T.Y B.Tech. Instrumentation and Control Semester-II										
Course Code	Course Title	Teaching Scheme			Examination Scheme				Marks	Credit
		Hours/Week								
		Lecture	Tutorial	Practical	In Sem	End Sem	Oral	Practical		
IN 3201	Process Loop Components	3	0	0	50	50	0	0	100	3
IN 3202	Digital Signal Processing	3	1	0	50	50	0	0	100	4
IN 3203	Unit Operations	3	1	0	50	50	0	0	100	4
PEIN 3201	Programme Elective- II	3	0	0	50	50	0	0	100	3
PEIN 3202	Programme Elective-III	3	0	0	50	50	0	0	100	3
IN 3204	Process Loop Components Lab	0	0	2	0	0	0	25	25	1
IN 3205	Digital Signal Processing Lab	0	0	2	0	0	0	25	25	1
PEIN 3203	Programme Elective-III Lab	0	0	2	0	0	25	0	25	1
IN 3206	Seminar on Mini Project	0	0	4	25	0	0	25	50	2
AC 3201	Audit Course	0	0	2	0	0	0	0	0	0
Total		**15**	**2**	**12**	**275**	**250**	**25**	**75**	**625**	**22**
Grand Total		**29**			**625**				**625**	**22**

PEIN 3201: Programme Elective-II

1. Environmental Instrumentation
2. Reliability Engineering
3. MEMS
4. Internet of Things (IoT)
5. Swayam Online Course

PEIN 3202: Programme Elective-III
PEIN 3203: Programme Elective-III Laboratory

1. Embedded Product Design
2. Advanced Biomedical Instrumentation
3. Computer Organization
4. Robotics

AC 3201: Audit Course: Employability Skills Development

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IN 3201: Process Loop Components

Teaching Scheme
Lecture: 3 Hr/week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisites: Sensors and transducers, op amp circuits, control system components

Course Objectives:

1. To understand the basics of process control
2. To explain the need, construction, working, types of process control components like transmitters, controllers, converters, control valves
3. To demonstrate PLC programming skill for industrial application

Course Outcomes: The student will be able to

1. develop and represent process control loops using standard symbols and notations by comprehending the fundamentals of process control
2. compare and analyze the working of different process loop components
3. select, configure and calibrate process control components like transmitters, convertors etc
4. develop control logic for various industrial applications

Unit 1: Fundamentals of Process Control **(06)**

Elements of process control loop, types of process variables, representation of process loop components using standard symbols (basics with reference to control loop), P & ID for temperature, flow, level, pressure process loops. Process Characteristics like process load, plant lags, dead time, capacity and regulation

Unit 2: Transmitters and Converters **(06)**

Need of transmitter (concept of field area & control room area), Need for standardization of signals current, voltage, and pneumatic signal standards Concept of live & dead zero. Types of transmitters (Two and four wire transmitters). Types, mounting (Installation), manifold, calibration setup, of electronic Differential Pressure Transmitter (DPT). DPT for Level measurement, zero elevation, zero suppression, square root extractor. Block schematic and calibration of Smart transmitter. Comparison of SMART with conventional transmitter. Difference between converter and transmitter. Converters like Current to pressure converter and Pressure to current converter

Unit 3: Controllers **(08)**

Discontinuous (Two position, time-proportional) and Continuous controllers (Proportional, Integral, Derivative, Proportional-Integral, Proportional- Derivative, Proportional- Integral-Derivative (PID)). Reset windup, Anti reset windup, Rate before reset, Bump less transfer, Effect of process characteristics on PID combination ,Tuning of controllers. Block schematic and face plate of digital controllers

Unit 4: Programmable Logic Controller (PLC) **(08)**

Continuous versus Discrete Process Control, Limitations of relay based system, architecture of PLC, types of Input & Output modules (AI, DI, DO, AO), wiring diagram, Fixed & Modular PLC (Rack, slot, grouping), Interfacing pneumatic & hydraulic systems to PLC, PLC specifications, PLC manufacturers, PLC Basic instructions, Timers (ON delay, OFF delay & Retentive) & Counters with timing diagrams, ladder programming for process applications

Unit 5: Control Valves **(06)**

Comparison of control valve with other final control element, parts of pneumatic control valve and control valve terminologies like range-ability, turndown, valve capacity, fail-safe conditions Inherent and Installed control valve characteristics. Construction, advantages, disadvantages and

applications of types of control valve (globe, 3-way, diaphragm, ball, butterfly)

Unit 6: Control Valve Accessories and Actuators **(06)**

Control valve accessories like volume boosters, pressure boosters, solenoid valves, air lock, limit switches, hand wheel, positioners (Need, applications, types, effect on performance of control valve). Construction, advantages, disadvantages and applications of different types of actuators (spring and diaphragm, piston cylinder (power cylinder), electric, electro-hydraulic and smart actuators.

Text Books:

1. C. D. Johnson, "Process control and Instrument technology", Tata McGraw Hill Publications
2. B. G. Liptak, "Process Control", Instrument Engineering Hand book CRC Press.
3. N.A. Anderson, Boca Ratan, "Instrumentation for Process measurement and control" CRC Press, Third ed., 1980.
4. Frank Petruzella, "Programmable Logic Controllers" McGraw-Hill, 2011
5. Gary Dunning, "Introduction to Programmable Logic Controller", Cengage Learning India Pvt. Ltd., Third ed., 2006.

Reference Books:

1. Armando B. Corripio,"Tuning of industrial control systems", ISA.
3. James W. Hutchinson, "Control valve Handbook", ISA
4. E. B. Jones, "Instrument Technology", Butterworth's, Forth ed., 1985
5. William Andrews, "Applied Instrumentation in Process Industries", Gulf, Second ed., 1979.

IN 3202: Digital Signal Processing

Teaching Scheme
Lecture: 3 Hr/Week
Tutorial: 1 Hr/Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 4

Prerequisite: Fourier Transform, Z-transforms and their properties, Continuous time system.

Course Objectives:
1. To provide better understanding of discrete and digital signals and systems in time and frequency domains.
2. To provide knowledge to analyze linear systems with difference equations
3. To study the characteristics to identify the correct type of filter required for a given problem and be able to demonstrate the design and implementation of a digital filter.

Course Outcomes: The student will be able to
1. list and define different time and frequency domain parameters in the given signal.
2. apply difference equations to analyze the given linear system.
3. design and implement FIR and IIR filters with different structures.
4. compare and select appropriate digital filter for the given application.

Unit 1: Introduction, Signals and Systems **(08)**
Introduction to Digital Signal Processing (DSP): Basic elements, advantages Classification of Signals:
Discrete Time Signals: sampling process / theorem, aliasing effect and reconstruction
Discrete Time Systems: input-output description of systems, block diagram representation

Unit 2: Analysis of Discrete-LTI Systems **(08)**
Linear convolution, causality and stability of discrete time systems, autocorrelation, cross correlation.
Z-transform and its properties, solving difference equations and analysis of discrete-time systems in z-domain.
Transfer function, pole-zero plot.

Unit 3: Frequency Analysis of Discrete-Time Signals **(08)**
The Discrete Time Fourier Transform (DTFT): symmetry properties and theorems of DTFT. Energy density spectrum and power density spectrum.
Discrete Fourier Transform (DFT): DFT, properties of DFT, symmetry properties, circular convolution, Frequency analysis of signals using DFT, Efficient computation of DFT.
Fast Fourier Transform (FFT) algorithms: radix-2 decimation-in-time (DIT) and decimation-in-frequency (DIF) FFT algorithms.

Unit 4: Digital Filter: FIR **(06)**
Frequency selective filters characteristics / response
Design of FIR filters: Introduction to FIR filters, linear phase filters, symmetric and anti-symmetric filters, FIR design methods.
Realizations of FIR Filters.

Unit 5: Digital Filter: IIR **(06)**

Design of digital IIR filters from analog filters

Introduction to analog IIR filters, Butterworth approximation, Chebyshev approximation.

Design of Digital IIR filter: impulse invariance method, bilinear transformation, approximation derivative method. Frequency transformations in analog and digital domain.

Realizations of IIR Filters.

Unit 6: DSP Applications **(06)**

Applications of Convolutions, Auto-correlation, Cross-correlations, DFT, Digital filters.

Text Books:

1. A. V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Pearson Education.
2. Salivahanan, A Vallaraj, C. Gnanapriya, "Digital Signal Processing", Tata McGraw-Hill Publishing Company Limited.
3. P. Ramesh Babu, "Digital Signal Processing", Sci-Tech Publications.
4. S. K. Mitra, "Digital Signal Processing-A Computer Based Approach", MGH

Reference Books:

1. J. G. Proakis and D. J. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", PHI, 2000.
3. Rabiner, Gold, "Theory and Applications of Digital Signal Processing", TMH.
4. E. C. Ifeachor and B. W. Jervis, "Digital Signal Processing-A practical Approach", Addison-Wesley publication

List of Tutorials:

1. Case study on different applications based on analog and digital signals to understand the advantages of DSP over ASP.
2. To reconstruct digital signal with various sampling frequency and understand the concept of Nyquist Criteria.
3. To solve real time problems based on linear convolution.
4. To solve problems based on D.E.
5. To prove numerically the properties of DFT.
6. FIR filter design problems
7. IIR filter design problems
8. Case study on real time DSP applications.

IN 3203: Unit Operations

Teaching Scheme
Lecture: 3 Hr/week
Tutorial: 1 Hr/week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 4

Prerequisites: Sensors and transducers, fluid properties

Course Objectives:
1.To learn various Unit Operations used in Industry.
2. To describe various equipments involved in various unit operations.
3. To understand different renewable and non-renewable energy sources

Course Outcomes: The student will be able to
1. disseminate various Unit Operations used in industry
2. select Unit Operations and related Instrumentation for the given application
3. compare and analyze renewable and non-renewable energy sources
4. apply various performance enhancement methods for boilers

Unit 1: Unit Operations and Fluid Transportation **(07)**
A. Introduction, Flow of incompressible fluids through pipes, transportation and metering of fluids, Pipes, Fittings, Valves, Pumps, Fans, Blowers, Compressors, Feeders, Dampers
B. Fluids filtration, solids fluidization

Unit 2: Unit Operations in Chemical Engineering **(07)**
A. Gas absorption and liquefaction, refrigeration
B. Mechanical processes, including solids transportation, crushing and pulverization, screening and sieving
C. Separation and mixing of fluids

Unit 3: Heat Transfer Operations **(07)**
A. Principles of heat flow in fluids, Heat transfer to fluids without phase change, Heat Transfer to fluids with phase change
B. Heat Exchange Equipment: Heat Exchangers, Condensers, Boilers and Calandria, Evaporators, Chillers, Cooling towers

Unit 4: Mass Transfer Operations and Introduction to Energy Sources **(07)**
A. Distillation: Flash and Continuous, Multi component Distillation, Leaching and Extraction
B. Drying of Solids and liquids, Crystallization
C. Introduction to Power generation
D. Energy Sources and their classification
Renewable: Small Hydro, modern biomass, wind power, solar, geothermal and bio-fuels.
Nonrenewable: fossil fuels (coal, oil and natural gas) and nuclear power.

Unit 5: Boiler Ancillaries **(07)**
A. Types of boilers like FBC, CFBC, DIPC, Fluidized Bed, boiler safety parameters
B. Instrumentation for Boiler, water treatment, electro-static precipitator, soot blower, economizer, de-aerator, super heater, chemical dosing systems, air pre-heater, coal and ash handling systems, fuel storage and distribution, Bag House Filters.

Unit 6: Unit Operations in Process Industry **(07)**

Study of Processes and Unit Operations applied to process industry, viz. sugar, paper and pulp, Dairy, Pharmaceutical, and Fertilizer

Text Books:

1. Unit Operations in Chemical Engineering by McCabe, W.L., Smith, J.C., and Harriot P., McGraw-Hill VII Edn. 2004.
2. Perry, "Chemical Engineer's Handbook", McGraw Hill, 1984.
3. Non-conventional energy resources by B. H. Khan, McGraw Hill, New Delhi.
4. Renewable energy Technology. Chetan Singh Solanki, Prentice Hall Publication.

Reference Books:

1. Process Control, B.G. Liptak
2. Solar Energy, by S. P. Sukhatme, Tata McGraw Hill, New Delhi.
3. Nonconventional Energy Sources. G. D. Rai, Khanna Publication.
4. M. G. Rao and Misting, "Outline of Chemical Technology", Second Edition, East West, 1973.
5. Leverspel O., "Chemical Reaction Engineering", Second Edition Willey Eastern Pvt Ltd.

List of Tutorials:

1. Numericals on Pumps, related to developed head, Power requirement, NPSH and efficiency
2. Numericals on Fans and Compressors
3. Study of Refrigeration process plant
4. Numericals on Enthalpy balances for Single Effect Evaporators
5. Material Balance in Plate column of Distillation Column
6. Numericals on McCabe Thiele Method
7. Study of Boiler Ancillaries
8. Study of SWAS
9. Renewable and Nonrenewable Energy Sources comparison

PEIN 3201 (A): Environmental Instrumentation

Teaching Scheme
Lecture: 3 Hr/week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisite: Sensor & Transducer, Analytical Instrumentation

Course Objectives:
1. To learn necessity of Instrumentation in Environmental Engineering.
2. To describe various components in Environmental Instrumentation.
3. To understand different types of Pollutions and various control strategies.

Course Outcomes: The student will be able to
1. identify the Instrumentation related to Environment.
2. analyze various aspects of disaster management and ecosystem
3. select various sensors and instruments for measurement of weather parameters.
4. select various sensors and instruments for measurement of air and water quality parameters

Unit 1: Sensors, Detectors, Analyzers for Environmental Instrumentation **(06)**
Necessity of instrumentation & control for environment, sensor requirement for environment, Instrumentation methodologies: Detectors & Analyzer

Unit 2: Disaster Management **(08)**
Concepts of Hazard, Types of Disaster, Impact of Disasters, Human resettlement and rehabilitation issues during and after disaster

Unit 3: ICT- Automatic Weather Station **(08)**
Instruments in Weather station like Barometer, Rain gauge, Ceilometer etc. Global environmental analysis, Virtual Instruments in Environmental Engineering Laboratory, Rover Environmental Monitoring Station (REMS).

Unit 4: Sustainable Development **(06)**
Ecological stability, Ecosystem services, Environmental degradation

Unit 5: Water Quality Parameters & Water Treatment **(07)**
Standards of raw & treated water, sources of water & their natural quality, effects of water quality, Water quality parameters & their application, conductivity analyzers & their application, Water treatment

Unit 6: Air Pollution and Sound Monitoring Systems **(07)**
Definitions, energy environment relationship, importance of air pollution, Air sampling methods &equipment, analytical methods for air pollution studies. Control of air pollution. Sound pollution: basics of sound pollution, its effect to environment. Acoustic noise measurement & monitoring

Text Books:

1. Water treatment technology by Walter J. Weber.
2. Air pollution engineering by M. N. Rao & H. V. N. Rao.
3. Air pollution control technology by Wark & Warner.

4. 'Environmental Engineering' by Peany Howard S, Donal R Rowe and George TachoBanoylous Teddy

Reference Books:

1. Environmental Instrumentation & Analysis Handbook by Randy D. Down.
2. Environmental Instrumentation & Analysis Handbook, by Randy D. Down & Jay H. Lehr, Wiley.
3. Environmental noise pollution by Patrick F. Cunniff, Wiley, May 1977
4. Environmental Engineering and Science by Gilber M Masters, Pearson Education (1997)

PEIN 3201 (B): Reliability Engineering

Teaching Scheme
Lecture: 3 Hr/week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisite: Engineering Mathematics

Course Objectives:
1. To know the basic principles of Reliability engineering
2. To know how to apply probability concepts in reliability
3. Apply the knowledge to system requirements, design and testing, with real world examples

Course Outcomes: The student will be able to
1. analyze different methods of failure.
2. calculate MTTF, MTBF, failure rate and hazard rate.
3. apply different probability methods to Reliability.
4. perform FEMA , FMECA, FTA and reliability testing

Unit 1: Fundamental Concepts of Reliability **(08)**
Introduction, concepts, terminologies and definitions of reliability engineering, Interrelationship of safety, quality and reliability, life characteristic phases, Product liability - Significance, importance of reliability, Introduction to maintainability, availability.
Concepts of Failure, failure density, failure Rate, hazard rate, probability distribution function. Modes of failure, Mean Time To Failure (MTTF), Mean Time Between Failure (MTBF)

Unit 2: Probability Concepts **(08)**
Basic probability concepts, Laws of probability, Introduction to independence, mutually exclusive, conditional probability, Discrete and continuous probability distributions, Comparison of probability distributions binomial, normal, lognormal, Poisson, Weibull, exponential, Standard deviation, variance, mean, mode and Central Limit Theorem.

Unit 3: System Reliability **(06)**
Analysis of series, parallel, mixed configuration systems, Concept of k-out of n structure, Conditional probability method, delta-star method for conditional probability analysis, Tie-set and Cut Set method

Unit 4: System Reliability Analysis **(06)**
Reliability Improvement, Redundancy, element redundancy, unit redundancy, standby redundancy types of standby redundancy, parallel components, single redundancy, multiple redundancies, Introduction to Reliability allocation.

Unit 5: Reliability in Design **(08)**
Reliability techniques - Failure mode, effects analysis (FMEA),Failure mode, effects and criticality analysis (FMECA) - Case Studies, Basic symbols, Fault Tree construction and analysis, Monte Carlo Simulation.

Unit 6: Reliability Testing **(06)**
Introduction to reliability testing, Stress strength interaction, Introduction to Markov model testing for Reliability and Durability - Accelerated Life Testing and Highly Accelerated Life Testing (HALT), highly accelerated stress Screening (HASS).

Text books:

1. S S. Rao, Reliability Based Design, McGraw Hill Inc. 1992
2. L.S.Srinath, Reliability Engineering, EWP , 4th Edition 2011

Reference books:

1. Chandrupatla, Quality and Reliability in Engineering Cambridge Uni. Press, India
2. Alessandro Birolini, Reliability Engineering Theory and Practice, Springer
3. Dr. Robert B. Abernathy, the New Weibull Handbook.
4. Bryan Dodson, Dennis Nolan, Reliability Engineering Handbook, Marcel Dekker Inc, 2002

PEIN 3201 (C): Micro Electro Mechanical System (MEMS)

Teaching Scheme
Lecture: 3 Hr/week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisites: Conventional sensors and materials, application of sensors

Course Objectives:

1. To introduce emerging MEMS field and importance of micro scaling to students
2. To provide knowledge of advanced materials, sensors and actuators
3. To learn advance micro fabrication techniques
4. To know advancement in instrumentation field of bio, automotive, aerospace field

Course Outcomes: The student will be able to,

1. compare smart material based on their characteristics
2. select the appropriate micro sensor and micro actuator for different application.
3. identify and define variuos phases of micro scaling and micro fabrication process.
4. develop application using MEMS devices.

Unit 1: Introduction to MEMS **(07)**

Introduction to MEMS, Introduction to micro sensors, Evaluation of MEMS, Micro sensors, Market Survey, Application of MEMS

Unit 2: Smart Material and Applications **(07)**

Shape memory Materials, Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials, Rheological Materials, Electro chromic Materials, Self-healing Material, Conducting polymer

Unit 3: Micro Sensor **(06)**

Silicon Capacitive Accelerometer, Piezoresistive Pressure Sensor, Conductometric Gas Sensor, Fiber-Optic Sensors, Electrostatic Comb-Drive

Unit 4: Micro Actuator **(06)**

Magnetic Micro relay, Microsystems at Radio Frequencies, Piezoelectric Inkjet Print Head, Portable Blood Analyzer, Micro mirror Array for Video Projection Micro-PCR Systems

Unit 5: Micro Fabrication **(07)**

Study of Silicon as a Material for Micro machining, Thin-film Deposition –Evaporation, Sputtering, Chemical Vapor Deposition, Epitaxial Growth of Silicon Thermal Oxidation, Lithography, Doping the Silicon Wafer: Diffusion and Ion, Implantation of Dopant, Etching. Dry Etching, Silicon Micro machining Bulk Micro machining, Surface Micro machining

Unit 6: MEMS –Electronics, Packaging and Applications **(07)**

Wafer Bonding & Packaging of MEMS Interface Electronics for MEMS, MEMS for Biomedical Applications (Bio-MEMS)

Text Books:

1. Micro And Smart Systems by G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Atre : Wiley, India (2010).

Reference Books:

1. Vijay, K., Varadan K., Vinoy J. Gopalakrisham S.: Smart Material Systems and MEMS: Design and Development Methodologies, Willey 2006
2. Addington, M. ,Schodek, Daniel L.: Smart materials and new technologies, Architectural Press, 2005.
3. Brain Culshaw – Smart Structure and Materials Artech House – Borton. London 1996
4. Srinivasan A.V., Michael McFarland D., Smart Structure analysis and design, Cambridge University Press, 2001

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PEIN 3201 (D): Internet of Things

Teaching Scheme
Lecture: 3 Hr/week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisites: Basics of sensors and actuators, networks, logic building ability

Course Objectives:
1. To study latest trends in Instrumentation.
2. To study various connectivity technologies for IoT.
3. To study wireless communication and protocols.

Course Outcomes: The student will be able to
1. apply suitable techniques for sensor networking.
2. compare different connectivity technologies for IoT.
3. select and justify the protocols for typical applications.
4. verify wireless sensor networks for typical applications.

Unit 1: Introduction to IoT **(07)**
IoT Basics, Components, architecture, Interdependencies, categories, gateways, associated technologies, Challenges, Considerations, Scalability
Role of sensors, actuators and networks in IoT
Connectivity technologies: Introduction, Features, Working principle, addressing, Routing and Applications of 6LoWPAN, RFID

Unit 2: IoT Networking **(07)**
Introduction, features, components, methods, variants, communication, Response models, message types and applications of MQTT, CoAP, XMPP, AMQP

Unit 3: Communication Protocols in IoT (Part I) **(07)**
Introduction, features, components, methods, variants, communication, topologies, Response models, message types and applications of IEEE802.15.4, Zigbee, HART and Wireless HART

Unit 4: Communication Protocols in IoT (Part II) **(07)**
Introduction, features, components, methods, variants, communication, topologies, Response models, message types and applications of Z wave, ISA100.11.A and NFC

Unit 5: Wireless Sensor Networks **(07)**
Introduction, features, components, multihop paths, challenges of WSN.
Sensor Web, Entanglement, Co-operation in WSN, Security challenges, Node behavior and dynamic misbehavior
Detection and Connectivity, Event Aware topology management, Information theoretic self-management of WSN
Introduction and Applications of Wireless Multimedia Sensor Networks

Unit 6: Paradigms of IoT **(07)**
UAV networks, Machine to machine communication in IoT, Interoperability in IoT.
Introduction to Cloud Computing and Fog Computing. Role of Microcontrollers in IoT

Text Books:

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press).
2. "Internet of Things: A Hands-on Approach", by ArshdeepBahga and Vijay Madisetti (Universities Press)

Reference Books:

1. "Architecting the Internet of Things", by Dieter Uckelmann, Mark Harrison, Florian, Springer
2. "The Internet of Things: Key Applications and Protocols", by Olivier Hersent, David Boswarthick, Elloumi, Wiley

PEIN 3202 (A): Embedded Product Design

Teaching Scheme
Lecture: 3 Hr/week

Examination Scheme
In Semester: 50 Marks
End Semester: 50Marks
Credit: 3

Prerequisites: Embedded system design, Knowledge of Assembly and C programming, Electronic instrumentation and system design

Course Objectives:
1. To give knowledge of interfacing analog and digital input devices to microcontrollers.
2. To give knowledge of interfacing analog and digital output devices to microcontrollers.
3. To implement different power optimization techniques for low power systems.
4. To give overview of product design with case study.

Course Outcomes: Students will be able to
1. To apply different methodologies to interface different sensors and devices to microcontroller.
2. To apply different methodologies to interface different actuators to microcontroller.
3. To compare and select proper power optimization techniques.
4. To design and test performance of system designed for practical application.

Unit 1: Programming and Interfacing Analog Input Devices **(07)**
Load cell, Temperature sensor, 2-wire transmitters, potentiometric sensors, LVDT, Linear opto-isolator IL300

Unit 2: Programming and Interfacing Analog Output Devices **(08)**
Linear opto IL300, PWM based DAC, serial DAC, Voltage to current converter, Lamp/indicator, miniature DC motor,

Unit 3: Programming and Interfacing Digital Input Devices **(08)**
Key board, Proximity switch, incremental Encoders, Ultrasonic sensors, serial ADC, RTC-1307, Opto coupler MCT2E

Unit 4: Programming and Interfacing Digital Output Devices **(08)**
Alpha-numeric LCD, 7-Segment LED display, serial memories, Opto coupler MCT2E, printer, Stepper motor, relays (SSR and Electro-mechanical)

Unit 5: Power Efficient System and Communication Design **(06)**
Design considerations for battery powered systems, communication based on RS-232, RS-485, Bluetooth and USB drives

Unit 6: Small System Design with Case Study **(05)**
Embedded system design for Temperature data logger, Burglar alarm, Fire alarm, WSN based system, RFID based access control

Text Books:

1. Microcontrollers: Theory & Applications by Dr. A. V. Deshmukh, Tata McGraw Hill, Publications
2. Programming and Customizing the AVR Microcontroller by Dhananjay V. Gadre, Tata McGraw Hill Publishing Company Limited, 2003.
3. AVR microcontroller & Embedded System by A. Mazidi , Prentice Hall

Reference Books:

1. Internet resources for AVR:
   a. Atmel AVR Page: http://www.atmel.com/images/doc2502.pdf
   b. http://www.atmel.in/Images/doc0856.pdf
   c. Datasheets of ATmega 8535, ATtiny2313
   c. Datasheets of IL300, RTC1307, MCT 2E, serial ADCs, DACs

PEIN 3202 (B): Advanced Biomedical Instrumentation

Teaching Scheme
Lecture: 3 Hr/week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisites: Physiology of human body organs and basics of monitoring equipments

Course Objectives:

1. To study diagnostic and operating instruments
2. To study life saving devices
3. Get the knowledge of laser technology
4. To learn various instruments used for checking performance of sensory organs

Course Outcomes: Students will be able to,

1. identify functionalities of various advanced biomedical instruments
2. compare and select the suitable biomedical instrument for appropriate diagnosis.
3. demonstrate the operation of biomedical instruments.
4. develop biomedical instrument system for various application.

Unit 1: Cardiovascular Instrumentation **(07)**

Pacemaker, Types of pacemakers: External and Internal, Programmable Pacemaker
Defibrillators: AC and DC Defibrillator, Implantable defibrillator, Heart Lung Machine

Unit 2: Clinical Lab Instrumentation **(07)**

Blood and its composition and function, Blood Cell Counters, Pulse Oximetry- principle, Invitro and Invivo Oximeter, Colorimeter, Spectrophotometer, Clinical flame photometer, Auto analyzers.
Telemetry- Time division and Frequency division multiplexing, Telemedicine

Unit 3: Respiratory and Kidney Instrumentation **(07)**

Spiro meters- volume and flow type, airflow measurement, Ventilators, Oxygenators-Bubble Type, Membrane Type
Dialysis System- Hemodialysis and Peritoneal dialysis, Artificial Kidney-types (Coil type, parallel plate type), Lithotripsy

Unit 4: Laser Applications and Rehabilitation Engineering **(06)**

Types of lasers, Properties of laser, Interaction of lasers with tissues- thermal and non thermal, Basic Endoscopes system and its characteristics, Laser applications in ophthalmology- Diabetic Retinopathy, glaucoma and Retinal hole and detachment treatment, Dermatology- Tattoo, port wine treatment.
Orthrotics & Prosthetic devices, overview of various orthotics and prosthetic devices along with its materials. Wheelchair types, material used in wheelchair

Unit 5: ICU and Operating Room Instrumentation **(07)**

Drug Delivery System, Infusion Pump
ICU layout, organization, Bedside monitor.
Operating room instrumentation: Electro surgical Unit - modes, electrode configuration, front panel controls and safety aspects, Anesthesia Machine

Unit 6: Sensory Instrumentation **(06)**

Basic Audiometer; Pure tone audiometer; Audiometer system Bekesy; Evoked response Audiometer system, Hearing Aids, Visual acuity, Slit Lamp, Tonometer, Ophthalmoscope, Perimeter

Text Books:

1. Medicine and Clinical Engineering by Jacobsons & Webster, PHI
2. Introduction to Biomedical Equipment Technology ByCarr & Brown
3. Biomedical Instrumentation and Measurements by Cromwell, PHI
4. Handbook of Biomedical Instrumentation by R. S. Khandpur, TMH

Reference Books:

1. The Biomedical Engineering Handbook, Bronzino, IEEE Press
2. Applied Chemical Engineering Feenberg,
3. Principles of Medical Imaging.-By: K. Kirk Shung, Michael B. Smith, Benjamin Tsui.-Pub: Academic Press.
4. Medical Laser Applications -By Carruth
5 .Biomedical Instrumentation and Measurement, R.Anandanatarajan

PEIN 3202 (C): Computer Organization

Teaching Scheme
Lecture: 3 Hr/Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisite: Basic computer skills and logic development skills

Course Objectives:
1. To provide better understanding of functions of different operating systems.
2. To provide knowledge of software testing and communication protocols
3. To understand the software development life cycle.

Course Outcomes: Students will be able
1. To list and define functionalities of operating system
2. Compare various standards related to computer communication
3. Develop Queries for Data Base Management Systems
4. Classify and compare software testing methodologies

Unit 1: Operating System Overview **(08)**
Concepts of Operating System and its services, Types of operating systems
Process Management: Concept, scheduling, operations on process
CPU scheduling: Basic concepts, CPU scheduling algorithms
Deadlocks: Characterization, Handling, Recovery Disk scheduling algorithms

Unit 2: Memory and File Management **(08)**
Memory Management: Address Binding, Overlays, Swapping, Contiguous memory allocation, Paging, Segmentation
Virtual memory: Concept, Demand paging, Preparing, Page size considerations, Page replacement algorithms, Thrashing
File system management: Concept, file access methods, directory structures, file allocation methods

Unit 3: RTOS, Parallel Computers **(08)**
Real Time & embedded System OS: Concepts, Types, their differences, Handheld Operating Systems. Interrupt Routines in RTOS environment, RTOS Tasks and their Scheduling models, Strategy for synchronization between the processes,
Parallel Computers: Basic concepts, Types of parallelism, Intertask dependencies, classification of parallel computers, vector computers, Array processors, Systolic Arrays
Data Compression, Encryption and decryption

Unit 4: Computer Communication **(06)**
Computer Communication: ISO-OSI Seven Layer model, The TCP/IP reference model Introduction to LAN, LAN topologies, IEEE standards for networking- IEEE 802.3, IEEE 802.4, IEEE 802.5, Circuit switching and Packet switching networks, Features and capabilities of TCP/IP, Industrial Ethernet, Introduction to IEEE 1394, IEEE 488(GPIB), its configuration and advantages.

Unit 5: Database Management System **(04)**
Introduction to DBMS, Disadvantages of File Processing System, characteristics of DBMS Data Model, SQL Programming.

Unit 6: Software Testing **(06)**

Software Development Life Cycle and its models:

a. Linear Sequential

b. Rapid development

c. Incremental

d. Component based Software Analysis, Software Design, Software Implementation

Software Testing: fundamentals, white box, black box testing, control structure testing, specific environment testing, comparison testing, orthogonal testing, strategic approach to testing, unit testing, integrated testing, validation testing, system testing, CASE tools

Software debugging: Standard guidelines, debugging techniques- use of break points, test macros, output files for sampled inputs, instruction set simulation, laboratory tools

Software maintenance: Preventive, Corrective, Adaptive, Enhancement, System Re-engineering

Text Books:

1. Operating System Concepts by Silberschatz, Galvin, Gagne
2. Parallel Computer architecture and programming by V. Rajaraman, C. SivaRam Murthy, PHI
3. Computer Networks by Andrew Tanenbaum, Prentice Hall.
4. Introduction To Data Compression by Khalid Sayood, Morgan Kaufmann Publishers, Inc.
5. Software Engineering by Ian Somerville, 4th edition, Addison Wesley publication

Reference Books:

1. Computer Architecture and Parallel processing by Kai Hwang, Faye Briggs, McGraw Hill International Editions
2. Computer Networks Protocols, Standards and Interfaces by Uyless Black, PHI
3. High Speed Networks TCP/IP and ATM design principles by William Stallings.
4. Introduction to Data Compression by Khalid Sayood, Morgan Kaufmann Publishers, Inc.

PEIN 3202 (D): Robotics

Teaching Scheme
Lecture: 3 Hr/Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisite: Basics of Mechatronics

Course Objectives:

1. Explain fundamentals of robotic system
2. Introduce kinematics, dynamics and control for robotics systems
3. Introduce trajectory planning for motion
4. Describe application of robots in automation

Course Outcomes: The student will be able to

1. classify robotic systems based on joint and arm configuration
2. compute forward and inverse kinematics of robot and trajectory planning
3. interface different sensors, actuators and grippers
4. design and program robot for industrial automation

Unit 1: Introduction to Robotics **(08)**

Definition of robotics ,components of Robot system-(manipulator, controller, sensors, power conversion unit etc.), Classification of robots based on co-ordinate systems, Degrees of freedom, links and joints ,progressive advancements in robots, Present trends and future trends in robotics.

Unit 2: Dynamics and Kinematics **(10)**

Dynamic constraints, velocity and acceleration of moving frames, robotic mass distribution and inertia, tension, Newton's equation, Euler equation, dynamic modelling of robotic manipulators. Homogeneous co-ordinate system, homogeneous co-ordinate vector operations. Co-ordinate reference frames, homogeneous transformation and manipulator orientation relative points reference frames, forward solutions: link co-ordinate frames, D-H matrix, Inverse or back solutions, techniques of using direct and geometric approach.

Unit 3: Robotic End Effectors, Sensors and Actuators **(08)**

Different types of grippers: vacuum and other methods of gripping, sensors used in robots, internal and external sensors, position, relocking and acceleration sensors, proximity sensors, force sensors, touch slip laser range tinder, camera and robot vision, overview of actuators: electric, pneumatic and hydraulic actuators.

Unit 4: Trajectory Planning and Control of Manipulators **(08)**

Trajectory Planning: Joint space techniques and Cartesian space techniques, control of manipulators, On-off trajectory, relocking and acceleration profile, Cartesian motion of Manipulator, joint interpolated control, Jacobean in terms of D-H Matrix, obstacle avoidance, basic control system, control loops of Robotic system

Unit 5: Robotics and Industrial Automation **(08)**

Programming Methods, Robot language, need for Automation, Robotics Intelligence and Tasking,

MEMS introduction and working principle, Nano Robots. Applications of Robotics: Application manufacturing: Material Transfer – Material handling, loading and unloading processing – spot and continuous arc welding and spray painting – Assembly Inspection, Robot Application in Medical, Industrial and Security.

Text Books:

1. Fundamentals of Robotics: Analysis and Control-*Robert schilling* ,PHI, New Delhi
2. Robotic Engineering-*Klafter, Thomos, Negin*, PHI, New Delhi

Reference Books:

1. Fundaments of Robotics-*T.C. Manjunath*,Nandu Publishers,Mumbai
2. Robotics and Control-*R.K.Mittal, I.J.Nagrath*, TMH,New Delhi
3. Mems and Microsystems Design and manufacture-*HSU*,TMH,New Delhi
4. Fu, Gonzales and Lee, Robotics McGraw Hill

IN 3204: Process Loop Components Lab

Teaching Scheme
Practical: 2 Hr/week

Examination Scheme
Practical: 25 Marks
Credit: 1

Course Outcomes: The student will be able to

1. calibrate various process control components like transmitter, converter by selecting proper test and measuring instruments
2. characterize performance of various process control components like transmitter, converter, control valve etc.
3. configure, test and tune various process control components like transmitter, controller, control valve by proper analysis of given application
4. develop and Implement PLC programs for the given application

List of Experiments:

Students are expected to perform Minimum 8 Experiments

1. Plotting the characteristics of two wire transmitter
2. Calibration and plotting the characteristics of Current to Pneumatic converter
3. Plotting the characteristics of Square root extractor
4. Calibration and plotting the characteristics of conventional differential pressure transmitter
5. Calibration of Smart differential pressure transmitter flow measurement using smart DPT
6. Plotting the step response of electronic controllers
7. Tuning of controllers
8. Study of PLC
9. PLC programming
10. Interfacing PLC to pneumatic circuit
11. Identifying parts of control valves by using cut sections of different types
12. Plotting control valve characteristics

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IN 3205: Digital Signal Processing Lab

Teaching Scheme
Practical: 2 Hr/Week

Examination Scheme
Practical: 25 Marks
Credit: 1

Course Outcomes: The student will be able to
1. Solve the mathematical problem using programming skills.
2. Select and implement appropriate signal processing operation for the given application.
3. Analyze discrete and digital signals and systems in time and frequency domains.
4. Design the signal processing filtering operation for specific application.

List of Experiments:
Students are expected to perform at least eight experiments using MATLAB or equivalent software:
1. Write a Program to generate the basic signals.
2. Write a Program to implement the basic DSP operations on the given signals.
3. Write a Program to implement Linear Convolution of the two given sequences.
4. Write a Program to obtain the auto-correlation and Cross-correlations of the given sequences.
5. Write a Program to obtain the transfer function and plot is pole-zero plot
6. Write a Program to find the DFT of the given sequences. Plot its magnitude and phase plot. Also find its IDFT to obtain the original sequence.
7. Write a Program to obtain the linear convolution using circular convolution of two given sequences.
8. Write a Program to obtain the DFT of the given sequences and plot its magnitude and phase spectrum.
9. Write a Program to design and implement FIR filters using difference windowing methods.
10. Write a Program to design and implement IIR filters (Using Butterworth or Chebyshev approximations).

PEIN 3203 (A): Embedded Product Design Lab

Teaching Scheme
Practical: 2 Hr/week

Examination Scheme
Oral: 25 Marks
Credit: 1

Course Outcomes: The student will be able to

1. develop, implement and test analog interfacing circuits for sensors and actuators.
2. develop, implement and test digital interfacing circuits for sensors and actuators.
3. develop power optimization techniques for battery powered instruments.
4. analyze and justify the design stages of industrial product.

List of Experiments:

Students are expected to perform 1st and any 4 Experiments from remaining list

1. Interfacing of Keyboard and LCD
2. Interfacing of temperature sensor LM35
3. Interfacing of 2-wire transmitter
4. Programmable voltage to current converter
5. Interfacing of miniature DC motor, Lamp/Power LED
6. Interfacing of proximity switch and relay using MCT 2E opto coupler
7. Interfacing of ultrasonic sensor HC-SR04
8. Design of up-down counter and Interfacing of 7-segment LED display
9. Design and testing of an application based on power down mode of microcontroller

PEIN 3203 (B): Advanced Biomedical Instrumentation

Teaching Scheme
Practical: 2 Hr/week

Examination Scheme
Oral: 25 Marks
Credit: 1

Course Outcome: The student will be able to
1. list the various parts of advanced biomedical instruments
2. identify various control of advanced biomedical instruments
3. record the response of human sensory organs
4. analyze and interpret the recorded data

List of Experiments: (minimum 8 experiments)
1. Study of various types of Pacemakers and its specifications
2. Study of specifications and applications of AC and DC Defibrillators.
3. Study of various equipments and their working in Clinical Lab.
4. Study principle and operation of electrosurgical machine.
5. Study of Basic telemetry system: ECG telemetry system
6. Study of instrumentation and various interlocks in the Dialysis equipment.
7. Recording and analysis of audiogram for different subjects using audiometer.
8. Study of various ophthalmic instruments
9. Study of dermatological laser treatments
10. Study of various Rehabilitation equipments, instrumentation involved and their applications.
11. Hospital visit Report

PEIN 3203 (C): Computer Organization Lab

Teaching Scheme
Practical: 2 Hr/Week

Examination Scheme
Oral: 25 Marks
Credit: 1

Course Outcomes: The student will be able to

1. develop logic for operating system functionalities
2. apply database management concepts for handling database
3. create their own test plan as a part of software development life cycle
4. compare standard communication protocols

List of Experiments:

Students are expected to perform at least eight experiments using MATLAB or equivalent software:

1. CPU scheduling algorithms.
2. Program on parallel computing

PEIN 3203 (D): Robotics Lab

Teaching Scheme
Practical: 2 Hr/Week

Examination Scheme
Oral: 25 Marks
Credit: 1

Course Outcomes: The student will be able to

1. describe mechanical configuration of robot manipulation
2. undertake kinematic analysis of robot manipulation
3. simulate the application of robot
4. develop program to perform specified task through a robot

List of Experiments:

1. To build robot arms using mechanical components and applying motor drives.
2. To build robot for given configuration and degree of freedom.
3. Motion of robot for each degree of freedom. Teaching a sequence to robot using Teach Pendent.
4. To perform pick and place operation using Simulation and Control Software.
5. Robot path planning using Simulation and Control Software.
6. 2D Simulation of 3 Degree of Freedom arm.
7. Direct Kinematics analysis of 4-axis robot using Software.
8. Use micro-controller program to use different sensors and further move model robot.

IN 3206: Seminar on Mini Project

Teaching Scheme
Practical: 4 Hr/Week

Examination Scheme
In Semester: 25 Marks
Practical: 25 Marks
Credits: 2

The students will present a seminar on the mini-project done by them. The students will work in a group of 2/3 per group.

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