College of Engineering Pune

Vision and Mission

Vision:

To be a leader amongst engineering institutions in India, offering value based world class education and constantly pursuing excellence.

Mission:

To strive for excellence in all facets of institute functioning.

COEP chartered in 1854 bore three fundamental values: strength, truth and endurance and captured these in its logo. While continuing to adhere to this original value system, COEP has gone ahead to include excellence in its mission.

COEP strives to create new knowledge through research, open the minds of students to the knowledge already available all around us, and create an academic ambience permitting freedom of expression, while respecting the dignity of each individual and make best advantage of the opportunities created through several clubs.

The college permits its students to explore their capabilities and interests and develop their full intellectual and human potential. The activities range from various art forms like dance, drama, music, to aero-modeling, automotive, boat club, environment club, entrepreneurship cell, history club, mind-spark, philosophy club, robotics club and zest, a sporting extravaganza.

The technologies being rapidly getting outdated, college has embarked on a mission to create individuals who are capable of learning on their own through a dictum learning to learn as a basic pedagogical philosophy with an eye for excellence.

Department of Instrumentation & Control

Vision & Mission

Vision:

To be a dynamic contributor to the global community through the development of expertise and dissemination of advance knowledge in the field of Instrumentation and Control and to create an environment that will facilitate the growth of individuals through innovative teaching, research and involvement of industry.

Mission:

- To provide high quality undergraduate and post graduate programs in Instrumentation and Control Engineering.
- To advance knowledge of Instrumentation and Control Engineering, strengthen and support R & D organizations/institutions, industry and enhance teaching.
- To work on socially relevant issues/problems, issues/problems of national importance

Program Education Objectives (PEOs):

1. To provide the students with solid foundation in mathematics, science and Instrumentation Engineering to solve real world problems appropriate to the discipline.
2. Be able to apply current industry accepted practices, new and emerging technologies to analyze, design, implement, and maintain state-of-art solutions.
3. Exhibit self- learning capabilities to assimilate and practice emerging theories and technologies. Exhibit teamwork and effective communication skills.
4. To inculcate professional and ethical attitude and ability to relate automation issues to society at large.
5. Be successfully employed or accepted into a graduate program / higher studies, and demonstrate a pursuit of lifelong learning.

Program Outcomes (POs):

On successful completion Graduates will demonstrate:

a. An ability to apply knowledge of mathematics, Science and Engineering to Instrumentation and Control Discipline
b. An ability to design and conduct experiments for measurement, measurement devices / elements, Control System, variety of control algorithms paradigms, final control elements, etc., and ability to analyze and interpret data.
c. Be able to apply the principles and practices for instrument / system / equipment / device design and development to real world problems adhering to safety and regulatory standards as applicable.
d. Be able to work effectively in a various team (may be multidisciplinary teams).
e. An ability to identify, formulate and solve a problem in Instrumentation and Control Engineering
f. Understand the social impact of automation, safety aspects of automation, hazards associated with various processes, environmental issues, professional ethics, etc.
g. An ability to communicate effectively in oral and written form while formulating project proposals, reports and other related documents.
h. Understand the impact of Instrumentation and Control solutions in a global, economic, environmental, and societal context.
i. Demonstrate the knowledge and capabilities necessary for pursuing a professional career or graduate studies; recognize the need for continuing professional development.
j. Understanding of contemporary and emerging technology for various processes and systems.
k. Ability to select and use latest hardware and software tools for various processes and systems.
l. Demonstrate an understanding of sensors / transducers, Control system, complete automation system.
m. Demonstrate proficiency in using a high-level / low level programming languages and network protocols for embedded system applications and networked systems.

Final Year B. Tech (Instrumentation and Control) – Semester VII

Sr. No.	Subject Title	Course Category	Contact hours L	T	P	Credits
01	Open Elective /Science Elective Course/Humanities Elective	OEC/SEC/ HSSC	3	-	-	3
02	Process Instrumentation	PCC	3	-	-	3
03	Project Engineering and Management	PCC	1	-	3	3
04	Departmental Elective-I	EC	3	-	-	3
05	Departmental Elective II	EC	3	-	-	3
06	Process Instrumentation Laboratory	LC	-	-	3	2
07	Industrial Automation Laboratory	LC	-	-	3	2
08	Project Stage I		-	-	-	2
09	Seminar		-	-	-	1
10	Liberal Learning Course	LLC	-	-	-	1
	Total		13	-	9	23

List of Departmental Elective-I and II

Sr. No.	Elective Course Name
01	Power Plant Instrumentation
02	Medical Instrumentation
03	Digital Control
04	Embedded System
05	Digital Image Processing
06	Optical Instrumentation

Process Instrumentation

Teaching Scheme		Examination Scheme
Lectures:3 hrs/week		Test-I-20
		Test-II-20
		End-Sem Exam- 60

Course Objectives:

- Design aspects of sensors and actuators for typical pilot plant
- Design advance controllers strategies
- Integrate various process loop components

Unit 1	Study of Pilot Plants	(7hrs)

Process flow diagram, design aspects for boiler, heat exchanger, evaporator, distillation column and spray dryer.

Unit 2	Selection criteria of Process loop components	(7hrs)

Design aspects and selection criteria for field instruments, development of instrumentation scheme for boiler, heat exchanger, evaporator, distillation column, spray dryer.

Unit 3	Loop Component Design	(7hrs)

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.

Unit 4	Process Characteristics	(7hrs)

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.

Unit 5	Analysis of some common loops	(7hrs)

Flow, pressure, level, temperature, pH etc. configuration of PID controller for specific loop.

Unit 6	Multi Loop & Multivariable process control systems	(7hrs)

Feedback, feed forward control, cascade control, ratio control, selective control, split-range control. Interaction & decoupling, relative process gain matrices (RPG) & applications, statistical process controls.

Course Outcomes:

i. Apply the principles and practices for system design and development to plant

operations [PEO2][PO-c]

ii. Apply various control techniques to processes [PEO1] [PO-a]
iii. Design multivariable control scheme [PEO5] [PO-i]

Text Books

- Bela G Liptak, "Instrument Engineers Handbook: Process Control", Chilton, 3rd ed., 1995.
- F. G. Shinskey, "Feedback controllers: Tuning, Applications & Design", McGraw-Hill, 4th ed.,2010.
- Krishna Kant, "Computer based Industrial control , Prentice Hall of India, First ed., 2009.
- F. G. Shinskey, "Process Control Systems", McGraw-Hill, 1996.

Reference Books

- William Andrews, "Applied Instrumentation in process industries ", Gulf, Second ed., 1979.
- Control Valve Handbook, Fisher Control International Inc., 3rd ed., 2001.
- G. Stephanopolous, "Chemical Process Control", Prentice Hall of India, 1984.
- Distillation column control ISA Publication
- ISA Handbook of Control Valves
- Douglas M. Considine, "Process Instrumentation and control Handbook", McGraw-Hill, 1984.

Project Engineering & Management

Teaching Scheme		Examination Scheme
Lectures: 1 hr/week		Test-I-20
		Test-II-20
		End-Sem Exam- 60

Course Objectives:

- Understand concept of project engineering management
- Understand flow of engineering project and related documentation
- Awareness to management and financial functions and usage of tools for the same

Unit 1	Introduction to project management	(5hrs)
Definition of project purpose - Scope, time, quality and organization structure. Basic and detailed engineering: Degree of automation, Project S curves, manpower considerations,		

inter-department and inter organization interactions, Multi agency interaction. Types of projects and types of contracts e.g. EPC, BOOT etc.

Unit 2	**Project management functions**	**(4hrs)**

Controlling, directing, project authority, responsibility, accountability, interpersonal influences and standard communication formats, project reviews. project planning and scheduling, life project engineering and management cycle phases, the statement of work (SOW), projects specifications, bar charts, milestones, schedules, work breakdown structures, cost breakdown structures and planning cycle.

Unit 3	**Project cost and estimation**	**(4hrs)**

Types and estimates, pricing process, salary and other overheads, man-hours, materials and support costs. program evaluation and review techniques (PERT) and critical path method (CPM), estimating activity time and total program time, total PERT/CPM planning crash times, software's used in project management.

Course Outcomes:

i. Understanding of different types of projects and its management [PEO-1][PO-a]
ii. Designing different documents and understanding the tools used [PEO-2][PO-j]
iii. Understanding project management and financial tools [PEO-2][PO-k]

Text Books :

- W.G. Andrew and H.B. Williams, "Applied instrumentation in process industries" Gulf Professional Publishing, 3rd ed. 2008.
- Harlod Kerzner and Van Nostrand, "Project management: A systems approach to planning scheduling and controlling" Reinhold Publishing, 11th ed., 2010.

Reference Books:

- Bela G Liptak, "Instrument Engineers Handbook: Process Control", Chilton, 3rd ed., 1995.

Power Plant Instrumentation

Teaching Scheme		**Examination Scheme**	
Lectures:3 hrs/week		Test-I-20	
		Test-II-20	
		End-Sem Exam- 60	

Course Objectives:

- Study of Instrumentation and Control Systems used in various power plants
- Understand various standards and protocols used in different power plants
- Discuss state of art technologies used in power sector

Unit 1	**Introduction to Power Plant**	**(7hrs)**

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.

Unit 2	**Boiler Ancillaries**	**(7hrs)**

Various ancillaries used in steam generation units, viz. water treatment, electro-static precipitator, 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.

Unit 3	**Boiler Control**	**(7hrs)**

Types of boilers, various control such as: combustion control, air to fuel ratio control, 3-element drum level control, steam temperature and pressure control, O_2/CO_2 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.

Unit 4	**Turbine Instrumentation**	**(7hrs)**

Turbine instrumentation and control, start-up and shut-down, thermal stress control, turbine supervisory instrumentation, condition monitoring, generator, power distribution instrumentation.

Unit 5	**Nuclear Power Plant Instrumentation:**	**(7hrs)**

Classification of nuclear reactors, nuclear reactor control loops, fuel cycle, control and safety instrumentation, reliability aspects and various modes of operations.

Unit 6	**Non-conventional energy sources and Power Distribution Schemes:**	**(7hrs)**

Wind power, solar power, tidal power, diesel generator controls, sub station automation and smart grid.

Course Outcome:

i. Understanding of Instrumentation used in power plant. [PEO1][PO-c]
ii. Ability to demonstrate the standards used in power plants [PEO5][PO-i]
iii. Understanding the impact of power plant operation in environmental and societal context [PEO4][PO-h]

Text Books

- Sam. G. Dukelow, "The Control of Boilers", ISA Press, New York, 2nd ed., 1991.
- David Lindsley, "Boiler Control Systems", McGraw Hill, New York, 1st ed., 1991.

Reference Books:

- Manoj Kumar Gupta, "Power Plant Engineering", PHI Learning Private Limited, 1st ed., 2012.
- G.S. Sawhney, "Non-Conventional Energy Resources", PHI Learning Private Limited, 1st ed., 2012
- Gill A.B, "Power Plant Performance", Butterworth, London, 1st ed., 1984.

Medical Instrumentation

Teaching Scheme		**Examination Scheme**	
Lectures:3 hrs/week		Test-I-20	
		Test-II-20	
		End-Sem Exam- 60	

Course Objectives:

- Study of various sensors, transducers related to biomedical field
- Design and analysis of various biomedical instruments/equipment/devices
- Implementation of signal feature extraction techniques

Unit 1	**Bio-potential measurement**	**(6 hrs)**
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.		
Unit 2	**Cardio-vascular system**	**(8rs)**
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.		

Unit 3	Central nervous systems and muscular system	(8hrs)
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.		
Unit 4	**Cardiovascular measurements, therapeutic devices and life saving devices**	**(7hrs)**
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.		
Unit 5	**Auditory and vision system**	**(8hrs)**
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.		
Unit 6	**Biomaterials**	**(8hrs)**
Structure and property relationships in materials, biocompatibility, metallic, ceramics, polymers, composite materials, biodegradable polymeric material, biologic biomaterials, interactions of materials with the human body: concepts and applications.		

Course Outcomes:

i. Utilize knowledge of mathematics, Science and Engineering to Biomedical Instrumentation[PEO1] [PO-a]
ii. Design different biological signal amplifiers and its analysis [PEO1] [PO-b]
iii. Usage of latest hardware and software tools for various biomedical systems design [PEO2] [PO-k]
iv. Identify, formulate and solve a given problem of Biomedical Instrumentation [PEO1] [PO-e]

Text Books

- John G. Webster ,"Medical Instrumentation Application and Design", John Wiley& Sons Pvt. Ltd,3rd ed., 2009.
- Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", Pearson Education, 2nd ed. 1980.
- R. S. Khandpur, "Handbook of Biomedical Instrumentation", TMH, 2nd ed., 2008.

Reference Books

- Vander, Shermen, "Human Physiology – The Mechanism of Body Functions", TMH, 13th ed., 2013.
- Tompkins, "Biomedical Digital Signal Processing", PHI, 5th ed., 2010.
- John G Webster, "Encyclopedia of Medical Devices and Instruments", Wiley Publications, 1988.
- M. Arumugam, "Biomedical Instrumentation", Amerada Publishers, 2nd ed., 1992.
- Carr and Brown "Introduction to Biomedical Equipment Technology", Pearson LPE, 4th ed., 2001.
- Richard Aston, "Principles of Biomedical Instrumentation and Measurement", Maxwell Macmillan, International ed., 1990.

Digital Control

Teaching Scheme		**Examination Scheme**
Lectures:3 hrs/week		Test-I-20
		Test-II-20
		End-Sem Exam- 60

Course Objectives:

- Study of different transform techniques for digital control
- Design of discrete controller for continuous system
- Stability analysis of discrete system

Unit 1	**Introduction to digital control**	**(6hrs)**

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.

Unit 2	**Controller design**	(**8hrs**)

Controller Design using transform techniques: Root locus and frequency domain analysis compensator design.

Unit 3	**State space theory**	**(6hrs)**
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, solution of state equations.		
Unit 4	**State space design**	**(6hrs)**
Design using state-space methods: controllability and observability, control law design, pole placement, pole placement design using computer aided control system design (CACSD).		
Unit 5	**Observer design**	**(8 hrs)**
Observer design, Deadbeat controller design, Delayed system, controller design for delayed systems.		
Unit 6	**Stability Analysis**	**(8hrs)**
Stability analysis and Jury's stability criterion, Lyapunov stability analysis to linear systems and discrete systems, Stability improvement by state feedback.		

Course Outcomes:

i. Ability to design discrete controllers for system in time domain [PEO2][PO-b]
ii. Ability to design discrete controllers for system in frequency domain [PEO2][PO-b]
iii. Ability to analyze stability of a discrete system [PEO1] [PO-a, PO-c]

Text Books

- K. Ogata, "Discrete Control Systems", PHI, 2nd ed., 1995
- M. Gopal, "Digital Control and state variable methods", TMH, 2nd ed., 2006

Reference Books

- Isermann, "Digital Control Systems", Springer-Verlag, 1989
- B. C. Kuo, "Digital Control System", 2nd ed., 1995

Embedded System

Teaching Scheme		**Examination Scheme**	
Lectures:3 hrs/week		Test-I-20	
		Test-II-20	

		End-Sem Exam- 60	

Course Objectives:
• Understand RISC architecture. • Understanding of ARM development tools. • Understanding linux kernel and device driver programming. • Study, design and develop various embedded applications using ARM processor.

Unit 1	**ARM-Cortex M series architecture**	**(6hrs)**
Embedded systems, classification, ARM 32-bit architecture—technology overview, Architectural Features of ARM Cortex M series: CPU modes, register organization, instruction set, pipelining, exceptions and its handling, memory, I/O's and addressing modes.		
Unit 2	**Operating system based development**	**(6hrs)**
Operating systems fundamentals, operating system services, memory management, process management, device management, file management, Operating system services- program execution, I/O operation, file manipulation, communication, Operating system properties - multitasking, parallel programming, interactivity, scheduling and scheduling algorithms, Linux: An overview of Red Hat Linux, installing Ubuntu, Linux commands, shell script programming, embedded Linux.		
Unit 3	**Development Tools (Open source)**	**(8 hrs**)
GNU tools, text editors- vi, nano, pico, etc. IDE-Eclipse, code lite, compilers-gcc, g++, debuggers, cross-compilers, gcc- arm specific tool chains and in line assembly, Writing and compiling C/C++ programs, cross-compilation for ARM development board, Basics of make file, static and dynamic libraries.		
Unit 4	**Kernel programming**	(**6hrs**)
Kernel, basic functionalities of kernel, kernel module programming, Linux kernel sources, kernel configuration, booting kernel, kernel booting parameters, root file system, boot loader, U-boot, porting Linux on ARM board, device driver programming, architecture, I/O communication, writing simple character device driver.		
Unit 5	**RTOS**	(**6hrs)**
RTOS concepts: foreground and background systems, critical section, shared resources, tasks, multitasking, context switching, kernels, pre-emptive and non-pre-emptive schedulers, static and dynamic priorities, priority inversion, mutual exclusion, synchronization, inter task communication mechanisms, Interrupts: latency, response and recovery, clock tick, memory requirements.		
Unit 6	**Interfacing and application development**	(**10hrs)**
Interfacing of: LED, LCD, touch screen, joy stick, and sensors, Development of web		

server, wireless module interfacing, camera interfacing, open CV on BBB. Control application, Java programming on BBB, porting android for mobile applications like controlling BBB I/O through mobile.

Course Outcomes:

i. Understanding of RISC architecture of processor, its features and applications [PEO 1] [PO- a]
ii. Hands on usage of IDE of processors and algorithm development [PEO 1] [PO- k]
iii. To understand concept of OS, RTOS and application perspectives [PEO 1] [PO- a]
iv. Study, design, analyze and prototype various embedded systems [PEO 5] [PO- b]

Text Books:

- Sloss Andrew N, Symes Dominic, Wright Chris, "ARM System Developer's Guide: Designing and Optimizing", Morgan Kaufman Publication, 2004.
- Michael Beck, "Linux kernel programming", Addison-Wesley Professional, 3rd ed. 2002.

Reference Books:

- Raj Kamal, "Embedded Systems – Architecture: Programming and Design", Tata McGraw-Hill Education, 3rd ed., 2003.

Digital Image Processing

Teaching Scheme		**Examination Scheme**	
Lectures:3 hrs/week		Test-I-20	
		Test-II-20	
		End-Sem Exam- 60	

Course Objectives:

- To understand fundamentals of image processing.
- To apply various processes on images for image understanding.
- To study, design and realize various image processing applications.

Unit 1	**Introduction and Digital Image Fundamentals**	**(6hrs)**
Introduction to image processing, origin, examples of fields, steps in image processing, components of image processing system, digital image fundamentals – elements of visual perception, light and electromagnetic spectrum, image sensing and acquisition, mathematical tools used in image processing.		
Unit 2	**Intensity Transformations, Spatial Filtering and Filtering in frequency domain**	**(8hrs)**
Basics intensity transformation functions, histogram processing, fundamentals of spatial filtering, smoothing and sharpening spatial filtering, combinations of image enhancement method, filtering in the frequency domain – Fourier transform of sample functions, DFT of one variable, extension to two variables, properties of 2 D DFTs, selective filtering, realization of FDT, FFT, filter design aspects.		
Unit 3	**Image Restoration and Reconstruction**	(**8 hrs**)
Model of the image degradation / restoration process, noise models, restoration in the presence of noise only – spatial filtering, periodic noise reduction by frequency domain filtering, estimating the degradation functions, inverse filtering, image reconstruction from projections.		
Unit 4	**Image Segmentation**	(**7hrs**)
Image segmentation - point, line and edge detection, Thresholding, Regions Based segmentation, segmentation using morphological watersheds, usage of motion in segmentation, edge linking and boundary detection, Hough transform, chain codes, boundary segments, skeletons, boundary descriptors, Fourier descriptors.		
Unit 5	**Image Compression**	**(8hrs**)
Image compression - image compression - data redundancies elements of information, variable-length coding, predictive coding, transform coding, image compression standards, wavelets and multi-resolution processing - image pyramids, sub-band coding.		
Unit 6	**Object Recognition and Case studies**	(**8hrs**)
Object Recognition- patterns and pattern classes, recognition based on decision – theoretic methods, structural methods, case studies – image analysis		

Course Outcomes:

i. Apply knowledge of mathematics for image understanding and analysis. [PEO 1][PO-a]
ii. Design and analysis of techniques / processes for image understanding. [PEO 2][PO- b]
iii. To design, realize and troubleshoot various algorithms for image processing case studies. [PEO 2][PO-e]
iv. Select the appropriate hardware and software tools (Contemporary) for image analysis. [PEO 5] [PO-k]

Text Books:

- Gonzalez & Woods, "Digital Image Processing", 3rd ed., Pearson education, 2008
- Jain Anil K., "Fundamentals Digital Image Processing", Prentice Hall India, 2010
- Pratt W.K, "Digital Image Processing", 3rd ed., John Wiley & Sons, 2007

Reference Books:

- Milan Sonka, Vaclav Hlavav, Roger Boyle, "Image Processing, Analysis and Machine Vision", 2nd ed., Thomson Learning, 2001
- Rangaraj M. Rangayyan, "Biomedical Image Analysis", CRC Press, 2005

Optical Instrumentation

Teaching Scheme		**Examination Scheme**	
Lectures:3 hrs/week		Test-I-20	
		Test-II-20	
		End-Sem Exam- 60	

Course Objectives:

- Understand the working of optical fiber as a sensor
- Apply and usage of optical fiber to measure various physical parameters
- Study and identify applications of LASER in instrumentation & measurement

Unit 1	**Optical fiber waveguide**	**(6hrs)**
Ray theory of transmission, total internal reflection, and electromagnetic mode theory of optical propagation, cylindrical fiber, classification of fibers, manufacturing of optical fiber.		
Unit 2	**Transmission characteristics of optical fiber**	**(7hrs)**
Attenuation, material absorption losses, scattering losses, nonlinear and linear scattering, fiber bend loss, dispersion, intermodal dispersion, dispersion modified single mode fiber, dispersion flattened fibers, polarization, nonlinear phenomena.		
Unit 3	**Optical sources and detectors**	(**8hrs**)
Optical emission from semiconductor, semiconductor LASER, non semiconductor LASER, LED as an optical source, optical detector principles, absorption, quantum efficiency, responsively, photo diodes, modulation.		
Unit 4	**Optical fiber sensors**	(**8hrs)**
Introduction to fiber optics sensors, sensors based on intensity modulation, application of optical fiber for displacement, strain, stress and pressure measurement. Active		

multimode FO sensors, micro-bend optical fiber sensors, current sensors, phase modulated, polarization modulated optical fiber sensors, fiber optic gyroscope.

Unit 5	**LASER applications**	**(7hrs**)

Introduction, application of LASER in biomedical instrumentation, LASER interferometry, performance parameters, LASER telemeters, measurement of distance, LIDAR, holography: basic principle of holography, measurement of strain, stress, bending moments and vibrations using hologram.

Unit 6	**Optical amplification and integrated optics**	(**6hrs**)

Optical amplifiers, integrated optics integrated optical devices: beam splitters, directional couplers, modulators, switches, optoelectronics integration and differentiation, analog arithmetic operations, digital optics.

Course Outcomes:

i. Apply LASER and Optical fiber for various physical parameter measurements.[PEO 2][PO-c]
ii. Analyzing the optical sensor technology on various parameters of measurements. [PEO 2][PO-l]

Text Books:

- Jose Miguel Lopez, "Optical fiber sensing technology", John Wiley & Sons, 2002
- Ajoy Ghatak, "Optics", Tata Mc- Graw Hill Publishing, 5th ed., 2012

Reference Book:

- Joseph T Verdeyen, "LASER Electronics", Prentice Hall of India, 3rd ed., 2003
- John M. Senior, "Optical fiber Communications Principles and Practice", PHI publication, 2nd ed., 2008

Process Instrumentation Laboratory

Teaching Scheme		**Examination Scheme**	
Lectures :3hrs/week		Continuous Evaluation: 50	
		Practical /Oral Exam- 50	

Course Objectives:

- To characterize various process parameters.
- To design controller suitable for a typical process.
- To design the process components.

List of Experiments:

1. Study & analysis of Process flow diagram, design aspects for Boiler, Heat Exchanger, Evaporator, Distillation Column, Spray Dryer.
2. Selection of field instruments for Boiler, Heat Exchanger, Evaporator, Distillation Column, Spray Dryer.
3. Designing of control valve for liquid/gas/vapor applications as per standard
4. Design of orifice plates for liquid/gas/vapor as per ISO 5167
5. Design of pneumatic or electric actuator
6. Development of control loops for Boiler, Heat Exchanger, Evaporator, Distillation Column, Spray Dryer.
7. Study & analysis of flow, pressure, and level control loop (Analysis includes process parameters such as type of process, dead time, capacity etc.)
8. Configuration of PID controller for specific loop
9. Design and Implementation of cascade controller for a given application.
10. Design & implementation of feed-forward controller for a given application.

Course Outcomes:

i. An ability to design and conduct experiments for process characteristics identification, collect the data from the system and interpret the classification of the system. [PEO1][PO-b]
ii. An ability to identify, control loop in a given process and apply appropriate control strategy. [PEO1][PO-e]
iii. An ability to select and use latest hardware and software tools for various processes and systems.[PEO2][PO-k]

Industrial Automation Laboratory

Teaching Scheme		**Examination Scheme**	
Lectures:3 hrs/week		Continuous Evaluation: 50	
		Practical /Oral Exam- 50	

Course Objectives:

- Understand different architecture for DCS
- Configure different blocks in DCS
- Design and implement DCS based control for a typical plant

List of Experiments:

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

Course Outcomes:

i. Understanding of different architecture and blocks in DCS. [PEO-1][PO-c]
ii. Designing and implementing a DCS based control for plant [PEO-1][PO-e]
iii. Understanding DCS as tools [PEO-2][PO-k]

Project Engineering Management Laboratory

Teaching Scheme		**Examination Scheme**	
Lectures:3 hrs/week		Continuous Evaluation: 50	
		Practical /Oral Exam- 50	

Course Objectives:

- Prepare documentation required during Project Engineering Management
- Solve practical problems that arrives during engineering project
- Usage of different tools for project management

List of Experiments:

1. Study of various symbols as per ISA used in process industries
2. Study of Piping and Instrument diagram for a plant under consideration
3. Prepare an Instrument Index sheet for the plant under consideration
4. Prepare Specification sheet as per ISA standard for the instruments used in the plant
5. Draw loop wiring diagram for various control loops
6. Draw hook-up diagram for the minimum 3 field instruments
7. Prepare the MCC, JB and cable schedule diagram
8. Draw the GA and wiring diagram of the control panel used in the plant
9. Prepare the cost estimation sheet for the project under consideration
10. Prepare work flow diagram and manpower estimation for the typical project.
11. Develop a GA diagram of the plant indicating all the equipment, and system

components.

Course Outcomes:

i. Preparation of different instrumentation documents for a case project. [PEO-1][PO-c]
ii. Understand a mock flow of project life cycle [PEO-1][PO-e]
iii. Understand tools used for project management [PEO-2][PO-k]

Project Stage-I

Teaching Scheme		**Examination Scheme**	
Lectures:2 hrs/week		Continuous Evaluation: 50	
		Presentation/demonstration: 50	

Course Objectives:

- Exhibit self- learning capabilities to assimilate and practice emerging theories and technologies.
- To understand emerging technology in various industries and appreciate multidisciplinary research.

Course Contents:

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.

Course Outcomes:

i. Ability to work effectively in a various team (may be multidisciplinary teams). [PEO3] [PO-d]
ii. Identify, formulate and solve a problem of Instrumentation and Control Engineering [PEO1] [PO-e]
iii. Understand the impact of Instrumentation and Control solutions in a global, economic , environmental and societal context [PEO4] [PO-h]

Seminar

Teaching Scheme		**Examination Scheme**	
Lectures:2 hrs/week		Continuous Evaluation: 50	
		Presentation/demonstration: 50	

Course Objectives:
• Exhibit self- learning capabilities to assimilate and practice emerging theories and technologies. • Reveal teamwork and effective communication skills.

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.

List of Experiments:

i. Ability to understand of contemporary / emerging technology for various processes and systems. [PEO2][PO-j]
ii. An ability to share knowledge effectively in oral and written form and formulate documents [PEO3][PO-g]

Liberal Learning

Teaching Scheme		**Examination Scheme**	
		Continuous Evaluation: 50	
		Presentation/demonstration: 50	

Course Objectives:
• To understand and master the learning process • To identify topic and define the learning

Course Contents:

Identification of topic and resources, scope, and synthesize viewpoints for the areas such as performing arts, basic Sciences, business, philosophy, sports and athletics, defense studies and education.

Course Outcomes:

i. Ability to exhibit self learning capabilities and its use in effective communication. [PEO3] [PO-g]
ii. An ability to inculcate impact of various areas to relate with society at large. [PEO4] [PO-h]

Final Year B. Tech (Instrumentation and Control) - Semester VIII

Sr. No.	Subject Title	Course Category	Contact hours L	T	P	Credits
01	Open Elective/Science Elective/Humanities Course	OEC/SEC/HSSC	3	-	-	3
02	Departmental Elective-III	EC	3	-	-	3
03	Departmental Elective-IV	EC	3	-	-	3
04	Project Stage II		-	-	-	10
05	Intellectual Property Rights	MLC	1	-	-	1
	Total		10	-	-	20

List of Departmental Elective-III and IV

Sr. No.	Elective Course Name
01	Batch Process Control
02	Automotive Instrumentation
03	Clinical Engineering
04	Advanced Control Systems
05	Building Automation
06	Robotics
07	Process Modeling & Optimization

Batch Process Control

Teaching Scheme		**Examination Scheme**	
Lectures:3 hrs/week		Test-I-20	
		Test-II-20	
		End-Sem Exam- 60	

Course Objectives:

- Examine the different techniques required for Batch process control
- Study different standards for batch process control.
- Implement the standards for different batch process P&IDs

Unit 1	**Introduction**	**(7hrs)**

Introduction to Batch Control System, Batch Control system terminology, Characteristics of Batch Processes, Hierarchical Batch Model, Control structure for batch systems.

Unit 2	**S88 standard**	**(8hrs)**

Role of standards in batch control systems, study of International Standards and Practices such as S88, S 95, USA FDA regulation, 21CFR 11, etc.

Unit 3	**Control of batch Process**	**(6hrs)**

General control requirements, safety interlocking, regulatory & discrete controls, sequential control of batch processes, Control activities and process management, information Handling for a batch process.

Unit 4	**Design of batch control systems**	**(6hrs)**

Batch management, recipe management, and production scheduling & information management. Batch control system design, system requirements, system hardware/reliability requirement.

Unit 5	**Specifications and data management**	**(6hrs)**

Batch control system specifications and implementation, Information/display requirements, cost justification and benefits, data management.

Unit 6	**Implementation & case studies**	**(7hrs)**

Generic implementation of batch processes, Case study of batch control system implementation for applications in food and beverages, pharmaceuticals etc.

Course Outcomes:

i. Acquired knowledge of standards used for Batch process control (PEO-1)[PO-c]
ii. Development of control schemes for different batch process P&IDs. (PEO-5) [PO-i]

Text Books

- Thomas .G. Fisher William M. Hawkins, "Batch Control Systems", ISA series, 1st ed., 2008
- Thomas .G. Fisher William M. Hawkins, "Batch Control Systems", ISA series, 2nd ed., 2012.

Clinical Engineering

Teaching Scheme		**Examination Scheme**	
Lectures:3 hrs/week		Test-I-20	
		Test-II-20	
		End-Sem Exam- 60	

Course Objectives:

- Study, design and analysis of various biomedical instruments/ equipment /devices
- Study of electrical safety aspects and safety analyzers
- Study of different bio-imaging modalities

Unit 1	**Respiratory instrumentation**	**(6hrs)**
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.		
Unit 2	**Clinical lab instrumentation**	**(6hrs)**
Blood and its composition and function, electron microscope, blood cell counters, electrophoresis, pulse oximetry, hemoglobin and glucose measurement, auto analyzer.		
Unit 3	**Operation room instrumentation**	**(8hrs)**
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.		
Unit 4	**Electrical safety**	**(6hrs)**
Significance of electrical danger, physiological effects of electrical current, ground shock hazards, methods of accident prevention, safety standards, and electrical safety		

analyzer.

Unit 5	**Concept of rehabilitation engineering**	**(8hrs)**

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.

Unit 6	**Imaging systems**	**(8 hrs)**

X-rays, image intensifiers, CT scanner, ultrasound scanner, nuclear methods, thermography, MRI, fusion imaging, artifacts, introduction to image processing.

Course Outcomes:

i. Application of mathematics, science and engineering to biomedical instrumentation. [PEO1] [PO-a]
ii. Design aspects of clinical laboratory instruments and analysis. [PEO1] [PO-b]
iii. Select and use latest hardware tools for various biomedical systems design. [PEO2] [PO-k]

Text Books

- Carr and Brown, Englewood Cliffs, "Introduction to biomedical equipment technology" N.J. REGENTS / Prentice Hall, 2nd ed., 1993.
- John G. Webster "Medical instrumentation application and design", John Wiley & Sons Pvt. Ltd, 4th ed., 2009.

Reference Books

- Jacobsons and Webster, "Medicine and clinical engineering", PHI, illustrated ed. 1977.
- Dr. John G Webster, "Encyclopedia of medical devices and instruments", Wiley Publication, 1988.
- M. Arumugam, "Biomedical instrumentation", Anuradha publishers, 4th ed., 1992.
- Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical instrumentation and measurements", Pearson Education, 2nd ed., 1980.
- R. S. Khandpur, "Handbook of biomedical instrumentation", TMH, 2nd ed., 2008.
- Richard Aston, "Principles of biomedical instrumentation and measurement", Maxwell Macmillan, International ed., 1990.

Advanced Control System

Teaching Scheme		Examination Scheme
Lectures:3 hrs/week		Test-I-20
		Test-II-20
		End-Sem Exam- 60

Course Objectives:

- Analyze nonlinear control system.
- Implementation of control laws.
- Estimation of states and disturbances.
- Design a sliding mode control for matched and unmatched system.

Unit 1	**Introduction of Nonlinear Systems**	**(6hrs)**
Nonlinear systems, inherent and intentional nonlinearities, analysis of nonlinear systems, stability analysis.		
Unit 2	**Uncertainties and Disturbances**	**(8hrs)**
Analysis of uncertainties and disturbances for matched and unmatched systems, estimation methods, time delay control (TDC), inertial delay control (IDC), disturbance observer (DO).		
Unit 3	**Observer and Controller Design**	**(8hrs)**
Observers and controllers design, Different control strategies, simultaneous state and disturbance observer design.		
Unit 4	**Advanced Control**	**(8hrs)**
Advanced control strategies, optimal control, optical nonlinear control, inverse optimal control for nonlinear affine systems, linear quadratic optimal regulator.		
Unit 5	**Sliding Mode Control**	**(6hrs)**
Sliding mode control (SMC), chatter control, reaching phase elimination, sliding mode control with unknown bounds.		
Unit 6	**Sliding Mode Observer**	**(6hrs)**
Sliding mode observer, SMC for unmatched systems, model following control.		

Course Outcomes:

i. Design controllers for nonlinear systems [PEO2][PO-b]
ii. Analysis of advanced control strategies for linear and nonlinear systems [PEO2][PO-a,PO-c]
iii. Stability analysis of nonlinear system [PEO2] [PO-a, PO-c]

Text Books:

- Alberto Isidori, "Nonlinear Control Systems (Communications and Control Engineering)", 2nd Ed.,Springer-Verlag, 1995
- C Edwards, S Spurgeon, "Sliding Mode Control: Theory And Applications (Series in Systems and Control)", CRC Press, 1998

Reference Books:

- W.M.Haddad&V.S.Chellabonia, "Nonlinear dynamical systems and control", Princeton publications, 2008.
- M. Vidyasagar, "Nonlinear system analysis", 2nd ed., SIAM publication, 2002.
- J. Gulder, Ma Shijun, Vadim Utkin, "Sliding Mode Control in Electromechanical Systems", 2nd ed., Taylor & Francis Series in Systems & Control Engineering, CRC Press, 1999.

Building Automation

Teaching Scheme		**Examination Scheme**	
Lectures:3 hrs/week		Test-I-20	
		Test-II-20	
		End-Sem Exam- 60	

Course Objectives:

- Understand the basic blocks of Building Management System
- Design various sub systems (modular system) of building automation
- Integrate all the sub systems

Unit 1	**Introduction**	**(7hrs)**
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.		
Unit 2	**HVAC system**	**(6hrs)**

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.		
Unit 3	**Access Control & Security System**	**(6hrs)**
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.		
Unit 4	**Fire & Alarm System**	**(6hrs)**
Different fire sensors, smoke detectors and their types, CO and CO2 sensors, Fire control panels, design considerations for the FA system concept of IP enabled fire & alarm system, design aspects and components of PA system.		
Unit 5	**CCTV System & Energy Management System**	**(6hrs)**
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.		
Unit 6	**EPBX System & BMS subsystem Integration**	**(7hrs)**
Design consideration of EPBX system and its components, integration of all the above systems to design BMS.		

Course Outcomes:

i. Understanding of basic blocks and systems for building automation[PEO-1][PO-c]
ii. Designing different systems for building automation and integrate those systems.[PEO-2][PO-e]

Text Book

- Jim Sinopoli, "Smart Buildings", Butterworth-Heinemann imprint of Elsevier,2nd ed., 2010.

Reference Book

- Albert Ting-Pat So, Wai Lok Chan, "Intelligent Building Systems" Kluwer Academic publisher, 3rd ed., 2012.

Robotics

Teaching Scheme		**Examination Scheme**	
Lectures:3 hrs/week		Test-I-20	
		Test-II-20	

		End-Sem Exam- 60	

Course Objectives:
• Study of basics of robot. • Understand robot sensors, robot controls, transformations. • Study of kinematics and dynamics.

Unit 1	**Basic Concepts**	**(7hrs)**
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.		
Unit 2	**Power Sources**	**(7hrs)**
Hydraulic, pneumatic and electric drives, determination of HP of motor and gearing ratio, variable speed arrangements, path determination, micro machines in robotics.		
Unit 3	**Manipulators, Actuators and Grippers**	**(7hrs)**
Construction of manipulators – manipulator dynamics and force control, electronic and pneumatic manipulator control circuits, end effectors, various types of grippers – design considerations.		
Unit 4	**Kinematics and Path Planning**	**(7hrs)**
Solution of inverse kinematics problem, multiple solution jacobian work envelop, hill climbing techniques, introduction to robot programming languages.		
Unit 5	**Sensors and Intelligent Robots**	**(7hrs)**
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.		
Unit 6	**Case Studies**	**(7hrs)**
Multiple robots, machine interface, robots in manufacturing and non- manufacturing applications, robot cell design, selection of robot.		

Course Outcomes:

i. Acquired comprehensive knowledge of robotics in the design, analysis and control point of view.[PEO2][PO-a,k]
ii. Understand the various parts of robots and fields of robotics. [PEO1][PO- a, c, l]
iii. Apply various kinematics, inverse kinematics of robots and various formulations of Robot dynamics.[PEO1][PO-a,b]

Text Books

- Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., "Industrial Robotics", McGraw-Hill,

Singapore, 1996.
- Ghosh, "Control in Robotics and Automation: Sensor Based Integration", Allied Publishers, Chennai, 1998.

Reference Books

- Deb.S.R., "Robotics technology and flexible Automation", John Wiley, USA 1992.
- Asfahl C.R., "Robots and manufacturing Automation", John Wiley, USA 1992.
- Klafter R.D., Chimielewski T.A., Negin M., "Robotic Engineering – An integrated approach", Prentice Hall of India, New Delhi, 1994.
- Mc Kerrow P.J., "Introduction to Robotics", Addison Wesley, USA, 1991.
- Issac Asimov, "I Robot", Ballantine Books, New York, 1986.

Automotive Instrumentation

Teaching Scheme		**Examination Scheme**	
Lectures:3 hrs/week		Test-I-20	
		Test-II-20	
		End-Sem Exam- 60	

Course Objectives:

- Study of Electronic Control Unit.
- Understanding of various automotive standards and Protocols
- Implementation of measurement and control strategies in automotive application.

Unit 1	**Introduction of Automobile System**	**(7hrs)**

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.

Unit 2	**Engine Management Systems**	**(7hrs)**

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.

Unit 3	**Vehicle Power Train and Motion Control**	**(7hrs)**

Electronic Transmission Control, Adaptive Power Steering, Adaptive cruise control,

Safety and comfort systems, Anti-lock braking, Traction Control and Electronic Stability, Active suspension control.

Unit 4	**Active and Passive Safety System**	**(7hrs)**

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.

Unit 5	**Automotive Standards and Protocols**	**(7hrs)**

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).

Unit 6	**System Design and Energy Management**	**(7hrs)**

BMS (Battery Management system), FCM (Fuel Control Module), Principles of system design, Assembly process of automotives and instrumentation systems.

Course Outcomes:

i. Ability to understand Electronic Control Unit. [PEO-1][PO-c]
ii. Acquire knowledge of various automotive standards and Protocols. [PEO-2][PO-f]
iii. Design aspects of measurement and control strategies in automotive application. [PEO-3][PO-c]

Text Books

- William B. Ribbens, "Understanding Automotive Electronics", 6th ed., 2003

Reference Books

- Young A.P., Griffiths, "Automotive Electrical Equipment" , ELBS & New Press, 1999.
- Tom Weather Jr. & Cland c. Ilunter, "Automotive computers and control system", Prentice Hall Inc., New Jersey.
- Crouse W.H., "Automobile Electrical Equipment", McGraw Hill Co. Inc., New York, 1995.
- Bechhold, "Understanding Automotive Electronic", SAE, 1998.
- Robert Boshe "Automotive Hand Book", Bentely Publishers, 5th ed. Germany, 2005.

Project Stage-II

Teaching Scheme		**Examination Scheme**	
Lectures: 8 hrs/week		Continuous Evaluation: 50	
		Presentation/demonstration: 50	

Course Objectives:

- To apply current industry accepted process control / automation practices
- To implement new and emerging technologies to analyze, design, maintain reliable, safe, and cost effective solution for industry problems.
- To exhibit teamwork and effective communication skills.

Course Contents:

Literature review to understand current technological development, study, analysis, design, fabrication, testing and calibration of a typical instrumentation and control based process, documentation based on the above mentioned parameters as a final project report.

Course Outcomes:

i. Ability to implement the principles and practices for instrument / system / equipment / device design and development to real world problems adhering to safety and regulatory standards as applicable. [PEO2] [PO-c]
ii. Ability to work effectively in a various team (may be multidisciplinary teams). [PEO3][PO-d]
iii. An ability to understand social impact of automation, safety aspects and hazards associated with various processes in core instrumentation industry [PEO4][PO-f]

Process Modeling & Optimization

Teaching Scheme		**Examination Scheme**	
Lectures:3 hrs/week		Test-I-20	
		Test-II-20	
		End-Sem Exam- 60	

Course Objectives:

- Identify the models related with various systems.
- Apply different types of optimization techniques.
- Study and analysis of nonlinear control strategy.

Unit 1	**Modeling of systems**	**(7hrs)**
Thermal system, Hydraulic System, Reactor System.		
Unit 2	**Data driven modeling**	**(7hrs)**
Boiler and Heat exchanger, evaporator, distillation column and spray dryer.		
Unit 3	**Objective Function Formulation**	**(7hrs)**
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.		
Unit 4	**Optimization techniques and applications**	**(7hrs)**
Single and multivariable optimization, line programming, sequential quadratic programming and reduce gradient optimization techniques and applications, Introduction to geometric programming and dynamic programming.		
Unit 5	**Advanced Controllers**	**(7hrs)**
Model Based controllers (self-tuning & Model reference Adaptive Controller), Optimal Controller using Kalman filter, Model Predictive Controller.		
Unit 6	**Intelligent Controllers**	**(7hrs)**
Expert systems & expert controllers (AI based), Fuzzy Controllers, Artificial Neural networks & ANN Controller, Neuro-Fuzzy Control System, Neuro-MPC.		

Course Outcomes:

i. An ability to apply knowledge of mathematics and science to obtain model of a system.[PEO1][PO-a]
ii. An ability to identify, formulate and solve a problem of optimization of a given plant. [PEO1][PO-e]
iii. Understanding of different non linear control systems.[PEO2][PO-j]

Text Books

- Singiresu S. Rao, "Engineering Optimization Theory and Practices", John Wiley & Sons, 4th ed., 2009
- F. G. Shinskey, "Process Control Systems", McGraw-Hill,3rd ed. 1996.
- Krishna Kant, "Computer based Industrial control , Prentice Hall of India, 1st ed., 2009
- G. Stephanopolous, "Chemical Process Control", Prentice Hall of India, 1984

Reference Books

- T. F. Edgar, D. M. Himmelblau, "Optimization of chemical Processes", McGraw-Hill International Edition
- W.L. Luyben, "Process modeling, simulation & control for chemical engineers", McGraw Hill, 2nd ed.,1990
- Bela G Liptak, "Instrument Engineers Handbook: Process Control", Chilton, 3rd ed., 1995

Intellectual Property Rights

Teaching Scheme		Examination Scheme
Lectures:1 hrs/week		Test-I-0
		Test-II-0
		End-Sem Exam- 50

Course Objectives:

- To understand the need of awareness and knowledge about IPR.
- To understand how IPR contributes to the economic development of the society and in turn the nation.
- To understand that IP is a law, economics, technology and business.
- Understand how IPR protection provides an incentive to inventors for further research work and investment in R & D.

Unit 1	**Introduction**	**(2 hrs)**
Nature of Intellectual Property, Patents, Designs, Trademarks and Copyrights, Process of patenting and Development-technological research, Innovation, patenting, development.		
Unit 2	**International Scenario**	**(2 hrs)**
International cooperation on Intellectual Property, Procedure for grants of patents, patenting under PCT.		
Unit 3	**Patent Rights**	**(3 hrs)**
Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications.		
Unit 4	**New developments in IPR**	**(3 hrs)**
Administration of Patent system, New developments in IPR, IPR Biological systems, Computers, Software etc., Traditional knowledge, Case studies, IPR and IIT's objectives towards learning IPR.		

Unit 5	**Trademark and patenting**	**(3 hrs)**
Registered and unregistered trademarks, designs, concepts, idea patenting.		

Course Outcomes:

i. Understood the importance of IPR [PEO4][PO-h]
ii. Understood how IPR are regarded as a source of national wealth and mark of an economic leadership in the context of global market scenario.[PEO4][PO-h]

Text Books

- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd., 2007

Reference Books

- Mayall, "Industrial Design", Mc Graw Hill
- Niebel, "Product Design", Mc Graw Hill
- Asimov, "Introduction to Design", Prentice Hall
- Robert P. Merges, Peter S. Meneil, Mark A. Lemley, "Intellectual Property in New Technological Age"
- T. Ramappa, S. Chand, "Intellectual Property Rights", Under WTO.