SE SEM I

IC0012: Sensors and Transducers for Mechanical Measurements

Objectives: Upon completion of this course, student should be able to:

- Know fundamentals of sensors
- Suggest suitable sensor for given applications.
- Validate sensor according to given specifications.
- Can build suitable measurement technique.
- Procure and install the sensor.

Unit 1 : Displacement Measurement: (12 Hrs)

Transducer Definition, Classification, and Performance Characteristics

Resistive: Potentiometers, types of potentiometer, loading effect, sensitivity

Piezo-resistive, Equivalent circuits, Charge and voltage sensitivity.

Inductive: LVDT, RVDT, Variable, reluctance, Self-inductance, Mutual inductance

Capacitive: Single plate, Differential capacitance cell, and Measurement circuits

Laser dimensional gauge, Fiber optic, Moiré's grating**.**

Displacement Measurement

Digital Transducers: Encoders – Types of Translational and Rotary

Proximity Sensors – Inductive, Capacitive, Optical, Ultrasonic, Hall effect, Magnetic

Flapper Nozzle: Sensitivity, Graph, Its application in air gauging

Thickness Measurement

Magnetic, Dielectric, LASER, Capacitive, Ultrasonic, LVDT

Unit-2: Velocity and Speed Measurement (5 Hrs)

Angular Velocity

Mechanical revolution counters , Hand held, Vibrating Reed, Centrifugal force, Hall effect proximity pickup, Capacitive, Magnetic (toothed rotor), Photoelectric, Photo-reflective, pulse counting method, stroboscopes, Toothed rotor, eddy current, Capacitive tachometer

Translational velocity

Electromagnetic transducers (Moving coil , Moving Magnet) , AC and DC tachometers Doppler Laser, Radar type.

Unit-3: Acceleration, Vibration, Shock and Jerk Measurement (5 Hrs)

Acceleration Measurement

Seismic, Potentiometric, Capacitive Strain gauge, LVDT, Piezoelectric, Calibration of accelerometers.

Angular Accelerometer, Variable Reluctance, Eddy Current proximity sensor

Vibration, Shock and Jerk Measurement

Vibrometer, Vibration exciters, Jerk meter.

Unit-4: Strain, Force, And Torque Measurement: (6 Hrs)

Strain Measurement

Strain gauge – classification (metallic, semiconductor), gauge factor, properties of gauge wire, rosettes, mounting, measurement circuits, compensation

Force Measurement

Basic methods of force measurement, Strain gauges, LVDT, Piezoelectric, Vibrating Wire type.

Torque Measurement

In-line rotating & stationery, Inductive, Photoelectric, proximity sensor, Strain gauge, Prony brake, Torsion Bar.

Shaft power Measurement

Belt, Gear Dynamometer, Absorption Dynamometer (servo control, absorption), Instantaneous power measurements, Alternator power measurement.

Weight Measurement
Load Cells –

Electromagnetic, Vibrating string, LVDT, Strain Gauge, Magneto-strictive, Magneto-elastic, Inductive, Piezo-Electric, and Cantilever beam.

Comparison of Pneumatic, Hydraulic and Electronic Load cell.

Outcome:

1. Able to suggest suitable sensor for given applications.
2. Able to validate sensor according to given specifications.
3. Can build suitable measurement technique

Text Books:

1. Rangan, Sharma,' Instrumentation Devices and Systems', Tata McGrawhill- Second Edition.
2. Nakra,Chaudhary,' Instrumentation Measurement and Analysis', Tata McGrawhill-21st Reprint.
3. Principles of Industrial Instrumentation- D. Patranabis - Tata McGrawhill-7th Reprint,1986
4. Electrical and Electronic Measurements and Instrumentation- A. K. Sawhney- Dhanpat Rai and Sons , Delhi-2002print
5. Mechanical and Industrial Measurement- R.K.Jain- Khanna Publications-9th print

Reference Books :

1. Andrew , Williams,' Applied Instrumentation in Process Industries (Vol. I)'- Gulf Publications Company- Second Edition
2. B. G. Liptak- Butterworth Heinemann, 'Process Measurement and Analysis' Third Edition
3. Jone's Instrument Technology (Vol. 1 and Vol. 2)- B. E. Noltingk EL / BS- Fourth Edition
4. E. O. Doebelin, 'Measurement System Application and Design- McGrawhill International- Fourth Edition

IC0022: Electrical and Electronic Measurements and Instruments.

Objective: Upon completion of this course, the students shall be able to:

- Understand principle, working and operation of various Electrical and electronic instruments.
- Learn techniques for measuring electrical parameters and electrical components.
- Applications of electrical and electronic instruments.

Unit 1: Analog electrical instruments (8Hrs)

Principle of moving coil and moving iron instruments, Static and dynamic characteristics, input impedance, loading effect etc. DC indicating instruments, voltmeters, ammeters,

Ohmmeter, multimeter and extension of instrument ranges.AC indicating instruments ammeter, voltmeter, and energy frequency meters effect of frequency and waveform on their operation.

Unit 2: **(6 Hrs)**

DC bridges: Wheatstone bridge and Kelvin Bridge design, sensitivity, errors in bridge circuit. Null type and deflection type bridges, current sensitive and voltage sensitive bridges, Applications of DC bridges.

AC bridges: Maxwell bridge, hey bridge, Schering Bridge and wein bridges.
Storage and dissipation factor. Applications of AC bridges.

Unit 3: Digital Instruments: (8Hrs)

Timers and counters, configurations, operating modes, accuracies and errors and applications, Digital multimeters, DMM circuits, accuracies sources
Of errors, automation in DMM and specifications, Digital R, L, C measurement techniques, Digital phase meter.

Unit 4: Oscilloscopes: (7 Hrs)

Principles of analog oscilloscopes, construction, deflection sensitivity,
and operating modes etc. Measurement of electrical parameters like voltage,
Current, frequency, phase , Sampling oscilloscope principle, working and applications.
Digital storage oscilloscope: block schematic, sampling techniques, memory considerations, operating modes, specifications and applications.

Unit 5 : Waveform generators and analyzers: (6 Hrs)

Waveform generation methods, function generators., Operating principles and working and applications of various analyzers such as including Logic analyzer, spectrum analyzers, wave analyzer, Distortion meter etc.

Unit 6: Recording and testing instruments: **(5 Hrs)**

Principle and working of strip chart y-t and x-y recorders, Data acquisition systems and data loggers, Virtual instrumentation techniques and application of virtual instrumentation.

Outcome: Basic and applied knowledge of electrical and electronic Instruments.

Text Books:

1. Cooper & Helfrick: Electronic Instrumentation and Measurement Tech. Prentice Hall of India, new Del, 1986.
2. Anand M S: Electronic Instruments and Instrumentation Technology. New Delhi. Prentice Hall Of India, 2004.
3. Bouwens A J: Digital Instrumentation.. New Delhi. Tata McGraw Hill Publishing Company LTD, 2005.
4. Kalsi H S: Electronic Instrumentation. (2nd) New Delhi. Tata Mc Graw Hill Pub Co., 2004.

Reference books:

1. Carr J J: Elements of Electronic Instrumentation & Measurement. (3rd) Delhi. Pearson Education (Singapore) Pvt. Ltd., 2003.
2. Oliver & Cage: Electronic Measurements & Instruments. McGraw Hill International Boo, 1985.

IC0032: Electronic Devices and Circuits

Objective: Upon completion of this course, the students shall understand:

- Fundamentals of electronic devices.
- Basic electronic circuits working and analysis
- Design and Applications of discrete electronic circuits.
- Pre requisite for other electronics subjects

Unit 1: Passive electronic components: (8 Hrs)

Classification, construction, identification and datasheet interprétation.

Includes: resistors, potentiometers, capacitors, inductors etc.

Semiconductor diodes:

Classification ,construction, identification , characteristics and

Datasheet interpretation.Includes: Various types of diodes such as rectifier, fast recovery, Switching, zener, shottky, varactor, LED, photodiode etc.

Unit 2: RC circuits: (7 Hrs)

Study, design and applications of: Low pass, high pass, band pass and band reject filters.

Diodes circuits: Study, design, analysis and applications of: Clipping, clamping and voltage multiplier circuits, half wave, full wave and bridge rectifier circuits.

Capacitor input filters, ripple voltage and ripple factor. Zener shunt regulator circuit.

Unit 3: Bipolar Junction Transistors (BJT): (6 Hrs)

Classification and Datasheet Interpretation of: Small signal, power, RF, Darlington transistors, Transistor CE and switching characteristics, Transistor switching applications. Astable ,bistable, flip-flop and monostable multivibrator. Current mirror circuit, constant current source.Zener series and feedback regulator with short circuit protection

Unit 4: Transistor Amplifiers (6 Hrs)

CC, CB, CE configurations, Classification of small signal amplifiers

Biasing circuits and their stability and thermal runaway

Class A, B, AB, C operations, CC and CE - RC coupled amplifiers and analysis,

DC and Transformer coupled amplifiers, Push Pull and Complementary Push Pull Amplifiers. Introduction to hybrid parameters.

Unit 5: FET: (6 Hrs)

Construction, characteristics, biasing circuits and applications.

MOSFETs: Types, construction, characteristics and applications

UJT: Construction, characteristics, and relaxation oscillator.

Oscillators: Principle classification of oscillators. Study of Hartley, Colpitts and phase shift oscillators.

Unit 6: Power Devices: (7 Hrs)

Classification, construction, principle and working of silicon controlled rectifier (SCR), TRIAC, DIAC,Power MOSFETs, IGBT, MOV, Photovoltaic Cells etc.

Outcome: Knowledge of discrete electronic devices, design, analysis and Applications of discrete electronic circuits

Text Books: 1. Mottershead A: Electronic Devices & Circuits. Prentice Hall Of India New Del, 1991.

2. Malvino Albert Paul: Electronic Principles. (6th) New Delhi. Tata McGraw-Hill Publishing Company Limited, 1999.

3. Boylestad R & Nashelsky L: Electronic Devices & Circuit Theory. (5) Prentice Hall Of India New Del, 1993.

4. Bell David A: Electronic Devices And Circuits. (4th) New Delhi. Prentice Hall Of India, 2004.

Reference Books:

1. Horowitz P & Hill W: Art of Electronics. (2) UK. Cambridge University Press, 2002.
2. MILLMAN J & HALKIAS C: INTEGRATED ELECTRONICS. NEW DELHI. Tata McGraw Hill Pub Co., 2003.

ES0212: Electrical Machines

Objective: The student studying this subject should

- Understand the basic concepts of electrical machines.
- Gain knowledge of solving numerical problems.
- Understand the relevance of electrical machines as applied to industrial applications.

Unit 1: Electrical power and its measurement (7 Hrs)

Instantaneous power, active power, reactive power, apparent power, power factor, Measurement and Calculation of active, reactive power, pf in 3 phase balanced circuits using three watt meters, one Wattmeter and two watt meter methods. Measurement of power using CT and PT.

Unit 2: DC Machines: (7 Hrs)

1. DC generators- Construction and working principle, commutator, EMF equation
2. DC motors- Operation, types, losses and basic equations of DC motor. Torque equation, motor characteristics, speed control methods (descriptive treatment only), DC Motor starters, Applications.

Unit 3: Transformers: (7 Hrs)

Single-phase transformers- Ideal & Practical Transformers, Equivalent circuit, Determination of transformer parameters (OC and SC tests), Efficiency and regulation of transformer.

1. Special transformers: Auto transformer, Ferrite core transformers, phase shift transformer.

Unit 4: (7 Hrs)

Three phase Induction Motors- Construction, operation, types, slip and torque equations, max torque, starting torque, full load torque, and condition for max torque, torque-slip characteristics.1 phase motors and Stepper motors. (Attention given to constant speed motors)

Outcome: After the completion of syllabus student will-

1. Be able to understand the basic concepts of electrical machines.
2. Be ready to work in industrial environment.
3. Gain knowledge of solving numerical problems.

Text books:

1. Electrical Technology Hughes, Pearson education
2. Electrical Machines 4th Edition Theodore Wildi, Pearson Education.

Reference books :

1. Electrical Machinery S.K. Bhattacharya, T.T.T.I. Chandigarh
2. Electrical Machines & Power system vol 1.Syed A. Nasar ,McGraw hill
3. Fractional and sub fractional horse power electrical motors.C.E. Veinou and J.E. Martits , McGraw hill
4. Electrical Engineering handbook,Siemens, Wiley eastern

ES0162: Engineering Mathematics -III

Objective: The fundamental objective of the course is to provide the opportunity for our students to develop a firm foundation in mathematics.The module explains the importance and symbiosis between Mathematics and Engineering. The objective of the course is to achieve a fluency with Mathematical tools which is an essential weapon in modern Graduate Engineer's Armory and the balance between the development of understanding and mastering of solution techniques with emphasis being on the development of student's ability to use Mathematics with understanding to solve Engineering problems by retaining the philosophy of '**learning by doing'.**

Unit 1: Linear Differential equations of higher order (7 Hrs)

Homogeneous Linear Differential Equations of Second Order, Higher Order Homogeneous & Non Homogeneous Linear Differential Equations with Constant Coefficients, Solutions by undetermined coefficients and Variation of Parameters method

,Euler – Cauchy Equation, System of ordinary differential equations and application to Engineering problems .

Unit 2: Complex Analysis (7 Hrs)

Derivative, Analytical function, Cauchy-Riemann equations, Complex Integration, Cauchy's Integral Theorem and formula, Residue Theorem and applications to Engineering Problems.

Unit 3: Laplace transforms (7 Hrs)

Introduction and definition of Laplace Transform, Transforms of simple functions, basic properties of Laplace Transform, Inverse Laplace Transform and its evaluation. Laplace Transform of unit step function, impulse function & periodic functions, Applications to Engineering Problems.

Unit 4: Fourier and Z- transform (7 Hrs)

Complex Fourier series and frequency spectrum, Fourier integrals, Fourier transforms in mathematics and in engineering. Properties of Fourier Transform., Fourier cosine and sine transforms with application to Engineering Problems. Introduction to Z Transform, properties of Z-Transform, Inverse Z-Transform, application of Z-transform to difference equations.

Unit 5: Probability and Statistics (7 Hrs)

Probability and rules of probability, Random variables, Probability distributions, Mean and variance of distributions, Binomial, Poission,Hypergeometric and Normal distributions. Regression and correlation analysis.

Unit6: Vector Calculus (7 Hrs)

Vector and scalar functions & fields, Derivative, Gradient of a scalar field, Directional derivative, Divergence and curl of a vector field, vector identities, Irrotational and solenoid vectors and potential functions, line and surface integrals, Green's, Stoke's and Gauss theorems and applications to Engineering Problems.

Text books:

1. Advanced Engineering Mathematics by Erwin Kreyszig, (8th Edition), John Wiley and sons, inc., 2003.

2. Higher Engineering Mathematics by Dr. B.S. Grewal, (38th Edition), Khanna Publishers, Delhi. 2000.

Reference Books:

1. Advanced Calculus by Murray R. Spiegel [Schaum's out line series].

2. Calculus and analytic Geometry (6th Edition) by Thomas, G. B. and Finney, Wesley/Narosa, 1985.

3. Advanced Engineering Mathematics (2nd Edition) by Dennis G. Zill and Michael R. Cullen, CBS, New Delhi, 2000.

4. Advanced Engineering mathematics (second Edition) by Michael D.Greenberg, Prentice Hall International, 1998.

5. Advanced Engineering mathematics by C. Ray Wylie, Louis C Barrett R. [McGraw-Hill Book Company]

6. Applied Mathematics for Engineers and Physicists by Pipes and Harvill, [McGraw-Hill Book Company]

7. Mathematical Techniques for Engineers & scientists by Larry C., Andrews & Ronald L. Philips, PHI Pvt. Ltd., New Delhi, 2005

8. Advanced Engineering mathematics by Alan Jeffrey**,** Academic Press, 2002.

Lab courses

IC5012: Sensors and Transducers for Mechanical Measurements

Objective: Upon completion of this course, student should be able to:

- Know fundamentals of sensors
- Suggest suitable sensor for given applications.
- Validate sensor according to given specifications.
- Can build suitable measurement technique.
- Procure and install the sensor.

List of Practicals

1. Measurement of Velocity Using Non-contact Method.
2. Measurement of Velocity Using Contact Method.

3. Characterization of strain gauge indicator and weight measurement using Load Cell.
4. Measurement of Displacement & Thickness using LVDT.
5. Study of Encoder as displacement sensor.
6. Study of different types of Proximity switches.
7. Study and Calibration of Vibrometer and Accelerometer.
8. Study of Flapper nozzle system and plot its characteristics.

Outcome:

1. Able to suggest suitable sensor for given applications.
2. Able to validate sensor according to given specifications.
3. Can build suitable measurement technique

Text Books:

1. Rangan Sharma,'Instrumentation Devices and Systems', Mani-Tata McGraw-Hill- Second Edition.
2. Nakra Chaudhary,' Instrumentation Measurement and Analysis', Tata McGrawhill-21st Reprint.
3. Principles of Industrial Instrumentation- D. Patranabis-Tata McGrawhill-7th Reprint,1986
4. Electrical and Electronic Measurements and Instrumentation- A. K. Sawhney- Dhanpat Rai and Sons , Delhi-2002print
5. Mechanical and Industrial Measurement- R.K.Jain- Khanna Publications-9th print

Reference Books:

1. Andrew, Williams,' Applied Instrumentation in Process Industries (Vol. I)'-Gulf Publications Company- Second Edition
2. B. G. Liptak- Butterworth Heinemann, 'Process Measurement and Analysis' Third Edition
3. Jone's Instrument Technology (Vol. 1 and Vol. 2)- B. E. Noltingk EL / BS- Fourth Edition

4. E. O. Doebelin, ’Measurement System Application and Design- McGraw-Hill International- Fourth Edition

IC5022: Electrical and Electronic Measurements and Instruments.

Objective: Upon completion of this course, the students shall be able to

- Understand principle, working and operation of various Electrical and electronic instruments.
- Learn techniques for measuring electrical parameters And electrical components.
- Applications of electrical and electronic instruments

List of Practical’s

1) Conversion of voltmeter and ammeter ranges
2) Study of energy meter
3) Design of wheat stone bridge

4) Design of a given AC bridge
5) Study of analog oscilloscope
6) Study of an universal counter
7) Study of a digital voltmeter.
8) Study of LCR meter
9) Study of a distortion meter
10) Study of a DSO

Outcome: Basic and applied knowledge of electrical and electronic Instruments.

Text Books:

1. Cooper & Helfrick: Electronic Instrumentation and Measurement Tech. Prentice Hall of India, New Delhi, 1986.
2. Anand M S: Electronic Instruments and Instrumentation Technology. New Delhi. Prentice Hall Of India, 2004.
3. Bouwens A J: Digital Instrumentation, New Delhi, Tata McGraw Hill Publishing Company LTD, 2005.
4. Kalsi H S: Electronic Instrumentation. (2nd) New Delhi. Tata Mc Graw Hill Pub Co., 2004.

Reference books:

1. Carr J J: Elements of Electronic Instrumentation & Measurement. (3rd) Delhi. Pearson Education (Singapore) Pvt. Ltd., 2003.
2. Oliver & Cage: Electronic Measurements & Instruments. McGraw Hill International Book, 1985.

IC5032: Electronic Devices and Circuits

Objective: Upon completion of this course, the students shall be able to:

- Fundamentals of electronic devices.
- Basic electronic circuits working and analysis
- Design and Applications of discrete electronic circuits.
- Pre requisite for other electronics subjects

List of Practical's

1) Study of electronic components
2) Design of LP and HP Filter
3) Study of rectifier circuits
4) Study of transistor characteristics
5) Study of astable multivibrator
6) Study of transistor biasing circuits
7) Design of CE RC coupled amplifier

8) Study of FET characteristics
9) Design of UJT relaxation oscillator
10) Determination of SCR I_H and I_L Current

Outcome: Knowledge of discrete electronic devices, design, analysis and Applications of discrete electronic circuits

Text Books:

1. Mottershead A: Electronic Devices & Circuits. Prentice Hall Of India New Del, 1991.
2. Malvino Albert Paul: Electronic Principles. (6th) New Delhi. Tata McGraw-Hill Publishing Company Limited, 1999.
3. 3. Boylestad R & Nashelsky L: Electronic Devices & Circuit Theory. (5) Prentice Hall Of India New Del, 1993.
4. 4. Bell David A: Electronic Devices And Circuits. (4th) New Delhi. Prentice Hall Of India, 2004.

Reference Books:

1. Horowitz P & Hill W: Art of Electronics. (2) UK. Cambridge University Press, 2002.
2. MILLMAN J & HALKIAS C: INTEGRATED ELECTRONICS. NEW DELHI. Tata Mc Graw Hill Pub Co., 2003.

IC5042: Advance ‘C’ Programming

Objective:

1. To make students aware about fundamentals of programming.
2. To provide exposure C programming Language.

List of Practicals

Term work shall consist of a record of 8 to10 assignments. Programs in C language, under Windows/LINUX platform, are based on the topic such as arrays, structure, pointers, files, etc. Sample list is given below. For each of the following programs, student should write an algorithm, draw a flowchart and only then code the program.

1. Write a program to perform various operations such as union and intersection on sets.
2. Write functions to determine whether the matrix is skewed and symmetric.
3. Write a program in C to carry out following operations on strings with
   Library functions

(a) To concatenate a String S2 to String S1.

(b) To find length of given string.

(c) To Compare the two string S1 and S2.

(d) To copy the String S2 to the String S1.

4. Write a program in C to carry out following operations on strings without Library functions

(a) To concatenate a String S2 to String S1.

(b) To find length of given string.

(c) To Compare the two string S1 and S2.

(d) To copy the String S2 to the String S1.

5. Write a program to insert and to delete an element from an array from a specific location.
6. Write a program to understand various logical & Bitwise operators.
7. Structure manipulation (for any database like students database) with or without pointers to structure.
8. Write a program to sort a list using bubble sort.
9. To create a text file, read it & convert into uppercase & write the contents into another text file by using command line arguments.
10. Write a simple program on pointers.

Outcome: By the end of course students should be able for programming with Engineering applications.

Text Books:

1. P. K. Sinha, 'Computer Fundamentals', BPB Publications, 3rd Edition, 2003.
2. E. Balaguruswamy, 'Programming in Ansi C', TMH Publication, 4th Edition.

Reference Books:

1. B. Gottfried, 'Programming with C-Shaum's outline Series', McGraw Hill.
2. Y.Kanetkar, 'Let us C', BPB Publications, 2nd Edition.

ES5212 : Electrical Machines

Objective: The student studying this subject should:

1. Understand the basic concepts of electrical machines.
2. Gain knowledge of solving numerical problems.
3. Understand the relevance of electrical machines as applied to industrial applications.

List of Practicals

1. DC Generators and Alternators
2. DC Motors – DC series, compound, shunt, PM, minimotors
3. Induction Motors –single phase, three phase
4. Synchronous Motors
    - Principle
    - Types
    - Constructional Details
    - Emf Equation/ Speed -Torque equations

- Classification
- Characteristics in detail
- Applications
- Problems

Outcome: After the completion of syllabus student will-

- Be able to understand the basic concepts of electrical machines.
- Be ready to work in industrial environment.
- Gain knowledge of solving numerical problems.

Text books:

1. Electrical Technology Hughes, Pearson education
2. Electrical Machines 4th Edition Theodore Wildi, Pearson Education.

Reference books :

1. S.K. Bhattacharya,'Electrical Machinery',T.T.T.I. Chandigarh.
2. Syed.A,'Electrical Machines & Power system', Nasar ,McGraw hill
3. C.E. Veinou and J.E. Martits ,'Fractional and sub fractional horse power electrical motors', McGraw Hill.
4. Electrical Engineering handbook, Siemens, Wiley eastern.

SE SEM II

IC0042: Process Parameter Measurements

Objectives: Upon completion of this course, student should be able to:

1. Know fundamentals of sensors.
2. Suggest suitable sensor for given applications.
3. Validate sensor according to given specifications.
4. Can build suitable measurement technique.
5. Procure and install the sensor.

Unit-1: Temperature Measurement (8 Hrs)

Temperature

Temperature Scales, Units and relations, Classification of temperature sensors

Mechanical: Bimetallic Thermometer – Working Principle, Various types

Filled system thermometers – SAMA classifications, Sources of errors and their remedies, Dip effect

Electrical: Resistance Temperature Detectors – Types and comparison, Circuits for lead wire compensation, Sources of errors and their remedies.

Thermistor: Types (NTC, PTC), Measuring Circuits

Thermocouple: Terminology, Types (B, E, J, K, R, S, T), Characteristics, Laws of thermoelectricity, Study of thermocouple tables, Lead wire compensation, Cold junction compensation techniques, Protection (Thermowell), EMF Measurement methods, Thermopiles

Unit-2: Temperature & Heat flux Measurement (5 Hrs)

Non-contact Types: Quartz crystal, Pyrometers (Total and Optical), Fiber Optic, and Infrared.

Heat flux

Needle type heat flux sensor, High temperature heat flux sensor. Radiation Convection heat flux sensor, Ring heat flux sensor, Change-of-heat-flux sensor

Thermal conductivity

Calorie : NIR Spectrometer.

Unit-2: Pressure Measurement (8 Hrs)

Pressure

Pressure scales, Units and relations

Manometers – U tube, Well type, inclined tube, Ring balance, Micro manometer,

Elastic – Bourdon, Diaphragm, Bellows and their types

Electronic – LVDT, Strain gauge, Capacitive, Piezoelectric, Thin film, Variable reluctance, Vibrating element (Diaphragm and Wire)

High Pressure Measurement – Bulk modulus cell, Bridgman type

Differential Pressure Measurement: Force balance, Motion balance, Capacitance delta cell, Ring balance DP cell, Diffused semiconductor strain gauges

Vacuum

Units and relations

McLeod gauge, Thermal Conductivity (Pirani Guage, Thermocouple),

Hot cathode ionization gauge, Molecular momentum (Knudsen) gauge, Cold Cathode ionization (Penning) gauge

Calibrating Instruments – Dead Weight Tester (Pressure, Vacuum), Digital Manometer

Unit-3: Flow Measurement (8 Hrs)

Fundamentals : Units , Newtonian and non-Newtonian Fluids , Reynolds's number , Laminar and turbulent flows , Velocity profile , Bernoulli's equation for incompressible flow , Density , Beta ratio, Reynolds's number correction , Square root relation

Head type flow meters : Orifice (Eccentric , segmental , concentric) , Different pressure taps, Venturi-meter , Flow nozzle , Dahl tube, , Pitot tube , Annu bar , Characteristics of head type flow meters

Open channel flow measurement: Notch, Weirs types

Variable area type: Rotameter

Other flowmeters : Turbine , Target , Electromagnetic , Ultrasonic (Doppler, Transit time i.e. Cross correlation) , Vortex shedding , Positive displacement , Anemometers (Hot wire , Laser)

Mass flow meters: Coriolis, Angular momentum, Thermal

Flow totalizer

Solid flow meters

Unit-4: Level Measurement (7 Hrs)

Direct (Gauges): Hook type,

Sight Glass: Tubular, Transparent and Reflex

Float type: Float & Tape, Float & wire, Float & Board

Magnetic: Bicolor flapper, capsule type, Dipstick

Indirect: Hydrostatic pressure

Electrical : Float , Displacer (Torque tube unit) , Bubbler , Diaphragm box DP cell , Ultrasonic , Capacitive , Radioactive , Radar (Contact , Non-contact – TDR / PDS), Resistance , Thermal , Fiber optics

Switches: Pivoted float, Guided float, Capacitive, Ultrasonic, Conductivity, Microwave, Vibrating type, Rotating Paddle Interface level.

Solid level detectors

Unit-5: Signal conditioning circuits (6 Hrs)

Amplifiers : Bridge circuits, Instrumentation amplifier.

Modulation: AM and data handling demodulator circuits.

Filters, ADC, DAC

Outcomes:

- Able to Suggest suitable sensor for given applications
- Able to validate sensor according to given specifications.
- Can build suitable measurement technique

Text Books:

1. Rangan Sharma,'Instrumentation Devices and Systems', Mani-Tata McGraw Hill- Second Edition.
2. Nakra Chaudhary,' Instrumentation Measurement and Analysis', Tata McGrawhill-21st Reprint.
3. D. Patranabis,'Principles of Industrial Instrumentation', Tata McGrawhill-7th Reprint, 1986.
4. A. K. Sawhney,'Electrical and Electronic Measurements and Instrumentation- A. K. Sawhney', Delhi-2002print.
5. R.K.Jain,'Mechanical and Industrial Measurement', Khanna Publications-9th print.

Reference Books:

1. Andrew Williams,' Applied Instrumentation in Process Industries (Vol. I)'-Gulf Publications Company- Second Edition
2. B. G. Liptak- Butterworth Heinemann, 'Process Measurement and Analysis' Third Edition
3. B. E. Noltingk EL / BS- ,'Jone's Instrument Technology , (Vol. 1 and Vol. 2)',Fourth Edition
4. E. O. Doebelin, 'Measurement System Application and Design- McGraw-Hill International- Fourth Edition

IC0052: Linear Integrated Circuits

Objective: Upon completion of this course, the students shall understand:

- Fundamentals of electronic devices.
- Basic electronic circuits working and analysis
- Design and Applications of discrete electronic circuits.

Unit 1 : **(6 Hrs)**

Introduction and properties of discrete differential amplifier.

Introduction of operational amplifiers, basic block schematic and characteristics of an ideal op-amp.Operational amplifier parameters and datasheet interpretation.Op-amp classification and selection criteria.

Unit: 2 **(8 Hrs)**

Various types of feedbacks and their characteristics.

Comparator and Schmitt trigger circuits.Voltage series and shunt feedback amplifiers, analysis for input impedance output impedance and voltage gain.Inverting and non-inverting amplifiers design and analysis. Estimation of output offset voltage and nulling methods.

Unit: 3 **(6 Hrs)**

Differential, summing and instrumentation amplifiers.

Half wave and full wave precision rectifiers.Peak detector, sample and hold, window detector, integrator and differentiator circuits.Analog switches and multiplexers.

Unit: 4 (6 Hrs)

Low pass, high pass, band pass, band reject all pass fiters, Butterworth filters, Notch filter and peaking amplifier.

Introduction to chebyshev and elliptic filters, Square wave generator, Triangular wave generator, Wein bridge and phase shift oscillators, Amplitude and frequency stability.

Unit: 5 (8 Hrs)

Voltage to current and current to voltage converters. Frequency to voltage and voltage to frequency converters. Triangular to sine wave converter. Digital to analog and analog to digital converters.

Unit: 6 (6 Hrs)

Timer IC555 block diagram, monostable and astable modes of operation, schmitt-trigger and pulse width modulation circuit.IC565 / IC CD4046 PLL block diagram, working principle and applications.Study of three pin voltage regulators such as LM78XX,79XX,LM317and LM337 series voltage regulators. Design of voltage regulators using IC LM723C.

Outcome: Knowledge of linear integrated circuits. Design, analysis and applications of Linear integrated circuits.

Text Books:

1. Gayakwad Ramakant. A,'Op-amps & Linear Integrated Circuits', (4) Delhi. Pearson Education / Prentice Hall of India, 2000.
2. Botkar. K .R,' Integrated Circuits', Delhi. Khanna Publishers, 2002.
3. Franco Sergio,'Design with Operational Amplifiers and Analog Integrated Circuits (3rd)', New Delhi. Tata McGraw Hill Publishing Co Ltd, 2002.

Reference Books:

1. Clayton .G & Winder. S,'Operational Amplifiers', (5th) Oxford Newnes, 2004.
2. Stanley William D,'Operational Amplifiers with Linear Integrated Circuits', (4th) New Delhi. Pearson Education, 2004.

IC0062: Control Systems

Objective: Develop fundamentals associated with the analysis, design and simulation of automatic control systems.

Unit 1: Introduction to Control Systems (6 Hrs)

Basic Concepts of control systems with examples: Feed-back, Open-loop, closed loop. Representation of physical Systems-Electrical, Mechanical F-V and F-I analogies, Electromechanical, Thermal, Pneumatic, Hydraulic Systems, Differential equations and Transfer functions, Block Diagram Algebra, Signal Flow graph, Conversion of Block Diagram to Signal Flow Graph, Conversion of Signal Flow Graph to Block Diagram

Unit-2: Time Domain Analysis of Control Systems (7 Hrs)

Introduction, Impulse Response of a System, First Order System, Second Order System and their Response to Step and Ramp Inputs Time Domain Specifications of First and Second Order Systems, Static and Dynamic Error Coefficients, Performance Indices

Unit-3: Stability Analysis (5 Hrs)

Introduction, Pole-Zero Plots, Effects of Addition of Poles and Zeros on Stability, Hurwitz Criteria, Routh Array.

Unit-4: Root Locus and Stability Analysis (8 Hrs)

Introduction, Root Locus: Definition and Properties, Rules for Constructing Root Locus, Stability Analysis, Systems with Dead-time.

Unit -5: Frequency Domain Analysis of Control Systems (10 Hrs)

Introduction, Frequency Response and Frequency Domain Specifications, Correlation between Frequency and Time Domain Specifications, Bode Plot, Polar plot, Nyquist plot, Stability Analysis

Systems with Dead-time

Unit-6: State Space Analysis (6 Hrs)

Introduction, Solution of State Equation, Stare Transition Matrix, Transfer Function ,Determination, State Space Representation, Similarity Transformations, Controllability, Observabilty, Liapunov Stability Criteria

Outcome:

1. Understanding of basic components of feedback control system.
2. To study the standard inputs and response of first, second order systems.
3. Students will get the concepts of stability.
4. Bode-plot, root-locus and nyquist plots ensure the fundamental steps towards system analysis.
5. Students will learn state space representation of control systems.

Text Books:

1. K. Ogata- Modern Control Engineering, Fourth edition, Pearson education India, 2002.
2. I. J. Nagarth and M. Gopal ,'Control systems Engineering', Third Edition, New age International Publishers, India, 2001.

Reference Books:

1. B. C. Kuo,'Automatic control systems, Seventh Edition, Prentice ', Hall of India, 2000.

2. Norman S. Nise,' Control systems engineering', Third Edition, John Wiley and sons, Inc, Singapore, 2001.
3. R.C.Dorf and R.H. Bishop- Modern Control systems, Eighth edition, Addison-Wesley, 1999.

EC4962: Digital Electronics

Objective: After completing the course, the students will be able to design a digital system

Unit 1: (8 Hrs)

1. **Introductory Concept-** analog and digital representation
2. **Number Systems** - Binary, Decimal, Hexadecimal, Octal number systems, their conversions and arithmetic operations.
3. **Logic Gates and Boolean Algebra –** all logic gates, Boolean Theorem, DeMorgan's Theorem, Universality of NAND gate representation, Alternate logic gate representation
4. **Combinational Logic Circuits –**SOP, POS, Simplification, minimization techniques. **Codes**: BCD, Excess 3, Gray code, ASCII, their conversions and applications.

Unit 2: (8 Hrs)

1. Flip-Flops and Related Devices - **Study of SR, JK, MSJK, T, D types of flip flops, conversion of flip flops, Race around condition.** Clock for digital circuits:

   TTL oscillators, Conversion of bipolar and unipolar signals to TTL, Manual pulsars, key debouncing techniques.

2. **Digital Arithmetic Operations and Circuits –** Binary- addition, subtraction, Representing signed number, addition & subtraction in the 2's Complement form, binary-multiplication, division, BCD addition, Hexadecimal arithmetic, arithmetic circuits- half & full adder, ALU integrated circuits.

Unit 3: (10 Hrs)

1. **Counters and Registers:** Asynchronous, synchronous, binary, up-down, presettable and programmable, non sequential, Decade, Mod n counters. Realization of counters using ICs. Design of counters, state and bush diagram representation.

   Shift Register: Basic operation, modes, Implementation of Johnson and Ring counter using Shift Register.

2. **Application:** Frequency counter, digital clock, frequency divider
3. **Integrated Circuit Registers**: PIPO, PISO, SISO, SIPO

Unit 4: (6 Hrs)

1. **Logic devices -** Study of multiplexers, demultiplexers, encoders, decoders, buffers, latches, transceivers.
2. **Display interfacing** - Interfacing of seven segments LED display to counters, multiplexed display system. Study of various BCD to 7 segment decoder/ driver ICs, LCD.

Unit 5: (4 Hrs)

1. **Integrated Circuit Logic Families - Digital** integrated circuits, levels of integration, concept of ECL, TTL CMOS, HMOS, NMOS, PMOS with detailed comparison between TTL and CMOS. Specifications and Operating characteristics of TTL and CMOS devices. Worst case design and interfacing of TTL and CMOS. Tristate logic and applications.

Unit 6: (4 Hrs)

1. **Memory devices –** memory terminology, general memory operation, ROM-architectures, types-PROM, EPROM,EEPROM, Basic operation of CD ROM. Flash memory, RAM- architecture, SRAM, DRAM
2. **Special memory functions**: power down storage, cache memory, FIFO, circular buffers
3. **PLD, CPLD,FPGA** - Fundamental , Architectures

Outcome: After completing the course, the students will be able to design a digital system.

Text Book:

1. Ronald J. Tocsin and Neal S. Widmer, "Digital Systems Principles and Application", Eighth Edition, Prentice Hall India Publication.

Reference Books:

1. Malvino and Leach, 'Digital Principals & Applications' –4th edition, TMH
2. Gothman,'Digital Electronics' –2nd edition, PHI.
3. Thomas Floyd, 'Digital Fundamentals '–3rd edition, Universal Book Stall
4. M. Morris Mano,'Digital Design' –3rd edition, Pearson Education Asia.

CH4902: Unit Operations

Objective: This course is designed as a foundation course assisting preparation of future instrumentation engineers for working within or along with process industries. The course shall focus more on application of principles with respect to industry practices.

Unit 1: - Unit Operations and Fluid Mechanics (6 Hrs)

Basic concepts and principles of commonly used unit operations with processes and their study related to different process industries like distillation extraction, drying, humidification / dehumidification, filtration, absorption etc.

Basic constructional details and operational concepts of pumps, compressors, fans, blowers etc.

Unit 2: - Material of construction & properties (6 Hrs)

Basic concepts of corrosion and protection from corrosion. Selection Materials, metals & alloys used in construction of field instruments. Properties like hardness, compression, tensile of alloys & metals. Heat and surface treatments on metals.

Unit 3: - Heat and Mass Transfer (9 Hrs)

Heat Transfer: Energy Balance, heat transfer coefficients,

Heat Transfer Equipments: Heat exchangers, boilers, condensers, evaporators, crystallizers, dryers, cooling towers, Chillers, refrigeration plants.

Mass Transfer: Material balance with or without chemical reactions mass transfer coefficients.

Process & mechanical design considerations for equipment such as Distillation Column, Chemical Reactors, Extrusion.

Unit 4: - Process Flow Diagrams (7 Hrs)

Importance of Process Flow Diagram and Development of same.

Case studies for Process flow diagrams of Water Treatment Plant, Pulp and Paper, Sugar, Cement, Petrochemical, Fertilizer.

Outcome: Knowledge of different process equipments

Text Books:

1. M. Gopal Rao & M. Sitting ,'Outline chemical technology', 3/E East West 1973.
2. O Leven spiel,'Chemical reaction Engineering'.Wiley & Sons.

Reference Books :

1. McCabe Smith,'Unit operations in Chemical Engg.', 4/e McGraw Hill.
2. Peiry,'Chemical Engineering Hand Book', McGraw Hill.

Lab courses

IC5052: Process Parameter Measurements

Objective: Upon completion of this course students should be able to:

- Know fundamentals of sensors.
- Suggest suitable sensor for given applications.
- Validate sensor according to given specifications.
- Can build suitable measurement technique.
- Procure and install the sensor.

List of Practicals

1. Measurement of Flow Using:

a) Orifice b) Venturi c) Rotameter.

2. Measurement of Flow Using Electromagnetic Flow meter or Turbine type flow meter.
3. Measurement of Level Using Capacitive probe
4. Measurement of Level using any float type transducer.
5. To plot the characteristics of:
   a) J/K/R/S/T Thermocouples
   b) Thermocouple simulator.
6. To plot the characteristics of:
   a) RTD Pt100 / Pt500 / Pt1000 (any two)
   b) RTD simulator.
7. Measurement of Pressure using Bellows, Bourdon gauge, Diaphragm.
8. Study of Dead Weight Tester.
9. Study of Vacuum Gauge Tester.
10. Study of any two process switches.
11. Design a Signal conditioning circuit for any two sensors.

Outcome:

1. Able to suggest suitable sensor for given applications.
2. Able to validate sensor according to given specifications.
3. Can build suitable measurement technique.

Text Books:

1. Rangan Sharma,'Instrumentation Devices and Systems', Mani-Tata McGrawhill- Second Edition.
2. Nakra Chaudhary,' Instrumentation Measurement and Analysis', Tata McGrawhill-21st Reprint.
3. D. Patranabis,'Principles of Industrial Instrumentation', Tata McGrawhill-7th Reprint, 1986.
4. A. K. Sawhney,'Electrical and Electronic Measurements and Instrumentation', Delhi-2002print.
5. R.K.Jain,'Mechanical and Industrial Measurement', Khanna Publications-9th print.

Reference Books:

1. Andrew Williams,' Applied Instrumentation in Process Industries ', (Vol. I), Gulf Publications Company- Second Edition.
2. B. G. Liptak,'Butterworth Heinemann, 'Process Measurement and Analysis', Third Edition.
3. B. E. Noltingk EL / BS,'Jone's Instrument Technology ',(Vol. 1 and Vol. 2), Fourth Edition
4. E. O. Doebelin, 'Measurement System Application and Design, McGraw Hill International, Fourth Edition

IC5062: Linear Integrated Circuits

Objective: Upon completion of this course, the students shall be able to:

- Fundamentals of electronic devices.
- Basic electronic circuits working and analysis
- Design and Applications of discrete electronic circuits.
- Pre requisite for other electronics subjects

List of Practicals

1) Design of a comparator and Schmitt trigger
2) Design of inverting and non inverting amplifier
3) Design of a full wave precision rectifier

4) Design of a band pass filter
5) Design of a wein bridge oscillator
6) Design of a triangular wave generator
7) Design of I/V and V/I converters
8) Design of F/V converter
9) Design of IC555 monostable and astable multivibrator
10) Design of a voltage regulator using IC723

Outcome: Knowledge of linear integrated circuits. Design, analysis and applications of Linear integrated circuits .

Text Books:

1. Gayakwad Ramakant A,'Op-amps & Linear Integrated Circuits',(4) Delhi. Pearson Education / Prentice Hall of India, 2000.
2. Botkar K R,'Integrated Circuits', Khanna Publishers. Delhi, 2002.
3. Franco Sergio: Design with Operational Amplifiers and Analog Integrated Circuits. (3rd) New Delhi. Tata McGraw Hill Publishing Co Ltd, 2002.

Reference Books:

1. Clayton G & Winder S,'Operational Amplifiers', (5th) Oxford Newnes, 2004.
2. Stanley William D,'Operational Amplifiers with Linear Integrated Circuits', (4th) New Delhi. Pearson Education, 2004.

IC5072: Control Systems

Objective: Develop fundamentals associated with the analysis, design and simulation of automatic control systems.

List of Practicals

1. Represent level system in differential form and Transfer function form
2. Obtain step and impulse response of Level system. Find the time constant of the level system
3. Obtain time domain specifications of mass-damper-spring system

4. Obtain the transfer function of R-L-C network and Investigate stability by Hurwitz criteria
5. Investigate stability of second/third order system by Routh criteria
6. Investigate the stability conditions of second/third order system using root loci
7. Investigate the effect of dead time on system performance
8. Obtain gain margin and phase margin and correspond frequencies of second/third order system
9. Investigate stability of given system using Nyquist plot
10. Obtain STM of given system using any software tool
11. Obtain solution of state equation for give system, Comment on controllability and observability.

Outcome:

1. Understanding of basic components of feedback control system.

2. To study the standard inputs and response of first, second order systems.

3. Students will get the concepts of stability.

4. Bode-plot, root-locus and nyquist plots ensure the fundamental steps towards system analysis.

5. Students will learn state space representation of control systems.

Text Books:

1. K. Ogata- Modern Control Engineering, Fourth edition, Pearson education India, 2002.
2. Nagrath and M. Gopal,' Control systems Engineering', Third Edition, New age International Publishers, India, 2001.

Reference Books:

1. B. C. Kuo,'Automatic control systems, Seventh Edition', Prentice Hall of India, 2000.

2. Norman S. Nise,'Control systems Engineering', Third Edition, John Wiley and sons, Inc, Singapore, 2001.
3. R.C.Dorf and R.H. Bishop,' Modern Control systems', Eighth edition, Addison-Wesley, 1999.

IC5082: Introduction to MATLAB and Circuit Simulation

Objectives: To understand and get acquainted with MATLAB and Simulink

List of Practicals

MATLAB PROGRAMMING:

1. Introduction to MATLAB and different TOOLBOX.
2. Study of syntax and implementation of different loops.
3. To build a program for certain application

4. Build an GUI for given application

CIRCUIT SIMULATION AND ANALYSIS: (minimum five of the following)

1. Design and simulation of a filter circuit.
2. Design and simulation of an analog amplifier.
3. Design and simulation of a counter circuit.
4. Design and simulation of an Astable Multivibrator.
5. Design and simulation of a voltage regulator.
6. Design and simulation of a combination logic circuit.
7. Design and simulation of an oscillator circuit.

Text Books:

- Rudra Pratap,'Introduction to MATLAB 7.0'.

EC9982: Digital Electronics

Objective: After completing the course, the students will be able to design a digital system.

List of Practicals

1. Experiment on Code conversion
2. Experiment on Study of flip flops using ICs and conversion of flip flop from one form to the other.

3. Experiment on Study of presettable up down counter using IC 74193 or equivalent.
4. Experiment on Study of Decade counter, Mod 12, Mod 16 counters using ICs 4017, 7490, 7492, 7493 respectively or equivalent.
5. Design and implementation of non sequential counter using flip flops.
6. Design and implementation of Mod n counters using standard counter ICs.
7. Design and implementation of Ring and Johnson counters using Shift registers.
8. Experiment on interfacing of 7 segment LED display using 7447, 4033, 4553 or equivalent.
9. Experiment on study of input and output characteristics of a logic gate for TTL and CMOS families.
10. Experiment on interfacing of TTL and CMOS logic families.
11. Design and implementation of any one application described in Unit VI.
12. Implementation of combination logic/ flip flops/ counters using PLD/ CPLD/ FPGA.

Outcome: After completing the course, the students will be able to design a digital system.

Text Books:

1.Ronald J. Tocci, Neal S. Widmer, "Digital Systems Principles and Application", Eighth Edition, Prentice Hall India Publication

Reference Books:

1. Malvino and Leach, 'Digital Principals & Applications' –4th edition, TMH
2. Gothman,'Digital Electronics' –2nd edition, PHI
3. Thomas Floyd, 'Digital Fundamentals '–3rd edition, Universal Book Stall
4. M. Morris Mano,'Digital Design' –3rd edition, Pearson Education Asia