

University of Mumbai
Syllabus Structure (R-2007)
At
B.E. (Instrumentation Engineering)
Semester-VII

S. No.	Subject	Scheme of Instructions Periods (60 min. each) per Week		Scheme of Evaluation					
		Theory	Practical	Paper		TW	Practical & Oral	Oral	Total Marks
				Hours	Marks				
1.	Industrial Process Control	04	02	3	100	25	--	25	150
2.	Biomedical Instrumentation.	04	02	3	100	25	--	25	150
3.	Advanced Control Systems	04	02	3	100	25	25	--	150
4.	Process Automation	04	02	3	100	25	--	25	150
5.	Elective-I	04	02	3	100	25	--	25	150
6.	Project-I	--	02	--	--	25	--	25	50
	Total	20	12	---	500	150	25	125	800

Semester-VIII

S. No.	Subject	Scheme of Instructions Periods (60 min. each) per Week		Scheme of Evaluation					
		Theory	Practical	Paper		TW	Practical & Oral	Oral	Total Marks
				Hours	Marks				
1.	Batch Process Automation	04	02	3	100	25	25	--	150
2.	Instrumentation Project Documentation & Execution	04	02	3	100	25	--	25	150
3.	Instrument & System Design	04	02	3	100	25	--	25	150
4.	Elective-II	04	02	3	100	25	--	25	150
5.	Project-II.	--	08	--	--	50	--	50	100
	Total	16	16	---	400	150	25	125	700

Elective Subjects

<u>Semester-VII</u>	<u>Semester-VIII</u>
Elective-I	Elective-II
Advanced Embedded Systems	Power Plant Instrumentation
Fiber Optic Instrumentation	Digital Control System
Process Modeling and Optimization	Optimal & Robust Control Systems
Image Processing	Nuclear Instrumentation
Expert Systems	Automation in Energy and Infrastructure

University of Mumbai			
Class: B.E.	Branch: Instrumentation Engineering	Semester: VII	
Subject: Industrial Process Control (Abbreviated as IPC)			
Periods per Week (60 min.each)	Lecture	04	
	Practical	02	
	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	03	100
	Oral	---	25
	Term Work	---	25
	Total	---	150

Module	Contents	Hours
01	Introduction: Review of all strategies for process control, SISO, MIMO, ISA symbols.	02
02	Control System for Heat transfer unit operations: Heat exchangers: classification as per fluid flow arrangement and construction, feedback, feed-forward, bypass control. Furnace control: Start- up heaters, fired re-boilers, process and safety controls. Evaporator control: Types of Evaporator and multiple effect evaporator, control systems for Evaporator including selective control, steady state model for Evaporator. Boiler controls: Temperature and Pressure control of steam, Combustion control, Drum level control, Furnace draft control, safety interlocks and Burner Management System.	13
03	Control System for Heat and mass transfer unit operations Distillation column: Basic principle, Batch and continuous distillation, accessories, Distillation column control strategies. Crystallizers: Super-saturation methods, Process of crystallization, types of crystallizer, control of evaporating crystallizer, cooling crystallizers, vacuum crystallizers. Dryer control: Process of drying, types of dryer- Tray, fluidized bed, rotary, and spray, and their control strategies. Reactor control: Reactor characteristics, runaway reaction, various schemes of temperature control of reactors.	12
04	Control system for compressor: Classification, Phenomenon of Surge, Methods of capacity control for compressors.	03

05	<p>Process control for Industries:</p> <p>Continuous Process Industries: Refinery Industry: Process flow diagram, separation, treatment-Hydro-desulphurization unit, conversion methods- Fluid Catalytic Cracking, blending. Iron and steel Industry: Process flow diagram, its Instrumentation.</p> <p>Batch Process Industries: Overview of food processing & pharmaceutical industries and the same to be studied with reference to following aspects</p> <ol style="list-style-type: none"> 1.Charging of Raw Materials 2.Heating/cooling using different utilities 3.Milti product recipe management 4.Reports 	14
06	<p>Safety in Instrumentation control systems:</p> <p>Area and material classification as per IEC and NEC standard, techniques used to reduce explosion hazards, intrinsic safety, and installation of intrinsically safe systems.</p>	04

Theory Examination:

1. Question paper will consist of total 7 questions carrying 20 marks each.
2. Only 5 questions need to be solved.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus

Oral Examination:

Oral examination will be based on entire subject.

Term work:

Term work consists of minimum six assignments/experiments, written test and report of Industrial Visit. Industrial visit consists of

- I) Process Flow Diagram From any of the industries listed above.
- II) Process and Control Simulation on Distillation Column, Heat Exchanger etc

The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :15 marks

Test (at least one) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Text Books :

1. W.L.McCabe and Julian Smith “Unit operation and chemical engineering” Tata McGrawHill- fifth edition.
2. Bela G. Liptak “Instrument engineers handbook- Process control” Chilton book company- 3rd edition.

3. Bela G. Liptak “Instrumentation in the processing industries” Chilton book company- 1st edition.

Reference Books :

- 1) M. Chidambaram, “Complete Control of Processes”, Narosa Publishing House.
- 2) Douglas M. Concidine “ Process industrial instruments and controls handbook” Mc-GrawHill- 4th edition.
- 3) George T. Austin “Shreve’s chemical process industries” Mc-GrawHill- fifth edition.
- 4) George Stephenopoulos, “Chemical process control”, PHI-1999.
- 5) David Lindsey, “Power Plant control and instrumentation – control of boilers HRSG”, Institution of Engineering and Technology.
- 6) G.F. Gilman “Boiler Control Systems Engineering”, 2005, ISA Publication.

University of Mumbai			
Class: B.E.	Branch: Instrumentation Engineering	Semester: VII	
Subject: Biomedical Instrumentation (Abbreviated as BMI)			
Periods per Week (60 min. each)	Lecture	04	
	Practical	02	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory	03	100
	Oral	---	25
	Term Work	---	25
	Total	---	150

Module	Contents	Hours
1	Human Body System Overview: Structure of cell, respiratory system, nervous system, nerve muscle physiology, Cardiovascular system.	4
2	Cell Activity and Origin of Bio-potential: Origin of Bio-potential, Electrical activity of cell, Action Potential and its propagation, Origin of EMG, EEG, ECG, ERG and EOG.	4
3	Measurement of Biochemical and Bioelectric potential: Biochemical transducers – pH, PO ₂ , PCO ₂ , Bio-potential electrodes- electrode theory, electrode – electrolyte interface, Types of electrodes, bio-potential amplifier and its characteristics.	4
4	Cardiovascular Measurements: Blood Flow, Blood Pressure, Blood volume, Cardiac Output and Heart sound measurement. Oxymeter.	8
5	Diagnostic Instruments: EMG, EEG, ECG. Therapeutic Instruments: Pacemaker, Defibrillator and Incubator. Life support systems: Heart Lung Machine, haemodialysers, and ventilators.	12
6	Imaging Techniques*: X-Ray Generation and X-Ray Machine, CT – Scanning, Ultrasound Imaging, Magnetic Resonance Imaging, Nuclear Medicine (Gamma Camera) and their applications.	12
7	Significance of Electrical Safety: Physiological effects of electrical current, Shock Hazards from electrical equipments	4

	and methods of accident prevention.	
--	-------------------------------------	--

***- A Hospital Visit is recommended for imaging Instruments.**

Theory Examination:

1. Question paper will consist of total 7 questions carrying 20 marks each.
2. Only 5 questions need to be attempted.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Oral Examination:

Oral examination will be based on entire subject.

Term Work:

Term work consists of experiment no. 1 and minimum 4 experiments from experiment no. 2 to 9, two assignments, report of hospital visit and a written test. The distribution of the term work shall be as follows-

Laboratory work (Journal)	:15 marks
Test (at least one)	:10 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term-work

List of Laboratory Experiments:

1. Demonstration of instruments like EMG, EEG, ECG, PPG, PCG etc.
2. Study of electrodes
3. To design and implement ECG signal conditioning along with lead fail detector, filters and adjustable threshold detector.
4. To Design and implement asynchronous Pacemaker CKT.
5. Microprocessor based heart rate indicator.
6. ECG simulation on PC.
7. ECG simulation using microcontroller
8. To design and implement EMG quantification Circuit.
9. To design Defibrillator Circuit.

Text Books:

- 1) Leslie Cromwell, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson Education, 1980.
- 2) Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment

Technology”, PHI/Pearson Education, 4th edition, 2001.

Reference Books:

- 1) Richard Aston, “Principles of Biomedical Instrumentation and Instruments”, 1991.
- 2) John G. Webster, “Medical Instrumentation”, John Wiley and Sons, 1999.
- 3) R. S. Khandpur, “Biomedical Instrumentation”, TMH, 1994

University of Mumbai			
Class: B. E.	Branch: Instrumentation Engineering	Semester: VII	
Subject: Advanced Control Systems (Abbreviated as ACS)			
Periods per Week (each 60 min)	Lecture	4	
	Practical	2	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory	3	100
	Practical & Oral	--	25
	Term Work	--	25
	Total	--	150

Module	Contents	Hours
Prerequisite	Modeling of linear systems, Simulation of system, System stability through transient response and frequency response techniques. Superposition theorem for differentiating linear and nonlinear systems.	1
1	<p>Nonlinear Control Systems and Analysis Definition of nonlinear systems, Difference between linear and nonlinear systems, Characteristics of nonlinear systems, Common physical nonlinearities.</p> <p>Analysis and Design of Nonlinear Control System: Phase Plane Analysis, Phase plane method - basic concept, trajectories, phase portrait, singular points and their classification, limit cycle and behavior of limit cycle, Phase plane analysis of nonlinear systems, Construction of phase trajectories using delta method.</p> <p>Describing Function Analysis (DF): Derivation of general DF, DF for different nonlinearities, and Stability analysis of nonlinear system: Prediction of stability of nonlinear systems using DF method, Relay, Dead-zone, Backlash, and Saturation.</p> <p>Linearization Techniques: Linearization by small signal analysis (Taylor series expansion), linearization by nonlinear feedback, linearization by inverse nonlinearity, and Conditional stability analysis using root locus.</p>	20
2	<p>Lyapunov Stability Analysis Norms for Signals and Systems: 1, 2 & inf norms for signals and systems</p> <p>Lyapunov Stability Analysis: Stability of equilibrium state, asymptotic stability, graphical representation, Lyapunov stability theorems, stability analysis of linear systems, nonlinear systems, construction of Lyapunov functions using</p>	12

	Krasovskii method, variable gradient method	
3	Introduction to Adaptive Control System Definition of adaptive control system, functions of adaptive control, gain scheduling, model reference, series and parallel schemes and their industrial applications.	06
4	Introduction to Sliding mode Control Introduction, concept of variable structure control (VSC), ideal sliding motion and chattering, switching function, reachability condition, properties of sliding motion	09

Theory Examination:

1. Question paper will consist of total 7 questions of 20 marks each.
2. Only 5 questions need to be solved.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.
6. No question should be asked from the pre-requisite module

Practical and Oral Examination:

Practical and oral examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term work:

Term work consists of minimum eight experiments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :15 marks
 Test (at least one) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Laboratory Experiments:

- 1) Nonlinear Control System and Analysis
 - a) Construct the trajectory for system represented by second order differential equation and for any initial condition by using Iso-cline and Delta Methods
 - b) Draw the trajectory for the system with nonlinear element – relay, saturation, etc. for any initial condition and step input by using Iso-Cline and Delta Methods.
 - c) Study the behavior of Limit Cycle with the help of Vander Pol's equation.
 - d) Derivation of DF for nonlinearities – relay with saturation, relay with dead-zone, dead-zone and saturation, relay with Hysteresis etc.
 - e) Investigate the stability of system with nonlinearities – relay, saturation, dead-zone, hysteresis and existence of limit cycle using DF technique.
- 2) Liyapunov Stability Analysis
 - a) Verify Sylvester theorem for the definiteness of the Liyapunov Function.

- b) Determine the stability of the system and construct the Liyapunov function for – Linear Time Invariant system.
 - c) By using Krasovskii method determine the stability of the system and construct the Liyapunov function.
 - d) By using Variable Gradient method determine the stability of nonlinear system.
- 3) Adaptive control
Study the different schemes of adaptive control and their applications.
- 4) Sliding Mode Control.
- a) Study the sliding modes of the system with at least two examples.
 - b) Study the properties of sliding motion with examples.

Books Recommended:

Text Books:

1. M. Gopal, "Modern Control System Theory", Wiley Eastern Ltd., New Delhi.
2. K. Ogata, "Modern Control Engineering", 3 ed. Prentice Hall of India (P) Ltd., New Delhi.
3. Dr. K.P. Mohandas, "Modern Control Engineering", revised edition, Sanguine Publishers, Bangalore, 2006.

Reference Books:

1. Gene F. Franklin, J David Powell, Abbas Emami-Naeini, "Feedback Control of Dynamic Systems", 5ed Pearson Educations.
2. Shankar Sastry, Marc Bodson, "Adaptive Control", Prentice Hall of India (P) Ltd., 1993.
3. John Doyle, Bruce Francis, Allen Tannenbaum, "Feedback Control Theory".
4. Pierre R. Belanger, "Control Engineering" Saunders college Publishing.
5. Norman Nise, "Control system Engineering, 4 ed.Wiley International Edition".
6. Christopher Edwards, Sarah K. Spurgeon, "Sliding Mode control: Theory and Application", 1998.
7. Karl J. Astrom, B. Wittenmark, "Adaptive Control", 2nd Edition, Pearson Education Asia, First Indian Reprint, 2001
8. Stanislaw H. Zak, "Systems and Control", Indian Edition, Oxford University Press, 2003.

University of Mumbai			
Class: B.E.	Branch: Instrumentation Engineering	Semester: VII	
Subject: Process Automation(Abbreviated as PA)			
Periods per Week (60 min. each)	Lecture	04	
	Practical	02	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory	03	100
	Oral	---	25
	Term Work	---	25
	Total	---	150

Module	Contents	Hours
01	<p>Automation Fundamentals</p> <p>1.1 Automation and its importance, automation applications, expectations of automation.</p> <p>1.2 Types of plant and control – categories in industry, open loop and close loop control functions, continuous processes, discrete processes, and mixed processes.</p> <p>1.3 Automation hierarchy – large control system hierarchy, data quantity & quality and hierarchical control.</p> <p>1.4 Control system architecture – evolution and current trends, comparison of different architectures.</p>	04
02	<p>Programmable Logic Controller</p> <p>Hardware</p> <p>2.1 Evolution of PLC, Definition, functions of PLC, Advantages, Architecture, working of PLC, Scan time, Types & Specifications.</p> <p>2.2 DI-DO-AI-AO examples and ratings, I/O modules, local and remote I/O expansion, special purpose modules, wiring diagrams of different I/O modules, communication modules,</p> <p>2.3 Memory & addressing- memory organization (system memory and application memory), I/O addressing, hardware to software interface.</p> <p>Software</p> <p>2.4 Development of Relay Logic Ladder Diagram, introduction to PLC Programming, programming devices, IEC standard PLC programming languages, LD programming- basic LD instructions, PLC Timers and Counters: Types and examples, data transfer & program control instructions, advanced PLC</p>	12

	<p>instructions, PID Control using PLC.</p> <p>Case study: 2.5 PLC selection and configuration for any one process applications.</p>	
03	<p>Distributed Control system : 3.1 Introduction to DCS – Evolution of DCS, DCS flow sheet symbols, architecture of DCS – controller, Input and output modules, communication module, data highway, local I/O bus, workstations, specifications of DCS. 3.2 Introduction to Hierarchical Control and memory: Task listing, Higher & Lower Computer level tasks. 3.3 Supervisory computer tasks and DCS configuration – Supervisory Computer functions, Control techniques, Supervisory Control Algorithm, DCS & Supervisory Computer displays, advanced control Strategies, Computer interface with DCS. 3.4 DCS – system integration with PLCs and computer: Man machine interface- sequencing, supervisory control, and integration with PLC, personal computers and direct I/O, serial linkages, network linkages, links between networks.</p>	12
04	<p>Database & Alarm Management 4.1 Database management, Historical Data use in logs, reports and trend displays, System Status Display, Process Reports, different types of logs and reports. 4.2 Philosophies of Alarm Management, Alarm reporting, types of alarms generated and acceptance of alarms.</p>	04
05	<p>Supervisory Control and Data Acquisition (SCADA) 5.1 SCADA introduction, brief history of SCADA, elements of SCADA. 5.2 Features of SCADA , MTU- functions of MTU, RTU- Functions of RTU, Protocol Detail 5.3 SCADA as a real time system 5.4 Communications in SCADA- types & methods used, components, Protocol structure and Mediums used for communications 5.5 SCADA Development for any one typical application</p>	08
06	<p>OPC, Historian, MES, Integration with enterprise system.</p>	04
07	<p>Safety Instrumented System (SIS) 7.1 Need for safety instrumentation- risk and risk reduction methods, hazards analysis. Process control systems and SIS. 7.2 Safety Integrity Levels (SIL) and availability. Introduction</p>	04

	to the international functional safety standard IEC61508.	
--	---	--

Theory Examination:

1. Question paper will consist of total 7 questions carrying 20 marks each.
2. Only 5 questions need to be attempted.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus

Oral Examination:

Oral examination will be based on entire subject.

Term Work:

Term work consists of minimum 4 assignments, 4 PLC programs for process control applications and a written test. The distribution of the term work shall be as follows,

Laboratory work (Journal)	:15 marks
Test (at least one)	:10 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term-work

Text Books:

- 1 Samuel M. Herb , “ Understanding Distributed Processor Systems for Control”, ISA Publication.
2. Thomas Hughes, “Programmable Logic Controller”, ISA Publication.
3. Stuart A. Boyer, “SCADA supervisory control and data acquisition”, ISA Publication.
4. Gruhn and Cheddie, “*Safety Shutdown Systems*” – ISA, 1998,

Reference Books:

1. Poppovik Bhatkar, “Distributed Computer Control for Industrial Automation”, Dekkar Publication.
2. S.K.Singh, “Computer Aided Process Control”, Prentice Hall of India.
3. Krishna Kant, “Computer Based Process Control”, Prentice Hall of India
4. N.E. Battikha, “The Management of Control System: Justification and Technical Auditing”, ISA.
5. Gary Dunning, “Introduction to Programmable Logic controller”, Thomas Learning, edition, 2001.
6. John. W.Webb Ronald A Reis, “Programmable Logic Controllers – Principles and Applications”, Third edition, Prentice Hall Inc., New Jersey, 1995.
7. Bela G. Liptak “Instrument engineers handbook- Process control” Chilton book company- 3rd edition.

8. D.J. Smith & K.G.L. Simpson

Functional Safety: A Straightforward Guide to IEC61508 and Related Standards -
Butterworth-Heinemann Publications;

University of Mumbai			
CLASS: B. E.	Branch: Instrumentation Engineering	Semester - VII	
Elective-I : Advanced Embedded Systems (abbreviated as AES)			
Periods per week (each of 60 minutes)	Lectures	04	
	Practical	02	
	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	03	100
	Practical & Oral	--	--
	Oral	--	25
	Term Work	--	25
	Total	--	150

Module	Contents	Hours
1.	<p>ARM Processor</p> <p>Introduction to ARM7 & ARM9 Architecture</p> <p>ARM 7: ARM-THUMB mode, programming model, instruction set, and programming. Development tools for High level language-C, Device programming & ISP.</p> <p>On-Chip Device peripherals</p> <ul style="list-style-type: none"> • RTC programming • On-chip ADC programming for Signal Sampling • Watchdog timer • Timer programming- Timer / Capture mode • Serial port programming for PC communication • PWM Signal generation • Idle and Power down mode • Interrupt handling • Frequency measurement <p>Interfacing with ARM based chip like LPC2129</p> <ul style="list-style-type: none"> • 7 segment display, Character and Graphics LCD • Keyboard (1 to 20) keys <p>SPI Interface based External DAC like MCP4921/22</p> <ul style="list-style-type: none"> • SPI Interface based External ADC like MCP3202/4/8 	8

	<ul style="list-style-type: none"> • IIC based Memory interface 24CXX • Relay/SSR LED interfacing with and without opto-isolation. 	
2.	<p>System Design</p> <p>Instrumentation System design with ARM processor (Instrumentation Hardware design to be at Block level only)</p> <ul style="list-style-type: none"> - Data Acquisition System with <ul style="list-style-type: none"> ○ MMI (Character/Graphics LCD with Keypad of 20 keys) ○ 4 channel Analog Inputs ○ Selectable Sampling rate ○ PC based Data Logging using Serial port. - PID Controller <ul style="list-style-type: none"> ○ 7 segment, 4- digit Dual Display with first one for Current parameter value and Second for Set parameter value. ○ 4 Keys for PID Setting input ○ One SSR/Relay output <p>Alarm using Buzzer, which will be reset on key press.</p>	18
3.	<p>Embedded/ Real Time Operating system Concepts:</p> <p>Definition, Embedded systems overview, System components, Multiple process & Tasks, Task states & TCB , Task scheduler models, Interrupt service routines, Interrupt Handling and Latency, Inter Process Communication: Semaphores, Shared Data, Mutex, IPC, Signals, Mail boxes, Message queue, Socket & events, pipes, and signals.</p> <p>OS Services: Process management, Memory management, timer function, Event Functions, Device and File I/O subsystems, RTOS Interrupt handling, Priority inversion problem. Basic Design using RTOS.</p> <p>Overview of Real time operating system: RTLinux, VxWorks, MicroC /OS.</p>	8
4.	<p>Real Time operating system</p> <p>Application development outlines using typical RTOS - RTOS Initialization and availing its services for application work.</p> <p>Functions provided for : System Level, Task Service and Time management, Time Delay, Memory management, Semaphore, Mailbox, and Queue Management</p>	9

5.	<p>Introduction and Architecture of PAL, PLA, CPLD, FPGA. Comparison of above devices & application areas. Advantages of above. Introduction to development tools. Project development cycle. Introduction of Hardware description Languages and its Features.</p> <p>Introduction to ASIC, PSOC.</p>	4
----	---	---

Theory Examination:

1. Question paper will have total 7 questions of 20 marks each.
2. Only 5 questions need to be solved.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Oral Examination:

Oral examination will be based on entire subject.

Term work:

Term work consists of 2 application case studies, & Experiments mentioned in the Unit 2 & 4 above (Use of RTOS is recommended wherever applicable).

A seminar presented by a group of about three students on latest state-of-the-art technologies in Embedded systems: Processor families and trends, Embedded Devices like Digital Camera, Cruise Controller, Mobile phone, Smartcard based Applications & Systems, Point of Sale terminals, DVD Systems, CPLD, FPGA, VHDL, Verilog etc., Various RTOSs like VxWorks, RTLinux, pSOS, Handheld OS- Symbian etc., Selection criteria & development tools For various processors like Cortex-M3, ARM9.

Distribution of the term work shall be as follows,

Laboratory work (Experiments, seminar & case study) :15 marks

Test (at least one) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Text Books:

1. Rajkamal, *Embedded Systems Architecture Programming and Design*, McGraw Hill, Second Edition.
2. Dr. K.V.K.K.Prasad, *Embedded /Real Time Systems: Concept, Design and Programming*, DreamTech Press.
3. John F. Wakerly, *Digital Design Principles and Practices* 4th Edition, Pearson Prentice Hall.

Websites:

1. www.nxp.com - LPC21XX Datasheets, IIC Datasheets
2. www.atmel.com - 24CXX Dataesheets, , IIC Datasheets

3. www.microchip.com - MCP 32XX and MCP 49XX Datasheets
4. www.xilinx.com - CPLD XC9500, XC4000 Datasheets

University of Mumbai			
Class: B.E.	Branch: Instrumentation Engineering	Semester-VII	
Elective-I : Fiber Optic Instrumentation (Abbreviated as FOI)			
Periods per Week (each 60 min)	Lecture	04	
	Practical	02	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory	3	100
	Oral	--	25
	Term Work	--	25
	Total	--	150

Module	Contents	Hours
1	Introduction to Optical Fiber Communication : Elements of an Optical Fiber Transmission link., Optical Fiber modes, and configurations, Single mode fibers, Fiber materials, Fiber fabrication, Fiber Optics – basic characteristics, sensors – basic principle and operational details. Holography: principles, holographic recording and readout devices, its application. Optical signal processing – Fourier optics, optical applications	08
2	Optoelectronics: Light sources- LED, Laser Diodes. Optical detectors, their characterization. Light source- linearity, Reliability considerations. Opto-isolators: their characteristics, advantages and limitations. Lasers-theory, types, characteristics.	06
3	POWER LAUNCHING & COUPLING: Sources to Fiber power launching, Lensing schemes for coupling improvement, Fiber to fiber joints, LED coupling to single mode fibers, Fiber splicing, Optical Fiber connectors.	06
4	PHOTODETECTOR: Physical principles of photo diodes, Photo detector noise, Detector response time, Avalanche multiplication noise, Temperature effect on avalanche gain.	04
5	WDM Concepts & Components: Operational principle of WDM, Passive components, Tunable sources, Tunable filters.	04
6	OPTICAL NETWORKS : Basic networks, SONET / SDH, Broadcast and select WDM networks, Wave length routed networks, Non linear effects on network performance, Performance of WDM +EDFA systems, Optical CDMA, Ultra high capacity networks.	04
7	MEASUREMENTS APPLICATIONS : Measurement Standards & Test Procedure Test equipments, Attenuation	08

	Measurement, Dispersion measurement, Distance measurement, Flow measurement, Level measurement, Pressure and Vibration measurement, Endoscopy, Holography.	
8	REMOTE SENSING : Parameters of a Sensors, Definition : Components of Remote sensing – Energy, sensor, interacting Body, Active & passive Remote sensing – platforms—Aerial & space platforms--Balloons, Helicopter, Aircraft & satellites – Synoptivity and Receptivity--Electro Magnetic Radiation (EMR) - EMR spectrum--visible, Infra Red (IR), Near IR, Middle IR, Thermal IR & Microwave-Black body radiation-plank’s Law-Stefan-Boltzman Law.	08

Theory Examination:

1. Question paper will have total 7 questions of 20 marks each.
2. Only 5 questions need to be solved.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus
6. No question should be asked from the pre-requisite module

Oral Examination:

Oral examination will be based on entire subject.

Term work:

Term work consists of minimum eight experiments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :15 marks

Test (at least one) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Laboratory Experiments:

- 1) To plot spectral response characteristics of photodiode
- 2) To plot spectral response characteristics of photo transistor
- 3) To plot intensity response of photo diode
- 4) To plot intensity response of phototransistor.
- 5) Study of Fiber optic communication set-up.
- 6) Numerical aperture measurement of optical fiber.
- 7) Displacement measurement by fiber optic sensor.
- 8) Data communication by optical fiber.
- 9) Characteristics of opto- coupler

Text Books:

1. “Fiber optics – communication”, Gerd Keiser.

2. "Integrated circuits and semiconductor devices theory and application" Deboo Burrous, McGraw Hill Second Edition.

Recommended Books:

1. "Opto Electronics – An Introduction", J.Wilson J.F.B.Hawkes, Prentice Hall of India New Delhi. 1996.
2. "Optical fiber communications principles and practice", J.M. senior Prentice Hall of India , Second Edition 1996
4. "Fiber optics - communication and other application", H. Zanger and Zanger McGraw Pub
5. "Optical fiber systems, Tecnology, Design & Application", Kao C.K.,McGraw Hill.
7. "Introduction to optical fibers", Cherin, McGraw Hill.
8. "Text book on optical fiber Communication & it's application" S.C.Gupta (PHI)
9. "Basics of Remote Sensing & GIS", By: Dr. S. Kumar (Laxmi publications)

University of Mumbai			
Class: B.E.	Branch: Instrumentation Engineering	Semester - VII	
Elective-I : Process Modeling and Optimization (PMO)			
Periods per week (each of 60 minutes)	Lectures	04	
	Practical	02	
	Tutorial	-----	
		Hours	Marks
Evaluation System	Theory	03	100
	Oral	-----	25
	Term Work	-----	25
		Total	150

Module No.	Contents	Hours
1.	Mathematical Modeling Use of mathematical models and principles of formulation, Fundamental laws: Continuity equations, Energy equation, Equations of motion, Chemical kinetics, Modeling of CSTR (isothermal, no-isothermal, constant holdup, variable holdup)	08
2.	Introduction to Optimization: Definition and meaning of optimization, need of optimization, conventional versus optimum design process, optimization problem formulation – statement of an optimization problem, terminology, design vector, objective function, design constraints, constraint surface, Iteration, convergence, classification of optimization problem, engineering applications of optimization.	05
3.	Classical Optimization Techniques: Fundamental concepts- local and global minima, local and global maxima, quadratic form, necessary and sufficient condition of single and multivariable optimization with no constraints, multivariable optimization with equality and inequality constraints(Kuhn-Tucker condition), Lagrange Theorem.	10
4.	Linear Programming : Definition of linear programming problem (LPP), standard form of LPP, terminology, basic concepts, Simplex Algorithm and flowchart, simplex method, two-phase simplex method, Big-M method, Duality in LPP	12
5.	Numerical Methods for Unconstrained Optimum Design: General algorithm for constrained and unconstrained minimization methods, rate of convergence, unimodal and multimodal function ,reduction of a single variable, one dimensional minimization methods- Equal Interval method,	13

	Golden section search method, Polynomial Interpolation : Quadratic Interpolation method, Cubic Interpolation method, Gradient of a function, properties of gradient vector, Steepest Descent, Conjugate gradient (Fletcher-Reeves), Quasi-Newton method: Davidon-Fletcher-Powell, Broyden-Fletcher-Goldfarb-Shanno.	
--	---	--

Theory Examination:

1. Question paper will consist of total 7 questions of 20 marks each.
2. Only 5 questions need to be solved.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus
6. No question should be asked from the pre-requisite module

Oral Examination:

Oral examination will be based on entire subject.

Term work:

Term work consists of minimum ten assignments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Assignments and Journal) :15 marks

Test (at least one) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Assignments: Each student shall do at least **One** assignment on Module No. 1, **Two** assignments on Module No. 2, **Three** Assignments on Module No. 3 and **Four** assignments on Module No. 4 and 5 each. For assignments on Module No. 5 use Optimization Toolbox of MATLAB.

Text Books:

- 1) S. S. Rao, "Optimization", 2nd edition
New Age International (P) Ltd., Publishers, New Delhi, 1995.
- 2) Jasbir S. Arora, "Introduction to Optimum Design",
ELSEVIER, Academic Press, USA – 2004.
- 3) T. E. Edger and D. M. Himmeblaue, "Optimization of Chemical Processes",
McGraw Hill International Editions, 1989.

Reference Books:

- 1) Kalyanmoy Deb, "Optimization For Engineering Design",
Prentice Hall of India (P) Ltd., New Delhi, 1998.
- 2) Ashok D. Belegundu, "Optimization concepts and applications in Engineering",
Pearson Education, 2002.
- 3) Hamby A. Taha, "Operation Research", Pearson education - 2007.

University of Mumbai			
CLASS: B. E.	Branch: Instrumentation Engineering	Semester - VII	
Elective-I: Image Processing (Abbreviated as IP)			
Periods per week (each of 60 minutes)	Lectures	04	
	Practical	02	
	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	03	100
	Oral	--	25
	Term Work	--	25
	Total	--	150

Module	Contents	Hours
1.	Introduction: Definition of image, generation of image, steps in image processing, elements of digital image processing systems, image enhancements, restoration and analysis.	04
2.	Digital Image Fundamentals: Elements of visible perception, image model, sampling and quantization, relationships between pixels, imaging geometry.	04
3.	Image Transforms: Introduction to D.F.T., 2-D.F.T., F.F.T., other separable image transforms (walsh, hadamard, discrete cosine, haar, slant, KL)	08
4.	Image Enhancements: Point operations, histogram modeling, spatial filtering-smoothing, sharpening, low pass, high pass, homomorphic filtering.	06
5.	2-D systems and mathematical preliminaries: Introduction and definitions, matrix theory, random signals, spectral density function, results from estimation and information theory.	08
6.	Image Restoration: Image observation models, inverse and wiener filtering, F.I.R. wiener filters, filtering using image transforms, least squares filters, generalized inverse, S.V.D. and interactive methods, recursive filtering, causal models, digital processing of speckle images, maximum entropy restoration.	08
7.	Image Segmentation: Detection of discontinuities, edge linking and boundary detection, thresholding region oriented segmentation, use of motion in segmentation.	05
8.	Image Data Compression: Introduction, pixel coding, predictive techniques (PCM, DPCM, etc), transform coding theory of images, hybrid coding and vector DPCM.	05

Theory Examination:

1. Question paper will consist of total 7 questions of 20 marks each.

2. Only 5 questions need to be solved.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Oral Examination:

Oral examination will be based on entire syllabus.

Term work: Term work consists of minimum eight experiments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal)	:15 marks
Test (at least one)	:10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

LIST OF EXPERIMENTS:

1. Program for 2-D convolution.
2. Image rotation scaling and translation.
3. Program for 2-D correlation.
4. Program for 2-D F.F.T.
5. Program for Discrete cosine transform.
6. Program for K L transform.
7. Program for Histogram equalization & Histogram specification.
8. Program for Mask operation (Spatial filtering).
9. Program for edge detection.
10. Program for Thresholding.
11. Function for determining boundary descriptors, like boundary length and curvature.

Text Books:

1. R. C. Gonzalez, "Image Processing" Pearson Education 2nd edition, 1999.
2. A. K. Jain, "Fundamental of Digital Image Processing", PHI 2nd edition, 1995.
3. W. K. Pratt, "Digital Image Processing", John Wiley and Sons, 1994.

Reference Books:

- 1) C. Phillips, "Image Processing in C", BPB Publication, 1995.
- 2) B. Chanda, D. Dutta Majumdar, "Digital Image processing", PHI, 2000.
- 3) Emmanuel C. Ifeachor and Barry W. Jervis, "Digital Signal Processing", Pearson Education, 2nd edition, 2000.
- 4) Don Pearson, "Image Processing" (The ESSEX series in Telecommunication and information systems, McGraw Hill International ETL engg. series), 1991.
- 5) Johnny Johnson, "Introduction to DSP", PHI – 1996.
- 6) Proakis, "DSP", PHI 1997.
- 7) Rabnier Gold, "Theory and Application of DSP", PHI, 1996.
- 8) Milan Sonka, Vaclav Hlavac, "Image Processing analysis and machine vision", Thomson Learning, 2nd edition, 1999.

University of Mumbai			
Class: B.E.	Branch: Instrumentation	Semester: VII	
Elective-I: Expert Systems (Abbreviated as ES)			
Periods per Week (60 min. each)	Lecture	04	
	Practical	02	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory	03	100
	Oral	---	25
	Term Work	---	25
	Total	---	150

Module	Contents	Hours
1	Introduction to Expert System What are Expert Systems, Features of Expert System, features of good Expert System, Role of human in Expert System, Expert System organization, Difference between expert system and conventional program, Basic activities of expert system and the areas in which they solve problems, Prospector systems-features, working	3
2	Expert System Tools Knowledge representation in expert systems-using rules semantic nets, frames, Types of tools available for expert system building and how they are used, Stages in the development of expert system tools, Examples of knowledge engineering	7
3	Building an Expert Systems Necessary requirements for expert systems development, Justification for expert system development, Task in building expert systems, Stages of expert system development, Choosing a tool for building expert system, Acquiring knowledge from the experts, Examples of the expert system-building process, Examples of expert system used in different areas	4
4	Difficulties in developing an expert system Common pitfalls in-planning an expert system, Scaling with the domain expert during development process.	5
5	Neural Network Introduction Biological neural networks-neuron physiology, eye's neural network, Artificial neuron models, Neural net architecture (Topologies), Learning in ANN, Characteristics of ANN	7

6	Supervised Learning Single layer networks-perceptrons, Linear separability, Perceptron training algorithm, Modifications multi-layer network-multi-layer discrimination, back propagation algorithm, Classification using back propagation algorithm, Application of back propagation algorithm, Adaptive multiplier networks-algorithm, boosting, prediction network, radial basis functions	6
7	Unsupervised Learning Winner-take all networks, Learning vector quantiser, Co-inter propagation networks, Adaptive response theory	5
8	Associative Networks Non-interactive procedures for association, Hopfield networks, Optimization using Hopfield networks, Brain state in a box network, Boltzmann machines, Hetero associators	5
9	Fuzzy Logic Propositional logic, Membership functions, Fuzzy logic, Fuzzy rule generation, De-fuzzification, Time dependent fuzzy logic, Temporal fuzzy logics, Case study-to use fuzzy logic for processes control problem	6

Theory Examination:

1. Question paper will consist of total 7 questions carrying 20 marks each.
2. Only 5 questions need to be attempted.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Oral Examination:

Oral examination will be based on entire subject.

Term Work:

Term work consists of minimum six experiments/assignments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :15 marks
Test (at least one) :10 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term-work

Text Books:

1. Stamatios V. Kartalopolous, "Understanding Neural Network and Fuzzy Logic", PHI Pvt Ltd.
2. Kishan Mehrotra, "Elements of ANN", 2nd Editon, Penram International Publishing (I) Pvt. Ltd.

Reference Books:

1. Donald A. Waterman, "A Guide to Expert Systems", Addison-Wesley Publishing Company.