FACULTY OF ENGINEERING

Syllabus for the

S.E (Instrumentation & Control)

(w. e. f 2009-2010)

UNIVERSITY OF PUNE

THE SYLLABUS IS PREPARED BY:

BOS- Instrumentation Engineering
University of Pune

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Note:- **This syllabus is subject to change without prior notice by the concerned BOS**

Faculty of Engineering

S.E. Instrumentation and Control

Term I

Subject Code No.	Subject	Teaching Scheme Hrs./week			Examination Scheme				
		Lecture	Tutorial	Practical	Paper	Term work	Practical	Oral	Total
207003	Engineering Mathematics-III	04	-	-	100	-	-	-	100
206261	Fundamentals of Instrumentation	04	-	02	100	50	-	-	150
206262	Linear Integrated Circuit-I	04	-	02	100	-	50	-	150
206263	Principles of Sensors & Transducers	04	-	02	100	25	50	-	175
206264	Automatic Control Systems	04	-	02/02	100	50	-	-	150
206265	Soft Skills	-	-	02/02	-	25	-	-	25
	Total	20		08	500	150	100	-	750

Term II

Subject Code No.	Subject	Teaching Scheme Hrs./week			Examination Scheme				
		Lecture	Tutorial	Practical	Paper	Term work	Practical	Oral	Total
206266	Digital Techniques	04	-	02	100	-	50	-	150
206267	Applied Electronics	04	-	02	100	-	50	-	150
206268	Transducers & Signal Conditioning	04	-	02	100	25	50	-	175
206269	Photonics & Instrumentation	04	-	02	100	50	-	-	150
206270	Drives and Controls	04	-	-	100	25	-	-	125
	Total	20		08	500	100	150		750

(206261) Fundamentals of Instrumentation

Lecture: 4 hours per week	Theory: 100 marks
Practical: 2 hours per week	Term work: 50 marks

Unit 1: Introduction
Static and Dynamic characteristics of instruments, dead zone, hysteresis, threshold, resolution, input & output impedance, loading effects, fundamentals of measurements, calibration of instruments, traceability, calibration report & certification.

Unit 2: Analog Indicating Instruments
DC galvanometer, PMMC and Moving Iron instruments, voltmeters, ammeters, ohmmeters, wattmeters, energy meters, multimeters and extension of range of instruments. AC indicating instruments, DC Potentiometers, self-balancing potentiometers

Unit 3: 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: Maxwell bridge, Hey bridge, Schering bridge, Wein bridge, storage and dissipation factor, applications of AC bridges

Unit 4: Digital Instruments
Digital Multimeter, Kilo Watt Hour meter, Phase meter, Digital Tachometer, Ultrasonic Distance meter, Digital Thermometer,

Unit 5: Oscilloscope
General purpose oscilloscope, construction, front panel controls, deflection sensitivity, dual trace CRO, measurement of electrical parameters like voltage, current, frequency, phase, Z-modulation, Digital Storage Oscilloscope

Unit 6: Recording Instruments and Waveform Generation
Principle and working of strip chart and X-Y recorders, multichannel recorders Waveform generation methods, Function generator, Virtual Instrumentation

Text and reference books:

1. W. D. Cooper & A. D. Helfrick, *'Electronic Instrumentation And Measurement Techniques',* $P^{H}{}_{I}$, 4^{th} e/d, 1987
2. David Bell, *'Electronic Instrumentation and Measurements',* $P^{H}{}_{I,}$ 2e/d,
3. Anand M. M. S., *'Electronic Instruments and Instrumentation Technology',* $P^{H}{}_{I,}$ 2004
4. Kalsi H. S., '*Electronic Instrumentation',* TMH, 2^{nd} e/d, 2004
5. R. Subburaj, *'The foundation for ISO 9000 and TQM',*
6. Bouwens A. J., *'Digital Instrumentation',*

(206262) Linear Integrated Circuits

Lectures: 04 hrs / week Theory Paper: 100 Marks
Practical: 02 hrs / week Practical : 50 Marks

Unit 1: Operational Amplifiers Fundamentals
Characteristics of Op Amp, Noise figure, Types of Noise, Causes of Slew Rate, Frequency response, Frequency / Phase Compensation Techniques. SR, CMRR, PSRR/SVRR. Offset adjustment techniques, Comparative study of different amplifier ICs (LM 741, LM 324,OP 07)

Unit 2: Feedback Amplifiers
Introduction to feedback amplifiers, Voltage series feed back amplifier (non inverting amplifier with feedback) and deriving closed loop gain. Voltage follower and its applications. Voltage shunt feedback (Inverting amplifier with feedback) and deriving closed loop gain.

Unit 3: Linear Applications of Op amp with practical considerations
Voltage Summing with averager, Voltage subtractor, Current booster, Integrator and practical integrator, Differentiator and practical differentiator, Instrumentation Amplifier with three op-amp and its disadvantage of low CMRR. Current to voltage and voltage to current converter (grounded and floating load.) Isolation amplifiers, chopper stabilized amplifiers. Equation solving.

Unit 4: Non linear Applications with practical considerations
Comparator characteristics, ZCD and its use, Schmitt trigger with external bias, window detector. Precision half wave and full wave rectifiers with IC 741. Sinusoidal oscillators using Op amplifiers: Barkhausen criteria, Wein Bridge oscillator, RC phase shift oscillator.

Unit 5: Timers and Voltage regulators
Timers: Triggerable and retriggerable, IC 555 monostable and astable. Designs and Applications. Voltage regulators : Linear and Switching DC Voltage regulators: Basic 78XX, Switching regulators : (Secondary switching regulators) Basic switching regulator, current waveforms, voltage waveforms, basic stepdown switching regulator.

Unit 6: Active Filters
Butterworth, Chebyshev and Bessel approximations, Low Pass, High Pass, Band Pass, Band Reject, Notch filters. First and Second Order filters. (Design of LP and HP VCVS Equal component filters), Difference between passive and active filters., (Filter terminology : passband, stopband, cutoff, rippl, Q, and order.)

List of Experiments: (At least 8 experiments from the following list)

1. Frequency response of Power amplifiers (LM 380):

2. Class A, B, C amplifiers using transistors: Circuits, and their efficiencies.

3. Wein bridge oscillator

4. Instrumentation amplifier using LM 324

5. CMRR, Slew rate, Measurement

6. Designing Integrator and Differentor circuit

7. Filter realization (Butterworth Design)

8. Comparator and Schmitt trigger and zero crossing detectors

9. Voltage regulators: Linear variable voltage regulator LM 723

10. Fixed voltage Regulators: 78xx, 79xx

11. Multivibrator circuits using LM 555

12. Applications of 555 (V/F converter, Schmitt trigger)

Text Books

1. *Ramakant Gaikwad, 'Operational Amplifiers'*, P^{H}_{I}**,** 3rd e/d, 1992
2. G. B. Clayton, Steve Winder, George Clayton, '*Operational Amplifi*ers', Newnes publication, 5th e/d, 2003
3. James Fiory, '*Op-Amps and Linear Integrated Circuits'* 4th/5th e/d, Amps and LIC Applications –, 5th e/d.
4. Albert Malvino, 'Electronic Principles', Career Education, 6th e/d,

(206263) Principles of Sensors and Transducers

Lectures: 4 hrs/week
Practicals: 2 hrs/week

Theory: 100 marks
Term work: 25 marks
Practical: 50 marks

Unit 1: Measurement instrumentation and calibration:
Introduction, measurement, instrument, Instrumentation classification of transducers, performance characteristics, errors in measurements, calibration and standards, static and dynamic characteristics of instrument

Unit 2: **Mechanical transducers-1**:
Basics of temperature measurement: scales, bimetallic and fluid expansion systems, Basics of pressure measurement: Manometers, diaphragms and capsules, Membranes, Bellows, Bourdon elements, Basics of force measurement: Springs, Cantilever beams, diaphragm elements, Load cells, Basics of torque measurement: Torsion bar and flat spiral spring, Shaft power measurement, Basics of gyroscope: rate gyro and integrating gyro.

Unit 3: Mechanical transducers-2:
Basics of density measurement, Hydrometer, Air bubbler system, U-tube weighing system, Basics of liquid-level measurement: Float element, Level-to-pressure convertor, Level-to-force convertor, Basics of viscosity measurement, Visocity-to-Pressure convertor, Visocity-to-Torque convertor, Visocity-to-Displacement convertor., Basics of flow measurement: Pitot-ststic tube, Flow obstruction elements, Centrifugal force element, Static vane elements, Rotating vane systems, Rotameter-float system.

Unit 4: Electrical transducers-1:
Resistive transducers for temperature, displacement, strain, pressure, moisture, magnetic flux, optical radiation, Inductive transducers for thickness, displacement, movable core type, eddy current type, Capacitive transducer: thickness, displacement, moisture

Unit 5: Electrical transducers-2:
Thermoelectric Transducers: Thermoelectric phenomena, common thermocouple systems Piezoelectric Transducers: Piezoelectric phenomena , piezoelectric materials, Piezoelectric transducers for Force, Strain, Torque, Pressure, Accelaration. Magnetostrictive Transducers: Magnetostriction Phenomena , Transducers for Force, Torsion, Hall-effect Transducer and applications, Electromechanical Transducers: Tachometers, Electrodynamic transducers for Vibration and Pressure, Electromagnetic flowmeter, Photoelectric Transducers: Photoelectric phenomenon, Photoconductive Transducers, Photovoltaic Transducers, Photoemissive Transducers

Ionization Transducers: Ionization vacuum Gauges and Displacement Transducers, Nuclear radiation transducers, Radioactive gauges for Vacuum, Thickness and Level measurement, Digital transducers: Digital Displacement Transducers, Digital Tachometer, Electrochemical transducers: Basics of Electrode Potentials, Reference Electrodes, Indicator electrodes, Measurement of pH

Unit 6: Miscellaneous Transducers and Systems

Feedback transducer systems, data display and recording systems: Self balancing systems, servo operated system, data- loggers, analog and digital readout systems, Analog and magnetic tape recorders, digital input-output devices.

List of Experiments: (Any eight)

1. Calibration of pressure gauge using dead weight pressure tester and preparation of report for the same,
   Equipment: Dead weight pressure tester setup, Standard weight set, pressure gauge
2. Calibration of glass thermometer using standard thermometer and preparation of report for the same.
   Equipment: calibrated thermometer as a standard thermometer, glass thermometer, Oven .
3. Characterization of strain gauge indicator and weight measurement using load cell.
   Equipment: strain gauge indicator with cantilever beam, standard weights, Mulimeter
4. Measurement of displacement using LVDT
   Equipment: LVDT with displacement measurement setup, CRO, function Generation.
5. Study of encoder as displacement sensor.
   Equipment: linear / rotary encoder with measurement setup.
6. Characterization of Thermocouples (J/T/K/R/S)
   Equipment: Oven, thermocouples, Multimeter, thermocouple reference table, Thermocouple simulator,
7. Characterization of RTD (PT100)
   Equipment: Oven, PT100 probe, RTD simulator, Temperature indicator, Multimeter
8. Calibration of vacuum gauge using vacuum gauge tester and preparation of the report.
   Equipment: Vacuum gauge tester, standard weights, vacuum gauge
9. study of x-y recorder, x-t recorder, paperless recorder
10. measurement of flow using rotameter
11. measurement of flow using DP cell.

Textbooks:

1. D. V. S. Murty, *'Transducers and Instrumentation'*, PHI, New Delhi, 2003.
2. E.O. Doebelin, '*Measurement Systems Application and Design'*, McGraw Hill, 4th Edition, 1990.

References:

1. D. Patranabis, *'Principles of Industrial Instrumentation'*, Tata McGraw-Hill- ,1986.
2. Rangan, Sarma, Mani, '*Instrumentation Devices and Systems*' Tata McGraw-Hill, Second Edition.
3. C. D. Johnson, '*Process Control Technology*' PHI-Seventh Edition.
4. Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard, '*Mechanical Measurements*', International student edition, Addison-Wesley- 5thEd.

(206264): Automatic Control Systems

Lectures: 4 hrs/week | Theory: 100 marks
Practicals: 2 hrs alternate weeks | Term work: 50 marks

Unit-1 Introduction to Control Systems
Introduction, brief classification of control systems: Open loop v/s closed loop, feedback v/s feedforward, linear v/s nonlinear, stable v/s unstable, time invariant v/s time variant, causal v/s noncausal (definitions only), representation of electrical, mechanical, electromechanical, thermal, pneumatic, hydraulic systems, force to voltage and force to current analogies.

Unit-2:Transfer function, block diagram algebra and signal flow graph
Concept of transfer function, block diagram algebra: Rules of block diagram reduction and determination of overall transfer function, Signal flow graph: Mason gain formula and its use to determine the overall transfer function, Conversion of block diagram to signal flow graph.

Unit-3: Time domain analysis of control systems
Standard test signals: impulse, step, ramp, sinusoidal, complex exponential, impulse response of a control system (from transfer function using inverse Laplace transform), Concept of pole, zero, order and type of a control system, first order , second order systems and their response to impulse and step inputs (for second order systems treat un damped, critically damped, under damped and over damped cases separately), time domain specifications of first order control systems from step response (first five time constants), time domain specifications of second order control systems from step response (natural frequency, damping factor, damped frequency, delay time, rise time, peak time, peak overshoot, settling time for 2% and 5% settling –derivation is expected), static error constants (k_p, k_v, k_a, e_{ss}),dynamic error constants.

Unit-4: Stability and Root Locus
A] Concept of Stability in *s* domain
Classification of Stability (BIBO stability and asymptotic stability), pole- zero plots in *s* domain, response term contributed by different types of poles, stability analysis by Hurwitz criterion and Routh array, determination of marginal gain and oscillation frequency using Routh array, concept of relative stability and its analysis using Routh array.
B] Root locus: definition, magnitude and angle conditions, 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-5: Frequency Domain Analysis and Stability

A] Frequency domain analysis of control systems

Response of control systems to sinusoidal inputs, frequency domain specifications of a second order system (resonant frequency, resonant peak), correlation between time domain and frequency domain specifications.

B] Stability analysis in frequency domain using Bode plot

Bode plot: Actual Bode plot and asymptotic Bode plot, Concept of gain margin, phase margin and bandwidth, stability analysis, Bode plot of systems with dead time, Determination of transfer function from asymptotic Bode plot

Unit-6 Stability and State Space Analysis

A] Polar plot and stability analysis in frequency domain using Nyquist plot

Polar plot: Concept and construction, Nyquist plot: mapping theorem, Nyquist stability criterion, Nyquist plot, special case of Nyquist plot for systems with pole or zero at origin, stability analysis.

B] Introduction to state space representation

Advantages of state space representation over classical representation, terminology of state space (state, state variables, state equations, state space), obtaining state model from transfer function by direct (companion I and II *i.e.* controllable canonical and observable canonical forms), parallel and cascade decomposition, Conversion of state model to transfer function

List of experiments: (Students are expected to perform first experiment and any three experiments out of remaining.)

1. Introduction to MATLAB and control system toolbox.
2. Obtaining transfer function, transient response and time domain parameters of second order electrical circuit (RLC series network) and compare the results with theoretical values and simulate the experiment using MATLAB.
3. Sketch the root locus for a given system and determine the system gain for a particular value of damping factor. Also simulate the same using MATLAB.
4. Sketch the Bode plot (actual and asymptotic) for a given system and analyse the stability. Also simulate the same using MATLAB.
5. Sketch the Nyquist plot for a given system and analyse the stability. Also simulate the same using MATLAB.
6. 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. Also develop a software program to obtain a state model for a given transfer function using MATLAB.

Text books:

1. I. J. Nagrath, M. Gopal, "*Control System Engineering*", 3^{rd} ed., New Age International Publishers, 1999.
2. B. S. Manke, "*Linear Control Systems*", 8^{th} ed., Khanna Publishers, New Delhi, 2007.
3. A. K. Jairath, "*Problems and Solutions of Control Systems*", 4^{th} ed. CBS Publishes, New Delhi, 2004.

Reference books:

1. K. Ogata, "*Modern Control Engineering*", 2^{nd} ed., PHI, New Delhi, 1994.
2. Norman S. Nise, "*Control System Engineering*", 4^{th} ed., John Wiley and Sons, 2003.
3. B. C. Kuo, "*Automatic Control Systems*", 3^{rd} ed., PHI, New Delhi, 1979.

(206265) Soft skills

Practical: 2 hours alternate weeks Term Work**:** 25 Marks

SUBJECT OBJECTIVE:
This program will help learners to: Communicate ideas with force and clarity, plan and organize professional presentations and present written material in captivating manner.

Unit 1: Conversation Skills
Develop Interpersonal, Intrapersonal skills, Reflective thinking, Critical thinking, Public Speaking skills, Discussion with peers, Listening for effective communication, Vision building, Adaptability.
Suggested Activity: Introduce yourself/peer, Analogies, Group Discussions.

Unit 2: Presentation Skills
Elements of effective presentation, Presentation tools, Structure of presentation, Voice modulation and Body language.
Suggested Activity: Technical Presentation, Video samples.

Unit 3: Career Skills
Present yourself through your 'Resume', Improve delivery of written material; get acquainted with the latest communication media.
Suggested Activity: Resume writing, Email Communication, Cover letter writing.

Unit 4: Writing Skills
Present written material in captivating manner, Understand the style, grammar, vocabulary for effective technical writing, Improve delivery of written material.
Suggested Activity**:** Project report writing, Newsletters, Technical manuals and Brochures.

Unit 5: Leadership Skills
Team playing, Group work, Leadership quality.
Suggested Activity: Games based on leader- followers, Priority and Dump Charades.

Reference Books:

1. *Non Verbal Communication by Albert Mehrabian*, Ph.D., Aldine Atherton, Inc.
2. *The Quick and Easy Way to Effective Speaking by Dale Carnegie, Dale Carnegie & Associates*, Inc, 290 Motor Parkway, Hauppauge, NY 11788.
3. *Effective Communication Skills for Scientific & Technical Professionals* by Harry E. Chambers, Perseus Publishing, Cambridge, Massachusetts.

4. *Effective Business and Technical Presentations* by George L. Morrisey, MOR Associates, Addison – Wesley Publishing Company, Inc.
5. John Seely, *The Oxford Guide to Writing & Speaking*, Oxford University Press, New Delhi.
6. Barker – *Improve Your Communication Skills* – Kogan Page India Pvt, Ltd, New Delhi.

206266: Digital Techniques

Lecture: 4 hrs./week. Theory. 100 marks
Practical: 2 hrs./week Practical: 50 marks

Unit1: Number systems and codes, Binary, Decimal, Hexadecimal, Octal num . ber systems, their conversions and arithmetic operations. BCD, Excess 3, Gray code, ASCII, their conversions and applications. Error detecting and error correcting codes. Minimization techniques: Boolean laws, minimization using Boolean laws, Karnaugh maps and Quine McCluskey method. Implementation of the reduced expression using gates and PLD, CPLD, FPGA.

Unit 2: Flip flops
Study of SR, JK, MSJK, T, D types of flip flops, conversion of flip flops, Race around condition. TTL oscillators, Conversion of bipolar and unipolar signals to TTL, Manual pulsars, key debouncing techniques. Storage devices, RAM, ROM, EPROM, E2PROM, FLASH memory, Bubble memory, PAL and PAL programming. Basic operation of CD ROM.

Unit 3: Counters
Asynchronous, synchronous, binary, up-down, presettable and programmable, non sequential, Decade, Mod n counters. Realisation of counters using ICs. Design of counters, state diagram representation. Shift Register: Basic operation, modes, Implementation of Johnson and Ring counter using Shift Register.

Unit 4: Logic devices
Study of multiplexers, demultiplexers, encoders, decoders, buffers', latches, transceivers. Display interfacing: Interfacing of seven segment LED display to counters, multiplexed display system. Study of various BCD to 7 segment decoder/ driver ICs. Introduction to PLD, CPLD, FPGA

Unit 5: 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: Application development using digital devices.

- Digital clock Digital Lock,
- Frequency counter
- Time counter
- Sequence generator
- Alarm Annunciator

List of Experiments (At least 6 experiments from I to 8, 1 experiment from 9 to 11 and experiment 12 is mandatory)

1 . Code conversion
2. Study of flip flops using ICs and conversion of flip flop from one form to the other.
3. Study of presettable up down counter using IC 74193 or equivalent.
4. Study of Decade counter, Mod 12, Mod 16 counters using ICs 4017, 7490, 7492, 7493 respectively or equivalent.
5, Design of non sequential counter using flip flops. 7476, 7474
6. Design of Mod-n counters using standard counter ICs, 7490, 7412, 7493
7. Design of Ring and Johnson counters using Shift registers 7495
8. Interfacing of 7 segment LED display using 7447, 4033 or equivalent.
9. Study of input and output characteristics of a logic gate for TTL and CMOs families.
10. Interfacing of TTL and CMOS logic families.
11. Design and implementation of any one application described in Unit 4
12. Implementation of combination logic/ flip flops/ counters using. -PLD/ CP1,"D1 FPGA

Note: Use of breadboards is mandatory

Text Books

1. Malvino and Leach, "*Digital Principals & Applications*", 4th edition, TMH
2. Gothman, '*Digital Electronics'*, 2nd edition, PHI

Reference Books

1. Thomas Floyd, '*Digital Fundamentals'* -, Universal Book Stall, 3rd e/d
2. M. Morris Mano,' *Digital Design'*, , Pearson Education Asia, 3rd e/d

(206267) Applied Electronics

Lectures: 04 hrs / week Theory Paper: 100 Marks
Practical: 02 hrs / week Practical: 50 Marks

Unit 1: Analog to Digital Converters
Analog switches and multiplexer, CD4051, sample and hold, Principles and working of ADCs: Counter Type, Dual Slope Integration, Flash, Successive Approximation,

Unit 2: Digital to analog converters
Principles of DACs : PWM, Binary weighted, R/2R ladder, Method of o/p: voltage / current . Resolution, monotonacity, Dynamic range considerations.

Unit 3 : Power Devices
Characteristics of SCR, DIAC, TRIAC, MOSFET, IGBTs, firing techniques, comparison of MOSFET and IGBT based on switching time, power dissipation, on resistance power handling capacity etc.

Unit 4: Batteries
Principle and Construction of Batteries: Types of batteries, performance specifications of Batteries, Physical Size – Weight and life Considerations charging and discharging constrains, battery charging techniques, Battery monitoring Systems. Solar cells

Unit 5: Signal converters
Voltage to current, current to voltage, voltage to time, voltage to frequency, frequency to voltage, principle and working of VCO (LM 566) and PLL (CD4046)

Unit 6: **Telemetry**
Modulation techniques: FM, AM, ASK, FSK, Time division and frequency division multiplexing, applications, signal isolation techniques (MCT2E),

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Experiments (Any 6)

1. application of Analog switch CD4051
2. study of SAR type ADC
3. implementation of 4-bit DAC using R/2R ladder
4. implementation of firing circuit for TRIAC using DIAC
5. battery charger for lead –accumulator battery using L200
6. VCO using 566
7. PLL using CD4046
8. voltage to current converter
9. current to voltage converter
10. frequency to voltage converter

Text Books:

1. *Ramakant Gaikwad, 'Operational Amplifiers'*, $P^{H}{}_{I}$**,** 3^{rd} e/d, 1992
2. W. D. Cooper & A. D. Helfrick, *'Electronic Instrumentation And Measurement Techniques',* $P^{H}{}_{I}$, 4^{th} e/d, 1987
3. Kalsi H. S., '*Electronic Instrumentation',* TMH, 2^{nd} e/d, 2004

Reference books:

1. Bouwens A. J., *'Digital Instrumentation',TMH,2007*
2. David Bell, *'Electronic Instrumentation and Measurements',* $P^{H}{}_{I,}$ 2e/d,
3. Art of Electronics-Horrowidtz

(206268) Transducers and Signal Conditioning

Lectures: 4 hrs/week
Practicals: 2 hrs/week

Theory: 100 marks
Term work: 25 marks
Practical: 50 marks

Unit 1: Temperature transducers:
RTD and Thermister: Resistance detection techniques, signal conversion techniques for temperature to voltage, current, frequency, time, Semiconductor type sensor: study of temperature sensors (AD590, LM35,LM75) and signal conditioning, Pyrometer: study of optical pyrometer and radiation pyrometer, comparative study for selection of sensors

Unit 2: Force and Pressure transducers:
Strain gauge and load cell: configuration of strain gauges (2-arm, 4-arm), excitation techniques for strain gauges, detection and signal conversion methods Semiconductor type strain gauge: use of semiconductor strain gauge for pressure sensors, signal conversion from pressure to voltage, current Piezoelectric devices: use of piezoelectric devices for pressure measurement and force generator, necessity of charge amplifier comparative study for selection of sensors

Unit 3: Linear and angular displacement transducers:
Ultrasonic transducers, Potentiometers, LVDT, RVDT: excitation methods for transducers, signal detection methods like phase demodulator, instrumentation amplifiers, Photoelectric transducers, optical encoders, stroboscope, tachometer: study and selection of optical sources and excitation techniques, detection of signal and conversion to analog and digital form, Speed pick-up, proximity switches: proximity detection techniques for capacitive, inductive, optical sensors, comparative study for selection of sensors

Unit 4: Level transducers for solid and liquid:
Electromechanical transducers: design aspects, construction and working of systems, Ultrasonic transducers: excitation and detection technique, interface measurement, Capacitive transducers: excitation and detection technique, limitation of the transducer, Nuclear level gauge: construction and principle of working comparative study for selection of sensors

Unit 5: Flow transducers:
Electromagnetic flow transducers: excitation and detection technique, Ultrasonic transducers: excitation and detection technique, DP cell, Turbine flow meter, Vortex flow meter, Mass flow meter: excitation and detection technique, comparative study for selection of sensors

Unit 6: Miscellaneous Transducers:
Acoustic Transducers: microphones, excitation and detection technique, pH meter: selection of electrodes excitation and detection technique, compensation for ambient temperature, Conductivity meter: principle of measurement, excitation and detection technique, Vibration transducers: electromagnetic and piezoelectric techniques, ceramic pick-ups, excitation and detection technique, comparative study for selection of sensors

List of experiments:

5 experiments should be performed from following list.

1. Design and implementation of electronic thermometer using PT100
2. Design and implementation of cold junction compensation technique for thermocouple.
3 Design and implementation of force measurement setup using load cell with 2-arm and 4-arm configuration.
4. Design and implementation displacement measurement setup using LVDT
5. Design and implementation displacement measurement setup using optical encoder
6. Design and implementation of liquid level measurement setup using electromechanical system
7. Design and implementation of liquid level measurement setup using capacitive level transducer.
8. characterization of microphone and study of constructional details of sound level meter.
9 study of pH meter and electrodes.

Text books

1. E.O. Doebelin, 'Measurement Systems Application and Design', McGraw Hill, 4th Edition, 1990.
2. Rangan, Sarma, Mani, '*Instrumentation Devices and Systems*' Tata McGraw-Hill, Second Edition.

Reference books;

1. Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard, '*Mechanical Measurements*', International student edition , Addison-Wesley- 5thEd.
2. D. Patranabis, *'Principles of Industrial Instrumentation'*, Tata McGraw-Hill- 1986.

(206269) Photonics and Instrumentation

Lecture: 4 hrs per week
Practical: 2 hrs. per week

Theory: 100 marks
Term Work: 50marks

Unit-1: Fundamentals of light
Nature of light, electromagnetic optics spectrum, propagation of light, electromagnetic waves in dielectric media, polarization and coherence, interactions of light with matter, absorption, scattering, dispersion, polarization, diffraction and interference.

Unit-2: Optical sources I
Electromagnetic spectrum, types of spectra- line, band and continuous light sources, radiometry and photometry, natural sources, incandescent lamp, gas discharge lamp.

Unit-3: Optical sources II
Light-emitting diodes- electro luminescent process, choice of LED materials, LED structures, infrared sources, semiconductor laser

Unit-4: Optical detectors
Thermal detectors and Quantum detectors, bolo meter, Photodiodes- PIN and avalanche photodiodes, phototransistors, photo multipliers, IR detectors, Solar cells, CCD devices.

Unit-5: Optical components
Mirrors-plane mirrors, paraboloidal mirrors, elliptic and hyperbolic mirrors, spherical mirrors. Prisms- dispersion prisms, reflection prisms. Filters- absorption filters and interference filter. ratings- equation of diffraction grating, resolving power, concave grating, volume diffraction grating, holographic grating. Lenses, Polarizers and Beam splitters.

Unit-6: Optical instruments
Eye, telescopes, microscopes, photographic lenses, optical projection systems, cameras, Abbe's refractromete, monochromatic.

Experiments:

1. To study current-intensity relationship of LED.
2. To plot the radiation pattern of LED.
3. To study current-intensity relationship of Laser diode.
4. To study polarization of light using polarizer-analyzer method.
5. To study application of diffraction grating
    a. To determine the wavelength of unknown monochromatic source e.g. laser diode/ sodium vapor lamp.
    b. To determine number of lines per inch of CD/DVD.

6. To determine the spectral bandwidth of LEDs
7. To determine the spectral bandwidth of Laser diode.
8. To study the Abbe's refractrometer.
9. To design astronomical telescope.
10. To plot the line spectra of Neon lamp.
11. Characterization of opto-isolators.

Textbooks and references:

1. Harold Kolimbiris, *'Fiber Optics Communications*', Pearson Education, 2004.
2. Pallab Bhattacharya, '*Semiconductor Optoelectronic Devices'*, Second Edition, Pearson Education, 1997.
3. Jose Miguel Lopez-Higuera, *'Handbook of Optical Fibre Sensing Technology'*, John Wiley & Sons, 2001.
4. Eugune Hecht, A.R. Ganesan, *'Optics'*, Fourth Edition, Person Education, 2008.

(206270) Drives and Control

Lectures: 4 hrs/week | Theory: 100 marks
Term work: 25 marks

Unit 1: DC Machines
DC generator, working principle, construction feature, types, emf equation, DC motors, motoring action, torque equation for DC motor, characteristics of DC motor, back emf in DC motor, conventional speed control of DC motors, Mathematical model of DC motor, Transfer function etc. Starters & applications.

Unit 2: AC Machines
Asynchronous Machine: Induction motors (3 phase): Concept of rotating magnetic field, working principle, constructional feature, types, torque equation, torque slip characteristics, efficiency, types of starter, conventional method of speed control. Ac position control system. Synchronous Machine. (Alternators)Working principle, construction feature, emf equation, Synchronous speed of Alternators.

Unit 3: Special purpose Machines
Working principle, construction feature, application and characteristics of Induction motors (single phase), synchronous motor, stepper motor, servo motor, universal motor.

Unit 4: Power devices
Construction, principle, Characteristics, Specification, applications of SCR (Gate trigger and communication circuit, series and parallel connection and its triggering arrangement for series and parallel SCRs), TRIAC, DIAC, MOSFET, IGBT and UJT

Unit 5: Controlled rectifier
Invertors and choppers, Single-phase rectifiers and single phase controlled rectifier (Half-wave and full-wave with resistive, capacitive and inductive loads etc.), 3-phase rectifier and 3 phase-controlled rectifier (Three phase full wave or six-phase half-wave rectifier, bridge rectifier with resistive load, L-C filter etc.)

Unit 6: Application of Motor control: **Industrial drive**
AC Motor control (speed control method of induction motor closed loop control, voltage fed inverter control the controlled-slip system slip power recovery system, VFD, braking of induction motor)
DC Motor control (single-phase SCR drive, Three-phase SCR drive, power factor in SCR motor devices, reversible SCR drives, starting and dynamic braking of separately excited dc motor, closed loop control system, chopper controlled dc drives).

Note: Term Work shall be based on the six assignments on above topics by the teacher concerned.

Text Books

1. Dave Polka, '*Motors and Drives'*, ISA, 2002
2. P. C. Sen,' *Power Electronics'*, TMH, 2007

Reference books

1. B. L. Thareja, *Electrical machines'*, S. chand & Suns, 2009
2. Mohamad Rashid,' *Power Electronics'*, PHI, 2nd e/d, 2004