VIII Semester B.E.
Instrumentation Engineering

EIGHTH SEMESTER B.E. INSTRUMENTATION ENGINEERING

Course Code: IN801
Title of the Course: Analytical Instrumentation and Pollution Control

Course Scheme					Evaluation Scheme (Theory)				
Lecture	Tutorial	Practical	Periods/ week	Credits	Duration of paper (in hrs)	MSE	IE	ESE	Total
3	1	0	4	3	3	10	10	80	100

Unit	Contents	Hours
1	Introduction to Chemical instrumental analysis, advantages over classical methods, classification: Spectral, electro analytical and separative methods, Interaction of radiation with matter, Laws of photometry (Beer and Lambert's law), Deviation from Beer's law, working of filters, prism and grating, monochromators, concept of design of analytical instrument	09
2	Colorimeters, online colorimeter for process applications, turbidity meter, UV-Visible spectrophotometers and its types with its optical system design, IR spectrophotometers, X-ray spectroscopy	09
3	Emission Spectra, Quantitative measurements, Flame Photometer and its applications , concept of design atomic absorption spectrophotometer, spectrum interpretation, interferences, applications of atomic absorption spectrophotometer.	09
4	Classification of Chromatographic methods, Gas chromatography, Process Gas Chromatograph, Liquid Chromatography, High Performance Liquid Chromatography	09
5	Different types of gas analyzers for measurement of Oxygen, NO2, CO, ammonia, carbon dioxide and hydrocarbons, Real world applications: Environmental monitoring system, real time gas leakage monitoring working principle and applications of laboratory instruments: centrifuge, oven, stirrers.	09
	Total	45

Text Book:

1. Willard, Merritt, John Aurie Dean, "Instrumental Methods of Analysis", CBS Publishers & Distributors, New Delhi, Seventh ed., 1988.
2. R. S. Khandpur, "Handbook of Analytical Instruments", Tata McGraw–Hill Publications, Second ed., 2006.

Reference Books:

1. Bela G Liptak, "Analytical Instrumentation Handbook", Chilton, Second ed., 1994.

EIGHTH SEMESTER B.E. INSTRUMENTATION ENGINEERING

Course Code: IN802
Title of the Course: Process Modeling and Optimization

Course Scheme					Evaluation Scheme (Theory)				
Lecture	Tutorial	Practical	Periods/ Week	Credits	Duration of paper (in hrs)	MSE	IE	ESE	Total
3	1	0	4	3	3	10	10	80	100

Units	Contents	Hours
1	**Mathematical models of Physical and Chemical systems:** System modeling: Principles of formulation and applications of mathematical models. Different types of models: White box model (using fundamental physical and chemical laws), Black box model (using input-output data), Gray box model. Fundamental laws: Continuity equations, Energy equation, Equations of motion, Equations of state, Equilibrium, Chemical kinetics. Examples of models: Modeling of CSTR's (isothermal, non-isothermal, constant holdup, variable holdup), Batch reactor, Ideal binary distillation column, Stirred tank heater (mixing tank), Field controlled and Armature controlled D.C. Motors.	10
2	**Numerical methods for solving algebraic and differential equations and curve fitting:** Solution of algebraic equations: Interval halving method, Newton Raphson method. Solution of differential equations: Euler method, Modified Euler method, Runge Kutta methods (2nd and 4th order), Adom Bashforth method. Curve fitting: Lagrange interpolation method, Least squares method.	10
3	**Modeling of Mechanical, Chemical systems:** Reaction dynamics, Modeling the chemical reactions, CSTR models, Plug flow reactor model, modeling of flash drum, Distillation columns, evaporators, dryers, heat exchangers.	07
4	**Basic concepts of optimization and unconstrained optimization:** Basic concept of optimization: Continuity of functions, Concave and convex functions, Unimodal and Multimodal functions, Necessary and sufficiency condition for an extremum of an unconstrained function. Unconstrained single-variable optimization: scanning and bracketing procedures. Numerical methods: Newton, Quasi Newton and Secant methods. Unconstrained Multivariable optimization: Direct methods: Conjugate search directions, Powell's method. Indirect methods: Gradient methods, Conjugate gradient method, Newton's method.	10
5	**Constrained optimization:** Linear and nonlinear programming. Linear programming: Degeneracy, Graphical method, Simplex method, Karmarkar Algorithm. Nonlinear programming: Lagrange multiplier method, Quadratic Programming.	08
		45

Text Books:

1. W. L. Luyben, "Process, Modeling, Simulation and Control for Chemical Engineers", McGraw Hill Publications.
2. T. F. Edgar, D. M. Himmelblau, "Optimization of Chemical Processes", McGraw Hill Publications.

Reference Books:

1. B. S. Grewal, “Higher Engineering Mathematics”, Khanna Publications
2. Singiresu S. Rao, Engineering Optimization (Theory & Practice), third Edition, New Age International(p) Ltd, Publishers.

EIGHTH SEMESTER B.E. INSTRUMENTATION ENGINEERING

Course Code: IN803
Title of the Course: Project Planning Estimation and Assessment

Course Scheme					Evaluation Scheme (Theory)				
Lecture	Tutorial	Practical	Periods/ Week	Credits	Duration of paper (in hrs)	MSE	IE	ESE	Total
3	1	0	4	3	3	10	10	80	100

Units	Contents	Hours
1	**Introduction to Project Engineering**: Project, Project Management & Report, structure, flow and deliverables, Project Planning and Scheduling, project scheduling estimating, configuration management, manpower planning, and degree of automation. The Project Team: Customer, designer and constructor.	10
2	**Standards used in instrumentation project:** ISA, ANSI, ASME, NFPA, NEMA, DIN, PIP, IEEE, ISO, SAMA Standard. **Project Documents and drawings.** Need for Engineering Documents, General Guidelines for Development of Documents, project stage**,** purpose, scope, contents, references for document, team of creation and users. Major Project Documents: Process Flow Diagram, Piping and Instrumentation diagrams (P&ID) - practical applications, Instrument Index Sheet, Instrument specifications sheet- for temperature, pressure, level, flow instruments and control valves, Instrument Location Plan, Cable Schedule, Junction Box Schedule, Utility requirement, Air header schedule, Instrument Hook- up diagrams - for control valve, transmitters (DP in liquid service, dry gas service,) Thermocouple, Temperature switch line mounted, flow transmitter, typical level switch, typical instrument air supply, connections for air supply and output. etc., Loop diagrams- pneumatic, electronic and digital data types, Logic diagrams.	10
3	**Procurement, Construction & Estimation:** **Procurement:** Engineering Procurement procedure, steps in purchasing, PO format, preparation and types of tender documents, bids, technical bid evaluation, Inspection: Need for Inspection, Documents for Inspection, General Inspection Guidelines, **Construction :** Site selection, bill of material, contracting, Factory acceptance test (FAT), Site acceptance test (SAT) & Customer Acceptance Test (CAT), check lists, bid analysis, **Estimation:**Types of Estimates, pricing process, salary overheads, labour hours, material and support costs, CPM & PERT.	09
4	**Installation and Commissioning:** Installation of instruments**,** Installation standards, installation sketches, installation details of systems – pressure, flow, temperature, etc., storage & fitting, cable laying (cable trays, cable types, cable glands, ferruling and terminations), Networking, tubing, instrument installation guidelines. **Commissioning:** Pre-commissioning Procedures, cold commissioning and hot commissioning, loop & hardware check out procedures, system check, punch list, correction verification, calibration, testing of instruments, operation and maintenance manual, commissioning Procedures, process startup, Onsite training.	08
5	**Control Centers and Panels:** Control room layout, control room engineering & significance, engineering aspects	08

	and design criteria, Control panels types, panel layout, panel piping and tubing, panel drawing, nameplate, tags and graphics display, panel inspection, Advantages of using software packages for documentation. Overview of documentation software packages used in industry like SPI -In tools.	
	Total	45

Text Books:

1. Andrew Williams, Applied instrumentation in the process industries, 2nd Edition, Vol. 1 & 2, Gulf publishing company.
2. Management systems, "John Bacon", (ISA).
3. Instrument installation project management, "John Bacon", (ISA).
4. H. H. Shah, Project: Engineering, Planning & Management, Chinttan Publication.

Reference Books:

1. Bela Liptak, Instrumentation engineering handbook, Vol-1,2
2. Michael D. Whitt, Successful Instrumentation and Control Systems Design, ISA Publication.
3. Installation of Instrumentation & Process control systems- EEUA Handbook.
4. Instrumentation engineering handbook by Considine.

EIGHTH SEMESTER B.E. INSTRUMENTATION ENGINEERING

Course Code: IN804 Elective-II (i)
Title of the Course: Elective-II: Digital Control System

Course Scheme					Evaluation Scheme (Theory)				
Lecture	Tutorial	Practical	Periods/ Week	Credits	Duration of paper (in hrs)	MSE	IE	ESE	Total
3	1	0	4	4	3	10	10	80	100

Units	Contents	Hours
1	**Introduction to Digital Control System:** Block diagram of Digital Control System, Advantages & limitations of Digital Control System, comparison of continuous data & discrete data control system, Examples of digital control system, data conversion and quantization, sampling period considerations, sampling as impulse modulation, sampled spectra & aliasing, principles of discretization, impulse invariance, finite difference approximation of derivatives, rectangular rules for integration, Bilinear transformation.	04
2	**Sampled Data Control System:** Introduction, sampling process, system representation in terms of difference equations, Realizations, The Z transform and Z transfer function, Inverse Z transform and response of linear discrete system. Z- transform analysis of sampled data control system. Z and S domain relationship. Pulse transfer function, zero order hold, Steady state error analysis.	12
3	**Stability Analysis:** Jury's stability test, bilinear transformation, Z domain Nyquist stability, stability analysis using root locus diagram. Correlation between time response and root locus in the Z plane and S plane.	06
4	**State Variable Method:** Discrete time state equations, similarity transformations, state diagrams, Realization of pulse transfer function, direct, cascade, parallel realizations, solution of discrete state equations, Controllability and observability of discrete systems. Pole placement, Lyapunov stability analysis.	12
5	**Design and Compensation:** Design of sampled data control system. Cascade compensation, DIR method, lead, lag, lag- lead compensators, Digital compensator design using root locus plots, Digital compensator design using Frequency response plots. PID controllers. Deadbeat algorithm.	11
	Total	45

Text Books:

1. M. Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill, 2ndEdition, March 2003.
2. K. Ogata, "Discrete Time Control Systems", Pearson Education Inc., 1995.
3. B.C. Kuo, "Digital Control Systems", Saunders College Publishing, 1992.

Reference Books:

1. Krishna Kant (1998), Computer based Industrial control PHI.

EIGHTH SEMESTER B.E. INSTRUMENTATION ENGINEERING

Course Code: IN 804 Elective –II (ii)
Title of the Course: Elective –II: Micro Electro Mechanical Systems

Course Scheme					Evaluation Scheme (Theory)				
Lecture	Tutorial	Practical	Periods/ week	Credits	Duration of paper (in hrs)	MSE	IE	ESE	Total
3	1	3	4	4	3	10	10	80	100

Units	Contents	Hours
1	**Introduction:** Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators –Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis– Flexural beam bending- Torsional deflection.	9
2	**Sensors And Actuators-I:** Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor –Comb drive devices – Thermal Sensing and Actuation – Thermal expansion – Thermal couples –Thermal resistors – Applications – Magnetic Actuators – Micro magnetic components.	9
3	**Sensors And Actuators-II:** Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements –Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators –piezoelectric effects –piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flowsensors.	9
4	**Micromachining:** Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching –Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies –Basic surface micromachining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – Assembly of 3D MEMS – Foundry process.	9
5	**Polymer And Optical MEMS:** Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene –Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS –Lenses and Mirrors – Actuators for Active Optical MEMS.	9
	Total	45

Text Book:

1. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2006.

Reference Books:

1. Nadim Maluf, "An introduction to Micro electro mechanical system design", Artech House, 2000.
2. Mohamed Gad-el-Hak, editor, "The MEMS Handbook", CRC press Baco Raton, 2000.
3. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.
4. Julian w. Gardner, Vijay k. varadan, Osama O. Awadelkarim, micro sensors mems and smart devices, John Wiley & son LTD,2002

EIGHTH SEMESTER B.E. INSTRUMENTATION ENGINEERING

Course Code: IN804 Elective-II (iii)
Title of the Course: Elective-II: Robotic Systems and Control

Course Scheme					Evaluation Scheme (Theory)				
Lecture	Tutorial	Practical	Periods/ Week	Credits	Duration of paper (in hrs)	MSE	IE	ESE	Total
3	1	0	4	4	3	10	10	80	100

Units	Contents	Hours
1	**Introduction:** Introduction to robotics, Components and Structure of Robots, Common Kinematic arrangements, Rotations, Composition of Rotations, Properties, Homogeneous Transformation, Skew symmetric Matrices, Angular Velocity and Acceleration, additional of angular velocities.	09
2	**Forward and Velocity Kinematics:** Kinematic Chains, Denavit-Hartenberg Representation, Derivation of the Jacobian, Examples, Singularities, Inverse Velocity and acceleration. **Dynamics:** Euler-Lagrange Equations, Expressions for kinetic and potential energy, Equation of Motions, Common configuration, Newton Euler Formulation, Planor Elbow Manipulator Revisited.	12
3	**Controls:** Introduction, Actuator dynamics, Set-Point Tracking, Drive Train Dynamics, Trajectory Interpolation, Feed forward Control and Computed Torque, PD control revisited, Inverse Dynamics, Implementation and Robustness Issues, Robust outer loop design.	11
4	**Force Control:** Natural and artificial constraints, stiffness and compliance, Inverse response in task space, Impedance Control, Hybrid Position/Force Control	05
5	**Feedback Linearization:** The Frobenius theorem, Single-Input Systems, Feedback Linearization for N-Link Robots, Introduction to outer loop design-Lyapunov's Second Method, Methods of Sliding Modes.	08
	Total	45

Text Book:

1. Mark W. Spong & M. Vidyasagar. "Robot Dynamics and Control", Willey India Publisher, 2009. ISBN: 978-81-265-1780-0.
2. Lee, K.S. Fu, R.C. Gonzalez & C.S.G - Robotics, McGraw Hill.
3. Bruno Sicilian (1996) - Modelling and controlling of Robot manipulations, Lorenzo Seivicco, TMH.

Reference Books:

1. Wolfram Stadler (1995) - Analytical robotics and Mechatronics, TMH.
2. Robert J. Schilling (1996) - Fundamentals of Robotics Analysis and control, PHI.

EIGHTH SEMESTER B.E. INSTRUMENTATION ENGINEERING

Course Code: IN804 Elective-II (iv)
Title of the Course: Elective-II: Wireless Sensor Network

Course Scheme					Evaluation Scheme (Theory)				
Lecture	Tutorial	Practical	Periods/ Week	Credits	Duration of paper (in hrs)	MSE	IE	ESE	Total
3	1	0	4	4	3	10	10	80	100

Units	Contents	Hours
1	Introduction and Overview of Wireless Sensor Networks, Commercial and Scientific Applications of Wireless Sensor Networks, Basic Wireless Sensor Technology, Sensor Taxonomy, wireless network environment, wireless network trends.	09
2	Sensors Network Protocols, Data dissemination and gathering, Routing Challenges and design issues in wireless sensor network, Routing strategies in WSN.	09
3	Radio technology primer, Available wireless technologies, Wireless Sensors Networks Protocols, Physical Layer, Fundamentals of Medium Access Control Protocols for Wireless Sensor Networks, MAC protocols for WSN, Case Study, IEEE 802.15 4LR WPAN, Standard case study.	09
4	Protocols, Transport Control Protocols for Wireless Sensors Networks, Traditional transport control protocol, transport protocol design issues, examples of existing transport control protocol, performance of TCP.	09
5	Middleware for Sensor Networks, WSN middleware principles, Middleware architecture, existing middleware.	09
	Total	45

Text Books:

1. Morgan Kaufmann F. Zhao and L. Guibas, 'Wireless Sensor Networks', a Francisco, 2004.
2. C. S. Raghavendra, Krishna M. Sivalingam, Taieb F. Znati , 'Wireless sensor networks', Edition: 2, Published by Springer, 2004 ISBN 1402078838, 9781402078835

Reference Books:

1. "Wireless Sensor Networks: Technology, Protocols, and Applications", Kazem Sohraby, Daniel, Minoli, Taieb Znati, WIey Interscience Publication, 2007
2. "Computer Networks" ,Andrew Tanenbaum, 4th ed., Pearson Education,2007

EIGHTH SEMESTER B.E. INSTRUMENTATION ENGINEERING

Course Code: IN805
Title of the Course: Analytical Instrumentation and Pollution Control (Practical)

Course Scheme				Evaluation Scheme (Laboratory)		
Lecture	Tutorial	Practical	Credits	TW	POE	Total
0	0	3	2	25	25	50

Course Objectives:

The content aims to develop the knowledge of the student in the direction of the different tools used for analysis of different components in the chemicals and also be able to measure & control the components of pollution.

List of Experiments:

Students are expected to perform Minimum 8 Experiments:

1. Study of filter photometer.
2. Study of flame photometer.
3. Study of optical densitometer.
4. Study of UV visible spectrophotometer.
5. Study of Mass spectrometer.
6. Study of Gas Chromatograph.
7. Study of HPLC.
8. Study of Atomic Absorption Spectrophotometer.
9. Study of NMR.
10. Study of ESR.

Course Outcomes:

Students are able to identify the contents of any type of the chemicals, its concentration in that chemical & control that concentration or contents by applying different control techniques.

EIGHTH SEMESTER B.E. INSTRUMENTATION ENGINEERING

Course Code: IN806
Title of the Course: Process Modelling and Optimization (Practical)

Course Scheme				Evaluation Scheme (Laboratory)		
Lecture	Tutorial	Practical	Credits	TW	POE	Total
0	0	3	2	25	25	50

Course Objectives:

The content aims to develop the knowledge of the student in the direction of the different tools used for processes modeling and optimization.

Maximum 10 experiments are to be performed from the list given below. (At-least 08 experiments are to be performed in addition to 02 demonstration experiments).

Term Work (TW) & POE:

Term work and practical/Oral examination shall consist of at least ten experiments based on contents of syllabi given in the course code IN806 in the form of a journal and necessary documentation.

Suggested list of Experiments:

1. Analysis of first/second order system by using step and ramp input.
2. Obtaining mathematical modeling of electrical/ mechanical system by first principle.
3. Obtaining mathematical modeling of liquid level system.
4. Simulation of CSTR system (In series) using MATLAB
5. Simulation of CSTR system (In Parallel) using MATLAB
6. Solving differential equation using Euler's method
7. Solving differential equation using Runge-Kutta 2^{nd} and 4^{th} order method.
8. Solving differential equation using Adams Bashforth method
9. Obtaining unknown parameters of second order process by least square technique.
10. Obtaining Relative gain array of any MIMO physical system.
11. Obtaining inverse Nyquist array of any Physical system.
12. Design of optimal control system by using quadratic approximation.
13. Analysis and comparisons of Quasi-Newton and secant methods

Course Outcomes:

Students will be able to do experiments based on syllabus using proper methodology and understand ethical issues, environmental impact and acquire management skills.

EIGHTH SEMESTER B.E. INSTRUMENTATION ENGINEERING

Course Code: IN807
Title of the Course: Project Planning Estimation and Assessment (Practical)

Course Scheme				Evaluation Scheme (Laboratory)		
Lecture	Tutorial	Practical	Credits	TW	POE	Total
0	0	3	2	25	25	50

Course Objectives:

The main objective of this subject is to represent the project and its birth and whole implementation into a large group activity into an engineering industry.
By studying this subject, the students will be able – to understand project structure, its management, planning & scheduling, various types of standard, instrumentation project drawing and documentation, installation & commissioning process of instrumentation, need of control room, panel arrangement & layouts.

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List of Experiments:

1. Develop & draw the project report format on drawing sheet.
2. Develop & draw the structure of Project Management.
3. Develop & draw the Piping & Instrumentation Diagrams (P & ID).
4. Develop & draw the Process Flow Sheet.
5. Develop & draw the Instrumentation Index Sheet.
6. Develop & draw the Instrumentation Specification Sheet.
7. Develop & draw the Loop Wiring Diagrams.
8. Develop & draw the purchase requisition note & purchase order form.
9. Develop & draw the installation diagram of typical level switch, in-line transmitting rotameter and dp sensing instrument in liquid service.
10. Develop & draw classification of cables & network topology.
11. Develop & draw the Control Room layouts.
12. Develop & draw the various Control Panels.

Note: Term work shall include minimum **8** experiments from above list.

Course Outcomes:

After studying this subject the students are able to understand the instrumentation project & its implementation in the real world. They are able to select particular standards for the specific items, need of documentation & drawings, and the process of installation & commissioning of the industry, purpose of control room & control panel's layouts in the industry.

EIGHTH SEMESTER B.E. INSTRUMENTATION ENGINEERING

Course Code: IN808
Title of the Course: Major Project Phase –II (Practical)

Course Scheme					Evaluation Scheme(Laboratory)		
Lecture	Tutorial	Practical	Periods/ week	Credits	TW	POE	Total
0	0	6	3	6	50	50	100

- The Major Project work Phase-II is to be conducted in continuation of the project work Phase-I which is to be carried out in the institution/industry/research laboratory.
- The duration of project work should be a minimum of two semesters (Project Phase –I & II).
- There will be a mid-semester evaluation of the project work done after about two months. An interim project report is to be submitted to the department during the mid-semester evaluation. The mid-semester evaluation will be done by the department project committee/project guide; this will carry weightage in final evaluation.
- Each student / project group has to submit to the department a project report in the prescribed format after completion of the project work. The final evaluation and viva-voce will be conducted by the project committee/Guide on the stipulated date at the end of the semester.
- Each student / project group has to make a demonstration on the work carried out, before the project committee for project evaluation. The end semester evaluation will be done by the project committee including the guide.