SAVITRIBAI PHULE PUNE UNIVERSITY

Syllabus

S. E. Instrumentation & Control

(2015 Course)

Faculty of Engineering

Board of Studies
Instrumentation & Control Engineering

(W.E. F. Academic Year. 2016-2017)

Savitribai Phule Pune University

Syllabus of S. E. Instrumentation & Control (2015 Course- Credit Base)

Semester- I

Course Code	Course	Teaching Scheme			Examination Scheme					Marks	Credits	
		Theory	Tut	Practical	Online Exam	End Sem Exam	PR	OR	TW		Theory + Tut	PR/ OR/ TW
207006	Engineering Mathematics- II	4	1	--	50	50	---	---	25	125	5	-
206261	Sensors & Transducers- I	4	--	2	50	50	50	---	---	150	4	1
206262	Basic Instrumentation	4	--	2	50	50	---	50	---	150	4	1
206263	Linear Integrated Circuits	4	--	2	50	50	50	---	---	150	4	1
206264	Network Theory	3	--	--	50	50	--	---	25	125	3	---
206265	Programming Languages	--	--	4	---	---	--	--	50	50	--	2
206266	Audit Course 1#	--	--	--	--	--	--	--	--	--	--	--
	Total	19	01	10	250	250	100	50	100	750	25	

Semester- II

Course Code	Course	Teaching Scheme			Examination Scheme					Marks	Credits	
		Theory	Tut	Practical	Online Exam	End Sem Exam	PR	OR	TW		Theory + Tut	PR/ OR/ TW
206267	Sensors & Transducers- II	4	--	2	50	50	50	---	---	150	4	1
206268	Automatic Control Systems	4	--	--	50	50	---	--	--	100	4	--
206269	Electronic Instrumentation	4	--	2	50	50	--	50	--	150	4	1
206270	Digital Techniques	4	--	2	50	50	50	---	---	150	4	1
206271	Industrial Drives	4	--	--	50	50	---	--	--	100	4	--
206272	Soft Skills	--	--	2	---	---	--	--	50	50	--	1
206273	Drives Control Laboratory**	--	--	2	--	--	--	--	50	50	--	1
206274	Audit Course 2#	--	--	--	--	--	--	--	--	--	--	--
	Total	20	--	10	250	250	100	50	100	750	25	

**** Drives and Control Laboratory: Practical's based on Automatic Control System and Industrial Drives should be conducted alternate week.**

 # Students can opt for any other audit course from the list of Audit Course of any branch of engineering

SEMESTER- I

[207206]- Engineering Mathematics- III

Teaching Scheme:
Lectures: 4 Hrs/ Week
Tutorial: 1 Hr/ Week

Examination Scheme:
Online Exam: 50 Marks
End Sem Exam: 50 Marks.
Term Work: 25 Marks

Total Marks: 125.
Credits: 5.

Pre requisites:

1. Differential and Integral Calculus .
2. Taylor series and Infinite series.
3. Differential equations of first order and first degree .
4. Fourier series, Vector algebra .
5. Algebra of complex numbers.

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Linear differential equations of higher order applicable to Control systems.
2. Transforms such as Laplace transform, Fourier transform, Z Transform and applications to Control systems and Signal processing Vector differentiation and integration required in Electro- Magnetics and Wave theory .
3. Complex functions, conformal mappings, contour integration applicable to Electrostatics, Digital filters, Signal and Image Processing.

Course Outcomes:

Upon successful completion of this course, the students will be able to :

1. Solve higher order linear differential equation using appropriate techniques for modelling and analysing electrical circuits .
2. Solve problems related to Laplace transform, Fourier transform, Z -Transform and applications to Signal processing and Control systems.
3. Perform vector differentiation and integration, analyse the vector fields and apply to Electro-Magnetic fields.
4. Analyse conformal mappings, transformations and perform contour integration of complex functions in the study of electrostatics and signal processing

Unit 01: Linear Differential Equations (LDE) and Applications: (9 Hrs)

LDE of nth order with constant coefficients, Method of variation of parameters, Cauchy's & Legendre's DE, Simultaneous & Symmetric simultaneous DE. Modeling of Electrical circuits

Unit 02: Laplace Transform (LT): (9 Hrs)

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 03: Fourier and Z – transforms: (9 Hrs)

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

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

Unit 04: Vector Differential Calculus: (9 Hrs)

Physical interpretation of Vector differentiation, Vector differential operator, Gradient, Divergence and Curl, Directional derivative, Solenoidal, Irrotational and Conservative fields, Scalar potential, Vector identities

Unit 05: Vector Integral Calculus and Applications : (9 Hrs)

Line, Surface and Volume integrals, Work-done, Green's Lemma, Gauss's Divergence theorem, Stoke's theorem. Applications to problems in Electro- magnetic fields

Unit 06: Complex Variables: (9 Hrs)

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

Text Books:

[T1] Erwin Kreyszig, "Advanced Engineering Mathematics", 9e,(Wiley India).
[T2] Peter V. O'Neil, "2. Advanced Engineering Mathematics", 7e,(Cengage Learning)

Reference Books:

[R1] M. D. Greenberg, "Advanced Engineering Mathematics", 2e, Pearson Education.
[R2] Wylie C.R. & Barrett L.C. "Advanced Engineering Mathematics", McGraw -Hill, Inc.
[R3] B. S. Grewal, "Higher Engineering Mathematics", Khanna Publication, Delhi.
[R4] P. N. Wartikar & J. N. Wartikar, "Applied Mathematics (Volumes I and II)", Pune Vidyarthi Griha Prakashan, Pune.
[R5] B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw -Hill.
[R6] Thomas L. Harman, James Dabney and Norman Richert, "Advanced Engineering Mathematics with MATLAB", 2e, Brooks/Cole, Thomson Learning.

Guidelines for Tutorial and Term Work:

1. Tutorial shall be engaged in four batches (batch size of 20 students maximum) per division.
2. Term work shall be based on continuous assessment of six assignments (one per each unit) and performance in internal tests

[206261]- Sensors & Transducers- I

Teaching Scheme:	**Examination Scheme:**	**Total Marks:** 150.
Lectures: 4 Hrs/ Week	Online Exam: 50 Marks	**Total Credits:** 5
Practical: 2 Hrs/ Week	End Sem Exam: 50 Marks.	Theory= 4
	Practical Exam: 50 Marks	Practical=1

Prerequisites: Basics of sensing elements, bridges and basic electronics

Course Objectives:

1. To Understand basic principles of sensing various parameters
2. To Develop mathematical background of sensor design
3. To Learn selection of sensors for typical applications

Course Outcomes:

On completion of the course, learner will be able to–

1. Identify, formulate and solve a problem of Instrumentation and Control Engineering
2. Ability to design and conduct experiments for measurement.
3. Demonstrate an understanding of sensors and transducers.

Unit-I : Introduction

Measurement and measurement system, industrial measuring parameters and their units, definitions of sensors and transducers, classification of transducers, static and dynamic characteristics, selection criteria, importance.

Unit-II : Displacement Measurement

Resistive: Potentiometer, Strain gauges, Inductive: LVDT and Eddy current type , Capacitive: Capacitance pickups, Differential capacitive type, Piezoelectric, Ultrasonic transducers and Hall effect transducers, Optical transducers.

Unit-III : Velocity, Speed, Vibration and Acceleration measurement

Velocity and Speed: Electromagnetic tachometer, Photoelectric tachometer, Toothed rotor variable reluctance tachometer. Magnetic pickups, Encoders, Photoelectric pickups, Stroboscopes, Shaft speed measurement.

Vibration and acceleration: Eddy current type, piezoelectric type, Seismic Transducer, Accelerometer: Potentiometric type, LVDT type, Piezo-electric type.

Unit-IV : Force and torque measurement

Basic methods of force measurement, elastic force traducers, strain gauge, load cells, piezoelectric force transducers, vibrating wire force transducers, Strain gauge torque meter, Inductive torque meter, Magnetostrictive transducers, torsion bar dynamometer, etc. Dynamometer (servo control and absorption) instantaneous power measurement and alternator power measurement.

Unit-V : Pressure measurement

Definition, pressure scale, standards, working principle, types, materials, design criterion: Manometers, elastic pressure sensors, secondary pressure sensors, differential pressure sensors, force balance type, motion balance

type, capacitive (delta cell), ring balance, vibrating cylinder type, high-pressure gauges, vacuum gauges, dead weight and vacuum gauge tester.

Unit-VI : Temperature measurement

Temperature Scales, Standards and Units and relations, Classification of temperature sensors Bimetallic Thermometer, Filled system thermometers, SAMA classifications, Resistance Temperature Detectors (RTD), Thermistor, Thermocouples, Study of thermocouple tables (calculation of intermediate temperature and voltage), Lead wire compensation, Cold junction compensation techniques, Protection (Thermo well), Thermopiles, Pyrometers, Temperature IC sensors (AD590 and LM35).

Suggested List of Experiments: (Any eight)

1. Measurement of displacement using LVDT.
2. Measurement of displacement using linear and rotary encoder.
3. Measurement of speed using tachometer.
4. Measurement of weight using strain gauge load cell.
5. Measurement of Pressure using manometer.
6. Calibration of pressure gauge using dead weight pressure tester
7. Measurement of Pressure using Bellows, Bourdon gauge, Diaphragm.
8. Calibration of vacuum gauge using vacuum gauge tester.
9. Characterization of Thermocouples (J/T/K/R/S)
10. Characterization of RTD (PT100)
11. Measurement of temperature using IC sensors (AD590 and LM35).

Text Books:

1. B. C. Nakra and K. K. Choudhari, “Instrumentation Measurements and Analysis”, Tata McGraw Hill Education.
2. D. Patranabis, “Principle of Industrial Instrumentation”, Tata McGraw Hill.
3. D.V.S. Murty, “Instrumentation and Measurement Principles”, PHI, New Delhi.

Reference:

1. E.O. Doebelin, “Measurement Systems”, McGraw Hill.
2. B.G. Liptak, “Process Measurement & Analysis”, Chilton Book Company.
3. Andrew Parr, “Industrial Control hand book”, Newnes Industrial Press.
4. C. S. Rangan, G. R. Sharma and V. S. Mani, ‘Instrumentation Devices and Systems’, Tata McGraw-Hill Publishing Company Ltd., New Delhi.

[206262]- Basic Instrumentation

Teaching Scheme:	**Examination Scheme:**	**Total Marks:** 150.
Lectures: 4 Hrs/ Week	Online Exam: 50 Marks	**Total Credits:** 5
Practical: 2 Hrs/ Week	End Sem Exam: 50 Marks.	Theory= 4
	Oral Exam: 50 Marks	Oral =1

Prerequisites: Elements of Electrical Engineering

Course Objectives:

1. To introduce the fundamentals of electrical measurements and instrumentation
2. To explain the working principle of analog and digital instruments for various quantities.
3. To study different bridge circuits used for measurement of electrical parameters such as R, L, C.
4. To learn the operation of Oscilloscope, Signal Generator, Digital instruments and Recorders
5. To introduce Virtual Instrumentation and its applications

Course Outcomes:

The students will be able to:

1. Explain the fundamentals of measurements and instrumentation system
2. Select proper instrument with appropriate characteristics for given application
3. Apply the fundamentals for various applications and instrument design
4. Calibrate and monitor a variety of electronic instruments

Unit I: Fundamentals of measurement

Need of Instrumentation, General Instrumentation System, Static and Dynamic characteristics of instruments, input & output impedance, loading effects of series and shunt connected instruments, Fundamentals of measurements, Types of Errors, Statistical Analysis, Probability of Errors, Limiting Errors, Calibration of instruments, calibration report & certification, traceability and traceability chart

Unit II: Analog Indicating Instruments

DC galvanometer, PMMC and Moving Iron instruments, voltmeters, ammeters, ohmmeters and extension of range of instruments, AC indicating instruments: EDM type instruments, EDM Wattmeter (single phase) and errors present,

1 Φ induction type energy meter, Potential and current transformers,

DC Potentiometers, standardization, applications of DC potentiometer

Unit III: Bridge Circuits

DC bridges: Wheatstone bridge and Kelvin bridge design, bridge sensitivity, errors in bridge circuits, null type and deflection type bridges, current sensitive and voltage sensitive bridges, applications of DC bridges

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

Unit IV: Oscilloscope

Introduction, General purpose oscilloscope Block Diagram, Cathode Ray Tube, Vertical Deflection System,

Horizontal Deflection System, deflection sensitivity, front panel controls, Delay Line, Oscilloscope Probes, Dual trace CRO,
ALT and CHOP modes, measurement of electrical parameters like voltage, current, frequency, phase, Z-modulation, Digital Storage oscilloscope, sampling rate and bandwidth, roll mode, applications like pre-trigger, post-trigger, zoom and restart

Unit V: Digital Instruments

Introduction to digital instruments, Advantages of Digital instruments over Analog instruments

Block diagram, principle of operation, Accuracy of measurement:

Digital Multimeter, Kilo Watt Hour meter, Digital Tachometer, Ultrasonic Distance meter, Digital Thermometer, Digital pH meter, Digital capacitance meter

Unit VI: Recording Instruments and Waveform Generation

Classification of recorders, Principle and working of strip chart and X-Y recorders, single and multi-channel recorders, driving systems for pen and chart, applications of recorders,
Waveform generation methods, Function generator,
Introduction to Virtual Instrumentation

Suggested List of Experiments (Students are expected to perform minimum 8 experiments.)

1. Loading effect of shunt or series connected instrument.
2. Design of multirange ammeter and voltmeter, conversion of ammeter into voltmeter
3. Design of series and shunt type ohmmeter
4. Design of Wheatstone's Bridge
5. Design of AC Bridge. (Schering bridge is preferred)
6. Measurement of unknown voltage using D.C. potentiometer.
7. Measurement of power using wattmeter (Single phase)
8. Measurement of power using Energy meter (Single phase.)
9. Measurement of voltage, Frequency and phase using CRO
10. To measure the unknown frequency by Z-Modulation
11. To measure response time of a relay using DSO
12. Study of y-t, X-Y recorders, frequency response of y-t recorder
13. Introduction to VI (NI LabVIEW software)

Text and reference books:

1. Sawhney A. K., Electrical and Electronics Measurements and Instruments
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,
4. Anand M. M. S., *'Electronic Instruments and Instrumentation Technology',* PHI, 2004
5. Kalsi H. S., '*Electronic Instrumentation',* TMH, 2nd or 3rd e/d, 2004/2010
6. R. Subburaj, *'The foundation for ISO 9000 and TQM',*.
7. Bouwens A. J., *'Digital Instrumentation'*

[206263]- Linear Integrated Circuits

Teaching Scheme:	**Examination Scheme:**	**Total Marks:** 150.
Lectures: 4 Hrs/ Week	Online Exam: 50 Marks	**Total Credits:** 5
Practical: 2 Hrs/ Week	End Sem Exam: 50 Marks.	Theory= 4
	Practical Exam: 50 Marks	Practical =1

Prerequisites: Elements of Electronics Engineering

Course Objectives:

1. To illustrate the concepts of the basic characteristics, construction, open loop & close loop operations of Operational-Amplifier(Op-asmp),
2. To enable students to analyze and design different linear and non-linear circuits using Op- amp,
3. To enable students to demonstrate Electronic Circuits for Multivibrator and Voltage regulator using special purpose ICs,
4. To illustrate types of filter, their applications and enable students to implement active filter circuits.

Course Outcomes:

1. Student will be able to illustrate AC and DC characteristics of operational amplifier and their significance in selection of Op-amp,
2. Student will be able to apply different configurations of op-amp,
3. Student will be able to design and implement linear, non-linear Op-Amp circuits and different electronic circuits using Specialized ICs,
4. Student will be able to analyse and interpret the designed, implemented data.

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

Block diagram of Operational amplifier, Noise in Op-amp, types of Noise(definitions of Shot noise, Thermal noise, Flicker noise, Burst noise, Avalanche noise, Noise colors), Introduction to Open and Closed Loop configurations of Op-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).

Unit II: Effect of Feedback in Op- Amplifier:

Introduction to feedback amplifiers,

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 simplifier with feedback): deriving close loop gain, input impedance, output impedance and bandwidth; Inverter circuit,

Differential amplifier with one op-amp: deriving close loop gain.

Unit III: Linear applications of Op- amplifier with practical considerations:

Voltage summing with average, Voltage substracter, Current booster, Integrator, and practical integrator, Differentiator and practical differentiator, Instrumentation amplifier with three Op-amps, Current to Voltage converter, voltage to current converter (grounded and floating load), Isolation amplifiers, chopper stabilized amplifiers, Equation solving with Op-amp.

Unit IV: Non linear applications with practical considerations:
Comparator and its characteristics, Study of IC-LM311, Zero Crossing Detector (ZCD) and its use, Schmitt trigger with external bias, window detector, 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 Voltage regulators:
Design and applications of Multivibrators: Astable, Monostable (Re-triggerable and Non- retriggerable), Bi-stable using IC- LM555;
Voltage 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), Basics of switching regulator, Voltage and current waveforms, basics of step-down (Buck) switching regulator.

Unit VI: Active filters:
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 filter and BP filter), Difference between active and passive filters and their merits and demerits. Filter terminology: Pass band, Stop band, cut off, Ripple, Q and order of the filter.

Suggested List of experiments:
Any eight experiments should be performed from following list:

1. Band width measurement of inverting and no inverting amplifier.
2. Measurement of CMRR, Slew rate and output offset voltage.
3. Designing and implementation of Instrumentation amplifier using IC LM324.
4. Designing and implementation of Integrator.
5. Designing and implementation of Differentiator.
6. Designing and implementation of Wien bridge oscillator.
7. Designing and implementation of Comparator, Schmitt trigger and Zero Crossing Detector.
8. Designing and implementation of Astable and Monostable multivibrator using LM555.
9. Voltage regulators: linear variable regulator LM723.
10. Measurement of performance of 78xx regulator.
11. Butterworth filter design and realization of first/second order Band Pass Filter.

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.

[206264]- Network Theory

Teaching Scheme:	**Examination Scheme:**	**Total Marks:** 125.
Lectures: 3 Hrs/ Week	Online Exam: 50 Marks	**Total Credits:** 3
	End Sem Exam: 50 Marks.	Theory= 3
	Term Work: 25 Marks	

Prerequisites: Fundamentals of Electrical engineering and Mathematics

Course Objectives:

1. To study and learn the initial conditions and differential equations of RLC networks.
2. To study Network Theorems, Network functions, filters, attenuators.
3. To study the different parameters to design Network.

Unit I: Methods of analysing the circuits

Kirchoff's Current (KCL) and Voltage Laws (KVL), Network analysis by Mesh, Node, Differential equations, initial conditions, Source transformation and source shifting. Star delta networks and transformations. Phasor diagram for RL, RC, and RLC circuits. Power relation in AC circuits

Unit II: Network Theorems

Network Theorems: Superposition, Thevenin's, Norton, Maximum Power Transfer, Reciprocity, Substitution, Miller, Tellegen

Unit III: Network functions

Driving point impedance and admittance, Transfer impedance and admittance, Voltage and current Transfer ratio, Concept of pole-zeros in network function, Necessary conditions for Driving point and transfer functions, Open and short circuit natural frequencies, Routh-Hurwitz criteria for stability of Network functions.

Unit IV: Two-Port parameters

Z, Y, H, ABCD Parameters, Interrelationship between parameters, reciprocity and symmetry conditions, parallel connection of two port networks, Analysis of common two ports.

Unit V: Network Synthesis

Realizability of one port network, Hurwitz property, positive realness, properties of positive real functions, Synthesis of R-L, R-C and L-C driving point functions, Foster and Cauer forms

Unit VI: Filters and attenuators

Filters: Fundamentals of filters, types of filters- low pass, high pass, band pass and band elimination filters, Constant K-filters.

Attenuators: Symmetric and asymmetric attenuators, T-attenuators, π-attenuators

Suggested List of Tutorials:

1. Using KCL,KVL, node, loop analysis and circuit simplification techniques
   Determine the currents through various given branches and voltages across the given branches. (One example each)
2. Formulate the differential equations and initial conditions

3. Determine the current through the various branches and voltages across the various branches using Network Theorems. (One problem on each theorem.)
4. Find the network functions. (Solve one problem for each)
5. Formulate Z, Y, h, ABCD Parameters, Interrelationship between parameters, reciprocity and symmetry conditions.
6. Solve one problem on Routh-Hurwitz criteria for stability of Network functions
7. Analyse the response of every filter and attenuator.

Text Books

1. D Roy Choudhury, Networks and Systems, New Age International Publishers
2. Smarajit Ghosh, Network Theory analysis and Synthesis, Prentice Hall of India Pvt. Ltd. , New Delhi
3. A Sudhakar, ShyammohanPalli, Circuits and Network Circuits Analysis and Synthesis

Reference Books

1. John D. Ryder, Network Lines and Fields by, PHI
2. M. E. Van Valkenburg, Network Analysis, PHI / Pearson Education, 3rd Edition. Reprint 2002
3. Franklin F. Kuo, Network analysis and Synthesis, , Wiley International Edition
4. V. K. Atre, Network Theory and Filter Design, 2nd edition. Wiley Estern Ltd. 1090

[206265]- Programming Languages

Teaching Scheme:	**Examination Scheme:**	**Total Marks:** 50.
Practical: 4 Hrs/ Week	Term Work: 50 Marks	**Total Credits:** 2
		Practical= 2

Prerequisite:

Writing algorithm and flow charts, Basic programming in C, conditional and arithmetic operators in C, input/output functions in C, various loops in C like if, for, while, do-while and switch case, basics of arrays.

Course Objectives:

1. To study the use of strings, arrays, functions, pointers and structures in C language.
2. To be able to use graphics mode in C language.
3. To possess the ability to design simple algorithms for solving computing problems.

Course Outcomes:

Students will be able to,

1. Apply appropriate technique using C language for solving computing problems.
2. Think critically and solve problems independently.
3. Use the graphics commands in C language for solving application based problem statements.

Suggested List of Experiments:

(All the experiments are compulsory)

1. 4-5 Assignments to revise the per-requisites.
2. Program for a simple calculator with the basic 4 operations using C.
3. Program for Linear & Binary Search methods using Arrays and functions in C.
4. Program for addition and multiplication of matrices in C.
5. Program for any 3 Sorting methods using Arrays and Functions in C.
6. Implementation of stack using arrays.
7. Implementation of Queue using arrays.
8. Program for polynomial addition using array of structure.
9. Program for database management using array of structure in C.
10. Program for any 2 code conversions in C (for eg: binary to decimal, decimal to binary, hex to decimal, decimal to hex).
11. Any one assignment involving graphics commands in C (for eg: various stages of moon, filling of tank).

Text Books:

1. Let us C by Yashwant Kanetkar
2. Programming in C by Denis Ritchie

Reference Books:

1. E Balgurusamy - Programming in ANSI C, Tata McGraw-Hill (Third Edition)

[206266]- 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 may opt for one of the audit courses per semester, starting in second year first semester. Though not mandatory, 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 and Assessment (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

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

- Written Test
- Demonstrations/ Practical Test
- Presentations
- IPR/Publication
- Report

Students can opt for any other audit course from the list of Audit Course of any branch of engineering.

SEMESTER- II

[206267]- Sensors & Transducers- II

Teaching Scheme:	**Examination Scheme:**	**Total Marks:** 150.
Lectures: 4 Hrs/ Week	Online Exam: 50 Marks	**Total Credits:** 5
Practical: 2 Hrs/ Week	End Sem Exam: 50 Marks.	Theory= 4
	Practical Exam: 50 Marks	Practical=1

Prerequisites:
Basics of sensing elements, bridges and basic electronics and Sensors and Transducer 1

Course Objectives:
1. To Understand basic principles of sensing various parameters
2. To Develop mathematical background of sensor design
3. To Learn selection of sensors for typical applications

Course Outcomes:
On completion of the course, learner will be able to–
1. Identify, formulate and solve a problem of Instrumentation and Control Engineering
2. Ability to design and conduct experiments for measurement.
3. Demonstrate an understanding of sensors and transducers

Unit-I : Flow Measurement
Units, Newtonian and non-Newtonian Fluids, Reynolds number, Laminar and turbulent flows, Velocity profile, Bernoulli's equation for incompressible flow, Density, Beta ratio, Reynolds number correction, Square root relation, Head type flow meters, Variable area type, Open channel flow measurement, Turbine , Electromagnetic , Ultrasonic , Vortex shedding, Positive displacement, Anemometers , Mass flow meters.

Unit-II : Level Measurement
Float, Displacer (Torque tube unit), Bubbler, Diaphragm box, DP cell, Ultrasonic, Capacitive, radioactive type, laser type transducers, level gages, resistance, thermal, radar, time domain reflectometry (TDR) / phase difference sensor (PDS), solid level detectors, fiber optic level detectors, Level switch.

Unit-III : Viscosity and Density Measurement
Viscosity: Saybolt, Searle's rotating cylinder, Cone and plate, Falling and rolling ball, Rotameter. **Density Measurement:** Chain-balanced float type, Hydrometer (Buoyancy type), U tube type, Hydrostatic Head (Air bubbler, DP Cell), Oscillating Coriolis, Float displacers, bubbler, and DP- cell, ultrasonic, capacitive.

Unit-IV : Miscellaneous Sensors
Leak detector, Flame detector, Smoke detector, Photo detectors, pH sensors, Conductivity sensors, Humidity sensors, Sound sensors, and Proximity sensors.

Unit-V : Sensor signal conditioning devices
Introduction, signal level and bias changes, linearization, conversion, filtering and impedance matching, concept of loading, divider circuits, bridge circuits, lead compensation, , excitation techniques (constant power, current, bridge), filters (low pass, high pass), Boolean algebra, Converters (comparators, DAC, ADC), Readout/

meter.

Unit-VI : Design of signal conditioning circuit

Thermocouple, RTD, Thermister, load cell, potentiometric sensors, Capacitive level sensor, LVDT, Optical sensors (LDR, photodiode, photo transistor, photo cell).

List of Experiments: (Total 06): Any three of the following

1. Measurement of flow Orifice and Venturi.
2. Calibration of Rotameter.
3. Measurement of flow using DP cell
4. Level measurement using capacitive/ resistive/ air purge method.
5. Measurement of pH / Conductivity.
6. Measurement of Viscosity / Density.
7. Study of Proximity sensors. (03 types)

Any three of the following

8. Design and implementation of temperature indicator using thermocouple with cold junction compensation technique
9. Design and implementation of temperature indicator using RTD.
10. Design and implementation of signal conditioning circuit for weighing machine using load cell
11. Design and implementation of signal conditioning circuit for liquid level indicator using electromechanical system.
12. Design and implementation of digital control logic for process using electronic hardware/ software.
13. Design and implementation of through beam / reflected beam type optical proximity sensors.

Text Books:

1. D. Patranabis, “Principle of Industrial Instrumentation”, Tata McGraw Hill.
2. B. C. Nakra and K. K. Choudhari, “Instrumentation Measurements and Analysis”, Tata McGraw Hill Education.
3. Curtis D. Johnson, “Process control instrumentation technology” , PHI learning Pvt. Ltd.
4. D.V.S. Murty, “Instrumentation and Measurement Principles”, PHI, New Delhi.

Reference Books:

1. C. S. Rangan, G. R. Sharma and V. S. Mani, ‘Instrumentation Devices and Systems’, Tata McGraw-Hill Publishing Company Ltd.
2. E.O. Doebelin, “Measurement Systems”, McGraw Hill.
3. B.G. Liptak, “Process Measurement & Analysis”, Chilton Book Company.
4. Andrew Parr, “Industrial Control hand book”, 3rd ed., Newnes Industrial Press.
5. R. K. Jain, Mechanical and Industrial Measurements, Khanna Publishers.

[206268]- Automatic Control Systems

Teaching Scheme:	**Examination Scheme:**	**Total Marks:** 100.
Lectures: 4 Hrs/ Week	Online Exam: 50 Marks	**Total Credits:** 4
	End Sem Exam: 50 Marks.	Theory= 4

Prerequisites: Concepts of Network theory and Mathematics

Course Objectives:

1. Understand the basic components of control system, types of control systems.
2. Learn to determine relationship between system input / output.
3. Learn to develop system's mathematical models.
4. To understand the basic mathematical tools for analysis of the control systems

Course Outcomes:

By the end of this course, students should be able to

1. Classify the control systems.
2. Develop mathematical models of control systems.
3. Analyze the Linear time invariant system in time and frequency domain.
4. Get familiar with modern control theory.

Unit-I: Introduction to Control Systems

Introduction, brief classification of control systems: Representation of: Electrical, mechanical, electromechanical, thermal, pneumatic, hydraulic systems, with differential equations. Concept of transfer function.

Unit-II: Transfer function, block diagram algebra and signal flow graph Representation of transfer function of electrical, mechanical with force to voltage and force to current analogies. Block diagram algebra, Signal flow graph

Unit-III: **Time domain analysis of control systems**

Standard test signals, first order, second order systems and their response, Time domain specifications of first order and second order control systems, derivations of time domain specifications. Static error constants (kp, kv, ka, ess), dynamic error constants.

Unit-IV: **Stability Analysis**

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, Evan's conditions for magnitude and angle, construction rules, determination of system gain at any point on root locus (from magnitude condition and by graphical method), Root locus of systems with dead time: Concept, approximation of dead time and construction rules

Unit-V: **Frequency Domain Analysis**

Fundamentals of frequency response, Bode plot, with and without dead time, determination of transfer function from asymptotic Bode plot, Polar plot, Nyquist plot

Unit-VI: **Introduction to State Space**

Terminology of state space (state, state variables, state equations, state space), state space representation. Advantages of state space representation over classical representation. Representation of state models: direct (companion I and II *i.e.* controllable canonical and observable canonical forms), parallel and cascade decomposition

Text Books

1. I. J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers.
2. B. S. Manke, "Linear Control Systems", Khanna Publishers, New Delhi.
3. A. K. Jairath, "Problems and Solutions of Control Systems", CBS Publishes, New Delhi.

Reference:

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

[206269]- Electronic Instrumentation

Teaching Scheme:	**Examination Scheme:**	**Total Marks:** 150.
Lectures: 4 Hrs/ Week	Online Exam: 50 Marks	**Total Credits:** 5
Practical: 2 Hrs/ Week	End Sem Exam: 50 Marks.	Theory= 4
	Oral Exam: 50 Marks	Oral =1

Prerequisites: Basics of Electronics and Linear Integrated Circuits

Course Objectives:

1. To course intends provide an overview and understand the internal structure of all laboratory Measuring Instruments, Signal Generators, Testing instruments, Signal Conversion techniques, Modulations and Signal Analyzers.
2. To introduce the theory and applications of popular integrated circuit applications like Analog Multiplexer-DE multiplexer, VCO, PLL, VTF and FTV.
3. To teach the theory of different types ADCs and DACs.
4. To understand different analog and digital modulation methods and understanding of major building blocks of data communication system.
5. To learn importance of LabVIEW software in simulations and some hardwares for real time implementation of applications

Course Outcomes:

1. Be able to analyze the operation of different types of measuring instruments like True-RMS Meter, DMM, RLC-Q meter, Distortion Factor Meter, Universal Counter and know the working of measuring instruments.
2. Be able to analyze the operation of different types of signal generating instruments like Arbitrary Waveform Generator, Ramp wave Generator, Pulse Generator. Know the working of signal generating instruments.
3. Know the complete internal structure of ADCs and DACs. Perform the experiments, analysis on ADC and DAC ICs.
4. In the LCR circuit student can determine experimentally the unknown inductance, capacitance and resistance and Q and D factor with the instruments with which he can know the different options and strengths of the instruments.
5. Further to know the knowledge in the field of integrated circuit technology and its applications like PLL, VCO, Analog MUX/DEMUX, VTF and FTV.
6. Students can understand and Analyze the types of modulations, Demonstrate about various blocks in Transmitters and Receivers, Analyse all Modulation techniques in time and frequency domains.
7. An ability to built, implement software programming using Labview to solve engineering problems.

Unit I: **Measuring Instruments**:

RMS concept and True RMS Meter, Automation in Digital Voltmeter, Digital LCR-Q Meter, Concept of frequency measurement and Universal Counter and Its Mode like Frequency, Totalizing, Period, Time Interval, Ratio, Measurement Errors in counter.

Unit II: Generators and semiconductor Testing Instrumentation:

Ramp Wave generator, Pulse generator, Frequency synthesis, Direct Digital Synthesis, Arbitrary Waveform

Generator, ATE, Semiconductor test instrumentation (PMU).

Unit III: Signal Convertors

Analog Multiplexer/Demultiplexer IC CD 4051, VCO IC LM 566, PLL IC LM 565, V to F and F to V IC LM331, V to I (using Op-Amp) with zero and span adjustment, I to V (using Op-Amp) with zero and span adjustment circuits.

Unit IV: ADCs and DACs

Sampling Theorem, Sample and Hold Circuit, ADC types like Flash, Counter, SAR and Dual-Slope, ADC Specifications, ADC Numerical, DAC types like Weighted-Resistor and R-2R ladder, DAC Specifications, DAC Numerical.

Unit V: Data Transmission:

Telemetry for process/bio data, Methods like AM, FM, PCM, ASK, FSK, Time Division and Frequency Division Multiplexing, Virtual Instrumentation: LabVIEW Software and Hardware, LabVIEW Application in Process/Biomedical or Electronic Instrumentation.

Unit VI: Signal Analyzers:

Distortion Analyzer, Spectrum Analyzers, Wave analyzers, FFT Analyzer, Logic Analyzer.

Suggested List of Experiments:

Students are expected to perform Minimum **8** Experiments**:**

1. Study and verify different modes of Universal Counter.
2. Study design and implementation of Ramp Waveform Generator using IC 555.
3. Study design and implementation of Pulse Wave Generator or PWM using IC 555 or IC 741 as an astable and monostable combination.
4. Study of Arbitrary Waveform Generator.
5. Study and perform Analog Multiplexing/Demultiplexing using IC CD4051.
6. Study, design and implement VCO to determine free running frequency (F_0) using IC LM 566.
7. Study, design and perform PLL to determine F_0, lock range (F_L) and capture range (F_C) using IC NE 565.
8. Study and implementation of ADC IC 0809 or Equivalent.
9. Study and implementation of DAC IC 0808 or Equivalent.
10. Study of Distortion Factor Meter **OR** Logic Analyzer **OR** FFT Analyzer.
11. Develop LabVIEW based application such as Spectrum Analyzer using DAQ/ or simulation or similar application.
12. Study and verification of different modulation techniques.
13. Study and design of V to Fconverter using LM331.
14. Study and design of F to V converter using LM331.
15. Study and design application of audio power amplifier using LM380/ or any suitable IC. (extra practical, not in syllabus, refer Ramakant Gayakwad).
16. Study and design application of audio function generator using 8038. (extra practical, not in syllabus, refer Ramakant Gayakwad)

Text Books:

1. Modern Electronic Instrumentation and Measurement Techniques by Helfrick and Cooper, PHI

2. Digital Instrumentation by A. J. Bowen
3. Electronic Instrumentation Handbook by Coombs.
4. Electronic Instrumentation by Oliver Cage, McGraw Hill.
5. Electronic Instruments and Instrumentation Technology by Anand M. M. S., PHI
6. Op-Amps and Linear Integrated Circuits by Ramakant Gaikwad, 4th edition.
7. Operational Amplifiers with Linear Integrated Circuits by William Stanley, 4th edition, Pearson Education.

Reference Books:

1. Electrical and Electronic Measurements and Instrumentation by David A. Bell, Prentice Hall of India.
2. Electrical and Electronics Measurement and Instrumentation by A.K. Sawhney, Dhanpat Rai & Co.
3. Electronic Instrumentation by J. J. Carr.
4. Electronic Instrumentation by H. S. Kalsi, McGraw Hill.

[206270]- Digital Techniques

Teaching Scheme:	**Examination Scheme:**	**Total Marks:** 150.
Lectures: 4 Hrs/ Week	Online Exam: 50 Marks	**Total Credits:** 5
Practical: 2 Hrs/ Week	End Sem Exam: 50 Marks.	Theory= 4
	Practical Exam: 50 Marks	Practical =1

Prerequisites: Basics of Transistor theory and Digital Electronics

Course Objectives:

1. Tolearn and understand basic digital design techniques.
2. Tolearn and understand design and construction of combinational and sequential circuits.
3. Tolay the foundation for further studies in embedded systems, VLSI, computer, micro-processor etc.

Course Outcomes:

1. To represent numerical values in various number systems and perform number conversions between different number systems.
2. Understand the basic logic gates and various variable reduction techniques of digital logic circuit.
3. Analyze, design and develop combinational and sequential digital circuits.
4. Understand operation of basic types of flip-flops, registers, counters, decoders, encoders, multiplexers, and de-multiplexers.

Unit I: Number system, Codes & Boolean algebra

Introduction: Binary, octal, decimal, hexadecimal numbers, number conversion and their arithmetic.
Signed Binary number representation: Sign magnitude, 1's complementand2'scomplementrepresentation.
Binary, Octal, Hexadecimal Arithmetic:2's complement arithmetic.
Codes:BCD,Excess-3,Graycode,Errordetecting&correctingcodes,ASCIIcode, code conversions, BCD Arithmetic.
Boolean algebra: Truth tables and Boolean algebra. Idealized logic gates and symbols. DeMorgan's rules ,Axiomatic definition of Boolean algebra, Basic theorems and properties of Boolean algebra

Unit II: Logic circuit minimization techniques & Logic Families

Logic minimization: Representation of truth-table, SOP form, POS form, simplification of logical functions, minimization of SOP and POS forms, Don't care Condition.
Reduction techniques: K-Maps up to 4 variables and Quine-McClusky technique.
Logic Families: Standard characteristics: speed, power dissipation, fan-in, fan-out, current and voltage parameters, noise margin, and operating temperature.
ECL, NMOS, PMOS families: Basic circuits, standard characteristics.
TTL: Standard TTL characteristics, operation of TTL NAND gate. TTL configurations- active pull-up, wired AND, totem pole, open collector.
CMOS: CMOS Inverter, CMOS characteristics, CMOS configurations-Wired Logic, Open drain output
Detail comparison of TTL&CMOS
Interfacing: TTL to CMOS and CMOS to TTL, Tri state logic

Unit III: Combinational Logic

Circuits: - Half- adder, full adder, half subtractor, full subtractor, BCD adder, look ahead and carry, parity

generator and checker , magnitude comparator, code convertors
Decoders-Working of decoder, implementation of expression using decoders, IC 74138, BCD to 7 segment decoder circuits, decoder/driverIC 7448/7447
Encoders - working of encoders, priority encoders, IC 74148
Multiplexers (MUX):-Working of MUX, Implementation of expression using MUX(IC 74153,74151).
Demultiplexers (DEMUX):-Working of DeMUX, Implementation of expression using DEMUX

Unit-IV: Sequential Logic
Introduction to sequential circuits. Difference between combinational circuits and sequential circuits
Flip- flops: Design, truth table, excitation table of SR, JK, D, T flip flops. Preset & clear, master slave configuration, conversion from one type to another type of flip flop, Study of flip flop ICs - 7473,7474, 7476. Application of flip-flops – Bounce elimination switch
Registers: Buffer register; shift register; IC 7495

Unit-V: Sequential Logic Design
Counters: Definition of modulus of counter**,** asynchronous counters, synchronous counters, state diagram representation, design of synchronous counters, preset table and programmable counters, decade/BCD counters, ring and Johnson counters, divide by N-counter, timing diagram of counters, realization of counters using ICs 7490,7492,7493and74193
Sequence Generator: using shift registers and counters
Unit VI: PLDs &Applications
PLD: PLA- Input, Output Buffers, AND, OR, Invert/Non-Invert Matrix.
DesignExample: Any4Variables SOP function using PLDs, study of basic architecture of FPGA and CPLD
Applications of digital circuits: Digital clock, alarm annunciator.

Suggested List of Experiments:
(Perform any 8experiments)

1. Code Conversion
2. Design and Implementation of full adder and subtractor using logic gates.
3. Study of Multiplexer IC74151
4. Study of Flip –Flop ICs and conversion of flip –flop from one other
5. Implementation of counter of different Mod numbers using 7490 & 7493 ICs
6. Design of Non sequential counter using flip –flop using ICs 7476,7474
7. Design Ring & Johnson counters using shift register IC 7495
8. Interfacing of 7 segment LED display using IC 7447
9. Study of Preset table Up / Down counter using IC 74193
10. Interfacing of TTL and CMOSICs

Books:
Text:

1. R. Jain, “Modern Digital Electronics”, 3rd Edition, Tata McGraw-Hill,.
2. Malvino and Leach, “Digital Principals &Applications”, 4th edition, TMH

Reference:

1. John Yarbrough, “Digital Logic applications and Design”Thomson
2. Flyod “Digital Principles”, Pearson Education
3. Malvino D.Leach “ Digital Principles and Applications”, 5th edition, Tata McGraw Hill
4. Gothman, ‘Digital Electronics’, 2nd edition, PHI
5. M. Morris Mano,’ Digital Design’, , Pearson Education Asia, 3rd e/d

[206271]- Industrial Drives

Teaching Scheme:	**Examination Scheme:**	**Total Marks:** 100.
Lectures: 4 Hrs/ Week	Online Exam: 50 Marks	**Total Credits:** 4
	End Sem Exam: 50 Marks.	Theory= 4

Prerequisites: Fundamentals of transistors, power devices and Electrical Engineering

Course Objectives:

1. To introduce different Power Devices, their construction, working, characteristics, triggering methods and commutation.
2. To give an exposure of working and analysis of converters, choppers and inverters.
3. To study different DC and AC motors.
4. To study different techniques for driving AC and DC motors and control strategies

Course Outcomes:

After completion of the course, students will be able to,

1. Understand construction, working, characteristics, triggering and commutation of different power devices.
2. Understand Principle, Working, and Classification of converters, choppers and inverters.
3. Understand Principle, Construction, Working, Characteristics and Applications of DC and AC motors.
4. Understand speed control techniques for different DC and AC motors

Unit 1: Introduction to Power devices

Construction, Working, Characteristics, Specifications and applications of SCR,TRIAC, DIAC, Power MOSFET,IGBT and UJT.SCR gate triggering and commutation circuits. Series and Parallel connection of SCR and its triggering arrangement.

Unit 2: Converters, Choppers and Inverters

Converters: Single Phase and Three Phase Controlled rectifiers, (Half wave, full wave and bridge Configuration) with R and R-L. **Choppers:** Principle, Working, Classification, Thyristorised Choppers- Jones Chopper, Morgan Chopper **Inverters:** Classification, Single Phase half bridge and full bridge Inverters, PWM Inverters

Unit 3. **DC Motors: Principle, Construction, Working, Characteristics and Applications of** DC Motors, Stepper motors, Permanent-Magnet DC Motors(PMDC), Position Servo, Miniature DC Motors. Printed Circuit DC Motors. Brushless DC Motor.

Unit 4: Single Phase AC Motors: Principle, Construction, Working, Characteristics and Applications of Single Phase Motors, Types of single phase motors (Split Phase Motor, Capacitor start, Capacitor Start-Capacitor Run, Permanent Split-Capacitor Motor), AC Synchronous Motors(PM), Shaded Pole Motor, Universal motors.

Unit 5: Controllers for DC motors

H-Bridge Drive, Stepper motor sequencer and drive, Half step and Full step method of stepper motor drive, Chopper drive, Speed and direction control, Brushless DC Motor control drive.

Unit 6: Controllers for AC motors

Solid state relays, Firing angle control, Closed loop control of induction motor, Speed and direction control, AC Synchronous motor drive, Closed loop control of synchronous motor, Variable frequency drive.

Books:

1. MD Singh, K B Khanchandani, 'Power Electronics', 2nd edition, McGraw Hill Company.
2. B. L. Theraja and A .K.T heraja, S. Chand &Sons,"A textbook of Electrical Technology", Volume-II, AC & DC Machines,

Reference books:

1. P. C. Sen,' *Power Electronics'*, TMH, 2007
2. Mohamad Rashid,' *Power Electronics'*, PHI, 2nd edition, 2004
3. G.K.Dubey, Power semiconductor controlled drives, Prentice Hall- 1989
4. Bhag S. Guru, Huseyin P. Hiziroglu,"Electric Machinery And Transformers", Third Edition, Oxford University Press.
5. Krishnan, Electrical Motor Drives, PHI-2003

[206272]- Soft Skills

Teaching Scheme:	**Examination Scheme:**	**Total Marks:** 50.
Practical: 2 Hrs/ Week	Term Work: 50 Marks	**Total Credits:** 1
		Practical= 1

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

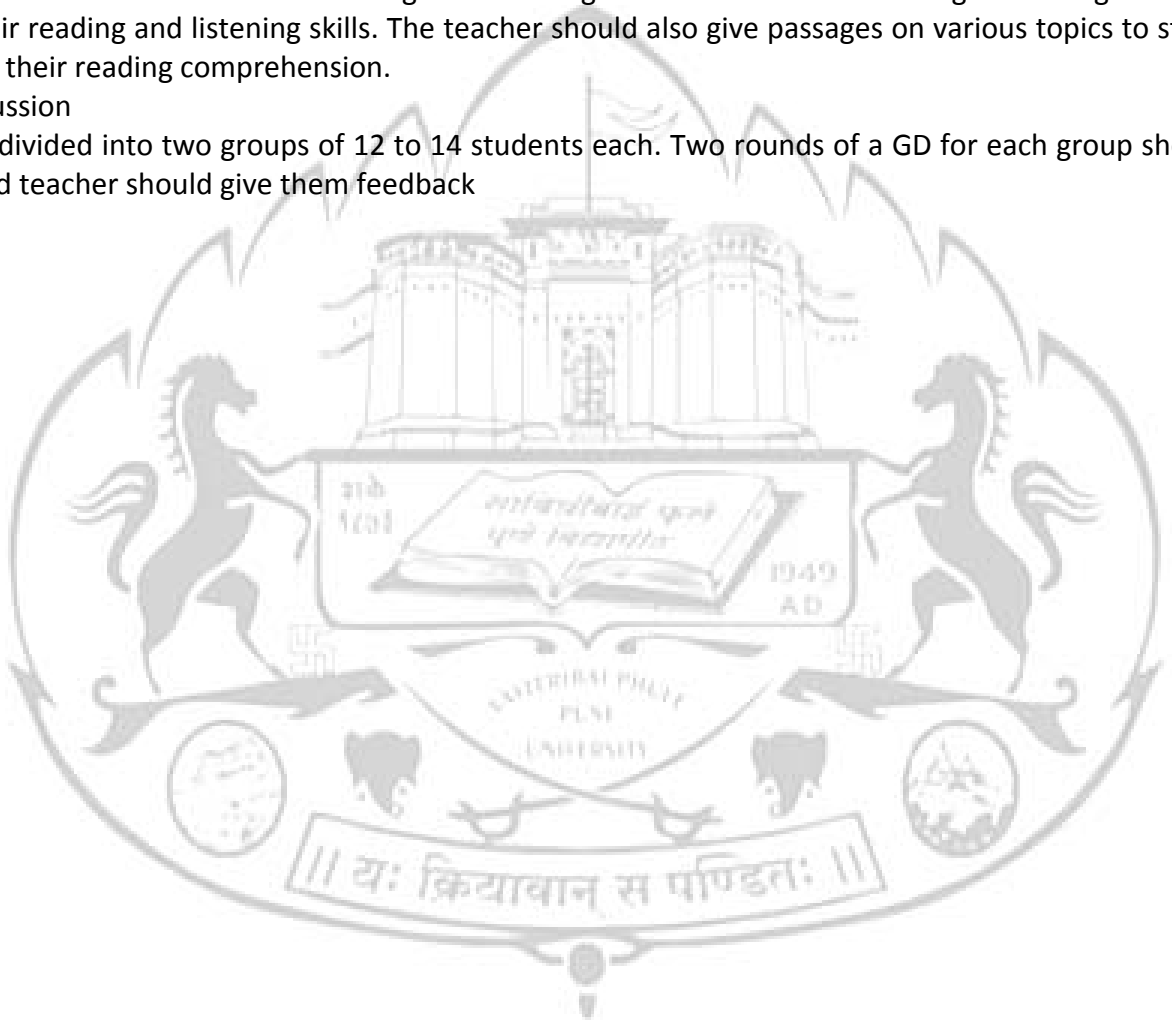
The teacher should teach the students how to write report. The teacher should give proper format and layouts. Each student will write one report based on visit / project / business proposal etc.

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



[206273]- Drives & Control Laboratory

Teaching Scheme:
Practical: 2 Hrs/ Week

Examination Scheme:
Term Work: 50 Marks

Total Marks: 50.
Total Credits: 1
Practical= 1

Automatic Control System:

Suggested List of Experiments:

Students are expected to perform any 4 experiments

1. Introduction to Fundamental of MATLAB.
2. Introduction to Simulink environment (Basic blocks)
3. Obtaining transfer function for Electrical (RC and RLC circuit)
4. Electro-mechanical System (Armature controlled and Field controlled DC Motor).
5. Transient response and time domain parameters of First and second order electrical circuits.
6. Simulation of transfer functions obtained in experiment 3 and 4.
7. Stability analysis using root locus approach.
8. Stability analysis using frequency response approach (Bode plot approach)
9. Stability analysis using Nyquist plot.
10. Obtain the state model for a given transfer function by direct (companion I and II *i.e.* controllable canonical and observable canonical forms), parallel and cascade decomposition.
11. Study of level/flow/temperature control system

Industrial Drives:

List of Experiments (Minimum 4 experiments are to be performed):

1. V-I Characteristics of SCR.
2. UJT SCR triggering circuit.
3. Single AC voltage controller using SCRs for R load.
4. Single phase Semi / Full converter with R load.
5. Pulse width modulation (PWM) control for servo, BLDC motor and miniature DC motor with direction control.
6. Speed control of stepper motor with full step and half step sequence.

[206274]- Audit Course-2

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 may opt for one of the audit courses per semester, starting in second year first semester. Though not mandatory, 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 and Assessment (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

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

- Written Test
- Demonstrations/ Practical Test
- Presentations
- IPR/Publication
- Report

Students can opt for any other audit course from the list of Audit Course of any branch of engineering.