EE501C	POWER SYSTEMS-II	3L:0T:0P	3 Credits
Sessional Marks :**40**		End Semester Examination Marks: **60**	

Pre-Requisites: Power systems-1, Network Analysis

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

1. Analyze the performance of different transmission lines and different voltage control methods
2. Understand the concepts of substations and overhead line insulators
3. Study and Evaluate power system transients
4. Understand the concepts of Underground Cables
5. Analyze and understand the concepts of Distribution systems

UNIT-I

Performance of transmission lines: Representation of lines - short transmission lines - medium transmission lines - Nominal pie and T representation of long lines by distributed parameters - Equivalent T and Pie representation of long transmission lines - Evaluation of ABCD parameters of long lines - Ferranti effect.

Voltage Control using Shunt and series capacitors - synchronous capacitors - Tap changing and Booster Transformers - Surge Impedance Loading (SIL).

UNIT-II

Substations: Number and size - Location and installation - The main equipment in substations - BusbarArrangements - Key diagram of a typical primary substation.

Overhead line insulators: Introduction - Types of insulators - Potential distribution over a stringof insulators - Methods of equalizing the potential, string efficiency - Testing of insulators.

UNIT–III

Power system transients: Introduction - Circuit closing transients - Sudden symmetrical short circuit analysis of alternator - Recovery transient due to removal of a short circuit - Travelling waves on transmission line - Surge impedance and wave velocity - Specification of travelling waves - Reflections and refractions of waves - Different types of terminations - Forked line - Successive reflections - Bewley's Lattice Diagram - Attenuation and Distortion - Arcing grounds.

UNIT-IV

Underground Cables: Introduction - The insulation types - Insulating materials for EHV voltage cables - Classification of cables - Parameters of single core cable - Grading of cables - Capacitance of three core belted cable break down of cables - Heating of cables – dielectric loss and Sheath losses - Current rating of cables

UNIT-V

AC Distribution: Comparison of AC single phase, 3 phase 3 wire and 3 phase 4 wire systems with DC 2 wire - Types of primary distribution systems - Types of secondary Distribution systems - AC distributors fed at one end and at both ends-Kelvin's law - Limitations of Kelvin's law - Load estimation - Selection voltage of primary distribution - Choice of scheme - Size of feeders, power factor correcting methods

Text Books:

1. C..L.Wadhwa, "Electrical Power systems" New age publications.
2. B.R.Gupta, "Power system analysis and design" third edition, Wheeler publishing.
3. William D.Stevenson "Elements of power system analysis" fourth edition, Mc Grawhill International editions.

Reference Books

1. C.L.Wadhwa, "Generation Distribution and utilization of Electrical energy" , New Age International
2. AR Bergen and Vijay Vittal, "Power system analysis", Pearson education, 2001

EE502C	LINEAR CONTROL SYSTEMS	3L:0T:0P	3 Credits
Sessional Marks: **40**		End Semester Examination Marks: **60**	

Pre-Requisites: Engineering Mathematics, Network Analysis

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

1. Understand the modeling of linear-time-invariant systems using transfer function and state-space representations.
2. Understand the concept of stability and its assessment for linear-time invariant systems.
3. Understand the applications of control systems in industries.

UNIT–I

Introduction: System representation – Classification of systems – Control system technologies – Types of control Systems: open loop and closed loop systems - Advantages and disadvantages of control systems – Examples of open loop and closed loop control systems – Transfer function and limitations

UNIT-II

Mathematical modeling of physical systems : Mathematical modeling and transfer functions of electrical, mechanical and electro-mechanical systems – Electrical analogues – Block diagram and their reduction techniques – Signal flow graphs – Introduction to servo motors – DC Servo motors – two-phase AC servo motors.

UNIT-III

Time domain analysis: Standard test input signals – step response of first and second order systems – Time domain specifications – steady state error – static error and generalized error coefficients – Problems.

UNIT-IV

Stability of control systems: Introduction – Bounded Input –Bounded Output (BIBO) – Necessary conditions for stability – Characteristic equation and location of roots in s-plane for stability – Routh-Hurwitz criterion – Root locus techniques – Rules for construction of root loci.

UNIT-V

Frequency domain analysis: Introduction to frequency domain specifications – correlation between time domain and frequency domain responses – Frequency response plots – polar plots – Nyquist Plots – Relative stability using Nyquist criterion – Bode plots – Gain margin and Phase margin.

Text Books:

1. I.J. Nagrath and M. Gopal, "Control system Engineering", Wiley Eastern Ltd.
2. Benjamin C. Kuo, "Automatic Control system", Prentice Hall, 1995.
3. Ch. Chengaiah and G.V Marutheswar, "Control Systems A comprehensive Lab Manual", B.S Publications, 2017.

EE503C	POWER ELECTRONICS	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Pre Requisites: Analog Electronics

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

1. Understand the differences between signal level and power level devices.
2. Analyze controlled rectifier circuits.
3. Analyze the operation of DC-DC choppers.
4. Analyze the operation of Inverters and Cyclo-Converters.

UNIT-I

Silicon controlled Rectifier – Static characteristics and ratings – turn-ON and turn-OFF mechanism – Gate characteristics – Series and parallel operation of SCR's static and dynamic equalization circuits – Protection circuits – Design of snubber circuit – Class A,B,C,D,E types of commutation circuits.

UNIT-II

Phase controlled Rectifiers - Principles of phase control – Half-wave and full- wave controlled rectifiers with resistive, inductive and RLC load – Freewheeling diode operation – Bridge rectifiers – Single phase and three phase Rectifiers with inductive load – Half and fully controlled rectifiers – freewheeling diode operation – Effect of source inductance – Dual converter – circulation and non-circulating current mode of operation.

UNIT-III

Choppers – D.C.Choppers – Principles of operation – control strategies, constant and variable frequency system, current limit control – Types of chopper circuits – Type-A, Type B and Type E chopper circuits Morgan chopper Jone's chopper

UNIT-IV

Inverters – Classification – series and parallel inverters improved series inverters – Bridge inverters – Commutation circuits – current and voltage commutation circuits – single phase and three phase inverters – output waveform control – Mc Murray Inverter – Introduction to PWM techniques

UNIT-V

Cyclo-converters – Principle of operation – single phase step-up and step down cycloconverters – Three-phase half-wave cycloconverters – output voltage equation – circulation and non-circulating current mode of operation – Load commutated cycloconverter.

Speed control – Speed control of DC motors using controlled rectifiers and choppers – Speed control of induction motors using inverters

Text Books:

1. An introduction to Thyristors and their application – Dr. M. Ramamoorthy – East Westpress.
2. Power Electronics - Dr. P.S. Bimbhra 2nd edition – Khanna publishers.
3. Power Electronics – M.D. SINGH and K.B. KHANCHANDANI – Tata Mc.Graw Hillpublishers.
4. Industrial and Power Electronics – RASHID (3rd Edition)

EE504C.i	WIND AND SOLAR ENERGY SYSTEMS	3L:0T:0P	3 Credits
Sessional Marks: **40**		End Semester Examination Marks: **60**	

Pre-Requisites: Power systems-I, Induction Motors and Synchronous Machines

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

1. Understand the solar radiation, measurements, characteristics of solar PV cell and windturbines.
2. Develop the models of PV system and wind turbine, and their applications.
3. Analyze the electrical characteristics and operation of various wind-driven electrical generators.
4. Understand various power electronic converters used for hybrid system

UNIT-I

Basic characteristics of sunlight – solar spectrum – insolation specifics– irradiance and irradiation-pyranometer – solar energy statics- Solar PV cell – I-V characteristics –P-V characteristics– fill factor-Modeling of solar cell– maximum power point tracking.

UNIT-II

PV module – blocking diode and bypass diodes– composite characteristics of PV module – PV array– PV system –PV-powered fan–PV fan with battery backup–PV-powered pumping system –PV powered lighting systems–grid- connected PV systems.

UNIT-III

Wind source–wind statistics-energy in the wind –turbine power characteristics - aerodynamics – rotor types – parts of wind turbines– braking systems–tower- control and monitoring system.

UNIT-IV

General characteristics of induction generators– grid-connected and self-excited systems–steady-state equivalent circuit-performance predetermination–permanent magnet alternators–steady- state performance.

UNIT-V

Power electronic converters for interfacing wind electric generators – power quality issues-hybrid systems-wind-diesel systems – wind-solar systems.

Text Books:

1. S N Bhadra, S Banerjee and D Kastha, 'Wind Electrical Systems', Oxford University Press, 1stEdition, 2005.
2. Chetan Singh Solanki, 'Solar Photovoltaics: Fundamentals, Technologies andApplications' PHILearning Publications, 2nd Edition, 2011.

Reference Books:

1. Roger A. Messenger and Jerry Ventre, 'Photovoltaic Systems Engineering', Taylor and FrancisGroup Publications, 2nd Edition, 2003.
2. M. Godoy Simoes and Felix A. Farret, 'Alternative Energy Systems: Design and Analysis withInduction Generators', CRC Press, 2nd Edition, 2008
3. Ion Boldea, 'The Electric Generators Handbook- Variable Speed Generators', CRC Press, 2010.
4. Bin Wu, Yongqiang Lang, Navid Zargari, Samir Kouro, 'Power Conversion and Control of Wind Energy Systems', IEEE Press Series on Power Engineering, John Wiley & Sons,2011.
5. S. Sumathi,L. Ashok Kumar,P. Surekha ,'Solar PV and Wind Energy Conversion Systems', Springer 2015

EE504C.ii	ELECTRICAL DISTRIBUTION SYSTEM	3L:0T:0P	3 Credits
Sessional Marks: **40**		End Semester Examination Marks: **60**	

Pre-Requisites: Power systems-1

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

1. Understand the basics of Distribution systems
2. Understand different Distribution Transformers &feeders
3. Understand the basics of Substations
4. Understand the working of Protective devices and coordination
5. Acquire the knowledge of power factor and voltage control

UNIT-I

Introduction to distribution systems: An overview of the role of computers in distribution system planning. Load modeling and characteristics. Coincidence factor, contribution factor and loss factor. Classification of loads (Residential, Commercial, Agricultural and Industrial) and their characteristics.

UNIT-II

Distribution Transformers &feeders – Distribution transformer types, regulation and efficiency. Design considerations of distribution feeders – Radial and loop types of primary feeders, voltage levels, feeder loading; basic design practice of the secondary distribution system.

UNIT-III

Substations – Introduction – types of substations - main equipments in substations - Busbar Arrangements- Key diagram of a typical primary substation - Rating of a distribution substation, service area within primary feeders. Benefits derived through optimal location of substations.

UNIT-IV

Protective devices and coordination – Objectives of distribution system protection, Types of common faults and procedure for fault calculations. Protective Devices: Principle of operation of fuses, circuit reclosures, line Sectionalizers, and circuit breakers. Coordination of protective devices General coordination procedure.

UNIT-V

Power factor improvement and voltage control – Capacitive compensation for power-factor control – Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and Switched), power factor correction, capacitor allocation.

Voltage control – Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation.

Text Books:

1. "Electric power Distribution system Engineering "– by Turan Gonen, Mc Graw-Hill book company.
2. V. Kamaraju, Electrical Power Distribution Systems, Tata Mc Graw Hill Publishing Company, 2nd edition, 2010.
3. Electric Power Distribution – by A.S. Pabla, Tata McGraw–hill Publishing company, 4th edition, 1997.

EE504C.iii	ELECTRICAL SAFETY	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Pre Requisites: Power Systems-1

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

1. Understand the need of electrical safety in different locations
2. Understand the need of electrical safety during installation of equipment's
3. Describe the electrical safety in residential, commercial and agricultural installations.
4. Explain the necessity of electrical safety in Hazardous zones
5. Understand electrical safety in distributed systems and usage of Fire extinguishers

UNIT-I

INTRODUCTION TO ELECTRICAL SAFETY, SHOCKS AND THEIR PREVENTION: Terms and definitions, objectives of safety and security measures, Hazards associated with electric current, and voltage, who is exposed, principles of electrical safety, Approaches to prevent Accidents, scope of subject electrical safety. Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and itseffects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shops.

UNIT-II

SAFETY DURING INSTALLATION OF PLANT AND EQUIPMENT: Introduction, preliminary preparations, preconditions for start of installation work, during, risks during installation of electrical plant and equipment, safety aspects during installation, field quality and safety during erection, personal protective equipment for erection personnel, installation of a large oil immersed power transformer, installation of outdoor switchyard equipment, safety during installation of electrical rotating machines, drying out and insulation resistance measurement of rotating machines.

UNIT-III

ELECTRICAL SAFETY IN RESIDENTIAL, COMMERCIAL AND AGRICULTURAL INSTALLATIONS: Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances

UNIT-IV

ELECTRICAL SAFETY IN HAZARDOUS AREAS: Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements –Specifications of electrical plants, equipments for hazardous locations – Classification ofequipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for

hazardous locations.

UNIT-V

ELECTRICAL SAFETY IN DISTRIBUTION SYSTEM: Total quality control and management – Importance of high load factor – Disadvantages of low power factor – Causes of low P.F. – power factor improvement – equipment – Importance of P.F. improvement

Fire Extinguishers: Fundamentals of fire-initiation of fires, types; extinguishing techniques, prevention of fire, types of fire extinguishers, fire detection and alarm system; CO_2 and Halogen gas schemes; foam schemes.

Text Books:

1. Rao, S. and Saluja, H.L., "Electrical Safety, Fire Safety Engineering and Safety Management", Khanna Publishers, 1988.
2. Pradeep Chaturvedi, "Energy Management Policy, Planning and Utilization", Concept Publishing Company, 1997.

Reference Books:

1. Cooper.W.F, "Electrical safety Engineering", Newnes-Butterworth Company, 1978.
2. John Codick, "Electrical safety hand book", McGraw Hill Inc., New Delhi, 2000.
3. Nagrath, I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1998.
4. Wadhwa, C.L., "Electric Power Systems", New Age International, 2004.

EE506L	CONTROL SYSTEMS LAB	0L:0T:3P	1.5 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Pre-requisites: Control Systems

Course Outcomes: At the end of the course, the student will be able to:

1. Simulate the physical control system for stability studies
2. Demonstrate feedback controllers
3. Develop logic gates using PLC

LIST OF EXPERIMENTS

1. Modeling of Physical Systems (Mechanical and Electrical systems).
2. Block Diagram Reduction of Linear Systems
3. Time response analysis of Linear Systems for impulse and step inputs
4. Frequency response analysis of Linear Systems
5. Stability and relative stability analysis of Linear Systems Using (Root Locus, Bode andNyquist plot).
6. Time Response analysis of Second Order System.
7. Study the effect of P, PD, PI, PID controllers on second order systems.
8. Magnitude and phase plot of Lag and lead compensators.
9. Determination of transfer function and effect of feedback on DC servo motor.
10. Study of logic gates using PLC

Additional Experiments

1. Design of Lag and Lead Compensators for a given system
2. Stepper motor control using Simulation tools.
3. Study the effect of P, PD, PI, PID controllers on DC servomotor system using PLC.

EE507L	**POWER ELECTRONICS LAB**	**0L:0T:3P**	**1.5 Credits**
Sessional Marks: **40**		End Semester Examination Marks: **60**	

Pre-requisites: Power electronics Theory

Course Outcomes: At the end of the course, the student will be able to :

1. Examine the characteristics of Power electronic devices
2. Analyze the performance of different power converters using trainer kits.
3. Evaluate the performance of different power converters using simulation tools

LIST OF EXPERIMENTS

1. Study the operation of a matrix converter.
2. Obtain the static V-I characteristics of SCR and IGBT.
3. Connect 1-Φ fully controlled rectifier and to control the speed of a DC motor.
4. Observe the output waveform of series inverter.
5. Verify the operation of dual converter.
6. Observe the output waveforms of 1-Φ parallel inverter at different frequencies.
7. Study the speed control of 3-Φ induction motor in open- loop and closed loop usingsinusoidal PWM techniques.
8. Study the circuit of 3-Φ half controlled rectifier.
9. Verify Jone's chopper.

EE508S	**MATLAB Laboratory**	**1L:2T:3P**	**2 Credits**
Sessional Marks: **40**		End Semester Examination Marks: **60**	

Pre-requisites: Computer Skills

Course Outcomes: At the end of the course, the student will be able to :

1. Learn the MATLAB environment and its programming fundamentals
2. Write programs using commands and functions
3. Handle and solve problems using MATLAB and to draw the plots
4. Create Simulink model

LIST OF EXPERIMENTS

1. To write a program for matrix operation and various functions.
2. To develop a program for finding solutions of linear equations and factorial of a number.
3. To develop a program for geometric progression and convolution of two signals.
4. To write a program to draw a circle and different type of plots.
5. To write a program for different types of waveforms with and without switch case.
6. To develop a program for integral and differentiation of a polynomial.
7. To develop a program to find largest & smallest and ascending & descending order byusing MATLAB software.
8. To write a program to find date & calendar, given input year is leap year or not
9. To develop a program for displaying multiplication table and factorial of a given number.
10. To write a program code for taking students and employee details

MC509A	UNIVERSAL HUMAN VALUES	2L:0T:0P	0 Credits
Sessional Marks: **100**		End Semester Examination Marks: **NIL**	

Pre-requisites/co-requisites: None.

COURSE OUTCOMES: At the end of this of this course, the students will be able

1. To become more aware of themselves, and their surroundings (family, society, nature)
2. To distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.
3. To Understand the role of a human being in ensuring harmony in society and nature.
4. To become sensitive to their commitment towards what they have understood (human values, human relationship and human society)
5. To Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.

UNIT I

Introduction - Need, Basic Guidelines, Content and Process for Value Education: Purpose and motivation for the course, Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly - A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

UNIT II

Understanding Harmony in The Human Being - Harmony in Myself: Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility (Sukh and Suvidha). Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning ofProsperity in detail. Programs to ensure Sanyam and Health.

UNIT III

Understanding Harmony in The Family and Society- Harmony in Human- Human Relationship: Understanding harmony in the Family - the basic unit of human interaction. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness (Ubhay-tripti); Trust **(Vishwas)** and Respect **(Samman)** as the foundational values of relationship. Understanding

the meaning of Trust; Difference between intention and competence.

Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution (Samadhan), Prosperity (Samridhi), fearlessness (**Abhay**) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society (Akhand Samaj), Universal Order (Sarvabhaum Vyawastha) - from family to world family.

UNIT IV

Understanding Harmony in The Nature and Existence - Whole Existence as Coexistence: Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence.

UNIT V

Implications of The Above Holistic Understanding of Harmony on Professional Ethics: Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basisfor Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations.

TEXT BOOKS:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, ExcelBooks,New Delhi, 2010.
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.

REFERENCE BOOKS:

1. E. F. Schumancher, 1973, Small is Beautiful: a study of economics as if people mattered.Blond & Briggs, Britain.
2. A. N. Tripathy, 2003, Human Values, New Age International Publishers.
3. Ivan IIlich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
4. A Nagraj, 1998 Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.
5. Sussan George, 1976, How the Other Half Dies, Penguin Press, Reprinted 1986, 1991.

6. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) Krishi TantraShodh, Amravati.
7. E G Seebauer & Robert L.Berry, 2000, Fundamentals of Ethics for Scientists & Engineers,Oxford University Press.
8. M Govindrajan, S Natrajan & V. S Senthil kumar, Engineering Ethics (including HumnaValues), Eastern Economy Edition, Prentice Hall of India Ltd.
9. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
10. India Wins Freedom - Maulana Abdul Kalam Azad.

Relevant CDs, Movies, Documentaries & Other Literature:

1. value Education website, http://www.uptu.ac.in
2. Story of Stuff, http://www.storyofstuff.com
3. AI Gore, An Inconvenient Truth, Paramount Classics, USA
4. Charle Chaplin, Modern Times, United Artists, USA
5. IIT Delhi, Modern Technology - the Untold Story.