ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
Guwahati

Course Structure and Syllabus

(From Academic Session 2018-19 onwards)

B.TECH
INSTRUMENTATION ENGINEERING

8th SEMESTER

ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY

Course Structure
(From Academic Session 2018-19 onwards)

B.Tech 8th Semester: Instrumentation Engineering
Semester VIII/ B.TECH/IE

Sl. No.	Sub-Code	Subject	Hours per Week			Credit	Marks	
			L	T	P	C	CE	ESE
Theory								
1	IE1818PE5*	Program Elective-5	3	0	0	3	30	70
2	IE1818PE6*	Program Elective-6	3	0	0	3	30	70
3	IE1818PE7*	Program Elective-7	3	0	0	3	30	70
4	IE1818OE4*	Open Elective-4	3	0	0	3	30	70
Practical								
1	IE181821	Project-2	0	0	12	6	100	50
TOTAL			12	0	12	**18**	**220**	**330**
Total Contact Hours per week: 24								
Total Credit: 18								

Program Elective-5

Sl. No.	Sub-Code	Subject
1	IE1818PE51	Power Plant Instrumentation
2	IE1818PE52	Aerospace and Navigation Instrumentation
3	EE1818PE53	VLSI Signal Processing
4	IE1818PE5*	Any other subject offered from time to time with the approval of the University

Program Elective-6

Sl. No.	Sub-Code	Subject
1	IE1818PE61	Logic and Distributed Control System
2	IE1818PE62	Environmental Instrumentation
3	IE1818PE63	Any other subject offered from time to time with the approval of the University

Program Elective-7

Sl. No.	Sub-Code	Subject
1	IE1818PE71	Petrochemical Instrumentation
2	IE1818PE72	Smart Sensors and Signal Processing
3	IE1818PE73	Micro Sensors and Micro Actuators
4	IE1818PE74	Instrumentation Project Documentation and Execution
5	IE1818PE7*	Any other subject offered from time to time with the approval of the University

Open Elective-4

Sl. No.	Sub-Code	Subject
1	IE1818OE41	Neural Network and Fuzzy logic
2	IE1818OE42	Digital Control Systems
3	IE1818OE43	VHDL and Embedded Based Systems Design
4	IE1817OE4*	Any other subject offered from time to time with the approval of the University

Detail Syllabus:

Course Code	Course Title	Hours per week L-T-P	Credit C
IE1818PE51	**Power Plant Instrumentation**	**3-0-0**	**3**

Course Outcomes (CO):

CO1: Identify various power generation techniques in terms of their performance parameter.
CO2: Analyze piping and instrumentation layout diagram used in a power plant.
CO3: Understand thermal power plant engineering
CO4: Explain about Nuclear power plant and issues related to it.
CO5: Relate various Nonconventional power generation techniques and identify various causes that lead to environmental damage.

MODULE 1: Introduction

Piping and instrumentation diagram of a thermal power plant, basic process on a boiler, Fuel measurement-review of pressure and temperature measurement steam and water flow measurement – instrument applications in power stations: review of indicating and recording instrument applications in power stations: review of indicating and recording instruments, water level gauge for boiler drums, closed circuit television instrument, gas analysis meters, smoke instruments, dust monitor-measurement of impurities in feed water and steam generator coolant controls and instruments-instrument maintenance aspects.

MODULE 2: Boiler Control-I

Boiler control objectives-combustion of fuels (gaseous, liquid and solid), excess air, combustion chemistry and products of combustion, requirement for excess combustion, air- circulation of efficiency of boiler: input/output method-stream temperature control systems super heaters and de-super heaters.

MODULE 3: Boiler Control-II

Feed water supply and boiler water circulation system-drum level control systems-boiler draft systems-measurement and control of furnace draft-measurement and control of combustion- draft and air flow control related functions.

MODULE 4: Flue Gas Analysis Trimming of Combustion Control Systems

Combustion control for liquid and gaseous fuel boilers coal or solid fuel strokes-combustion control for stoker-fired boilers- pulverised coal-fired boilers. Turbine monitoring and control: speed, vibration, shell temperature monitoring.

MODULE 5: Nuclear Power Plant Instrumentation

Piping and instrumentation diagram of different types of nuclear power plants-radiation detection instruments-process sensors for nuclear power plants-spectrum analyzers-nuclear reactor control systems and allied instrumentation.

REFERENCES:

1. B.G.Liptak, Instrumentation in process industries, Vol. I and II, Chilton books co, 1973.
2. Sam G. Dukelow. The control of boilers, Instrument Society of America press.
3. Sherryet. Al. (Editors), Modern power station practice, Vol.6 (Instrumentation controls and testing), Pergamon Press, 1971.

Course Code	Course Title	Hours per week L-T-P	Credit C
IE1818PE52	**Aerospace and Navigation Instrumentation**	**3-0-0**	**3**

Course Outcomes (CO):

CO1: Explain the history of flight.
CO2: Illustrate the instrumentation used in an aircraft.
CO3: Demonstrate how aircraft flies.
CO4: Demonstrate the navigation system used in aviation and space flight.
CO5: Design and Simulate Aircraft flight Instrumentation of aerospace system.

MODULE 1: History of aviation and space flight- anatomy of airplane and space vehicle with emphasis on control surfaces- airfoil nomenclature- basics of aerodynamics to illustrate lift and drag- types of drag – finite wings – swept wings –flaps.

MODULE 2: Airplane performance- thrust –power- rate of climb absolute and service ceiling- range and endurance. Introduction to turbojet and turbofan engines. Space vehicle trajectories- Kepler's laws- rocket engines, propellants and staging.

MODULE 3: Basic engine instruments- Capacitive fuel content- Gauges. Standard atmosphere- Altimeters Aneroid and radio 6 15% altimeters.

MODULE 4: Aircraft compass- Remote indicating magnetic compass Rate of climb indicator- Pitot static system- Air speed indicator- Mach meters- Integrated flight instruments.

MODULE 5: GPS and GNSS, - Automatic Pilots- Aircraft flight simulation instrumentation Introduction to guidance, navigation and avionics- Radio navigational aids- automatic direction finder VHF- Phase Comparison direction finder.

MODULE 6: Introduction to navigation and guidance instrumentation: Principle, construction and applications of inertial sensors. Gyroscope and accelerometers- Ring laser gyroscope- Fibre optic gyroscope, MEMS gyroscopes and accelerometers.

REFERENCES:

1. Binns Chris. ***Aircraft Systems: Instruments, Communications, Navigation, and Control***, Wiley-Blackwell, New Jersey (2018)
2. Noton Maxwell. ***Spacecraft Navigation and Guidance (Advances in Industrial Control)***, Springer, United Sates (2011)

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1818PE53	VLSI Signal Processing	3-0-0	3

COURSE OBJECTIVES:

- To teach Advance Concepts of Digital Signal Processing Algorithms.

Course Outcomes (CO):

CO1: Describe structure, components and mathematical formulation of VLSI signal processing systems
CO2: Analyze VLSI signal processing systems
CO3: Design VLSI signal processing systems for utilization in societal, academic and industrial purposes.

MODULE 1: Iteration Bound

Typical DSP algorithms, DSP application demands and scaled CMOS technology, Representation of DSP algorithms; Data-flow graph representations, Loop bound and iteration bound, Algorithms for computing iteration bound, Iteration bound of multirate data-flow graphs

MODULE 2: Pipelining and Parallel Processing

Pipelining of FIR digital filters, Parallel processing, Pipelining and parallel processing for low power; Numerical strength reduction – Synchronous, Wave and Asynchronous pipelines; Low power design

MODULE 3: Retiming, Unfolding, Folding

Retiming: Definitions and properties, Solving systems of inequalities, Retiming techniques.

Unfolding: An algorithm for unfolding, Properties of unfolding, Critical path, unfolding and retiming, Applications of unfolding.

Folding: Folding transformation, Register minimization techniques, Register minimization in folding architectures, Folding of multirate systems

MODULE 4: Systolic Architecture Design

Systolic array design methodology, FIR systolic arrays, Selection of scheduling vector, Matrix-matrix multiplication and 2D systolic array design, Systolic design for space representations containing delays; Scaling and round off noise; Digital lattice filter structures

MODULE 5: Bit-Level Arithmetic Architecture

Parallel multipliers, Interleaved floor-plan and bit-plane-based digital filters, Bit-serial multipliers, Bit-serial filter design and implementation, Canonic signed digit arithmetic, Distributed arithmetic; Bit level arithmetic architecture; Redundant arithmetic

MODULE 6: PROGRAMMABLE DIGITAL SIGNAL PROCESSORS

Evolution of programmable digital signal processors, Important features of DSP processors, DSP processors for mobile and wireless communications, Processors for multimedia signal processing

TEXTBOOK:

1. K. K. Parhi: VLSI Digital Signal Processing Systems, Design and Implementation, Wiley Interscience, New Delhi, 1999

REFERENCES:

1. K. P. Keshab: VLSI Digital Signal Processing Systems: Design and Implementation, Jacaranda Wiley, 1999
2. Richard J. Higgins: Digital Signal Processing in VLSI , Prentice Hall
3. M.A. Bayoumi: VLSI Design Methodology for DSP Architectures, Kluwer, 1994
4. Mohammad Ismail and Terri Fiez: Analog VLSI signal and information processing, McGraw-Hill
5. S.Y. Kung, H.J. White House, T. Kailath: VLSI and Modern Signal Processing, Prentice Hall, 1985
6. Multirate Systems and Filter Banks 1st Ed 1992 – P. P. Vaidyanathan, Prentice Hall
7. Digital Signal Processing: A Practical Approach 2nd Ed 2004 - Emmanuel Ifeachor and Barrie Jervis, Prentice Hall
8. Discrete-Time Signal Processing 2nd Ed 1999 – Alan V. Oppenheim, Ronald W. Schafer, John R. Buck, PHI
9. Adaptive Signal Processing 1985 - Bernard Widrow and Peter N. Stearns, Pearson
10. Adaptive Filter Theory 5th Ed 2013 - Simon Haykin, Pearson
11. Wavelets and Filter Banks 2nd Ed 1996 - G Strang and T Nguyen, Wellesley-Cambridge Press
12. Time Frequency analysis: Theory and Applications 1994 - Leon Cohen, Prentice Hall
13. Optimum Signal Processing: An Introduction 2nd Ed 1988 - Sophocles J Orfanidis, Collier Macmillan
14. J. G. Proakis, D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms And Applications", Pearson 2007.
15. Digital Signal Processing 2014 - Tarun Kumar Rawat, Oxford University Press

Course Code	Course Title	Hours per week L-T-P	Credit C
IE1818PE61	Logic and Distributed Control System	3-0-0	3

Course Outcomes (CO):

CO1: Demonstrate the computer-based control system techniques.

CO2: Develop a PLC program for a specific controller.

CO3: Implement a controller in PLC system and can compile technical report.

CO4: Understand the architecture and local control unit of Distributed Control System (DCS).

CO5: Interface various control loops in DCS.

MODULE 1: Review of Computers in Process Control

Data loggers, Data Acquisition Systems (DAS), Direct Digital Control (DDC). Supervisory Control and Data Acquisition Systems (SCADA), sampling considerations. Functional block diagram of computer control systems. alarms, interrupts. Characteristics of digital data, controller software, linearization. Digital controller modes: Error, proportional, derivative and composite controller modes.

MODULE 2: Programmable Logic Controller (PLC) Basics

Definition, overview of PLC systems, input/output modules, power supplies, isolators. General PLC programming procedures, programming on-off inputs/ outputs. Auxiliary commands and functions: PLC Basic Functions: Register basics, timer functions, counter functions.

MODULE 3: PLC Intermediate Functions

Arithmetic functions, number comparison functions, Skip and MCR functions, data move systems. PLC Advanced intermediate functions: Utilizing digital bits, sequencer functions, matrix functions. PLC Advanced functions: Alternate programming languages, analog PLC operation, networking of PLC, PLC-PID functions, PLC installation, troubleshooting and maintenance, design of interlocks and alarms using PLC. Creating ladder diagrams from process control descriptions.

MODULE 4: Interface and Backplane Bus Standards for Instrumentation Systems. Field Bus

Introduction, concept. HART protocol: Method of operation, structure, operating conditions, and applications. Smart transmitters, examples, smart valves and smart actuators.

MODULE 5: Distributed Control Systems (DCS)

Definition, Local Control (LCU) architecture, LCU languages, LCU - Process interfacing issues, communication facilities, configuration of DCS, displays, redundancy concept - case studies in DCS.

REFERENCES:

1. John. W. Webb Ronald A Reis , Programmable Logic Controllers - Principles and Applications, Third edition, Prentice Hall Inc., New Jersey, 1995.
2. Lukcas M.P Distributed Control Systems, Van Nostrand Reinhold Co., New York, 1986.
3. Deshpande P.B and Ash R.H, Elements of Process Control Applications, ISA Press, NewYork, 1995.
4. Curtis D. Johnson, Process Control Instrumentation Technology, Fourth edition, PHI

Course Code	Course Title	Hours per week L-T-P	Credit C
IE1818PE62	Environmental Instrumentation	3-0-0	3

Course Outcomes (CO):

CO1: Design instrumentation systems for environment monitoring.
CO2: Develop methodology for wastewater treatment.
CO3: Measure and analyze air quality and other parameters.
CO4: Measure and analyze water quality.
CO5: Provide solution to reduce pollution

MODULE 1: Introduction

Necessity of instrumentation & control for environment, sensor requirement for environment. Instrumentation methodologies: Ultraviolet analyzers, total hydrocarbon analyzers using flame, ionization detector, Gas chromatography in environmental analysis, photoionization, portable & stationary analytical instruments.

MODULE 2: Quality of Water

Standards of raw & treated water, sources of water & their natural quality, effects of water quality. Water quality parameters: Thermal conductivity, detectors, Opacity monitors, pH analyzers & their application, conductivity analyzers & their application. Water treatment: Requirement of water treatment facilities, process design.

MODULE 3: Sedimentation and Flotation

General equation for settling or rising of discrete particles, hindered settling, effect of temperature, Viscosity, efficiency of an ideal settling basin, reduction in efficiency due to various causes, sludge, storage & removal, design criteria of settling tank, effect of temperature on coagulation. Ground water monitoring: Level measurement in ground water monitoring wells, laboratory analysis of ground water samples, instrumentation in ground water monitoring, instrumentation in assessment of soil & ground water pollution.

MODULE 4: Waste Water Monitoring System

Automatic waste water sampling, optimum waste water sampling locations, and waste water measurement techniques. Instrumentation set up for waste water treatment plant. Latest methods of waste water treatment plants, Chemical Oxygen Demand (COD), Biochemcal Oxygen Demand (BOD) Flow monitoring: Non open channel flow measurement, open channel waste water flow measurement. Rain water harvesting: necessity, methods, role of NGOs & Municipal Corporation.

MODULE 5: Instruments in Weather Stations

Instruments in Weather station like Barometer, Rain gauge, Ceilometer etc., Global environmental analysis, VirtualInstrumentsinEnvironmentalEngineering Laboratory, Rover Environmental Monitoring station (REMS).

TEXT BOOKS:

1. Walter J Weber, "Physical-chemical processes for water quality control", Wiley Inter-science Publications 2012.
2. M N Rao and S K S Rao, "Air pollution", TMH publications 26th reprint 2007.

3. Rao, M. N. and Rao, H. V. N, " Air Pollution", Tata McGraw Hill Publishing Company Limited, NewDelhi, 1989, ISBN-13: 978-0074518717
4. Kenneth Wark, Cecil F. Warner, Wayne T. Davis, "Air Pollution: Its Origin and Control", Pearson; 3 edition (13 November 1997), ISBN-13: 978-0673994165
5. Peany Howard S, Donal R Rowe and George Tacho Banoylous Teddy, "Environmental Engineering". McGraw Hill Education; First edition (1 July 2017), ISBN-13: 978-9351340263
6. Patrick F. Cunniff, "Environmental Noise Pollution", John Wiley & Sons Inc (4 May 1977),ISBN-13:978-0471189435.
7. Gilber M Masters, "Environmental Engineering and Science", Pearson Education (1997).

REFERENCES:

1. Randy D. Down & Jay H. Lehr, "Environmental Instrumentation & Analysis Handbook", Wiley-Blackwell (7 October 2004), ISBN-13: 978-0471463542

Course Code	Course Title	Hours per week L-T-P	Credit C
IE1818PE71	Petrochemical Instrumentation	3-0-0	3

Course Outcomes (COs):

CO1: To acquire a basic knowledge about petrochemical industry.
CO2: To explain different chemicals from petroleum products.
CO3: To summarize operations involved in petrochemical industry.
CO4: Designing of models for petrochemical process.
CO5: Illustrate the control loop in petrochemical industry.

MODULE 1: Petroleum Processing

Petroleum exploration – Recovery techniques – Oil – Gas separation - Processing wet gases – Refining of crude oil

MODULE 2: Operations in Petroleum Industry

Thermal cracking – Catalytic cracking – Catalytic reforming – Polymerization – Alkylation – Isomerization – Production of ethylene, acetylene and propylene from petroleum

MODULE 3: Chemicals from Petroleum Products

Chemicals from petroleum – Methane derivatives – Acetylene derivatives – Ethylene derivatives – Propylene derivatives – Other products

MODULE 4: Measurements in Petrochemical Industry

Parameters to be measured in refinery and petrochemical industry – Selection and maintenance of measuring instruments – Intrinsic safety of Instruments

MODULE 5: Control Loops in Petrochemical Industry

Process control in refinery and petrochemical industry – Control of distillation column – Control of catalytic crackers and pyrolysis unit – Automatic control of polyethylene production – Control of vinyl chloride and PVC production

REFERENCES :

1. A.L. Waddams, „Chemicals from Petroleum", Butter and Janner Ltd., 1968.
2. J.G. Balchan. and K.I. Mumme, „Process Control Structures and Applications", Van Nostrand Reinhold Company, New York, 1988.
3. Austin G.T. Shreeves, „Chemical Process Industries", McGraw Hill International Student edition, Singapore
4. B.G Liptak, „Instrumentation in Process Industries", Chilton Book Company.

Course Code	Course Title	Hours per week L-T-P	Credit C
IE1818PE72	Smart Sensors and Signal Processing	3-0-0	3

Course Outcomes (COs):

CO1: Develop a strong understanding of sensing and sensor devices, including design, modelling, simulation, and implementation.

CO2: Select a suitable communication protocol and smart sensor for particular applications.

CO3: Understand the uses and risks related to sensing technology.

MODULE 1: Basics of Smart Sensors & Micromachining

Introduction, Mechanical-Electronic transitions in sensing, nature of sensors, overview of smart sensing and control systems, integration of micromachining and microelectronics, introduction to micromachining, bulk micromachining, wafer bonding, surface micromachining, other micromachining techniques.

MODULE 2: Sensor Information to MCU

Introduction, amplification and signal conditioning, separate versus integrated signal conditioning, digital conversion.

MODULE 3: MCUS and DSPS to Increase Sensor IQ

Introduction, MCU control, MCUs for sensor interface, DSP control, Software, tools and support, sensor integration.

MODULE 4: Communications for Smart Sensors

Introduction, definitions and background, sources and standards, automotive protocols, industrial networks, office & building automation, home automation, protocols in silicon, other aspects of network communications.

MODULE 5: Control Techniques

Introduction, state machines, fuzzy logic, neural networks, combined fuzzy logic and neural networks, adaptive control, other control areas.

MODULE 6: Sensor Communication & MEMS

Wireless zone sensing, surface acoustical wave devices, intelligent transportation system, RF-ID, Microoptics, microgrippers, microprobes, micromirrors, FEDs.

MODULE 7: Packaging, Testing and Reliability of Smart Sensors

Introduction, Semiconductor packaging applied to sensors, hybrid packaging, packaging for monolithic sensors, reliability implications, testing smart sensors. UNIT Standards for Smart Sensors: Introduction, setting the standards for smart sensors and systems, IEEE 1451.1, IEEE 1451.2, IEEE P1451.3, IEEE 1451.4, extending the systems to network.

MODULE 8: Implications of Smart Sensor Standards and Recent Trends

Introduction, sensor plug-and-play, communicating sensor data via existing wiring, automated/remote sensing and web, process control over the internet, alternative standards,

HVAC sensor chip, MCU with integrated pressure sensors, alternative views of smart sensing, smart loop.

TEXTBOOK:

1. Suarez Daniel E. ***Smart Sensors and Sensing Technology.*** Nova Science Publishers, New York (2011)

Course Code	Course Title	Hours per week L-T-P	Credit C
IE1818PE73	**Micro Sensors and Micro Actuators**	**3-0-0**	**3**

Course Outcomes:

CO1: Explain the concept of basics of Smart sensors
CO2: Employ signal conditioning techniques for smart sensing
CO3: Identify the difference between micro sensors and actuators and working principle.
CO4: Explain design concepts and employ commonly used micro sensors in industry for measurement
CO5: Explain the Fabrication of micro sensors in clean room.

MODULE 1: Introduction

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.

MODULE 2: Basics of Smart Sensor and Sensing

Basics of Smart Sensors & Micromachining: Introduction, Mechanical-Electronic transitions in sensing, nature of sensors, Signal Conditions, overview of smart sensing and control systems, integration of micromachining and microelectronics.

MODULE 3: Micro Sensors and Actuators-I

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors – Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph Applications – Magnetic Actuators – Micro magnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys.

MODULE 4: Micro Sensors and Actuator-2

Piezo resistive sensors – Piezo resistive 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 Flow sensors.

MODULE 5: 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 micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

TEXT BOOKS:

1. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.
2. Stephen D Senturia, 'Microsystem Design', Springer Publication, 2000.
3. Tai Ran Hsu, "MEMS & Micro systems Designand Manufacture"TataMcGraw Hill, New Delhi, 2002.

Course Code	Course Title	Hours per week L-T-P	Credit C
IE1818PE74	**Instrumentation Project Documentation and Execution**	**3-0-0**	**3**

Course Outcome (CO):

CO1: Design & Develop Basic & Detailed Engineering Project Deliverables.

CO2: Understand Types of Project Executed in I & C Projects.

CO3: Develop skills to Execute and carry different activities in process industry.

CO4: Understand Procedures, Guidelines and Thumb Rules for performing Precommissioning activities.

CO5: Overall Development of the students by Hands on working Experience.

MODULE 1: The Project

Introduction, predictability, structure, flow and deliverables, Project Planning and Scheduling – project scheduling estimating, configuration management.

MODULE 2: The Project Team

Customer, designer and constructor

MODULE 3: Standards Used in Instrumentation Project

ISA, ANSI, & ASTM, ASME, NFPA, NEMA.

Project Documents- 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:

1) Process Flow Diagram. Piping and Instrumentation diagrams (P&ID) - practical applications. 3) Instrument Index Sheet 4) Instrument specifications sheet- for temperature, pressure, level, flow instruments and control valves. 5) Instrument Location Plan 6) Cable and Tray Routing 7) Cable Schedule 8) JB Schedule 9) Utility requirement 10) Air header schedule 11) 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. 12) BOM for erection 13) Loop diagrams- pneumatic, electronic and digital data types. 14) Logic diagrams, SAMA Standard.

MODULE 4: Systems Integration

Division of labour, control logic specification, HMI specification Development, System Architecture Design, Network single line diagram generation, Other tasks like control system cabinet design, I/O address assignment (Partitioning)-Hardware & software address, System testing.

MODULE 5: Procurement, Installation and Commissioning

Procurement: Engineering Procurement procedure, PO format, preparation of tenderdocuments, bids, technical bid evaluation.

Inspection: Need for Inspection, Documents for Inspection, General Inspection Guidelines, Factory acceptance test (FAT) & Site acceptance test (SAT), check lists.

Installation of instruments- Installation standards, installation of instrument junction box, earthing system, cable laying (cable trays, cable types, cable glands), tubing, instrument installation

guidelines.

Commissioning: Pre-commissioning Procedures, check out procedure of control valve, DP transmitter etc. calibration, testing of instruments, operation and maintenance manual, commissioning Procedures. Onsite training.

MODULE 6: Advantages of using software packages for documentation. Overview of documentation software packages used in industry like SPI -Intools

TEXT BOOKS:

1. Andrew Williams, Applied instrumentation in the process industries, 2nd Edition, Vol. 2, Gulf publishing company.
2. Michael D. whitt, Successful Instrumentation and Control Systems Design, ISA Publication.
3. Installation of Instrumentation & Process control systems- EEUA Handbook.

Course Code	Course Title	Hours per week L-T-P	Credit C
IE1818OE41	Neural Network and Fuzzy Logic	3-0-0	3

Course Outcomes (CO):

CO1: Comprehend the concepts of neural networks.
CO2: Explain and represent the neural network.
CO3: Develop fuzzy logic for a system.
CO4: Apply knowledge of fuzzy logic for practical implementations in engineering applications.
CO5: Analysis and Interface of neuro and fuzzy logic control.

MODULE 1: Introduction

Introduction and principles of artificial neuron, activation function, different architectures of neural networks- single layer and multi-layer networks, adaptive resonance theory, applications: The role of neural networks in engineering, artificial intelligence, and cognitive modelling.

MODULE 2: Learning in Neural Networks

MLP- Back propagation, Gradient-descent learning, Hopefield networks, Kohonen self-organization maps, Schemes of neuro-control, identification and control of dynamical systems, adaptive neuro-controller, case study.

MODULE 3: Fuzzy Logic

Introduction to fuzzy logic system, fuzzy sets, membership function, linguistic variables, rules and algorithm, fuzzy relations.

MODULE 4: Fuzzy Logic Control System

Fuzzy logic controller, fuzzification interface, knowledge base, decision making logic, de-fuzzification interface, Inference mechanisms, construction of data base and rule base of FLC design of fuzzy logic controller, case study.

MODULE 5: Neuro – Fuzzy Logic Control

Optimization of membership function and rules base of fuzzy logic controller using neural networks, genetic algorithm, fuzzy neuron, adaptive fuzzy systems, case study.

TEXT BOOKS:

1. Fausett Laurance. ***Fundamentals of Neural Networks***. Prentice Hall, Englewood cliffs, New Jersey (1992).
2. Zimmermann Hans Jurgen. ***Fuzzy set theory and its applications***. Allied Publication Ltd, New York (2001).
3. Klir George J. and Yuan Boe. ***Fuzzy sets and fuzzy logic: Theory and Applications***. Pearson Education India, New Delhi (2015).
4. Driankov Dimiter, Hellendron Hans and Reinfrank Michael. ***An Introduction to Fuzzy control***. Narosa publishing House, New Delhi (1996).
5. Thomas Millon, Richard Sutton and Webrose Paul. ***Neural Networks for control***. MIT Press, United States (1995)

Course Code	Course Title	Hours per week L-T-P	Credit C
IE1818OE42	Digital Control Systems	3-0-0	3

Couse Outcomes (CO):

CO1: Understand mathematical models of linear discrete-time control systems using transfer functions and state-space models.

CO2: Analyze transient and steady-state behaviors of linear discrete time control systems.

CO3: Determine whether performance of linear discrete-time control systems meet specified design criteria.

CO4: Design controllers and observers for linear discrete-time control systems so that their performance meets specified design criteria.

CO5: Design PID controllers.

MODULE 1: Introduction

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, samplingasimpulsemodulation, sampledspectra&aliasing, Reconstruction of analog signals, zero order hold, first order hold **Principles of discretization**- impulse invariance, finite difference approximation of derivatives, rectangular rules for integration, Bilinear transformation, Mapping between s-plane & z-plane.

MODULE 2: Representation of Digital Control System

Linear difference equations, pulse transfer function, input output model, examples of first order continuous and discrete time systems, Signal flow graph applied to digital control systems.

MODULE 3: Stability of Digital Control System in Z-Domain and Time Domain Analysis

Jury's method, R.H. criteria, Comparison of time response of continuous data and digital control system, steady state analysis of digital control system, Effect of sampling period on transient response characteristics.

MODULE 4: State Space Analysis

Discrete time state equations in standard canonical forms, similarity transformation, state transition matrix, solution of discrete time state equation, Discretization of continuous state space model & its solution.

MODULE 5: Pole Placement and Observer Designs

Concept of reachability, Controllability, Constructability & Observability, Design of controller via Pole placement method, dead beat controller design, concept of duality, state observer design, Concept of Multi rate output feedback (MROF) based state estimation.

MODULE 6: Transfer Function Approach to Controller Design

Control Structures, Internal Stability and Realizability, Internal Model Principle and System Type, Well Behaved Signals, Solving Aryabhatt's Identity. **Proportional, Integral, Derivative Controllers-** Discretization of PID Controllers, Pole Placement Controller with Performance Specifications, Implementation of Unstable Controllers.

TEXT BOOKS:

1. M. Gopal, "Digital Contol 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.
4. K.M. Moudgalya, “Digital Control”, Wiley-India, Indian Edition, 2009.
5. B. Bandopadhyay and S. Janardhanan, “Discrete Time Sliding Mode Control-A Multirate Output Feedback Approach”, Springer, 2005

Course Code	Course Title	Hours per week L-T-P	Credit C
IE1818OE43	VHDL and Embedded Based Systems Design	3-0-0	3

Couse Outcomes (CO):

CO1: Make an in-depth knowledge of VHDL

CO2: Design the combinational and sequential logic circuits using VHDL

CO3: Build in-depth understanding of embedded based systems

MODULE 1: Introduction to VHDL

Introduction to HDL; Basic language elements; Entity declaration; Architecture; Configurations; Identifiers; Data objects; Data types; Operators; VHDL attributes; IEEE Standard 1076

MODULE 2: Modeling and Simulation using VHDL

Behavioral modeling; Data flow modeling; Structural modeling; Generics and configurations; Subprograms and operator overloading; Packages and libraries; Model simulation; Test bench; Waveform generation; Realization of combinational and sequential circuits using HDL, Flip flops, Counters, Registers

MODULE 3: Digital Design with State Machine Charts

State machine description; Derivation of SM charts; Realization of SM charts; Design of simple FSM using SM chart; Design BCD counter using SM chart; Modeling of Moore and Mealy FSM; Generic state machine

MODULE 4: Embedded systems

Embedded Systems and general purpose computer systems; Harvard or Von-Neumann architecture; RISC and CISC controllers; Microcontroller architecture; Intel 8051: Pin configuration, Internal RAM structure, Register banks, SFR, Programming

MODULE 5: Hardware Interfacing

Interfacing 8051 with external RAM, ROM, and ADC; Communication interface; I^2C bus; Bus standards: RS-232 C, IEEE 488, Universal Serial Bus (USB)

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1. S. Brown and Z. Vranesic, 'Fundamentals of Digital Logic with VHDL Design', Third edition, McGraw Hill, 2009.
2. J. Bhasker, 'A VHDL Primer', 3rd edition, PHI Learning Private Limited, 2010.
3. D. L. Perry, 'VHDL: Programming by Example' 4th edition, McGraw-Hill Education, 2002.
4. A. Deshmukh, 'Microcontroller - Theory and Applications', Tata McGraw Hill.
5. M. A. Mazidi, J. G. Mazidi and R. D. McKinlay, 'The 8051 Micocontroller and Embedded Systems: Using Assembly and C', Pearson Education India, 2012.

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