes**: Flow diagram of sugar plant, sensors and instrumentation set-up for it, Oil extraction plant and instrumentation set-up, Juice extraction control set-up	6
4	**Instrumentation for Agriculture**: Irrigation systems: necessity, irrigation methods: overhead, centre pivot, lateral move, micro irrigation systems & it's performance, comparison of different irrigation systems, soil moisture measurement methods	7
5	Major Processes: Application of SCADA for DAM parameters and control, Water distribution and management control, Auto-Drip irrigation systems, Irrigation Canal management, upstream and downstream control concepts, supervisory control	7
6	**Green houses and Instrumentation**: Ventilation, cooling and heating wind speed, temperature and humidity, rain gauge, carbon dioxide enrichment measurement and control	6
	References: 1. Process Control Instrumentation Technology, Johnson C. D., 7th Edition, Pearson Education, New Delhi, 2003 2. Industrial Instrumentation, D. Patranabis, 3rd edition, Tata McGraw Hill 3. Process Instrumentation, and Control Handbook, Considine D. M ., 3rd edition, McGraw Hill International publications, New Delhi.	

IEL 804.1. Smart Materials and system

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	Perform detailed analysis of the response of materials and systems exhibiting piezoelectricity and apply principles of dynamic elasticity for structural health monitoring and repair Perform detailed analysis of the response of systems exhibiting shape memory effects Demonstrate knowledge of electro-active fluidic systems	
Unit	Contents	Contact Hrs
1	Prerequisites: Foundational knowledge from Principles of mechanics, including basic statics, dynamics, and strength of materials, machine or structure design.	
2	Piezoelectric materials: Properties - Piezoelectricity, characteristics, applications - vibration control, health monitoring, energy harvesting.	
3	Shape-memory materials: Properties, shape memory materials, characteristics, applications - vibration control, shape control, health monitoring.	
4	Electro-Rheological (ER) fluids: Suspensions and ER fluids, ER phenomenon, charge migration mechanism, ER fluid actuators, applications of ER fluids.	
5	Magneto-Rheological (MR) fluids: Composition of MR fluid, applications of MR fluids.	
6	Other smart materials and their applications: Magnetostrictive materials, Electrostrictive materials, Magnetic Shape Memory Alloy, Composites, Ionic Polymer Metal Composites. Bio inspired engineering and micro electro mechanical systems using smart materials.	
	Text/Reference Books: 1. Mukesh V Gandhi, Brian S Thompson, Smart Materials and Structures, Kluwer Academic Publishers, 1992. 2. Mel Schwartz, Encyclopedia of smart materials, John Wiley and Sons, 2001. 3. Srinivasan A. V., Michael McFarland D., Smart Structure analysis and design, Cambridge University Press, 2001 4. Culshaw B., Smart structures and Materials, Artech house, 1996 5. Leo, D.J. Engineering Analysis of Smart Material Systems, Wiley, (2007).	

IEL 804.2. Building Automation

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	Understandingof basic blocks and systems for building automation. Designing different systems for building automation and integrate those systems.	
Unit	Contents	Contact Hrs
1	Introduction: Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS.	
2	HVAC system: Different components of HVAC system like heating, cooling system, chillers, AHUs, compressors and filter units and their types. Design issues in consideration with respect to efficiency and economics, concept of district cooling and heating.	
3	Access control &security system: Concept of automation in access control system for safety, Physical security system with components, RFID enabled access control with components, Computer system access control - DAC, MAC, RBAC.	
4	Fire &alarm system: Different fire sensors, smoke detectors and their types, CO and C02 sensors, Fire control panels, design considerations for the FA system concept of IP enabled fire&alarm system, design aspects and components of PA system.	
5	CCTV system &energy management system: Components of CCTV system like cameras, types of lenses, typical types of cables, controlling system, concept of energy management system, occupancy sensors, fans & lighting controller.	
6	EPBX System &BMS subsystem integration: Design consideration of EPBX system and its components, integration of all the above systems to design BMS.	
	Text/Reference Books: 1. Jim Sinopoli/'Smart Buildings", Butterworth-Heinemann imprint of Elsevier,2nd ed., 2010. 2. Albert Ting-Pat So, WaiLok Chan, "Intelligent Building Systems" Kluwer Academic publisher,3rd ed., 2012.	

IEL 804.3. Batch Process Control.

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	To introduce students the terminology, concepts and practices of process modeling and automatic process control. To impart knowledgeable in the design of control systems and controller tuning for processes	
Unit		Contact Hrs
1	Process Control System: Terms and objectives, piping and Instrumentation diagram, instrument terms and symbols. Regulatory and servo control, classification of variables. Process characteristics: Process equation, degrees of freedom, modeling of simple system, Self-regulating processes, interacting and non- interacting processes, Process lag, load disturbance and their effect on processes	8
2	Controller modes: Basic control action, two position, multiposition, floating control modes. Continuous controller modes: proportional, integral, derivative. Composite controller modes: P-l, P- D, P-l-D, Integral wind-up and prevention. Auto/Manual transfer, Bumpless transfer. Response of controllers for different test inputs. Selection of control modes for processes like level, pressure, temperature and flow	7
3	Controller tuning Methods: Evaluation criteria - IAE, ISE, ITAE. Process reaction curve method, continuous oscillation method, damped oscillation method. Auto tuning. Closed loop response of I & II order systems, with and without valve, measuring element dynamics	7
4	Final control elements: Pneumatic and electrical actuators, Valve positioners. Pneumatic and electrical dampers, Control valves types, construction details, various plug characteristics. Valve sizing. Selection of control valves. Inherent and installed valve characteristics. Fail-safe operation, Cavitation and flashing in control valves Instrument air supply specifications	7
5	Advanced control system: Cascade control, ratio control, feed forward control. Over-ride, split range and selective control. Multivariate process control, interaction of control loops..	7
6	Case Studies: Distillation column, boiler drum level control and chemical reactor control	6
	Reference: 1. G.Stephanopoulos, Chemical Process Control-An Introduction to Theory and Practice Prentice Hall of India, New Delhi, 3rd Edition, 2008. 2. D.R. Coughanowr, Process Systems Analysis and Control, McGraw Hill, Singapore, 3rd Edition, 2009. 3. B.W. Bequette, Process Control Modeling, Design and Simulation, Prentice Hall of India, New Delhi, 2004.	

IEL 804.4. .Data Analytics and Decision Support systems

Teaching scheme:
Theory: 3 hrs
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome		
Unit		Contact Hrs
1	Descriptive Statistics: Introduction to the course, Descriptive Statistics, Probability Distributions. Inferential Statistics: Inferential Statistics through hypothesis tests. Regres. Machine Learning: Introduction and Concepts: Differentiating algorithmic and model based frameworks, Regression: Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbours Regression & Classification. sion & ANOVA: Regression, ANOVA(Analysis of Variance).	
2	Supervised Learning with Regression and Classification techniques-1: Bias-Variance Dichotomy, Model Validation Approaches, Logistic Regression, Linear Discriminant Analysis, Quadratic Discriminant Analysis, Regression and Classification Trees, Support Vector Machines. Supervised Learning with Regression and Classification techniques-2: Ensemble Methods: Random Forest, Neural Networks, Deep learning.	
3	Unsupervised Learning and Challenges for Big Data Analytics: Clustering, Associative Rule Mining, Challenges for big data analytics. Prescriptive analytics: Creating data for analytics through designed experiments, Creating data for analytics through Active learning, Creating data for analytics through Reinforcement learning.	
4		
5		
6		

IEP 805 Process Modeling& Optimization Lab

Teaching scheme:
Lab work : 2hrs
Total credit: 1

Examination Scheme:
Continuous Assessment (T/W): 25 Marks
Pr/oral: 25 Marks

Pre requisite	Basic electrical engineering	
Course Objective		
Course Outcome		
Expt No	Title of Expt	
1	Modeling of Thermal system	
2	Modeling of hydraulic system	
3	Modeling of nuclear system	
4	Single and multivariate optimization	
5	Introduction to geometric programming.	
6	Introduction to dynamic programming.	
7	optimal controller using Kalman filter	
8	Expert systems &expert controllers (AI based)	
9	fuzzy controllers	
10	artificial neural networks & ANN controller	
11	Neuro-fuzzy control system.	
12	neuro-MPC	

IEP 806 . PLC and SCADA Lab.

Teaching scheme:
Lab work : 2hrs
Total credit: 1

Examination Scheme:
Continuous Assessment (T/W): 25 Marks
Pr/oral: 25 Marks

4	Combination of counter & timer for lamp on/off operation	
5	To study set and reset operation of lamp	
6	DOL starter & star delta starter operation by usingPLC	
7	PLC based temperature sensing using RTD	
8	PLC based thermal on/off	
9	PLC interface with SCADA and status read/ command transfer	
10	Parameter reading of PLC in SCADA	
11	Alarm annunciation using SCADA	
12	Report and trending in SCADA system	
13	Temperature sensor using SCADA	

IEP 708. Project Phase-II

Teaching scheme:
Lab work : 8hrs
Total credit: 6

Examination Scheme:
Continuous Assessment (T/W): 50 Marks
Pr/oral: 50 Marks

Course Objective	3. Exhibit self- learning capabilities to assimilate and practice emerging theories and technologies. 4. To understand emerging technology in various industries and appreciate multidisciplinary research	
Course Outcome	4. Ability to work effectively in a various team (may be multidisciplinary teams). 5. Identify, formulate and solve a problem of Instrumentation and Control Engineering. 6. Understand the impact of Instrumentation and Control solutions in a global, economic , environmental and societal context	
Course Contents:	2. To familiarize the students about the standards and practices used in industry/ research organization/In-house research. The study leads towards finalization of the problem statement for project work, which is helpful to establish a link between industry and academia for low cost solution, identification of current need of the society as well as industrial research	