Department of Electrical Engineering
Syllabus Structure for
Third Year B.Tech (Electrical Engineering) 2015-16

Approved By BOS
Electrical Engineering

On 23rd January, 2015

Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute)
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Total Credits: 26, Total Contact Hours: 30 Hrs.
ISE: In Semester Evaluation        ESE: End Semester Examination
### Third Year U.G. Program in Electrical Engineering
#### Semester VI

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**Total Credits:** 27, **Total Contact Hours:** 31 Hrs.

ISE: In Semester Evaluation  
ESE: End Semester Examination

* Classes to be conducted on Zero hours.
Teaching Scheme: Lecture: 3 hours/week, Tutorial: - 1 hour / Week
Exam Scheme: Paper: 100 Marks (ISE 20 + MSE 30 + ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Define electric and magnetic fields according to their force effect.
2. Understand the physical meanings of the differential equations for electrostatic and magneto static fields
3. Calculate the electric field from the stationary charge distributions and magnetic fields from steady current distributions
4. Describe and use simple models of electric and magnetic field interactions with materials
5. Explain the concept of electromotive force, Maxwell's equations and their physical meanings
6. Analyze energy transportation and wave propagation in an electromagnetic field.

Unit I: Scalars and Vectors
Scalar and vector fields, coulomb’s law and concept of electric field, divergence, the divergence theorem and gauss’ law, concept of electrostatic potential, Poisson’s equation

Unit II: Electrostatics
Energy in the field, capacitance - capacitance of common two-plate capacitors, including two-wire capacitors, dielectrics, dielectric boundary conditions, solution of Laplace’s equation and Poisson’s equation in 1-d. Capacitance, calculations with multiple dielectrics

Unit III: Magneto statics
Force due to a magnetic field, force due to combined electric and magnetic fields, biot-savart law, calculation of magnetic field for simple coil configurations, ampere’s law, magnetic flux, stokes theorem, magnetic materials, magnetic boundary conditions, inductance calculations for common geometries, force on a dipole.

Unit IV: Slowly Time-Varying Systems
Frames of reference and motional emf, faraday’s law, stored energy in the magnetic field, inductance equation, examples from electric machines and transformers.

Unit V: Time-Varying Fields 1
Displacement current, Maxwell’s equation, wave equation in 1-dimension, solution of the wave equation, plane waves, wave propagation in vacuum and lossy dielectrics.

Unit VI: Time-Varying Fields 2
Skin depth and frequency dependence of lumped elements, energy transport by waves, the poynting vector, reflection at boundaries, normal incidence formula and impedance matching.
Texts and References:

2) Antenna and Wave Propagation, K. D. Prasad, SatyaPrakashan
3) Electromagnetic field theory fundamental, Guru and Hizirogli, Thomson Publication
4) Electromagnetic, J.D. Kraus, McGraw Hill, 4th Edition
5) Electromagnetic Engineering, Ryder
T.Y. B. Tech (ELECTRICAL ENGINEERING)-PART I (SEM - V)
Course Code - EE3031: Power Electronics

**Teaching Scheme:** Lecture: 3 hours/week, Tutorial: - 1 hour / Week
**Exam Scheme:** Paper: 100 Marks (ISE 20 + MSE 30 + ESE 50)

**Course Outcomes:**
On successful completion of this course the students will be able to:

1. Understand the behavior of semiconductor devices operated as power switches.
2. Explain operation, waveform and performance parameters of phase controlled converters, uncontrolled rectifiers.
3. Analyze and design ac-to-dc converters.
4. Explain operation of DC-DC converters, their types.
5. Explain the basic topologies of DC-DC converters analyze and design dc-to-dc converters.
6. Explain different modulation techniques of pulse width modulated inverters and to understand the harmonic reduction methods. Analyze and design dc-to-ac inverters.
7. Explain operation of AC voltage controller
8. Simulate, analyze and design power electronic circuits using MATLAB software.
9. Apply the electronic devices for conversion, control and conditioning of power.

**Unit I: Power Semi-Conductor Devices and Commutation Circuits** 06
Power Diodes, Thyristors – Silicon Controlled Rectifiers (SCR’s), BJT, Power MOSFET, Power IGBT and their characteristics and other thyristors, Basic theory of operation of SCR, Static characteristics, Turn on and turn off methods, Dynamic characteristics of SCR, Turn on and Turn off times, UJT firing circuit, Series and parallel connections of SCR’s Line Commutation and Forced Commutation circuits.

**Unit II: Diode Rectifiers** 06

**Unit III: Controlled Converters** 06

**Unit IV: DC – DC Converters** 06
Introduction, Principle of step – down operation, Step down converter with RL load, Principle of Step-Up Operation, Performance Parameters, Converter Classification, Switched mode Regulators-Buck, Boost, Buck-Boost and Cuk Regulators, voltage control methods, Multi output

**Unit V: Inverters 06**
Principle of operation, Performance Parameters, Single Phase Bridge Inverter, three-phase- six step (120/180 degree mode of operation), Voltage control, PWM techniques, Introduction to three level inverters, applications of VSI, current Source Inverter, advantages, applications of CSI. Numerical expected.

**Unit VI: AC Voltage Controller and Cycloconverters and applications 06**
Higher applications – regulated power supply, UPS, solid-state motor starters, static circuit breakers, HVDC systems, reactive power compensation. Power control in metallurgical and chemical processes, illumination etc.

**Text Books:**

**Reference Books:**
1) Power Electronics – by Vedam Subramanyam, New Age International (P) Limited, Publishers
7) B.W.Williams, “Power Electronics”, John Willey.
Course Code - EE3051: Power System Stability and Control

Teaching Scheme: Lecture: 3 hours/week, Tutorial: - 1 hour / Week
Exam Scheme: Paper: 100 Marks (ISE 20 + MSE 30 + ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Classify the different types of faults occurring in Power Systems.
2. Distinguish between the types of faults using mathematical tools
3. Interpret the necessity of governor systems and Automatic Generation control.
4. Explain the Steady state and dynamic response of and isolated Power systems
5. Deduce the Equal-Area criterion for transient stability & analyze the economic dependency of Power system operation to system constraints and the Generator Cost

Unit I: Symmetrical fault analysis 06
Short circuit transients on transmission line, short circuit currents and reactance of a Synchronous Machine, Internal voltages of loaded Synchronous machine under transient Conditions

Unit II: Symmetrical Components 06
Fundamentals of Symmetrical Components, sequence impedances and sequence networks of Synchronous machine, star connected loads, transmission lines and transformer.

Unit III: Unsymmetrical fault analysis 06
Analysis of Single Line to Ground (LG) fault, Line-To-Line (LL) fault, Double-Line-To- Ground (LLG) fault, One conductor open fault, Two conductors open fault

Unit IV: Power System Control 06
Load frequency control (Single and two area), modeling of Generator, Governor, prime mover, Load, Load frequency control and economic dispatch, Automatic generation control, Steady state analysis and dynamic response of an isolated power system, Automatic voltage control, reactive power control.

Unit V: Optimal Power System Operation 06
System constraints, Generator operating cost, Input-output and incremental fuel characteristics of a generating unit, optimal operation of generators on a bus bar, algorithm and flow chart for optimal power flow study, optimal unit commitment, spinning reserve, thermal and hydro constraints
**Unit VI: Power System stability**

Dynamics of Synchronous machine, Swing equation for single machine connected to infinite bus, Steady state stability and transient state stability, Equal area criterion, Numerical solution of swing equation, factors affecting transient stability, methods for improving stability of system. Voltage stability analysis, mathematical formulation, voltage collapse

**Text Books:**
4) Power systems Analysis by D.Das, New Age International Publishers.

**Reference Books:**
2) Power System Analysis by A.R. Bergen and Vijay Vittal, 2nd edition, Pearson Education
Course Code - EE3071: Feedback Control Systems

Teaching Scheme: Lecture: 3 hours/week, Tutorial: - 1 hour / Week
Exam Scheme: Paper: 100 Marks (ISE 20 + MSE 30 + ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. identify the basic elements and structures and demonstrate an understanding of the fundamentals of feedback control systems.
2. represent the mathematical models of any physical systems such as: state space, transfer function
3. determine the response of different order systems for various standard signals.
4. interpret and analyse time domain and frequency domain systems
5. relate the common physical non-linearities in the system.
6. develop, analyse and interpret the models in virtual environment – MATLAB.

Unit I: Introduction to Control Engineering 06
Feedback principle, examples of open-loop and closed-loop systems, Classification of feedback control systems, Effects of feedback.

Unit II: Components of Control Systems 06
Modeling of elements of control systems- AC/DC servo motor, synchro, tacho generator, stepper motor.

Unit III: Modeling of Systems and Their Representations 06
Transfer function of typical control-system devices. Block diagram, Signal flow graphs, State-variable representation and state-diagram. Different Canonical forms, Controllability, Observability. MATLAB assignments.

Unit IV: Time Domain Analysis 06
Servo specifications in time domain, type 0, 1, 2 systems and error coefficients. Stability: Routh Hurwitz Criterion. Root locus techniques. MATLAB assignments

Unit V: Frequency Response Analysis-I 06
Correlation between Time Response and Frequency Response, Graphical representation- Bode plot and relative stability criteria, Stability, Gain Margin and Phase Margin via Bode plots and Using MATLAB.

Unit VI: Frequency Response Analysis-II 06
Polar plots and Nyquist stability criterion, Nichols chart, Stability: Gain Margin and Phase Margin via Polar and Nyquist plot. MATLAB assignments.
Text Books:

Reference Books:
1) Basic Control Systems Engineering, Paul H. Lewis & Chang Yang, Pentice Hall
3) Modern Control system, Dorf and Bishop, 8th Edition Adison Wesley Longman 1998.
T.Y. B. Tech (ELECTRICAL ENGINEERING)-PART I (SEM - V)

Course Code - EE3091: Microprocessors and Microcontrollers

Teaching Scheme: Lecture: 3 hours/week, Tutorial: - 1 hour / Week
Exam Scheme: Paper: 100 Marks (ISE 20 + MSE 30 + ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. describe the architecture of microprocessor and microcontroller
2. write assembly language programs for 8085.
3. explain a typical I/O interface and to discuss timing issues.
4. identify instruction addressing modes and syntax for 8051.
5. create an assembly language or C program for 8051 that performs a prescribed task.
6. design and implement a microcontroller-based embedded system.

Unit I: Architecture of Microprocessor
General definitions of mini computers, microprocessors, micro controllers and digital signal processors. Overview of 8085 microprocessor. Internal architecture of 8085.

Unit II: Assembly language of 8085
Description of Instructions. Assembly directives. Assembly software programs with Algorithms of 8085.

Unit III: Interfacing with 8085
Interfacing with RAMs, ROMs along with the explanation of timing diagrams. Interfacing with peripheral ICs like 8255, 8279, 8259, etc. Interfacing with key boards, LEDs, LCDs, ADCs, and DACs etc.

Unit IV: Architecture of Micro controllers
Overview of the architecture of 8051 microcontroller, 8051 pin diagram.

Unit V: Assembly language of 8051
Description of Instructions. Assembly directives. Assembly software programs with Algorithms of 8051. Use of assembler and C.

Unit VI: Applications of 8051
Interfacing with keyboards, LEDs, 7 segment LEDs, LCDs, Interfacing with ADCs. Interfacing with DACs, etc.

Text Books:
References:


Course Code - EE3511: Power Electronics Lab

Teaching Scheme: Practical: 2 hours/week
Exam Scheme: Practical: 100 Marks (ISE 50+ ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Understand the behavior, turn on & turn off schemes of semiconductor devices operated as power switches.
2. Analyze, sketch, examine waveforms, and calculate, measure performance factors of output of ac-to-dc converters.
3. Analyze, sketch, examine waveforms, and calculate, measure performance factors of output of dc-to-dc converters.
4. Analyze, sketch, examine waveforms, and calculate, measure performance factors of output of dc-to-ac inverters.
5. Simulate, analyze and design power electronic circuits using MATLAB software.

List of Experiments:
1. Study of Characteristics of SCR, MOSFET & IGBT.
2. Gate firing circuits for SCR’s (R, RC, UJT, ramp and pedestal.)
6. Three Phase half controlled bridge converter with R-load.
7. Three Phase half wave controlled converter with R-load.
11. Single Phase AC Voltage Controller with R and RL Loads in MATLAB / SIMULINK.
12. Single Phase Half controlled converter with R load in MATLAB / SIMULINK.
13. Three Phase half controlled bridge converter with R-load in MATLAB / SIMULINK.
T.Y. B. Tech (ELECTRICAL ENGINEERING)-PART I (SEM - V)

Course Code - EE3531: Feedback Control System Lab

Teaching Scheme: Practical: 2 hours/week
Exam Scheme: Practical: 100 Marks (ISE 50 + ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Find the mathematical model of different electromechanical systems.
2. Model any given electrical, mechanical system.
3. Select appropriate feedback signals, synthesis feedback gains, and analyse their results and Deduce the first and second order responses
4. Draw the root locus and analyse the system
5. Plot the bode plot, polar and Nyquist plot and analyse frequency domain
6. Represent the system in state space and determine controllability and observability

List of experiments:
1. Modeling of DC Motor:
   A} Armature controlled
   B} Field controlled
2. T.F. of AC Servomotor & Speed-Torque characteristics
3. DC Position Control system
4. Synchro Transmitter-Receiver
5. Stepper Motor
6. First order and second order system
7. Root Locus Plot
8. Bode Plot
9. Polar & Nyquist Plot
10. State Space Representation - Controllability & Observability
Teaching Scheme: Practical: 2 hours/week
Exam Scheme: Practical: 100 Marks (ISE 50 + ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. create a template program, compile it, and then build the executable file.
2. examine the effects of executing many of the 8085 and 8051 instructions by tracing the
   execution of a program in CodeView and Keil for microprocessor and microcontroller
   respectively.
3. write their own program in assembly language for 8085 and 8051.
4. write the steps they go through to perform their tasks.
5. apply their programming knowledge (assembly and C) for real time applications.

List of experiments:
1. Arithmetic and Logical operations using 8085.
2. Data Transfer operation using 8085.
4. Programs on finding largest/smallest number using 8085.
5. Parallel port interfacing using 8255.
6. ADC/ DAC Interfacing using 8085.
7. Arithmetic and Logical operations using 8051.
8. Programs on ascending/descending order using 8051.
9. Programs on LED / 7-Segment display / LCD interfacing.
10. DC motor interfacing using 8051.
T.Y. B. Tech (ELECTRICAL ENGINEERING)-PART I (SEM - V)

Course Code - EE3571: Seminar

Teaching Scheme: Practical: 2 hours/week
Exam Scheme: Practical: 100 Marks (ISE 100)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Improve presentation and documentation skills.
2. Apply theoretical knowledge to industrial problems and research assignment.
3. Help contribute in analyzing, planning, and synthesizing problems in Electrical engineering.

Guidelines:
• Each student is expected to give a seminar on a topic of current relevance in Electrical Engineering.
• They have to refer published papers from standard journals
• The seminar report must not be the reproduction of the original papers.
T.Y. B. Tech (ELECTRICAL ENGINEERING)-PART I (SEM - V)

Course Code - SH3511: Professional Skills Development – II (Lab Course)

Teaching Scheme: Practical: 2 hours/week
Exam Scheme: Practical: 100 Marks (ISE 50 + ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Interact with others observing etiquettes in the context.
2. Incorporate leadership traits while heading activities in personal and professional life.
3. Develop meeting styles, planning and participation.
4. Hone team work skills in diverse groups and working creatively.
5. Enhance presentations in academic and professional writings.

Details of the Practical:
1. **Introduction to Corporate Etiquettes:** Business dress and grooming – Office etiquettes – Telephone etiquettes – Dining etiquettes – Meeting etiquettes – Travel etiquettes – Students will be given case studies or will be asked to perform role plays and will be assessed in presence of the student.
2. **Learn to Excel as a Leader:** Leader as visionary – Leader as a problem solver - Leader as a team builder - Leader as a manager - Leader as a communicator - Leader as a power distributor - Leader as a liaison - Leader as a planner.
3. **Building Successful Teams:** Improving team effectiveness (Characteristics of an effective team) – Effective recruitment – Developing, coaching and motivating your team – Managing different types of people at workplace.
4. **Formal Meeting and Decision Making:** Set objectives - Assemble attendees - Create an agenda - Maintain control - Minutes of meeting - Follow-up – Mock meeting of students on an issue will be conducted and assessed - Decision making models – Choosing between options – Deciding whether to go ahead – Financial decisions – Improving decision making – Impact of ethics and values – Group decision making.
5. **How to Write Proposals:** Executive summary – Need – Objectives – Methods – Evaluation – Timetable – Budget – Items in the proposal will be discussed with students with the help of one or two sample proposals.
6. **Writing Project Reports:** Structuring your document effectively (title page, introduction, summary, analysis) – Use of figures, graphs and tables – Conclusion and recommendations – Appendices – References.
7. **Writing Scientific Articles and Research Papers:** General form – Title page – Abstract – Introduction – Materials and Methods – results – Literature cited – Proof reading – Grammar and spelling – Common mistakes – Students will be asked to select a paper and analyse it on the basis of discussed items.
An Introduction to RTI: A General overview of the RTI Act, 2005 – RTI movement in India: A historical perspective - RTI legislations in states - Key terms and concepts in the act - Public authorities and their obligations under the act - Accepting an information request, processing and disposing it - Exemptions from disclosure of information, partial disclosure and “Third Party” information - Information commission: Powers and functions.

Reference Text (for teacher):
1) David A. McMurrey and Joanne Buckley, Handbook for Technical Writing; Cengage Learning, 2011.
T.Y. B. Tech (ELECTRICAL ENGINEERING)-PART II (SEM - VI)

Course Code - EE3021: Switchgear and Protection

Teaching Scheme: Lecture: 3 hours/week, Tutorial: 1 hour/week
Exam Scheme: Paper: 100 (ISE 20 + MSE 30 + ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Introduce with the fundamentals
2. Classify and explain circuit breakers
3. Categorize and describe Relays
4. Discuss distance protection scheme and relays
5. State faults and give protection against it for Transformer and Generator
6. Find causes, effects and protections for overvoltage

Unit I: Fundamentals

Unit II: Circuit Breakers

Unit III: Relays
Desirable characteristics, Classification of Relays on the basis of technology used, functions & characteristics, construction and working of these Relays. Current & time setting of relay (PSM & TMS). Numericals.

Unit IV: Distance protection

Unit V: Transformer protection and Generator protection
Transformer protection:-Buchholz relay, percentage differential protection, harmonic restraint and harmonic blocking schemes, restricted earth fault protection,
Generator protection:- Stator earth fault, phase fault, stator current unbalance (NPS), protection, Rotor overheating, earth fault protection, excitation failure and protection against motoring, generator-transformer unit protection. Numericals.

Unit VI: Overvoltage Protection

Causes & effects of over voltages, protection against-direct lightening strokes & travelling waves, insulation co-ordination. Numericals.

Text Books:
1) Power System Protection and Switchgear: B.Ram and D.N. Vishwakarma

Reference Books
1) Power System Protection and Switchgear: Oza/Nair/Mehta/Makwana
2) Switchgear and Protection: M.V. Deshpande
3) Power System Protection and Switchgear:- B. Ravindrnath
T.Y. B. Tech (ELECTRICAL ENGINEERING)-PART II (SEM - VI)

Course Code - EE3041: Control System Design

Teaching Scheme: Lecture: 3 hours/week Tutorial: 1 hour/week

Exam Scheme: Paper: 100 (ISE 20 + MSE 30 + ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Demonstrate an understanding of the fundamentals of (feedback) control systems.
2. Determine and use models of physical systems in forms suitable for use in the analysis and design of control systems.
3. Design and analyze stability using Root Locus technique and frequency domain to achieve desired system performance using phase-lead and phase-lag compensators.
4. Design and fine tune PID controllers and understand the role P, I & D feedback control.
5. Analyze the dynamic behavior of mechanical/process systems and design full state feedback controllers and observers using state variable models.
6. Evaluate and communicate the effect of various control strategies on systems performance by effectively using MATLAB and Simulink in the analysis, design, simulation, and real-time implementation of closed-loop systems.

Unit I: Principles of Feedback Control 03
Control objective, feedback control system characteristic, Controller for closed loop systems- Proportional mode, integral mode, derivative mode of control system, alternative control system configurations- P, PI, PD & PID.

Unit II: Classical Design in the s-Plane 07

Unit III: System Stability and Performance in Frequency Domain 08
Review of Nyquist criterion, co-relation between time and frequency domain specification, M-circles, Nichols charts, stability margins. Sensitivity in frequency domain.

Unit IV: Classical Design in the Frequency Domain 06
Introduction, Reshaping Bode plot, Compensator design- lead, lag and lag-lead compensation.

Unit V: Hardware Implementation 06
Introduction, passive electric network, operational amplifier usage, tunable PID controllers, Ziegler-Nichols method for controller tuning.
Unit VI: State Space Design

Review of state space, controllability, observability, state variable feedback design, pole placement, State Observers, observer design using error dynamics, Ackermann’s formula, LQR design, overview of robust control.

Text Books:-

2) Control system principles and design, M. Gopal, TMH publication, 3rd edition, 2008
Teaching Scheme: Lecture: 3 hours/week, Tutorial: - 1 hour / Week
Exam Scheme: Paper: 100 Marks (ISE 20 + MSE 30 + ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Describe the basic concepts & characteristics of Instruments
2. Explain the basic principles of power & energy measuring devices
3. Analyze the performance of instrument transformers
4. Assess the performance of different bridges
5. Explain the performance of digital instruments
6. Categorize the different Data Acquisition system

Unit I: Basic Concept of Measurements and Instruments
Static & Dynamic Characteristics, Working Standards, Types of Error, Multi range ammeter and voltmeter. Moving coil and Moving iron instrument: Construction and principle of operation of attraction and Repulsion type, limitation, scale equation of moving iron for power factor measurement.

Unit II: Power and Energy Measurement
Dynamometer wattmeter, power factor measurement, power measurement in single phase circuit, active and reactive power measurement in three phase circuit using wattmeter’s, Construction and working principle of single phase and Three phase energy meter.

Unit III: Instrument Transformers
Construction and working principle, phasor diagram, application of C.T. and P.T. and potentiometers, CVT.

Unit IV: Measurement of Circuit Parameters
A.C. Bridges: Maxwells Inductance Bridge, Maxwell –Wein Bridge, Anderson Bridge, Hay’s Bridge, The Owen Bridge, Heaviside Campbell equal ratio bridge, Capacitance bridge, De Sauty Bridge, Schering Bridge, Wein’s Series bridge, Wein’s Parallel bridge.

Unit V: Measurement Using Digital Instruments

Unit VI: Data Acquisition System
Voltage Recording Instruments, Digital Voltmeters, Strip Chart Recorder, X-Y recorder, Data Acquisition System.
Text Books:
1) Electrical & Electronic Measurement E.W.Golding ELBS Edition
2) Electrical & Electronic Measurement -- A.K.Sawhney

References:
1) Instrumentation Devices & Systems --- Rangan,Mani, Sharma
2) Process Control Instrumentation Technology – Johnson
3) Industrial Instrumentation and Control – S.K.Singh
4) Electrical measurement and measuring Instrumentation - G.P.Gupta.
Teaching Scheme: Lecture: 3 hours/week, Tutorial: - 1 hour / Week

Exam Scheme: Paper: 100 Marks (ISE 20 + MSE 30 + ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Understand the stability, moment of inertia and torque in drive systems
2. Design block schematics of closed loop control of drives.
3. Evaluate the motor rating for the given duty as per standard IS4722.
4. Explain the D.C. motor drives starting, braking and speed control operated from single phase and three phase converters.
5. Solve the numerical problems on D.C. drives.
6. Understand, analyze the operation of v/f, constant torque and constant power control of induction motor using different drives, VSI and CSI.
7. Understand the vector control of induction motor drives.
8. Understand the operation speed control of synchronous motor drives.

Unit I: Introduction
06
Basic Elements, Types of Electric Drives, Factors influencing the choice of electrical drives, Fundamental torque equation, speed torque, Heating and cooling curves, Loading conditions and classes of duty, Selection of power rating for drive motors with regard to thermal overloading and Load variation factors.

Unit II: Control of Electrical Drives
06
Modes of operation, speed control and drives classification, closed loop control of drives, Current limit control, closed loop torque control, closed loop speed control, closed loop speed control of multi-motor drives, speed sensing, current sensing, phase locked loop(PLL) control, closed loop position control.

Unit III: DC Motors Drives
06
Methods of Braking and Speed control, Single phase and Three phase fully controlled and half controlled converter fed DC Drives, Speed torque characteristics, Power in load and source circuits, Multi quadrant operation of separately excited DC motor drives, Dual converter fed DC motor drives, Chopper fed drives, Single, two and four quadrant chopper drives.

Unit IV: Induction Motors Drives
06
Stator voltage control, Rotor resistance and Slip power recovery scheme for slip ring induction motor, Static Kramer’s drive, Static Scherbius drive.
V/f control – constant torque and constant power control, close loop control.
Voltage Source Inverter – Application to induction motor drives – v/f, e/f, flux weakening schemes of control.
Current Source Inverter – application to induction motor drives – operation under fixed frequency – operation under variable frequency.
Unit V: Vector Control of Induction Motor

Dynamic d-q Model – Axes Transformation, Synchronously rotating reference frame dynamic model, Stationary frame dynamic model. Principal of Vector control, Direct vector control, indirect vector control.

Unit VI: Speed control of synchronous motors and other special motors

Synchronous motor, operation from fixed frequency supply, synchronous motor variable speed drives, Energy conservation in Electrical Drives, Introduction of Brushless DC motor, Stepper motor and switched reluctance motor drives and their industrial applications.

Text Books:

1) Fundamentals of the electrical drives: Gopal K Dubey, Narosa publication
2) Electrical Drives Concept and application: Vedam Subrahnyam

Reference Books:

1) Advanced power Electronics and A.C. Drives: B.K. Bose
2) Analysis of thyristor power conditioned motors: S.K. Pillai
3) Electrical Drives Concept and application: Vedam Subrahnyam
4) Electrical Motor Drives: R Krishnan
Teaching Scheme: Lecture: 3 hours/week Tutorial: 1 hour/week
Exam Scheme: Paper: 100 Marks (ISE 20 + MSE 30 + ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Explain the needs and methods adopted for restructuring of Power industry
2. Interpret the basics of economics and analyze the power markets using them.
3. Discover the different paradigms of restructuring adopted in different countries.
4. Explain the ideas of Transmission Open Access.
5. Point out the needs of Ancillary services and the methods adopted to provide them.
6. Analyze the implications of Indian Electricity Act (2003)
7. Identify the salient features of IEGC and the organizational and administrative responsibilities of various organization involved in the Power Sector of India.

Unit I: Introduction to Restructuring and its objectives 06
Reasons for restructuring / deregulation of power industry, Understanding the restructuring process, Introduction to issues involved in deregulation, Reasons and objectives of deregulation of various power systems across the world,

Unit II: Fundamentals of Economics 06
Consumer behavior, Supplier behavior, Market equilibrium, Short-run and Long-run costs, various costs of production, Relationship between short-run and long-run average costs, perfectly competitive market.

Unit III: Deregulation of Electric utilities 06
Traditional Central utility model, Reform motivations, Separation of ownership and operation, competition and direct access in the electricity markets, Independent system operator, Retail electricity providers, Experience of England and wales, Norway, California, Scotland, New Zealand, The European union and Germany.

Unit IV: Transmission Open Access and Ancillary Service Management 06
Transmission open access methodology, Classification of ancillary services, Load-generation balancing related services, Voltage control and reactive power support services, Black start capability service, Mandatory provision of ancillary services, Markets for ancillary services

Unit V: Indian Electricity Act 2003 06
Salient Features and their implications
Unit VI: Indian Electricity Grid Code and roles of various organizations in Indian Power Sector

Introduction to IEGC, Connection code, Criteria’s for simulation studies, Role of Various organizations in Indian Power Sector (NLDC, SLDC, RLDC, RPC, CERC, etc.)

Reference Books:
1) Power system Restructuring and Deregulation – Loi Lei Lai
2) Restructured Power system NPTEL Web course- S.A.Kaparde- NPTEL
3) Operation of Restructured Power Systems - Kankhar Bhattacharya
Teaching Scheme: Lecture: 1 hour/week
Exam Scheme: Paper: 100 (ISE 100)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Understand different approaches to legal ethics.
2. Debate current ethical issues and think critically about existing practices.
3. Apply ethical rules to practical scenario.
4. Understand the moral and characterization to be an example of faith, character and high professional ethics.

Unit I: 02
Science, Technology and Engineering as Knowledge and as Social and Professional Activities
Effects of Technological depletion of resources. Reports of the Club of Rome. Limits to growth; sustainable development. Growth Rapid Technological growth and Energy Crisis; Renewable Energy Resources.

Unit II: 02
Environmental degradation and pollution, Eco-friendly Technologies, Environmental Regulations.

Unit III: 02

Unit IV: 02

Unit V: 02

Unit VI: 02
Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity Moral and ethical values: Nature of moral judgments; canons of ethics; Ethics of virtue; ethics of duty; ethics of responsibility. Work ethics, professional ethics.

**Text and References:**

1) Managing Corporate Ethics: Learning from America's Ethical Companies How to Supercharge Business Performance: Francis Joseph Aguilar

Course Code - EE3521: Control System Design Lab

**Teaching Scheme:** Practical: 2 hours/week

**Exam Scheme:** Practical: 100 Marks (ISE 50+ ESE 50).

**Course Outcomes:**
On successful completion of this course the students will be able to:
1. determine the mathematical model of electromechanical systems.
2. design the compensators for LTI using time domain and frequency domain analysis.
3. design state feedback controller for SISO system.
4. analyse and interpret the models in virtual environment – MATLAB.

**List of Experiments:**
1. Study of P, PI, PD & PID Controllers
2. Design of Lead Compensator using root locus technique
3. Design of Lead compensator using Bode Plot
4. Design of Lag Compensator using root locus technique
5. Design of Lag compensator using Bode Plot
6. Design of Lag-lead Compensator using root locus
7. Design & fine tune of PID controller
8. Study of controllability, observability of systems
9. Study of state feedback controllers
10. Study of Pole Placement Design
Course Code - EE3541: Switchgear and Protection Lab

Teaching Scheme: Practical: 2 hours/week
Exam Scheme: Practical: 100 Marks (ISE 50+ ESE 50)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Identify different switches and circuit breakers
2. Observe and explain MCCB
3. Plot characteristics of Relays
4. Assure working of Relays based on their technology and characteristics
5. Discuss different protection schemes
6. Demonstrate for Transformer and Generator protection

List of Experiments
a) Switchgear and Protection
1. Introduction of different switches, MCB, ELCB, MCCB.
2. Study construction and working of induction disc type relay.
3. Plotting of $T \alpha I$ characteristics of an over current relay.
4. Plotting of $T \alpha V$ characteristics of an over voltage and under voltage relay.
5. Plotting of $T \alpha %Z$ characteristics of an Impedance relay
6. Experimental realization of microprocessor based over current relay
7. Experimental realization of Transformer protection demo panel
8. Experimental realization of Generator protection demo panel
Teaching Scheme: Practical: 4 hours/week
Exam Scheme: Practical: 100 Marks (ISE 50 + ESE 50).

Course Outcomes: After successful completion of this course students will be to;
1. Understand, demonstrate and sketch the speed-torque characteristics of electrical drives fed from power electronic converters.
2. Understand, examine closed loop control of electrical drives.
3. Apply simulation software for analyzing electrical drives.
4. Calculate and measure the input, output parameters of electrical drives.
5. Select the rating of motor of electrical drive for particular application according load duty as per IS4722-1968.
6. Evaluate the stability, analyze performance of electrical drives (A.C. and D.C. drives.)
7. Understand advanced electrical drives SRM, BLDC, PMSM and examine their behavior using MATLAB/ SIMULINK.

List of Experiments:

1. Study of torque-speed characteristics of separately excited DC motor from single phase full converter.
2. Open loop speed control of separately excited DC motor using chopper at high frequency.
4. Study of torque-speed characteristics of separately excited DC motor from single phase dual converter in closed loop.
5. Study of torque-speed characteristics of separately excited DC motor from three phase half controlled converter.
6. Three phase induction motor speed control using slip power recovery scheme.
7. V/F Control of three phase induction motor.
8. Three phase induction motor speed control using rotor resistance control.
9. Simulation of chopper fed DC drive using MATLAB/SIMULINK.
10. Simulation of variable frequency induction motor drive using MATLAB/SIMULINK.
11. Simulation of three phase converter fed separately excited DC motor control using MATLAB/SIMULINK.
12. Simulation of single phase converter fed separately excited DC motor control using MATLAB/SIMULINK.
13. Simulation of BLDC/PMSM motor control using MATLAB/SIMULINK.
Teaching Scheme: Practical: 2 hours/week
Exam Scheme: Practical: 100 Marks (ISE 100)

Course Outcomes:
On successful completion of this course the students will be able to:
1. Formulate a real world problem and develop its requirements.
2. Develop and design solution for a set of requirements.
3. Test and validate the conformance of the developed prototype against the original requirements of the problem.
4. Work as a responsible member and possibly a leader of a team in developing solutions to problems.
5. Express technical ideas, strategies and methodologies in written form and prepare and conduct oral presentations
6. Self-learn new tools, algorithms, and/or techniques that contribute to the solution of the project

Project work: Mini projects based on theory subjects studied.
- A Group of not more than 03 students should work to design, build and test a small Electrical /Electronic system.