Maulana Abul Kalam Azad University of Technology, West Bengal
(Formerly West Bengal University of Technology)
Syllabus for B. Tech in Instrumentation and Control Engineering (ICE)
(Applicable from the academic session 2018-2019)

Semester-V

PC-IC-501	**INDUSTRIAL INSTRUMENTATION**	**3L:0T: 0P**	**3 credits**

Module I : Measurement of Pressure: (**11 hours**)

Manometers –various types, accuracy, ranges.

Elastic Pressure Sensor Instruments –Bourdon gauge, diaphragm type, Bellows element type Pressure and DP switches, D/P transmitters, Electronic type : capacitive, piezoresistive and resonator type. Installation of pressure measuring devices and systems with accessories like seals, snubbers, manifolds.

Vacuum: McLeod Gauge, thermal conductivity gauge, ionization gauge.

Installation Requirements Installation of pressure measuring instruments with accessories like seals, snubbers, 2 valve manifolds Installation of DP measuring instruments with head producing devices.

Module II : Flow rate Measurement: (**11 hours**)

General consideration of fluid flow rate meters, units etc. Laminar flow, Reynolds's number, Effect of temperature and pressure on flow rate measurement, Calibration of flow meters.

Head type: orifice, venturi, Pitot Tube-analysis and calculation. Area flow meter: Rotameter

Mass flow meter: Coriolis, Thermal. Electromagnetic type, Ultrasonic type, Vortex type, Turbomagnetic type, Positive displacement type. Open channel flowmeter. Solid flowrate measuremen

Module III :Level Measurement: (6 hours)

Gauge glass, float, displacers and hydrostatic types - their construction, errors and ranges, D/P type sensors and their installation arrangement.

Capacitive type, Conductivity type ,Bi-colour level gauges, Magnetic level gauges ,Ultrasonic type, Microwave type, Radiation type Level gauges, Level switches

Module IV : Temperature Measurement: (7 hours)

Temperature scale, ITS 90, fixed points .

Filled in systems: liquid, gas and vapour, ranges, media, errors, construction details and comparison, classification.

Bimetal elements, Thermostats,

RTD: measuring circuits, ranges, errors and minimization of errors,

Thermocouples including MI thermocouples: Circuits, ranges, errors, cold junction compensation, compensating cables, Optical Pyrometers.

Module V :Instrumentation in hazardous area: (5 hours)

Material and temperature classification. Intrinsic safety, pressurization, incendiary and non-incendiary systems, Combustible gas detection, enclosures- explosion proof type, other classification. Safety standards: IP and NEMA.

Reference Books:

1. D. Patranabis, Principles of Industrial Instrumentation, TMH, New Delhi, 2nd Ed.

2. B. G. Liptak, Instrument Engineers Handbook, vol-I and vol-II, Chilton Book Co. Philadelphia

3. D. M. Considine and G. D. Considine (Eds.) Process Instruments and controls Handbook, Mc Graw Hill, New York

4. K. Krishnaswami and S. Vijayachitra –Industrial Instrumentation-New age international Publishers (2nd Ed.)

5. *S. K. Singh-Industrial Instrumentation* & Control ,Tata McGraw-Hill

6. Ernest O. Doeblin, Measurement Systems – Application and Design, Tata-McGraw Hill

7. C. R. Alavala, Principles of Industrial Instrumentation and Control Systems, Cengage Learning

8. D.C. Sikdar, Instrumentation & Process Control, Khanna Publishing House (2018)

Course Outcome

1. To understand the purpose of instrumentation in Industrial processes. Know the different types of flow, level, temperature and pressure measuring instrument in industry.
2. To learn working principle of flow, level, temperature and pressure measuring instrument in industry according to basic knowledge of physics.
3. Differentiate merits and demerits and evaluate of different measuring instrument according to their industrial application.

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PC-IC502	**Digital Signal Processing**	**3L:0T:0P**	**3 credits**

Course Outcomes:
At the end of this course, students will demonstrate the ability to
 Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
 Analyse discrete-time systems using z-transform.
 Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
 Design digital filters for various applications.
 Apply digital signal processing for the analysis of real-life signals.

Module 1: Discrete-time signals (5 hours)
Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences,-periodic, energy, power, unit-sample, unit step, unit ramp & complex exponentials, arithmetic operations on sequences.

Module 2: LTI systems (5 hours)
Definition, representation, impulse response, derivation for the output sequence, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples and exercise, properties of convolution, interconnection of LTI systems with physical interpretations, stability and causality conditions, recursive and non recursive systems.

Module 3: Z- Transforms (7 hours)
Definition, mapping between s-plane & z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples & exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z- transform, initial value theorem, Perseval's relation, inverse Z- transform by contour integration, power series & partialfraction expansions with examples and exercises.

Module 4: Discrete and Fast Fourier Transform (10 hours)
Concept and relations for DFT/IDFT, Twiddle factors and their properties, computational burden on direct DFT, DFT/IDFT as linear transformation, DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication

of DFTs, circulation convolution, computation of circular convolution by graphical, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences-Overlap-Save and Overlap-Add methods with examples and exercises.

Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithm, signal flow graph, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises.

Module 5: Filter design (7 hours)
Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analog filter using impulse invariant and bilinear transform, design of linear phase FIR filters, no. of taps, rectangular, Hamming and Blackman windows.

Module 6: Applications of Digital Signal Processing (6 hours)
Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Text/Reference Books:
1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
3. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms And Applications",
Prentice Hall, 1997.
4. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
5. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
6. D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

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PC-IC 503	**Control Systems II**	**3L:0T:0P**	**3 credits**

At the end of this course, students will demonstrate the ability to
- Design State variable model of continuous dynamic systems
- Solve open allocation problems.
- Analyse the stability of non linear system.
- understand state regulator problem.

Module 1: State variable model of continuous dynamic systems (16 hours)
Converting higher order linear differential equation into state variable (SV) form. Obtaining SV model from transfer function. Obtaining characteristic equation and transfer functions from SV model. Obtaining SV equations directly from R-L-C and Spring-Mass-Dashpot systems. Concept and properties associated with state equations. Linear Transformations on state variables. Canonical forms of SV equations. Companion forms. Solutions of state equations. State transition matrix. Properties of state transition matrix.Controllability and observability. Linear state variable feedback controller. The pole allocation problems. Linear system design by state variable feedback. State oberver design.

Module 2: Introduction to nonlinear system (16 hours)
Block diagram and state variable representations. Characteristics of common nonlinearities. Phase plane analysis of linear and non-linear second order systems. Methods of obtaining phase plane trajectories by graphical method-isoclines method. Qualitative analysis of simple control systems by phase plane methods. Describing function method. Limit cycles in non-linear systems. Prediction of limit cycles using describing function. Stability concepts for nonlinear systems. BIBO vs. State stability. Lyapunov's definition. Asymptotic stability. Global asymptotic stability. The first and second methods of Lyapunov to analyze non-linear systems.

Module 3: Optimal Control (8 hours)
Formulation of optimal control problem. Minimum time, Minimum energy, minimum fuel problems.State regulator problem. Output regulator problem. Tracking problem, Continuous-Time Linear Regulators.

Text Books :
1. Digital control and state variables, M.Gopal , 4th Edition, McGraw Hill

2. Control System Engineering, D. Roy Choudhuri, PHI
3. Control Systems, A. Ambikapathy, Khanna Publishing House
4. Control System Engineering, I.J. Nagrath& M. Gopal, New Age International.
5. Introduction to control Systems, D.K. Anand& R.B. Zmood, 3rd Edition, (Butterworth-Heiemann), Asian Books.

PE-IC501	**Optical Instrumentation**	**3L:0T:0P**	**3 credits**

Module I

Optoelectronics: Characteristics of optical emission, electro-luminescence. LED: Power and efficiency calculation, Structure of LED and its characteristics, Heterojunction LED	4
Laser: semiconductor based lasers - double heterojunction broad area laser, stripe geometry DH laser,.	2

Module II

Photo diode: PIN photodiode, hetero junction diode, Avalanche Photo diode, Phototransistor. LDR, photovoltaic cells, photo emissive cells - types, materials, construction, response, opto-couplers – characteristics, noise figures, applications in analogue and digital devices.	3 6

Module III

Fiber optics: Optical fibre – materials, construction, step index and graded index fibres, ray propagation, attenuation. Modes in optical fibres, intermodal dispersion.	3
singlemode fibre- working principle, attenuation, dispersion and bandwidth. Multimode fibre- attenuation, dispersion. propagation of EM waves, fibre coupling.	5

Module IV

Fibre-optic sensors: classification. Intensity modulated sensors, phase modulated sensors, spectrally modulated sensors.	3
Fibre optic sensors for Industrial applications: temperature, displacement, pressure and liquid-level sensors.	4
Total	30

Books:

1. P. Bhattacharjee, Semiconductor Optoelectronic Devices, PHI
2. W. Hawkes, Optoelectronics- An Introduction, PHI
3. C. K. Sarkar, Optoelectronics and Fiberoptics communication, New Age International
4. John M. Senior, Optical Fibre Communications, PHI
5. Culshaw B. and Dakin J(Ed) - Optical Fibre Sensors, Vol.1.2 Artech House, 1989.
6. Chin-Lin-Chon -Elements of Optoelectronic & Fibre Option, MGH

PE-IC502	**Introduction to MEMS**	**3L:0T:0P**	**3 credits**

Introduction and Historical Background, Scaling Effects. Micro/Nano Sensors, Actuators and Systems overview: Case studies. Review of Basic MEMS fabrication modules: Oxidation, Deposition Techniques, Lithography (LIGA), and Etching. Micromachining: Surface Micromachining, sacrificial layer processes, Stiction; Bulk Micromachining, Isotropic Etching and Anisotropic Etching, Wafer Bonding. Mechanics of solids in MEMS/NEMS: Stresses, Strain, Hookes's law, Poisson effect, Linear Thermal Expansion, Bending; Energy methods, Overview of Finite Element Method, Modeling of Coupled Electromechanical Systems.

Text/Reference Book:

1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalkrishnan K. N. Bhat, V. K. Aatre, Micro and Smart Systems, Wiley India, 2012.

2. S. E.Lyshevski, Nano-and Micro-Electromechanical systems: Fundamentals of Nano-and Microengineering (Vol. 8). CRC press, (2005).

3. S. D. Senturia, Microsystem Design, Kluwer Academic Publishers, 2001.
4. M. Madou, Fundamentals of Microfabrication, CRC Press, 1997.

5. G. Kovacs, Micromachined Transducers Sourcebook, McGraw-Hill, Boston, 1998.

6. M.H. Bao, Micromechanical Transducers: Pressure sensors, accelerometers, and Gyroscopes, Elsevier, New York, 2000.

Course Outcomes:
At the end of the course the students will be able to
1. Appreciate the underlying working principles of MEMS and NEMS devices.
2. Design and model MEMS devices.

OE-IC-501	**EMBEDDED SYSTEM**	**3L:0T:0P**	**3 credits**

Module 1: Introduction to Embedded systems: (10 hours)
Introduction – Features – Microprocessors – ALU - Von Neumann and Harvard Architecture - CISC and RISC - Instruction pipelining.
Microcontroller: characteristics and Features, Overview and architectures of Atmel 89C52 and Microchip PIC16F877 and 18F452. Examples of embedded Systems: Bar-code scanner, Laser printer, Underground tank monitoring.
Module 2: PIC Microcontroller: (08 **hours)**
PIC Microcontrollers: 16F877 Architecture and Instruction Set. External Interrupts, Timers,
watch-dog timer, I/O port Expansion, analog-to-digital converter, UART, I2C and SPI Bus for
Peripheral Chips, Accessories and special features

Module 3: Software architecture and RTOS: (08 **hours)**
Software Architecture: Round Robin- Round Robin with interrupts -Function Queue. Scheduling
Architecture RTOS: Architecture -Tasks and Task States -Tasks and Data - Semaphores and
Shared Data - Message Queues -Mail Boxes and pipes -Timer Functions -Events - Memory Management Interrupt, Routines.

Module 4: Basic design using a real time operating system: (06 **hours)**
Overview. General principles. Design of an embedded system.

Module 5: Software development tools and debugging techniques: (08 **hours)**
Development Tool: Cross-Compiler, Cross-Assemblers, Linker/locator. PROM Programmers, ROM Emulator, In-Circuit Emulators. Debugging Techniques. Instruction set simulators. The assert macro. Testing using laboratory tools.

Text Books:
1. Raj Kamal, Embedded Systems Architecture, Programming and Design, TMH, 2008.
2. Simon, D. E., An Embedded Software Primer, Pearson Education, 1999.
3. Peatman, J. B., Design with PIC Microcontrollers, Pearson Education, 1998

Reference Books:
1. Steve Heath Embedded Systems Design, Second Edition-2003, Newnes,
2. Wayne Wolf, Computers as Components; Principles of Embedded Computing System Design – Harcourt India, Morgan Kaufman Publishers, First Indian Reprint. 2001
3. Frank Vahid and Tony Givargis, Embedded Systems Design – A unified Hardware/Software Introduction, John Wiley, 2002.

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OE-IC-502	**DATA BASE MANAGEMENT SYSTEM**	**3L:0T:0P**	**3 credits**

Module 1: Introduction: (04 hours)
Concept & Overview of DBMS, Data model, Database language, Database administrator, Database users, Three Schema architecture of DBMS.
Module 2: **Entity-Relationship Model: (06 hours)**
Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity sets, Extended E-R features.

Module 3: **Relational Model: (**05 **hours)**
Structure of relational Databases, Relational Algebra, Relational; calculus, Extended Relational Algebra operations, Views, Modification of the Database.

Module 4: **SQL and Integrity Constraints: (**08 **hours)**
Concept of DDL, DML, DCL. Basic structure, Set operations, Aggregate functions, Null values, Domain constraints, Referential integrity, Constraints, assertions, views, Nested sub queries, Data base security application development using SQL, Stored procedures and triggers.

Module 5: **Relational Database design: (**09 **hours)**
Functional dependency, Different anomalies in designing a Database, Normalization using functional dependencies, Decomposition, Boyce-Codd normal form, 3NF, Normalization using multi-valued dependencies, 4NF, 5 NF.

Module 6: **Internal of RDBMS: (**07 **hours)**
Physical data structures, Query optimization: join algorithm, statistics and cost base optimization, Transaction processing, Concurrency control and recovery management: transaction model properties, state serializability, look base protocols, two phase locking.

Module 7: **File organization & index structures : (**05 **hours)**
File & records concepts, Placing file records on disk, Fixed and variable sized recotds, Types of single –Level index (primary. Secondary, clustering), Multilevel Indexes, Dynamic multilevel indexes using B tree and B+ tree.

Text Books:
1. Database System Concepts, F. Henry & Abraham Silderscharz, McGraw Hill.
2. Database Management system, Ramakrishnan, McGraw Hill.
3. Principles of Database Systems, J.D. Ullman, Galgotia Publication.
4. Database Management Systems, R.P. Mahapatra, Khanna Publishing House
Reference Books:

1. Principles of Database Management Systems. Martin James. PHI.
2. Database management Systems, A.K. Majumder & Pritimaybhattacharjya, Tata McGraw Hill.

HM-HU-501	**Economics for Engineers**	**3L:0T:0P**	**3 credits**

1. Economic Decisions Making – Overview, Problems, Role, Decision making process.

2. Engineering Costs & Estimation – Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models - Per-Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits.

3. Cash Flow, Interest and Equivalence: Cash Flow – Diagrams, Categories & Computation, Time Value Of Money, Debt repayment, Nominal & Effective Interest.

4. Present Worth Analysis : End-Of-Year Convention, Viewpoint Of Economic Analysis Studies, Borrowed Money Viewpoint, Effect Of Inflation & Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives.

5. Cash Flow & Rate Of Return Analysis – Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate Of Return, Calculating Rate Of Return, Incremental Analysis; Best Alternative Choosing An Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity And Breakeven Analysis. Economic Analysis In The Public Sector - Quantifying And Valuing Benefits & drawbacks.

6. Uncertainty In Future Events - Estimates And Their Use In Economic Analysis, Range Of Estimates, Probability, Joint Probability Distributions, Expected Value, Economic Decision Trees, Risk, Risk vs Return, Simulation, Real Options.

7. Depreciation - Basic Aspects, Deterioration & Obsolescence, Depreciation And Expenses, Types Of Property, Depreciation Calculation Fundamentals, Depreciation And Capital Allowance Methods, Straight-Line Depreciation Declining Balance Depreciation, Common Elements Of Tax Regulations For Depreciation And Capital Allowances.

8. Replacement Analysis - Replacement Analysis Decision Map, Minimum Cost Life Of A New Asset, Marginal Cost, Minimum Cost Life Problems.

9. Inflation And Price Change – Definition, Effects, Causes, Price Change With Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates.

10. Accounting – Function, Balance Sheet, Income Statement, Financial Ratios Capital Transactions, Cost Accounting, Direct and Indirect Costs, Indirect Cost Allocation.

Text Books:

1. Premvir Kapoor, Sociology & Economics for Engineers, Khanna Publishing House
2. James L.Riggs,David D. Bedworth, Sabah U. Randhawa : Economics for Engineers 4e , Tata McGraw-Hill

3. Donald Newnan, Ted Eschembach, Jerome Lavelle : Engineering Economics Analysis, OUP
4. John A. White, Kenneth E.Case,DavidB.Pratt : Principle of Engineering Economic Analysis, John Wiley
5. Sullivan and Wicks: Engineering Economy, Pearson
6. R.PaneerSeelvan: Engineering Economics, PHI
7. Michael R Lindeburg : Engineering Economics Analysis, Professional Pub.

PC-IC591	**Industrial Instrumentation Lab**	**0L:0T:3P**	**1.5 credits**

1. Calibration of Pressure Gauge using Dead Weight Tester.
2. Measurements of flow rate Reynolds's No. of fluid flow by head type flow meter.
3. Measurements of flow rate and velocity of fluid flow by Variable Area type flow meter and also the accuracy of the system.
4. Measurement of level using capacitive type level instrument.
5. Study of Thermocouple characteristics and Measurement of Temperature with it.
6. Study of RTD characteristics and Measurement of Temperature with it.
7. Measurement of viscosity.

PC-IC592	**Control System II Lab**	**0L:0T:3P**	**1.5 credits**

CONTROL SYSTEM II LABORATORY

1. Study of a practical position control system. To obtain closed step response for over damped and under damped condition with gain setting. To determine the rise time and peak time using individualized components in SIMULINK.

Determination of undamped natural frequency and damping ration from experimental data.

2. Tuning of P, PI and PID controller for first order plant with dead time using Z-N method. To compute controller gain by Z-N method for the process parameter (time constant and delay/lag) provided. The steady state and transient performance of the closed loop plant with and without steady disturbances to be noted. Theoretical phase and gain margins to be manually computed for each gain setting.

3. Design of Lead and Lag compensation. Step response to be obtained with the plant transfer function provided.

4. State variable analysis. To obtain
(a) Transfer function from SV model and vice versa.
(b) Step response for a SISO system in SV form.

5. State variable analysis. To obtain step response and initial condition response for a single input, two output system given in SV form.

6. Performance analysis of a discrete time system. Study of closed response of a continuous system with a digital controller with sample and hold circuit.

8. Study of the effects of nonlinearity in a feedback controlled system using time response. To determine of step response with limiter nonlinearity introduced into the forward path of 2nd order.

OE-IC591	**Embedded System Laboratory**	**0L:0T:3P**	**1.5 credits**

1. Familiarization with a microcontroller kit (and its associated PC based development system).Entering and executing a program, interfacing a LED matrix and display a specific pattern (digit) on the matrix.
2. Key board-MCU interfacing: Interfacing a 4X4 switch matrix with microcontroller-
   Detect keyboard operation through interrupt, take an input from the keyboard and display the data on an LED Matrix.

3. Generation of triangular wave analog signal by PWM, triggering through internal timer.
4. MCU-DAC interfacing and generation of triangular wave, triggering through timer (on chip timer).
5. MCU interfacing and displaying a string in an LCD Display.
6. Interfacing of an ADC and data transfer by software polling.
7. ADC triggering through timer(on chip timer),Interrupt driven data transfer from ADC.
8. Stepper motor position control using a Microcontroller. Generating a periodic staircase triangular wave position pattern with a fixed time period. Recording the rotor position in a video.
9. Serial communication between Microcontroller and PC.
10. Temperature control (PD and PID) using a microcontroller and PWM output.

Reference Books:

1. Stuart Ball, ”Analog Interfacing to Embedded Microprocessor-Real World Design”, Newnes & Butterworth-Heinemann,2001.
2. Dogan Ibrahim, ”Microcontroller based Applied Digital Control” John Wiley & Sons Ltd,2006.
3. Rob Williams, ”Real-Time Systems development”, Butterworth-Heinemann (Elsevier)2006.

OE-IC592	**Data Base Management System Laboratory**	**0L:0T:3P**	**1.5 credits**

1. Creating Database:

· Creating a Database
· Creating a table
· Specifying Relational Data Types
· Specifying Constraints
· Creating Indexes.

2. Table and record Handling

a. INSERT statement

b. Using SELECT and INSERT together

c. DELETE, UPDATE, TRUNCATE statements

d. DROP, ALTER statements

3. Retrieving Data from Database

· The SELECT statement

· Using the WHERE clause

· Using Logical Operators in the WHERE clause

· Using IN, BETWEEN, LIKE, ORDER,BY GROUP BY and HAVING

4. Clause

· Using AGGREGATE function

· Combining Tables using JOINS

· Sub queries

5. Database Management.

· Creating views

· Creating Column Aliases

· Creating Database Users

· Using GRANT and REVOKE