## M.E. INSTRUMENTATION ENGINEERING

### SEMESTER I

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**TOTAL CREDITS TO BE EARNED FOR THE AWARD THE DEGREE = 67**

### ELECTIVES FOR M.E INSTRUMENTATION ENGINEERING

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COURSE OBJECTIVES
- To give an overview of the Industrial data communications systems
- To provide a fundamental understanding of common principles, various standards, protocols
- To provide an insight into some of the new principles those are evolving for future networks.

COURSE OUTCOMES
- Ability to develop an understanding of and be able to select and use most appropriate technologies and standards for a given application
- Ability to design and ensuring that best practice is followed in installing and commissioning the data communications links to ensure they run fault-free

UNIT I DATA NETWORK FUNDAMENTALS

UNIT II PLC, PLC PROGRAMMING & SCADA
Evolutions of PLCs – Programmable Controllers – Architecture – Comparative study of Industrial PLCs. –PLC Programming:- Ladder logic, Functional block programming, Sequential function chart, Instruction list and Structured text programming. SCADA:- Remote terminal units, Master station, Communication architectures and Open SCADA protocols.

UNIT III DISTRIBUTED CONTROL SYSTEM & HART

UNIT IV PROFIBUS AND FF
Fieldbus:- Introduction, General Fieldbus architecture, Basic requirements of Fieldbus standard, Fieldbus topology, Interoperability and Interchangeability Profibus:- Introduction, Profibus protocol stack, Profibus communication model, Communication objects, System operation and Troubleshooting – Foundation fieldbus versus Profibus.

UNIT V AS – INTERFACE (AS-I), DEVICENET AND INDUSTRIAL ETHERNET
AS interface:- Introduction, Physical layer, Data link layer and Operating characteristics. Devicenet:- Introduction, Physical layer, Data link layer and Application layer. Industrial Ethernet:- Introduction, 10Mbps Ethernet and 100Mbps Ethernet - Introduction to OLE for process control

TOTAL 45 PERIODS
REFERENCE BOOKS


IN8102 LINEAR AND NON-LINEAR SYSTEMS THEORY

COURSE OBJECTIVES
- To develop the skills needed to represent the system in state space form
- To impart knowledge required to design state feedback controller and state observers
- To impart knowledge and skills needed to classify singular points and construct phase trajectory using delta and isocline methods.
- To make the students understand the concepts of stability and introduce techniques to assess the stability of certain class of non-linear system using describing function, Lyapunov Stability, Popov’s Stability Criterion and Circle Criterion
- To make the students understand the various non-linear behaviors such as Limit cycles, input multiplicity and output multiplicity, Bifurcation and Chaos.

COURSE OUTCOMES
- Ability to represent the time-invariant systems in state space form as well as analyze, whether the system is stabilizable, controllable, observable and detectable.
- Ability to design state feedback controller and state observers
- Ability to classify singular points and construct phase trajectory using delta and isocline methods.
- Use the techniques such as describing function, Lyapunov Stability, Popov’s Stability Criterion and Circle Criterion to assess the stability of certain class of non-linear system.
- Ability to describe non-linear behaviors such as Limit cycles, input multiplicity and output multiplicity, Bifurcation and Chaos.
UNIT I  STATE SPACE APPROACH

UNIT II  STATE FEEDBACK CONTROL AND STATE ESTIMATOR
Controllability and observability – Stabilizability and Detectability - Kalman Decomposition - State Feedback – Pole placement technique – Full order and Reduced Order Observers

UNIT III  NON-LINEAR SYSTEMS

UNIT IV  STABILITY OF NON-LINEAR SYSTEMS

UNIT V  NON-LINEAR SYSTEMS ANALYSIS

REFERENCE BOOKS

TOTAL 45 PERIODS
COURSE OBJECTIVES
- To give an overview of the features associated with Industrial Type PID Controller such as reset windup, bumpless auto-manual transfer, proportional kick and derivative kick.
- To make the students understand the various PID tuning methods.
- To elaborate different types of control schemes such as cascade control, feed-forward control, DMC, GPC, Inferential control schemes, Multi-variable control schemes etc.

COURSE OUTCOMES
- Ability to apply knowledge of mathematics, science, and engineering to the build and analyze models for flow, level, and thermal processes.
- Ability to determine the advanced features supported by the Industrial Type PID Controller.
- Ability to design, tune and implement SISO P/Pi/PID Controllers to achieve desired performance for various processes.
- Ability to analyze multivariable systems and design multi-variable and multi-loop control schemes for various processes namely four-tank system, pH process, bio-reactor, distillation column.
- Ability to identify, formulate, and solve problems in the process control domain.

UNIT I PROCESS DYNAMICS & CONTROL ACTIONS

UNIT II PID CONTROLLER TUNING – SINGLE LOOP REGULATORY CONTROL

UNIT III ENHANCEMENT TO SINGLE LOOP REGULATORY CONTROL & MODEL BASED CONTROL SCHEMES

UNIT IV MULTIVARIABLE SYSTEMS & MULTI-LOOP REGULATORY CONTROL
UNIT V MULTIVARIABLE REGULATORY CONTROL & CASE STUDIES


TOTAL 45 PERIODS

REFERENCE BOOKS


IN8104 TRANSDUCERS AND SMART INSTRUMENTS

COURSE OBJECTIVES

- To give a detailed knowledge on transducer characteristics and uncertainties in measurement.
- To provide a detailed knowledge on error and determination of uncertainties in measurement.
- To give a comprehensive knowledge on smart sensor Design, Development and Challenges.
- To give exposure to manufacturing techniques and different types of Micro sensors and actuators.
- To give an overview of latest advancement and trend in transducer systems.

COURSE OUTCOMES

Students’

- Will be able to completely characterize a conventional transducer.
- Can confidently analyze and quantify the uncertainties in measurement data.
- Will have the capability to design and develop customized smart sensors.
- Acquire a comprehensive Knowledge of manufacturing techniques and design aspects of micro sensors and actuators.
- Get exposure to latest sensor technology and advanced measurement Methodologies.
UNIT I  OVERVIEW OF CONVENTIONAL TRANSDUCERS AND ITS CHARACTERISTICS
Overview of conventional sensors - Resistive, Capacitive, Inductive, Piezoelectric, Magnetostrictive and Hall effect sensors - Static and Dynamic Characteristics and specifications.

UNIT II  MEASUREMENT ERROR AND UNCERTAINTY ANALYSIS
Importance of error analysis - Uncertainties, precision and accuracy in measurement - Random errors - Distributions, mean, width and standard error - Uncertainty as probability - Gaussian and Poisson probability distribution functions, confidence limits, error bars, and central limit theorem - Error propagation - single and multi-variable functions, propagating error in functions - Data visualization and reduction - Least square fitting of complex functions

UNIT III  SMART SENSORS

UNIT IV  MICRO SENSORS AND ACTUATORS

UNIT V  RECENT TRENDS IN SENSOR TECHNOLOGIES

TOTAL 45 PERIODS

REFERENCE BOOKS
COURSE OBJECTIVES

- To give an overview of Advanced Digital Signal Processing subject with conceptual clarity.
- To provide the foundation for signal modeling, linear prediction and estimation theory.
- To impart knowledge on adaptive filter design, multi-rate signal processing and filter banks.

COURSE OUTCOMES

- Ability to apply the knowledge of mathematics, science, and engineering for the analysis and design of digital systems.
- Ability to identify, formulate and solve engineering problems in the area of random signal processing and spectrum estimation.
- Ability to design adaptive filters with realistic constraints.

UNIT I REVIEW OF DIGITAL SIGNALS, SYSTEMS AND FILTERS

UNIT II RANDOM SIGNAL PROCESSING AND SPECTRUM ESTIMATION

UNIT III LINEAR ESTIMATION AND PREDICTION

UNIT IV ADAPTIVE FILTERS

UNIT V MULTIRATE DIGITAL SIGNAL PROCESSING
Mathematical description of change of sampling rate - Interpolation and Decimation - continuous time model - Direct digital domain approach - Decimation by an integer factor - Interpolation by an integer factor - Single and multistage realization - poly phase realization - Application to sub band coding - Wavelet transform and filter bank implementation of wavelet expansion of signals.

TOTAL 45 PERIODS
REFERENCE BOOKS


MA8155 ADVANCED NUMERICAL METHODS

COURSE OBJECTIVES

- To make the students understand the methods/algorithms to numerically solve set of simultaneous algebraic equations
- To make the students understand the methods to numerically solve set of simultaneous ordinary differential equations
- To make the students understand the methods to numerically solve partial differential equations

COURSE OUTCOMES

- Ability to solve numerically set of simultaneous algebraic equations
- Ability to solve numerically set of simultaneous ordinary differential equations (IVP)
- Ability to solve numerically set of Partial differential equations

UNIT I ALGEBRAIC EQUATIONS


UNIT II ORDINARY DIFFERENTIAL EQUATIONS

Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method
UNIT III  FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION
Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines – Wave equation: Explicit scheme- Stability of above schemes

UNIT IV  FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS
Laplace and Poisson’s equations in a rectangular region: Five point finite difference schemes, Leibmann’s iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes – approximation of derivatives near a curved boundary while using a square mesh.

UNIT V  FINITE ELEMENT METHOD

L:45 +T: 15 TOTAL: 60 PERIODS

REFERENCE BOOKS
1. (a) Study of Process Control Training plant  
   (b) Piping and Instrumentation diagram

2. Simulation of lumped parameter and Distributed parameter systems.
4. (a) Design and implementation PID Control scheme on the simulated process.  
   (b) PID Implementation issues

5. Level and pressure control (with and without Interaction) in process control Test Rig.
6. Auto- Tuning of PID controller
7. Design and implementation of Feed forward and Cascade control schemes on the simulated model of CSTR process.
8. (a) Analysis of MIMO system.

   (b) Design and implementation of Multi-loop PID and Multivariable PID control schemes on the simulated model of two-tank systems.

9. Design and implementation of Robust PID control schemes on the simulated model of variable area tank process.

10. a) Design and implementation of Self-tuning and Model Reference Adaptive Control schemes on the simulated model of variable area tank process.

    (b) Design and implementation of gain scheduled Adaptive controller on the simulated model of variable area tank process.

11. Study of MPC toolbox.

12  a) On-line Monitoring and Control Using Distributed Control System

    b) Implementation of Discrete Control Sequence using Programmable Logic Controller.

   TOTAL 45 PERIODS
COURSE OBJECTIVES
- To teach students to build and analyze models for time-varying systems and non-linear systems.
- To develop the skills needed to design adaptive controllers such as gain-scheduled adaptive controller, Model-reference adaptive controller and Self-tuning controller for various applications.
- To make the students learn to formulate optimal control schemes.
- To provide basic knowledge about Fractional-order systems and Fractional-order controller and to lay the foundation for the systematic approach to Design controller for fractional order systems.
- To introduce FDI Techniques, such as Principal component Analysis, state observer to detect and diagnose faults in sensors and actuators.

COURSE OUTCOMES
- Ability to Apply knowledge of mathematics, science, and engineering to build and analyze models for time-varying systems and non-linear systems.
- Ability to design and implement adaptive controllers such as gain-scheduled adaptive controller, Model-reference adaptive controller and Self-tuning controller.
- Ability to Identify, formulate, and solve optimal controller.
- Ability to Analyze Fractional-order systems, Fractional-order controller and Design controller for fractional order systems.
- Ability to design and implement $H_2$ and $H$-infinity Controllers.
- Ability to use the FDI Techniques, such as Principal component Analysis, state observer to detect and diagnose faults in sensors and actuators.

UNIT I CONTROL OF TIME-VARYING AND NONLINEAR SYSTEMS

UNIT II OPTIMAL CONTROL & FILTERING

UNIT III FRACTIONAL ORDER SYSTEM & CONTROLLER
Fractional-order Calculus and Its Computations – Frequency and Time Domain Analysis of Fractional-Order Linear Systems - Filter Approximations to Fractional-Order Differentiations – Model reduction Techniques for Fractional Order Systems – Controller Design Studies for Fractional Order.

UNIT IV H-INFINITY CONTROLLER
UNIT V  FAULT DIAGNOSIS AND FAULT-TOLERANT CONTROL


REFERENCE BOOKS


IN8202  INSTRUMENTATION SYSTEM DESIGN

COURSE OBJECTIVES

- To impart knowledge on the design of signal conditioning circuits for the measurement of Level, temperature and pH.
- To develop the skills needed to design, fabricate and test Analog/ Digital PID controller, Data Loggers and Alarm Annunciator
- To make the students familiarize design orifice and control valve sizing.

COURSE OUTCOMES

- Ability to design signal conditioning circuits for temperature sensors, V/I and I/V converters
- Ability to design and fabricate smart transmitters
- Ability to design, fabricate and test PID controllers and alarm circuits
- Ability to carryout orifice and control valve sizing for Liquid/Steam Services

UNIT I  DESIGN OF SIGNAL CONDITIONING CIRCUITS

UNIT II  DESIGN OF TRANSMITTERS
Study of 2 wire and 4 wire transmitters – Design of RTD based Temperature Transmitter, Thermocouple based Temperature Transmitter, Capacitance based Level Transmitter and Smart Flow Transmitters.

UNIT III  DESIGN OF DATA LOGGER AND PID CONTROLLER
Design of ON / OFF Controller using Linear Integrated Circuits - Electronic PID Controller – Microcontroller Based Digital Two-degree of freedom PID Controller - Microcontroller based Data Logger – Design of PC based Data Acquisition Cards

UNIT IV  ORIFICE AND CONTROL VALVE SIZING
Orifice, Venturi and flow nozzle Sizing: - Liquid, Gas and steam services – Control valve sizing – Liquid, Gas and steam Services – Rotameter Design.

UNIT V  DESIGN OF ALARM AND ANNUNCIATION CIRCUIT
Alarm and Annunciation circuits using Analog and Digital Circuits – Design of Programmable Logic Controller - Design of configurable sequential controller using PLDs

TOTAL 45 PERIODS

Practical Component
1. Design Fabrication and Testing of 2 wire / 4 wire analog transmitters 5 Hrs
2. Design, Fabrication and Testing of Data Logger 5 Hrs
3. Design Fabrication and Testing of PID Controllers (Analog / Digital) 5 Hrs
4. Design Fabrication and Testing of Alarm Annunciation Circuits 5 Hrs
5. Development of Software Package for sizing Orifice/ Control valve / Rotameter 5 Hrs
6. Design of Programming Logic Controller using Microcontroller 5 Hrs

TOTAL 30 PERIODS

REFERENCE BOOKS
COURSE OBJECTIVES
To enable students
- To acquire knowledge about the various techniques used for the measurement of primary industrial parameters like flow, level, temperature and pressure.
- understand the important parameters to be monitored and analyzed in Thermal power Plant
- To get an exposure on the important parameters to be monitored and analyzed in Petrochemical Industry
- To learn about the hazardous zone classification and intrinsic safety techniques to the adapted in industries.
- Learn about other special purpose instruments like Nuclear radiation detection techniques, fibre optic sensors, Instrumentation for NDT applications etc

COURSE OUTCOMES
On completion of this course, students will be able to
- understand the instrumentation behind flow, level, temperature and pressure measurement
- Acquire basic knowledge on the important measurement parameters and required analyzers with respect to Boilers in Thermal power plant,
- know about the working principle of instruments used in different operations in petrochemical industry
- explain about the necessary safety techniques to be adopted in a typical Process industry
- Understand about the Instrumentation used in Nuclear Radiation Detection, corrosion monitoring and to have an exposure on NDT analysis.

UNIT I REVIEW OF INDUSTRIAL INSTRUMENTATION
Overview of Measurement of Flow, level, Temperature and Pressure

UNIT II MEASUREMENT IN THERMAL POWER PLANT (BOILERS)
Selection and Installation of instruments used for the Measurement of fuel flow, Air flow, Drum level, Steam pressure, Steam temperature – Feed water quality measurement- Flue gas Oxygen Analyzers- Coal Analyzer.

UNIT III MEASUREMENT IN PETROLEUM REFINERY
Parameters to be measured in petroleum industry:-Flow, Level, Temperature and Pressure measurement in Distillation, Pyrolysis, catalytic cracking and reforming process-Hydrocarbon analyzers-oil in or on water-sulphur in oil Analyzer.

UNIT IV INSTRUMENTATION FOR INDUSTRIAL SAFETY
Electrical and Intrinsic Safety - Explosion Suppression and Deluge systems -Conservation and emergency vents - Flame, fire and smoke detectors - Leak Detectors - Metal Detectors.
UNIT V SPECIAL PURPOSE INSTRUMENTATION

Detection of Nuclear Radiation – Corrosion monitoring – Fibre optic sensors
- Instrumentation in weather stations - Instrumentation for NDT applications - Image processing Technique for measurements.

TOTAL 45 PERIODS

REFERENCE BOOKS

4 Håvard Devold, “Oil and Gas Production Handbook - An Introduction to Oil and Gas Production”, ABB ATPA oil and gas, 2006

IN8001 ACTIVE FAULT TOLERANT CONTROL

COURSE OBJECTIVES

- To give an overview of different Fault Detection and Diagnosis methods
- To impart knowledge and skills needed to design and detect sensor and actuators faults using structured residual approach as well as directional structured residual approach
- To impart knowledge and skills needed design and detect faults in sensor and actuators using GLR and MLR based Approaches
- To present an overview of various types of fault tolerant control schemes such as Passive and active approaches
- To impart knowledge and skills needed to detect and quantify and compensate stiction in Control valves

COURSE OUTCOMES

- Ability to Explain different approaches to Fault Detection and Diagnosis
- Ability to design and detect sensor and actuators faults using structured residual approach as well as directional structured residual approach
- Ability to design and detect faults in sensor and actuators using GLR and MLR based Approaches
- Ability to explain various types of fault tolerant control schemes such as Passive and active approaches
- Ability to Design fault-tolerant control scheme in the presence of actuator failures
• Ability to detect and quantify and compensate stiction in Control valves

UNIT I INTRODUCTION & ANALYTICAL REDUNDANCY CONCEPTS
Introduction - Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches-Introduction-Mathematical representation of Faults and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation

UNIT II DESIGN OF STRUCTURED RESIDUALS & DIRECTIONAL STRUCTURED RESIDUALS
Introduction- Residual structure of single fault Isolation: Structural and Canonical structures- Residual structure of multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation - Directional Specifications: Directional specification with and without disturbances – Parity Equation Implementation

UNIT III FAULT DIAGNOSIS USING STATE ESTIMATORS

UNIT IV FAULT TOLERANT CONTROL

UNIT V CASE STUDIES
Fault tolerant Control of Three-tank System – Diagnosis and Fault-tolerant control of chemical process – supervision of steam generator – Different types of faults in Control valves – Automatic detection, quantification and compensation of valve stiction

TOTAL 45 PERIODS

REFERENCE BOOKS
IN8002 ADAPTIVE CONTROL

COURSE OBJECTIVES
- To impart knowledge on how to recursively estimate the parameters of discrete input – output models (ARX/ARMAX etc) using recursive parameter estimation methods.
- To make the student understand the principles of STR, MRAC and Gain scheduling.
- To make the student design simple adaptive controllers for linear systems using above methods.

COURSE OUTCOMES
- Will be able to design simple adaptive controllers for linear systems.
- Ability to identify, formulate, analyse the implementation of adaptive controllers to engineering problems.

UNIT I INTRODUCTION

UNIT II GAIN SCHEDULING
- Introduction- The principle - Design of gain scheduling controllers- Nonlinear transformations - application of gain scheduling - Auto-tuning techniques: Methods based on Relay feedback

UNIT III DETERMINISTIC SELF-TUNING REGULATORS
- Introduction- Pole Placement design - Indirect Self-tuning regulators - direct self-tuning regulators – Disturbances with known characteristics

UNIT IV STOCHASTIC AND PREDICTIVE SELF-TUNING REGULATORS

UNIT V MODEL – REFERENCE ADAPTIVE SYSTEMATIONS

TOTAL 45 PERIODS

REFERENCE BOOKS
# IN8003  ADVANCED IMAGE PROCESSING

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## COURSE OBJECTIVES
- To introduce the image fundamentals and transforms
- To impart knowledge in image enhancement
- To give exposure to image restoration and image compression
- To familiarize the students on image analysis
- To make the students to understand the concept of pattern recognition

## COURSE OUTCOMES
- Be able to apply image enhancement, image compression, restoration techniques, image segmentation approaches.
- Ability to apply image processing techniques in both the spatial and frequency domains.
- Be capable of applying image processing algorithms to real problems.

## UNIT I  IMAGE FUNDAMENTALS AND TRANSFORMS
9
Elements of Digital image processing systems-Digital image representation- visual perception-Sampling, Quantization, Image basis function- Two dimensional DFT- Discrete cosine transform –Walsh-Hadamard transform-Wavelet transform-Principal Component Analysis-Color image Processing.

## UNIT II  IMAGE ENHANCEMENT
9

## UNIT III  IMAGE RESTORATION AND COMPRESSION
9

## UNIT IV  IMAGE ANALYSIS
9
Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding methods, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm.

## UNIT V  PATTERN RECOGNITION
9
Recognition based on Decision Theoretic methods-Structural Recognition- Linear Discriminant Analysis – Baye’s Classifier – Neural net- Fuzzy system – Optimization Techniques in Recognition - Applications in particle size measurement – Flow measurement - Food processing – Case studies.

**TOTAL 45 PERIODS**
REFERENCE BOOKS

IN8004  ADVANCED OPERATING SYSTEM PRINCIPLES  L  T  P  C  3 0 0 3

COURSE OBJECTIVES
- To introduce fundamental concepts and mechanisms of advanced operating system.
- To provide a basic foundation in the design of operating system.
- To provide various alternative approaches to the solution of the problems encountered in the design of operating system.

COURSE OUTCOMES
- Ability to have the knowledge of distributed operating systems.
- Ability to implement the state of art techniques to address the various design issues in advanced operating system.

UNIT I  OPERATING SYSTEM  9

UNIT II  DISTRIBUTED SYSTEMS  9
Introduction – Advantages of distributed system over centralized system, Limitations of distributed system, Communication in distributed systems – ATM, Client-Server model distributed operating system – Issues, Communication primitives – Message passing model, Remote procedure call.

UNIT III  SYNCHRONIZATION IN DISTRIBUTED SYSTEMS  9
Clock synchronization – Lamport’s logical clock, Vector clock, Causal ordering of messages, Causal ordering of messages, Mutual exclusion – Non token based and token based algorithm, Atomic transactions, Distributed deadlock detection and prevention.

UNIT IV  DISTRIBUTED RESOURCE MANAGEMENT  9
Distributed file system – Trend, design and implementation, Distributed Shared Memory (DSM) – Memory coherence, Page based DSM, Shared variable DSM, Object based DSM, Distributed scheduling.

UNIT V  FAILURE RECOVERY AND FAULT TOLERANCE  9
Recovery – Classification, Backward and forward error recovery, Recovery in concurrent systems, synchronous check pointing and recovery, Check pointing for Distributed database system, Fault tolerant – commit protocols, Voting protocols, Dynamic vote reassignment protocol, Failure Resilient processes.

TOTAL 45 PERIODS

REFERENCE BOOKS
COURSE OBJECTIVES
- To introduce the principles and design issues of biomedical instrumentation
- To understand the nature and complexities of biomedical measurements

COURSE OUTCOMES
- Ability to apply fundamental principles for designing and modelling biomedical systems.
- Ability to use mathematical/computational tools for biomedical image and signal analysis

UNIT I  INTRODUCTION TO BIOMEDICAL MEASUREMENTS  9
Physiological systems and measurable variables- Nature and complexities of biomedical measurements- Medical equipment standards- organization, classification and regulation- Biocompatibility - Human and Equipment safety – Physiological effects of electricity, Micro and macro shocks, thermal effects.

UNIT II  ADVANCES IN MODELING AND SIMULATIONS IN BIOMEDICAL INSTRUMENTATION  9

UNIT III  BIOMEDICAL SIGNALS AND THEIR ACQUISITIONS  9
Types and Classification of biological signals – Signal transactions – Noise and artifacts and their management - Biopotential electrodes- types and characteristics - Origin, recording schemes and analysis of biomedical signals with typical examples of Electrocardiography(ECG), Electroencephalography(EEG), and Electromyography (EMG)– Processing and transformation of signals-applications of wavelet transforms in signal compression and denoising.

UNIT IV  INSTRUMENTATION FOR DIAGNOSIS AND MONITORING  9
Advanced medical imaging techniques and modalities -Instrumentation and applications in monitoring and diagnosis- Computed tomography, Magnetic Resonance Imaging and ultrasound- Algorithms and applications of artificial intelligence in medical image analysis and diagnosis-Telemedicine and its applications in telemonitoring.

UNIT V  BIOMEDICAL IMPLANTS AND MICROSYSTEMS  9
Implantable medical devices: artificial valves, vascular grafts and artificial joints- cochlear implants - cardiac pacemakers – Microfabrication technologies for biomedical Microsystems- microsensors for clinical applications – biomedical microfluid systems

TOTAL 45 PERIODS

REFERENCE BOOKS
5. L. Cromwell, Fred J. Weibell and Erich A. Pfeiffer, “Biomedical Instrumentation and
IN8006  APPLICATION SOFT COMPUTING

COURSE OBJECTIVES

- To review the fundamentals of ANN and fuzzy set theory
- To make the students understand the use of ANN for modeling and control of non-linear system and to get familiarized with the ANN tool box.
- To give exposure to the different ANN architectures and online training algorithm.
- To impart knowledge of using Fuzzy logic for modeling and control of non-linear systems and get familiarized with the FLC tool box.
- To familiarize the students on various hybrid control schemes, P.S.O and get familiarized with the ANFIS tool box.

COURSE OUTCOMES

- Will be able to know the basic ANN architectures, algorithms and their limitations.
- Also will be able to know the different operations on the fuzzy sets.
- Will be capable of developing ANN based models and control schemes for non-linear system.
- Will get expertise in the use of different ANN structures and online training algorithm.
- Will be knowledgeable to use Fuzzy logic for modeling and control of non-linear systems.
- Will be competent to use hybrid control schemes and P.S.O and support vector Regressive.

UNIT I  OVERVIEW OF ARTIFICIAL NEURAL NETWORK (ANN) & FUZZY LOGIC


UNIT II  NEURAL NETWORKS FOR MODELLING AND CONTROL

Modeling of non linear systems using ANN- NARX,NNSS,NARMAX - Generation of training data - optimal architecture – Model validation- Control of non linear system using ANN- Direct and Indirect neuro control schemes- Adaptive neuro controller – Case study - Familiarization of Neural Network Control Tool Box.
UNIT III  ADVANCED ANN STRUCTURES AND ONLINE TRAINING ALGORITHMS  
Recurrent neural network (RNN)- Adaptive resonance theory (ART) based network - Radial basis function network - Introduction to Complex Neural Network - Online learning algorithms: BP through time, RTRL algorithms, Least Mean square algorithm and Reinforcement learning  

UNIT IV  FUZZY LOGIC FOR MODELLING AND CONTROL  
Modeling of non linear systems using fuzzy models (Mamdani and Sugeno) - TSK model - Fuzzy Logic controller - Fuzzification - Knowledge base - Decision making logic - Defuzzification - Adaptive fuzzy systems - Case study - Familiarization of Fuzzy Logic Tool Box.  

UNIT V  HYBRID CONTROL SCHEMES  
Fuzzification and rule base using ANN - Neuro fuzzy systems - ANFIS - Optimization of membership function and rule base using Genetic Algorithm Particle Swarm Optimization - Case study - Introduction to Support Vector Regression - Familiarization of ANFIS Tool Box.  

REFERENCE BOOKS  

TOTAL 45 PERIODS
COURSE OBJECTIVES
- To introduce fundamental, theoretical and methodological principles of biosignal processing and analysis
- To estimate parametric models of the measured biosignals for prediction, simulation and diagnostic purposes

COURSE OUTCOMES
- Ability to estimate suitable models of the measured biosignals
- Ability to use mathematical/computational tools for biomedical image and signal analysis

UNIT I INTRODUCTION TO SIGNALS
Sources of Biomedical signals, types of signals – Deterministic, stochastic, fractal and chaotic, auto correlation, cross correlation, auto covariance, DFT, FFT algorithm – Digital filters – Introduction to FIR and IIR filter.

UNIT II CLASSICAL SPECTRAL ESTIMATION TECHNIQUES

UNIT III ADAPTIVE NOISE CANCELLATION
Introduction, principle of adaptive noise canceling, adaptive Noise cancellation with the LMS and RLS adaptation algorithm - applications – adaptive noise canceling method to enhance ECG monitoring, adaptive noise canceling method to enhance Fetal ECG monitoring, adaptive noise canceling method to enhance Electro gastric measurements.

UNIT IV PARAMETRIC MODELING METHODS
Autoregressive (AR) methods – Linear Prediction and Autoregressive methods, the autocorrelation (Yule - walker) methods, applications of AR methods AR modeling of seizure EEG, ECG signals and surface EMG. Autoregressive Moving Average (ARMA) method – MLE method, Akaike method, Durbin method, applications – ARMA modeling of somatosensory Evoked Potentials (SEPs), Diastolic Heart sounds and cutaneous Electro gastric signals.

UNIT V NON LINEAR BIOSIGNAL PROCESSING AND WAVELET TRANSFORM
Clustering methods – hard and fuzzy clustering, applications of Fuzzy clustering to Biomedical signal processing, Neural Networks – Introduction – NN in processing and analysis of Biomedical signals wavelet transform – Introduction, Filter bank implementation of discrete wavelet transform, signal Denoising using wavelet transform, wavelet based compression.

TOTAL 45 PERIODS

REFERENCE BOOKS

IN8008  EMBEDDED SYSTEMS ARCHITECTURE  L  T  P  C
3  0  0  3

COURSE OBJECTIVES
- To introduce the Building blocks of Real Time Embedded System
- To familiarize the embedded hardware components & its interface
- To impart knowledge on embedded software development process
- To make the students understand the Real Time Operating Systems
- To give exposure to the Case studies in various fields

COURSE OUTCOMES
- Ability to select embedded hardware components & its interface
- Gain knowledge on embedded software development process
- Acquire knowledge on Real Time Operating Systems
- Gain expertise in the Case studies in various fields

UNIT I  INTRODUCTION TO REAL TIME SYSTEMS

UNIT II  EMBEDDED SYSTEM COMPONENTS AND ITS INTERFACE

UNIT III  EMBEDDED SYSTEM SOFTWARE DEVELOPMENT
Software embedded in a system – IDE , Assembler, Compiler ,linker, simulator,debugger,In -circuit Emulator(ICE), Target hardware debugging , Program modeling – Program models, Data flow model, State machine programming models, UML models - High level language descriptions in embedded system, Java based embedded system design.

UNIT IV  RTOS BASED EMBEDDED SYSTEM DESIGN
Introduction to basic concepts of RTOS –Task, Process and Threads, Interrupt routines in RTOS, Multiprocessing & Multitasking, Preemptive and non-Preemptive scheduling, Task communication – shared memory –Inter Process communication – synchronization between processes – semaphores, mail box, pipes, priority Inversion, priority Inheritance, comparison of Real time operating systems: Vxworks, µC/OS II.

UNIT V  CASE STUDIES
Case studies of Embedded System Design and Coding in application areas of digital consumer electronics , automotives and networking/communication.

TOTAL 45 PERIODS
REFERENCE BOOKS

COURSE OBJECTIVES

- To give an overview on fundamental aspects of motor-load systems and basic characteristics of dc and ac drives.
- To introduce various modeling methods of dc and ac drives.
- To give detailed knowledge on operation, analysis and control of converter and chopper driven dc drives
- To give exposure to principle, techniques of conventional control of ac drives
- To introduce advanced control strategies of ac drives and latest developments in the field of control of electric drives.

COURSE OUTCOMES

Students

- Get a thorough understanding of motor-load system dynamics and stability, modern drive system objectives and fundamentals of dc and ac motors.
- Will have the ability to model both dc and ac motors in various conventional methods.
- Confidently design and analyze both converter and chopper driven dc drives
- Will have a thorough understanding of conventional control techniques of ac drives and will have the ability to design and analyze such system
- Get a detailed knowledge on advanced high performance control strategies for ac drives and emerging technologies in electric drives.

UNIT I  INTRODUCTION TO ELECTRIC DRIVES  9
Motor-Load system–Dynamics, load torque, steady state stability, Multi quadrant operations of drives. DC motors- speed reversal, speed control and breaking techniques, Characteristics of Induction motor and Synchronous motors-Dynamic and regenerative braking ac drives.

UNIT II  MODELING OF DC AND AC MACHINES  9
Circuit model of Electric Machines-Transfer function and State space models of series and separately excited DC motor-AC Machines –Dynamic modeling –linear transformations-equations in stator, rotor and synchronously rotating reference frames-flux linkage equations-Dynamic state space model-modeling of Synchronous motor

UNIT III  CONTROL OF DC DRIVES  9
Analysis of series and separately excited DC motor with single phase and Three phase converters operating in different modes and configurations- Analysis of series and separately excited DC motor fed from different choppers,-two quadrant and four quadrant operation-Closed loop control of dc drives-Design of controllers

UNIT IV  CONTROL OF AC DRIVES  9
Operation of induction motor with non-sinusoidal supply waveforms, Variable frequency operation of 3-phase inductions motors, constant flux operation, current fed operations, Constant torque operations, Static rotor resistance control and slip power recovery scheme –Synchronous motor control, control of stepped motors, Parameter sensitivity of ac drives.
UNIT V ADVANCED CONTROL OF AC DRIVES

Principles of vector control – Direct and indirect vector control of induction motor – DTC - sensor less vector control - speed estimation methods - Applications of Fuzzy logic and Artificial Neural Network for the control of AC drives.

TOTAL 45 PERIODS

REFERENCE BOOKS

COURSE OBJECTIVES
To enable students to acquire knowledge about
- The different methods of crude oil recovery, processing and refining
- Important Unit operations in petroleum refinery and petrochemical industry
- Production routes of important petrochemicals, and
- Control of selected petrochemicals production processes.
- Hazards and therefore the necessary safety measure in planning and function of petrochemical Industry.

COURSE OUTCOME
After completing this course the student will:
- Gain basic knowledge about the methodologies applied for recovery and processing of petroleum.
- Be familiar with different unit operations involved in Petroleum industry.
- Have a general understanding of the production routes for important petrochemicals.
- Be able to describe the control of Important processes like FCCU, Catalytic Reformer, Alkylation.
- Be able to classify the hazardous zones and gain knowledge about the techniques used to reduce the explosion hazards.

UNIT I OIL EXTRACTION AND PROCESSING
Techniques used for oil discovery:- seismic survey - methods of oil extraction - oil rig system –
Primary, Secondary and Enhanced oil recovery - separation of gas and water from oil - control loops in oil gas separator - scrubber – coalescer.

UNIT II PETROLEUM REFINING
Petroleum refining process - unit operations in refinery :- thermal cracking - catalytic cracking - catalytic reforming - polymerization - isomerization - alkylation - Production of ethylene, acetylene and propylene from petroleum.

UNIT III CHEMICALS FROM PETROLEUM
Chemicals from methane, acetylene, ethylene and propylene - production routes of important petrochemicals such as polyethylene, polypropylene, ethylene dioxide, methanol, xylene, benzene, toluene, styrene, VCM and PVC.

UNIT IV CONTROL LOOPS IN PETROCHEMICAL INDUSTRY
Control of binary and fractional distillation columns - Control of catalytic and thermal crackers -
control of catalytic reformer - control of alkylation process - Control of polyethylene production –
Control of VCM and PVC production.

UNIT V SAFETY IN INSTRUMENTATION SYSTEM
Area and material classification as per National Electric Code (NEC) - Classification as per International Electro technical Commission (IEC) - Techniques used to reduce explosion hazards -
Pressurization techniques - Type X, Type Y and Type Z - Intrinsic safety - Mechanical and Electrical isolation - Lower and Upper explosion limit.
REFERENCE BOOKS


2 Håvard Devold, “Oil and Gas Production Handbook-An Introduction to Oil and Gas Production” ABB ATPA Oil and Gas, 2006.


IN8011  OPTIMAL CONTROL  L  T  P  C  3  0  0  3

COURSE OBJECTIVES
- To give exposure to different type of optimal control problems such as time-optimal, fuel optimal, energy optimal control problems
- To impart knowledge and skills needed to design Linear Quadratic Regulator for Time-invariant and Time-varying Linear system (Continuous time and Discrete-time systems)
- To introduce concepts needed to design optimal controller using Dynamic Programming Approach and H-J-B equation.
- To give exposure to various types of fault tolerant control schemes such as Passive and active approaches
- To introduce concepts needed to design optimal controller in the presence of state constraints and time optimal controller

COURSE OUTCOMES
- Ability to explain different type of optimal control problems such as time-optimal, fuel optimal, energy optimal control problems
- Ability to design Linear Quadratic Regulator for Time-invariant and Time-varying Linear system (Continuous time and Discrete-time systems)
- Ability to design optimal controller using Dynamic Programming Approach and H-J-B equation.
- Ability to Explain the Pontryagin Minimum Principle.
- Ability to design optimal controller in the presence of state constraints and time optimal controller.

UNIT I  CALCULUS OF VARIATIONS AND OPTIMAL CONTROL  9
Introduction – Performance Index– Constraints – Formal statement of optimal control system – Calculus of variations – Function, Functional, Increment, Differential and variation and optimum of function and functional – The basic variational problem Extrema of functions and functionals with conditions – variational approach to optimal control system

UNIT II  LINEAR QUADRATIC OPTIMAL CONTROL SYSTEM  9
Problem formulation – Finite time Linear Quadratic regulator – Infinite time LQR system: Time Varying case- Time-invariant case – Stability issues of Time-invariant regulator – Linear Quadratic Tracking system: Fine time case and Infinite time case

UNIT III  DISCRETE TIME OPTIMAL CONTROL SYSTEMS  9
Variational calculus for Discrete time systems – Discrete time optimal control systems:- Fixed-final state and open-loop optimal control and Free-final state and open-loop optimal control - Discrete time linear state regulator system – Steady state regulator system

UNIT IV  PONTRYAGIN MINIMUM PRINCIPLE  9
UNIT V  CONSTRAINED OPTIMAL CONTROL SYSTEMS


TOTAL 45 PERIODS

REFERENCE BOOKS

COURSE OBJECTIVES

- To impart Knowledge and Skills
- To design and implement a Discrete Kalman Filter
- To design and implement Extended Kalman Filter, Iterated Extended Kalman Filter, and Second-order Extended Kalman filter
- To design and implement Derivative Free Kalman filter such as Unscented Kalman filter and its variants and Ensemble Kalman Filter
- To design and implement Particle Filter, Unscented Particle Filter

COURSE OUTCOMES

- Ability to Design and Implement Kalman Filter for Linear systems
- Ability to Design and Implement variants of Derivative Based Kalman Filters such as Extended Kalman filter, Iterated Extended Kalman filter, Second order Extended Kalman Filter for non-linear systems
- Ability to Design and Implement variants of Derivative free Kalman Filters such as Unscented Kalman filter, Spherical and Simplex transformations based Unscented Kalman filter
- Ability to Design and Implement variants of H-infinity filters.
- Ability to Design and Implement various types of Particle filters for non-linear and non-Gaussian systems.

UNIT I INTRODUCTION TO STATE ESTIMATION AND KALMAN FILTER


UNIT II EXTENDED KALMAN FILTER


UNIT III UNSCENTED KALMAN FILTER


UNIT IV THE H-INFINITY FILTER

UNIT V  ENSEMBLE KALMAN FILTER & PARTICLE FILTER
Bayesian state Estimation - Ensemble Kalman filter – Introduction to Particle filtering – SIS – Implémentation issues: - Sample Impoverishment - SIR - Particle filter with EKF as proposal - Unscented Particle filter - Case Studies

TOTAL 45 PERIODS

REFERENCE BOOKS

3  A. Gelb, Applied Optimal Estimation, MIT Press
COURSE OBJECTIVES

- To make the students understand the basic concepts of robots, their kinematics and trajectory planning of robots
- To elaborate the modeling of robot dynamics using tools such as Euler dynamic model and Lagrangian formulation
- To give an overview of the various methods of control of robots, robotic applications, mobile robots and the related issues in industrial automation

COURSE OUTCOMES

- Ability to analyze the workspace and trajectory panning of robots
- Ability to model the motion of Robots
- Ability to develop application based Robots
- Ability to formulate models for the control of mobile robots in various industrial applications

UNIT I   INTRODUCTION AND ROBOT KINEMATICS


UNIT II   DYNAMIC OF ROBOTS

Continuous path motion-interpolated motion - Straight line motion - Tool configuration Jacobian matrix and manipulator Jacobian - Manipulator Dynamics - Kinetic of potential energy - Energized forces - Lagrange’s Equation - Euler Dynamic model.

UNIT III   ROBOT CONTROL AND MICRO ROBOTICS


UNIT IV   ROBOT VISION


UNIT V   MOBILE ROBOTS AND CONTROL ISSUES

Industrial automation - General layout - general configuration of an automated flow line - conveyor systems - major features – types - Roller, State wheel, Belt, Chain and overhead trolley - Inspection station with feedback loops to up steam workstations - shop floor control - 3 phases - order scheduling.

TOTAL 45 PERIODS
REFERENCE BOOKS
COURSE OBJECTIVES
• To give an overview on the different data driven identification methods
• To make the student understand the principles of relay based identification
• To enable the student to select a suitable model for identification
• To elaborate the concept of estimating the parameters of the selected models using parameter estimation algorithm
• To provide the background on the practical aspects of conducting experiments for real time system identification

COURSE OUTCOMES
• Ability to develop various models from the experimental data
• Will be able to select a suitable model and parameter estimation algorithm for the identification of systems
• Will be able to carry out the verification and validation of identified model
• Will gain expertise on using the model for prediction and simulation purposes and for developing suitable control schemes

UNIT I INTRODUCTION

UNIT II PARAMETER ESTIMATION METHODS

UNIT III RELAY FEEDBACK IDENTIFICATION

UNIT IV CLOSED-LOOP IDENTIFICATION
Identification of systems operating in closed loop: Identifiability considerations – direct identification – indirect identification - Subspace Identification methods : classical and innovation forms, free and structures parameterizations.

UNIT V PRACTICAL ASPECTS OF IDENTIFICATION

TOTAL 45 PERIODS
REFERENCE BOOKS

COURSE OBJECTIVE
After completion of the course the students will acquire extensive knowledge about:

- Operation & importance of Instrumentation in Thermal power plant
- Development of Mathematical model of different systems in Thermal power plant
- Conventional and advanced control schemes applied to various processes in Thermal Power Plant
- Measurement of important parameters and control techniques applied to steam turbines
- Calculation and optimization of Boiler efficiency by including various losses in thermal power plant

COURSE OUTCOME

- The student will be equipped with the basic knowledge of function of different systems in Thermal power plant
- The student knows the procedural steps to obtain the mathematical model of various units in Thermal power plant
- Will be able to explain conventional and advanced control concepts and their implementation in various processes.
- Will get idea on the parameters to be monitored, measured and controlled in steam turbines
- Calculation and optimization of Boiler efficiency by including various losses in thermal power plant

UNIT I  BASICS OF THERMAL POWER PLANT  9

UNIT II  BOILER MODELING  9
Development of first principle and data driven models:- combustion chamber, boiler drum,superheater and attemporator

UNIT III  BOILER CONTROL  9

UNIT IV  TURBINE & ALTERNATOR - MONITORING AND CONTROL  9
Measurement of speed, vibration, shell temperature of steam turbine – Steam pressure Control – Speed control of turbine – Alternator- Monitoring voltage and frequency –Operation of several units in parallel- Synchronization.

UNIT V  OPTIMIZATION OF THERMAL POWER PLANT OPERATION  9

TOTAL 45 PERIODS
COURSE OBJECTIVES

- To provide the background for developing a VI
- To make the student become competent in using state-of-the-art VI tools.
- To enable the student to gain experience in data acquisition and instrument control

COURSE OUTCOMES

- Ability to develop software program called VI
- Student will be able to experiment with plug-in DAQ interfaces for prototype measurement systems

UNIT I  INTRODUCTION
Virtual Instrumentation: Historical perspective - advantages - block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - data-flow techniques, graphical programming in data flow, comparison with conventional programming.

UNIT II  VI PROGRAMMING TECHNIQUES
VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, State machine, string and file I/O.

UNIT III  DATA ACQUISITION
Introduction to latest ADCs, DACs. Introduction to PC based data acquisition - typical plug-in data acquisition board - multiplexing of analog inputs - single ended and differential inputs - different strategy for sampling of multi channel analog inputs. Concept of universal DAQ card - use of timers/counters

UNIT IV  VI TOOLSETS
Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, windowing and filtering. Simulation of level, thermal, reactor processes. On-Off controller PID Controller.

UNIT V  APPLICATIONS
Distributed I/O modules-Virtual Laboratory, Virtual Oscilloscope, Virtual function generator, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.
REFERENCE BOOKS


TOTAL 45 PERIODS

IN8017  VLSI SYSTEM DESIGN

COURSE OBJECTIVES
- To introduce the fundamentals of various MOS device characteristics.
- To familiarize the design rules and layout for NMOS and CMOS.
- To give exposure on the design of simple examples using various logic design methods.
- To lay foundation about issues involved in the selection of PLD.
- To impart knowledge on implementation of the above design in VHDL programming environment.

COURSE OUTCOMES
- Will be able to gain the knowledge of the characteristics and performance of MOS devices.
- Will have an exposure to design of stick diagrams and layout of gates.
- Ability to carry out design of simple circuits using various logic schemes.
- Will be able to select appropriate PLD for an application.
- Will gain expertise in developing and effectively synthesizing VHDL programs for combinational and sequential applications.

UNIT I  BASIC DEVICE CHARACTERISTICS
NMOS, PMOS, enhancement and depletion mode transistor, MOSFET threshold voltage, linear and saturated operation, standard CMOS inverter, transit time and switching speed of NMOS and CMOS inverters. Circuit characteristics and performance estimation: delay estimation, transistor sizing, power distribution, scaling, noise margin and latch up.

UNIT II  DESIGN RULES AND LAYOUT
Purpose of design rules, NMOS and CMOS design rules and layout, Design of NMOS and CMOS inverters, NAND and NOR gates. Stick diagrams and layout of logic gates.
UNIT III  VLSI SUBSYSTEM DESIGN
Pass Transistor Logic, transmission gate logic, NMOS logic, Static/Dynamic CMOS logic and BiCMOS logic. Design examples: logic gates, multiplexer, flip flop and shift registers.

UNIT IV  FPGAs AND CPLDs
Introduction to PLDs -PLA, PAL, GAL. FPGA: Architecture, logic element, interconnects technology. CPLD: Architecture, logic array block, Macrocell, PIA Technology. Specific GAL, FPGA and CPLD devices from Altera / Xilinx.

UNIT V  PRINCIPLES OF HDL
VHDL design Entity- Signal and Variable - Concurrent Assignment Statements – Sequential Assignment Statements – Combinational circuits: Multiplexers, adders, priority encoder. Sequential circuits: different types of flip flops, registers, shift register and counters. An introduction to High level VLSI synthesis and design tools. Realizing PID controller in VHDL.

TOTAL 45 PERIODS

REFERENCE BOOKS

COURSE OBJECTIVES

- To introduce the technologies and applications for the emerging domain of wireless sensor networks,
- To impart knowledge on the design and development of the various layers in the WSN protocol stack
- To elaborate the various issues related to WSN implementations
- To familiarize the students with the hardware and software platforms used in the design of WSN

COURSE OUTCOMES

- Ability to analyze WSN with respect to various performance parameters in the protocol stack
- Ability to understand MAC algorithms and Network protocols used for specific WSN applications
- Design and develop a WSN for a given application

UNIT I  INTRODUCTION

Challenges for wireless sensor networks, Comparison of sensor network with ad hoc network, Single node architecture – Hardware components, energy consumption of sensor nodes, Network architecture – Sensor network scenarios, types of sources and sinks, single hop versus multi-hop networks, multiple sinks and sources, design principles, Development of wireless sensor networks.

UNIT II  PHYSICAL LAYER

Wireless channel and communication fundamentals – frequency allocation, modulation and demodulation, wave propagation effects and noise, channels models, spread spectrum communication, packet transmission and synchronization, quality of wireless channels and measures for improvement, physical layer and transceiver design consideration in wireless sensor networks, energy usage profile, choice of modulation, power management.

UNIT III  DATA LINK LAYER

MAC protocols – fundamentals of wireless MAC protocols, low duty cycle protocols and wakeup concepts, contention-based protocols, Schedule-based protocols, Link Layer protocols – fundamentals task and requirements, error control, framing, link management

UNIT IV  NETWORK LAYER

Gossiping and agent-based uni-cast forwarding, Energy-efficient unicast, Broadcast and multicast, geographic routing, mobile nodes, Data-centric and content-based networking – Data-centric routing, Data aggregation, Data-centric storage, Higher layer design issue

UNIT V  CASE STUDIES

Target detection and tracking, Habitat monitoring, Environmental disaster monitoring, Practical implementation issues, IEEE 802.15.4 low rate WPAN, Sensor Network Platforms and tools-Sensor node hardware, Node-level software platforms, node-level simulators.

TOTAL 45 PERIODS
REFERENCE BOOKS

COURSE OBJECTIVES

- To introduce norms, random spaces and robustness measures
- To educate on H2 optimal control and estimation techniques
- To educate on H-infinity optimal control techniques
- To educate on the LMI approach of H-infinity control
- To educate on synthesis techniques for robust controllers and illustrate through case studies

UNIT I INTRODUCTION

UNIT II H2 OPTIMAL CONTROL
Linear Quadratic Controllers – Characterization of H2 optimal controllers – H2 optimal estimation-Kalman Bucy Filter – LQG Controller

UNIT III H-INFINITY OPTIMAL CONTROL- RICCATI APPROACH
Formation – Characterization of H-infinity sub-optimal controllers by means of Riccati equations – H-infinity control with full information – H-infinity estimation

UNIT IV H-INFINITY OPTIMAL CONTROL- LMI APPROACH

UNIT V SYNTHESIS OF ROBUST CONTROLLERS & CASE STUDIES
Synthesis of Robust Controllers – Small Gain Theorem – D-K –iteration- Control of Inverted Pendulum- Control of CSTR – Control of Aircraft – Robust Control of Second-order Plant- Robust Control of Distillation Column

TOTAL : 45 PERIODS

REFERENCES
Pre-requisites: Basics of Signal Processing, Mathematics of Transforms, microcontroller

COURSE OBJECTIVES
- To expose the students to the fundamentals of data security.
- To teach the fundamentals of mathematical aspects in creating Encryption keys.
- To teach the fundamentals of Security in data communication.
- To teach the fundamentals of Secured system operation.
- To teach the fundamentals of Security in wireless communication.

UNIT I SYMMETRIC CIPHERS

UNIT II PUBLIC-KEY ENCRYPTION AND HASH FUNCTIONS

UNIT III NETWORK SECURITY PRACTICE

UNIT IV SYSTEM SECURITY

UNIT V WIRELESS SECURITY

TOTAL: 45 PERIODS

TEXT BOOKS

REFERENCES