SAVITRIBAI PHULE PUNE UNIVERSITY

Syllabus

S. E. Instrumentation & Control

(2019 Course- Credit Based)

Board of Studies

Instrumentation & Control Engineering

(w.e.f. June- 2020)

Savitribai Phule Pune University, Pune

SE Instrumentation and Control (2019 Course) Credit Based System

SEMESTER- I

Subject code	Subject	Teaching Scheme			Examination Scheme					Total	Credits	
					TH		PR	Oral	TW		TH	PR/ TUT
		TH	PR	Tut	Insem	Endsem						
207008	Engineering Mathematics III	3	--	1	30	70	--	--	25	125	3	1
206261	Sensors and Transducers	3	2	--	30	70	50	--	--	150	3	1
206262	Linear Integrated Circuits	3	2	--	30	70	25	--	--	125	3	1
206263	Electrical Measurements & Instrumentation	3	2	--	30	70	--	25	--	125	3	1
206264	Control System Components	3	2	--	30	70	--	25	--	125	3	1
206265	Computational Techniques	--	2	--	--	--	--	--	25	25	--	1
206266	Communication Skills	--	2	--	--	--	--	--	25	25	-	1
206267	Audit Course- III	--	--	--	--	--	--	--	--	--	--	--
		15	**12**	**01**	**150**	**350**	**75**	**50**	**75**	**700**	**15**	**07**

SEMESTER- II

Subject code	Subject	Teaching Scheme			Examination Scheme					Total	Credits	
					TH		PR	Oral	TW		TH	PR/ TUT
		TH	PR	Tut	Insem	Endsem						
206268	Control Systems	3	2	--	30	70	--	25	--	125	3	1
206269	Digital Electronics	3	2	--	30	70	25	--	--	125	3	1
206270	Process Loop Elements	3	2	--	30	70	50	--	--	150	3	1
206271	Signals and Systems	3	2	--	30	70	--	--	25	125	3	1
206272	Data Structures	3	2	--	30	70	--	--	25	125	3	1
206273	Project based learning	--	4	--	--	--	--	--	50	50	--	2
206274	Audit Course- IV	--	--	--	--	--	--	--	--	--	--	--
		15	**14**	**--**	**150**	**350**	**75**	**25**	**100**	**700**	**15**	**07**

SEMESTER- I

207008: Engineering Mathematics- III

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Tutorial: 1 Hr/ Week	In semester Assessment: 30 Marks	Tutorial: 1
	End Semester Assessment: 70 Marks.	Total: 4 credits
	Term Work : 25 Marks	

Prerequisites: Differential and Integral calculus, Taylor series, Differential equations of first order and first degree, Fourier series, Vector algebra and Algebra of complex numbers.

Course Outcomes (COs): On completion of the course, the students will be able to:

1. Solve higher order linear differential equation using appropriate techniques to model and analyze electrical circuits.
2. Apply Integral transforms such as Laplace transform, Fourier transform and Z-Transform to solve problems related to signal processing and control systems.
3. Apply Statistical methods like correlation, regression and Probability theory as applicable to analyze and interpret experimental data related to energy management, power systems, testing and quality control.
4. Perform Vector differentiation and integration, analyze the vector fields and apply to wave theory and electro-magnetic fields.
5. Analyze Complex functions, conformal mappings, and perform contour integration in the study of electrostatics, signal and image processing.

Unit I: Linear Differential Equations (LDE) and Applications (08)

LDE of n^{th} order with constant coefficients, Complementary Function, Particular Integral, General method, Short methods, Method of variation of parameters, Cauchy's and Legendre's DE, Simultaneous and Symmetric simultaneous DE. Modeling of Electrical circuits.

Unit II: Laplace Transform (LT) (07)

Definition of LT, Inverse LT, Properties & theorems, LT of standard functions, LT of some special functions viz. Periodic, Unit Step, Unit Impulse. Applications of LT for solving Linear differential equations.

Unit III: Fourier and Z – transforms (08)

Fourier Transform (FT): Complex exponential form of Fourier series, Fourier integral theorem, Fourier Sine & Cosine integrals, Fourier transform, Fourier Sine & Cosine transforms and their inverses.

Z - Transform (ZT): Introduction, Definition, Standard properties, ZT of standard sequences and their inverses. Solution of difference equations.

Unit IV: Statistics and Probability (07)

Measures of central tendency, Measures of dispersion, Coefficient of variation, Moments, Skewness and Kurtosis, Correlation and Regression, Reliability of Regression estimates.

Probability, Probability density function, Probability distributions: Binomial, Poisson, Normal, Test of hypothesis: Chi-square test.

Unit V: Vector Calculus (08)

Vector differentiation, Gradient, Divergence and Curl, Directional derivative, Solenoidal and Irrotational fields, Vector identities. Line, Surface and Volume integrals, Green's Lemma, Gauss's Divergence theorem and Stoke's theorem.

Unit VI: Complex Variables (08)

Functions of a Complex variable, Analytic functions, Cauchy-Riemann equations, Conformal mapping, Bilinear transformation, Cauchy's integral theorem, Cauchy's integral formula and Residue theorem.

Text Books:

1. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
2. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).

Reference Books:

1. Advanced Engineering Mathematics, 10e, by Erwin Kreyszig (Wiley India).
2. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
3. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).
4. Differential Equations, 3e by S. L. Ross (Wiley India).
5. Introduction to Probability and Statistics for Engineers and Scientists, 5e, by Sheldon M. Ross (Elsevier Academic Press).
6. Complex Variables and Applications, 8e, by J. W. Brown and R. V. Churchill (McGraw-Hill Inc.).

206261: Sensors and Transducers

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Practical: 1
	End Semester Assessment: 70 Marks.	Total: 4 credits
	Practical : 50 Marks	

Prerequisites: Basic knowledge of Physics

Course Outcomes (COs): On completion of the course, the students will be able to

1. Understand the working principle, construction, operation, characteristics and features of sensors and transducers.
2. Examine the performance specifications of various sensors and transducers.
3. Select sensors and transducers for measurement applications.
4. Design sensor/transducer circuits for measurement of physical parameters.

Unit 1: Displacement and Speed Measurement (08)

Need of sensors and transducers, transducers definition, classification, performance characteristics and selection criteria.

Displacement Measurement: resistive-potentiometers, inductive-LVDT and RVDT, capacitive, piezoelectric, ultrasonic, hall effect, optical and proximity sensors.

Speed Measurement: Tachometer, Magnetic pickups, Encoders, Photoelectric pickups, Stroboscopes, Shaft speed measurement.

Vibration Measurement: Piezoelectric, Seismic, Potentiometric, and LVDT.

Unit II: Force and Torque measurement (06)

Elastic elements, strain gauges, load cells, piezoelectric, vibrating string, strain gauge torque meter, inductive torque meter, magneto-restrictive transducers, torsion bar dynamometers.

Unit III: Pressure measurement (07)

units and their relations, manometers and their types, elastic sensors, piezoelectric secondary transducers, differential pressure sensors, capacitive (delta cell), high-pressure gauges, vacuum gauges, dead weight tester and vacuum gauge tester.

Unit IV: Temperature measurement (07)

Temperature scales, units and their relations, classification of temperature sensors, bimetallic thermometer, Resistance temperature detectors (RTD), types of RTD, lead wire compensation, thermistors, Thermocouples, thermocouple tables, cold junction compensation techniques, thermopiles, thermo well, pyrometers, temperature IC sensor LM35, design of signal conditioning circuits for RTD and Thermocouple.

Unit V: Flow Measurement (07)

Units, Newtonian and non-Newtonian fluids, Reynolds's number, laminar and turbulent flows, velocity profile, Bernoulli's equation for incompressible flow, head type flow meters (orifice, venture meter and pitot tube), variable area type, turbine, electromagnetic , ultrasonic , vortex shedding, anemometers , mass flow meter: Coriolis flow meter.

Unit VI: Level and Miscellaneous Measurement (07)

Level Measurement: Float, Bubbler, DP cell, Ultrasonic, Capacitive, radioactive type, radar, solid level detectors.

Viscosity: Saybolt, Searle's rotating cylinder, Cone and plate, Falling and rolling ball, Rotameter.

Density: Chain-balanced float type, Hydrometer (Buoyancy type), U tube type, Hydrostatic Head (Air bubbler, DP Cell).

Humidity: resistive and capacitive type sensors

Miscellaneous Sensors: pH sensors, Conductivity sensors.

List of Experiments :

Students are expected to perform minimum eight experiments: **(Any 7) and one from 12 and 13**

1. Determine characteristics LVDT for displacement measurement.
2. Determine characteristics of different proximity sensors.
3. Compare performance of encoder and tachometer for speed measurement.
4. Evaluate performance characteristics of strain gauge load cell for weight measurement.
5. Calibration of pressure gauge using dead weight pressure tester
6. Calibration of pressure gauge using vacuum gauge tester
7. Determine temperature using LM35
8. Compare performance of thermocouple and RTD for temperature measurement.
9. Compare performance of Orifice and Venture for flow measurement.
10. Level measurement using ultrasonic sensors.
11. Evaluate performance characteristics of capacitive/ resistive/ air purge method for level measurement.
12. Design a signal conditioning circuit for temperature measurement using Thermocouple.
13. Design a signal conditioning circuit for temperature measurement using RTD.

Text Books:

1. Principle of Industrial Instrumentation by D. Patranabis, Tata McGraw Hill, 2nd Ed.
2. Instrumentation and Measurement Principles by . D.V.S. Murty, PHI, New Delhi, 2nd Ed.
3. Electrical and Electronics Measurement and Instrumentation by A.K. Sawhney, Dhanpat Rai & Co, 2nd Ed.
4. Process control instrumentation technology by Curtis D. Johnson, PHI learning Pvt. Ltd, 07th Ed.

Reference Books:

1. Measurement Systems by E.O. Doebelin, McGraw Hill, 06th Ed.
2. Process Measurement & Analysis by B.G. Liptak, CRC press, 04th Ed.
3. Instrumentation Devices and Systems by C. S. Rangan, G. R. Sharma and V. S. Mani, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 02nd Ed.
4. Mechanical and Industrial Measurements by R. K. Jain, Khanna Publishers, 02nd Ed.

206262: Linear Integrated Circuits

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Practical: 1
	End Semester Assessment: 70 Marks.	Total: 4 credits
	Practical : 25 Marks	

Prerequisites: Basic Electronics Engineering

Course Outcomes (COs): On completion of the course, the students will be able to:

1. Analyze the op-amp characteristics and understand their significance.
2. Evaluate the performance of linear and non-linear circuits using Op- Amp.
3. Test the performance of Voltage controlled oscillator, Phase lock loop, Sample and Hold Circuit.
4. Design and implement active filter circuits and voltage regulator using special purpose ICs.
5. Design and test multivibrator circuits using timer.

Unit I: Fundamentals of Operational amplifier (Op-amp) (07)

Block diagram of Operational amplifier, , Characteristics of Operational amplifier, Causes of Slew rate, Measurement of Slew rate (SR), Common Mode Rejection Ratio (CMRR), Power Supply Rejection ratio (PSRR/SVRR), Frequency response, Offset nullification techniques, comparative study of different amplifiers (LM741,LM324,OP07). Introduction to Open and Closed Loop configurations of Op-Amplifier

Noise in Op-amp: types of Noise (definitions of Shot noise, Thermal noise, Flicker noise, Burst noise, Avalanche noise, Noise colors).

Unit II: Closed loop Op- Amplifier circuits (07)

Introduction to feedback amplifiers, Loading effect. Voltage series feedback (Non-inverting amplifier with feedback): deriving close loop gain, input impedance, output impedance and bandwidth; Voltage follower and its applications, Voltage shunt feedback (Inverting amplifier with feedback): deriving close loop gain, input impedance, output impedance and bandwidth; Inverter circuit, Differential amplifier with one op-amp. With derivation of close loop gain.

Unit III: Operational amplifier- linear applications (07)

Voltage summing and substracter, Integrator and practical integrator, Differentiator and practical differentiator, Instrumentation amplifier with three Op-amps, Current to Voltage converter with zero and span adjustment circuit, Voltage to current converter with zero and span adjustment circuit, Current booster , Isolation amplifiers, Equation solving with Op-amp.

Unit IV: Operational amplifier- non- linear applications (06)

Comparator and its characteristics, Zero Crossing Detector (ZCD) and its use, Schmitt trigger with external bias, Precision half wave and full wave rectifiers.

Sine wave oscillators using op-amp.: Barkhausen criteria, Wein bridge oscillator, RC phase shift oscillator.

Unit V: Timers and Special purpose ICs (07)

Design and applications of Astable, Monostable (Re-triggerable and Non- retriggerable) and Bistable Multivibrators using LM555.

Voltage controlled oscillator(LM 566), Phase locked Loop(LM 565), V to F and F to V converter(LM331), Analog Multiplexer/Demultiplexer (CD 4051).

Unit VI: Active filters and Regulators (08)

Filters: Definition, types and Difference between active and passive filters , their merits and demerits. Filter terminology: Pass band, Stop band, cut off, Ripple, Q and order of the filter. Butterworth approximations, Low pass (LP), High pass (HP), Band pass(BP), Narrow band pass, Band reject, Notch filter, First and second order filters, (Design of LP, HP and BP filter).

Regulators: Performance parameters (line regulation, load regulation, ripple rejection), Fixed volt regulators (IC78xx, 79xx), Linear voltage regulator IC 723(High voltage, low voltage regulator circuits)

List of Experiments :

Students are expected to perform minimum eight experiments:

1. Bandwidth measurement of inverting and non- inverting amplifier using LM 741.
2. Measurement of CMRR, Slew rate and output offset voltage of LM 741.
3. Designing and implementation of Instrumentation amplifier using LM324
4. Designing and implementation of Integrator using LM 741.
5. Designing and implementation of Differentiator using LM 741.
6. Designing and implementation of Wien bridge oscillator using LM 741.
7. Designing and implementation of Comparator, Schmitt trigger and Zero Crossing Detector using LM 741.
8. Designing and implementation of Astable and Monostable multivibrator using LM 555.
9. Design and implement VCO to determine free running frequency (F_0) using LM 566.
10. Design and perform PLL to determine F_0, lock range (F_L) and capture range (F_C) using NE 565.
11. Design and implement V to F and V to F converter using LM331.

12. Design and implement first/second order Butterworth High Pass/ Low Pass/ Band Pass Filter using LM 741.
13. Design and implement Voltage regulators: linear variable regulator LM723.
14. Design and implement fixed voltage regulator using 78xx.

Text Books:

1. Ramakant Gaikwad, " Operational Amplifiers" PHI, 3 rd ed., 1992.
2. William D. Stanley, "Operational Amplifiers With Linear Integrated Circuits", 4th ed., Pearson Education India, 2002.
3. D. Roy Choudhury, "Linear Integrated Circuits" New Age International, 4th edition.

Reference Books:

1. Paul Horowitz, Winfield Hill, "The Art of Electronics", 2 nd Ed., Cambridge University press, 2008.

206263: Electrical Measurements and Instrumentation

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	Total: 4 credits
	Oral : 25 Marks	

Prerequisites: Basics of Electrical and Electronics Systems

Course Outcomes (COs): On completion of the course, the students will be able to:

1. Apply fundamental knowledge of Instrument for electrical measurements.
2. Distinguish analog and digital instruments.
3. Design the voltmeter and ammeter for different ranges.
4. Compute the values of inductance, resistance and capacitance using bridges.
5. Implement ADC and DAC using special purpose IC.
6. Determine voltage, frequency and phase shift of unknown signals using CRO

Unit I: Fundamentals of Measurement (07)

Need of Instrumentation, General Measurement System, Classification of Instruments, Static and Dynamic characteristics of instruments, Error: limiting error, Types of Errors. Loading effect: Input impedance and admittance of load & output impedance and admittance of source, loading effects of series and shunt connected instruments, Calibration: Definition, calibration report & certification, traceability and traceability chart.

Unit II: Analog Indicating Instruments (08)

DC galvanometer, PMMC and Moving Iron instruments, Voltmeter, Ammeter, RMS and True RMS concept, Extension of range of ammeter, design of multirange ammeter, extension of range of voltmeter, design of multirange voltmeter, series and shunt type ohmmeter, Single phase wattmeter: construction and working.

Unit III: Oscilloscope (06)

Introduction, General purpose oscilloscope Block Diagram, Cathode Ray Tube, deflection sensitivity, front panel controls, Oscilloscope Probes 1:1 and 10:1, Dual trace CRO, ALT and CHOP modes, measurement of electrical parameters like voltage, current, frequency and phase, frequency measurement by Lissajous pattern and Z-modulation.

Digital Storage oscilloscope block diagram, sampling rate, bandwidth, roll mode.

Unit IV: Bridge Circuits (07)

DC bridges: Wheatstone bridge construction and general balance condition, errors in bridge circuits, bridge sensitivity, current sensitivity and voltage sensitivity of bridge, Kelvin bridge, Kelvin double bridge, applications of DC bridges.

AC bridges: Quality factor (Q) and dissipation factor(D), General equations for bridge balance, detectors for AC bridges, Maxwell's bridges, Hay bridge, Schering bridge, Wien bridge, applications of AC bridges.

Unit V: Digital Instruments (08)

Introduction to digital instruments, Advantages of Digital instruments over Analog instruments, Block diagram, principle of operation, Accuracy of digital instruments, Need of ADC, ADC types like Flash, Counter, SAR and Dual-Slope, ADC Specifications, ADC Numerical, Need of DAC, DAC types like Weighted-Resistor and R-2R ladder, DAC Specifications, Its applications in digital instruments like Digital Multimeter, Digital Kilo Watt Hour meter, Digital Clamp meter.

Unit VI: Recording Instruments and Virtual Instrumentation (06)

Concept and classification of recorder, Basic Strip chart recorder Types of Strip chart recorder-XY Recorder, Magnetic Tape recorder, Different marking mechanism in recorder, Application of recorders

Introduction to virtual instrumentation, Role of Software in Virtual Instrumentation ,Virtual Instrumentation With LabVIEW, Components of Lab VIEW application.

List of Experiments :

Students are expected to perform minimum eight experiments:

1. Design of multirange ammeter, voltmeter, conversion of ammeter into voltmeter
2. Design of series and shunt type ohmmeter
3. Calibration of instrument and report preparation.
4. Measurement of power using single phase wattmeter.
5. Measurement of voltage, Frequency and phase using CRO
6. To measure the unknown frequency by Z-Modulation technique.
7. To measure response time of a relay using DSO
8. Measurement of unknown resistance by Wheatstone's Bridge.
9. Measurement of respective parameter by AC bridge (any one from syllabus).
10. Measurement of energy using single phase Energy meter (Analog or Digital)
11. Measurement of current by digital clamp meter
12. Study and implementation of Analog to digital conversion using IC 0809
13. Study and implementation of Digital to Analog conversion using IC 0808
14. Study of y-t or X-Y recorder.
15. Study of Lab view software

Text Books:

1. Sawhney A. K., Electrical and Electronics Measurements and Instruments, Dhanpat Rai & Co. 02nd Ed..
2. W. D. Cooper & A. D. Helfrick, 'Electronic Instrumentation and Measurement Techniques', PHI, 4th e/d, 1987.
3. David Bell, 'Electronic Instrumentation and Measurements', PHI, 2e/d,

Reference Books:

1. Anand M. M. S., 'Electronic Instruments and Instrumentation Technology', PHI, 2004, 02nd Ed.
2. Kalsi H. S., 'Electronic Instrumentation', TMH, 2nd or 3rd e/d, 2004/2010.
3. R. Subburaj, ' Calibration the Foundation for ISO 9000 and TQM
4. Bouwens A. J., 'Digital Instrumentation, McGraw-Hill, second edition

206264: Control System Components

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	Total: 4 credits
	Oral : 25 Marks	

Prerequisites: DC/AC Motors, Flapper Nozzle Transducer.

Course Outcome (COs): On completion of the course, the students will be able to:

1. Implement logic gates using relays.
2. Develop electrical circuits for motor control operations.
3. Construct pneumatic and hydraulic circuits for control applications using appropriate pneumatic and hydraulic components
4. Design of SCR triggering circuit using UJT.
5. Understand the need of electronic safety circuits.

Unit I: Industrial Control Devices (07)

Switches:
Construction, symbolic representation, working, application of Toggle switch, Slide switch, DIP switch, Rotary switch, Thumbwheel switch, Selector switch, Push button, Drum switch, Limit switch, Temperature switch, Pressure switch, Level switch, Flow switch.

Relays:
Construction, working, specifications/selection criteria and applications of Electromechanical relay, Reed relay, Hermetically sealed relay, Solid state relays.

Contactors:

Construction, working, specifications and applications of contactors and their comparison with relays.

Unit II: Sequencing & Interlocking for Motors (08)

Standard symbols used for Electrical Wiring Diagram, Electrical Wiring Diagram in relation to motors: Concept of sequencing & Interlocking ,Starting, Stopping, Emergency shutdown, (Direct on line, star delta)

Protection of motors: Short circuit protection, over load protection, Low/Under voltage protection, Phase reversal Protection, Over temperature protection.

Reversing direction of rotation, Braking, Starting with variable speeds, Jogging/Inching, Motor Control Center: Concept and wiring diagrams.

Unit III: Introduction to Pneumatic Components (08)

Comparison of Pneumatic, Hydraulic & Electrical systems.

Pneumatic components: Pneumatic Power Supply and its components ,Pneumatic relay (Bleed & Non bleed, Reverse & direct) ,Single acting & Double acting cylinder, Special cylinders: Cushion, Double rod, Tandem, Multiple position, and Rotary, Pneumatic valves (direction controlled valves and flow control) ,Special types of valves like relief valve, pressure reducing and Time delay valve.

Pneumatic Circuits Standard Symbols used for developing pneumatic circuits, Sequence diagram (step-displacement) for implementing pneumatic circuits, Different Pneumatic Circuits: Reciprocating, Sequencing, Direction control and Speed regulation.

Unit IV: Introduction to Hydraulic components (06)

Hydraulic components:

Hydraulic supply, Hydraulic pumps, Actuator (cylinder & motor), Hydraulic valves

Hydraulic Circuits:

Standard Symbols for developing hydraulic circuits, Different Hydraulic Circuits: Meter in, Meter out, Reciprocating, speed control, Sequencing of cylinders and Direction control.

Unit V: Power Control Elements (07)
Construction, working, characteristics, specifications and applications of SCR, UJT, TRIAC, DIAC, MOSFET, IGBT, Triggering and Commutation of SCR.

Unit VI: Auxiliary components & Safety Measures (06)

Auxiliary components:

Construction, working & applications of: Synchros (Transmitter and Receiver), Alarm annunciator, Square root extractor, Flow totalizer and Computing relays.

Safety Measures

Hazardous Area & Material classification as per NEC Standards, Explosion Proof Housing, Encapsulation, Sealing, & Immersion, Purging systems

Intrinsic Safety: Definition, designing for intrinsic Safety, Circuit Breaker and Fuses, Isolation or Encapsulation (Series & Shunt Protective elements & Zener barrier).Introduction to HaZOP.

List of Experiments :

Students are expected to perform Minimum 8 Experiments :

1. Implementation of Logic Gates using relays.
2. Study of various pneumatic and hydraulic components and power supplies.
3. Implementation and testing of Pneumatic circuits.
4. Implementation and testing of Hydraulic circuits.
5. Study of Synchro transmitter and receiver system
6. Study of Pressure/temperature/level/flow Switches (any two).
7. Study of Motor control Center based on industrial visit.
8. Study and Calibration of P/I converter.
9. Demonstration & study of auxiliary components: flow totalizer, Alarm annunciator, computing relay and square root extractor (any two)
10. Designing intrinsic safety circuits (Zener barriers)
11. V-I characteristics of SCR.
12. Design of SCR triggering circuit using UJT.

Text Books:

1. Industrial Electronics, Petruzella, McGraw-Hill, ISE Editions
2. Pneumatic Instrumentation, Majumdhar, TMH, 01st Edition
3. Industrial Hydraulics, Pipenger, McGraw-Hill Education, 3rd Edition
4. Process Control, Instrument Engineering Hand book, B.G. Liptak, Butterworth-Heinemann Ltd, Butterworth-Heinemann Ltd, 3rd Edition
5. MD Singh, K B Khanchandani, 'Power Electronics', , McGraw Hill Company, 2nd edition.

Reference Books:

1. Pneumatics, Festo Didactic
2. Hydraulics, Festo Didactic
3. Process control and Instrument technology, C.D.Johnson, TMH, 07th Ed.
4. P. C. Sen,' *Power Electronics*', TMH, 2007, 02nd Ed.
5. Mohamad Rashid,' *Power Electronics*', PHI, 2nd edition, 2004

206265: Computational Techniques

Teaching Scheme:	**Examination Scheme:**	**Total Marks:** 25.
Practical: 2 Hrs/ Week	Term Work : 25 Marks	**Total Credits:** 1
		Term Work= 1

Prerequisites: Basics of logic design.

Course Outcome (COs): On completion of the course, the students will be able to:

1. Practice with MATLAB environment.
2. Develop MATLAB program for mathematical problem.
3. Import and Export data using MATLAB
4. Develop simulink model of system.
5. Design GUI model for specific applications

Introduction to MATLAB

Brief Introduction Installation of MATLAB, MatLab environment: MATLAB window Command window Workspace Command history Setting directory working with the MATLAB user interface Basic commands Assigning variables, operations with variables.

Basic and Matrices Operations

Data types: int float, double, long character,etc, MatLab command format, BODMAS Rules, Arithmetic operations, Operators and special characters, Mathematical and logical operators. Solving arithmetic equations. Typing Matrices, Indexing of Arrays and Matrix, Manipulation of Arrays and Matrix like Concatenating Matrices, etc, Transpose. Useful Matrix Generators, Subscripting, End as a subscript Deleting Rows or Columns, Matrix Arithmetic.

Programming

Writing scripts in Matlab. M files working with script tools Writing Script file Executing script files The MATLAB Editor Saving m files Scripts, Functions, Flow Control,
Conditional loop: If, elseif, else, switch Case, otherwise, break
Loops: For, While, Break, Continue, return, pause, parfor, end
Publishing script,
Calling and exporting data form and to external sources like excel, image etc

Basic Graphics:

Components of figure window, Types of plots, ploting 2D Plot, single plot and multiple plots in sane figure window, Formating and Annotations
Subplots, Clearing the Figure Window , Three-Dimensional Plots,

GUI Design

Introduction of Graphical User Interface, GUI Function, Property, GUI Component Design, GUI Container Writing the code of GUI Callback Dialog Box Menu Designing Applications.

MATLAB Simulink

Introduction of Simulink, Simulink Environment & Interface, Study of Library, Circuit Oriented Design, Equation Oriented Design, Models.

Various Functions and Toolboxes

Documentation, Miscellaneous Useful Functions, Graphical, Symbolic Toolbox, Control system Toolbox, Hardware Interface

**** Students must perform minimum eight experiments of which two experiments on numerical methods and two experiments on simulink.**

Text Books:

1. A Guide to MATLAB: For Beginners and Experienced User, Brian R Hunt, Ronald L Lipsman, J.M. Rosenberg 3rd Edition
2. MATLAB for Beginners: A Gentle Approach: Peter Kattan Revised Edition.
3. Begging MATLAB and Simulink , Sulaymon Eshkabilov, APRESS Publication
4. MATLAB and Introduction with Application, Gilat A, John Wiley Publication,4th Edition

206266: Communication Skills

Teaching Scheme:	**Examination Scheme:**	**Total Marks:** 25.
Practical: 2 Hrs/ Week	Term Work: 25 Marks	**Total Credits:** 1
		Term Work= 1

Course Outcomes: On completion of the course, student will be able to:

1. Effectively communicate through verbal/oral communication and improve the listening skills
2. Write precise briefs or reports and technical documents.
3. Actively participate in group discussion / meetings / interviews and prepare & deliver presentations.
4. Become more effective individual through goal/target setting, self motivation and practicing creative thinking.
5. Function effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality.

Term work will consist of any 8 assignments of following exercises:

1. SWOT analysis
2. Personal & Career Goal setting – Short term & Long term
3. Presentation Skill
4. Letter/ Application writing
5. Report writing
6. Listening skills
7. Group discussion
8. Resume writing
9. Public Speaking
10. Stress management
11. Team Activity

-- Use of Language laboratory

Teaching Methodology

Each class should be divided into three batches of 20-25 students each. The sessions should be activity based and should give students adequate opportunity to participate actively in each activity. Teachers and students must communicate only in English during the session. Specific details about the teaching methodology have been explained in every activity given below.

Practical Assignments (Term work)

Minimum 8 assignments are compulsory and teachers must complete them during the practical sessions within the semester. The teacher should explain the topics mentioned in the syllabus during the practical sessions followed by the actual demonstration of the

exercises. Students will submit report of their exercise (minimum 8) assignments as their term work at the end of the semester but it should be noted that the teacher should assess their assignment as soon as an activity is conducted. The continual assessment process should be followed.

1. SWOT analysis

The students should be made aware of their goals, strengths and weaknesses, attitude, moral values, self confidence, etiquettes, non-verbal skills, achievements etc. through this activity. The teacher should explain to them on how to set goals, SWOT Analysis, Confidence improvement, values, positive attitude, positive thinking and self esteem. The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.

2. Personal & Career Goal setting – Short term & Long term

3. Presentation Skills

Students should make a presentation on any informative topic of their choice. The topic may be technical or non-technical. The teacher should guide them on effective presentation skills. Each student should make a presentation for at least 10 minutes.

4. Letter/Application writing

Each student will write one formal letter, and one application. The teacher should teach the students how to write the letter and application. The teacher should give proper format and layouts.

5. Report writing

The teacher should teach the students how to write report. The teacher should give proper format and layouts. Each student will write one report based on visit / project / business proposal etc.

6. Listening skills

The batch can be divided into pairs. Each pair will be given an article (any topic) by the teacher. Each pair would come on the stage and read aloud the article one by one. After reading by each pair, the other students will be asked questions on the article by the readers. Students will get marks for correct answers and also for their reading skills. This will evaluate their reading and listening skills. The teacher should give them guidelines on improving their reading and listening skills. The teacher should also give passages on various topics to students for evaluating their reading comprehension.

7. Group discussion

Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback

206267: Audit Course- I

In addition to credits course, it is recommended that there should be audit course (non-credit course) preferably in each semester from second year. The student will be awarded grade as AP on successful completion of audit course. The student have to opt for one of the audit courses per semester, starting in second year first semester. Such audit courses can help the student to get awareness of different issues which make impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in each semester is provided in curriculum. Each student has to choose one audit course from the list per semester. Evaluation of audit course will be done at institute level. Method of conduction and method of assessment for audit courses is suggested.

The student registered for audit course shall be awarded the grade AP and shall be included such grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself.

(Ref-http://www.unipune.ac.in/Syllabi_PDF/revised-2015/engineering/UG_RULE_REGULATIONS_FOR_CREDIT_SYSTEM-2015_18June.pdf)

Guidelines for Conduction (Any one or more of following but not limited to)

- Lectures/ Guest Lectures
- Visits (Social/Field) and reports
- Demonstrations
- Surveys
- Mini Project
- Hands on experience on specific focused topic
- Any relevant courses from NPTEL/ SWAYAM/ MOOCs/ ARPIT etc.

Guidelines for Assessment (Any one or more of following but not limited to)

- Written Test
- Demonstrations/ Practical Test
- Presentations
- IPR/Publication
- Report
- Assignments from NPTEL/ SWAYAM/ MOOCs/ ARPIT etc.

Audit courses suggested by BoS, Instrumentation Engineering:

1. Road Safety
2. Smart Cities
3. Stress Relief: Yoga and Meditation
4. Foreign Language – Japanese /German Module 1

SEMESTER- II

206268: Control Systems

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	Total: 4 credits
	Oral : 25 Marks	

Prerequisites: Concepts of Mathematics and Electrical Engineering

Course Outcomes (COs): On completion of the course, the students will be able to:

1. Classify the control systems.
2. Develop mathematical models of LTI (Linear Time Invariant) systems.
3. Represent the system in canonical forms (signal flow graph)
4. Analyze the LTI system in time domain and frequency domain.
5. Test the stability of LTI system using conventional methods.

Unit I: Introduction to Control Systems (06)

Introduction, Concepts of control systems, Classification of systems-Linear and Non-linear Systems, Time-invariant and Time variant systems, Static and Dynamic systems, Causal and Non-causal Systems, Open loop and closed loop. Laplace transform and Inverse Laplace transform with their properties. Solving the differential equations.

Unit-II: Modeling of systems (08)

Representation of: Electrical, mechanical, electromechanical with differential equations. Concept of transfer function. Properties of transfer function. Representation of transfer functions for electrical, mechanical with force to voltage and force to current analogies.

Unit-III: Block diagram and signal flow graph (07)

System in canonical form. Introduction to block diagram, block diagram reduction rules. Introduction to Signal flow graph, terminologies used in signal flow graph, conversion of block diagrams to signal flow graph, Mason's gain formula.

Unit-IV: Time domain analysis of control systems (08)

Standard test signals. First order, second order systems and their response. Time domain specifications of first order and second order systems. Derivations of time domain specifications. Static error constants (kp, kv, ka,) and steady state error (ess)

Unit-V: Stability Analysis (08)

Concept of Stability in s domain, Classification of Stability (BIBO stability and asymptotic stability), stability analysis by Hurwitz criterion and Routh array, concept of relative stability and its analysis using Routh array.

Root locus: Definition, construction rules, determination of system gain at any point on root locus (from magnitude condition and by graphical method).

Unit-VI: Frequency Domain Analysis (05)

Fundamentals of frequency response. Polar Plots, Bode plot. Determination of transfer functions from asymptotic Bode plot and Polar plot.

List of Experiments :

Students are expected to perform minimum eight experiments:

1. Transfer function of RC System and its step response.
2. Transfer function of RLC System step response.
3. Study of first and second order system response and find its time constant and verify it, Theoretically.
4. Find steady state error of Type 0, 1, 2 systems.
5. Study of under damped, over damped and critically damped response of second order system (RLC ckt) and theoretically verify it
6. Find TF of two RC n/w using Bode plot
7. Introduction to Control System Toolbox in MATLAB.
8. Introduction to Simulink (Basic blocks used in Control system).
9. Calculation of time domain specifications using MATLAB.
10. Stability analysis using root locus approach.
11. Stability analysis using frequency response approach (Bode plot approach)

Term Work:

Students are expected to complete minimum eight assignments on the above units.

Text Books:

1. I. J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers, 05th Ed.
2. B. S. Manke, "Linear Control Systems", Khanna Publishers, New Delhi, 02nd Ed.
3. A. K. Jairath, "Problems and Solutions of Control Systems", CBS Publishes, New Delhi, 06th Ed.
4. S. K. Bhattacharya, "Control System Engineering", Pearson India, 02nd Ed.

Reference Books:

1. K. Ogata, "Modern Control Engineering", PHI, New Delhi, 06th Ed..
2. Norman S. Nise, "Control System Engineering", John Wiley and Sons, 07th Ed.
3. B. C. Kuo, "Automatic Control Systems", PHI, New Delhi, 07th Ed.

206269: Digital Electronics

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Practical: 1
	End Semester Assessment: 70 Marks.	Total: 4 credits
	Practical : 25 Marks	

Prerequisites: Basics of Transistor

Course Outcomes (COs): On completion of the course, the students will be able to:

1. Represent numerical values in various number systems and their conversion / Simplify logical expressions using Boolean Laws, K-map method and design them using logic gates.
2. Understand different logic families.
3. Design combinational digital circuits using logic gates
4. Understand operation basics of flip-flops, registers, decoders, encoders, multiplexers and de-multiplexers.
5. Design synchronous, asynchronous sequential and non- sequential counters.
6. Design digital clock and frequency counter circuits.

Unit I: Number system, Logic Gates and Codes (08)

Number system: Binary, Octal numbers, Hexadecimal numbers, number conversion and their arithmetic. Signed Magnitude, 1's complement and 2's Complement representation. 2's complement arithmetic.

Logic Gates: Logic gates, Universal gates.

Codes: BCD codes, Excess-3, Gray code, Error detecting & correcting Codes, ASCII Code and code conversions, BCD Arithmetic.

Unit II: Logic circuit minimization techniques (06)

Boolean algebra, De-Morgan's Thermos, Representation of truth-table, SOP form, POS form, Simplification of logical functions, Minimization of SOP and POS forms, Don't care Conditions. K-Maps up to 4 variables and Quine-McClusky techniques.

Unit III: Combinational Logic Circuits (06)

Design of Full Adder and Full Subtractor, Binary Parallel Adder , BCD Adder, Magnitude comparator. Multiplexer, De-multiplexer, Decoder, Encoder, Priority Encoder, BCD to 7 segment decoder circuits , BCD to 7 segment decoder/driver IC 7448/7447. Equation solving by MUX and DEMUX

Unit IV: Sequential Logic (06)

Sequential Circuits. Difference between combinational circuits and Sequential circuits.

Flip-flop: SR, JK, MSJK, D, T types of flip flop, their truth tables and excitation tables, Preset & Clear. Conversion from one type to another type of Flip Flop. Key debouncing techniques, TTL oscillator.

Memory: RAM, ROM, EPROM, E2 PROM, Flash Memory, bubble memory, CD ROM .

Unit V: Counters (08)

Definition of counter, Modulus of counter**,** Asynchronous counters. Synchronous counters, state diagram representation, Design of Synchronous , binary, up-down, Pre-settable and programmable counters, Decade/BCD counters, ring and Johnson counters, Divide by N counter, timing diagram of counters, Realization of counters using ICs 7490, 7492,7493 and 74193

Registers: Buffer register; shift register; IC 7495, Sequence Generator.

Unit VI: Programmable logic devices and Logic families(08)

PLD: PLA- Input, Output Buffers, AND, OR, Invert/ Non-Invert Matrix

Logic Families: Logic levels, propagation delay, power dissipation, fan-out and fan-in, noise margin, logic families and their characteristics-RTL, TTL, ECL, CMOS

Applications of digital circuits: Digital Clock and Frequency counter,

List of Experiments :

Students are expected to perform minimum eight experiments:

1. Verification of truth table of various logic gates and study of input & output characteristics of TTL logic family
2. Code Conversion
3. Design and Implementation of full adder and subtractor using logic gates.
4. Study of Multiplexer IC 74151
5. Study of Flip –Flop ICs (7476,7474) and conversion of flip –flop from one other
6. Implementation of counter of different Mod numbers using 7490 & 7493 ICs
7. Design of Sequential counter using type T and Type D design.
8. Design of Non sequential counter using type T and Type D design.
9. Design of 1-bit and 2-bit comparator using logic gates.
10. Design Ring & Johnson counters using shift register IC 7495
11. Interfacing of 7 segment LED display using IC 7447
12. Study of Presettable Up / Down counter using IC 74193.
13. Interfacing of TTL and CMOS ICs

Text Books:

1. Floyd "Digital Principles", Pearson Education, 11th Ed.
2. Gothman, 'Digital Electronics', 2nd edition, PHI
3. M. Morris Mano,' Digital Design', Pearson Education, 03rd Ed.

Reference Books:

1. Leach, Malvino , Saha; *Digital Principles and Applications;* 7th Edition, McGraw Hill
2. R. P. Jain; *Modern Digital Electronics;* 4th Edition, McGraw Hill

206270: Process Loop Elements

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Practical: 1
	End Semester Assessment: 70 Marks.	Total: 4 credits
	Practical : 50 Marks	

Prerequisites: Fundamentals of sensors and transducers, divider and bridge circuits, op-amp circuits in instrumentation.

Course Outcomes (COs): On completion of the course, the students will be able to:

1. Define the control objectives, input variables (manipulated and disturbance) and output variables and draw the process control loops.
2. Demonstrate the working of process loop components.
3. Understand the need of standard signals and Use DPT for level and flow measurement.
4. Determine the response of discontinuous and continuous (P, I, D, PI, PD and PID) control actions for standard input signals and estimate the PID controller parameters by using process reaction curve, Ziegler-Nichols and frequency response method for a given process.
5. Analyze characteristics of control valve, select and determine control valve size for gas, vapor and liquid services.
6. Demonstrate the working of control valve accessories and design a spring and diaphragm actuator.

Unit I: Fundamentals of Process Control (06)

Elements of process control loop: Control system evaluation, Concept of process variables, set point, controlled variable, manipulated variable, load variable.
Representation of Process loop components using standard symbols (basics with reference to control loop), and Examples of process loops like temperature, flow, level, pressure etc.
Process Characteristics: Process equation, capacity, self – regulation, disturbances, control lag, process lag, distance/velocity lag (dead time).

Unit II: Transmitters and convertors (07)

Need of transmitter (concept of field area and control room area), need for standardization of signals current, voltage and pressure signal standards, concept of live, dead zero, two and four wire transmitters.
Electronic Capacitive Differential Pressure Transmitter: Types, installation, calibration setup, application of DPT for level and flow measurement, zero elevation and suppression, manifold.
SMART: Comparison with conventional transmitter, block schematic, specifications.
Converters: Difference between converter and transmitter, current to pressure converter, pressure to current converter.

Unit III: Controller principles (08)

Control system parameters: Error, variable range, cycling, direct/reverse action.
Discontinuous: two position, multi-position and floating control modes.
Continuous: Proportional, integral, derivative, proportional-integral, proportional- derivative, proportional- integral-derivative (PID) control modes, reset windup, rate before reset, bumpless transfer.

Unit IV: Tuning of controller (07)

Tuning of controller: Different criteria like Quarter amplitude decay ratio, Loop disturbance, Optimum control, Measure of quality, Stability criteria.
Tuning Methods: Process reaction curve (open loop), Ziegler Nichols (closed loop), & Frequency response method.
Digital PID controllers: Velocity & Position algorithm, Block schematic, Faceplate of Digital controller, Introduction to Direct Digital Control.

Unit V: Control valves (07)

Necessity of final control elements.
Control valve terminology: Rangeability, turndown, viscosity index, valve capacity, distortion coefficient, AO, AC, fail-safe actions, cavitation, flashing and noise, their effects and remedies.
Control valve characteristics: Inherent and installed.
Control valve classification, constructions, advantages, disadvantages and applications of globe- Single seated, double seated, 3-way, diaphragm, rotary, angle, Gate, Needle, ball, butterfly.
Designing control valve for gas, vapor and liquid services: valve sizing by ANSI/ISA 75.01 std., high temperature-pressure service valves.

Unit VI: Control valve accessories and actuators (07)

Control valve accessories: Need of accessories, volume boosters, pressure boosters, solenoid valves, air lock, limit switches, hand wheel.
Positioners: Need, applications, types, effect on performance of control valve.
Actuators: construction, advantages, disadvantages and applications of spring and diaphragm, piston cylinder actuators and smart actuators. Design of a spring and diaphragm actuators.

List of Experiments :

Students are expected to perform minimum eight experiments:

1. Study of D.P. Transmitter and its application for flow measurement.
2. Measurement of level using DPT.
3. Study and Calibration of I/P converter
4. Study and Calibration of P/I converter
5. Study & verification of different control actions (P, I, D, PI, PD, PID) for step input.
6. Study of on-off control mode for temperature control process.
7. Tuning of PID controller for temperature/pressure control loop.

8. Tuning of PID controller for level/flow control loop.
9. Study of Control valve & plot installed characteristics of Control valve
10. Control valve design using any software package.

Text Books:

1. C. D. Johnson, "Process control and Instrument technology", Tata McGraw Hill Publications, 08th Ed.
2. N.A. Anderson, Boca Ratan, "Instrumentation for Process measurement and control", Radnor Pennsylvania, CRC Press, 03rd Ed..

Reference Books:

1. G. Liptak, "Process Control", Instrument Engineering Hand book CRC Press, 03rd Ed.
2. "Tuning of industrial control systems", ISA.
3. "Control valve Handbook", ISA.

206271: Signals and Systems

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	TW: 1
	End Semester Assessment: 70 Marks.	Total: 4 credits
	Term Work: 25 Marks	

Prerequisites: Basics of Mathematics and programming skills

Course Outcomes (COs): On completion of the course, the students will be able to:

1. Identify and represent the type of signals and systems and Perform elementary operations on signals.
2. Classify systems based on their properties
3. Understand fundamental properties of LTI systems and be able to determine response of the system for given input.
4. Determine Fourier series and Fourier transform of Continuous time signals and understand how to interpret and plot Fourier transform magnitude and phase functions
5. Analyse and design of an LTI systems using Fourier transform and Laplace transform..
6. Understand the concept of probability and statistical properties of signals.

Unit I : Introduction to Signals and Systems (08)

Introduction and Classification of signals: Definition of signal and systems, Continuous time and discrete time signal. Classification of signals: Even and Odd, Periodic and Non-periodic, Energy and Power, Deterministic and random signal. Basic Elementary Operations on signals: Amplitude scaling, addition, multiplication, subtraction, time scaling, time shifting and time folding. Transformations of the Independent Variable, Systems: Definition, Classification: linear and non-linear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable, invertible.

Unit II : Time domain representation of LTI System (07)

System modeling: Input-output relation of system, System interconnection, system properties, definition of impulse response, Continuous-Time LTI Systems: The Convolution Integral, Discrete-Time LTI Systems: The Convolution Sum.Properties of Linear Time-Invariant Systems, Causal LTI Systems Described by Differential and Difference Equations.

Unit III : Fourier Series (07)

Fourier Series Representation of Continuous-Time Periodic Signals, Convergence of the Fourier Series, Properties of Continuous-Time Fourier Series Dirichlet condition for existence of Fourier series, orthogonality, basis functions, Amplitude and phase response, Fourier Series and LTI Systems Properties and Applications of Fourier series.

Unit IV : Fourier transform (07)

Fourier Transform (FT) representation of Aperiodic CT signals, Dirichlet condition for existence of Fourier transform, evaluation of magnitude and phase response, FT of standard

CT signals, FT of standard periodic CT signals, Properties and their significance

Unit V : Laplace Transform (07)

Definition of Laplace Transform (LT), Limitations of Fourier transform and need of Laplace transform, ROC, Laplace transform of standard periodic and Aperiodic functions, properties of Laplace transform and their significance, Laplace transform evaluation using properties, Inverse Laplace transform based on partial fraction expansion, stability considerations in S-domain, Application of Laplace transform to the LTI system analysis.

Unit VI : Probability and Random Signals (06)

Probability: Experiment, sample space, event, probability, conditional probability and statistical independence. Random variables: Continuous and Discrete random variables, cumulative distributive function, Probability density function, properties of CDF and PDF. Statistical averages, mean, moments and expectations, standard deviation and variance, covariance, dispersion.

List of Experiments :

Students are expected to perform minimum eight experiments:

1. Write a Program to generate the basic signals
2. Write a Program to implement the Elementary operations on the given signals.
3. Write a Program to compute the Linear Convolution of the two given signals.
4. Write a Program to obtain the auto-correlation of sequence
5. Write a Program to obtain the cross-correlations of the given sequences.
6. Write a Program to obtain Fourier Series Coefficient.
7. Write a program to find Fourier transform of continuous time signals.
8. Write program to solve differential equation using Laplace Transform
9. Write program to compute Probability distribution function and cumulative distribution function.
10. Write program to compute of Mean, Moments, deviation and variance of signals.

Text Books:

1. Signals and Systems, A. Nagoor Kanni, Mc Graw Hill. 2nd Edition.
2. A Practical Approach to Signals and Systems, D Sundarrajan, Wiley Publishers, 1st edition
3. Signals and Systems , Ramesh Babu, Sci-Tech Publications, 2nd Edition.

References

1. Signals and Systems by Alan V. Oppenheim, Alan S. Willsky S. Hamid , 2nd Edition ,Prentice Hall Inc
2. Theory and Problems of Signals and Systems - SIE Hwei P. Hsu,, McGraw Hill, 2nd Editions.

206272: Data Structures

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	TW: 1
	End Semester Assessment: 70 Marks.	Total: 4 credits
	Term Work: 25 Marks	

Prerequisites: Basics of Python Programming.

Course Outcomes (COs): On completion of the course, the students will be able to:

1. Understand and comprehend the basics of python programming.
2. Test various operations of Array, Matrix and Lists
3. Implement various operations on Sets, Maps and Link Structures.
4. Demonstrate various operations on Stacks Ques.
5. Choose appropriate data structure for application

Unit I: Introduction to Python (07)

Getting Started**:** Introduction to Python- an interpreted high level language, interactive mode and script mode.

Variables, Expressions and Statements

Variables and Types-mutable and Immutable variable and Keywords. Operators and Operands in Python.(Arithmetic, relational and logical operators), Operator precedence , Expressions and Statements(Assignment statement); Taking input (using raw_input() and input()) and displaying output - print statement, Comments in Python.

Data Types

Unit II: Conditional Loop and Functions (07)

Conditional and Looping Construct

If - Else statement and nested if – else while, for, use of range function in for, Nested loops break, continue, pass statement, Use of compound expression in conditional constructs.,

data types- Tuples, Lists and Dictionary

Function:

Built-In Function, invoking built in functions, Module (Importing entire module or selected objects, using from statement), Functions from math, random, time & date module. Composition User Define Function : Defining , invoking functions, passing parameters *(default parameter values, keyword arguments)*Scope of variables, void functions and functions returning values

Data Types

Unit III: Array (07)

Basics of array, Array as abstract Data Type, Implementing Array: *ctypes* Module, Hardware Array, The Class Definitions

Two Dimensional Array: , implementation of 2 Dimensional array, Basic Operations: Element Access**.**

Matrix : Implementation of matrix, Matrix operation like addition, subtraction, scaling. Multiplication. Transpose.
Lists: Creating python list, Appending Items, extending A List, Inserting Items, Removing Items, List Slice.

Unit IV : Sets and Map (07)
Sets: Set Abstract Data Type(ADT), Selecting Data Structure, List Based Implementations: Adding Elements **,** Comparing two sets, The Set Union,
Maps: map Abstract Data Type, List based Implementations,

Multidimensional Arrays: MultiArray ADT, Data Organisation, Array Storage, Index Computation, Variable Length Arguments, Implementing MultiArray: Constructor, Dimensionality and Lengths, Element Access, Computing the Offset.

Unit V: Link Structures (06)
The Singly Linked List, Traversing the Nodes, Searching for a Node,
The Bag ADT : Linked List Implementation, Comparing Implementations, Linked List Iterators.
Ways to Build a Linked List: Using a Tail Reference : Appending Nodes, Removing Nodes, The Sorted Linked List: Linear Search, Inserting Nodes, Traversing and Deleting

Unit VI: Stacks and Queues (08)
The Stack ADT, Implementing the Stack: Using a Python List, Using a Linked List
Stack Applications: Balanced Delimiters, Evaluating Postfix Expressions, Converting from Infix to Postfix, Postfix Evaluation Algorithm,
Queues: The Queue ADT, Implementing the Queue: Using a Python List, Using a Circular Array, Queue Implementation, Using a Linked List.
Priority Queues: The Priority Queue ADT, Implementation: Unbounded Priority Queue: Python List Implementation, Linked List Implementation, Implementation: Bounded Priority Queue.

List of Experiments :
Students are expected to perform minimum eight experiments: **(Language Python) First two experiments are compulsory and should cover basic concepts of python programming for unit 1 and 2**

1. Write a program for unit conversion for physical parameters for temperature, pressure and flow.
2. Create a function of program written for unit conversion of each parameter.
3. Generate a array of some values and use function developed for unit conversion using array operations.
4. Write a program for bubble sort using Array
5. Write a program for operation of 2 dimensional Arrays.
6. Write a program for matrix operations.
7. Write program for various operations on list.

8. Write program for various operations on set.
9. Write program for various operations on Map
10. Write program for various operations on multidimensional array
11. Write program for various operations on BAG ADT
12. Write program for various operations on Linked List
13. Write program for various operations on Stack
14. Write program for various operations on Ques

Text Books:

1. Rance D. Necaise, Data Structures and Algorithms Using Python by, John Wiley and Sons. ISSN: 9788126562169
2. Reema Thareja, "Python Programming Using Problem Solving Approach", Oxford University Press, ISBN 13: 978-0-19-948017-6.
3. R. Nageswara Rao, "Core Python Programming", Dreamtech Press; Second edition ISBN-10: 938605230X, ISBN-13: 978-9386052308 ASIN: B07BFSR3LL

References

1. Narasimha Karumanchi, Data Structures And Algorithms Made Easy, Career Monk Publications
2. Y Daniel Liang, "Introduction to Programming using Python", Pearson.
3. Benjamin Baka, David Julian, "Python Data Structures and Algorithms", Packt Publishers,2017

206273: Project Based Learning

Teaching Scheme:	Examination Scheme:	Credits:
Practical: 4 Hrs/ Week	Term Work: 50 Marks	TW: 2
		Total: 2 credits

Preamble:

For better learning experience, along with traditional classroom teaching and laboratory learning; project based learning has been introduced with an objective to motivate students to learn by working in group cooperatively to solve a problem.

Project-based learning (PBL) is a student-centric pedagogy that involves a dynamic classroom approach in which it is believed that students acquire a deeper knowledge through active exploration of real-world challenges and problems. Students learn about a subject by working for an extended period of time to investigate and respond to a complex question, challenge, or problem. It is a style of active learning and inquiry-based learning. (Reference: Wikipedia). Problem based learning will also redefine the role of teacher as mentor in learning process. Along with communicating knowledge to students, often in a lecture setting, the teacher will also to act as an initiator and facilitator in the collaborative process of knowledge transfer and development.

Course Outcomes (COs): On completion of the course, the students will be able to:

1. Identify projects relevant to Instrumentation and Control systems
2. Use different electronic components and sensors/transducers to provide practical solution to real life problems.
3. Design/model/simulate/and fabricate a prototype
4. Designing and implementation of mini project which includes measurement of parameter signal processing, controlling, debugging related to objectives defined in the problem statement.
5. Prepare the project report

Group Structure:

Working in supervisor/mentor –monitored groups. The students plan, manage and complete a task/project/activity which addresses the stated problem.

- There should be team/group of 5 -6 students
- A supervisor/mentor teacher assigned to individual groups

Selection of Project/Problem

The problem-based project oriented model for learning is recommended. The model begins with the identifying of a problem, often growing out of a question or "wondering". This formulated problem then stands as the starting point for learning. Students design and analyze the problem within an articulated interdisciplinary or subject frame.

A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific and grows out of students' wondering within different disciplines and professional environments. A chosen problem has to be **exemplary**. The problem may involve an

interdisciplinary approach in both the analysis and solving phases.
By exemplarity, a problem needs to refer back to a particular practical, scientific, social and/or technical domain. The problem should stand as one specific example or manifestation of more general learning outcomes related to knowledge and/or modes of inquiry.
There are no commonly shared criteria for what constitutes an acceptable project. Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content and structure of the activity.

- A few hands-on activities that may or may not be multidisciplinary
- Use of technology in meaningful ways to help them investigate, collaborate, analyze, synthesize and present their learning.
- Activities may include- Solving real life problem, investigation /study and Writing reports of in depth study, field work.

Assessment:
The institution/head/mentor is committed to assessing and evaluating both student performance and program effectiveness.
Progress of PBL is monitored regularly on weekly basis. Weekly review of the work is necessary. During process of monitoring and continuous assessment AND evaluation the individual and team performance is to be measured. PBL is monitored and continuous assessment is done by supervisor /mentor and authorities.
Students must maintain an institutional culture of authentic collaboration, self-motivation, peer-learning and personal responsibility. The institution/department should support students in this regard through guidance/orientation programs and the provision of appropriate resources and services. Supervisor/mentor and Students must actively participate in assessment and evaluation processes.
Group may demonstrate their knowledge and skills by developing a public product and/or report and/or presentation.

- Individual assessment for each student (Understanding individual capacity, role and involvement in the project)
- Group assessment (roles defined, distribution of work, intra-team communication and togetherness)
- Documentation and presentation

Evaluation and Continuous Assessment:
It is recommended that the all activities are to be record and regularly, regular assessment of work to be done and proper documents are to be maintained at college end by both students as well as mentor (you may call it PBL work book).
Continuous Assessment Sheet (CAS) is to be maintained by all mentors/department and institutes.
Recommended parameters for assessment, evaluation and weightage:

- Idea Inception **(5%)**
- Outcomes of PBL/ Problem Solving Skills/ Solution provided/ Final product **(50%)** (Individual assessment and team assessment)
- Documentation (Gathering requirements, design & modeling, implementation/execution, use of technology and final report, other documents) **(25%)**

- Demonstration (Presentation, User Interface, Usability etc) **(10%)**
- Contest Participation/ publication **(5%)**
- Awareness /Consideration of -Environment/ Social /Ethics/ Safety measures/Legal aspects **(5%)**

PBL workbook will serve the purpose and facilitate the job of students, mentor and project coordinator. This workbook will reflect accountability, punctuality, technical writing ability and work flow of the work undertaken.

206274: Audit Course- II

In addition to credits course, it is recommended that there should be audit course (non-credit course) preferably in each semester from second year. The student will be awarded grade as AP on successful completion of audit course. The student have to opt for one of the audit courses per semester, starting in second year first semester. Such audit courses can help the student to get awareness of different issues which make impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in each semester is provided in curriculum. Each student has to choose one audit course from the list per semester. Evaluation of audit course will be done at institute level. Method of conduction and method of assessment for audit courses is suggested.

The student registered for audit course shall be awarded the grade AP and shall be included such grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself.

(Ref-http://www.unipune.ac.in/Syllabi_PDF/revised-2015/engineering/UG_RULE_REGULATIONS_FOR_CREDIT_SYSTEM-2015_18June.pdf)

Guidelines for Conduction (Any one or more of following but not limited to)

- Lectures/ Guest Lectures
- Visits (Social/Field) and reports
- Demonstrations
- Surveys
- Mini Project
- Hands on experience on specific focused topic
- Any relevant courses from NPTEL/ SWAYAM/ MOOCs/ ARPIT etc.

Guidelines for Assessment (Any one or more of following but not limited to)

- Written Test
- Demonstrations/ Practical Test
- Presentations
- IPR/Publication
- Report
- Assignments from NPTEL/ SWAYAM/ MOOCs/ ARPIT etc.

Audit courses suggested by BoS, Instrumentation Engineering:

1. Professional Ethics and Etiquettes
2. Intellectual Property Rights
3. Employability Skill Development
4. Foreign Language – Japanese /German Module 2