Syllabus & Scheme for

M.Tech. (Electronics Instrumentation Engg.)

Department of Electronics Engineering

YMCA University of Science & Technology, Faridabad

(Haryana)
**M. Tech. (Electronics Instrumentation Engg.) Scheme**

Total credit requirement of the course : 71  Max. Marks: 2250
Core Courses : 10  Labs: 4
Electives Courses : 02  Seminar: 1
Project / Dissertation : 02

**First Semester**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Title</th>
<th>Credit (L-T-P)</th>
<th>Marks Weightage</th>
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<tr>
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<td>E 601 C</td>
<td>Modern Control System</td>
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<td>60 40</td>
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<td>E 603 C</td>
<td>Industrial Process Control</td>
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<td>E 611 C</td>
<td>Modelling and Simulation Lab</td>
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## Second Semester

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### Third Semester

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<td>Stochastic Control</td>
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*The student will have to select subject from list of elective as under*

**List of Elective**

**Elective – I**
1. Microprocessor based Control System
2. Digital Signal Processing
3. Reliability Engineering

**Elective – II**
1. Robotics and Automation
2. Biomedical Instrumentation
E-601 C MODERN CONTROL SYSTEM

**State Variable Analysis** – Introduction, vectors and matrices, state variable representation, conversion of transfer function model to state variable model, conversion of state variable model to transfer function model, decomposition of transfer function into canonical state variable models, Eigen values and Eigen vectors, solution of state equations. Concept of controllability and observability, equivalence between transfer function and state variable representation.

**Discrete time system and Z transform methods** – Introduction to discrete time system, the Z transform, solution of difference equations, inverse Z transform, pulse transfer function, Stability analysis in Z plane.

**State variable analysis of discrete time system** – state space analysis of linear discrete time system, controllability and observability, multivariable system.

**Pole placement and state observers** – introduction, stability improvement by state feedback, necessary and sufficient condition for arbitrary pole placement, state regulator design, design of state observers, state feedback with integral control, digital control system with state feedback.

Text books –

1. Control System by B. C. Kuo.
2. Digital and non linear control by M. Gopal
3. Control System by Nagrath and Gopal.
E 603 C Industrial Process Control

Historical prospective, incentives of process control, synthesis of control system, classification and definition of variables.

Need and application of mathematical modeling, lumped and distributed parameters, analogies, thermal, electrical and chemical systems, modeling of CSTR, heat exchanger, interacting and non interacting type of systems, dead time elements.

Control modes, definition, characteristics and comparison of P, PI, PD, PID controllers.

Dynamic behavior of feedback controlled process for different control modes, control system quality, IAE, ISE, IATE criterion, tuning of controllers, Ziegler-Nicholos and Cohen coon methods.

Realization of different control modes in electric and electronic controllers.

Control valves, types, function, hydraulic, pneumatic actuators, solenoid, stepper motors.

Review and limitation of single loop control, need for multi loop systems.

Principle, analysis and application of cascade, ratio, feed forward, feedback, override, split range, selective, auctioneering control.

Introduction to adaptive and self tuning control.

Interaction and decoupling of loops.

Text Books-

1. George Stephnopolous “Chemical Process Control” Prentice Hall
2. Peter Herriot, ” Process control” Tata McGraw Hill
E 605 C Industrial Electronics

Unit I. Industrial Solid State Devices :SCR, ASCR, RCT, Triac, Diac, Unijunction Transistor, SUS, SBS, Power MOSFETs, MCT, Static Induction Devices

Unit II. Industrial Converter and Regulated Power Suppliers: Single phase, three phase and six phase controlled rectifiers and their performance, dual converters, single phase and three phase ac regulators.

Unit III. Industrial Choppers: Chopper classification, chopper operation, control strategies, chopper configuration, thyristor chopper circuits, Jones chopper, Morgan chopper, Multiphase chopper

Unit IV. Industrial Invertors : Requirement of practical inverters - Types of inverters - Single phase inverters using Thyristers -Ability to operate into inductive load - Overcurrent protection - Output. Voltage control - waveform control Typical inverter circuits - Three phase inverters.

Unit V. Industrial Process Control and applications :

(b) Induction heating - basic Principle - Theory - Applications - High frequency Power Source for Induction heating.
(c) Dielectric heating - basic Principle - Theory - Applications - Electrodes used in Dielectric heating - Method of Coupling of Electrodes to the R.F. Generator - Thermal losses in Dielectric heating.
(d) UPS, SMPS

Text Books

1. Industrial Electronics - G.K. Mittal
2. Industrial Electronics - Noel Morris
Introduction –

Optimization concepts, Euclidean space, convex functions, gradient vector, Hessian matrix, formulation of engineering problems amenable to optimization, direct approach and indirect methods.

Classical optimization techniques –

maxima minima for functions of several variables, necessary and sufficient conditions, formulation of non linear optimization problems with equality and inequality constraints, solution techniques using Lagrange’s multiplier and kuhn-tuckker conditions.

Uni dimensional optimization –

Elimination methods, interpolation methods.

Multivariable optimization –

Concepts of Hill climbing, methods of steepest descent, Newton Raphson methods, Fletcher power method, constrained optimization.

Other techniques –

principle of optimality, solution for simple multistage problems, Dynamic Programming, Geometric Programming.

Books:

S. S. Rao, “Optimization Techniques” -
E 602 C Non linear Systems

Describing function analysis of non linear control systems –
Introduction to non linear system, nonlinear control system, Describing functions, describing function analysis to non linear control systems.

Phase plane analysis -
Introduction, methods of constructing trajectories, obtaining time solutions from phase plane plots, singular points, phase plane analysis of linear control systems, phase plane analysis of nonlinear systems.

Liapunov stability Analysis –
Introductions, definitions, second method of liapunov, stability analysis of linear system, stability analysis of non linear systems, estimating the time response behavior of dynamic system, methods to formulate liapunov function.

Text Books:
K Ogatta, “Control System Theory”
Gibson, “Non Linear Control System”
M. Gopal “ Discrete and non linear system”
E 604 C Optimal Control Theory

Introduction –

Introduction, optimal control system, performance indices, Formulation of optimization problems, time optimal control systems.

Controllability –

Linear independence, complete state controllability of continuous system, complete state controllability of discrete system, alternate form of the conditions of complete state controllability, output controllability.

Observability –

Complete state Observability of continuous system, complete state Observability of discrete system, alternate form of the conditions of complete state Observability, Principle of duality.

Time Optimal Control System –

Time optimal control for continuous time system with bounded control signals, time optimal control for discrete time system.


Text Books:


M. Gopal, “introducing Optimal Control System”

M. Gopal, “Descrete and Non Linear system”

Nagrath And Gopal, “Control System”

K.Ogatta, Modern Control System
**E707C1 Robotics and Automation**

Fundamentals: historical information, robot components, robot characteristics, robot anatomy, basic structure of robots, resolution, accuracy and repeatability

Robot Kinematics: Position Analysis forward and inverse kinematics of robots, including frame representations, transformations, position and orientation analysis, and the Denavit-Hartenberg representation of robot kinematics, the manipulators, the wrist motion and grippers. Examples-Kinematics analysis and inverse kinematics analysis of four axis, five axis and six axis robot

Differential motions, Inverse Manipulator Kinematics: differential motions and velocity analysis of robots and frames

Dynamic Analysis and Forces analysis of robot dynamics and forces. Lagrangian mechanics is used as the primary method of analysis and development

Trajectory Planning methods of path and trajectory planning, both in joint-space and in Cartesian-space

Actuators and Sensors actuators, including hydraulic devices, electric motors such as DC servomotors and stepper motors, Pneumatic devices, as well as many other novel actuators. It also covers microprocessor control of these actuators, mechatronics. Tactile sensors, proximity and range sensors, force and torque sensors, uses of sensors in robotics

Robot Programming, Systems and Applications: Robot languages, Method of robots programming, lead through programming methods, a robot programs as a path in space, motion interpolation, WAIT, SIGNAL and DELAY commands, branching capabilities and limitation of lead through methods and robotic applications

Fuzzy Logic Control: Basic principles of fuzzy logic and its applications in microprocessor control and robotics.

**Recommended Books**

E 606 C Electronic Instrumentation

Unit I
Error Analysis: Types of errors, Methods of error analysis, Uncertainty analysis, Statistical analysis, Gaussian error distribution, Chi-Square test, Correlation coefficient, Student’s t-test, Method of least square, Curve fitting, Graphical analysis, rejection of data.

Unit II
Static and Dynamic characteristics: Dynamic analysis of instrumentation system, Relative merits of analytical and experimental modeling of dynamic behavior, Response of zero, first and 2nd order system to step, Pulse, Harmonic and random test signals, Frequency spectra, Auto correlation spectral density, Loading effects under static and dynamic conditions, Simulation of dynamic response.

Unit III
Classification, selection of transducers, Resistance, inductance and capacitance type of transducers, measurement of displacement, strain, force, liquid level, pressure, velocity and acceleration.

Unit IV
Measurement of low, medium, and high resistance, A.C. Bridges, Measurement of inductance and capacitance, R.L.C. Measurement, DeSauty’s, Maxwell’s, Anderson’s, Schering and Campbell’s bridges, errors in bridge measurements.

Unit V
Radioactive instrumentation and Refractometry
   a) X-ray spectrometry: Instrumentation for X-ray spectrometry, X-ray diffractometer: Bragg’s law, Auger emission spectroscopy, Electron spectroscopy for chemical analysis (ESCA).
   b) Radiation detectors: Ionization chamber, Geiger-Muller counter, proportional counter, scintillation counters
   c) Refractometry: Principle, Abbe and Differential refractometer

UNIT VI
Methods of Data transmission, General telemetry systems, DC and AC telemetry system. Modulation, Pulse telemetry systems, Digital telemetry.

UNIT VII
Graphic Recorders: Graphic analog recorder, magnetic tape analog recorders, oscillographic analog recorders, digital recorders

Text Books:

4. Electrical Measurement & Measuring Instruments E.W.Golding
5. Electrical Measurement A.K.Sawhney
UNIT I: Computer control-Introduction-Review of z transform, modified Z transform and Delta transform Relation between discrete and continuous transfer function –poles and Zeroes of Sample data system (SDS)- Stability Analysis in Z domain.

UNIT II: Introduction to Pulse Transfer function –Open loop and closed loop response of SDS design and implementation of different digital control algorithm: Dead beat, Dahlin and internal Model Control algorithm with Examples


Text book

1. Lennart ljung- system Identification. Theory for The user-PTR Prentice Hal Information and system sciences series, NJ, 1999

2. P. Deshponde and ash, computer controlled system ISA Press, USA


E703 C Artificial Neural Network and Fuzzy Control

Unit 1
Introduction, Neural network characteristics, history of development of neural network principles, artificial neural net terminology, models of neuron, topology.

Unit 2
Learning methods and neural network models, types of learning, supervised, unsupervised, reinforced learning, knowledge, representation and acquisition, Basic Hopfield model, basic learning laws, unsupervised learning, competitive learning, Kmeans clustering algorithm. Kohnen’s feature maps.

Unit 3

Unit 4
Applications of neural nets, applications such as pattern recognition, pattern mapping, Associative memories, speech and decision making.

Unit 5
Fuzzy logic Basic concepts of fuzzy logic, fuzzy Vs crisp set, linguistic variables, membership functions, fuzzy sets and operations on fuzzy sets, IF-Then rules, variable inference techniques, De-fuzzyfication. Basic fuzzy inference algorithm, Fuzzy system design, antilock breaking system, industrial applications.

Text Books:
B. Yagnanarayana, “Artificial neural networks” PHI
Z. M. Zurada, “Introduction to artificial neural systems” Jaico Publications
Ross J.T.”fuzzy logic with engineering applications”
1. Introduction
   Overview of stochastic process, limitation of deterministic control and processes.
2. Probability and axioms
   Definitions, axioms and probability, conditional probability.
3. Repeated Trails
   Combined experiments, Bernoulli trails, asymptotic theorems, poison theorem, Bay’s theorem and statistics.
4. Random Variables
   Distribution and density function, conditional distributions, total probability and Bay’s theorem, mean and variance, moments characteristics functions, two random variables, moments and conditional statistics.
5. Stationary processes, system with stochastic inputs, Periodicity, correlation and spectra.

Text Books
Populis, “Probability, Random Variables and stochastic process” McGraw Hill
E-608 C2 Digital Signal Processing

Unit 1
Classification of signals, concept of frequency in continuous time and discrete time signals A/D, D/A conversion i.e. sampling and quantization. Classification of discrete time systems, introduction to IIR and FIR systems.

Unit 2
Analysis of discrete time linear time invariant system, techniques for the analysis of linear systems, convolution sum, properties of convolution and the interconnection of LTI systems, stability of LTI systems, difference equations to describe LTI systems, impulse response of LTI system.

Unit 3
Z transformation, ROC, Properties of Z transformation, rational Z transformation, one sided Z transformation, solution of difference equation, basic network structure of IIR system, direct form cascade form, parallel form, basic network structure of FIR system, DFT and its properties, fast fourier transform (FFT), decimation in time algorithm, decimation in frequency algorithm, design of IIR filter by bilinear transformation, design of FIR using windows, properties of FIR filters.

Unit 4
Lionear prediction and optimum linear filters-forword and backword linear prediction, Levinson-Durbin algorithm, Schur algorithm, AR and ARMA model, Wiener Filter- FIR, IIR, non casual (speech recognition application)

Unit 5
Effects of finite register lengths in digital signal processing, effects of truncation and rounding, finite register length effects in realization of digital signal IIR filter, statistical analysis of quantization in floating point realization of IIR filters, finite register length effects in realization of FIR filters, statistical analysis of quantization in fixed point realization of FIR filters, statistical analysis of quantization in floating point realization of FIR filters.

Text Books:

E-608 C3 Reliability Engineering

Unit 1

Basic Definitions, concept and need for reliability, inherent value of reliability in modern systems, hazard rate, failure density function, mean time to failure and repair, relationship between basic variables, analytical form of reliability function, derivation for exponential distribution function, other kind of distribution

Unit 2

Different types and modes of failure, causes of failure in different systems, systems structures, series, parallel, standby, k-out-off-n configuration, their reliability analysis

Unit 3

Reliability evaluation techniques applicable to general non series parallel systems, Marko processes for repairable and non repairable systems and their applications in reliability analysis, faults and digital circuits, use of TMR and multiplex TMR.

Unit 4

Methods to improve reliability, quality control, derating, debugging, environmental control, use of various kinds of redundancy etc.

Unit 5

Reliability optimization- various methods, redundancy allocation, the trade off between reliability and cost.

Unit 6

Reliability allocation, reliability testing methods, maintenance, distinction of repair and maintenance, analysis of simple maintenance policies, system diagnostic, fault free analysis, top down and bottom up approach, diagnostic charts

Text Books

1. L.S.Srinath, Concepts of Reliability
2. Ballaguruswamy, Reliability Engineering
E707 C2 Bio Medical Instrumentation

Unit 1
Introduction, general block diagram of bio medical instrumentation system, origin of bio electric signals, recording systems, preamplifiers, main amplifiers and transducers used for medical instrumentation system, types of recorders

Unit 2
Biomedical recorders and display systems-ECG, EEG, EMG, electrodes used for ECG, EEG and EMG, oscilloscopes used for bio medical measurement, multi channel display

Unit 3
Blood gas analyzer- blood pressure measurement, patient monitoring systems, blood pH measurement, blood PO2, PCO2, complete blood gas analyzer

Unit 4
Special machines- X ray machine, MRI, ultrasonic imaging systems, A-scanner, B-scanner, echo cardiograph

Unit 5
Cardiac pacemakers and defibrillators- external pace maker, implanted pace maker, programmable pace maker, DC defibrillators, implantable defibrillators

Unit 6
Laser applications in bio medical field- ruby laser, argon laser, helium neon laser, CO2 laser, Na-yag laser

Text Books
1. R.S.Khandpur, “Introduction to bio medical Instrumentation”
2. Cromwell, “Bio medical Instrumentation”
E707 C2  Bio Medical Instrumentation

Unit I
Characteristics of Transducers and Electrodes for Biological Measurement: Introduction to human body; block diagram, classification, characteristics, Various physiological events and suitable transducer for their recording, Bioelectric potentials.

Unit II
Cardiac System: Cardiac musculature, Electro cardiology, ECG recording, Phonocardiography, holter recording ECG lead system, Heart rate meter, vector cardiology, Pacemakers, Defibrillators.

Unit III

Unit IV
Respiratory System: Mechanics of breathing, Parameters of respiration, Respiratory system measurements, Respiratory therapy instruments.

Unit V
Musculoskeletal systems: EMG, Clinical applications, Muscles stimulator.

Unit VI
Instrumentation for Measuring Nervous Function: EEG signal, frequency band classification, Lead systems, EEG recording, Clinical applications of EEG signal, X-ray CT scan, MRI, PET.

Unit VII
Clinical Laboratory Instrumentation: Test on blood cell, Blood cell counter, Blood glucose monitors, auto analyzer, Pulse-oximeter.

Unit VIII

Unit IX
Troubleshooting & Electrical Safety of Biomedical Instruments: Physiological effect of current and safety measurement.

Text Books
1. R.S.Khandpur, “Introduction to bio medical Instrumentation”
2. Cromwell, “Bio medical Instrumentation”