Transducers – II

S.E. Sem. IV [INST]

EVALUATION SYSTEM

	Time	Marks
Theory Exam	3 Hrs.	100
Practical & Oral Exam	2 Hrs.	50
Oral Exam	–	25*
Term Work	–	25

* - Oral examination will be based on object-oriented industrial visit.

SYLLABUS

1. **Flow Measurement**
   - **(a) Introduction to fluid flow :** properties of fluids, type of fluid, dimensionless numbers, type of fluid flow, fluid pressure measurement using manometer (U tube-types, well type, inclined type, micro-manometer), continuity equation, Bernoulli's equation, hydrostatic law, Pascal's law, flow through pipes – major and minor losses, flow measurement through open channel-weirs and notches.
     Materials used for flow sensors, performance of materials, corrosion resistors, erosion, effect of vapour pressure, cavitation and flashing.
   - **(b) Head type :** orifice, venturi, nozzle, pitot tube, characteristics of head type flow meters. Variable Area type : Rotameter.
   - **(c) Other flow meters :** Turbine, electromagnetic, ultrasonic, positive displacement, anemometers, hot wire, mass flow meter, solid flow meter.

2. **Strain Measurement**
   Introduction, types of strain gauges, gauge factor calculation, materials for strain gauge, resistance strain gauge bridges, temperature compensation and application of strain gauges.

3. **Pressure Measurement**
   Pressure scales, units and relations, classification, elastic elements – bourdon tube, diaphragm, bellows. Calibration using dead weight tester.
   - **(a) Elastic materials :** Properties and selection of elastic materials for elastic transducers like spring, diaphragm, bourdon tube, bellows, piezo-electric and magneto-strictive materials.
   - **(b) Electronic :** Capacitive, piezo-electric, variable reluctance.
   - **(c) Conversion methods :** LVDT, strain gauge.
   - **(d) High Pressure measurement :** Bulk modulus cell, Bridgeman type.
   - **(e) Differential pressure measurement :** Force balance, motion balance, DP Cell, semiconductor strain gauges.

4. **Vacuum Measurement**
   Units & relations, Mc-leod gauge, Pirani gauge, Pirani thermocouple, hot cathode ionization gauge, Knudsen gauge, Calibration using dead weight tester.

5. **Electro-chemical Sensors**
   Terminology, equations, units. PH measurement-electrodes, measuring circuits, maintenance, temperature compensation, calibration. Conductivity measurement – probes and measuring circuits. ORP (Oxidation Reduction Potential) Measurement.

6. **Force, Torque and Power Measurement**
   (a) Force measurement : strain gauge, LVDT, piezoelectric
   (b) Torque : Tortion bar, strain gauge.
   (c) Power : Dynamometer, instantaneous power measurement, alternator power measurement.

7. **Miscellaneous Transducers :**
   Position, speed, velocity, acceleration, vibration, sound, viscosity, density, humidity and moisture measurement, nanosensors.

References :

1. Instrumentation Measurement and Analysis (*Nakra B. C., Chaudhary K. K.*) Tata Mc Graw Hill.
2. Electrical and Electronic Measurement and Instrumentation (*Sawney A. K.*) Dhanpatrai and Co.
3. Measurement system (*Doeblin E. D.*) 4th edition.
4. Instrument engineer's handbook- Process measurement and analysis (*Liptak B. G.*)
5. Process Instruments and Controls Handbook (*Douglas M. Considine*) Mc Graw Hill.
6. Process Control Instrumentation Technology (*Curtis Johnson*) 5th edition.
7. Instrumentation Systems and Devices (*Rangan, Mani, Sarma*) 2nd edition, Tata Mc Graw Hill.
8. Applied Instrumentation in process industry (*Andrew Williams*) vol-I, Gulf publishing company.
9. Fluid Mechanisms and Hydraulic Machines (*Bansal R. K.*) Laxmi publications.
10. Industrial Flow Measurement (*David W. Spitzer*) ISA Publication.

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Feedback Control System [FCS]

S.E. Sem. IV [INST]

EVALUATION SYSTEM

	Time	Marks
Theory Exam	3 Hrs.	100
Practical & Oral Exam	2 Hrs.	50
Oral Exam	–	–
Term Work	–	25

SYLLABUS

1. **Introduction**
   Definition of control system and related terms, open loop and closed loop system, examples. Development of automatic control systems, classification of control system, examples.

2. **Servomechanism**
   Definition of servomechanism, block diagram of servo systems– AC servo system, DC servo system, servo components– potentiometer, synchros, AC servomotor, DC servomotor, AC/DC Tachometer, servo amplifiers.

3. **Mathematical Models of Physical Systems**
   Definition of physical systems, principle of superposition and homogeneity, linear non–linear, time varying, time invariant systems. Types of dynamic model, linear elements of electrical and mechanical systems, differential equations of physical systems–mechanical systems, electrical systems, thermal systems, fluid systems, pneumatic systems. Analogous systems.

4. **Transfer Function and Feedback characteristics**
   Definition of transfer function, sinusoidal transfer function, transfer functions of physical systems, block diagram algebra, reduction rules, signal flow graphs–definition, construction, properties, and Mason's gain formula, sensitivity of closed loop and open loop system, effect of feedback, effect of disturbances signals, regenerative feedback with examples.

5. **Time Response Analysis**
   Standard test signal – pulse and impulse function, step function, ramp function, parabolic function, sinusoidal function, dynamic response, time response of first order system, time response of second order system, specifications, steady – state error, system types and error constants, effect of adding zeros and poles to a system, design specifications of second order system– desired close loop pole location and the dominant condition.

6. **Stability Analysis and Root Locus**
   Concept of stability, definitions, bounded input–bounded output stability, relative stability, necessary and sufficient conditions for stability, Routh stability criterion, relative stability analysis, root locus technique, applications, concept, construction of root loci, root loci of different systems.

7. **Frequency Response and Stability Analysis**
   Correlation between time and frequency response, polar plots, Bode plots, log magnitude versus phase plots, Nyquist stability criterion, frequency response specifications, stability analysis using–bode, polar, log–magnitude versus phase plots, definitions and significance of gain margin and phase margin, sensitivity analysis in frequency domain.

References :

1. Control System Engineering (*Nagrath I. G., Gopal M.*) New Age International (P) Ltd. Publishers 2000.
2. Automatic Control Systems (*Kuo Benjamin C.*) Prentice Hall of India, New Delhi, 1993
3. Control Systems Principles and Design (*Gopal M.*) 6th edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi, 1998.
4. Control Systems Engineering (*Nise Norman S.*) 3rd edition, John Wiley and Sons, Inc. – 2000.
5. Basic Control Systems Engineering (*Lewis Paul H., Chang Yang*) Prentice Hall International, Inc. 1997.
6. Design of Feedback Control Systems (*Raymond T. Stegani, Bahram Shahian, late Clement J. Savant and late Gene H. Hostetter*) 4th edition, Oxford University Press, New Delhi, 2001.

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Electrical Technology & Instruments [ETI]

S.E. Sem. IV [INST]

EVALUATION SYSTEM

	Time	Marks
Theory Exam	3 Hrs.	100
Practical & Oral Exam	–	–
Oral Exam	–	25
Term Work	–	25

SYLLABUS

1. **D. C. Machines**
   Constructional details, types (shunt, series and compound), generator action, emf equation, motoring action, significance of back emf, torque and speed equations, torque-armature current, speed-armature current and torque-speed characteristics of different types of motors, speed control, starter, applications. General specifications of D. C. Machine and their significance.

2. **Induction Motor**
   Rotating magnetic field, construction and principle of operation, slip, rotor frequency, torque-slip characteristic, relationship between slip and rotor copper loss, speed control, starting methods, motor ratings. General specification of induction motor and their significance.

3. **Fractional Horse Power Motors**
   Construction and principle of operation of single phase induction motor, types of single phase induction motor (resistance split phase, capacitance split phase) and their applications. Shaded pole induction motor.

4. **Analog Meters :**
   Construction and working principle of : ammeters, voltmeters, ohmmeters, power factor meter, energy meter, Q meters, D'Arsonaval galvanometers – PMMC and PMMI instruments. Shunts and multipliers-Measurement of phase and frequency, analog multimeters.

5. **Measurement of R, L, C**
   Measurement of medium, low and high resistance, megger, A. C. and D. C. potentiometers : A. C. Bridges, measurement of self and mutual inductances. Measurement of capacitance, Derivation and numericals related to all bridges.

6. **Electronic Measuring Instruments**
   Electronic voltmeters, DVM and DMM, automation in voltmeters (ranging, zeroing, polarity indication).

7. **Input/Output Sevices**
   (a) Digital I/O devices : punched card, paper tape, bar codes, line printer, ink-jet printer, digital tape recording, floppy disk.
   (b) Display devices : LED, LCD, seven segment display driver, alpha numeric displays and recorders.

8. **Cathode Ray Oscilloscope**
   CRT, Types of CRO : Single beam, double beam, digital storage (DSO) and sampling. Brief comparison between CROs. Application in instrumentation and measurement.

References :

1. Electrical and Electronics Measurement and Instrumentation (*Sawhney A. K.*) Dhanpat Rai and Co. Pvt. Ltd.
2. Electrical Machines (*Nagrath I. J., Kothari D. P.*) Tata McGraw Hill, New Delhi, 1997.
3. Electric Machinery and Transformers (*Guru Bhag S., Hiziroglu Huseyin R.*) 3rd edition, Oxford University Press, New Delhi 2007.
4. The performance and Design of Alternating Current Machines (*Say M. G.*) 3rd edition, CBS Publisher and Distributor, Delhi 1983.
5. FHP Motors (*Taylor Openshaw*) Addison Wesley 1976.
6. Electronics Instrumentation (*Kalsi H. S.*) Tata McGraw Hill, New Delhi 1997.
7. Preventive Maintenance and Troubleshooting (*Khandpur R. S.*) Tata McGraw Hill, New Delhi 1997.
8. Electronic Instrumentation and Measurement Techniques (*Cooper W. D., Helfrick A. D.*) Prentice Hall of India Limited, New Delhi.
9. Instrumentation Devices and Systems (*Rangan C. S., Sharma G. R., Mani V. S.*) 2nd edition, Tata McGraw Hill, New Delhi 1997.
10. Digital Measurement Techniques (*Rathore-Narosa T. S.*)
11. Modern Electronic Measurements and Instrumentation (*Oliver and Cage*) MGH.
12. Digital Instrumentation (*Bouwens A. J.*) MGH.
13. Technical Manuals of DSO : APLAB, Scientific, HP etc.
14. Technical Manuals for Virtual CRO.

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Analytical Instrumentation [AI]

S.E. Sem. IV [INST]

EVALUATION SYSTEM

	Time	Marks
Theory Exam	3 Hrs.	100
Practical & Oral Exam	–	–
Oral Exam	–	25
Term Work	–	25

SYLLABUS

1. **Overview and Introduction**
   Introduction to the analytical process and Electromagnetic Spectrum.

2. **Basics of Spectroscopy**
   Laws of photometry – Light and its interaction with matter Introduction to Spectroscopic methods. Components of Optical Systems (viz. Radiation sources and detectors, filters and mono-chromators, signal processors and readouts.)

3. **Atomic Spectroscopy**
   Atomic absorption spectroscopy, Atomic Emission Spectroscopy

4. **Molecular Spectroscopy**
   (a) **Electronic transitions :** Introduction to UV-Visible molecular spectroscopy, Applications of UV-Visible spectroscopy, Fluorescence, phosphorescence and chemiluminescence Raman scattering and Raman spectrophotometer.
   (b) **Nuclear transitions :** Nuclear Magnetic Resonance (NMR)
   (c) **Vibrational excitation :** IR absorption spectroscopy, Applications of Infrared Spectrometry.

5. **Additional Instrumental Methods for Organic Structural Analysis**
   Mass Spectrometry.

6. **Separation Science :**
   Fundamentals of chromatographic separations, Gas chromatography – Gas chromatograph and its components High performance liquid chromatography.

7. **Industrial Gas Analyzers**
   Oxygen, Carbon dioxide, NOx analyzers. Online Gas Analyzers, Nephalometer, Densitometer etc.

8. **Radio Chemical Instrumentation**
   Radio Chemical methods, radiation detectors – ionization chamber. Giger Muller counter, proportional counter, scintillation counter, semiconductor detectors, pulse height analyzer, X-ray spectrometry, X-ray spectrometry, X-ray spectrum, X-ray spectrometry, X-ray diffractometers, X-ray absorption meter.

References :

1. Instrumental Methods of Analysis (*Williard, Merritt, Dean, Settle*) CBS Publishers and Distributors, New Delhi, 7th edition.
2. Handbook of Analytical Instruments (*Khandpur R. S.*) Tata McGraw-Hill Publications, 3rd edition.
3. Thomson Principles of Instrumental Analysis (*Skoog, Holler, Nieman*) Book-cole publications, 5th edition.
4. Instrumental Methods of Chemical Analysis (*Ewing Galen W.*) McGraw-Hill Book Company, 5th edition.
5. Introduction to Instrumental Analysis (*Braun Robert D.*) McGraw-Hill Book Company.
6. Analytical Instrumentation (*Sherman R. E.*) ISA Publication.

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Engineering Mathematics – IV [EM-IV]

S.E. Sem. IV [INST]

EVALUATION SYSTEM

	Time	Marks
Theory Exam	3 Hrs.	100
Practical & Oral Exam	–	–
Oral Exam	–	–
Term Work	–	–

SYLLABUS

1. **Vector Analysis**
   Scalar and vector point functions, curl, gradient and divergence, conservative, irrotational and Solenoidal fields.
   (a) Line Integral, Greens theorem for plane regions and properties of the integral, Stoke's theorem, Gauss's Divergence theorem (without proof) related identities and deductions.

2. **Matrices**
   (a) Types of matrices, adjoint of a matrix, inverse of a matrix, rank of a matrix, linear dependence and independence of rows and columns of a matrix over a real field, reduction to normal form and partitioning of a matrix.
   (b) Systems of homogeneous and non–homogeneous equations, their consistency and solutions.
   (c) Brief revision of vectors over real fields, inner product, norm, linear independence and orthogonality of vectors.
   (d) Characteristics Polynomial, characteristic equation, characteristic roots, and characteristic vectors of square matrix, properties of characteristic roots and vectors of different types of matrices such as orthogonal matrix, Hermitian matrix, skew–Hermitian matrix, Diagonal matrix, Cayley–Hamilton theorem (without proof), functions of square matrix, minimal polynomial and derogatory matrix.
   (e) Quadratic forms, Congruent and orthogonal reduction of quadratic form, rank, index, signature and class value of quadratic form.

3. **Probability and Statistics**
   Concept of probability, conditional probability. Baye's theorem (without proof).
   (a) Random variable : Probability distribution for discrete and continuous random variables. Density function and distribution function. Expected value, variance, moments, moment generating function, binomial, Poisson, normal distributions for detailed study with proof,
   (b) Curve fitting : Correlation, Karl Pearson coefficient and Spearman's rank correlation coefficient (without proof), regression, lines of regression.

References :

1. Textbook of Applied Mathematics (*Wartikkar P. N., Wartikar J. N.*) Pune Vidyarthi Griha Prakashan, 1981.
2. Advanced Engineering Mathematics (*Kreyszig Erwin*) 8th edition, Wiley Student Edition, New Delhi, 2006.
3. Engineering Mathematics (*Shastri S. S.*) Prentice Hall.
4. Matrices (*Shantinarayan*) S. Chand & Co.
5. Mathematical Statistics (*Gupta Kapoor*)
6. Advanced Modern Engineering Mathematics (*Glyn James*) 3rd edition, Pearson Education Ltd., 2004.
7. (*Potter Merle C., Goldberg J. L., Aboufadel Edward F.*) Oxford University Press, Delhi, 2005.

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