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,	10

	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.	
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-state error and transient response by feedback compensation, cascade compensation, -integral, derivative compensation, Lag, Lead, Lag-Lead compensation,	10
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:

36. Question paper will comprise of total 7 questions, each of 20 marks.
37. Only 5 questions need to be solved.
38. Q.1 will be compulsory and based on the entire syllabus.
39. Remaining questions will be mixed in nature.
40. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus
41. 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) :15 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:

31. Question paper will comprise of total 7 questions, each of 20 marks.
32. Only 5 questions need to be solved.
33. Q.1 will be compulsory and based on the entire syllabus.
34. Remaining questions will be mixed in nature.
35. 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) :15 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 (ADC, DAC example), introduction to USB & CAN Bus.	05
6.	**Case studies:** Interfacing keyboard, displays, ADC, DAC, relay,	10

	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.	
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:

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

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) :15 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,	12

	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.	
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:

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.

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	12

	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.	
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 and frequencies operation. Principle of ZVC/ZCS resonant converters.	06
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:

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.

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) :15 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. SCR Characteristics.
2. TRIAC and DIAC characteristics.
3. Study of various triggering circuits.
4. Half wave and full wave controlled rectifier.
5. SCR based series inverter.
6. SCR based parallel inverter.
7. IGBT based inverter.
8. Induction heating.
9. Dielectric heating.
10. DC motor speed control using chopper.
11. SCR/TRIAC based AC power control circuit.
12. Applications using MOSFET/IGBT.
13. Study of SMPS.
14. PWM drive for induction motor using IGBT
15. 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,	05

	Tuning of Multivariable controllers, relative gain analysis, Decoupler design	
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:

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, two 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
~~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.