SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

Draft Syllabus of B.E. Semester V & VI B.E. [Electrical Engineering] – NEP

SEMESTER V

5EE220PC – Power Electronics

Course Outcomes:

After completing this course student will be able to

1. Explain the knowledge about fundamental concepts and techniques used in power Electronics.
2. Analyze various single phase and three phase power converter and Inverter circuits.
3. Analyze the operation of DC/DC and AC/AC converter circuits.
4. Implement industrial applications of power electronic circuits.

Unit I: SCR, Triac, Diac – Construction and Applications, two Transistor Analogy of SCR, SCR turn ON mechanism, different methods for turning ON SCR, turn OFF mechanism, Thyristor firing circuits, introduction to Power MOSFET and IGBT their construction and characteristics.

Unit II: Series-Parallel operation of SCRs, firing circuits for series and parallel operations, static and dynamic equalizing circuit, equalization of current in parallel connected SCRs, string efficiency, de-rating factors, protections of SCRs against di/dt, dv/dt, over-voltage and over-current protection, Gate protections.

Unit III: Principle of phase control, half wave-controlled rectifier, half controlled bridge and fully controlled bridge rectifier for R, RL and RLE load, derivation for output voltage and current, effect of freewheeling diode, effect of source inductance. Three phase half-controlled bridge and fully controlled bridge rectifier.

Unit IV: Classification of circuit for forced commutation, series inverter, improved series inverter, parallel inverter, single phase PWM inverters, principle of operation of three phase bridge inverter in 120^{o} and 180^{o} mode.

Unit V: Basic principle of Chopper, Time ratio control and current limit-controlled technique, Voltage commutated Chopper circuit, Jones Chopper, Step up Chopper, Step down Chopper and AC Chopper.

Unit VI: Speed control of DC series motor using chopper, Speed control of DC shunt motor using phase-controlled rectifier. Speed control of three phase Induction motor by stator voltage control method, V/f control

Text Books:

1. M.D. Singh & K.B. Khanchandani, “Power Electronics “Tata Mc-Graw Hill, New Delhi
2. Rashid Muhammad, H., “Power Electronics: Circuits, Devices and Applications”, 2nd Edition. Prentice- Hall, 1998

Reference Books:

1. Mohan Ned, Undeland Tore, M. and Robbins William, P., “Power Electronics: Converter, Applications and Design”, John Wiley & Sons, 1994.
2. Landev Cyrill, W., “Power Electronics”, McGraw Hills, London, 1981.
3. Dewan, S.B. and Satrughan A., “Power Semiconductor Circuits”, John Wiley & Sons,
4. Dubey, G.K., Doradlla, S.R., “Thyristerised Power Controllers”, Wiley Eastern, 1987.

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5EP221PC/5EE221PC Electrical Machines - II

Course Outcomes:

After completing this course students will be able to

1. Describe the construction, working principle & performance characteristics of three phase Induction Motor
2. Analyze the starting, braking and speed control of three phase induction motors by various methods.
3. Explain the construction, operation & application of single-phase Induction Motor
4. Demonstrate the construction, working operation & performance characteristics of synchronous machine.
5. Explain the construction & working of special motors like Universal, Reluctance, PMSM & BLDC Motor

Unit I: Three phase induction motor - I

Construction, Types: - Squirrel cage and slip-ring, Rotating Magnetic Fields, principles of operation, Working, slip, Rotor torque, Starting and Maximum Torque, Torque Slip Characteristics, Effect of parameter variation on torque slip characteristics. Equivalent circuit, calculations of parameters of equivalent circuit, Power flow, Phasor Diagram, circle diagram, Performance evaluation by direct & indirect methods.

Unit II: Three phase induction motor - II

Starters for squirrel cage &slip-ring type IM, Methods of speed control, electric braking, High Torque IM, single phasing, cogging and crawling, Induction Generator, Doubly-Fed Induction Generator.

Unit III: Single phase Induction Motor: Double revolving field theory, Constructional features, equivalent circuit, working, Split-phase starting methods and applications of single-phase Induction motors.

Unit IV: Synchronous Generator :
Constructional details, working principle, operation, armature reaction, circuit model, determinations of parameters of the circuit model, phasor diagrams, various methods of determining the voltage regulations and efficiency, Parallel operation of alternators - synchronization and load division.

Unit V: Synchronous Motor:
Construction, principle of operation, working, starting methods, torque equation - V-curve, Inverted V curve &power angle characteristics, hunting & damping, applications. Transient, sub transient & steady state reactance of synchronous machines.

Unit VI: Special Motors :
Construction, working principle, characteristics and applications of Universal motor, Reluctance Motor, Permanent Magnet Synchronous Motor & BLDC Motor.

Text Books:

1. D. P. Kothari & I. J. Nagrath, "Electrical Machines"- 5thEdition, TMH Publication.
2. S. Langsdorf, "Alternating current machines", McGraw Hill Publication

Reference Books:

1. Stephen D. Umans, "Fitzgerald and Kingsley's Electric Machinery", 7th Edition, McGraw Hill Publication, 2020.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. C L Dawes, "A Course in Electrical Engineering (Volume -2)", McGraw Hill Publication.

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5EP222PC/5EE222PC - Power System - I

Course Outcomes :

After successful completion of the course, students will be able to -

1. Determine the parameters of transmission lines.
2. Evaluate the performance of transmission line.
3. Describe transmission line's voltage control and power factor improvement methods.
4. Explain representation of power system, Ferranti effect and corona phenomenon.
5. Demonstrate various Insulators, its string efficiency & underground cables

Unit I: Transmission line parameters –

Calculation of resistance, inductance and capacitance of single phase and three phase transmission lines, skin effect and proximity effect, transposition, G.M.D. & G.M.R. methods, double circuit lines, bundled conductors, effect of earth on inductance and capacitance, interference with communication lines.

Unit II: Electrical characteristics of transmission line –

V-I characteristics of short, medium and long lines, A, B, C, D constants, nominal T and equivalent π representations.

Unit III: Voltage control and power factor improvement –

Methods of voltage control and power factor improvement, use of static VAR generators and synchronous condenser, automatic voltage control. Receiving end and Sending end power circle diagrams.

Unit IV: Representation of power systems –

Single line diagrams, per unit system and one-line impedance and reactance diagrams. Ferranti effect, corona phenomenon, Introduction to Travelling waves.

Unit V: **Insulators –**

Materials used, types, comparison of pin type and suspension type insulators, voltage distribution and string efficiency, methods of increasing string efficiency, grading rings and arcing horns. Introduction to insulator testing, line supports for LV, HV, EHV and UHV.

Unit VI: Underground cables –

Material used for conductor & insulation, different types of cables and their construction, parameters of underground cable, grading of cable, losses, break down and rating, selection of cables.

Text Books:

1. Modern Power System Analysis by D. P. Kothari, I. J. Nagrath TMH company ltd., New Delhi.
2. Elements of power system analysis by William D. Stevenson, Jr, McGraw-Hill International edition.

Reference Books:

1. Power System Engineering by D. P. Kothari, I. J. Nagrath TMH company ltd., New Delhi
2. Narain G. Hingorani and Lazlo Gyugyi – "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems".
3. Principles of power system by V. K. Mehta, S. Chand & company ltd., New Delhi.
4. Electrical Power Systems by C. L. Wadhwa, New Age International Publishers, New Delhi
5. Electrical Power Systems by Ashfaq Husain, CBS Publishers & Distributors Pvt. Ltd., New Delhi.
6. Electrical Power system Design by M. V. Deshpande, TMH Company Ltd., New Delhi.

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Professional Elective – I

5EP223PE1/5EE223PE1 - Advanced Control Systems

Course Outcomes:

After completing this course students will be able to-
1. Design compensator using time domain and frequency domain specifications
2. Represent system using state space model
3. Analyze controllability and observability for systems and design full state feedback controller.
4. Analyze digital systems using Z Transform
5. Develop the describing function for the nonlinearity to assess the stability of the system.
6. Analyze the Nonlinear system using Phase plane Analysis

Unit I: Compensation Techniques:

Introduction, preliminary consideration of classical design. Lead compensator and Lag Compensator using time domain and frequency domain specifications

Unit II: State Space Technique I:

State, state space and state variables, SISO /MIMO linear systems state Variable models- differential equations, transfer functions, block diagrams and state diagrams. Transfer function decomposition –Phase variable Forms, canonical forms and Jordan canonical forms, STM computation, L.T, Canonical transformation, and Cayley Hamilton theorem. Time Response –SISO systems.

Unit III: State Space Technique II:

Concept-controllability and observability, Gilbert's method and Kalman's test; SISO controllable Systems design – state feedback.

Unit IV: Sampled Data Control Systems:

Representation, Z transform, Sampler and hold, ZOH, Open loop and closed loop SDCS, , difference equation solution, Z transfer Function, Stability Analysis, S and Z domain relationship, Jury's test, and bilinear Transformation.

Unit V: Non-Linear System Analysis I:

Nonlinear system behavior, types and characteristics, Describing function of nonlinearities. Stability Analysis of Non-Linear Systems

Unit VI: Non-Linear System Analysis II:

Linearization, Singular points, Classification and nature, Phase plane method, nonlinear system analysis, Construction of Phase Trajectories–analytical and graphical method by isoclines

Text Books:
1. Nagrath and Gopal, "Control system Engineering" Wiley Eastern Ltd, New Delhi
2. K. Ogata," Modern Control Theory "Prentice Hall of India Pvt Ltd, New Delhi.

Reference Books:
1. Naresh Sinha. "Control system Engineering" Wiley Eastern Pvt. Ltd., New Delhi.
2. B.C. Kuo. "Automatic Control system "Prentice Hall of India Pvt Ltd Delhi
3. D Roy Choudhury," "Modern Control Engineering" Publisher: PHI Learning.

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5EP223PE2/5EE223PE2 - Industrial Automation

Course Outcomes:

After successful completion of this course, students will be able to:

1. Explain the concepts, need, benefits, hierarchy, and components of industrial automation systems.
2. Identify appropriate industrial sensors, actuators, and drives for automation applications.
3. Describe the architecture, working principles, and hardware configuration of PLC systems.

4. Develop basic PLC programs using IEC programming languages and ladder logic.
5. Implement PLC-based control solutions for typical industrial applications such as motor control and process automation.
6. Interpret the role and architecture of SCADA, HMI, and industrial robots in modern automation systems.

Unit I: Introduction to Industrial Automation

Definitions of Automation, Need and benefits of Automation in Industry, Automation Hierarchy, Basic components of automation system, description of each component, Types of automation system: Fixed, programmable, flexible, Different systems for Industrial automation: PLC, SCADA & HMI.

Unit II: Industrial Sensors, Actuators and Drives

Definitions of Sensors, Actuators and Drives, Proximity Sensors, Ultrasonic Sensor, LVDT, Hall effect sensor, Temperature sensor (RTD, Thermocouple, thermistor), Strain Gauge, Flow sensor, Level sensor, load cell, Solenoids, Relays and contactors, stepper motors, servo motors, VFDs.

Unit III: PLC Fundamentals Definitions & history of PLC, building blocks of PLC: CPU, memory organization, Input-output modules (discrete and analog), special I/O modules, power supply, working principles of PLC, applications of PLCs in industries, types of PLCs (compact, modular, rack-mounted), advantages & limitations, selection criteria for PLC, redundancy in PLC module, I/O module selection criteria, interfacing different I/O devices with appropriate I/O modules.

Unit IV: Basics of PLC Programming

IEC Programming Standard, Ladder Diagram, Function Block Diagram, Instruction List and Structured Text, Development of PLC ladder diagram, Basic components & their symbols in ladder diagram, Fundamentals of ladder diagram, Boolean logic & relay logic, Input ON/OFF switching devices, Input analog devices, Output ON/OFF devices, Output analog devices, Overview of PLC software.

Unit V: PLC Programming and Applications

Advanced Programming Instructions: Mathematical Instructions, Comparison Instructions, Logical Instructions, Subroutines.

PLC Applications: DOL starter, Star-Delta starter, Forward-Reverse motor control, Conveyor bottle filling, Water level control, Traffic light control.

Unit VI: SCADA, HMI and Introduction to Industrial Robotics

Definition and evolution of SCADA, SCADA architecture, SCADA components, benefits of SCADA, Interfacing SCADA with PLC, Definition and role of HMI in industrial automation, basic Robot architecture, types of robot, industrial applications of robot.

BOOKS RECOMMENDED:

Text Books:

1. Gary Dunning, Cengage, “Introduction to Programmable Logic Controllers”, Third Edition, 2006, Learning Pub.
2. Sanjay B Katariya, “Industrial Automation Solutions For PLC, SCADA, Drive and Field Instruments” Notion Press, Chennai, 1st edition (23 May 2020).

Reference Books:

1. Himanshu Kumar, “Advanced Industrial Automation”, Notion Press, Chennai (1 July 2020)
2. K. S. Manoj, “Industrial Automation with SCADA”, Notion Press, Chennai 2019.
3. Stamatios Manesis, George Nikolakopoulos, “Introduction to Industrial Automation”, CRC Press, Tylor & Francis.

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5EP223PE3/5EE223PE3- Process Control System

Course Outcomes:
After Completing this course student will be able to
1. Explain the various Electronic Instruments for measurement of electrical parameters.
2. Analyse the different signals
3. Demonstrate the signal counting, recording and working of digital readout devices.
4. Demonstrate the Various techniques of A/D and D/A conversions.
5. Apply various signal processing tools as per requirement
6. Develop ladder diagrams & programmes for PLC

Unit I: Electronics Instruments for Measurement of Electrical Parameters Advantages of Electronic Instruments, Electronic Voltmeters Electronic Multi-meter, differential volt meter, Digital voltmeter, Q meter, vector impedance meter, vector voltmeter.

Unit II: Signal Generation and Analysis Signal generators, Function generators. Wave analyzer Harmonic Distortion Analysers, Spectrum Analysis.

Unit III: Signal Counting and Recording Decade counting Assembly, Binary counter, Decimal counter, Decade counter with digital display, universal counter, Digital readout devices, storage type CRO, Servo type X-Y recorder.

Unit IV: Signal conditioning and Conversions. Frequency characteristics of various types of signals, active filters bandpass, low pass and high pass filters using opAmps. Various techniques of A/D and D/A conversions. Modulation and demodulation PCM techniques, phase locked loop. DRAFT

Unit V: Signal Processing Pulse times, triggered delayed sweeps, discrete pulse delay circuits, pulse sequencing, analog multiplexers and de-multiplexers, digital multiplexing sample and hold circuits, serial and parallel digital data conversion. Signal transmission, Analog and digital telemetry techniques, MODEM and UART, keyboard and character generators, tape recorder,

Unit VI: Introduction to Processor and Processor based Techniques. Introduction to PLC, PLC architecture, programming; ladder diagram and examples, micro controller-based instrumentation.

Text Books:

1. H.S. Kalsi – Electronic Instrumentation, - Tata Mc-Graw Hill Publishing Company, New Delhi.
2. Cooper, Helfrick – Electronic Instrumentation and Measurement Techniques, A Prentice Hall of India. New Delhi.

Reference Books:

1. B.R. Gupta-Electronics and Instrumentation – Wheeler Publishing.
2. Rangan, Sharma & Mani – "Instrumentation – devices & Systems." Tata Mc-Graw Hill Publishing Company, New Delhi.
3. R.P. Jain-Digital Electronics, Tata Mc-Graw Hill Publishing Company, New Delhi.
4. Microprocessors and Digital Systems, by: D. V. Hall, TMH Publishing Company, New Delhi.
5. Shoen Beck- Electronic Communication, Prentice Hall of India. Pvt. Ltd. New Delhi.
6. B. Ram- fundamental of Microprocessors, Dhanpat Rai & Sons, New Delhi.
7. A.K. Sawhney – A Course in Electrical & Electronics Instrumentation, Dhanpat Rai & Sons, New Delhi.

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5EE224PC Power Electronics - Lab

Conduct minimum eight experiments based on the syllabus of Power Electronics (5EE220PC)

5EP225PC/5EE225PC Electrical Machines - II Lab

Conduct minimum eight experiments based on the syllabus of Electrical Machines - II (5EP221PC/5EE221PC)

5EP226PC/5EE226PC Power System - I Lab

Conduct minimum eight experiments based on the syllabus of Power System – I (5EP222PC/5EE222PC)

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Multi-Disciplinary Minor (MDM)

5EP227MD/5EE227MD - DC Machines

Course Outcomes:

After Completing this course student will be able to

1. Explain the construction, principle of operation, EMF equation and torque equation of DC machines.
2. CO2: Classify the types of DC generators with their circuit diagrams, characteristics, and applications, including parallel operation.
3. CO3: Describe characteristics, applications, starting methods and speed control methods of various types of DC motors.

Unit I: D.C. Machines:

Construction - Yoke, Armature, Field Poles, Field Coils, Cummutator, Brushes used for Construction – Martial Used for Construction, Principle of Operation, EMF Equation, Torque Equation. Armature winding – Lap, wave, single layer, double layer. Commutation, Process of commutation

Unit II : D.C. Generators:

Types DC Generator & Their Circuit Diagram with Current, Voltage Power Equation, Open Circuit, Internal & External Characteristics of Self Excited and Separately Excited DC Generator, Applications of D. C. Generators, Parallel Operation of D.C. Generators.

Unit III : D.C. Motors:

Principle of DC Motor, Back EMF, Types- Permanent Magnet, Separately Excited Characteristics, Self Excited DC Motor, Applications of D.C. Motors. Need of Starter- Three Point Starter & four Point Starter, Speed Control of DC Motors- Field Control, Armature Control and Voltage Control Method.

Text Book: Electrical Machines by D P Kothari & I J Nagrath Published by Tata McGraw-Hill Book Comp. New Delhi.

Reference Books:

1) C. Dawes: Electrical Engineering, Vol.I: Direct current (IV Edition), (McGraw Hill Book Company)

2) H. Cotton: Advance Electrical Technology, (Wheeler publication)

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Multi-Disciplinary Minor (MDM)
5EP228MD/5EE228MD - AC Machines

Course Outcomes:
After Completing this course student will be able to

1. Explain single-phase induction motor construction, operation, types, characteristics, and applications.
2. Demonstrate the construction, operation, characteristics, applications, starting methods and speed control methods of three-phase induction motors.
3. Summarize construction, operation, and applications of special motors like BLDC motor, universal motor, stepper motor, PMSM, SRM.

Unit I: Single-Phase Induction Motors

Construction- Stator & Rotor, Working Principle, Double Revolving Theory, Classification - Split-Phase Motors, Capacitor Motors, Shaded Pole Motors of single-phase induction motors, Characteristics and applications.

Unit II: Three-Phase Induction Motors

Construction, Working Principle, characteristics of 3 phase Induction motors, applications. Starting, Speed Control Method- Supply voltage control, Supply frequency control (V/f control using VFD), Pole changing method, Rotor resistance control, Slip power recovery methods

Unit III: Special Motors

Constructional details, working and applications of universal motor, SRM motor, brushless DC motors, stepper motors, servo Motor, permanent magnet synchronous motor

Text Book: D. P. Kothari & I. J. Nagrath, "Electrical Machines"- 5thEdition, TMH Publication.

Reference Books:

1. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
2. C L Dawes, "A Course in Electrical Engineering (Volume -2)", McGraw Hill Publication

5EP229MD/5EE229MD Electrical Machines Lab

Conduct minimum eight experiments based on the syllabus of DC Machines (5EP227MD/5EE227MD) & AC Machines (5EP228MD/5EE228MD**)**

Open Elective III

5EP230OE1/5EE230OE1 - Energy Audit and Management

Course Outcomes:
After completing this course student will be able to:
1. Summarize energy scenario, its management and the energy audit procedures.
2. Determine the economics of energy conservation.
3. Discuss various energy Conservation methods & energy audit case studies.

Unit I:

Energy Scenario & Management: Indian energy scenario, India Energy sector reforms, various forms of energy, Energy and environment, Energy strategy for the future, Concept of supply side management and demand side management.

Energy Audit: Definition, Need of energy audit, Preliminary and detailed energy audit. Procedure for carrying out energy audit, Instruments used for energy audit, Sankey diagram, Recommendations for energy conservation, Action plan, Executive Summary.

Unit II:

Economics of energy conservation: Cost factors, Budgeting, Standard costing and Sources of capital, Cash flow diagram and activity chart, Simple Payback period analysis, Time value of money, Net present value method, internal rate of return method, Profitability index for benefit cost ratio.

Unit III:

Energy Conservation: Energy conservation in motive power, Illumination, Heating & cooling systems, Pumping systems.

Energy Audit Case Studies: Energy Intensive Industries, Commercial, Municipal and Hospitals.

Text Book:

Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, Book-2, Book-3, Book-4 (available online BEE website)

Reference Books:

1. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.

2. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

3. Energy Conservation and Audit by Thumman, Fairmont Press

4. Energy Audit and Conservation TERI

5EP230OE2/5EE230OE2 - Electrical Estimation and Costing

Course Outcomes:

After completion of the course students will be able to

1. Explain the fundamentals of electrical installations and service connections.
2. Prepare detailed estimates and costing for residential, commercial, and small industrial electrical installations.
3. Analyze distribution systems and tendering procedures for execution of electrical works.

Unit I: Electrical Installation and Service Connection

Classification and general requirements of electrical installations. Important definitions related to installation work. Concept, types, features, and methods of service connections. Basic estimation of service connections.

Unit II: Electrification and Estimation of Installations

Design and estimation of residential, commercial, and small industrial installations including load assessment, circuit planning, motor wiring concepts, and selection of wiring systems, cables, and bus bars. Earthing methods for electrical installations. Preparation of detailed estimates and costing for buildings and factory units.

Unit III: Distribution Systems, Substations and Contract Procedures

Design and estimation of feeders, distributors, and distribution substations (indoor and outdoor), including selection of transformer size and location. Tender procedures, contract conditions, comparative statements, administrative approval, technical sanction, execution of works, and billing of completed projects.

Text & Reference Books:

1. Electrical Design; Estimating and costing by K.B. Raina, S. K. Bhattacharya New Age International Pvt Limited, New Delhi.

2. Electrical Estimating and costing by Surjit Singh Dhanpat Rai and company, New Delhi

3. Electrical Estimating and costing by N. Alagappan S. Ekambaram, Tata Mc Graw Hill Publication New Delhi.

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