University of Mumbai

Syllabus Structure (R-2007)

at

T.E. (Instrumentation Engineering)

Semester-V

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.	Control System Components	04	02	3	100	25	--	25	150
2.	Signal Conditioning Circuit Design	04	02	3	100	25	25	*25	175
3.	Signals & Systems	04	2(T)$	3	100	25	--	--	125
4.	Microprocessors and Applications	04	2	3	100	25	25	--	150
5.	Communications Systems	04	2	3	100	25	--	--	125
6.	Application Software Practices-II	--	2	--	--	25	25	--	50
7.	Environment Studies	02	1(T)#	2	50	25	--	--	75
	Total	22	13	---	550	175	75	50	850

*-Oral examination will be based on mini-project.

$- Tutorial to be conducted batch wise.

#- Tutorial to be conducted class wise.

Semester-VI

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.	Process Instrumentation Systems	04	02	3	100	25	--	25	150
2.	Power Electronics & Drives	04	02	3	100	25	25	--	150
3.	Digital Signal Processing	04	02	3	100	25	25	---	150
4.	Industrial Data Communications	04	02	3	100	25	--	--	125
5.	Control System Design	04	02	3	100	25	--	--	125
6.	Embedded Systems for Instrumentation	04	02	3	100	25	25	--	150
	Total	24	12	---	600	150	75	25	850

University of Mumbai			
Class: T.E.	**Branch:** Instrumentation Engineering	**Semester:** V	
Subject: Application Software Practices (Abbreviated as ASP)			
Periods per Week (60 min. each)	Lecture	---	
	Practical	02	
	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	---	---
	Practical and Oral	02	25
	Oral	---	---
	Term Work	---	25
	Total	02	50

Objective: To study LabView as a tool for interfacing and developing HMI for measurement and process instrumentation.

Module	Contents	Hours
1	Introduction to terms: Measurement system, calibration, DAS, measurement hardware, sampling ADC, digitizer.	1
2	Introduction to terms: Control system block diagram, feedback control, feed forward control, cascade control, ratio control, batch and continuous process control, controller modes, alarm conditions.	1
3	HMI: Requirements, types and development tools available.	
4	LabView Programing: Components of virtual instrument, creating VI and sub-Vis, types of variables, debugging techniques, loops, shift registers, feedback node, graphs and charts, arrays, clusters, case and sequence structures, formula nodes, local and global variables, string handling and file I/O, signal generator.	15
5	Data Acquisition with LabVIEW, Add–on cards, Labview modules and toolsets, general applications of LabView.	3

List of Programs

1) To create and use Sub VI
2) To create VI for studying array functions
3) To create VI for studying loops
4) To create VI for studying case structures
5) To create VI for studying Sequence structure
6) To create VI for studying properties and options of graphs/charts.
7) To create VI to read and write to file
8) To design VI for simulation of feed back control loop
9) To design VI for simulation of cascade control
10) To design VI for simulation of batch process control
11) To design VI for simulation of continuous process control.
12) To create VI for controlling multiple parameters (Sub VI and main VI)
13) Measurement of AC/ DC voltage and current using add-on cards.

Practical & Oral Examination:

Practical & oral examination will be based on the various experiments performed. The distribution of the marks shall be as follows,

Practical and Oral examination : 25 marks

Term work:

Term work consists of programs on the above contents. The distribution of the term work marks shall be as follows,

Laboratory work (Journal) : 10 Marks
Laboratory Test : 10 Marks
Attendance (Practical) : 05 Marks

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

References

1. LabView users manual.
2. National instruments Product catalog.
3. Virtual Instrumentation Using LabView, *Gupta S.*, Tata McGraw Hill Publishing Company Limited.

Website: www.ni.com

University of Mumbai			
Class: T.E.	**Branch:** Instrumentation Engineering	**Semester:** V	
Subject: Communications Systems (abbreviated as CS)			
Periods per Week (60 min. each)	Lecture	04	
	Practical	02	
	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	03	100
	Practical & Oral	---	---
	Oral	---	---
	Term Work	---	25
	Total	03	125

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Module	Contents	Hours
1	**Introduction to Communications Systems:** Elements of a communication system, noise in communication systems, introduction to radio wave propagation.	02
2	**Amplitude Modulation:** Introduction, time and frequency domain analysis, power relations, basic requirements and description of various modulators, comparison of DSB, SSB, VSB, spectrum modulator and detectors.	08
3	**Angle Modulation:** Introduction, frequency modulation, phase modulation, spectrum of FM, effect of noise in FM, generation of FM, detection of FM.	08
4	**Transmitters and Receivers:** Introduction, transmitters - requirements, topologies, AM and FM transmitters, receiver - topologies, characteristics, variations, measurements, transceivers, characteristics and block diagram of broadcast radio transmitters.	10
5	**Pulse and Digital Modulation:** pulse modulation methods, pulse amplitude (PAM), pulse position (PPM), pulse duration/width (PDM/PWM)) Modulation methods for digital signals over analogue: amplitude shift keying(ASK), frequency shift keying (FSK), phase shift keying (PSK), Quaternary Phase ShiftKeying (QPSK), Quaternary Amplitude Modulation (QAM)) *Digital modulation methods*: Pulse Code Modulation (PCM); Delta modulation; Adaptive Delta modulation, *Multiplexing techniques*: space division; frequency division; time division; wavelength division.	12
6	**Telemetry:** Methods of data transmission, general telemetry	08

	system, types of telemetering systems - land line telemetering, RF telemetering, voltage telemetering system, current telemetering system, force balance telemetering, impulse and position telemetering system, land line telemetry feedback systems, FM telemetry systems, PAM telemetry, PCM telemetry.	

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.

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) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 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 analyze the signals in frequency domain.
2. To analyze the AM generation and detection and calculate the modulation index.
3. To analyze the SSB generation and detection.
4. To observe the FM generation and detection and measure frequency deviation and modulation index of FM.
5. To generate and detect phase modulation.
6. To analyze PAM generation and detection.
7. To analyze PWM generation and detection.
8. To analyze PPM generation and detection.
9. To analyze PCM generation and detection.
10. To analyze delta modulation and demodulation.
11. To observe time division multiplexing.
12. To observe frequency division multiplexing.
13. To analyze FSK modulation.
14. To analyze PSK modulation.

Text Books:

1. Blake, *Electronic Communication Systems*, 2nd Edition, Thomson Learning, 1989.
2. Haykin, Simon S., *Communication Systems*, John Wiley, New York, 1978.

Reference Books:

1. Taub & Schilling, *Principles of Communication Engineering*, 2nd Edition, McGraw Hill, 1993.
2. Bruce Carlson, *Communication Systems*, 2nd Edition, McGraw Hill, 1994.
3. Kennedy and Davis, *Electronic Communication Systems*, McGraw Hill, 1985.
4. Lathi Ghagwandas Pannalal, *Signals, Systems and Communications*, John Wiley, New York, 2000.
5. Dennis Roddy and John Coolen, *Electronic Communications*, 3rd Edition, Prentice Hall of India (P) Ltd., New Delhi, 1986.
6. A.K. Sawhney, *A Course in Electrical and Electronic Measurements and Instrumentation*, Dhanpat Rai and Co., 1997.
7. Perry A. Borden and W.J. Mayo, *Telemetering Systems*, Wells Reinhold publishing corporation, New York, 1959.
8. William Schweber, *Electronic Commu nication Systems*, PHI, 4th Edition, 2002.

University of Mumbai			
Class: T.E.	**Branch:** Instrumentation Engineering	**Semester:** V	
Subject: Control System Components (abbreviated as CSC)			
Periods per Week (60 min. each)	Lecture	04	
	Practical	02	
	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	03	100
	Practical and Oral	---	---
	Oral	---	25
	Term Work	---	25
	Total	03	150

Module	Contents	Hours
1	**Pneumatics** Pneumatic System Components: ISO symbols, pneumatic air supply system, Air compressors, Pressure regulation devices, Directional control valves and special types of pneumatic valve such as Pilot-operated valves, Non-return valves, Flow control valves, Sequence valves, and Time delay valve. Linear actuators- Single-acting, Double-acting, and special type of double-acting cylinder. Rotary actuators- Air motors. Process Control Pneumatics: Flapper Nozzle system, Volume boosters, Air relays, Pneumatic transmitters and controllers. Pneumatic logic gates, dynamic modeling of pneumatic circuits	10
2	**Hydraulics** Hydraulic System Components: Hydraulic pumps, Pressure regulation method, Loading valves. Hydraulic valves and actuators. Speed control circuits for hydraulic actuators. Selection and comparison of pneumatic, hydraulic and electric systems.	03
3	**Transmitters** Electronic versus pneumatic transmitters, 2-wire; 3-wire and 4-wire current transmitters, Electronic type-temperature; pressure; differential pressure; level; flow transmitters and their applications, Smart(Intelligent) transmitters, Buoyancy transmitters and their applications. Converters- Pneumatic to Electrical and Electrical to Pneumatic converters.	05
4	**Process Control Valves** Control valve terminology, Types- Globe, Ball, Needle, Butterfly, Diaphragm, Pinch, Gate, Solenoid, Smart control valves, and special designs of Globe valves. Flow characteristics, Control valve parameters -control valve capacity; valve rangeabilty and turn-down; valve size; and valve gain, Selection criteria. Specifications and Installation of control valves. Valve positioners: necessity, types-motion balance and force-balance, and effect on performance of control valve. Control Valve Actuators- Electrical, Pneumatic, Hydraulic, Electro-mechanical, and Digital actuators. Selection criteria of valve actuators.	15
5	**Auxiliary Process Control Components** Alarm annunciators, Square root extractor, Feeders, Dampers, Temperature regulator, Flow regulator, Temperature switch, Flow switch, Level switch,	07

	Pressure Switch, Relief valves, safety valves and rupture disk. Thermostats and Humidistat.	
6	**Industrial Motor Control Components** Switches: Construction, symbolic representation, working, application of Toggle switches, Push buttons, Selector switches, DIP switches, Rotary switches, Thumbwheel switches, Drum switch, Limit switches- contact, non contact- type, Switch specifications. Control Relays: Construction, working, specifications, selection criteria and applications of Electro-mechanical relay, Reed relay, hermetically sealed relay, Solid state relays. Interposing relays and Overload relays. Contactors/starters: Construction, working, specifications and applications of starters and contactors. Comparison between relays and starters /contactors. Timers: On delay timers**;** Off delay; and retentive timers. Auxiliary output devices: Pilot Lights, Horns, Solenoids, Heaters and stepper motors. Development of relay ladder and wiring diagrams for motor control applications using above components.	08

Theory Examination:

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

Oral Examination:

The oral will be based on entire subject and a visit to relevant industry.

Term work:

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

Laboratory work (Experiments and Journal) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 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. Study of various pneumatic and hydraulic system components.
2. Development, implementation and testing of pneumatic circuits.
3. Development, implementation and testing of hydraulic circuits.
4. Study of operation and calibration of 2-wire DP transmitter for flow and level control.
5. Design of a two-wire temperature transmitter.
6. Study of cut-view section of pneumatically operated control valve.
7. Calibration of I to P and P to I converters.
8. Study of control valve Flow characteristics.
9. Study of valve positioner.
10. Study of different types of control valve actuator.
11. Study of pressure/temperature/level/flow switches.
12. Study of square root extractor.
13. Study of different types of control relay.

14. Development, implementation and testing of motor control circuits using different types of switches and control relays.

Text Books

1. Bella G. Liptak, *Process Control and Optimization, Instrument Engineer's Handbook*, 4th Edition, CRC Press.
2. WG Andrews and Williams, Applied *Instrumentation in the process Industries*, Vol. - I and II, Gulf Publication.

Reference Books

1. Andrew Parr, *Hydraulics and Pneumatics- A technician's and engineer's guide*, Jaico Publishing House, Mumbai.
2. Pneumatics, Festo Didactic.
3. Hydraulics, Festo Didactic.
4. C.D.Johnson, *Process Control and Instrument Technology*, TMH.
5. P. Harriot, *Process Control*, Tata McGraw Hill, 2001.
6. Less Driskell, *Control Valve Selection and Sizing*, ISA.
7. J. W. Hatchison, *ISA Handbook of Control Valves*, 2nd Edition, ISA, 1990.
8. E. B. Jones, *Instrument Technology*, vol-III, Butterworth Publication.
9. D.P. Ekman, *Automatic Process Control*, Wiley Eastern, 1990.
10. Thomas E. Kisell, *Industrial Electronics*, 3rd Edition, PHI.

University of Mumbai			
CLASS: T.E. (Instrumentation Engineering)		**Semester - V**	
SUBJECT: Environment Studies (Abbreviated as EVS)			
Periods per week (each of 60 min.)	Lecture	2	
	Practical	-	
	Tutorial	1#	
		Hours	Marks
Evaluation System	Theory Examination	2	50
	Practical examination	-	-
	Oral Examination	-	-
	Term Work	-	25
	Total		75
#- Tutorial to be conducted class wise.			

Sr. No.	Details	Hrs
Objective	Objective of this course is to create environmental awareness, of variety of environmental concerns.	-
Unit 1	**The Multidisciplinary nature of environmental studies** Definition, scope and importance Need for public awareness	2
Unit 2	**Natural resources:** **Renewable and non-renewable resources:** Natural resources & associated problems. a. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and teir effects on forests and tribal people. b. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams benefits and problems. c. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d. Food resources: World food problems overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e. Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies. f. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual in conservation of natural resources. • Equitable use of resources for sustainable lifestyles.	4
Unit 3	**Ecosystems** • Concepts of an ecosystem. • Structure and function of an ecosystem.	3

	• Producers, consumers and decomposers. • Energy flow in the ecosystem. • Ecological succession. • Food chains, food webs and ecological pyramids. • Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries)	
Unit 4	**Biodiversity and its Conservation** • Introduction-Definition: genetic species and ecosystem diversity • Bio-geographical classification of India • Value of biodiversity : Consumptive use, productive use, social, ethical, aesthetic and option values • Bio-diversity at global, national, local levels • India as a mega diversity nation • Hot spots of bio-diversity • Threats to biodiversity: Habitat loss, poaching of wild life, man-wildlife conflicts • Endangered and endemic species of India • Conservation of biodiversity: In- situ and Ex-situ conservation of biodiversity	3
Unit 5	**Environmental Pollution** Definition – • Causes, effects and control measures of: 1. Air pollution 2. Water pollution 3. Soil pollution 4. Marine pollution 5. Noise pollution 6. Thermal pollution 7. Nuclear Hazards • Solid waste management: Causes, effect and control measures of urban and industrial wastes • Role of an individual in prevention of pollution • Pollution case studies • Disaster management: floods, earthquake, cyclone and land slides	4
Unit 6	**Social issues and Environment** • From unsustainable to sustainable development • Urban problems related to energy • Water conservation, rain water harvesting, watershed management • Re-settlement and rehabilitation of people: Its problems and	4

	concerns. Case studies. • Environmental ethics: issues and possible solution • Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. • Wasteland reclamation • Consumerism and waste products • Environment protection act • Air(Prevention and control of pollution) act • Water (Prevention and control of pollution) act • Wildlife protection act • Forest conservation act • Issues involved in enforcement of environmental legislation • Public awareness	
Unit 7	**Human population and the environment** • Population growth, variation among nations • Population Explosion- family welfare program • Environment and human health • Human rights • Value education • HIV/AIDS • Women and child welfare • Role of information technology in environment and human health • Case studies	4

Theory Examination:

1. Question paper will be comprising of total 7 questions, each of 10 marks.
2. Only 5 questions need to be solved.
3. Question number 1 will be compulsory and covering the all modules.
4. Remaining questions will be mixed in nature. (e.g.- suppose Q.2 has part (a) from, module 3 then part (b) will be from any module other than module 3.)
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Term work:

Term work shall consist of minimum five projects (**projects shall be designed on the same guide- line of given text book**) and a written test.
The distribution of marks for term work shall be as follows,
Laboratory work (Tutorial/Project 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 book

1. Erach Bharucha, *Text book of environmental studies*, Universities Press.

Reference book

1. Jagdish Krishnaswami, R J Ranjit Daniels, *Environmental Studies*, Wiley India Private Ltd. New Delhi.

2. Anindita Basak, *Environmental Studies*, Pearson Education.

3. Deeksha Dave, S. S. Katewa, *Text book of Environmental Studies*, Cengage learning.

4. Benny Joseph, *Environmental Studies*, Tata McGRAW HILL.

5. R Rajgopalan, *Environmental Studies*, Oxford University Press.

6. Aloka Debi, 'Environmental science and Engineering", University press.

7. Kurian Joseph, R. Nagendran, *Essential Environmental Studies*, Pearson Education.

University of Mumbai			
Class: T.E.	**Branch:** Instrumentation Engineering	**Semester:** V	
Subject: Microprocessors and Applications (abbreviated as MPA)			
Periods per Week (60 min. each)	Lecture	04	
	Practical	02	
	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	03	100
	Practical and Oral	02	25
	Oral	---	---
	Term Work	---	25
	Total	05	150

Module	Contents	Hours
1	**Introduction:** Microprocessor definition, operation of ALU, Van Numan, Haward architecture, evolution of microprocessors, block diagram of microprocessor based system and development cycle, Machine language, Assembly language, high level language, assembler, compilers.	05
2	**8085 Microprocessors & Memory Interfacing** 8085 architecture and its functional blocks, 8085 microprocessor IC pin outs and signals, de-multiplexing address and data bus, generation of control signals, machine cycles and timing diagram of instruction. Memory interfacing.	06
3	**Programming of 8085 Microprocessor** Programming model of 8085. Instruction set of 8085, addressing modes, writing assembly language programs, looping, counting, and indexing operations, BCD arithmetic, stack and subroutines, Conditional call and return instructions.	08
4	**Interfacing:** Basic interfacing concepts, interfacing input and output devices, memory mapped I/O and I/O mapped I/O. 8155 Interfacing and programming, 8255 Interfacing and programming, Keyboard and display Interfacing and programming ADC(0801/0808) and DAC (DAC 0808/DAC 0809) Interfacing and programming,	11
5	**Interrupt, DMA, and Serial Communication** Interrupt structure of 8085, RST instruction, vectored interrupts, interrupt process, 8259 interrupt controller Data transfer techniques, 8257 DMA controller Serial I/O lines of 8085 and implementation asynchronous serial data communication using SID, SOD lines	06
6	**Instrumentation Applications** Multi-channel Data Acquisition System (Minimum 4 channel with input	06

	modules of Pressure, voltage, current, temp, etc). Generation of different signals using DAC DC drives using h bridge Temperature Control application, Stepper motor control	
7	**Advanced Processors** Architecture and organization of 8086, bus interface unit, operation of queue, 8086 hardware pin signals, timing diagram of 8086 family microprocessor, minimum and maximum mode, memory organization and addressing modes. Pipelining, super-scalar execution concept.	06

Theory Examination:

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

Practical & Oral Examination:

Practical 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) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 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. 16 bit arithmetic (addition and subtraction)
2. 8 bit multiplication.
3. Hex to BCD conversion.
4. BCD arithmetic.
5. Finding largest & smallest no from given series.
6. Programs using stack and subroutines.
7. Generation of square wave on SOD pin of 8085
8. Generation of square wave using 8155 timer.
9. Program based Interfacing of 8255 (keyboard and 7 segment display).
10. Interfacing of ADC (DAQ).
11. Generation of different types of signals using DAC.
12. Temperature controller.
13. Stepper motor control.
14. Serial communication with PC.

Note: Experiments 1 to 5 may be performed on simulator

Text books

1. R. S. Gaonkar, *Microprocessor, Architecture, Programming and Application with 8085*, Penram International Publishing (India) Pvt. Ltd. Fifth Edition
2. Prof.U.V.Kulkarni, Dr. T.R.Sontakke, *The 8085 Basic, Programming and Interfacing*, SadhuSudha Prakashan

Reference books:

1. Douglas V. Hall, *Microprocessor and Interfacing*, Tata McGraw-Hill Publishing Co. Ltd. 2nd edition.
2. Udaykumar, *The 8085 Microprocessor : Architecture, Programming & Interfacing* , Pearson Education
3. Chowdhury et.al Microprocessors & Peripherals, SciTech Publications (India) Pvt. Ltd., Chennai.

University of Mumbai			
Class: T.E.	**Branch:** Instrumentation	**Semester:** V	
Subject: Signals and Systems (abbreviated as S&S)			
Periods per Week (60 min. each)	Lecture	04	
	Practical	--	
	Tutorial	02($)	
		Hours	Marks
Evaluation System	Theory	3	100
	Practical & Oral	---	---
	Oral	---	---
	Term Work	--	25
	Total	3	125

$- Tutorial to be conducted batch wise.

Module	Contents	Hours
1	**Introduction:** 1. Definition of signal, Basic signals in continuous time and discrete time domain. Basic operation on continuous and Discrete signal. 2. Singular Functions: Ramp, step and Impulse functions, Axiomatic, Definition of impulse function, approx. to impulse function and the generalized impulse function. 3. Classification of signals: Periodic/ non-periodic, Even/Odd, Deterministic/ Stochastic and Energy/ Power signals. 4. Representation of a system as a mapping between input and output signals, System as a means of transformation of signals. 5. System representation in continuous and discrete time domain in terms of differential and difference equation respectively. Normal form representation of signals. 6. Block diagram of continuous and Discrete time system, Classification of systems: Causal / Non-causal, time-varying, time-invariant, stable/ unstable, invertible / non- invertible and lumped/distributed parameter systems.	11
2	**Linear Time Invariant System:** Continuous Time LTI system: Linear differential equations. Representation of signals by a continuum of impulses, system impulse response and the convolution integral. Evaluation and Interpretation of Convolution Integral. Discrete Time LTI system: Convolution sum (linear and Circular convolution). Properties of LTI system.	04
3	**Laplace Transform:** Definition and its Properties, Inverse Laplace. Transient and steady state response of LTI system. Stability of system.	03

4	**Z-Transform:** Definition, Convergence, properties and inversion of Z-Transform. Concept of single and double sided Laplace Transform. Analysis of discrete time system using Z-Transform. Relationship between Laplace and Z-Transform, Fourier transforms.	10
5	**Continuous and Discrete Time Fourier Series:** Orthogonal functions: Definitions, approximations, coefficient calculation on the basis of minimum mean square error. Fourier series: Representation of Fourier series in terms of trigonometric, exponential functions. The complex Fourier spectrum. Properties of Fourier series. Convergence of Fourier series. Gibbs's phenomenon.	05
6	**Continuous and Discrete Time Fourier Transform:** Continuous and Discrete time Fourier transform and its properties.	03

Theory Examination:

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

Term work:

Term work consists of minimum eight tutorials properly recorded and graded as well as assessed test paper. The distribution of the term work shall be as follows,

Laboratory work (Journal) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 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 Tutorials:

1. Difference between continuous time and discrete time signals, classification, problems on Signals classification.
2. Difference between continuous time and discrete time signals, classification, problems on Systems classification.
3. Problems on Basic Operations on signals.
4. Singular functions, Impulse function and its approximation, I/O systems. Difference equation formulation.

5. Problems on convolution Integral, convolution sum and correlation.
6. Problems on laplace and its properties.
7. Concept of Z-Transform (Single and Double Sided), analysis, relation between Laplace Transform and Z-Transform.
8. Fourier series representation, properties, problems on Fourier series and Fourier Transform.
9. Fourier Transform, properties, problems on Fourier Transform.
10. Relation between Fourier and Laplace, Solutions to differential equations

Text Books:

1. Oppenhelm, Wilsky and Nawab, *Signals and Systems*, PHI / Pearson Education, 2nd edition, 2002.
2. S. P. Xavier, *Signals and Systems*, 2nd Edition, S. Chand and Co., 1998.
3. J.B. Gurung, *Signals and Systems*, 1st Edition, PHI, 2009.

Reference Books:

1. Reddy and Prasad, *Signals Processing*, TMH, Vol. II, 1994.
2. Taylor, *Principles of Signals and Systems*, McGraw Hill, 1994.
3. Haykin, Simon S., *Signals and Systems*, John Wiley, New York, 1978.
4. Lathi B. P., *Signals Processing and Linear Systems*, Oxford University Press,2003.
5. I. J. Nagrath, *Signals and Systems*, 1st Edition, TMH, 2000.
6. Douglas K. Lindner, *Introduction to Signals and Systems*, TMH, 1999.
7. Rodger E. Ziemer, William H. Tranter, *Signals & Systems – Continuous and Discrete*, Pearson Education, 4th Edition, 2002.

University of Mumbai			
Class: T.E.	**Branch:** Instrumentation Engineering	**Semester:** V	
Subject: Signal Conditioning Circuit Design (abbreviated as SCCD)			
Periods per Week (60 min. each)	Lecture	04	
	Practical	02	
	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	03	100
	Practical & Oral	02	25
	Oral	---	*25
	Term Work	---	25
	Total	05	175

*-Oral examination will be based on a mini-project.

Module	Contents	Hours
1	**Components of Analog Signal Conditioning** Signal level and bias changes, linearization, conversion, filtering and impedance matching, concept of loading. Passive signal conditioners- voltage divider, Wheatstone bridge circuits (Current, Voltage, Balanced and Unbalanced), RC filters, and Active signal conditioners- op-amp based circuits. Standard Signals (Analog)	05
2	**Operational Amplifier** Ideal & practical op-amp, Differential Amplifier- a.c. & d.c. analysis, improving voltage gain using active load etc, current sources, unbalanced op-amp frequency response & stabilizing unbalanced operation, circuit diagram of IC741 & working in detail, a.c. & d.c. characteristics, specifications, measurement of op-amp parameters.	06
3	**Operational Amplifier Circuits in Instrumentation** Voltage follower, inverting & non-inverting Amplifier, Adder, Subtractor, Differential Amplifier, Instrumentation Amplifier, V to I & I to V converter with floating load & grounded load, Integrator, differentiator & compensated differentiator, Precision rectifier- half wave, full wave, absolute value circuits, clipping, clamping circuits, practical clamping circuits, sample & hold circuits, peak detectors, log amplifiers, temperature compensated log amplifier, antilog amp., multiplier, divider, comparator, threshold detector, zero crossing detector, window detector, Schmitt trigger, free running multivibrator, Wien-bridge oscillator, Phase shift oscillator, Active filters**,** Astable, Monostable, and Bistable multivibrators, Norton amplifier, Pulse, Triangle and Sine wave generator, PLL. Guidelines for analog signal conditioning design, design problems based on these guidelines.	15
4	**Components of Digital Signal conditioning**	08

	Converters - ADC, DAC, V to F (LM331 and 555 Timer) and F to V- Types and Structure, conversion, resolution and other characteristics. Characteristics of digital data- digitized value, sampled data system and linearization. Standard signals (Digital). Data acquisition system hardware, Data Logger.	
5	**Transducer signal conditioning design** Thermal sensor conditioning – design considerations and applications for RTD, Thermistor, thermocouple and solid state temperature sensors. Optical sensor conditioning–photoconductor, photovoltaic, photodiode, phototransistor, and photomultiplier tube, Optical encoder conditioning for linear displacement, linear velocity and angular displacement application. Other Sensors conditioning - Potentiometer , LVDT , strain gages, piezoelectric transducers and capacitive transducers	10
6	**Power Supply Design: -** Power Supply design using 78xx series, 79xx series and adjustable IC regulator 723/317. Switch mode Power Supply (SMPS) Block Diagram with advantages and disadvantages over conventional power supply.	04

Theory Examination:

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

Practical & Oral Examination:

Practical 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 (four experiments From 1 to 6 and four from 7 to 14 of list given below) experiments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 marks

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

*Oral Examination Based on Mini project

Mini-project should be a hardware based on subject of SCCD. The student should submit a detail

report containing the design and implementation of the mini project. (Group of maximum 3 students)
The subject teacher will coordinate the activity. Oral examination will be based on project report and demonstration.

List of Laboratory Experiments:

All Experiments should be performed using Bread Board and discrete components:

1. Measurement of Operational amplifier Parameters.
2. Linear Applications of Op Amps.(any Four)
3. To design an Instrumentation Amplifier using Op Amps.
4. Non-Linear Applications of Op Amps(Any Three)
5. To design and implement a-stable and mono-stable multi-vibrator using IC555 timer.
6. Low Pass and High Pass Filter design.
7. To design general signal conditioning to convert sensor O/p to 0-5V.
8. To design general signal conditioning to convert sensor O/p to 4-20 mA.
9. To design signal conditioning for an RTD.
10. To design thermocouple signal conditioning with reference junction compensation.
11. To design general signal conditioning of weight measurement system using strain gauges.
12. To design signal conditioning for capacitive transducer using oscillator and F to V converter with offset and gain control.
13. Power Supply Design for +/- 5 V ,+/-12V.
14. To design adjustable low and high voltage regulator using IC723/LM317 (High Power Design).

Text Books:

1. Ramakant Gaikwad, *Op-Amp & Linear ICs*, PHI Perason Education.
2. C. D. Johnson, *Process Control Instrumentation Technology (VIII th Ed.)*

Reference Books:

1. Coughlin & Driscoll, *Op-amp and linear ICs*, 6th edition, PHI, 2002.
2. Robert G. Seippel, *Transducer Interfacing- signal conditioning for process control*, Prentice Hall.
3. C. D. Johnson, Microprocessor Based *Process Control, PH*
4. Sergio Franco, Design with op-amp analog ICs, Mcgraw Hill, 1988.
5. Roy Choudhary, Linear Integrated Circuits, Wiley Eastern, 1991.
6. Burr-Brown *General Catalog*, Tucson, Ariz: Burr- Brown, 1979.
7. Datel - Intersil *Data Acquisition Component Handbook*, Mansfield, Mass: Datel –Intersil, Inc., 1980.
8. D.E. Pippenger and E. J. Tobanen, *Linear and Interfece Circuits Applications*, 2nd Edition, Mcgraw Hill Book Company, 1988.

University of Mumbai			
Class: T.E.	**Branch:** Instrumentation Engineering	**Semester:** VI	
Subject: Control Systems Design (abbreviated as CSD)			
Periods per Week (each 60 min)	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory	3	100
	Practical & Oral	---	---
	Term Work	---	25
	Total	3	125

	Contents	Hours
Prerequisite	Review of stability analysis through Nyquist criterion, bode, root-locus techniques. Time and frequency domain specifications, error constants.	
1	**State – Space Analysis of Control System:** Concept of state-space, and state model for Linear Systems – SISO and MIMO systems, Linearization, state model for Linear continuous time system - State-Space representation using phase variables, Phase variable formulation for transfer function with poles and zeros, state space representation using canonical variables, derivation of transfer function from state model. Diagonalizaion, eigenvalues and eigenvectors, Solution of State equations – properties of state transition matrix, computation of state transition matrix using Laplace Transformation, Cayley – Hamilton theorem.	10
2	Controller and Observer Design using State-Space: Concept of controllability and observability, definitions, phase variable form, properties, effect of pole-zero cancellation in transfer function, **State Feedback and Pole placement** – Stabilizability, choosing pole locations, limitations of state feedback **Tracking Problems:** Integral control **Controller design** - for phase variable form, by matching coefficients, by transformation. **Observer design** – for observer canonical form, by observability matrix, by transformation, by matching coefficients. Control using observers, separation property **Reduced order observer design** – separation property, reduced order observer transfer function Applications of above	10
3	**Introduction to Compensator:** Analysis of the basic approaches to compensation, cascade compensation, feedback compensation, Effect of measuring elements on system performance, block diagram of automatic control system. Derivative and integral error compensation.	4
4	**Compensator Design using Root Locus:** Improving steady-	10

	state error and transient response by feedback compensation, cascade compensation, -integral, derivative compensation, Lag, Lead, Lag-Lead compensation,	
5	**Compensator Design using Frequency Response:** Steady-state error characteristics of Type 0,1, and 2 systems, Time delay, transient response through gain adjustment, Lag, Lead, Lag-Lead compensation	10
6	**PID Compensator Design:** Tuning rules for PID controller, Ziegler-Nichols rules, Designing PID controller using Root-Locus technique.	4

Theory Examination:

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

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) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 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. Design of Lead Compensator in Time domain.
2. Design of Lag Compensator in Time domain.
3. Design of Lag-Lead Compensator in Time domain.
4. Design of Lead Compensator in Frequency domain.
5. Design of Lag Compensator in Frequency domain.
6. Design of Lag-Lead Compensator in Frequency domain.
7. Design of PID in Time domain.
8. Design of PID in Frequency domain.
9. Design of state feedback controller in state space using pole placement.
10. Design of observers in state space using pole placement.
11. Verification of controllability and observability .

Note: Perform Experiment Nos. 1 to 8 by using MATLAB or equivalent software. To realize the circuits by using op-amp for at least 3 experiments also obtain the response of the circuits.

Text Books:

1. K. Ogata, *Modern Control Engineering*, Prentice Hall of India, 4th edition, 2002.
2. Norman S. Nise, *Control Systems Engineering*,John Wiley and Sons, Inc. 2000.

Reference Books:

1. M. Gopal, *Control Systems Principles and Design*, TMH, New Delhi, 2nd edition, 2002.
2. Stefani, Shahian, Savant, Hostetter, *Design of Feedback Control Systems*, Oxford University Press, 4th Edition, 2007.
3. Richard C. Dorf, Robert H. Bishop, *Modern Control Systems*, Addition-Wesley, 1999.
4. I. J. Nagrath and M. Gopal, *Control System Engineering*, 3rd Edition, New Age International (P) Ltd., Publishers – 2000.
5. B. C. Kuo, FaridGdna Golnaraghi, *Automatic Control Systems*, PHI, 7th edition, 2003.
6. Jacqueline Wilkie, Michael Johnson, Reza Kalebi, *Control Engineering – an Introductory Course*, Palgrave, 2002.
7. M. N. Bandopadhay, *Control Engineering – Theory & Practice*, PHI, 2003.

University of Mumbai			
Class: T.E.	**Branch:** Instrumentation Engineering	**Semester:** VI	
Subject: Digital Signal Processing (abbreviated as DSP)			
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	3	150

	Contents	Hours
1	**Brief review**: Discrete time signals and systems, difference equations, Fourier series & Transform, Z-Transform, theorems, properties etc.	04
2	**Introduction to digital signal processing:** Block diagram of DSP, Advantages, and Sampling Theorem, Classification of Digital Filter (IIR and FIR).	02
3	**Analysis of Digital Filter:** Classification of filter on their pole zero diagram. Frequency response of IIR filters frequency response analysis of all types of linear phase system. Difference between IIR and FIR Filters.	08
4	**Realization of systems:** Realization of IIR systems by Direct form-I, Direct form-II, Cascade and Parallel. Realization of FIR systems by Direct form, cascade and linear phase system.	04
5	**Digital Filter Design Techniques:** Properties of IIR filter Discritization Methods like IIT and BLT. Design of Butterworth and Chebyshev-I IIR filter.	08
6	**FIR filter Design:** Design of FIR filter by using Different Windowing Technique. By using Frequency Sampling. Realization of system by using Frequency Sampling Technique.	04
7	**Discrete Fourier Transform:** Introduction to DTFT, Fourier representation of finite duration sequences, the Discrete Fourier Transform, properties of the DFT, Linear convolution using the DFT and IDFT.	08
8	**Computation of the Discrete Fourier Transform :** Decimation in frequency (DIF) algorithms, Decimation in time (DIT) algorithms for Radix 2,3,composite. Overlap add and save Methods.	06
9	**Introduction to Digital Hardware and Applications:** Digital signal processor series Texas 320, Motorola 56000. Application to speech , Radar, CT scanner and Digital touch tone receiver.	04

Theory Examination:

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

Practical & Oral Examination:

Practical 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) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 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:

(Experiments 1 to 6 Using C or C++ and verifying the results using MATLAB)

1. Program for finding linear convolution.
2. Program for finding circular convolution.
3. Program for finding linear convolution using circular convolution.
4. Program for finding correlation (auto and cross).
5. Program for finding DFT's. & IDFT.
6. Implementation of FFT algorithms (DIT, DIF) etc.
7. Program on filter designing.(FIR) (Using MATLAB only)
8. Program on Filter Designing (IIR) (Using MATLAB only)
9. Minimum two assignments based on structure realizations (IIR, FIR).
10. Study of any DSP processor series and their differences.

Text Books :

1. A.V.Oppenhiem & R.W. Scheifer, *Discrete signal processing*, (PHI) 1999.
2. Johny Johnson, *Introduction to D.S.P.*, (PHI), 1996.

Reference Books :

1. Rabnier Gold , *Theory and application of DSP*, (PHI EEE edi.) 1996.
2. Proakis and Manoliakis, *Digital signal processing*, (PHI 3rd) 1997.
3. Sanjit. K. Mitra, *Computer aided approach to DSP*, TMH, 1998.
4. A Antonion, *Digital filter analysis,design and application*, TMH pub. 2ed. 1993.
5. B. Vankataramani & M. Bhaskar, *Digital Signal Processors*, Tata McGraw Hill, 2002.
6. Emmauel C. Ifeachor & Barrie W. Jervis, *Digital Signal Processing*, Pearson Education, 2nd edition, 2000.
7. Ashok Ambardar, *Analog and Digital Signal Processing*, Thomson Learning, 2nd edition, 1999.
8. Thonas J. Cavicchi, *Digital Signal Processing*, Jhon Wiley 2000.

University of Mumbai			
CLASS: T. E.	**Branch:** Instrumentation Engineering	**Semester** - VI	
SUBJECT: Embedded Systems for Instrumentation (abbreviated as ESI)			
Periods per week (each of 60 minutes)	**Lectures**	04	
	Practical	02	
	Tutorial	---	
		Hours	**Marks**
Evaluation System	Theory	03	100
	Practical & Oral	02	25
	Oral	---	---
	Term Work	---	25
	Total	**05**	150

Chapter. No.	Contents	Hours
1.	**Embedded systems**: Definition, embedded system overview, classifications, Design challenges, processor technology, IC technology and Design Technology and trade offs. Examples of embedded system.	04
2.	**MCS-51 microcontroller** Architecture of MCS 51 family of microcontroller, and its variants and comparison. Comparison of microprocessor & microcontroller. CPU timing and machine cycle. Memory organization, SFRS. Integrated peripherals such as Timers/Counters, Serial port, parallel I/0 ports, Interrupt Structure., memory interfacing. Power saving & power down mode.	07
3.	**Development tools:** Simulator, in-circuit debugger, in-circuit emulator, programmers, integrated development environment (IDE), cross compilers. Merits & demerits of above tools.	02
4	**8051 programming** Assembly language programming process. Programming tools. Instruction set, addressing modes. Assembly language Programming practice using assembly & C compiler.	09
5.	**Serial communication protocols** Operation of serial port. Programming for implementation of asynchronous serial communication. Buses like I^2C (RTC/EEPROM Memory Example), SPI	05

	(ADC, DAC example), introduction to USB & CAN Bus.	
6.	**Case studies:** Interfacing keyboard, displays, ADC, DAC, relay, optoisolator, LEDs with following examples with assembly & C programming. Process parameter measurement example. (DAQ) Digital Weighing machine. Implementing digital PID Controller for temperature control application Speed control of DC motor. Frequency counter. Stepper motor control.	10
7.	**RISC Microcontroller** Difference between RISC and CISC Architectures. Study of RISC controller (PIC16f87x) Architecture. Memory organization. Interrupts. Inbuilt controller features (ADC, PWM, timer, etc). Assembly instruction set and Introduction to assembly & C Programming.	06
8.	**Real Time Operating System (RTOS)** Introduction to RTOS concept. RTOS Scheduling models interrupt latency and response times of the tasks as performance metrics. Example of any tiny RTOS	05

Theory Examination:

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

Practical & Oral Examination:

Practical 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) :10 marks
Test (at least one) :10 marks

Attendance (Practical and Theory) :05 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. 16 bit Arithmetic operations (addition, subtraction ,multiplication)
2. Code conversion
3. Generating square wave on port pins.
4. Generation of square wave using timer
5. Interfacing keyboard, 7 segments displays.
6. Interfacing LCD display
7. Serial Communication with PC.
8. Interfacing RTC
9. Interfacing DAC and its application
10. Temperature Controller
11. Speed control of DC Motor
12. Frequency measurement
13. Implementing PID controller
14. Stepper motor control.
15. PIC programming examples

Text Books:

1. Madizi M.A., *The 8051 Microcontroller & Embedded systems*, Pearson Education Second edition.
2. Kenneth Ayala, Penram International Publishing (India) Pvt. Ltd. Second Edition.

Reference Books:

1. Rajkamal, *Embedded Systems*, TMH, Second Edition.
2. Tony Givargis, Wiley Student Edition.
3. Manoharan et.al , Microcontroller based system design , Scitech Publications (India) Pvt. Ltd.

Websites:

1. www.atmel.com
2. www.microchip.com
3. www.nxp.com

University of Mumbai			
Class: T.E.	**Branch:** Instrumentation Engineering	**Semester:** VI	
Subject: Industrial Data Communications(abbreviated as IDC)			
Periods per Week (60 min.each)	Lecture	04	
	Practical	02	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory	03	100
	Practical and Oral	---	---
	Oral	---	---
	Term Work	---	25
	Total	03	125

Module	Contents	Hours
1	**Introduction:** OSI reference model, Systems engineering approach, State transition structure, Detailed design, Media, Physical connections, Protocols, Noise, Cable spacing, Ingress protection.	04
2	**Communications and control:** Introduction, Evolution of industrial control process, communication interface- serial and parallel, communication mode-simplex, half duplex and full duplex, synchronization and timing.	04
3	**Industrial network**: network requirements, OSI implementation, Enterprise network: types of networks, LAN – architecture, topology, transmission media: Cable characteristics, Cable selection, unshielded twisted-pair cable, shielded twisted-pair cable, Coaxial cables, Fiber optics, wireless media. physical and logical media access and arbitration methods – token passing, ring, bus master-slave, peer-peer, network and transport layer services, real time implications, Session, presentation, and application layers. LAN standards for open LAN, bridges, routers and gateways, Manchester coding.	12
4	**Open control network:** RS232, RS422, EIA 485, Ethernet-MODBUS – structure, function codes and implementation, General Purpose Instrument Bus, specifications. **Proprietary control network**: MODBUS plus, data highway plus.	05
5	**Networks at different levels:** Sensor level network: AS-i, CAN, Devicenet, Interbus and LON Device network: Foundation Fieldbus –H1, HART, PROFIBUS-PA Control network: BACnet, ControlNet, FF-HSE, PROFIBUS-DP, Ethernet, TCP/IP	08

6	**HART:** Architecture – physical, data link, application layer, communication technique, normal and burst mode of communication, troubleshooting, benefits of HART.	05
7	**Foundation fieldbus:** Fieldbus requirement, features, advantages, fieldbus components, types, architecture–physical, data link, application layer, system and network management, wiring, segment functionality checking, installation in safe and hazardous area and troubleshooting, function block application process.	07
8	**Wireless technologies:** Satellite systems, Wireless LANs (WLANs), Radio and wireless communication, WiFi, GSM, GPRS and VSAT – their comparison, limitations and characteristics.	03

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.

Term Work:

Term work consists of minimum six experiments based on above syllabus, two assignments and written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 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. Deon Reynders, Steve Mackay ,Edwin Wright, *Practical Industrial Data Communications*, 1st edition ELSEVIER, 2005.
2. Lawrence M Thompson, *Industrial data Communication*, 2nd edition, 1997.

Reference Books:

1. Daniel T Miklovic, *Real time control network*, ISA 1993.
2. Bela G Liptak, *Process software and digital networks*, 3rd edition, 2002.
3. Andrew S. Tanenbaum, *Computer Networks*, 4th Edition, PHI/Pearson Education, 2002.
4. Behrouz A. Forouzan, *Data Communications and Networking*, 2nd update Edition, Tata McGraw Hill Publishing Company, New Delhi, 2000.

5. Douglas E. Comer, *Computer Networks and Internets*, 2nd Edition, Pearson Education Asia, 5th Indian reprint, 2001.

University of Mumbai			
CLASS: T. E.	Branch: Instrumentation Engineering	**Semester** - VI	
SUBJECT: Power Electronics and Drives(abbreviated as PED)			
Periods per week (each of 60 minutes)	Lectures	04	
	Practical	02	
	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	03	100
	Practical & Oral	02	25
	Oral	---	---
	Term Work	---	25
	Total	05	150

Chapter. No.	Contents	Hours
1.	**POWER SEMICONDUCTOR DEVICES**: a) Introduction to construction, characteristics, ratings, data sheets and applications of power diodes, power BJT, power MOSFET, SIT and IGBT. b) Study of Thyristors: constructions, characteristics, ratings of SCR, TRIAC, MCT, GTO and LASCR. c) Comparison and selection criteria for above devices. d) Switching / triggering method: Switching methods/ types of triggering, triggering devices DIAC, SUS, 585, UJT and PUT. e) Thyristors Commutation Techniques. f) Protection Scheme against over-current, over-voltage, dv/dt and di/dt.	10
2.	**THYRISTOR APPLICATION:** a) Controlled rectifiers: Principles of operations of phase controlled converters, single phase half bridge, semi converter and bridge converters. Design of SCR based DC power circuits including UJT as triggering device and application. b) AC power control using SCR-UJT and TRIAC-DIAC like universal speed controller fan regulator. Design of SCR/TRIAC based AC power control circuits including UJT/DIAC as a triggering device.	12
3.	**INVERTERS:** Principles of operation of inverters, PWM inverter, series and parallel inverters, bridge inverter, basic circuit scheme of IGBT/Power MOSFET based inverter circuits. Suitability in different applications of different capacities	06

	and frequencies operation. Principle of ZVC/ZCS resonant converters.	
4	**CHOPPERS:** Basic operation of choppers, study of different types of simple chopper circuits like step up choppers, step down choppers and Jones chopper, DC motor speed control application using chopper.	04
5.	**SWITCH MODE POWER SUPPLIES:** Basic concept schemes, Working principles of Buck, Boost, Buck-Boost converter merits and demerits and applications.	04
6.	**DRIVES:** a.) AC Motor Drives: Concept and requirement of drives, Current fed and voltage fed drives, PWM technique (using IGBT/BJT) for control. b.) DC Motor Drives: DC drives for brushed/brushless motors, methods of motor control using constant voltage and constant current techniques.	06
7.	**INDUSTRIAL APPLICATIONS:** a.)Induction and Dielectric heating process, Block diagram, Merits/demerits and applications. b.)Temperature controller using thyristor principle and circuit scheme.	06

Theory Examination:

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

Practical & Oral Examination:

Practical 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) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 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:

16. SCR Characteristics.
17. TRIAC and DIAC characteristics.
18. Study of various triggering circuits.
19. Half wave and full wave controlled rectifier.
20. SCR based series inverter.
21. SCR based parallel inverter.
22. IGBT based inverter.
23. Induction heating.
24. Dielectric heating.
25. DC motor speed control using chopper.
26. SCR/TRIAC based AC power control circuit.
27. Applications using MOSFET/IGBT.
28. Study of SMPS.
29. PWM drive for induction motor using IGBT
30. Study of various drives for its use, specifications, and connectivity.

Text Books:

1. P.S.Bimbhra, *Power Electronics*, Khanna Publishers, 2004.
2. M.H.Rashid, *Power Electronics*, 2nd Edition, PHI,2005.

Reference Books:

1. P. C. Sen, *Power Electronics*, Tata McGraw Hill, 2005.
2. Mohan Undeland Robbins, *Power Electronics- Converters application and Design*, Wiley Eastern, 1996.
3. Dubey, Doralda, *Thyristorised Power Controller*, Wiley Eastern Ltd., 1993.
4. Samir K.Datte, *Power Electronics and Control*, PHI,1986.
5. S.K.Bhattacharya, *Industrial Electronics and Control*, TATA McGraw Hill, 2007.
6. P.C.Sen, *Modern Power Electronics*, Wheeler Publications, 1992.
7. Jerrald E William, *Practical Transistor Circuits-Design and Analysis*, Tata McGraw Hill, 1976.
8. Jai P. Aggarwal, *Power Electronics System Theory and Design*, Pearson Education Asia, 2001.
9. Vedam Subrahmanyam, *Power Electronics*, New Edge Intl.2000.

University of Mumbai			
Class: T.E.	**Branch:** Instrumentation Engineering	**Semester:** VI	
Subject: Process Instrumentation Systems(abbreviated as PIS)			
Periods per Week (60 min.each)	**Lecture**	04	
	Practical	02	
	Tutorial	---	
		Hours	**Marks**
Evaluation System	**Theory**	03	100
	Practical & Oral	---	---
	Oral	---	25
	Term Work	---	25
	Total	03	150

Module	Contents	Hours
1	**Process dynamics** Dynamic elements in a control loop, Dead time processes and smith predictor compensator. Inverse response behavior of processes and compensator. Dynamic behavior of first and second order systems. Interacting and non-interacting systems.	04
2	**Process Controllers** Elements of process control, Controller Principle, Process Characteristics, Control system parameters, discontinuous, continuous and composite controller modes/actions (P,I,D,PI,PD and PID).	09
3	**Analog and Digital controllers** General features, construction and working of Pneumatic, Hydraulic, Electronic and Digital controller.	07
4	**Controller tuning** Process reaction curve method, Zigler-Nichols method, Cohen-coon correction for quarter amplitude, Frequency response method, Relay based tuning.	04
5	**Control Schemes** Feedback, feedforward, cascade, ratio, split range, selective control, adaptive control, and model based control.	05
6	**Multivariable Control** Block diagram analysis of multivariable systems, Interaction, Tuning of Multivariable controllers, relative gain analysis, Decoupler design	05
7	**Discrete-State process control** Discrete state process control characteristics of the system, variables, process specification and event sequence description, Physical ladder diagram-elements and examples.	06
8	**Batch and continuous process control** Batch mode, nomenclature, formulation, Batch versus continuous process control. Types of control, Classifications, Batch recipe management. Design of control system for a complete plant.	08

Theory Examination:

6. Question paper will consist of total 7 questions carrying 20 marks each**.**
7. Only 5 questions need to be attempted.
8. Q.1 will be compulsory and based on the entire syllabus.
9. Remaining questions will be mixed in nature.
10. 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, two assignments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 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. Study of ON-OFF Controller.
2. Study of controller modes (pure and composite) on a PID controller with a recorder.
3. Study of specifications and wiring of an electronic PID controller with alarm annunciator.
4. Tuning of a PID controller.
5. Study of Cascade control (wiring, settings and tuning).
6. Study of split range control.
7. Study of Ratio control.
8. Interaction analysis using RGA for a MIMO process.

Note: All above experiments should be performed on a pilot plant for real time I/Os

Text Books:

1. Curtis Johnson, *Process Control Instrumentation Technology*, PHI /Pearson Education 2002.
2. George Stephenopolos, *Chemical process control*, PHI-1999.

Reference Books:

1. M.Chidambaram, *Computer Control of Processes*, Narosa, 2002.
2. Deshpande P.B and Ash R.H, *Elements of Process Control Applications*, ISA Press, New York,1995.
3. D. Patranabis, *Principles of Process Control*, Seconnd edition, TMH.
4. F.G.Shinsky, *Process Control System*, TMH.
5. N.E. Battikha,Condensed Handbook of Measurement and Control,3rd Ed., ISA Publication.
6. Donald P. Eckman, Automatic Process Control, Wiley Eastern Ltd.