

**Curricula for M.Tech Program in Electrical Engineering  
(For Teachers of AICTE-recognized Programmes of Engineering Colleges)**

**Proposed Curriculum  
First Year Spring Semester-1**

<b>Sub no.</b>	<b>Sub name</b>	<b>LTP</b>	<b>Cr</b>
MA80001	Applied Mathematics	3 1 0	4
EE80002	Control Theory	3 1 0	4
	Elective-1	3 0 0	3
EE89002	Laboratory-1	0 0 3	2
	<b>Total</b>	<b>9 2 3</b>	<b>13</b>

**First Year Autumn Semester-2**

<b>Sub no.</b>	<b>Sub name</b>	<b>LTP</b>	<b>Cr</b>
EE80001	Power Electronics Converters & Machine Drives	3 1 0	4
ET80001	Pedagogic Principles of Educational Technology	3 0 0	3
	Elective-2	3 0 0	3
EE89001	Laboratory-2	0 0 3	2
	<b>Total</b>	<b>9 1 3</b>	<b>12</b>

### Second Year Spring Semester-3

Sub no.	Sub name	LTP	Cr
EE80004	Power System Analysis and Operation	3 1 0	4
EE80006	Industrial Instrumentation	3 1 0	4
	Elective-3	3 0 0	3
EE88002	Seminar-1	0 0 3	2
	Total	9 2 3	13

### Second Year Autumn Semester-4

Sub no.	Sub name	LTP	Cr.
	Elective-4	3 3 0	3
	Elective-5	3 0 0	3
	Elective-6	3 0 0	3
EE88001	Seminar-2	0 0 3	2
	Total	9 3 3	11

### Third Year Spring Semester-5

Sub no.	Sub name	Cr
EE97002	Project-1	20
EE88004	Comprehensive viva	3
	Total	23

### Third Year Autumn Semester-6

Sub no.	Sub name	Cr
EE97001	Project-2	20

**Total Credit: 92**

**Department Core Subjects:**

1. EE80002 Control Theory (3-1-0)
2. EE80001 Power Electronics Converters & Machine Drives (3-1-0)
3. EE80004 Power System Analysis and Operation (3-1-0)
4. EE80006 Industrial Instrumentation (3-1-0)

**Department Elective Subjects:**

## 1. Elective-1

EE80010 Machine Analysis (3-0-0)

EE80012 Special Machines (3-0-0)

## 2. Elective-2

EE80011 Optimal Control (3-0-0)

EE80013 Digital Control (3-0-0)

## 3. Elective-3

EE80014 Estimation of Signals and Systems (3-0-0)

EE80016 Digital Signal Processing (3-0-0)

## 4. Elective-4

EE80015 Power System Protection (3-0-0)

EE80017 Power Transmission Systems (3-0-0)

## 5. Elective-5

EE80018 Data Communication Systems (3-0-0)

EE80020 Industrial Automation &amp; Control (3-0-0)

## 6. Elective-6

EE80019 Intelligent Control (3-0-0)

EE80021 Analog Signal Processing (3-0-0)

XXxxxxx Suitable elective may be chosen from the list of E&ECE, CSE and Mathematics department.

**Laboratories:**

Laboratory-1 and Laboratory-2

# Syllabus of Department core subjects

## **EE80002 Control Theory (3-1-0)**

Review of classical compensation techniques.

State space representation of LTI systems, Linearization of non-linear systems, Solution of state equations, Evaluation of state transition matrices, Fadeeva's algorithm to obtain transfer function representation from state space model.

Controllability and Observability – definitions and theorems, Canonical and Minimal realizations of SISO and MIMO systems in observable and controllable forms. Pole placement via state feedback. Linear Quadratic regulators. Observers and design of the same. Introduction to H-infinity compensation.

## **EE80001 Power Electronic Converters and Machine Drives (3-1-0)**

Power Electronic Devices: Diodes, Transistors, Thyristors, MOSFET and IGBT - operating principle and characteristics, Data sheet ratings, gate drive circuits;

Single and three phase half controlled and fully controlled AC/DC bridge converter with motor loads: operation in continuous/discontinuous conduction mode, effect of input line inductance; Torque-speed characteristics of converter controlled separately excited dc motor in continuous and discontinuous mode of conduction; Series and parallel operation of converters, power factor improvement, 12 pulse operation, transformer connection, dual converters;

Basic DC-DC converters: buck, boost buck-boost and Cuk converter, operation, waveforms and design; DC-DC choppers: basic voltage commutated thyristor chopper analysis, Separately excited DC motor drive using DC-DC choppers, four quadrant operation, dynamic and regenerative braking of series DC motor using choppers;

DC-AC inverters using gate controlled devices: single phase and three phase square wave inverters, operation waveforms and harmonics; Output voltage control in single phase square wave inverter using phase shift, harmonic analysis; Operating principles of single phase and three phase PWM inverters, modulation techniques and comparison among different PWM techniques;

Variable frequency operation of three phase induction motors: Steady state analysis, Torque-speed, current-speed and slip frequency -speed characteristics; Operating limits with constant volts/Hz and constant air gap flux operation, implementation using PWM VSI.

## **EE80004 Power System Analysis and Operation (3-1-0)**

Power Flow Analysis, Sparse Matrix Techniques - Direct solution of sparse network equations by optimally ordered triangular factorization, Analysis of symmetrical and unsymmetrical faults, Static State Estimation, Dynamic State Estimation, Load forecasting, Unit Commitment, Economic Dispatch, Hydrothermal Coordination, Optimal power flow, Power system security, Multi-area operation - Interchange of Power and Energy, Power System Restructuring, Power pools and Power exchanges.

## **EE80006 Industrial Instrumentation: (3 - 1 - 0)**

Static and dynamic characteristics of sensors, Resistive, Inductive and Capacitive sensors and signal conditioning circuits. Temperature, pressure, flow and level measurement techniques. pH and conductivity sensors. Piezo-electric and ultrasonic sensors and its application in process and biomedical Instrumentation. Measurement of viscosity, humidity and thermal conductivity. Optical Instrumentation: devices, intensity modulation and interferometric technique. Nucleonic gauges: Sources and Detectors and its application. Interfacing Sensors and actuators using LabVIEW programs. Instrumentation system Design.

# Syllabus of Department Electives

## Elective-1

### **EE80010 Machine Analysis: (3 - 0 - 0)**

Principles of electromagnetic energy conversion: General expression of stored magnetic energy, co-energy and force/torque, example using single and doubly excited system; Calculation of air gap mmf and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine, three phase symmetrical induction machine and salient pole synchronous machines in phase variable form; Introduction to reference frame theory: static and rotating reference frames, transformation relationships, examples using static symmetrical three phase R, R-L, R-L-M and R-L-C circuits, application of reference frame theory to three phase symmetrical induction and synchronous machines, dynamic direct and quadrature axis model in arbitrarily rotating reference frames, voltage and torque equations, derivation of steady state phasor relationship from dynamic model, generalized theory of rotating electrical machine and Kron's primitive machine; Determination of synchronous machine dynamic equivalent circuit parameters: standard and derived machine time constants, frequency response test; Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine; Permanent magnet synchronous machine: Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines, construction, operating principle and true synchronous characteristics, dynamic modeling and self controlled operation; Analysis of Switch Reluctance Motors: design trade-off and basic operating characteristics.

### **EE80012 Special Electrical Machines (3-0-0)**

Field aspects of electrical machines: Review of Maxwell's equations and solution of Laplace's and Poisson's equations. Concept of magnetic vector potential. Eddy current brake;

Linear motors: Basic principle of operation and types. End effects & transverse edge effects. Field analysis & Propulsion force; equivalent circuit.

Stepper motor: Basic construction and principle of operation; types-synchronous inductor & variable reluctance. Logic circuit for open loop & closed loop operation; modeling and dynamic analysis.

Switched reluctance motor (SRM): Construction, importance of stator & rotor arc angles; L-? profile, position sensor & indirect rotor position sensing; torque expression, steady state and dynamic performance.

Permanent magnet, Hysteresis & reluctance motors.

## Elective-2

### **EE80011 Optimal Control (3 - 0 - 0)**

Static optimization, Linear programming, Simplex methods. Dynamic optimization. Calculus of variations, Euler's equation, application to control problems. Pontryagin's maximum principle, control with constraints, time optimal control. Optimal tracking control problem, Gain scheduling, Model reference and Self-tuning control problem. Discrete optimal control, Bellman's dynamic programming method. Continuous Kalman Filter, Square root Kalman filter. Non-linear system optimization, Gradient optimization techniques, steepest ascent and descent in parameter plane, Rosenbrock's conjugate gradient method, David' Fletcher-Power method, etc. Evolutionary methods, Genetic algorithms

### **EE80013 Digital Control (3-0-0)**

Introduction: Overview of design approaches, continuous versus digital control, sampling process, effect of sampling rate. Calculus of difference equations. Z-transform. Signal flow graphs. State space approach: Controllability, Observability, Discretization of continuous transfer functions; Digital filter properties. Controller design using transformation techniques: Z-plane specifications. Design in the  $w, w'$  domain. PID controller., deadbeat controller. Root Locus design. State space methods: Pole placement design, stabilization and all stabilizing controllers. Observer design. Infinite time optimal regulator, Stability and tracking in SD systems, Quantization effects: limit cycles and dither. Sample rate reduction. Multi-rate sampled data system and stability studies. Design of digital controller using fast output sampling. Microprocessor and DSP control: Mechanization of control algorithms. Iterative computation via parallel, direct, canonical, cascade realization; Effects of computing time. Systems with time delay. Case studies.

### **Elective-3**

#### **EE80014 Estimation of Signals & Systems: (3 - 0 - 0)**

Recursive least squares (RLS), Consistency of estimation, Weighted LS; Full and reduced order observers, Kalman filter; Parametric models, LS estimation, bias; Generalized least squares (GLS) and instrumental variable (IV) method; Persistently exciting input signal; Likelihood functions and maximum likelihood estimation (MLE); Singular value decomposition (SVD); Stochastic approximation algorithm (STA); Order and structure determination, Yule-Walker equation; Multi-variable system representation, controllability and observability indices; Feedback system identification.

#### **EE80016 Digital Signal Processing (3-0-0)**

Short introduction -Discrete time systems and signals; Z-transform, Difference equation.

Filter design by transformation - Impulse and step Invariant, Bi-linear Z-transform, matched Z-transform.

Signal Model-AR, MA, ARMA, State Variable model, Lattice structures.

FIR filter design, Frequency windowing technique, Equi ripple Chebyshev and Butterworth criterion.

Filter performance and design in presence of noise, FIR filters banks-subband decomposition.

Inverse filtering-Deconvolution and equalization techniques-Weiner, Linear prediction etc., Signal reconstruction.

Time frequency Analysis - STFT, WT, DSP hardware - Design methodologies,

Popular architectures and overview of programming Application notes.

Filter implementation: Topology, Scaling, Coefficient quantization, Signal quantization, Sensitivity analysis.

### **Elective-4**

#### **EE80015 Power System Protection: (3 - 0 - 0 )**

Review on Power System Protection Schemes, Digital Protection-

Phasor based protection, Time domain algorithms, Travelling wave based protection, Distance, Differential, Directional relay algorithms, Fault Locating Algorithms, adaptive relaying, Wide area measurement based protection. Switchgear – ACBs, SF6CB, VCBs and Short Circuit testing.

#### **EE80017 Power Transmission Systems (3-0-0)**

Transmission line Trends and preliminaries, Corona effects - Power loss and audible noise, Radio interference. Electrostatic field of EHV lines. General comparison of A.C. and D.C. transmission,

AC\DC converters and components, control and protection for HVDC systems. Reactive power management. Integrated AC-DC systems. Multi-terminal D.C transmission. Flexible AC transmission systems-concept and devices.

### **Elective-5**

#### **EE80018 Data Communication Systems (3-0-0)**

Introduction to communication systems. Significance and impact on distributed industrial control and automation. Fundamentals of analog and digital communication -Modulation and demodulation (AM, FM,PSK,FSK, PCM), Transmitters and receivers, Noise and bandwidth factors, Synchronization, Communication media, Circuit realization and communication chips. Digital signal formats, error detection, correction and recovery, circuit, message and packet switching.

Overview of analog and digital telephone systems-Basic configuration and standards, Digital PBX for voice and data communication

Overview of wireless communication-Radio, Microwave and satellite communication. Application in telemetry.

Overview of power line carrier communications-Interface equipment and communication standards.

Local Area Computer Networks - Introduction, Basic topologies, Layered architecture. Access techniques (CS/CD), Lan technology-Ethernet: media, interface equipment, controller cards, application, software issues - networking support in UNIX and DOS, Client Server computing.

Advanced Topics; -Fibre distributed data interface (FDDI), Integration service digital networks (ISDN), Manufacturing automation protocol (MAP), Any other.

#### **EE80020 Industrial Automation & Control (3-0-0)**

Benefits and Impact of Automation on Manufacturing and Process Industries; Architecture of Industrial Automation Systems; Process Control: P-I-D Control, Controller Tuning, Special Control Structures: Feedforward and Ratio Control, Predictive Control, Control of Systems with Inverse Response, Cascade Control, Advanced Control Schemes. Process and Instrumentation Diagrams; Sequence Control: PLCs and Relay Ladder Logic, Scan Cycle, RLL Syntax, Structured Design Approach, Advanced RLL Programming, Hardware environment; Control of Machine tools: Introduction to CNC Machines, Analysis of a control loop ; Flow Control Valves ; Hydraulic Actuator Systems : Components, Proportional and Servo Valves; Pneumatic Control Systems : System Components, Controllers ; Electric Drives : Energy Saving with adjustable Speed Drives, AC and DC Adjustable Speed Drives, Step motor Drives, Servo Drives ; Communication and Networking of Sensors, Actuators and Controllers; Supervisory Production Control and Management Systems ; Integration with Management and Enterprise Systems

### **Elective-6**

#### **EE80019 Intelligent Control (3-0-0)**

Introduction and motivation. Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems.

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron. Learning and Training the neural network. Data Processing: Scaling, Fourier transformation, principal-component analysis and wavelet transformations.

Networks: Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller

Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox.

Stability analysis of Neural-Network interconnection systems.

Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems.

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Fuzzy logic control for nonlinear time-delay system. Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox. Stability analysis of fuzzy control systems.

### **EE80021 Analog Signal Processing (3-0-0)**

Bipolar operational amplifiers. MOS diode, active resistor and current mirrors, CMOS amplifier and operational amplifier. Approximation functions: Butterworth, Chebyshev and Bessel approximations, Frequency transformation. Continuous time filter: Active filter; Second order filter: Single amplifier and multiple amplifier structures and filter parameter sensitivities. Cascade filter. Sampled data filter: Switched Capacitor filter; Switched capacitor integrator and filter. Filter transfer function in z-domain, Filter parameter sensitivities with respect to capacitor ratios. Mixed signal circuits: Introduction to Switched current filter, current cell. Simple second order structure. Analog multiplexer, Sample and Hold Circuits, aliasing error and antialiasing filter, Digital to analog converter (DAC), Analog to Digital Converter (ADC), flash, dual slope and multi slope ADC. Over sampling method for A/D and D/A conversion. Delta-Sigma data converter. Noise and noise reductions. Interference signals and their reduction: Capacitive, inductive coupling and ground loop interferences and its reduction. Logarithmic and exponential amplifiers, analog multipliers and divider, Voltage controlled oscillator, Phase locked loop. Waveform generator and Oscillator.

### **EE8xxxx**

To be chosen from the elective lists of Electronics & Communication Engineering, Computer Science & Engineering and Mathematics with the advice of the course co-ordinator.

## **Laboratory-1**

Eight experiments will be offered from experiments listed under Lab-1A and under Lab-1B

### **Lab-1A Machine Drives and Power Electronics Laboratory**

1. Operation of synchronous machine as motor and generator when connected to grid.
2. Determination of various reactances of synchronous machine.
3. Performance characteristics of single phase induction motor and estimation of optimum capacitance value during starting.
4. Induction generator operation in isolation and when connected to grid.
5. Effect of 3-rd harmonics in 3-phase transformer and in a bank of 3-phase transformer for various connections.
6. Experiments on single phase (i) fully controlled and (ii) semicontrolled bridge converters.
7. Experiments on 3-phase (i) fully controlled and (ii) semicontrolled bridge converters.

8. Experiments on (i) thyristor based chopper and on (ii) buck & buck-boost converters.
9. Experiment on 3-phase VSI driving induction motor.
10. Experiment on closed loop operation of d.c motor operated from a converter.
11. Mini project.

### **Lab-1B Power System Engineering Laboratory**

1. Experiments on grid connected and self-excited operation of induction generator,
2. Grid connected alternators,
3. Three-phase three-winding transformers and grounding transformers.
4. Experiments on over current relay, under voltage relay, differential relay, directional relay and distance relay
5. Experiments on impulse generator, corona, dielectric strength testing of transformer oil and soil resistivity testing.
6. Experiments on determination of symmetrical components and determination of phase sequence of a given supply.

## Laboratory-2

Eight experiments will be offered from experiments listed under Lab-2A and under Lab-2B

### **Lab-2A Control System Engineering Lab**

1. To obtain the torque-speed Characteristics of a D.C machine and its parameters, and hence determine the transfer function of a D.C Machine. Obtain the closed loop system response using P, PI and PID controllers.
2. To obtain the torque-speed characteristics of a 2-phase ac servo motor and hence determine the incremental transfer function at different operating conditions.
3. To obtain position and speed control of a D.C Motor (i) with /without velocity feedback (ii) with PID controller.
4. To regulate the outlet water temperature of Process Control System using (i) on/off controller (ii) industrial controllers (P, PI, PID controllers).
5. To study the basic problem formulations of ball-beam experimental setup and obtain its mathematical model. Control the position of a ball on a beam using digital controller and also study the tracking control problem using dual ball-beam setup.
6. To obtain a mathematical model of liquid level system and control the water level of a coupled tank setup using different control laws.
7. To obtain the Galvanometer constants and its response in time domain and frequency domain respectively.
8. To run the digital pendulum system in (i) the crane mode (ii) the swing-up and upright stabilization mode. Investigate the effects of inverted pendulum system behavior with changes in control parameters and sampling time.
9. Familiarization with Matlab programs and obtain the response of a dynamic system and its stability analysis using MATLAB program (ii) response of a simple D.C drive system with load torque using Simulink software.
10. To obtain (i) the parameters of an electric oven and hence find its the transfer function (ii) the time response of thermal system using on/off (or relay) and P, PI, PID controllers (selecting controller parameters using Ziegler and Nichols tuning technique).

## **Lab-2B Instrumentation Laboratory**

1. Experiments with Piezoelectric sensors, Strain gauge, LVDT
2. Experiments with different temperature sensors (RTD, Thermocouple, Thermistors, AD590)
3. Experiment with different types of flow meters (V-Notch, Electromagnetic flow meter, Optical flow meter, Anemometer, Orifice meter)
4. Experiment with servo systems
5. Experiment on different types of process loop (P, PI, PID control and tuning)
6. Experiment on PLC
7. Mini project

Linear and Matrix Algebra:

Linear Equations and Matrices, LDU Factorization, Vector Spaces, Bases and Dimensions, Row and Column Spaces, Rank and Nullity, Base Matrices, Eigen Values, Eigen Functions, Matrix Decomposition, Linear Transformations, Inner Product Spaces, Orthogonalization, Diagonalization.

Transform Calculus and Calculus of Variation:

Introduction to Integral Transforms, Basic Algebra and Calculus of Laplace, Fourier(Complex, Sine & Cosine) Transforms and their Properties, Use of these Transforms for Solving Initial and Boundary Value Problems, Essentials of Partial Differential Equations of 1<sup>st</sup> and 2<sup>nd</sup> Order, Basic Results of Calculus of Variations.

Probability and Statistics:

Probability: Classical, Relative frequency and Axiomatic Definitions of Probability, Addition Rule, Conditional Probability, Multiplication Rule, Bayes' Theorem.

Random Variables: Discrete and Continuous Variables, Probability Mass, Probability Density and Cumulative Distribution Functions, Mathematical Expectation, Moments, Moment Generation Function.

Standard Distribution: Uniform, Binomial, Geometric, Negative Binomial, Poisson, Exponential, Gamma and Normal.

Static and Dynamic Optimization:

Linear Optimization, Some Continuous and Discrete Models, Algorithms, Duality Theory, Constrained and Unconstrained Non-linear Optimization, Necessary and Sufficient Conditions, Solution Procedures. Fundamental of Dynamic Programming, Principle of Optimality, Forward and Backward Approach and Applications.

# Educational Technology course for M.Tech programme for AICTE teachers through video-conferencing

## Course name : Pedagogic Principles of Educational Technology 3 0 0 - 3

### Course Description :

The course intends to provide teachers of engineering colleges in the country with detailed knowledge of relevant pedagogical principles. It also aims to enable the teachers to develop curricula based on clear pedagogical standards and approaches. Modalities of technology-enhanced learning and e-learning standards are also dealt with in this course.

### Syllabus :

1. *Introduction*
  - Education & Society
  - Education Vs Training
  
2. *Domains & Levels of Learning*
  - Bloom's & Krathwol's Taxonomies
  - Vincentti's model
  - SOLO Taxonomy
  
3. *Instructional Objectives*
  - General & Specific Instructional Objectives
  - Instructional objectives & Action verbs
  - Specification Matrix
  
4. *Evaluation*
  - Purpose of Evaluation
    - Formative
    - Summative
  
  - Types of Evaluation
    - Norm Referenced
    - Criterion Referenced
  
  - Concepts of
    - Validity
    - Reliability
  
  - Planning a Test
    - Types of Test Items and their uses
  
  - Test Item Analysis
    - Facilitation Value
    - Discrimination Index
    - Effectiveness of Distractor

5. Curriculum design in terms of Instructional Objectives
  - Course Design
  - Lesson Planning
  - Evaluation planning
6. Learning Theories & Applications
  - Behaviourist
  - Cognitivist
  - Constructivist
  - Connectivist
7. Learning Styles & Approaches
  - Perception model
  - Input model
  - Processing model
  - Understanding model
  - Depth of Approaches
8. Learning modes
  - Cooperative
  - Collaborative
  - Competitive
  - Problem-based learning
9. Concept Maps
10. Technology-enhanced Learning
  - E- learning / Blended learning
11. Learning Technologies
  - Game-based learning
  - Video-based instruction
  - SCORM
  - LMS - Moodle

## **References**

1. **Teaching Concepts: An Instructional Guide**  
Merril M.d; Tennyson, R.D and Posey, L. D;  
Educational Technology Publication  
2<sup>nd</sup> Ed, 1992
2. **Constructivism and the Technology of Instruction: A conversation**  
Duffy, T.M and Jonassen, D.H  
Lawrence Erlbaum Associates; 1992
3. **Taxonomy of Educational Objectives**  
The classification of Educational Goals, Handbooks: I, II & III;

**4. Principles of Instructional Design**

Goagne RM et al  
Thompson Wadsworth, 2005

**5. Essentials of Educational Measurement**

Ebel L Robert and Frisbie D.A  
PHI, Latest Ed.

**6. HRD Training and Development**

Vol 1 to 6  
Mager, R.F; Jaico Publishing House; 1999