### CURRICULUM

#### I SEMESTER

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<tr>
<th>Subject Code</th>
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Total Credits: 26

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**Total Credits** 16

A representative list of processional development courses is given below:

a) Industrial training (Limited to one credit)
b) Specific field knowledge training (Limited to a maximum of two credits)
c) Seminar related with directed study (Limited to a maximum of two credits)
d) Paper presentation in SCI journals (Limited to one credit)

#CA-Continuous Assessment, SE-Semester examination, TM-Total marks,
*TY-Theory, TCM=Theory with mini project, LB-Laboratory, PR-Practice
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SYLLABUS (Core Subjects)
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**Prerequisite**

- To introduce LPP ideas
- To familiarize the students with ideas of Linear algebra
- To introduce stochastic problem

**Objectives**

- Understand LPP
- Understand vector space and transformation can able to apply random process

**Outcome**

- Understand LPP
- Understand vector space and transformation can able to apply random process

**UNIT – I  Vector Spaces**

Vector spaces, subspaces, span of a set, linear independence and dependence, Dimension and Bases, inner product spaces - Gram-Schmidt orthogonalization.

**UNIT – II  Linear Transformations**

Definition and examples, Range and Kernel of a linear map, rank and nullity, Inverse of a linear transformation, consequences of Rank-Nullity theorem, the space L (U, V), composition of linear maps, Matrix associated with a linear map and linear map associated with a matrix.

**UNIT – III  Linear Programming**

Basic concepts – Graphical and Simplex methods - Big M-techniques – Two Phase methods.

**UNIT – IV  Dynamic and Quadratic Programming**


**UNIT – V  Random Process**

Stochastic Process – Classification of Stochastic process - Poisson process -Gaussian process - Markov chains - Auto correlation - Cross correlation

**Total contact Hours: 45  Total Tutorials: 15  Total Practical Classes:  Total Hours: 60**

**Text Books:**


**Reference Books:**

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**Prerequisite**

- The modeling of dynamic system in state space
- To analyze the dynamic system for controllability and observability
- The design of pole placement controller and state observers
- The stability of dynamic systems using Liapunov method
- To formulate the optimal control problems and solve them

**Objectives**

- Model any dynamic system using state space approach
- Analyze the dynamic systems for controllability, observability and stability
- Design controller and observer for systems modeled in state space
- Solve optimal control problems and design optimal controller

**Outcome**

- Model any dynamic system using state space approach
- Analyze the dynamic systems for controllability, observability and stability
- Design controller and observer for systems modeled in state space
- Solve optimal control problems and design optimal controller

**UNIT – I**

**Introduction to State Space Approach**


**UNIT – II**

**State Space Analysis**

- Eigen values and Eigen vectors – Cayley Hamilton theorem – minimal polynomial concept – Controllability and Observability – Tests – Kalman decomposition technique.

**UNIT – III**

**State Feedback Controller Design**


**UNIT – IV**

**Stability Analysis**


**UNIT – V**

**Optimal Control**

- Linear quadratic optimal regulator (LQR) problem formulation – optimal regulator design by parameter adjustment (Lyapunov method) – optimal regulator design by Continuous - time Algebraic Riccatti Equation (CARE) - Introduction to Kalman filter – optimal controller design using LQG framework.

**Total contact Hours: 45**  **Total Tutorials: 15**  **Total Practical Classes:**  **Total Hours: 60**

**Text Books:**


**Reference Books:**

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<td>M.Tech. (Electrical Drives and Control)</td>
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**Prerequisite**

**Objectives**
- To learn and design natural and forced commutated Power converters
- To learn various switching techniques

**Outcome**
- Able to design and analyze the performance of various power electronics circuits.
- To construct improved converter topologies for specific applications

**UNIT – I**

**Natural Commutated Converters**

**Hours: 9**


**UNIT – II**

**Cyclo-Converter and Voltage Controller**

**Hours: 9**

Principle of operation of cycloconverters - three phase to single phase - three phase to three phase - input and output performances - output voltage and frequency ranges - harmonics - pulse generation and controls for cycloconverter. Introduction to bi-directional switches - Single phase and three phase ac voltage controller - output voltage control – phase angle range – per unit plot for various loads - input and output performance - gating requirements – harmonics.

**UNIT – III**

**Forced Commutated Converters**

**Hours: 9**


**UNIT – IV**

**Modulation Techniques**

**Hours: 9**


**UNIT – V**

**High Power Applications**

**Hours: 9**

High power converters - higher pulse operation - series connected – parallel connected converters - high power inverters - phase shifted operation – parallel connected – cascaded connected inverters – inverters with/without transformer –design of high power converters and inverters. Introduction to multilevel inverters - diode clamped, flying capacitor, cascade type multilevel inverters - comparison of multilevel inverters – applications

**Total contact Hours: 45**

**Total Tutorials: 15**

**Total Practical Classes: 15**

**Total Hours: 60**

**Text Books:**

**Reference Books:**
### Course Code: EE153

**Course Name:** Solid State Controlled Electrical Drives

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**Prerequisite:**

**Objectives:**

- To learn converter and chopper control of dc drives
- To learn the concept of closed loop control of AC and DC drives
- To learn about digital control of drives

**Outcome:**

- Ability to determine the characteristics of drives
- Ability to design converter fed dc drives and chopper fed dc drives
- Ability to design of closed loop control of drives

**UNIT – I**

**Speed Control of DC Motors**

Industrial motor drive requirements - typical load torque speed curves – energy savings - variable speed drives - load dynamics and modeling - load type and duty ratio - motor choice - speed control principles - constant torque - constant power – multi quadrant operations.


**UNIT – II**

**Design of Controller and Converter for DC Drives**


**UNIT – III**

**Speed Control of Induction Motor–Stator Side**

Comparison of different ac power controllers – principles of speed control – variable voltage - variable frequency operation – constant flux operation - constant power operation – speed control of VSI and CSI fed drives - design examples. Closed loop control schemes - dynamic and regenerative braking - speed reversal – tracing of critical waveforms - effect of non- sinusoidal supply.

**UNIT – IV**

**Speed Control of Induction Motor–Rotor Side**


**UNIT – V**

**Speed Control of Synchronous Motor Drives**

Need for leading PF operation - open loop VSI fed drive – group drive applications. Self-control – margin angle control - torque angle control - power factor control -simple design examples Closed loop speed control scheme with various power controllers - starting methods– brush less excitation systems

**Total contact Hours:** 45

**Total Tutorials:** 15

**Total Practical Classes:**

**Total Hours:** 60

**Text Books:**


**Reference Books:**

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**Prerequisite**

**Objectives**

To provide a practical understanding of some of the concepts learnt in the theory course on electrical Drives.

**Outcome**

The Students would have gained practical experience about some of the Theoretical concepts learnt in the electrical Drives.

**List of Experiments:**

Design and validation of solid state systems choosing any ten systems as listed below

1. Firing Pulse Generation Schemes for Two Pulse and Six Pulse Converters
2. Power Factor Improvement Methods
3. Higher-Pulse Converters
4. Thyristor Controlled Reactor
5. Thyristor Switched Capacitor
6. Thyristor Controlled Series Compensator
7. Three/Six Phase Delta Connected Thyristor Controlled Reactor
8. Static Tap Changing of Transformer
9. DC-DC Converters
10. Three Phase Voltage Source Inverter
11. Single Phase Sinusoidal PWM Inverter
12. Multi-Level Inverters
**Department:** Electrical and Electronics Engineering  
**Programme:** M.Tech. (Electrical Drives and Control)  
**Semester:** Two  
**Category:** TY

**Subject Code:** EE155  
**Subject:** Digital Control and Controller Design

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**Prerequisite:** Modern Control Theory

**Objectives:**
- Basics of digital control systems
- The modeling of digital control system using state space approach
- The analysis of digital control system for controllability and observability
- The design of controllers using classical and state space approaches
- The stability of dynamic systems using Liapunov method
- To formulate the optimal control problems and solve them

**Outcome:**
- Understand the digital control concepts
- Model any sampled data system using state space approach
- Analyze the discrete time systems for controllability, observability and stability
- Design classical and pole placement controller and observer for systems modeled in state space
- Solve discrete time optimal control problems

**UNIT – I**  
**Introduction**  
Hours: 9


**UNIT – II**  
**State Variable Technique**  
Hours: 9

State equations of discrete time systems – solution of state equation – state transition matrix, its properties – state space realization and state diagram – pulse transfer function from state equation - characteristic equation - Eigen values -Eigen vectors - Similarity transformation – transformation into various canonical forms.

**UNIT – III**  
**Controllability, Observability and Stability**  
Hours: 9


**UNIT – IV**  
**Controller Design – I**  
Hours: 9


**UNIT – V**  
**Controller Design – II**  
Hours: 9


**Text Books:**

**Reference Books:**
### EE156 Vector Controlled AC Drives

**Prerequisite**: Solid State Controlled Electric Drives

**Objectives**
- To introduce vector control concepts
- To apply vector control techniques to various AC Drives

**Outcome**
- Ability to incorporate closed loop control techniques using d-q transformation for various power converter applications
- Ability to develop high performance closed loop controller for AC drives

**UNIT – I Dynamic Modelling of Induction Motor**

Dynamic modeling of induction machines- Dynamic d-q model, Axes transformation, Stationary a-b-c frame to d-q frame transformation, stationary d-q frame to synchronously rotating frame d-e transformation. Inverse transformations.


**UNIT – II Direct Vector Control of Induction Motor**

Principles of vector control- Scalar versus vector control, Vector control concept, DC motor analogy.

Direct vector control-FOC with rotor flux orientation, Flux vector estimation-voltage model and current model. Implementations using VSI and CSI, Direct vector control of line side PWM rectifier.

**UNIT – III Indirect and Stator Flux Oriented Vector Control of Induction Motor**

Indirect vector control –phasor diagram, flux and slip speed estimation, implementation for servo drive with open loop flux control, synchronous current control.

Stator flux oriented control, Vector control of CSI fed drives, vector control of cycloconverter drive.

**UNIT – IV Vector Control of Synchronous Motor Drives**

D-q axis (Park) model of synchronous machines; Vector control of Synchronous motors – Field weakening mode; Control strategies- constant torque angle control, Unity power factor control, Constant mutual flux control, Optimum torque per ampere control and flux weakening control; Implementation using CSI.

**UNIT – V Direct Torque Control**

Direct torque and Flux Control- Torque expression with stator and rotor fluxes, Control strategy, DTC of Induction motor using Direct self control and space vector modulation.

**Text Books**:


**Reference Books**:

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**Prerequisite**

To provide a practical understanding of some of the concepts learnt in the theory course on electrical Drives.

**Outcome**

The Students would have gained practical experience about some of the Theoretical concepts learnt in the electrical Drives.

**List of Experiments:**

Simulation study of following drive systems

1. Analysis of 1 phase angle controlled converter drives and case study on closed loop speed control.
2. Analysis of 3 phase angle controlled converter drives and case study on closed loop speed control.
3. Transfer function modelling of DC motor and design of speed and current loop feedback controllers.
4. Analysis of DC chopper drives and case study on closed loop speed control.
5. V/f control of PWM inverter based three phase Induction motor.
6. V/f control of three phased Induction motor using Cyclo-converters
9. Modeling of three Phase Square cage Induction Motor
10. Direct vector control of Induction Motor.

*Demonstration Experiments*

1. Study of single phase Half controlled converter fed DC motor.
2. Study of three phased Inverter fed induction motor drives
Subject code: EE158
Subject: Research Methodology

Objectives:
- To educate students to methods of selection of research problems
- To expose students to different research methods

Outcomes:
- Students will be capable to identify and narrow down to the area of research on the basis the requirements of industrial and global requirements
- Students will exhibit the domain skill to choose suitable research methods to execute research effectively
- Students will possess knowledge to further their academic program, namely, Ph.D program.

- Characteristics of research: Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach.
- Types of research: Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches.
- Research procedure: Formulating the Research Problem, Literature Review, Developing the objectives, Preparing the research design including sample. Design, Sample size.
- Considerations in selecting research problem: Relevance, interest, available data, choice of data, Analysis of data, Generalization and interpretation of analysis.

Reference books:
1. Dawson, Catherine, Practical Research Methods, UBS Publishers and Distributors, New Delhi, 2002
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**Prerequisite**

**Objectives**
To develop a solution to existing problem in Electric Drives and Control

**Outcome**
The students can able to perform literature survey, indentify a problem and solve it

**Description:** An individual project needs to be performed by each student under a supervisor. Specific research problem needs to be identified through detailed literature survey. The theoretical/simulation study needs to be carried out. The results along with the literature survey have be submitted as a report.
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**Prerequisite**

- To develop an additional solution or further improvement to the problem identified in Phase-I

**Objectives**

- The students can able to compare their results with the state of the art contributions.
- Can provide improvements, perform an application specific design and development of proto-type models

**Outcome**

**Description:** The problem identified in the Phase-I may be further investigated. The improved solution may be provided. The prototype system may be developed with appropriate design. A separate report needs to be submitted.
SYLLABUS (Elective Subjects)
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<tr>
<td>EEE51</td>
<td>Adaptive Control Theory</td>
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</table>

### Prerequisite

- To understand the basics of adaptive control
- To understand the concept of model reference adaptive systems
- To know the adaptation mechanisms such as auto-tuning and gain scheduling
- To know few applications of adaptive control

### Objectives

- Understands the model reference adaptive systems
- Know the auto-tuning and gain scheduling methods
- Understands the applications of adaptive control concepts to physical systems

### Outcome:

- Understands the model reference adaptive systems
- Know the auto-tuning and gain scheduling methods
- Understands the applications of adaptive control concepts to physical systems

### UNIT – I  Modelinng and Simulation


### UNIT – II Identification Technique

- Off-line, on line methods. Least square, fixed memory, maximum likelihood. Instrument variable. Stochastic approximate method.

### UNIT – III MRAS & STC

- Introduction, the gradient approach, MIT rule Liapunov Functions. Control policies. Pole placement control, minimum variance control, Predictive control.

### UNIT – IV Auto-Tuning and Gain Scheduling


### UNIT – V Applications and Expert Control


<table>
<thead>
<tr>
<th>Total contact Hours: 45</th>
<th>Total Tutorials: 15</th>
<th>Total Practical Classes:</th>
<th>Total Hours: 60</th>
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### Text Books:


### Reference Books:

**Subject Code**: EEE52  
**Subject**: Advanced Digital Signal Processing

<table>
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<th>Credit</th>
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<td>3</td>
<td>1</td>
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</table>

**Prerequisite**: 
- To understand the concepts of digital signals and systems
- To understand the design of digital filters
- To know the concept of adaptive filters and to know its applications
- To understand the concept of sampling rate alteration
- To study and understand the different Digital signal processors.

**Objectives**

- Analyze and classify the digital signals and systems.
- Design digital filters, adaptive filters
- Do sampling rate alterations
- Understand and choose different digital signal processors for electrical control applications

**Outcome**

- Analyze and classify the digital signals and systems.
- Design digital filters, adaptive filters
- Do sampling rate alterations
- Understand and choose different digital signal processors for electrical control applications

**UNIT – I  **  
**Discrete Time Signals**  
**Hours**: 9


**UNIT – II  **  
**Digital Filter Design**  
**Hours**: 9

Design of IIR filter. filter structures. Design from analog filter; Design of FIR filters - structures. windowing - Design examples.

**UNIT – III  **  
**Adaptive Digital Filters**  
**Hours**: 9

Adaptive filters. Examples of Adaptive filtering. The minimum mean square error criterion; The Widrow and Hoff LMS Algorithm. Recursive least square Algorithm. Applications

**UNIT – IV  **  
**Application of Sampling Rate Alteration**  
**Hours**: 9

The basic sample rate Alteration Devices-Filters with sampling rate Alteration systems, Multistage Design of Decimators and Interpolators. Arbitrating rate sampling rate converter. Poly-phase decomposition. digital filter design -Application.

**UNIT – V  **  
**Digital Signal Processors**  
**Hours**: 9

Digital signal processors. Introduction DSP processor memory Architecture. some example of DSP processors . pipelining - overview of TMS 320 family DSP processor. First generations TMS 320eix to sixth generation TMS 320cxb processor.

**Text Books:**

**Reference Books:**
2. Simon Haylaim and Barry van veen, Signals and systems, John wiley and sons India, 1998.
<table>
<thead>
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<th>Subject Code</th>
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<th>Maximum Marks</th>
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<td>EEE53</td>
<td>Diagnosis and Protection for Solid State Systems</td>
<td>3 1 0</td>
<td>4</td>
<td>40 60 100</td>
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</table>

**Prerequisite**
- To understand the basics of adaptive control
- To understand the concept of model reference adaptive systems
- To know the adaptation mechanisms such as auto-tuning and gain scheduling
- To know few applications of adaptive control

**Objectives**
- Understands the model reference adaptive systems
- Know the auto-tuning and gain scheduling methods
- Understands the applications of adaptive control concepts to physical systems

**Outcome**
- Understands the model reference adaptive systems
- Know the auto-tuning and gain scheduling methods
- Understands the applications of adaptive control concepts to physical systems

**UNIT – I**
**Protection and Fault Diagnosis of Converter Systems**


**UNIT – II**
**Protection and Diagnosis of Solid State Devices in Power Systems**

- Protections to solid state compensators/voltage regulator. TCR, TCS, SVC, TCSC, UPFC, solid state tap changer; Fault diagnosis through waveform/performance analysis of device failures, phase failures, sensor failures; Protection and fault diagnosis of filter. aging of passive components and detuning. auto tuning methods.

**UNIT – III**
**Protection and Fault Diagnosis of Solid State DC Drives**

- Protections to solid state DC drives. field failures, armature failures, commutator short/open, operations with converter/chopper failures. device, input source, filter component failures. Closed loop control failures. failure of controllers and limiters, sensor and references. Diagnosis of solid state dc drive systems faults - starting and braking.

**UNIT – IV**
**Protection And Diagnosis Of Solid State AC Drives**

- Protection to AC Machines - phase failures, slip-ring/brush failures, bearing failures; Effects of solid state converter/inverter systems failures of device, PWM modulators, input source, filter components - voltage/current ripple effects, closed loop failures: failure of controller. sensor - references. Diagnosis of solid state ac drive systems faults.

**UNIT – V**
**Protection And Diagnosis Of HVDC, UPS And Excitation Systems**

- Protection and faults in HVDC, UPS, Generator excitation systems: individual systems, multiple systems operating in parallel/series. redundancy - diagnosis of faults through characterization. Analysis of simple faults in complex solid state systems.

**Total contact Hours: 45**  **Total Tutorials: 15**  **Total Practical Classes:**  **Total Hours:60**

**Text Books:**

**Reference Books:**
<table>
<thead>
<tr>
<th>Subject Code</th>
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<tr>
<td>EEE54</td>
<td>Embedded Systems</td>
<td>3 1 0 4</td>
<td>40 60 100</td>
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</table>

**Prerequisite**

- To know the concept of embedded system
- To understand the architecture of embedded system
- To know the peripherals used in embedded system
- To know the concept of RTOS
- To know the Testing and validation of embedded system

**Objectives**

- Understands the architecture of embedded system
- Knows the peripherals used in embedded system
- Understands the performance metrics of RTOS
- Knows the testing and validation of embedded systems

**Outcome**

**UNIT – I**  
Introduction to Embedded Systems  
Introduction to embedded system - Definition and Classification – Overview of Processors and hardware units in an embedded system – Software embedded into the system – Exemplary Embedded Systems – Embedded Systems on a Chip (SoC).

**UNIT – II**  
Embedded System Architecture  

**UNIT – III**  
Embedded Computing Platform  

**UNIT – IV**  
Real Time Operating Systems  
Definitions of process, tasks and threads – I/O Subsystems – Interrupt Routines Handling in RTOS - RTOS Task scheduling models - Handling of task scheduling and latency and deadlines as performance metrics – Co-operative Round Robin Scheduling – Case Studies of Programming with RTOS.

**UNIT – V**  
Validation and Testing of Embedded Systems  

**Total contact Hours:** 45  
**Total Tutorials:** 15  
**Total Practical Classes:**  
**Total Hours:** 60

**Text Books:**


**Reference Books:**

Department : Electrical and Electronics Engineering
Programme: M.Tech. (Electrical Drives and Control)

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<th>Credit</th>
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<tr>
<td>EEE55</td>
<td>Flexible AC Transmission System Controllers</td>
<td>L  T  P  C  CA  SE  TM</td>
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<td></td>
<td></td>
<td>3  1  0  4  40  60  100</td>
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</table>

Prerequisite

Objectives

- To emphasize the need for FACTS controllers.
- To learn the characteristics, applications and modeling of series and shunt FACTS controllers.
- To analyze the interaction of different FACTS controller and perform control coordination.

Outcome

- Ability to design and develop different various VAR compensators for transmission systems.
- Able to identify optimum FACTS controller for specific application.

UNIT – I
Introduction

Review of basics of power transmission networks-control of power flow in AC transmission line- Analysis of uncompensated AC Transmission line- Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers.

UNIT – II
Static VAR Compensator (SVC)

Configuration of SVC- voltage regulation by SVC- Modelling of SVC for load flow analysis- Modelling of SVC for stability studies-Design of SVC to regulate the mid-point voltage of a SMIB system- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line.

UNIT – III
THYRISTOR AND GTO THYRISTOR CONTROLLED SERIES CAPACITORS (TCSC and GCSC)

Concepts of Controlled Series Compensation – Operation of TCSC and GCSCAnalysis of TCSC for load flow studies modeling TCSC and GCSC for stability studied- Applications of TCSC and GCSC.

UNIT – IV
Voltage Source Converter Based Facts Controllers


UNIT – V
Controllers and Their Coordination


Total contact Hours: 45  Total Tutorials: 15  Total Practical Classes:  Total Hours: 60

Text Books:


Reference Books:

Department: Electrical and Electronics Engineering  
Programme: M.Tech. (Electrical Drives and Control)  

<table>
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<th>Credit</th>
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<tr>
<td>EEE56</td>
<td>FPGA Based System Design</td>
<td>3 1 0 4 40 60 100</td>
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</table>

**Prerequisite**
- To know various programmable logic devices
- To understand the FPGA based system design
- To know the FPGA based combinational and sequential logic designs
- To know the FPGA based large scale systems

**Objectives**
- Understands various PLDs and its uses
- Ability to design FPGA based system
- Ability to design FPGA based combinational and sequential logic systems

**Outcome**
- Understands various PLDs and its uses
- Ability to design FPGA based system
- Ability to design FPGA based combinational and sequential logic systems

**UNIT – I**  
Introduction  
Hours: 9
Programmable Logic Devices-Types-PLA, PAL, FPGA-architectures, SRAM-based FPGAs, Permanently Programmed FPGAs, Chip I/O. Circuit Design of FPGA Fabrics. Architecture of FPGA Fabrics.

**UNIT – II**  
FPGA-Based Systems and VLSI Technology  
Hours: 9

**UNIT – III**  
Combinational Logic  
Hours: 9

**UNIT – IV**  
Sequentional Machines  
Hours: 9

**UNIT – V**  
Large Scale Systems  
Hours: 9

**Total contact Hours:** 45  
**Total Tutorials:** 15  
**Total Practical Classes:**  
**Total Hours:** 60

**Text Books:**

**REFERENCE BOOKS**
**Department**: Electrical and Electronics Engineering  
**Programme**: M.Tech. (Electrical Drives and Control)  
**Semester**:  
**Category**: TY  

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<td>EEE57</td>
<td>Fuzzy Control</td>
<td>3 1 0 4</td>
<td>40 60 100</td>
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</table>

**Prerequisite**
- To understand fuzzification and defuzzification
- To know the design of fuzzy logic control
- To study few design examples of fuzzy control
- To understand the applications of fuzzy logic to nonlinear analysis and identification of system
- To know the applications of fuzzy logic to adaptive and machine learning controls

**Objectives**
- Knows the concept of fuzzy logic, fuzzification and defuzzification methods
- Able to design fuzzy logic controllers
- Able to use fuzzy logic for nonlinear analysis and identifications
- Know the application of fuzzy logic to adaptive control

**Outcome**

**UNIT – I**  
Introduction  
Hours: 9  

**UNIT – II**  
Fuzzy Control  
Hours: 9  
Conventional Control System- Design. Fuzzy control system- choice of controller inputs and outputs, rule base using control knowledge, fuzzy quantification of knowledge, rule determination, converting decisions into actions.

**UNIT – III**  
Design Examples of Fuzzy Control  
Hours: 9  
The inverted pendulum-scaling-tuning membership functions-basic design guidelines, real time implementation issues-computational time, memory requirements, typical design example.

**UNIT – IV**  
Nonlinear Analysis, Identification and Estimation  
Hours: 9  
Parameterized fuzzy controllers, fuzzy-P, PI, PID controllers, Lyapunov stability Analysis -direct and indirect. Fuzzy identification, estimation- fitting functions to data, least squares method, gradient methods, clustering methods, and extraction of rules from data.

**UNIT – V**  
Adaptive and Supervisory Fuzzy Control  
Hours: 9  
Fuzzy model reference learning control (FMRLC)-reference model, fuzzy controller, learning mechanism, knowledge based modifiers, design and implementation, casestudy. Supervision of fuzzy controllers, tuning, gain scheduling, supervision of fuzzy control-rule based supervision-case study.

Total contact Hours: 45  
Total Tutorials: 15  
Total Practical Classes:  
Total Hours: 60

**Text Books:**

**Reference Books:**
Semester: Electrical and Electronics Engineering

Programme: M.Tech. (Electrical Drives and Control)

Subject Code: EEE58

Subject: Modern Power Electronic Converters

Prerequisite:

Objectives:
- To understand the design of SMPS
- To understand the operation of hard switched and soft switched converters

Outcome:
- Students can able to design SMPS specific to application.
- Students can able to analyse recent AC-DC, DC-AC, AC-DC converters

UNIT I
Switched Mode Power Supplies (SMPS)

Hours: 9

DC Power supplies and Classification; Switched mode dc power supplies - with and without isolation, single and multiple outputs; Pump circuits - developed, transformer type and super lift pumps; Luo converters - positive, negative and double output; SEPIC converter. Voltage-lift converters and Super lift converters - types and basic circuit operation. Closed loop control and regulation; Design examples on converter and closed loop performance.

UNIT II
AC-DC Converters

Hours: 9


UNIT III
DC-AC Converters

Hours: 9

Multi-level Inversion - concept, classification of multilevel inverters, Principle of operation, main features and analysis of Diode clamped, Flying capacitor and cascaded multilevel inverters; Modulation schemes, waveforms and harmonic content; Comparison of topologies – device stress, losses, component count and dc link voltage balancing. Z - Source converters; Active filters – topologies, operation and closed loop control.

UNIT IV
AC-AC Converters with and without DC Link

Hours: 9

Matrix converters – Basic topology of matrix converter; Commutation – current path; Modulation techniques - scalar modulation, indirect modulation; Matrix converter as only ac-dc converter; Vienna Rectifier – Principle of operation, main features and analysis, types and applications AC-AC converter with DC link - topologies and operation - with and without resonance link - converter with dc link converter; Performance comparison with matrix converter with DC link converters.

UNIT V
Soft-Switching Power Converters

Hours: 9

Power electronic converters – analysis and determination of power losses – loss reduction techniques; Soft switching techniques – ZVS, ZCS, ZVT, quasi resonance operation; Performance comparison hard switched and soft switched converters –ac-dc converter, dc-dc converter, dc-ac converter – ac-ac converter; Resonant dc power supplies - bidirectional power supplies; Introduction to concept of integrated topologies.

Total contact Hours: 45
Total Tutorials: 15
Total Practical Classes: 25
Total Hours: 60

Text Books:
3. Control in Power Electronics- Selected Problem, Marian P.Kazmierkowski,

Reference Books:
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<td>EEE59</td>
<td>Neural Networks</td>
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**Prerequisite**

- This paper exposes the student to the fundamental concepts of Neural Network architecture, algorithms and design.
- The capability and applicability of Neural Network based solutions for modeling, control and estimation would be covered.
- In the last unit the major applications of NN to power electronics and drives from literature is discussed.
- MATLAB based programming exercises and Simulink toolbox will be used.
- The knowledge and skill to build Neural network based systems would be covered in the course.

**Objectives**

- The student would acquire the knowledge to identify the suitable Neural architecture and learning algorithm to design NN based solutions.
- Implement the same for problems in Electrical Drives and Control.

**Outcome**

- **UNIT – I Introduction**
  - Hours: 9
  - Introduction – Biological neural network – Artificial Neural network – comparison, motivation and Development.
  - Neuron model – single / multiple inputs, transfer functions.

- **UNIT – II Supervised Learning**
  - Hours: 9
  - Learning mechanism – supervised learning – multiplayer perceptrons for pattern classification and function approximation.
  - The back propagation algorithm – numerical examples.
  - Drawbacks in Back propagation – Momentum method, variable learning rate, Levenburg Marguardt Algorithm.
  - Other supervised learning methods – supervised Hebb’s rule, Widrow Hoff learning rule – Adaline network.

- **UNIT – III Associative Networks**
  - Hours: 9

- **UNIT – IV Competitive & Self Organizing Networks**
  - Hours: 9
  - Adaptive resonance theory – ART1; architecture, algorithm.

- **UNIT – V Applications to Electrical Drives and Control**
  - Hours: 9
  - Filtering using Neural Networks.
  - Choice of Neural architectures and training algorithms for the various applications.

**Total contact Hours:** 45  |  **Total Tutorials:** 15  |  **Total Practical Classes:**  |  **Total Hours:** 60

**Text Books:**


**Reference Books:**

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<th>Department</th>
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<td>M.Tech. (Electrical Drives and Control)</td>
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| Semester : | Category : TY |

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<td>EEE60</td>
<td>Nonlinear Control Systems</td>
<td>3 1 0 4</td>
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<table>
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<th>Prerequisite</th>
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- To understand the different nonlinearities and their characteristics
- To analyze the stability analysis of non-linear system using Lyapunov method
- To know the different methods of linearization of nonlinear systems
- The analysis of nonlinear systems using phase plane and describing function methods

<table>
<thead>
<tr>
<th>Objectives</th>
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- Identify different nonlinearities of physical systems
- Analyze the stability of nonlinear systems
- Linearize nonlinear systems
- Analyze nonlinear systems using phase plane analysis and describing function methods

<table>
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<table>
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<tr>
<th>UNIT – I</th>
<th>Properties of Nonlinear Systems</th>
<th>Hours: 9</th>
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<tr>
<td></td>
<td>Basic mathematical and structural models of nonlinear systems – basic properties of nonlinear systems - Stability and Equilibrium States – basic properties of nonlinear functions - Typical Nonlinear Elements – basic nonlinearity classes.</td>
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<tr>
<th>UNIT – II</th>
<th>Stability</th>
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<th>UNIT – III</th>
<th>Linearization Methods</th>
<th>Hours: 9</th>
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<th>UNIT – IV</th>
<th>Phase Trajectories</th>
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<td></td>
<td>Operating Modes of Nonlinear Control Systems - Self-Oscillations – Forced Oscillations - Effects of High-Frequency Signal-Dither - Methods of Dynamic Analysis of Nonlinear Systems - Phase Plane - Phase Trajectories of Linear and Nonlinear Systems - Methods of Defining Phase Trajectories - Examples of Application of Various Methods to obtain Phase Trajectories</td>
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<tr>
<th>UNIT – V</th>
<th>Dynamic Analysis of Non-Linear Control Systems</th>
<th>Hours: 9</th>
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<th>Total Hours:60</th>
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**Department**: Electrical and Electronics Engineering  
**Programme**: M.Tech. (Electrical Drives and Control)  
**Semester**:  
**Category**: TY  

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<th>Credit</th>
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<tbody>
<tr>
<td>EEE61</td>
<td>Optimal Control Theory</td>
<td>L</td>
<td>3</td>
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</table>

**Prerequisite**: Modern Control Theory

**Objectives**

- To know the formulation of optimal control problems
- To understand the method of dynamic programming
- To know the concept of functional and constrained optimization problems
- To know the pontryagin’s principle and to solve regulator problem
- The numerical methods to solve optimal control problems

**Outcome**

- Ability to Formulate optimal control problems
- Ability to Solve optimal control problems using dynamic programming
- Ability to Solve minimum time/minimum control effort problems
- Ability to Solve optimal control problem using numerical methods

**UNIT – I**  
**Performance Measure**  

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<th>Hours: 9</th>
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**UNIT – II**  
**Dynamic Programming**  

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<th>Hours: 9</th>
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**UNIT – III**  
**Calculus of Variations**  

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<th>Hours: 9</th>
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**UNIT – IV**  
**Variational Approach to Optimal Control Problem**  

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<th>Hours: 9</th>
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**UNIT – V**  
**Numerical Methods of Optimal Control**  

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<thead>
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<th>Hours: 9</th>
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**Total contact Hours**: 45  
**Total Tutorials**: 15  
**Total Practical Classes**:  
**Total Hours**: 60

**Text Books**:


**Reference Books**:

Department : Electrical and Electronics Engineering  
Programme: M.Tech. (Electrical Drives and Control)

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<td>Subject Code</td>
<td>Subject</td>
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<tr>
<td>EEE62</td>
<td>Power Electronics in Power Systems</td>
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Prerequisite

<table>
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<th>Objectives</th>
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<tbody>
<tr>
<td>• To study about reactive power compensators and the different VAR compensators</td>
</tr>
<tr>
<td>• To study the Applications of converters in HVDC systems</td>
</tr>
</tbody>
</table>

Outcome

| Ability to determine the characteristics of different types of VAR compensators |
| Ability to design different types of converters models for HVDC system based on LFA |

UNIT – I Reactive Power Requirements  
Hours: 9


UNIT – II Reactive Power Compensation and Regulation  
Hours: 9


UNIT – III Static Compensators and Components  
Hours: 9


UNIT – IV Design Of UPFC and Static Tap Changers  
Hours: 9


UNIT – V HVDC AND Static Generator Excitation Systems  
Hours: 9

HVDC components - kinds of DC links – modern HVDC converters – commutation issues - control characteristics – constant phase angle control – constant current and extinction angle control - twelve and higher pulse operation - introduction to modern converters – protections - reactive power requirements – harmonics – filter types and design of various ac and dc filters. Solid state excitation of synchronous generators – different schemes – Generator excitation systems – redundancy and reliability.

Text Books:


Reference Books:

Department: Electrical and Electronics Engineering  
Programme: M.Tech. (Electrical Drives and Control)  

<table>
<thead>
<tr>
<th>Subject Code</th>
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<th>Credit</th>
<th>Maximum Marks</th>
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<tr>
<td>EEE63</td>
<td>Power Quality</td>
<td>3 L 1 T 0 P 4 C</td>
<td>40 CA 60 SE 100 TM</td>
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</table>

Prerequisite

Objectives

- To study the power quality problems in grid connected system and isolated systems
- To study the various power quality improvement techniques.
- To study about the various harmonics elimination methods.

Outcome

- Ability to apply knowledge of power quality and harmonics in power systems and engineering to the analysis and design of electrical circuits
- Ability to design a system, components or process to meet desired needs within realistic constraints and to mitigate PQ problems such as economic, environmental, social, ethical, health and safety.
- Ability to function on multi-disciplinary teams.

UNIT – I  
Introduction  
Hours: 9

Introduction - Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage Imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage - Power quality standards.

UNIT – II  
Non-Linear Loads  
Hours: 9

Single phase static and rotating AC/DC converters, Three phase static AC/DC converters, Battery chargers, Arc furnaces, Fluorescent lighting, pulse modulated devices, Adjustable speed drives.

UNIT – III  
Measurement and Analysis Methods  
Hours: 9

Voltage, Current, Power and Energy measurements, power factor measurements and definitions, event recorders, Measurement Error - Analysis: Analysis in the periodic steady state, Time domain methods Frequency domain methods: Laplace's, Fourier and Hartley transform - The Walsh Transform - Wavelet Transform.

UNIT – IV  
Analysis and Conventional Mitigation Methods  
Hours: 9

Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion.  
On-line extraction of fundamental sequence components from measured samples - Harmonic Indices - Analysis of voltage sag: Detorit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI) - Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop balancing, Closed loop balancing current balancing, Harmonic reduction, Voltage sag reduction.

UNIT – V  
Power Quality Improvement  
Hours: 9

Utility-Customer interface - Harmonic filters: passive, Active and hybrid filters - Custom power devices:  
Custom power park – Status of application of custom power devices.

Total contact Hours: 45  
Total Tutorials: 15  
Total Practical Classes:  
Total Hours: 60

Text Books:


Reference Books:

## Subject: Wind Energy Conversion Systems

**Subject Code:** EEE64  
**Hours / Week:** 3  
**Credit:** 1  
**Maximum Marks:** 4

### Prerequisite

To study the wind energy conversion systems in detail  
To study the application of power converters for wind electric systems.  
To study the concept of PV technology and its application to the generation of electricity

### Objectives

- To study the wind energy conversion systems in detail
- To study the application of power converters for wind electric systems.
- To study the concept of PV technology and its application to the generation of electricity

### Outcome

- Ability to investigate the performance of wind and PV systems
- Ability to design the power converters for grid connected and off grid applications

### UNIT – I  
**Introduction**  
**Hours:** 9


### UNIT – II  
**Aerodynamics of Wind Turbines**  
**Hours:** 9

Aerodynamics of aerofoil: lift; drag; stall; actuator disc concept; momentum theory and Betz coefficient; wind turbine blade; effect of stall and blade, turbulence and wakes - Site selection - Wind speed and direction measurements.

### UNIT – III  
**Performance of Wind Turbines**  
**Hours:** 9


### UNIT – IV  
**Grid Connected Wind Energy Systems**  
**Hours:** 9


### UNIT – V  
**Stand-Alone Wind Energy Systems**  
**Hours:** 9

Self-excitation process- effect of excitation capacitance equivalent circuit - voltage and frequency control techniques - power flow studies -- power quality issues - Direct Drive Generators- Small wind hybrid systems – Energy Storage – Batteries – Fuel Cells

**Total contact Hours:** 45  
**Total Tutorials:** 15  
**Total Practical Classes:**  
**Total Hours:** 60

### Text Books:


### Reference Books:

**Department**: Electrical and Electronics Engineering  
**Programme**: M.Tech. (Electrical Drives and Control)  

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>EEE65</td>
<td>Special Electrical Machines</td>
<td>3 1 0 4</td>
<td>40 60 100</td>
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<table>
<thead>
<tr>
<th>Prerequisite</th>
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| • Understand the Construction and principle of operation and performance of various single phase machines.  
• Understand the Construction and principle of operation and performance of stepper motor and switched reluctance motor |

<table>
<thead>
<tr>
<th>Objectives</th>
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| • The students are expected to understand the principle, construction operation and performance characteristic of various special machines  
• Students will be capable of carrying out projects work in the field for different analysis. |

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<th>Outcome</th>
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| • The students are expected to understand the principle, construction operation and performance characteristic of various special machines  
• Students will be capable of carrying out projects work in the field for different analysis. |

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<thead>
<tr>
<th>UNIT – I</th>
<th>Single Phase Machines</th>
<th>Hours: 9</th>
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<tr>
<th>UNIT – II</th>
<th>Stepper Motors</th>
<th>Hours: 9</th>
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<tbody>
<tr>
<td>Constructional features - Principle of operation - Modes of excitation – Types of motors – Drive systems and circuit for control of Stepper motor – Applications Dynamic characteristics.</td>
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<th>UNIT – III</th>
<th>Switched Reluctance Motors</th>
<th>Hours:</th>
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<tr>
<td>Constructional features - Principle of operation - Torque prediction – Power controllers - Characteristics and control - Applications.</td>
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<th>UNIT – IV</th>
<th>Permanent Magnet Brushless DC Motors</th>
<th>Hours: 9</th>
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<tr>
<td>Commutation in DC motors - Difference between mechanical and electronic commutators - permanent magnet brushless motor drives - Torque and EMF equation; Torque-Speed characteristics; Sensors - Controllers; Applications.</td>
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<th>UNIT – V</th>
<th>Three Phase AC Machines</th>
<th>Hours: 9</th>
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