# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

## (Autonomous)

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

## COURSE STRUCTURE & SYLLABUS

**EEE- B. Tech - VII Semester**

| S. No | Course Code | Course Title | Hour per week | | | Total | Credits |
|---|---|---|---|---|---|---|---|
| | | | Lecture | Tutorial | Practical | | |
| 1 | **B27PC1** | Power System Operation and Control | 3 | 0 | 0 | 3 | 3 |
| 2 | **B27PE2** | Professional Elective-III<br>1. Wind and Solar Energy Systems<br>2. Hybrid Electrical Vehicles<br>3. Flexible AC Transmission Systems | 3 | 0 | 0 | 3 | 3 |
| 3 | **B27PC3** | Power System Protection | 3 | 0 | 0 | 3 | 3 |
| 4 | | Open Elective – III | 3 | 0 | 0 | 3 | 3 |
| 5 | **B27PC5** | Power systems Lab | 0 | 0 | 3 | 3 | 1.5 |
| 6 | **B27PW6** | Project Stage-I | 0 | 0 | 8 | 8 | 4 |
| | | | | | | **Total** | **17.5** |

**EEE- B. Tech - VIII Semester**

| S. No | Course Code | Course Title | Hour per week | | | Total | Credits |
|---|---|---|---|---|---|---|---|
| | | | Lecture | Tutorial | Practical | | |
| 1 | **B28PE1** | Professional Elective-IV<br>1. HVDC Transmission Systems<br>2. Computational Electromagnetics<br>3. Electromagnetic Waves | 3 | 0 | 0 | 3 | 3 |
| 2 | **B28PE2** | Professional Elective-V<br>1. Industrial Electrical Systems<br>2. Modern Control Theory<br>3. Electrical Drives | 3 | 0 | 0 | 3 | 3 |
| 3 | **B28PE3** | Professional Elective-VI<br>1. Utilization of Electrical Energy<br>2. High Voltage Engineering<br>3. Computer Aided Design of Electrical Machines | 3 | 0 | 0 | 3 | 3 |
| 4 | **B28PW4** | Project Stage-II | 0 | 0 | 16 | 16 | 8 |
| 5 | **B28CT5** | Comprehensive Test | 0 | 0 | 0 | 0 | 3 |
| | | | | | | **Total** | **20** |

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

## (Autonomous)

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

### POWER SYSTEM OPERATION AND CONTROL–B27PC1

**B.Tech. VII Semester** **L/T/P/C**

**3/0/0/3**

**COURSE OBJECTIVES:**

1. To have an overview of power system operation and control.
2. Economic operation of Power Systems, Hydrothermal scheduling and modeling of turbines, generators and automatic controllers
3. To model power-frequency dynamics and to design power-frequency controller.
4. To model reactive power-voltage interaction and t-he control actions to be implemented for maintaining the voltage profile against varying system load.
5. To study the economic operation of power system.
6. To teach about SCADA and its application for real time operation and control of power systems.

**COURSE OUTCOMES:** After completion of this course, the students will be able to

1. Understand the economic load dispatch
2. Analyze the unit commitment problems, constraints and hydrothermal scheduling of power plants
3. Analyze the load frequency control
4. Understand reactive power and voltage control of a power system
5. Apply the computer control techniques for the power systems.

**UNIT-I:**

**Economic Operation of Power Systems**: Optimal operation of Generators in Thermal Power Stations, – heat rate Curve — Cost Curve — Incremental fuel and Production costs, input-output characteristics, Optimum generation allocation with line losses neglected. Optimum generation allocation including the effect of transmission line losses — Loss Coefficients, General transmission line loss formula.

**UNIT-II:**

**Hydrothermal Scheduling**: Optimal scheduling of Hydrothermal System: Hydroelectric power plant models, scheduling problems-Short term hydrothermal scheduling problem.

**Modeling: Modeling of Turbine**: First order Turbine model, Block Diagram representation of Steam Turbines and Approximate Linear Models.

**Modeling of Governor**: Mathematical Modeling of Speed Governing System — Derivation of small signal transfer function. Modeling of Excitation System: Fundamental Characteristics of an Excitation system, Transfer function, Block Diagram Representation of IEEE Type-1 Model.

**UNIT-III:**

**Single Area & Two Area Load Frequency Control**: Necessity of keeping frequency constant, Definitions of Control area Single area control Block diagram representation of an isolated power system — Steady state analysis Dynamic response — Uncontrolled case,

**Load frequency control of area system:** Uncontrolled case and controlled case, tie1ine bias control.

**Load Frequency Controllers**: Proportional plus Integral control of single area and its block diagram representation, steady state response — Load Frequency Control and Economic dispatch control.

**UNIT-IV:**

**Reactive Power Control**: Overview of Reactive Power control — Reactive Power compensation in transmission systems — advantages and disadvantages of different types of compensating equipment for transmission systems. Load compensation: Specifications of load compensator, Uncompensated and compensated transmission lines: shunt and Series Compensation. (Qualitative treatment)

**UNIT-V:**

**Computer control of Power System**: Need for computer control of power systems - concept of energy control centre - functions - system monitoring - data acquisition and control - system hardware configuration – SCADA and EMS functions - network topology - state estimation – WLSE - Contingency Analysis - state transition diagram showing various state transitions and control strategies.

**TEXT BOOKS**


1. Olle.I.Elgerd, 'Electric Energy Systems theory - An introduction', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 34th reprint, 2010.
2. Nagrath I.J. and Kothari D.P., 'Modern Power System Analysis', Tata McGraw-Hill, Fourth Edition, 2011.


**REFERENCE BOOKS**


1. Operation and Control in Power Systems, PSR Murthy, BS Publications.
2. Power systems stability and control, PrabhaKundur, The McGraw — Hill companies.

3. Allen. J. Wood and Bruce F. Wollenberg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 2003.

4.AbhijitChakrabarti, SunitaHalder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

## (Autonomous)

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

### WIND AND SOLAR ENERGY SYSTEMS (Professional Elective-III)–B27PE2

**B.Tech. VII Semester** **L/T/P/C**
**3/0/0/3**

**COURSE OBJECTIVES:**

1. To understand the different renewable energy sources
2. Discuss wind power generation using different topologies
3. Study the Solar system and generation with photovoltaic systems
4. Development of integrated solar and wind generation system

**COURSE OUTCOMES:**

At the end of this course, students will demonstrate the ability to

1. Understand the energy scenario and the consequent growth of the power generation from Renewable energy sources.
2. Study the basic physics of wind and solar power generation.
3. Analyse the power electronic interfaces for wind and solar generation.
4. Understand the issues related to the grid-integration of solar and wind energy systems.

**Unit 1: Physics of Wind Power:**
History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speedratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed andpower-cumulative distribution functions.

**Unit 2: Wind generator topologies:**
Review of modern wind turbine technologies, Fixed and Variable speed wind turbines,Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power electronics converters. Generator-Converterconfigurations, Converter Control.

**Unit 3: The Solar Resource:**
Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles,solar day length, Estimation of solar energy availability.

**Unit 4: Solar photovoltaic:**
Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell,PV module, array, Power Electronic Converters for Solar Systems, Maximum Power PointTracking (MPPT) algorithms – perturb &observe method and incremental conductance method,Converter Control.

**Unit 5: Network Integration Issues:**
Overview of grid code technical requirements. Fault ride-through for wind farms - real andreactive power regulation, voltage and frequency operating limits, solar PV and wind farmbehavior during grid disturbances. Power quality issues. Power system interconnectionexperiences in the world. Hybrid and isolated operations of solar PV and wind systems.Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond,elementary analysis.

**TEXTBOOKS**
1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems**",** John Wiley and Sons, 2004.
3. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
4. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley
and Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
6. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

## (Autonomous)

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

### HYBRID ELECTRICAL VEHICLES (PROFESSIONAL ELECTIVE-III)–B27PE2

**B.Tech. VII Semester** **L/T/P/C**
**3/0/0/3**

**COURSE OBJECTIVES:**

1. Classification of different electrical vehicles concepts
2. Apply drives for Electric Train system
3. Illustrate energy storage devices for vehicle application

**COURSE OUTCOMES:** At the end of this course, students will demonstrate the ability to

1. Understand the models to describe hybrid vehicles and their performance.
2. Understand the different possible ways of energy storage.
3. Understand the different strategies related to energy storage systems.

**UNIT-I: Introduction Conventional Vehicles:** Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

**UNIT -II: Introduction to Hybrid Electric Vehicles:** History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

**Hybrid Electric Drive-trains:** Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

**UNIT -III: Electric Trains**

**Electric Drive-trains:** Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

**UNIT -IV: Energy Storage**

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

**UNIT V: Energy Management Strategies**

**Energy Management Strategies:** Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

**TEXTBOOKS**

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.

2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.

3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.

4. T. Denton, “Electric and Hybrid Vehicles”, Routledge, 2016.

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

**(Autonomous)**

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

**FLEXIBLE AC TRANSMISSION SYSTEMS (Professional Elective-III)-B27PE2**

**B.Tech. VII Semester** **L/T/P/C**

**3/0/0/3**

**PREREQUISITE:** Power Electronics, Power System Analysis & Power System Operation and Control

**COURSE OBJECTIVES:**

1.To understand the fundamentals of FACTS Controllers,

2.To know the importance of controllable parameters and types of FACTS controllers &their benefits

3.To understand the objectives of Shunt and Series compensation

4.To Control STATCOM and SVC and their comparison and the regulation of STATCOM, Functioning and control of GCSC, TSSC and TCSC

**COURSE OUTCOMES:** After completion of this course, the students will be able to

1. Understand the basic concept of FACTs and FACTs controller
2. Understand the working of single phase and three phase voltage source inverter
3. Understand the concept of static shunt compensation.
4. Analyze SVC & STATCOM
5. Understand the Power and control circuits of Series Controllers GCSC, TSSC and TCSC

**UNIT - I**

**Facts Concepts:** Need of FACTS devices,merits and demerits of FACTS devices. Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, and benefits from FACTS controllers.

**Voltage Source Converters:** Single phase, three phase full wave bridge converters transformer connections for 12 pulse operation.

**UNIT - II**

**Static Shunt Compensation:,** midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of controllable var generation, variable impedance type static var generators, switching converter type var generators and hybrid var generators.

**UNIT - III**

**SVC and STATCOM:** SVC: FC-TCR and TSC-TCR. STATCOM: The regulation and slope. Comparison between SVC and STATCOM

**UNIT - IV**

**Static Series Compensators:** Objectives of Series compensation, concept of series capacitive compensation, GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC) control schemes for GSC TSSC and TCSC.

**UNIT - V**

Introduction to UPFC and IPFC, special types of FACTS devices.

**Text Books:**

1. "N.G. Hingorani and L. Guygi", Understanding FACTS Devices, IEEE Press Publications 2000.

**Reference Books:**

1. "Kalyan K. Sen and Meylingsen", Introduction to FACTS Controllers, John wiley& sons, Inc., Mohamed E.EI – Hawary Series editor, 2009.

2. "K. R Padiyar, Motilal",FACTS controllers in power transmission and distribution UK Books of India 2007.

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

## (Autonomous)

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

## POWER SYSTEM PROTECTION-B27PC3

**B.Tech. VII Semester** **L/T/P/C**

**3/0/0/3**

**PREREQUISITE:** Power Systems - I & Power Systems - II

**COURSE OBJECTIVES:** The main objectives of the course are

1. To classify protection system schemes
2. To analyze different types of faults
3. Develop protection schemes using simulation

**COURSE OUTCOMES:** At the end of this course, students will demonstrate the ability to

1. Understand the different components of a protection system.
2. Evaluate different over current protection schemes.
3. Understand the protection schemes for Generator ,Transformer and Transmission
4. Understand different microprocessor based protection schemes.
5. Understand Phasor Measurement Units and Wide-Area Measurement Systems (WAMS).

**UNIT- I:**

**Introduction and Components of a Protection System**

Overview of faults, different protection Scheme, Principles of Power System Protection, Relays, Instrument transformers, Circuit Breakers.

**UNIT- II:**

**Over-Current Protection**

Sequence Networks. Introduction to Over current Protection and over current relay co-ordination. Protection of parallel feeders.

**UNIT- III:**

**Protection Schemes of Generator ,Transformer and Transmission**

Directional, Distance, Differential protection. Transformer and Generator protection. Bus bar Protection, Bus Bar arrangement schemes

**UNIT- IV:**

**Digital Protection**

Computer-aided protection, Fourier analysis and estimation of Phasors from DFT. Sampling, aliasing issues. Microprocessor based protection schemes.

**UNIT-V:**

**System Protection**

Effect of Power Swings on Distance Relaying. System Protection Schemes. Under-frequency, under-voltage and df/dt relays, Out-of-step protection, Synchro- phasors, Phasor Measurement Units and Wide-Area Measurement Systems (WAMS). Application of WAMS for improving protection systems.

**TEXTBOOKS**

1.Badriram and DN vishwakarma,"power system protection and switch gear" Tata McGraw-Hill Education, 01-Apr-2001

2. J. L. Blackburn, "Protective Relaying: Principles and Applications", Marcel Dekker, New York, 1987.

**REFERENCE BOOKS**

1. Y. G.Paithankar and S. R. Bhide, "Fundamentals of power system protection", Prentice Hall, India, 2010.
2.. A. G. Phadke and J. S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer, 2008.
3. D. Reimert, "Protective Relaying for Power Generation Systems", Taylor and Francis, 2006.

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

**(Autonomous)**

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

### POWER SYSTEMS LAB -B27PC5

**B.Tech. VII Semester** **L/T/P/C**

**0/0/3/1.5**

**PREREQUISITE:** Power Systems & Electrical Machines.

**COURSE OBJECTIVES:**

1. Perform testing of CT, PT's and Insulator strings
2. To find sequence impedances of 3-Φ synchronous machine and Transformer
3. To perform fault analysis on Transmission line models and Generators.

**Course Outcomes:** After completion of this course, the students will be able to

1. Test different types of relays and their characteristics.
2. Apply various load flow techniques for the power flow studies.
3. Understand Different protection methods
4. Analyze various faults, ABCD constants, Regulation and transient stability of transmission line.

**The following experiments are required to be conducted as compulsory experiments:**

**Part-A**

1. Characteristics of IDMT over Current Relay.
2. Differential protection of 1-Φtransformer.
3. Characteristics of Microprocessor based Over Voltage/Under Voltage relay.
4. Testing of CT, PT's and Insulator strings.
5. Finding the sequence impedances of 3-Φ synchronous machine.
6. Finding the sequence impedances of 3-Φ Transformer.

**In addition to the above six experiments, at least any four of the experiments from the following list are required to be conducted.**

**Part-B**

1. Formation of $Y_{bus}$
2. Load Flow Analysis using Gauss Seidal (GS) Method.
3. Load Flow Analysis using Fast Decoupled (FD) Method.
4. Formation of $Z_{bus}$.
5. LG, LL and 3-Φ fault analysis of 3-Φ synchronous machine.
6. Power circle diagrams of a 3-Φtransmission line model.
7. ABCD constants and Regulation of a 3-Φ transmission line model.
8. Transient Stability Analysis for Single Machine connected to Infinite Bus by Point by Point method.

**Reference Books:**


1. C.L. Wadhwa: Electrical Power Systems–Third Edition, New Age International Pub.Co.,2001
2. Hadi Sadat: Power System Analysis–Tata McGrawHill Pub.Co.2002.
3. D.P.Kothari: Modern Power System Analysis-TataMcGrawHillPub.Co.2003

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

## (Autonomous)

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

### HVDC TRANSMISSION SYSTEMS (Professional Elective-IV)-B28PE1

**B.Tech. VIII Semester** **L/T/P/C**

**3/0/0/3**

**PREREQUISITE:** Power Systems & Power Electronics Course

**COURSE OBJECTIVES:**

1. To compare EHV AC and HVDC systems
2. To analyze Graetz circuit and also explain 6 and 12 pulse converters
3. To control HVDC systems with various methods and to perform power flow analysis in AC/DC systems.
4. To describe various protection methods for HVDC systems and Harmonics

**COURSE OUTCOMES:** After completion of this course, the students will be able to

1. Understand basic concepts of HVDC system.
2. Analyze various methods for the reactive power control of HVDC systems and converters used.
3. Analyze power flow analysis in AC/DC systems
4. Understand various faults and protection methods for HVDC systems.
5. Analyze the harmonics generation and design different types of filters

**UNIT – I:**

**Basic Concepts:** Necessity of HVDC systems, Economics and Terminal equipment of HVDC transmission systems, Types of HVDC Links, Apparatus required for HVDC Systems, Comparison of AC and DC Transmission, Application of DC Transmission System, Planning and Modern trends in D.C. Transmission. Analysis of HVDC Converters: Choice of Converter Configuration, Analysis of Graetz circuit, Characteristics of 6 Pulse and 12 Pulse converters, Cases of two 3 phase converters in Y/Y mode – their performance.

**UNIT – II:**

**Converter and HVDC System Control:** Principle of DC Link Control, Converters Control Characteristics, Firing angle control, Current and extinction angle control, Effect of source inductance on the system, Starting and stopping of DC link, Power Control.

**Reactive Power Control In HVDC:** Introduction, Reactive Power Requirements in steady state, sources of reactive power- Static VAR Compensators, Reactive power control during transients

**UNIT – III:**

**Power Flow Analysis in AC/DC Systems:** Modeling of DC Links, DC Network, DC Converter, Controller Equations, Solution of DC load flow, P.U. System for DC quantities, solution of AC-DC Power flow-Simultaneous method-Sequential method.

**UNIT - IV :**

**Converter Faults and Protection:** Converter faults, protection against over current and over voltage in converter station, surge arresters, smoothing reactors, DC breakers, Audible noise, space charge field, corona effects on DC lines, Radio interference.

**UNIT –V: Harmonic**s: Generation of Harmonics, Characteristics harmonics, calculation of AC Harmonics, Non- Characteristics harmonics, adverse effects of harmonics, Calculation of voltage and Current harmonics, Effect of Pulse number on harmonics Filters: Types of AC filters, Design of Single tuned filters –Design of High pass filters.

**TEXT BOOKS**


1. "K. R. Padiyar", HVDC Power Transmission Systems: Technology and system Interactions, New Age International (P) Limited, and Publishers, 1990.
2. "S K Kamakshaiah, V Kamaraju", HVDC Transmission , TMH Publishers, 2011
3. "S. Rao", EHVAC and HVDC Transmission Engineering and Practice, Khanna publications, 3 rd Edition 1999.


**Reference Book**s:


1. "Jos Arrillaga", HVDC Transmission, The institution of electrical engineers, IEE power & energy series 29, 2nd edition 1998.
2. "E. W. Kimbark", Direct Current Transmission, John Wiley and Sons, volume 1, 1971.
3. "E. Uhlmann", Power Transmission by Direct Current, B. S. Publications, 2009

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

## (Autonomous)

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

### COMPUTATIONAL ELECTROMAGNETICS (Professional Elective-IV)-B28PE1

**B.Tech. VIII Semester** **L/T/P/C**
**3/0/0/3**

**COURSE OBJECTIVES:**

1. To classify electromagnetic and electrostatics theory
2. To apply analytical methods to solve field equations
3. To discuss low frequency drives

**COURSE OUTCOMES:**

At the end of this course, students will demonstrate the ability to

1. Understand the basic concepts of electromagnetics.
2. Understand computational techniques for computing fields.
3. Apply the techniques to simple real-life problems.

**UNIT-I:**

**Introduction**

Conventional design methodology, Computer aided design aspects – Advantages. Review ofbasic fundamentals of Electrostatics and Electromagnetics. Development of Helmhotz equation, energy transformer vectors- Poynting and Slepian, magnetic Diffusion-transientsand time-harmonic.

**UNIT-II:**

**Analytical Methods**

Analytical methods of solving field equations, method of separation of variables, Roth'smethod, integral methods- Green's function, method of images.

**UNIT-III:**

**Finite Difference Method (FDM)**

Finite Difference schemes, treatment of irregular boundaries, accuracy and stability of FDsolutions, Finite-Difference Time-Domain (FDTD) method- Uniqueness and convergence.

**Finite Element Method (FEM)**

Overview of FEM, Variational and Galerkin Methods, shape functions, lower and higher order elements, vector elements, 2D and 3D finite elements, efficient finite element computations.

**UNIT-IV:**

**Special Topics**

Background of experimental methods-electrolytic tank, R-C network solution, Field plotting (Graphical method), hybrid methods, coupled circuit - field computations, electromagnetic -Thermal and electromagnetic - structural coupled computations, solution of equations, method of moments, Poisson's field

**UNIT-V:**

**Applications**

Low frequency electrical devices, static / time-harmonic / transient problems in transformers, Rotating machines, actuators. CAD packages.

**Text/Reference Books**

1. P. P. Silvester and R. L. Ferrari "Finite Element for Electrical Engineers", Cambridge University press, 1996.
2. M. N. O. Sadiku, "Numerical Techniques in Electromagnetics", CRC press, 2001.

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

## (Autonomous)

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

### ELECTROMAGNETIC WAVES (Professional Elective-IV)-B28PE1

**B.Tech. VIII Semester** **L/T/P/C**

**3/0/0/3**

**COURSE OBJECTIVES:**

1. Define transmission lines
2. Apply Maxwell equations to field theory
3. Explain wave generation and applications

**COURSE OUTCOMES:** At the end of this course, students will demonstrate the ability to

1. Analyze transmission lines and estimate voltage and current at any point on Transmission line for different load conditions.
2. Provide solution to real life plane wave problems for various boundary conditions.
3. Analyze the field equations for the wave propagation in special cases such as lossy and low loss dielectric media.
4. Visualize TE and TM mode patterns of field distributions in a rectangular wave-guide.
5. Understand and analyse radiation by antennas.

**UNIT-I:**

**Transmission Lines**

Introduction, Concept of distributed elements, Equations of voltage and current, Standing waves and impedance transformation, Lossless and low-loss transmission lines, Power transfer on a transmission line, Analysis of transmission line in terms of admittances, Transmission line calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.

**UNIT-II:**

**Maxwell's Equations**

Basic quantities of Electromagnetics, Basic laws of Electromagnetics: Gauss's law, Ampere's Circuital law, Faraday's law of Electromagnetic induction. Maxwell's equations, Surface charge and surface current, Boundary conditions at media interface.

**UNIT-III:**

**Uniform Plane Wave**

Homogeneous unbound medium, Wave equation for time harmonic fields, Solution of the wave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting medium, Phase velocity of a wave, Power flow and Poynting vector.

**UNIT-IV:**

**Plane Waves at Media Interface** Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction of waves at dielectric interface, Total internal reflection, Wave polarization at media interface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary.

**UNIT-V:**

**Waveguides** Parallel plane waveguide: Transverse Electric (TE) mode, transverse Magnetic(TM) mode,

Cut-off frequency, Phase velocity and dispersion. Transverse Electromagnetic (TEM) mode, Analysis of waveguide-general approach, Rectangular waveguides.

**Antennas**

Radiation parameters of antenna, Potential functions, Solution for potential functions, Radiations from Hertz dipole, Near field, Far field, Total power radiated by a dipole, Radiation resistance and radiation pattern of Hertz dipole, Hertz dipole in receiving mode.

**Text/Reference Books**


1. R. K. Shevgaonkar, **"**Electromagnetic Waves**"**, Tata McGraw Hill, 2005.
2. D. K. Cheng, "Field and Wave Electromagnetics**"**, Addison-Wesley, 1989.
3. M. N.O. Sadiku, "Elements of Electromagnetics**"**, Oxford University Press, 2007.
4. C. A. Balanis, "Advanced Engineering Electromagnetics", John Wiley & Sons, 2012.
5. C. A. Balanis, "Antenna Theory: Analysis and Design**"**, John Wiley & Sons, 2005.

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

## (Autonomous)

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

### INDUSTRIAL ELECTRICAL SYSTEMS (Professional Elective-V)-B28PE2

**B.Tech. VIII Semester** **L/T/P/C 3/0/0/3**

**COURSE OBJECTIVES:**

1. Illustrate different electrical system components
2. Explain illumination systems
3. To solve industrial electrical systems

**COURSE OUTCOMES:**

At the end of this course, students will demonstrate the ability to

1. Understand the electrical wiring systems for residential, commercial and industrial
2. Consumers, representing the systems with standard symbols and drawings, SLD.
3. Understand various components of industrial electrical systems.
4. Analyze and selectthe proper size of various electrical system components.

**UNIT-I: Electrical System Components**

LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices

**UNIT-II: Residential and Commercial Electrical Systems**

Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

**UNIT-III: Illumination Systems**

Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

**UNIT-IV: Industrial Electrical Systems I**

HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC,MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

**UNIT-V: Industrial Electrical Systems II**

DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing theDG, UPS and Battery Banks, Selection of UPS and Battery Banks.

**Industrial Electrical System Automation**

Study of basic PLC, Role of in automation, advantages of process automation, PLC basedcontrol system design, Panel Metering and Introduction to SCADA system for distributionautomation.

**TEXT BOOKS**

2. S. L. Uppal and G. C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna publishers, 2008.
3. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.
4. S. Singh and R. D. Singh, “Electrical estimating and costing”, DhanpatRai and Co., 1997.
5. Web site for IS Standards.
6. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008.

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

## (Autonomous)

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

### MODERN CONTROL THEORY (Professional Elective-V)-B28PE2

**B.Tech. VIII Semester** **L/T/P/C**
**3/0/0/3**

**COURSE OBJECTIVES:** The objective of the course is to

1. Understand state space representation of systems and study controllability and Observability tests for continuous time-invariant systems.
2. Understand the problem formulation of non linear systems and study the performance.
3. Understand different types of optimal control techniques and its applications

**COURSE OUTCOMES:** After completion of the course, the student acquires knowledge to

1. Represent a system in state space form and analyze controllability and Observability concepts.
2. Define the stability of a non linear system using lyapunov stability method.
3. linear and non linear systems in state model
4. stability analysis of linear and non linear systems through describing functions

**UNIT–I:**

**Mathematical Preliminaries:** Fields, Vectors and Vector Spaces – Linear combinations and Bases –Linear Transformations and Matrices – Scalar Product and Norms – Eigen-values, Eigen Vectors and a Canonical form representation of Linear operators – The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Non-uniqueness of state model – State diagrams for Continuous-Time State models.

**UNIT-II:**

**State Variable Analysis:** Linear Continuous time models for Physical systems– Non Linear Models- Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and its properties. General concept of controllability – General concept of Observability – Controllability tests for Continuous-Time Invariant Systems – Observability tests for Continuous-Time Invariant Systems –

Controllability and Observability of State Model in Jordan Canonical form – Controllability and Observability Canonical forms of State model

**UNIT-III:**

**Non Linear Systems:** Introduction – Non Linear Systems - Types of Non-Linearities – Saturation –Dead- Zone - Backlash – Jump Phenomenon etc;– Singular Points – Introduction to Linearization of nonlinear systems, Properties of Non-Linear systems – Describing function–describing function analysis of nonlinear systems – Stability analysis of Non-Linear systems through describing functions.

**UNIT-IV:**

**Phase-Plane Analysis:** Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points phase-plane analysis of nonlinear control systems

**UNIT-V:**

**Stability Analysis:** Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems - Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method. State feedback controller design through Pole Assignment – State observers: Full order and Reduced order.

**TEXT BOOKS:**


1. Modern Control System Theory by M.Gopal – New Age International-1984
2. Modern Control Engineering by Ogata.K Prentice Hall – 1997 N.K.Sinha, control systems, New Age International, 3rd edition.


**REFERENCES**:


Optimal control by kircks

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

## (Autonomous)

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

### ELECTRICAL DRIVES (Professional Elective-V)-B28PE2

**B.Tech. VIII Semester** **L/T/P/C**
**3/0/0/3**

**COURSE OBJECTIVES:**

1. This course is an extension of Power Electronics applications to AC and DC drives.
2. Control of DC motor drives with single phase and three phase converters and choppers are given in detail.
3. The control of AC motor drives with variable frequency converters and variable voltage are presented.

**COURSE OUTCOMES:**

After Completion of this course, the students will be able to

1. Discuss control of DC Motors through Phase Controlled Rectifiers
2. Develop Four Quadrant Operation of DC Drives through Dual Converters
3. Explain Control of DC Motors by Choppers
4. Demonstrate different control techniques of induction motors
5. Demonstrate different control techniques of synchronous motors

**UNIT – I:**

**Control of DC Motors through Phase Controlled Rectifiers**

Introduction to Thyristor controlled Drives, Single Phase semi and fully controlled converters connected to DC separately excited and DC series motors – continuous current operation – output voltage and current waveform – Speed and Torque expressions – Speed – Torque Characteristics- Problems on Converter fed DC motors. Three phase semi and fully controlled converters connected to DC separately excited and DC series motors – output voltage and current waveform – Speed and Torque expressions – Speed – Torque characteristics – Problems.

**UNIT – II:**

**Four Quadrant Operation of DC Drives through Dual Converters**

Introduction to Four quadrant operation – Motoring operations. Electric Braking – Plugging, Dynamic and Regenerative Braking operations. Four quadrant operation of DC motors by dual converters – Closed loop operation of DC motor (Block Diagram Only).

**UNIT-III:**

**Control of DC Motors by Choppers (1-, 2-, 4- Quadrant Operations)**

Single quadrant, Two -quadrant and four quadrant chopper fed dc separately excited and series excited motors – Continuous current operation – Output voltage and current wave forms – Speed torque expressions – speed torque characteristics – Problems on Chopper fed DC Motors – Closed Loop operation ( Block Diagram Only).

**UNIT –IV:**

**Control of Induction Motors: Variable voltage characteristics:**

Control of Induction Motor by Ac Voltage Controllers – Waveforms – speed torque characteristics.

**Variable frequency characteristics:**

Variable frequency control of induction motor by Voltage source and current source inverter and cyclo-converters- PWM control – Comparison of VSI and CSI operations – Speed torqu characteristics – numerical problems on induction motor drives – Closed loop operation of induction motor drives (Block Diagram Only).

**Static rotor resistance control:**

Slip power recovery – Static Scherbius drive – Static Kramer Drive – their performance and speed torque characteristics – advantages applications – problems.

**UNIT – V:**

**Control of Synchronous Motors:**

Separate control &self control of synchronous motors – Operation of self controlled synchronous motors by VSI and CSI cyclo converters. Load commutated CSI fed Synchronous Motor – Operation – Waveforms – speed torque characteristics – Applications – Advantages and Numerical Problems – Closed Loop control operation of synchronous motor drives (Block Diagram Only),variable frequency control, Cyclo converter, PWM, VFI, CSI.

**TEXT BOOKS**


1. Power Semiconductor Drives, PV Rao, BS Publications.
2. Fundamentals of Electric Drives, G K Dubey Narosa Publications

**REFERENCE BOOKS**


1. Power Semiconductor Drives, S. B. Dewan, G. R. Slemon , A. Straughen, Wiley Pvt Ltd.
2. Electric Drives N. K. De, P. K. Sen, PHI Learning Private Ltd.
3. Thyristor Control of Electric drives, VedamSubramanyam Tata McGraw Hill Publications.
4. Electrical machines and Drive Systems, John Hindmarsh, Alasdair Renfrew, Newnes.
5. Electric Motors and Drives, Fundamentals, Types and Applications Austin Hughes, Newnes.
6. Power Electronics and Variable Frequency Drives Technology and Applications, Bimal K. Bose, Wiley India Pvt. Ltd.
7. A First course on Electrical Drives, S K Pillai, New Age International (P) Ltd.
8. Modern Power Electronics and AC Drives, B.K.Bose, PHI.
9. Power Electronic Circuits, Devices and applications, M.H.Rashid, PHI.

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

**(Autonomous)**

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

## UTILIZATION OF ELECTRICAL ENERGY (Professional Elective-VI)-B28PE3

**B.Tech. VIII Semester** **L/T/P/C**
**3/0/0/3**

**PREREQUISITE:** Electrical Machines-I & Electrical Machines-II

**COURSE OBJECTIVES:**

1. To understand the fundamentals of illumination and good lighting practices
2. To understand the methods of electric heating and welding.
3. To understand the concepts of electric drives and their application to electrical traction systems.

**COURSE OUTCOMES:**

After completion of this course, the students will be able to

1. Understand the electric drives and types of loads.
2. Understands the concepts and methods of electric heating and welding.
3. Analyze the various illumination methods.
4. Apply the electric drives to electric traction applications.
5. Analyze various calculations involved in electric traction.

**UNIT – I:**

**Electric Drives:** Type of electric drives, choice of motor, starting and running characteristics, speed control, temperature rise, particular applications of electric drives, types of industrial loads, continuous, intermittent and variable loads, load equalization.

**UNIT – II:**

**Electric Heating:** Advantages and methods of electric heating, resistance heating induction heating and dielectric heating.

**Electric Welding:** Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding.

**UNIT – III:**

**Illumination:** Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light.

**Various Illumination Methods:** Discharge lamps, MV and SV lamps – comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting and flood lighting.

**UNIT – IV:**

**Electric Traction – I:** System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking-plugging rheostat braking and regenerative braking.Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves.

**UNIT – V:**

**Electric Traction-II:** Calculations of tractive effort, power, specific energy consumption for given run, effect of varying acceleration and braking retardation, adhesive weight and coefficient of adhesion.

**TEXT BOOKS:**


1. E. Openshaw Taylor, Utilisation of Electric Energy – by University press,1961.
2. Partab, H., 'Art and Science of Utilisation of Electrical Energy', Dhanpat Rai and Sons, New Delhi,1986.


**REFERENCE BOOKS:**


1. N. V. Suryanarayana, Utilization of Electrical Power including Electric drives and Electric traction, New Age International (P) Limited, Publishers,1996.
2. C. L. Wadhwa, Generation, Distribution and Utilization of electrical Energy,New Age International (P) Limited, Publishers,1997.
3. Tripathy, S.C., 'Electric Energy Utilisation and Conservation', Tata McGraw Hill Publishing Company Ltd. New Delhi,1991.

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

## (Autonomous)

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

### HIGH VOLTAGE ENGINEERING (Professional Elective-VI)-B28PE3

**B.Tech. VIII Semester** **L/T/P/C**
**3/0/0/3**

**PREREQUISITE:** Power Systems-I

**COURSE OBJECTIVES:**

1. To get the knowledge of dielectric materials.
2. Deals with Various Dielectric Materials, Numerical methods for electric field computation and Applications.
3. To learn the over voltage phenomena and insulation co-ordination
4. Deals with high voltage testing of materials and electrical apparatus

**COURSEOUTCOMES:**

After completion of this course the students will be able to

1. Understand Various Dielectric Materials, Numerical methods for electric field computation and Applications.
2. Analyze break down occurs in Gaseous, Solid and liquid dielectrics.
3. Understand the generation and measurement of high voltages and currents.
4. Analyze the causes of over voltage and insulation coordination.
5. Analyze the High Voltage Testing of Electrical Apparatus and Non Destructive materials.

**UNIT-I: INTRODUCTION TO HIGH VOLTAGE TECHNOLOGY ANDAPPLICATIONS**

Electric Field Stresses, Gas / Vacuums Insulator, Liquid Dielectrics, Solids and Composites, Estimation and Control of Electric Stress, Numerical methods for electric field computation, Surge voltages, their distribution and control, Applications of insulating materials in transformers, rotating machines, circuit breakers, cable power capacitors and bushings.

**UNIT-II: BREAKDOWN INGASEOUS, SOLID ANDLIQUID DIELECTRICS**

Gases as insulating media, collision process, Ionization process, Townsend's criteria of breakdown in gases, Paschen's law. Liquid as Insulator, pure and commercial liquids, breakdown in pure and commercial liquids. Intrinsic breakdown, electromechanical breakdown, thermal breakdown,

breakdown of solid dielectrics in practice, Breakdown in composite dielectrics, solid dielectrics used in practice.

**UNIT-III: GENERATION AND MEASUREMENTSOFHIGH VOLTAGESAND CURRENTS**

Generation of High Direct Current Voltages, Generation of High alternating voltages, Generation of Impulse Voltages, Generation of Impulse currents, Tripping and control of impulse generators. Measurement of High Direct Current voltages, Measurement of High Voltages alternating and impulse, Measurement of High Currents-direct, alternating and Impulse, Oscilloscope for impulse voltage and current measurements and trapping.

**UNIT-IV: OVER VOLTAGEPHENOMENON ANDINSULATION CO-ORDINATION**

Natural causes for over voltages–Lightning phenomenon, Over voltage due to switching surges, system faults and other abnormal conditions, Principles of Insulation Coordination on High voltage and Extra High Voltage power systems.

**UNIT-V: NON-DESTRUCTIVE ANDHIGHVOLTAGE TESTINGOFMATERIAL AND ELECTRICAL APPARATUS**

Measurement of D.C Resistivity, Measurement of Dielectric Constant and loss factor, Partial discharge measurements. Testing of Insulators and bushings, Testing of Isolators and circuit breakers, Testing of cables, Testing of Transformers, Testing of Surge Arresters, Radio Interference measurements.

**TEXT BOOKS:**


1. High Voltage Engineering-M.S.NaiduandV.Kamaraju–TMHPublications,3rdEdition, 2009.
2. High Voltage Engineering-C.L.Wadhwa, New Age Internationals (P)Limited, 1997.


**REFERENCE BOOKS:**


1. High Voltage Insulation Engineering – Ravindra Arora, Wolfgang Mosch, New Age International (P)Limited, 1995.
2. High Voltage Engineering: Fundamentals - E.Kuffel, W.S.Zaengl, J.Kuffel, Elsevier publications, 2nd Edition,2000.

# T K R COLLEGE OF ENGINEERING &TECHNOLOGY

## (Autonomous)

## B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING -R18

**COMPUTER AIDED DESIGN OF ELECTRICAL MACHINES (Professional Elective-VI)-B28PE3**

**B.Tech. VIII Semester** **L/T/P/C**
**3/0/0/3**

**PREREQUISITE:** Elements of Electrical Engineering, DC Machines and Transformer, Elements of Electrical Design.

**COURSE OBJECTIVES:** The main objectives of the course are:

1. To introduce the basic concepts of CAD.
2. To teach the application of finite element method in design
3. To teach the CAD of electrical machines.

**COURSE OUTCOMES:** After completion of this course, the students will be able to:

1. Explain the concepts related to computer aided design of electrical equipments.
2. Formulate and solve the optimum design problems with computers.
3. Discuss application of finite element method in designing.
4. Develop computer aided design of electrical apparatus.
5. Explain the computer aided design of dc machines and transformers.

**UNIT —I:**

**CONCEPT OF COMPUTER-AIDED DESIGN AND OPTIMIZATION**

Introduction; Computer Aided Design; Explanation of details of flow chart; Input data to be fed into the program; Applicable constraints Max or Minimum permissible limits; Output data to be printed after execution of program; Various objective parameters for optimization in an electrical machine; Selection of optimal design; Explanation of lowest cost and significance of "Kg/KVA";Flowcharts.

**UNIT –II:**

**BASIC CONCEPTS OF DESIGN:**

Introduction; Specification; Output coefficient; Importance of specific loadings; Electrical Materials: Conducting Materials, Insulating Materials and Magnetic Materials; Magnetic circuit calculations; General procedure for calculation of Amp-Turns; Heating and Cooling; Modes of heat dissipation; Standard ratings of Electrical machines; Ventilation schemes in static machines (Transformers) and in rotating machines; Quantity of cooling medium; Types of enclosures; General design procedure; Steps to get optimal design.

**UNIT – III:**

**APPLICATION OF FINITE ELEMENT METHOD IN DESIGN**

Introduction; Basics of Finite element, Shape functions, Single element computation. Assembly of elemental coefficient matrix, Global coefficient matrix, Application of FEM technique for design problems. Use of open source FEM software for 2D design. Computation of Capacitance of capacitor, cable, multi dielectric cable through FEM, Computation of electrostatic field for various geometry, skin and proximity effect in conductors.

**UNIT – IV:**

**COMPUTER AIDED DESIGN OF ELECTRICAL APPARATUS**

Introduction; Flowcharts and programs for computer aided design of Starters, field regulators, small transformers, choke coils. 2D FEM open source software based electrical apparatus design.

**UNIT – V:**

**COMPUTER AIDED DESIGN OF DC MACHINES**

Introduction; Flowcharts and programs for computer aided design of DC machines. 2D FEM open source software based DC machine part design.

**COMPUTER AIDED DESIGN OF TRANSFORMERS**

Introduction; Flowcharts and programs for computer aided design of transformers, 2D FEM open source software based transformer part design.

**TEXT BOOKS**


1. Computer aided design of electrical machines - K M Vishnu Murthy, B S Publications
2. Computer aided design of electrical machines – Maurya, Jallan, Shukla, Kataria publication


**REFERENCE BOOKS**


1.An Introduction to the Finite Element Method – J Reddy, TMH Publication