# M.E. INDUSTRIAL AUTOMATION AND RADIO FREQUENCY ENGINEERING

## Scheme of Instruction and Syllabus

### Semester I

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subjects</th>
<th>No. of Hrs / Week</th>
<th>Scheme of Examination</th>
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<tr>
<td>MEIARF1.1</td>
<td>Electromagnetic Field Theory</td>
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<tr>
<td>MEIARF1.2</td>
<td>Control System Analysis and Design</td>
<td>4</td>
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<td>MEIARF1.3</td>
<td>Industrial Drives And Control</td>
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<tr>
<td>MEIARF1.4</td>
<td>Radiating Systems</td>
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<tr>
<td>MEIARF1.5</td>
<td>Robotics And Automation</td>
<td>4</td>
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<td>MEIARF1.6</td>
<td>Electromagnetic Field and Radiating Systems Lab</td>
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<td>MEIARF1.7</td>
<td>Process Control And Instrumentation Lab</td>
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IA – Internal Assessment

### Semester II

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<td>Embedded System &amp; Parallel Processing</td>
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<td>MEIARF 2.2</td>
<td>Industrial Data Networks</td>
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<tr>
<td>MEIARF 2.3</td>
<td>Microwave Engineering</td>
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<tr>
<td>MEIARF 2.4</td>
<td>Microwave Electronics and Semiconductor Devices</td>
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<tr>
<td>MEIARF 2.5</td>
<td>Industrial Management</td>
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<td>Microwave Lab</td>
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<tr>
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<td>Embedded System &amp; Parallel Processing Lab</td>
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#### List of Electives

**Elective 1:**
- A) ADVANCED PROCESS CONTROL
- B) VIRTUAL INSTRUMENTATION
- C) RADAR SYSTEMS ENGINEERING
- D) MICROWAVE SOLID STATE DEVICES
- E) CHEMICAL PROCESS SYSTEMS
- F) BIOPROCESS INSTRUMENTATION & CONTROL
- G) LOGIC AND DISTRIBUTED CONTROL SYSTEMS
- H) INSTRUMENTATION SYSTEM DESIGN
- I) PHARMACEUTICAL BUSINESS MANAGEMENT
- J) RF MICROELECTRONIC CHIP DESIGN
- K) POWER ELECTRONICS

**Electives 2**
- L) INSTRUMENTATION
- M) SENSORS IN INSTRUMENTATION
- N) SIMULATION OF CIRCUITS AND DEVICES
- O) IMAGE PROCESSING
- P) ERROR CORRECTING CODES
- Q) ADVANCED ELECTRONIC SYSTEM DESIGN
- R) APPLIED INDUSTRIAL INSTRUMENTATION
- S) APPLIED BIOMEDICAL INSTRUMENTATION
- T) ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY
- U) TELEMETRY
- V) PROCESS MODELLING AND SIMULATION
- W) ADVANCED OPTICAL COMMUNICATION

### Semester IV

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<td><strong>6 - 14 20</strong></td>
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**Semester I**

**MEIARF1.1: Electromagnetic Field Theory**

Maxwell's equations: Differential and integral forms; continuity equation; constitutive relations; media classification; boundary conditions; Poynting theorem; time harmonic fields; complex Poynting vector, homogeneous wave equation and its solution

Plane waves: Polarization, attenuation, reflection, and refraction; Field representations and solutions in unbounded space:


**TEXT BOOK:**
1. Advanced Engineering Electromagnetics by C. A. Balanis
2. Waves and Fields in Inhomogeneous Media by W. C. Chew
3. Field Theory of Guided Waves by R. E. Collin
4. Electromagnetic Wave Theory by J. A. Kong

**MEIARF1.2: Control System Analysis and Design**

Review of frequency and time response analysis and specifications of control systems, need for controllers, continues time compensations, continues time PI, PD, PID controllers, digital PID controllers.

Sampling, time and frequency domain description, aliasing, hold operation, mathematical model of sample and hold, zero and first order hold, factors limiting the choice of sampling rate, reconstruction.

Difference equation description, Z-transform method of description, pulse transfer function, time and frequency response of discrete time control systems, stability of digital control systems, Jury's stability test, state variable concepts, first companion, second companion, Jordan canonical models, discrete state variable models, elementary principles.

Review of principle of compensator design, Z-plane specifications, digital compensator design using frequency response plots, discrete integrator, discrete differentiator, development of digital PID controller, transfer function, design in the Z-plane.

Algorithm development of PID control algorithms, software implementation, implementation using microprocessors and microcontrollers, finite word length effects, choice of data acquisition systems, microcontroller based temperature control systems, microcontroller based motor speed control systems.

**TEXT BOOK:**
MEIARF1.3: Industrial Drives and Control

INTRODUCTION TO ELECTRIC DRIVES: Motor-Load system –Dynamics, load torque, steady state stability, speed control and multiquadrant operation –speed Torque characteristics of DC motor –breaking of series and separately excited dc motor, speed torque characteristics of induction motor
MODELING OF AC AND DC MACHINES: Circuit model of Electric Machines-Transfer function 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
CONTROL OF DC DRIVES: 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, effect of saturation in series motors-Closed loop control of dc drives-two quadrant and four quadrant operation
CONTROL OF AC DRIVES: Operation of induction motor with non-sinusoidal supply waveforms, Variable frequency operation of 3-phase inductions motors, constant flux operation, current fed operations, Dynamic and regenerative braking of CSI and VSI fed drives, Torque Equations, Constant torque operations, Static rotor resistance control and slip power recovery scheme –Combined stator voltage control and rotor resistance control-Synchronous motor control, control of stepped motors.
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

TEXT BOOK:

MEIARF1.4: Radiating systems

Electromagnetic Waves :The Helmhotz Equation, Plane waves in Lossless medium, Plane waves in a lossy medium, Poynting Vector and Power Flow in Electromagnetic Fields, Polarisation of plane wave, Behaviour of Plane waves at the interface of two media
Concepts of Radiation: Basic Antenna Parameters, Radiated field of anHertzian dipole
Linear Wire Antennas: Half Wave Dipole Antenna, Quarter Wave Monopole Antenna, Ground plane effects, Loop Antennas
Antenna Arrays: Two element array, N element uniform linear array, planar array
Smart antennas: Antenna impedance - Self and mutual impedances, mutual coupling in arrays, Microstrip antennas, Frequency independent antennas, fundamental limits on, electrically small antennas
Aperture antennas, horn antennas, reflector antennas
Introduction to Numerical Techniques in Electromagnetics : Finite difference method, Basic Concepts of the Method of Moments, Method of Moments for Wire Antennas and Wire Scatterers

Texts/References
MEIARF1.5: Robotics and Automation

Brief History automation-classification-specifications: Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

Rotation matrices, Euler angle and RPY representation, Homogeneous transformation matrices, Denavit-Hartenberg notation, representation of absolute position and orientation in terms of joint parameters, direct kinematics.

Inverse Kinematics, inverse orientation, inverse locations, Singularities, Jacobian, Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks, sensor based motion planning: The Bug Algorithm, The Tangent Bug Algorithm, The Incremental Voronoi Graph.

Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangean and Newton-Euler formulations of RR and RP type planar robots., Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, force feedback, hybrid control.

Mobile robots and control issues: Industrial automation-General layout-general configuration of an automated flow line-conveyor systems and major elements.

Sensors and controllers: Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder.

Robot vision: image processing fundamentals for robotic applications, image acquisition and preprocessing. Segmentation and region characterization object recognition by image matching and based on features.

References:

MEIARF1.6: Electromagnetic Fields and Radiating Systems Laboratory

Lab will be based on theory of Electromagnetic Field Theory and Radiating Systems and minimum of 08 experiments.

MEIARF1.7: Process Control And Instrumentation Laboratory

1. Study of Process Control Training plant
   Piping and Instrumentation diagram
2. Simulation of coupled parameter and Distributed parameter system.
3. Identification of linear dynamic model of a process using non parametric methods.
   (a) Design and implementation PID Control scheme on simulated process.
   (b) PID Implementation issues
4. Level and pressure control (with and without Interaction) in process control Test Rig.
   (a) Auto- Tuning of PID controller
5. (b) Design and implementation of gain scheduled Adaptive controller on the simulated model of
   variable area tank process.
6. Design and implementation of Feed forward and Cascade control schemes on the simulated model of
   CSIR process.
7. (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.
8. Design and implementation of Robust PID control schemes on the simulated
9. model of variable area tank process.
10. Design and implementation of Self tuning and Model Reference Adaptive
11. Control schemes on the simulated model of variable area tank process.

Semester II

MEIARF2.1: Embedded System and Parallel Processing
Introduction: ARM embedded systems, RISC design philosophy, ARM processor fundamentals,
Programmer’s model, pipeline, ARM processor families.

ARM Instruction set:
Data processing instructions, Branch & load-store instructions, Software interrupt instructions, Program
status register instructions, Manipulating bits & bit patterns, Arithmetic operations.

I/O related operations:
Input & output, Semi hosting, Serial IO, Input from switches & external events, Timing of IO actions,
Programming.

ARM Hardware:
ARM hardware, ARM nodes, Exceptions & Exception Handlers, Program structures & testing.

Embedded ARM Applications:
VLSI Ruby II Advanced communication Processor.
VLSI ISDN subscriber processor.
Ericsson-Bluetooth baseband controller.
ARM 1176 – JZFS in Raspberry Pi.
ARM Cortex –A8 (armv7a) in Beagle Bone.

Introduction to CUDA: Data Parallelism CUDA Program Structure, A Matrix-Matrix Multiplication
Example, Device Memories and Data Transfer, Kernel Functions and
Threading; Function declarations, Kernel launch, Predefined variables, Runtime API.CUDA Thread
Organization, Using block Id x and thread Id x, Synchronization and Transparent Scalability, Thread
Assignment, Thread Scheduling and Latency Tolerance

CUDA Memories: Importance of Memory Access Efficiency,
CUDA Device Memory Types, A Strategy for Reducing Global Memory Traffic Memory as a Limiting Factor to Parallelism, Global Memory Bandwidth, Dynamic Partitioning of SM Resources, Data Prefetching, Instruction Mix, Thread Granularity, Measured Performance

Introduction to OPENCL: Introduction to OPENCL Background, Data Parallelism Model, Device Architecture, Kernel Functions, Device Management and Kernel Launch, Electrostatic Potential Map in OpenCL.

Textbooks/ References:

ME1ARF2.2: Industrial Data Networks


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.


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 (OPC).

TEXT BOOK:

MEIARF2.3: Microwave Engineering

TEXTBOOKS:
7. T.K. Ishii, Handbook of Microwave Technology, vol 1

MEIARF2.4: Microwave Electronics and Semiconductor Devices

Linear and nonlinear representations of active devices. Matching networks and signal flow graphs. Microwave transistor amplifier design theory. Noise, broadband, and high-power design methods. Microwave transistor oscillator design. Nonlinear RF measurement, modeling and circuit design. Linearization of amplifiers and modulators. Design, simulation, fabrication and testing a microwave electronic circuit

TEXTBOOKS:
1. High Speed Heterostructure Devices by Patrick Roblin
2. Microwave Transistor Amplifiers by Guillermo Gonzalez

MEIARF2.5: Industrial Management
Enterprise Management
Quality, Health, Safety and Environment Management and Enterprise Excellence
Quality Circles/ Forums, Quality Objectives, use of Statistical Process Control, Introduction to ISO 9000 and ISO 14000, Safety And Environmental norms.

Production Planning, Inventory Control and Supply Chain Management
Manufacturing Excellence, Outsourcing, Production planning techniques, Purchase and Inventory Management, inventory control using Economic Order Quantity, Minimum Order Quantity, Ordering Level, store keeping, Finished goods, semi finished goods, raw material handling and storage, Value Addition, Supply Chain concepts and management for leveraging profit

Human Resources Management
Manpower planning, Human Resources: exploiting true potential, Staff training and development, Motivation, Selection and training of manpower, Appraisal and increments management, Leadership skills, Delegation and development for growth. Objectives and Job Descriptions/ Role Summary

Financial Management

Statutory Requirements
Company Laws, Taxation and Liabilities, Labor laws, Factory Inspection, Value Added Tax, Excise and Service tax, Market Participant Identification Number, Permanent Account Number
E-Waste Management, RoHS Compliance
EMI- EMC Testing

Text books:

1. Management in Engineering- Gail Freeman- Bell and James Balkwill (PHI).
2. Modern Economic Theory- Dewett K. K.

MEIARF2.6: Microwave lab

- MIC component characterization, design simulation fabrication of MIC components.
- Measurement of wave length and Frequency, equivalent circuit of cavity wave meters.
- Typical wave meters, Resonant cavities.
- Measurement of microwave power: Typical barrater elements, thermistor.
- Bolometer bridge circuits, extending range of bolometer devices, low and high power measurement techniques.
- Measurements of radiation pattern, Antenna gain measurements. Far field and Near field techniques.
Textbook:
3. Montgomery, CC., Techniques of Microwave Measurements, Radiation Lab Series

MEIARF2.7: Embedded Systems & Parallel Processing Laboratory

Lab will be based on theory of Embedded System & Parallel Processing and minimum of 08 experiments having ARM Processors, CUDA and OPENCL Concepts.

Semester III

Elective I

A) Advanced Process Control
Special Control Techniques: Advanced control techniques, cascade, ratio, feed forward, adaptive control, selective controls, computing relays, simple alarms, Smith predictor, internal model control, theoretical analysis of complex processes.
Multivariable Control Analysis of multivariable systems, Interaction, examples of storage tanks. Review of matrix algebra, Bristol arrays, Niederlinski index - Tuning of multivariable controllers.
Sample Data Controllers: Basic review of Z transforms, Response of discrete systems to various inputs. Open and closed loop response to step, impulse and sinusoidal inputs, closed loop response of discrete systems.
Design of digital controllers.

Textbook:

B) Virtual Instrumentation
Virtual Instrumentation: Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming. VI programming techniques: VIS and sub-VIS, loops and
charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string

TEXTBOOKS:

C) Radar Systems Engineering

TEXTBOOKS:

D) Microwave Solid State Devices
**TEXTBOOKS:**


**E) Chemical Process Systems**

Typical products and their and uses, Systematic analysis of chemical processes. Flow sheets and symbols for various operations. Variation in process conditions, raw materials and fuels – effect on end products and economy.

Overall Balances, Component balances in engineering equipment, combustion reactions, Stoichiometric balances in manufacturing processes. Forms of energy, Total balance, Heat balance, Heat effects and combustion reactions,

Energy balances in manufacturing processes, optimum utilization of energy, Heat transfer operations in chemical reactors. Equipments- Fundamental concepts in heat exchangers, Evaporators and distillation column, Design and classification of heat exchangers,

Evaporators and distillation column. Fundamental principles and classification of heat exchangers, Evaporators, Distillation columns and equipment for Agitation and mixing of fluids dimensional analysis to estimate power consumption for agitation.

Energy Conservation in process systems and industries, Optimization principles and pinch analysis to calculate energy consumption.

**TEXT BOOK:**


**F) Bioprocess Instrumentation & Control**

Physical and chemical sensors; Biosensors; On-line sensors for cell properties; off-line Analytical methods.

Agitation and capacity coefficient in fermenters; Control of pH, dissolved oxygen, dissolved carbon dioxide, temperature of fermenters; Rheological measurement and control application of microcomputers in the study of microbial process. Elements of Digital computers; Computer Interfaces and peripheral devices; Fermentation software systems Data smoothing and interpolation; State and parameter estimation; Direct regulatory control; cascade control of metabolism. Programmed batch bio-reaction; Design and operation strategies for batch plants; Continuous process control.

**TEXT BOOKS:**

G) Logic and Distributed Control Systems

TEXT BOOKS:

H) Instrumentation System Design
Orifice Sizing: - Liquid, Gas and steam services - Control Valves – Valve body:-Commercial valve bodies – Control valve sizing – Liquid, Gas and steam Services – Cavitation and flashing –Selection criteria – RotameterDesign DESIGN OF ALARM AND ANNUNCIATION CIRCUIT

TEXT BOOKS
1) **Pharmaceutical Business Management**


Planning: Nature and purpose of planning, important steps in planning, types of planning, planning process, advantages and limitations. Sales forecasting methods, analysis, advantages and limitations.

Objectives: Types of objectives, Importance of objective, Management by objectives, Advantages and Limitations

Organizing: Organizational structure, basic principals of organization, Departmentalization, Delegation, Decentralization, Staffing, Line & Staff organization. Decision making: Types of strategies, Policies, Definition and Importance of decision making, Decision making process

Controlling: Concepts and purpose of control techniques, Budgetary and non budgetary control, Management audit, Management information system, Break even analysis, Network techniques (PERT & CPM), Profit and loss account, Balance sheets


Human Resource and Development Motivation: definition, concept, Theory’s- Maslow’s Theory, Hertzberg’s theory, Vroom’s theory, Expectancy theory, Reinforcement theory, Equity or social comparison theory X & Y. Leadership: definition, importance, qualities of leadership, leadership styles, trait theory, managerial grid Communication: importance, functions, communication process, forms of communication, types of communication

Interview techniques: presentation skills, group discussion Performance appraisal: need and techniques, recruitment and training International market. Pharmaceutical export, procedure, documentation. Export, registration authorities, regulatory agencies

**TEXT BOOKS**

J) RF Microelectronic Chip Design:

TEXT BOOKS

K) PowerElectronics
Principles of Steady State Converter Analysis – Boost and Buck Converter Examples
Steady-State Equivalent Circuit Modeling, Losses, and Efficiency – Equivalent circuit model – complete circuit model - - Switch Realization- Switching loss - Converter Circuits – Circuit manipulation – Transformer isolation – Converter evaluation and design
Power Phasors in Sinusoidal Systems - Harmonic Currents in Three-Phase Systems - AC Line Current Harmonic Standards - Line-Commutated Rectifiers - The Single-Phase Full-Wave Rectifier - The Three-Phase Bridge Rectifier - Phase Control - Pulse-Width Modulated Rectifiers - Realization of a Near-Ideal Rectifier - Control of the Current Waveform - Ideal Three-Phase Rectifiers

**TEXT BOOKS**


**Elective II**

1. **L) Instrumentation**

      (b) Process Flow of fermenter and control (Batch process)(b) Oil extraction plant and instrumentation set-up
      (c) Pesticides manufacturing process and control
4. (a) Process Flow diagram of Diary and confectionary industry and instrumentation set-up.
   (b) Juice extraction control set-up
5. Water Management and Instrumentation:(a) Application of SCADA for DAM parameters and control
   (b) Water distribution and management control, Auto-Drip irrigation systems(c) Irrigation Canal management, upstream and downstream flow control concepts, supervisory control.
6. Green houses and Instrumentation; ventilation, cooling and heating wind speed, temperature and humidity, rain gauge, carbon dioxide enrichment measurement and control. 7. Farm Equipments and Modernisation : (a) Automation in Earth Moving Equipment and farm implements, pneumatic, hydraulic and electronic control circuits in harvesters, cotton pickers, tractors etc.
   (b) Automation in packaging industry. 8. (a) Leaf area, length, evapotranspiration, temperature, wetness and respiration measurement and data logging. Electromagnetic, radiation, photosynthesis, infrared and CV, bio sensor methods in agriculture. (b) Agro meteorological instrumentation weather stations.

**TEXT BOOKS**

M) Sensors in Instrumentation:
Sensor characteristics; R, L and C sensors: Hall effect sensors; Piezoelectric sensors; Micro-sensors. Sensors for displacement, pressure, temperature, flow etc. Optical sensors; chemical and bio-sensors. Sensor applications in non-destructive testing. Interfacing sensors with microprocessors and micro controllers.

TEXT BOOKS
2) J. P. Bentley, Principles of measurement systems, Wiley, 1989
4) S. M. Sze, Semiconductor Sensors, Wiley, 1994

N) Simulation of Circuits and Devices
Formulation of network equations: Nodal, mesh, modified nodal and hybrid analysis equations. Sparse matrix techniques; Solution of nonlinear networks through Newton-Raphson technique. Multistep methods: convergence and stability; Special classes of multistep methods: Adams-bashforth, Adams-Moulton and Gear's methods; Solution of stiff systems of equations; Adaptation of multistep methods to the solution of electrical networks; General purpose circuit simulators. Review of semiconductor equations (Poisson, continuity, drift-diffusion, trap rate). Finite difference formulation of these equations in 1D and 2D. Grid generation. Physical/empirical models of semiconductor parameters (mobility, lifetime, band gap, etc.). Computation of characteristics of simple devices (p-n junction, MOS capacitor, MOSFET, etc.); Small-signal analysis.

TEXT BOOKS

O) Image Processing:

TEXT BOOKS
6) H. C. Andrew and B. R. Hunt, Digital image restoration, Prentice Hall, 1977
**P) Error Correcting Codes**

Linear block codes: Systematic linear codes and optimum decoding for the binary symmetric channel; Generator and Parity Check matrices, Syndrome decoding on symmetric channels; Hamming codes; Weight enumerators and the MacWilliams identities; Perfect codes.

Introduction to finite fields and finite rings; factorization of \((X^n-1)\) over a finite field; Cyclic Codes. BCH codes; Idempotents and Mattson-Solomon polynomials; Reed-Solomon codes, Justeen codes, MDS codes, Alterant, Goppa and generalized BCH codes; Spectral properties of cyclic codes.


Convolution codes; Wozencraft's sequential decoding algorithm, Fann's algorithm and other sequential decoding algorithms; Viterbi decoding algorithm.

**TEXT BOOKS**


**Q) Advanced Electronic System Design**


DC power supply design using transistors and SCRs, Design of crowbar and foldback protection circuits, Switched mode power supplies, Forward, flyback, buck and boost converters, Design of transformers and control circuits for SMPS.

Amplification of Low level signals, Grounding, Shielding and Guarding techniques, Dual slope, quad slope and high speed A/D converters, Microprocessors Compatible A/D converters, Multiplying A/D converters and Logarithmic A/D converters, Sample and Hold, Design of two and four wire transmitters. Introduction to technology of printed circuit boards (PCB), General lay out and rules and parameters, PCB design rules for Digital, High Frequency, Analog, Power Electronics and Microwave circuits, Computer Aided design of PCBs.

**TEXT BOOKS**

R) Applied Industrial Instrumentation


TEXT BOOKS

S) Applied Biomedical Instrumentation

INTRODUCTION TO BIOMEDICAL MEASUREMENTS
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.

ADVANCES IN MODELING AND SIMULATIONS IN BIOMEDICAL INSTRUMENTATIONModeling and simulation in Biomedical instrumentation – Difference in modeling engineering systems and physiological systems – Model based analysis of Action Potentials - cardiac output – respiratory mechanism - Blood glucose regulation and neuromuscular function. BIOMEDICAL SIGNALS AND THEIR ACQUISITIONSTypes 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.

INSTRUMENTATION FOR DIAGNOSIS AND MONITORING 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.BIOMEDICAL IMPLANTS AND MICROSYSTEMS 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
T) Electromagnetic Interference and Electromagnetic Compatibility

INTRODUCTION Sources of EMI, Conducted and radiated interference- Characteristics - Designing for electromagnetic compatibility (EMC)- EMC regulation- typical noise path- use of network theory- methods of eliminating interferences.


Electrostatic discharge,STANDARDS AND LABORATORY TECHNIQUES

Static Generation- human body model- static discharges-ED protection in equipment design- ESD versus EMC, Industrial and Government standards – FCC requirements – CISPR recommendations-Laboratory techniques-Measurement methods for field strength-EMI

U) Telemetry

CLASSIFICATION OF TELEMETRY SYSTEMS

Voltage, current, position, frequency, pulse, land – line and radio telemetry. telemetry system overview, Bio-telemetry; radio telemetry services single and multi-channel telemetry circuits.

LAND – LINE TELEMETRY

Voltage telemetering system current telemetering system motion balance current telemetering system force balancing current telemetering system position telemetering system using bridge configuration position telemetering system using synchors.
AMPLITUDE MODULATION AND DEMODULATION OF A CARRIER WAVE
Expression for an AM – wave frequency spectrum of an AM – wave bandwidth AM – detector illustration of AM for a measuring system full – wave phase sensitive demodulator block diagram of a carrier amplifier system.

FREQUENCY MODULATION AND DEMODULATION OF A CARRIER WAVE
Expression for an FM – wave frequency spectrum of an FM – wave bandwidth diode FM modulator reactance modulator phase shift discriminator ratio detector.

AMPLITUDE MODULATION AND DEMODULATION CIRCUITS FOR MEASURENT SYSTEMS:
Basic configuration for a modular electronical chopper semiconductor modulator balanced modulator basic configuration of a demodulator chopper demodulator semiconductor demodulators balanced demodulator.

MULTIPLEXING IN TELEMETRY SYSTEMS: Block diagram of a multiplexer and its mechanical switch equivalent block diagram of a demultiplexer and its mechanical switch equivalent frequency division multiplexing time division multiplexing sample –and – hold circuit an outline of pulse modulation techniques used in telemetry.

RADIO TELEMETRY SYSTEMS: Analog TDM system FM – FM telemetry system standard telemetry channel frequencies for FDM block diagrams of PAM, PCM and FDM telemetry systems.

TRANSMISSION CHANNEL: Wire line channels, radio channels, micro – wave channels, power line carrier channels and fiber optic transmission.

TEXT BOOKS:
1) Introduction to Telemetry by Alan Andrews, Foulsham – Sams technical books, Published by W – Foulsham& Co
2) Ltd., England.
3) Understanding telemetry circuits, by John D. Lenk, Foulsham – Sams technical books, Published by W. Foulsham

V) Process Modelling And Simulation

TEXT BOOKS:

W) Advanced Optical Communication
Generations of Optical Fiber Links. Description of a 8 Mbps Optical fiber communication link: System Architecture, System Technology, Hardware Architecture, Specifications, Types of LASERS used. Description of a 2.5 Gbps Optical fiber communication link: Optical Transport Network Concept, Optical Cross-connect
Photonic Packet Switching: Synchronization of Networks, Unslotted Networks, Optical Buffering.

**TEXT BOOKS:**
5. Gerd Keiser: Optical fiber communication, McGraw Hill

**SEMESTER 4**

**Thesis work**
Thesis work will start from the 3rd semester and will continue in the 4th semester.