UNIVERSITY OF MUMBAI

Bachelor of Engineering

Instrumentation Engineering (Third Year – Sem. V & VI),
Revised course
(REV- 2012) from Academic Year 2014 -15,
Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

Semester V

Subject Code	Subject Name	Teaching Scheme		Credits Assigned		
		Theory	Pract./ Tut.	Theory	Pract./ Tut.	Total
ISC501	Signals and Systems	4	2	4	1	5
ISC502	Applications of Microcontroller -I	4	2	4	1	5
ISC503	Control System Design	4	2	4	1	5
ISC504	Signal Conditioning Circuit Design	4	2	4	1	5
ISC505	Control system components	4	2	4	1	5
ISC506	Business Communication and Ethics	-	2*+2	-	2	2
		20	14	20	7	27

Subject Code	Subject Name	Examination scheme							
		Theory Marks					Term work	Pract./ Oral	Total
		Internal Assessment			End Sem exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ISC501	Signals and Systems	20	20	20	80	03	25	-	125
ISC502	Applications of Microcontroller -I	20	20	20	80	03	25	25	150
ISC503	Control System Design	20	20	20	80	03	25	-	125
ISC504	Signal Conditioning Circuit Design	20	20	20	80	03	25	50+	175
ISC505	Control system components	20	20	20	80	03	25	25+	150
ISC506	Business Communication and Ethics	-	-	-	-	-	50	-	50
Total				100	400	--	175	100	775

+ Includes both Practical and Oral examination,

*** Theory for entire class to be conducted**

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ISC501	Signals and Systems	4	2	--	4	1	--	5

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg					
ISC501	Signals and Systems	20	20	20	80	25	--	--	125

Subject Code	**Subject Name**	**Credits**
ISC501	**Signals and System**	**5**
Course Objectives	• To introduce students to the idea of signal and system analysis and characterization in time and frequency domain. • To provide foundation of signal and system concepts to areas like communication, control and comprehend applications of signal processing in communication systems.	
Course Outcomes	• Students will be able to understand significance of signals and systems in the time and frequency domains. • Students will be able to interpret and analyze signal and report results. • Students will be able to evaluate the time and frequency response of continuous and discrete time, system which is useful in understanding behavior of communication and control systems.	

Module	**Topics**	**Hours**
1	**Introduction:** Definition of signal, Singular Functions, Basic Operations on signal such as: Addition, Multiplication, Time Scaling, Time Shifting, Folding, and Amplitude Scaling. Classification: C.T. D.T, Periodic, aperiodic, / non-periodic, Even/Odd, Energy/ Power, causal and anticausal signals. Classification of System: Static and dynamic, time invariant and time variant, Linear and Non linear, Causal and Non causal stable and unstable invertible and non invertible.	10
2	**Linear Time Invariant System:** Linear differential equations, Impulse response Representation of signals by a continuum of impulses.	07

	Convolution for continues time and discrete time (Linear and Circular) Properties of LTI System.	
3	**Fourier Series** Orthogonal functions, definitions, Approximation, Co-efficient calculation on the basis of min. Mean square error. Representation of Fourier series in terms of trigonometric, exponential, complex. Gibbs phenomenon.	04
4	**Fourier Transform** Continuous and Discrete time Fourier transform Properties. Linearity, time shifting, time reversal, frequency shifting, Scaling, Convolution in time domain, diff. in time domain. Differentiation in freq. domain parsevals relation. Relationship between Z, Laplace and Fourier transform.	06
5	**Laplace Transform:** Definition ROC concept, Properties, Inverse LT Transient and steady state response of LTI system. Stability & Causality of system.	07
6	**Z-Transform:** Definition, Convergence, properties and inversion (PFE long division Residue method) of Z-Transform. Concept of single and double sided Z-Transform. Analysis of discrete time system using Z-Transform. Stability and Causality.	14

List of Tutorials / Experiments:

1. Difference between continuous time and discrete time signals, classification, problems on Signal 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

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.

4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to 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 tutorials. The distribution of the term work shall be as follows,

Laboratory work (Experiments / Assignments)	:10 marks
Laboratory work (Programs / Journal)	: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.

Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

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.

Sub code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC502	Applications of Microcontroller - I	4	2	-	4	1	-	5

Sub code	Subject Name	Examination Scheme							
		Theory(out of 100)				Term Work	Pract and oral	Oral	Total
		Internal Assessment (out of 20)			End sem Exam				
		Test 1	Test 2	Avg					
ISC502	Applications of Microcontroller - I	20	20	20	80	25	25	--	150

Subject Code	**Subject Name**	**Credits**
ISC502	**Applications of Microcontroller - I**	**5**
Course Objectives	• To make the students understand the fundamentals of 8051 Microcontroller. Students should understand the working of these systems and should be able to determine hardware and software interfacing with real time systems. They should further understand how to design any application based on these systems.	
Course Outcomes	The students will be able to • Define Microprocessor and Microcontroller family with comparison. • Understand working of 8051/8052and MCS251 Microcontrolle Architecture and Programming model. • Understand the concept of Timer, Interrupt, I/O Port interfacing with 8051 Microcontroller. • Understand the concept of Interfacing with Real time System.	

Module	**Topics**	**Hrs.**
1	**Introduction** Microprocessor Definition ,Microcontroller Definition Operation of ALU, Evolution of Microprocessors ,Block Diagram of microprocessor based system and development cycle ,RISC and CISC processors	05
2	**MCS-51 microcontroller** Architecture of MCS 51 family of microcontroller, and its Variants and comparison. Comparison of microprocessor &microcontroller. CPU timing and machine eye le. Memory organization, SFRS. Integrated peripherals such as Timers/Counters, Serial port, parallel I/O pins. Interrupt Structure. Memory interfacing. Power saving & power down mode.	09
3	**Advanced MCS-51 architecture**	06

	8052 enhancements Indirect Memory access,Timer2 ,PCA Architecture of MCS151 Architecture of MCS251	
4	**Programming & Tools** Simulator, in-circuit debugger, in-circuit emulator, programmers, integrated development environment (IDE),cross compilers. Merits & demerits of above tools. Assembly language programming process. Programming tools. Instruction set, addressing modes. Assembly language Programming practice using assembly & C compiler	12
5	**Serial communication protocols** Operation of serial port. Programming for implementation of asynchronous serial communication. Buses like I2C RTC –DS1307 EEPROM Memory -24C256 SPI – MCP3201	06
6	**Interfacing & Case Studies** Interfacing to LCD, 7 segment display, ADC, DAC, relay, opt isolator. Data acquisition systems, Digital weighing machine, Washing machines, PID temperature controller ,Speed Control of DC motors and similar system design	10

List of Experiments:

1. 16 bit Arithmetic operations (addition, subtraction ,multiplication)
2. Logical operation
3. Code conversion
4. Generating square wave on port pins.
5. Generation of square wave using timer
6. Interfacing keyboard, 7 segments displays.
7. Interfacing LCD display
8. Serial Communication with PC.
9. Interfacing RTC
10. Interfacing DAC and its application
11. Temperature Controller
12. Speed control of DC Motor
13. Frequency measurement
14. Implementing PID controller
15. Stepper motor control.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.

5. In question paper weightage of each module will be proportional to 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 tutorials. The distribution of the term work shall be as follows,

Laboratory work (Experiments / Assignment)	: 10 Marks
Laboratory work (programs / journal)	: 10 Marks
Attendance (Theory and 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.

Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. Madizi M.A., The 8085 Microcontroller & Embedded systems, Pearson Educatio 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.
4. 8051 / MC151 / MCS251 Datasheets

Websites:

1. www.atmel.com
2. www.microchip.corn
3. www.nXp.com

Sub code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC503	Control System Design	4	2	-	4	1	-	5

Sub code	Subject Name	Examination Scheme							
		Theory(out of 100)				Term Work	Pract. and oral	Oral	Total
		Internal Assessment (out of 20)			End sem Exam				
		Test 1	Test 2	Avg.					
ISC503	Control System Design	20	20	20	80	25		-	125

Subject Code	**Subject Name**	**Credits**
ISC503	**Control system Design**	**5**
Course Objectives	• To make students understand the concept of state –space analysis ,to design the compensator in time and frequency domain, to design the PID compensator.	
Course Outcomes	The students will be able to • Represent any system in any canonical form. • Determine response of system • Design Lead, Lag and Lead –lag compensator using frequency domain method or time domain method. • Design PID compensator.	

Module	**Topics**	**Hours**
1.	Review: Time and Frequency domain specifications, error constants, effect of addition of poles and zeros on the system response, stability analysis using bode plot and root-locus techniques.	2
2.	**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.	12

3.	**Controller 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.	8
4.	**Introduction to Compensator:** Analysis of the basic approaches to compensation, cascade compensation, feedback compensation, Derivative and integral error compensation, Limitations of actuator saturation on controller design. **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,	11
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.	8
6.	**PID Compensator Design:** PID controller tuning: Cohen-coon method, Ziegler-Nichols method, Performance analysis of designed controllers based on optimal performance indices like ISE,ITAE,IAE and MSE. Designing PID controller using Root-Locus and Bode plot technique.	7

List of Laboratory Experiments(Using MATLAB/Scilab or any equivalent software):

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. Verification of controllability and observability.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.

5. In question paper weightage of each module will be proportional to 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 two case studies.
The distribution of the term work shall be as follows,

Laboratory work (Experiments / Assignment)	: 10 Marks
Laboratory work (programs / journal)	: 10 Marks
Attendance (Theory and 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.

Case Study:

1. Design a controller using time-domain/frequency domain/pole placement approach for an inverted pendulum on a cart and simulate the same using MATLAB/ Scilab.
2. Design a controller using time-domain/frequency domain/pole placement approach for speed control of DC motor and simulate the same using MATLAB/ Scilab.
3. Design a controller using time-domain/frequency domain/pole placement approach for Magnetic levitation system and simulate the same using MATLAB/ Scilab.
4. Design a controller using time-domain/frequency domain/pole placement approach for any other physical system available in laboratory (Flow loop, pressure loop, level loop etc.) and simulate the same using MATLAB/ Scilab.

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

Sub code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC504	Signal Conditioning Circuit Design	5*	2	-	4	1	-	5

* Out of 5 Theory lecture hours – 4 hours would be Lectures and 1 hour would be for Miniproject (for entire class)

Sub code	Subject Name	Examination Scheme							
		Theory(out of 100)				Term Work	Pract. and oral	Oral (miniproject)	Total
		Internal Assessment (out of 20)			End sem Exam				
		Test 1	Test 2	Avg.					
ISC504	Signal Conditioning Circuit Design	20	20	20	80	25	25	50*	175

Subject Code	**Subject Name**	**Credits**
ISC504	**Signal Conditioning Circuit Design**	**5**
Course Objectives	• To make students understand the working principle and design of various analog and digital signal conditioning circuits used in industrial applications.	
Course Outcomes	The students will be able to • Understand principle of working of various signal conditioners used with Temperature, Displacement, Optical and various miscellaneous other sensors. • Design signal conditioning circuits for various transducers. • Understand applications of various signal conditioners used in industry. • Capable of selecting best suited signal conditioners for any given application.	

Module	**Topics**	**Hrs.**
1	**Components of Analog Signal Conditioning:** Standard analog signals, 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.	8
2	**Analog signal conditioners and their design**: Practical applications of Op-amp based circuits with design - Differentiators and Integrator, 3 op-amp Instrumentation amplifier with applications, Precision rectifiers – Half wave, full wave, absolute value circuit, Log and anti-log amplifier with temperature	10

	compensation and applications, Active filters, sample and hold circuit , peak detector, threshold detector, zero crossing detector, window detector and Phase locked loops. Guidelines for analog signal conditioning design and design based problems.	
3	**Components of Digital Signal Conditioning** : Converters – ADCs and their different types, DACs and their different types, V to F and F to V converters. 555 Timer – modes of operation with applications. Characteristics of digital data – digitized value, sampled data system and linearization. Data acquisition system design, Encoders and Data logger circuit.	8
4	**Thermal and Pressure Transducer Signal conditioning Design:** Thermal sensor signal conditioning – design considerations and applications for RTD, Thermistor, thermocouple and solid state temperature sensors. Pressure sensor signal conditioning - design considerations and applications for various pressure sensors.	8
5	**Optical and Other Transducer Signal Conditioning Design:** Optical sensor signal conditioning – photo-diode with photo-conducting and photovoltaic modes, photo-transistor and photomultiplier tube. Optical encoder signal conditioning for linear displacement, velocity and angular displacement applications. Other sensor signal conditioning – Potentiometer, LVDT, strain gauges, piezoelectric transducer and capacitive transducers.	8
6	**Power Supply Design:** Power supply design using 78xx series, 79xx series and adjustable voltage IC regulators like 723 and 317. Switched Mode Power Supply (SMPS) – Block diagram with advantages and disadvantages over conventional power supply.	6

List of Experiments:

1. To design general signal conditioning circuit to convert sensor output to 0-5 V
2. To design general signal conditioning circuit to convert sensor output to 4-20 mA
3. To design signal conditioning circuit for low level signals in micro-volts region
4. To design absolute value circuit for an application

5. To design signal conditioning circuit for weight measuring system using strain gauge
6. To design signal conditioning circuit for capacitive transducer
7. To design a second order LPF and HPF for any application
8. To design signal conditioning circuit for RTD
9. To design signal conditioning circuit for LDR
10. To design an analog-to-digital convertor circuit for an application
11. To design and implement Astable and Monostable Multivibrator using 555 timer
12. To design adjustable voltage regulators using IC723/ LM317

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to 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.

Miniproject/ Orals:

Students in group of 2-3 would perform a Mini-project on any one application of signal conditioning circuit design and appear for Oral examination of the same.

Term Work:

Term work shall consist of minimum eight experiments (04 experiments from experiment list of 1 to 6 and 04 experiments from experiment list of 7 to 12)

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments)	: 10 Marks
Laboratory work (programs / journal)	: 10 Marks
Attendance (Theory and 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.

Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. Ramakant Gaikwad, "Op-amp & Linear ICs", PHI Pearson Education.
2. C. D. Johnson, "Process Control Instrumentation Technology (VIII Edition)".

Reference Books:

1. Roy Choudhary, "Linear Integrated Circuits", Wiley Eastern, 1991.
2. Coughlin & Driscoll, "Op-amp and Linear ICs" 6th Edition, PHI 2002.
3. C. D. Johnson, "Microprocessor Based Process Control" , PHI
4. Sergio Franco, "Design with op-amp analog ICs" McGraw Hill, 1988.
5. Robert G. Seippel, "Transducer Interfacing – Signal Conditioning for Process Control", Prentice Hill.
6. D. E. Pippenger and E. J. Tobanen, "Linear and Interface Circuits Applications", McGraw Hill, 1988.
7. Burr-Brown, "General Catalog", Tucson, Ariz:Burr-Brown, 1979.

Sub code	Subject Name	Teaching Scheme (Hrs)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC505	Control System Components	4	2	-	4	1	-	5

Sub code	Subject Name	Examination Scheme							
		Theory(out of 100)							
		Internal Assessment (out of 20)			End sem Exam	Term Work	Pract. and oral	Oral	Total
		Test 1	Test 2	Avg.					
ISC505	Control System Components	20	20	20	80	25	25*	-	150

Subject Code	**Subject Name**	**Credits**
ISC505	**Control System Components**	5
Course Objectives	• This course develops the students approach to identify different Control system components like Hydraulic, Pneumatic, Electrical and Electronic. • Students are expected to learn different types of Transmitters. • Students are expected to understand concept of Control Valve, different types of Control valve, their schematic, operation, etc. • They should able to understand different auxiliary process components like feeders, dampers etc.	
Course Outcomes	• The students will demonstrate different control system components like pumps, compressors, flapper nozzle. • The students will demonstrate working of different pneumatic circuits like Single acting cylinder, Double acting cylinder, hydraulic braking systems by using directional control valves. • The students will demonstrate the knowledge of different transmitters, how to use SMART transmitter. • The students will demonstrate the knowledge of control valves, installation, different valve accessories. • The students will learn importance of Alarm annunciators system, square root extractor , pressure and level switches	

Module	Topics	Hrs.
1	**Pneumatics** Pneumatic System Components: ISO symbols Instrument Air and Plant Air ,Air supply system and its components, Air compressors, Pressure regulation devices, air dryers , 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 , Pneumatic Circuits- Standard Symbols used for developing pneumatic circuits, Sequence diagram, dynamic modeling of pneumatic circuits.	10
2	**Hydraulics** Hydraulic System Components: Hydraulic pumps, Pressure regulation method, Loading valves, Hydraulic valves, Hydraulic actuators (cylinder and motor) , Speed control circuits for hydraulic actuators , Selection and comparison of pneumatic, hydraulic and electric systems.	03
3	**Transmitters** Need of transmitter, Need for Standardization of signals, concept of live zero and dead zero, 2-wire; 3-wire and 4-wire current transmitters, Electronic versus pneumatic transmitters, Electronic type transmitters -temperature; pressure; differential pressure; level; flow transmitter, SMART (Intelligent) Block schematic and Comparison with conventional transmitter, Buoyancy transmitter and their applications, Converters- Pneumatic to Electrical and Electrical to Pneumatic converters.	06
4	**Process Control Valves** Control valve terminology: Rangeabilty, Turndown; Valve size; control valve capacity and valve gain, Air to Open(AO), Air to Close (AC) ,selection criterion etc. MOC (Material of construction), type of actuation, applications, advantages, disadvantage of - Globe, Ball, Needle, Butterfly, Diaphragm, Pinch, Gate, Solenoid, Smart control valves, and special designs of Globe valves. Flow characteristics (Inherent and Installed), Valve positioners: necessity, types-motion balance and force-balance, effect on performance of control valve.Control Valve Actuators- Electrical, Pneumatic, Hydraulic, Electro-mechanical, and Digital actuators. Selection criteria of valve actuators.	14
5	**Auxiliary Process Control Components** Construction, working & application area of- Synchros (Transmitter and Receiver), error detector, Alarm annunciators Fire and gas detectors (types –flame, gas, fire and gas siren), Square root extractor, Feeders, Dampers, Temperature regulator, Flow regulator, Temperature , Flow, Level and, Pressure Switch, Relief valves, safety valves and rupture disk, Thermostats and Humidistat, Steeper motor	4

6	**Industrial 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. RFID - basic principles, frequencies, Active and passive RFID systems , mode of communication, various technologies for In house and outdoor RFID systems, Basic theory and devices for vision components, sensors and systems, Image processing and multi camera systems,	14

List of 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.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to 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 shall consist of minimum eight experiments.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments)	: 10 Marks
Journal	: 10 Marks
Attendance (Theory and 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.

Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. Andrew Parr, *Hydraulics and Pneumatics- A technician's and engineer's guide*, Jaico Publishing House, Mumbai.
2. C.D.Johnson, *Process Control and Instrument Technology*, TMH.
3. P. Harriot, *Process Control*, Tata McGraw Hill, 2001.
4. E. B. Jones, *Instrument Technology,* vol-III, Butterworth Publication.
5. D.P. Ekman, *Automatic Process Control*, Wiley Eastern, 1990.
6. Thomas E. Kisell, *Industrial Electronics*, 3rd Edition, PHI.
7. I. J. Nagrath , M. Gopal , Control System Engineering, 5th Editiom, Anshan Publishers, 2008

Reference Books:

1. Pneumatics, Festo Didactic.
2. Hydraulics, Festo Didactic
3. Bella G. Liptak, *Process Control and Optimization, Instrument Engineer's Handbook*, 4th Edition, CRC Press.
4. WG Andrews and Williams, Applied *Instrumentation in the process Industries*, Vol. - I and II, Gulf Publication.
5. Less Driskell, *Control Valve Selection and Sizing*, ISA.
6. J. W. Hatchison, *ISA Handbook of Control Valves*, 2nd Edition, ISA, 1990