Scheme of Instruction and Syllabi
of
Choice Based Credit System (CBCS) of

BE / B.TECH V AND VI SEMESTERS
OF
FOUR YEAR DEGREE COURSE
IN

ELECTRICAL & ELECTRONICS ENGINEERING

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
(An Autonomous Institution)
Affiliated to OU; All U.G. and 5 P.G. Programmes (Civil, CSE, ECE, Mech. & EEE)
Accredited by NBA; Accredited by NAAC - 'A' Grade (UGC); ISO Certified 9001:2015
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CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Choice Based Credit System (with effect from 2018-19)

B.E (Electrical and Electronics Engineering)

SEMESTER-V

S.No	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			
			Hours per week		Duration in Hours	Maximum Marks		Credits
			L/T	P/D		CIE	SEE	
THEORY								
1.	**16EEC15**	Power Systems – II	3/1	-	3	30	70	4
2.	**16EEC16**	Electrical Machinery – II	3/1	-	3	30	70	4
3.	**16EEC17**	Power Electronics	4	-	3	30	70	4
4.	**16EEC18**	Linear Control Systems	3/1	-	3	30	70	4
5.	**16EEEXX**	Program Specific Elective-1	3	-	3	30	70	3
PRACTICALS								
6.	**16EEC19**	Electrical Machinery – II Lab	0/1	2	3	25	50	2
7.	**16EEC20**	Power Electronics Lab	0/1	2	3	25	50	2
8.	**16EEC21**	Linear Control Systems Lab	0/1	2	3	25	50	2
			22	**06**	**-**	**225**	**500**	**25**

L: Lecture T: Tutorial D: Drawing P: Practical
CIE - Continuous Internal Evaluation SEE - Semester End Examination

Course Code	Program Specific Elective-1
16EE E01	Non Conventional Energy Sources (NCES)
16EE E02	Electrical Engineering Materials (EEM)
16EE E03	Electronic Instrumentation (EI)
16MT E01	Statistical and Numerical Methods (SNM)
	Courses offered to other Departments
16EE E04	Electrical Technology (for BE3/4, ECE, V-SEM) (Elective)
16EEC22	Electrical Machines and Microcontroller Applications Lab (Core) (for BE3/4, Mech & Prod, V-SEM)

16EEEC15

POWER SYSTEMS – II

Instruction	3L+1T Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: The objective of the course is to

1. Comprehend inductance and capacitance calculations for different line configurations.
2. Understand per unit system representation in power systems.
3. Know the importance of transmission line representation in terms of short, medium and long lines in finding performance of lines.
4. Study the importance of sequence components in power systems.
5. Understand the importance of symmetrical and un-symmetrical faults in power systems.
6. Study the causes of over voltages and Bewley lattice diagram.

Course Outcomes: After completion of the course, the student will be able to

1. Compute the inductance and capacitance of Transmission lines.
2. Solve the problems on transmission line performance and power circle diagrams.
3. Analyze the causes of corona and factors affecting corona.
4. Describe different types of faults and its relevance in relay settings.
5. Develop the transmission line wave equation and find various coefficients of lines which will be useful to draw Bewley Lattice diagram.
6. Calculate the per unit values of the given power systems.

UNIT-I

Line Parameter Calculations: Review of 3 phase circuit analysis, Symmetrical components importance**,** Inductance & Capacitance calculations of Transmission Line, single-phase and three-phase symmetrical composite conductors, GMD, GMR, Transposition of conductors, Bundled conductors, effect of earth capacitance.

UNIT-II

Modeling of Transmission Lines: Short, medium, long lines, Line calculations, Tuned Lines, Surge impedance loading.

Corona: Causes, Disruptive and Visual Critical Voltages, Power loss, minimization of Corona effects.

UNIT-III

Per Unit System of Representation: Use of per unit quantities in power systems, Advantages of per unit system.

Symmetrical Faults: Short Circuit Currents, Reactance of Synchronous Machines, fault calculations, Short circuit capacity of a bus.

UNIT-IV

Unsymmetrical Faults: Symmetrical components of unsymmetrical Phasors, Power in terms of symmetrical components, sequence impedance and sequence networks. Sequence networks of unloaded generators, Sequence impedances of circuit elements, Single line to ground, line-to-line and double line to ground faults on unloaded generator, Unsymmetrical faults of power systems.

UNIT-V

Transients in Power Systems: Causes of Overvoltage, Travelling Wave Theory, Wave equation, Reflection and refraction coefficients, Junction of cable and overhead lines, Junction of three lines of different natural impedances, Bewley Lattice diagram, Introduction to EMTP.

Text Books:

1. C.L. Wadhwa, "Electrical Power Systems", Wiley Eastern Ltd., 4th Edition, 2006.
2. I.J. Nagrath, D.P.Kothari, "Modern Power Systems Analysis", TMH Edition, 2003.

Suggested Reading:

1. John J. Grainger, William D. Stevenson Jr. "Power System Analysis", Tata McGraw Hill, 2003.
2. A.Chakrabarti, M.L.Soni, P.V.Gupta, U.S.Bhatnagar, "A Text Book on Power System", Dhanpat Rai & Co, 1999.
3. Eiichi Haginomori, Tadashi Koshiduka, Junichi Arai, Hisatochi Ikeda, "Power System Transient Analysis: Theory and Practice Using Simulation Programs" (ATP-EMTP),Wiley Publications, First edition,2016.

16EEC16

ELECTRICAL MACHINERY-II

Instruction	3L+1T Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: The objective of the course is to

1. Understand the cooling arrangement methods in power transformers, testing methods of transformers.
2. Study the principles of tap changing, effects of third harmonic voltages and auto-transformer.
3. Understand constructional features of different types of three phase induction motors.
4. Discuss about speed control and starting methods of three phase induction motors.
5. Analyze unbalanced operation of three phase induction motors and three phase transformers.
6. Familiarize the construction details, principle of operation, prediction of performance of single phase induction motors.

Course Outcomes: After completion of the course, the student will be able to

1. Describe different methods of cooling arrangements of transformers.
2. Apply basic principles of tap changing and auto-transformer.
3. Explain the operation and performance analysis of three phase induction motors.
4. Apply the concepts of speed control and starting methods of three phase induction motors.
5. Analyze unbalanced operation of three phase induction motors and three phase transformers.
6. Discuss the concept of single phase induction motors and operate different types of single phase induction motors.

UNIT-I

Transformers: Cooling arrangement in Transformers, Testing of Transformers, Routine Tests and Special tests, Measurement of Voltage ratio and check for voltage vector relationship, Measurement of Insulation resistance, Maintenance of Transformers, Tap changer on transformers, No-load tap changer, On-load tap changer, Third harmonic voltages and tertiary winding in three phase transformers, Auto Transformer, Comparison with two winding transformers, Conversion of two winding transformer to auto transformer.

UNIT-II

Three-phase Induction Motor: Constructional features, Rotating Magnetic field theory, Principle of operation of squirrel cage and slip ring motors, Vector Diagram, Equivalent circuit, Expression for torque, Starting torque, Maximum torque, Slip/ Torque characteristics, Performance characteristics, Equivalent circuits from test, Current loci circle diagram, Predetermination of characteristics of Induction Motors.

UNIT-III

Starting methods of Induction Motors: Modes of operation, torque and power limits of Induction motors, Speed control methods, Resistance Control, Voltage control, pole changing, Cascading, variable frequency control, Cogging, Crawling, Double cage Induction motors, Induction generator, Doubly fed Induction Generator.

UNIT-IV

Unbalanced Operation: Voltage Unbalance, Unbalanced Operation of 3-phase Induction Motor, Per Phase Equivalent Circuits, Single Phasing, Unbalanced Operation of 3-Phase Transformers, Single-phase load on Three-phase transformers Single Phasing in 3-phase transformers- Delta /Star and Star/Delta transformers.

UNIT-V

Single Phase Motors: Single phase motors, Theory and operation of single phase motors, Shaded pole, Split phase and capacitor motors, Compensated and uncompensated series and repulsion motors. Linear Induction motors.

Text Books:

1. P.S. Bhimbra, "Electrical Machinery", Khanna Publications, 7th Edition, 2003.
2. Nagrath I.J & Kothari D.P, "Electrical Machines", Tata McGraw Hill Publications, Sigma Series, 2006.
3. J.B Gupta , "Theory and Performance of Electrical Machines", S.K. Kataria & Sons,14th Edition, 2014.

Suggested Reading:

1. Juha pyrhone, Tapani Jokinen, "Design of Rotating Electrical Machines", John Wiley & Sons, Ltd. 2008.
2. Fitzgerald, Kingsley, Umans, "Electric Machinery", Tata Mc-Graw Hill Publications, 6th Edition, 2002.
3. Ashfaq Hussain , "Electrical Machines", Danpatrai and sons, 3rd Edition, 2012.

16EEEC17

POWER ELECTRONICS

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objective: The objective of the course is to

1. Identify the characteristics of different static switches.
2. Understand the necessity of protection, turn-ON & turn-OFF methods of SCR.
3. Know the principles of AC-DC, DC-DC, AC-AC and DC-AC energy conversions.
4. Study various methods of voltage control in power converters.
5. Become familiar with quadrant operation of different power converters.
6. Recognize applications of various static switches and power converters.

Course Outcomes: After completion of the course, the student will be able to

1. Gain knowledge of basic operation of various power semiconductor devices and to compare their characteristics.
2. Analyze protection circuit, turn-ON & turn-OFF methods for SCR.
3. Acquaint with the principles of phase controlled converters.
4. Analyze the operation principles of different DC-DC, AC-AC converters.
5. Identify different topologies of DC-AC converters.
6. Know the practical application of static switches and power electronic converters.

UNIT-I

Power Diodes and Transistors: Power diode, characteristics, Recovery characteristics, Types of power diodes, General purpose diodes, Fast recovery diodes, their applications. Bipolar Junction Transistors(BJT), Power MOSFETs, IGBTs-Basic structure and working, Steady state and switching characteristics, Comparison of BJT, MOSFET and IGBT, Their applications.

UNIT-II

Silicon Controlled Rectifier (SCR): SCR-Static characteristics, Two transistor analogy, Protection of SCRs, Dynamic characteristics, Series and parallel operation of SCRs, SCR trigger circuits-R, RC and UJT triggering circuits, Commutation methods of SCR.

UNIT-III

Principles of Phase Controlled Converters: Study of Single-phase and three-phase half wave and full wave controlled rectifiers with R, RL, RLE loads, significance of freewheeling diode, Effect of source inductance, Dual converters - circulating and non circulating current modes.

UNIT-IV

DC-DC Converters: Principles of Step-down, Step-up, Step UP/Down choppers, Time ratio control and current limit control, Types of choppers Type- A, B, C, D and E, Introduction to Buck, Boost and Buck-Boost regulators.

AC-AC Converters:

Principle of operation of Single phase Cyclo-converters and their applications. Single-phase AC Voltage Controllers with R and RL loads.

UNIT-V

Inverters: Principle of operation of Single-phase Inverters, Voltage control methods, Single pulse width modulation, Multiple pulse width modulation, Sinusoidal pulse width modulation, Comparison of Voltage Source Inverters and Current Source Inverters, Three-phase bridge Inverters, 180^0 & 120^0 modes of operation.

Text Books:

1. Singh.M.D, Khanchandani.K.B, "Power Electronics", Tata McGraw Hill, 2nd Edition, 2006.
2. Rashid.M.H., "Power Electronics Circuits Devices and Applications", Prentice Hall of India, 2003.
3. Bimbra.P.S, "Power Electronics", Khanna Publishers, 3rd Edition, 2013.

Suggested Reading:

1. Mohan, Undeland , Robbins, "Power Electronics", John Wiley, 1996.
2. P.C.Sen, "Power Electronics", Tata Mc-Graw Hill, 1st Edition, 2001.

16EEC18

LINEAR CONTROL SYSTEMS

Instruction	3L + 1T Hour per week
Duration of Semester Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: The objective of the course is to

1. Understand different types of linear control systems and their mathematical modeling.
2. Gain knowledge of real time applications of closed loop control systems.
3. Study the transfer function of control system components.
4. Study the stability analysis in time domain.
5. Study the stability analysis in frequency domain.
6. Study the concepts of State space representation of Linear Time invariant systems (LTI).

Course Outcomes: After completion of the course, the student will be able to

1. Define different mathematical models for any LTI systems.
2. Outline the transfer function of components used in feedback control systems.
3. Specify design region in the s-plane in terms of settling-time, rise-time and overshoot to step-response.
4. Illustrate the concepts of stability analysis in time domains, which is essential to analyze any system performance.
5. Illustrate the concepts of stability analysis in frequency domains, which is essential to analyze any system performance.
6. Employ the concepts of state space controls.

UNIT-I

Introduction: Open loop, Closed loop System with illustrations and other classification of control systems, Impulse response and Transfer Function, Mathematical modelling of Mechanical and Electrical Systems, Analogous systems, Feedback control characteristics - effects of feedback.

UNIT-II

Transfer Function Representation: Components of control system- Potentiometers, Synchros, DC and AC servo motors, Block diagram representation and its reduction techniques, Signal flow graphs, problems on conversion from block diagram to signal flow graph.

UNIT-III

Time Response Analysis: Standard test signals, Time response of first and second order systems for unit step input, Time domain specifications , Type of system - Steady state error, static error coefficients,

Stability Analysis-Concept of stability, Routh-Hurwitz criterion, Root locus technique, effect of addition of poles and zeros to open loop transfer function on Root locus, Introduction to PID Controller.

UNIT-IV

Stability Analysis-Frequency Domain: Frequency Domain specifications for a standard second order system, Correlation between time and frequency domain specifications, Stability analysis from Bode plots, Polar plots and Nyquist plots, Introduction to compensators.

UNIT-V

State Space Representation: Concept of State, State Variable, State Models of linear time invariant systems, Derivation for state models from transfer functions and differential equations, Solution of State equation by Laplace method, State Transition matrix and properties, Concept of Observability and Controllability.

Text Books:

1. I.J.Nagrath, M.Gopal, "Control System Engineering", New Age International (P) Limited Publishers, 5th Edition, 2008.
2. B.C. Kuo, "Automatic Control Systems", John wiley and son's Publishers, 9th Edition, 2009
3. K.Ogata, "Modern Control Systems", 5th Edition.PHI publication, 2010.

Suggested Reading:

1. M.Gopal, "Control Systems Principles and Design",- Tata McGraw Hill, 2nd Edition, 2003.
2. N.C Jagan, "Control Systems", BS Publications, 2nd Edition, 2008
3. N. Nise, "Control Systems Engineering",6th Edition, Willey Publications, 2011.

16EEC19

ELECTRICAL MACHINES - II LAB

Instruction	1T+2Periods per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: The objective of the course is to

1. Understand and apply Scott connection for three phase to two phase conversion.
2. Comprehend the principles of voltage regulation of Alternators and compute the values by different methods .
3. Predict the performance of Three Phase Induction Motor by conducting No-load test and Blocked rotor test
4. Operate the induction motor with various speed control methods and compare the different methods.
5. Analyze the performance of three phase induction motor under different loading conditions and assess the performance.
6. Estimate the improvement in power factor of Induction Motor using capacitors.

Course Outcomes: After completion of the course, the student will be able to

1. Apply phase conversion method to obtain balanced two phase supply from three phase supply.
2. Appraise the voltage regulation of Synchronous generator using various methods.
3. Assess the performance of three phase induction motor by conducting no-load test and blocked rotor tests.
4. Discuss practical aspects of AC machine analysis.
5. Assess the proper AC machine and its usage for a given load application
6. Use capacitors for power factor improvement.

List of Experiments:

1. Three phase to Two-phase conversion (Scott connection).
2. Heat run test on Three-phase transformer.
3. No-load test, blocked rotor test and load test on 3-phase Induction motor.
4. Speed control of Three-phase Induction motor by
   a). Rotor impedance control
   b). V/f control.
5. Synchronization of an alternator with infinite bus-bars by dark lamp method.
6. Performance characteristics of Single-phase Induction motor.

7. No- load test of slip ring induction motor to determine the relationship between
   i) Applied voltage and speed,
   ii) Applied voltage and rotor current,
   iii) Applied voltage and stator current,
   iv) Applied voltage and power factor,
   v) Applied voltage and power input.
8. Voltage regulation of Alternator by
   a). Synchronous Impedance method
   b). Ampere-Turn method.
   c). Zero Power factor method.
9. Voltage Regulation of Alternator by slip test.
10. Determination of V curves and inverted V curves of synchronous motor.
11. Power angle characteristics of a synchronous motor.
12. To determine the transient and sub-transient reactance's and time constants of synchronous machine.
13. Power Factor Improvement of Induction motor using capacitors.

Note: At least TEN experiments should be conducted in the semester.

16EEC20

POWER ELECTRONICS LAB

Instruction	1T + 2P Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives:

1. To obtain and plot the characteristics of different static switches.
2. To analyze the triggering and commutation circuits for SCR.
3. To familiarize the conversion principle of single & three phase controlled rectifiers.
4. To understand the operation of various DC-DC conversion circuits and their applications.
5. To know the operation of various AC-AC conversion circuits and their applications.
6. To identify about DC-AC conversion in single phase circuits.

Course Outcomes: After completion of the course, the student will be able to

1. Analyze the effects of control signals on static switches.
2. Distinguish the characteristics of different controlled switches and their applications.
3. Acquainted with the conversion principles of AC-DC converters.
4. Observe the operation of different DC-DC choppers.
5. Familiar with AC-AC converters
6. Understand the principle of DC-AC conversion.

List of Experiments

1. S.C.R. Characteristics
2. BJT, MOSFET and IGBT Characteristics
3. Gate triggering circuits for SCR using R, RC and UJT.
4. Single phase step down Cyclo converter with Rand RL loads.
5. A.C voltage controllers with R and RL loads.
6. Study of forced commutation techniques.
7. Single phase full converter as a rectifier and inverter.
8. Single phase fully controlled bridge rectifier with Rand RL loads.
9. Single phase half controlled bridge rectifier with Rand RL loads.
10. Three phase half controlled bridge rectifier with Rand RL loads.
11. Three phase fully controlled bridge rectifier with Rand RL loads.
12. Buck and Boost choppers.
13. Voltage commutated chopper with R&RL loads
14. Current commutated chopper with R&RL loads.
15. Half and Full bridge inverter with R&RL loads.

Note: At least **TEN experiments** should be conducted in the semester.

16EEC21

LINEAR CONTROL SYSTEMS LAB

Instruction	1T + 2 Periods per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: The objective of the course is to

1. Understand the characteristics of DC Servo Motor.
2. Understand the characteristics of AC Servo Motor.
3. Understand Synchro pair operation.
4. Understand the time domain specifications in time domain.
5. Understand the frequency response of compensating networks.
6. Study the closed loop performance for given plant using
   i) P, PI and PID controllers ii) ON/OFF controller.

Course Outcomes: After completion of the course, the student will be able to

1. Define DC, AC Servo Motors Characteristics.
2. Describe and analyze Synchro pair Characteristics.
3. Design and Analyze the performance of a given second order plant in time domain.
4. Design and Analyze the performance of a given second order plant in frequency domain.
5. Select and state the design function of position and level control systems.
6. Acquire knowledge in analyzing the performance of P, PI, PID and ON/OFF controller.

List of Experiments

1. Characteristics of D.C. Servo motor.
2. Characteristics of A.C. Servo motor.
3. Characteristics of Synchro Pair.
4. Step response of second order system.
5. Frequency response of compensating networks.
6. Closed loop P, PI and PID Controller for temperature of a given plant.
7. Step response and Frequency response of a given plant.
8. Level Control System.
9. Temperature control system-ON/OFF Control.
10. Characteristics of magnetic amplifier.
11. Linear System simulator.
12. DC Position Control System.
13. AC Position Control System.

Note: **At least TEN experiments should be conducted in the Semester.**

16EEE01

NON-CONVENTIONAL ENERGY SOURCES

Instruction	3Hours per week
Duration of Semester Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To understand the fundaments of energy and significance of conventional and non conventional energy sources.
2. To comprehend the list of various Energy Sources
3. To know the design of solar PV system
4. To become familiar in implementing solar thermal systems.
5. To become aware about wind energy conversion systems.
6. To understand the need of Energy Conservation and its related features.

Course Outcomes: The student will be able to

1. Acquire the knowledge of various Non conventional energy sources and its relative merits and demerits.
2. Identify the need of energy conservation and storage methods.
3. Experiment with solar photo voltaic systems to validate theoretical analysis.
4. Compare the various MPPT techniques.
5. Assess the solar thermal application for a given requirement
6. Justify the suitability of wind Energy Conversion Systems for a given site conditions.

UNIT-I

Fundamentals of Energy: Introduction, Classification of energy resources, importance of Non Conventional Energy Sources, Common forms of energy, Advantages and Disadvantages of conventional energy sources, Merits and Demerits of non conventional energy sources, various aspects of energy conservation, co- generation, Energy storage methods (Elementary treatment only)

UNIT-II

Introduction to Energy Sources: Solar Energy, Wind energy, Biomass energy, Geothermal energy, Ocean energy, Fuel Cell, MHD, Small Hydro resources.

UNIT-III

Solar Photo Voltaic Systems: Solar cell fundamentals, Solar Cell characteristics, solar cell classification, solar cell, Module, Panel and Array Construction, Maximizing the solar PV output and load matching, MPPT, Solar PV Systems, solar PV applications.

UNIT-IV

Solar Thermal Systems: Solar collectors, Solar water heater, solar cooker, Solar furnace, Solar dryer, Solar distillation.

UNIT-V

Wind Energy Systems: Origin of winds, wind turbine sitting, major applications of wind power, wind turbine aerodynamics, Wind energy conversion systems (WECS), Wind Energy Storage.

Text Books:

1. B.H. Khan, "Non Conventional Energy Resources" McGraw-Hill Education, 2015.
2. Chetan Singh Solanki, "Renewable Energy Technology - A practical guide for beginners", PHI, 2009.

Suggested Reading:

1. D.P.Kothari, KC Singal, Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI, 2014.
2. Mukharjee D., "Renewable Energy Systems", New Age International 2004.

16EE E02

ELECTRICAL ENGINEERING MATERIALS

Instruction	3Hours per week
Duration of Semester Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The objective of the course is to

1. Analyze the mechanical, magnetic and the electrical properties of materials.
2. Select materials for various engineering application.
3. Establish how failures occur in materials and how to prevent them.
4. Observe the changes in behavior of the material while subjected to stress.
5. Know the economical aspects of a design.
6. Update the technical advancements in materials technology.

Course Outcomes: After completion of the course, the student will be able to

1. Classify the given material based on its properties.
2. Select a proper material for a given application.
3. Experiment on materials in order to test its adaptability.
4. Investigate the suitability of material for the latest technological requirement.
5. Compare and contrast the characteristics of the materials.
6. Assess the changes in properties while alloying

UNIT- I

Conducting Materials: Electrical conducting Materials, High conductivity materials, Materials of High Resistivity, Materials used for precision work, rheostats; heating devices, Super conductivity, Special types of alloys, Applications & Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale integration techniques (VLSI).

UNIT -II

Insulating Materials: Classification of Insulting materials, temperature rise, electrical properties of insulating materials used for wires-laminations- machines and their applications, Ceramics, Plastics, DC electrical properties, AC electrical properties, Dielectric properties of insulators, Dielectric materials used for various electrical applications, suitability.

UNIT- III

Magnetic Materials: Magnetic parameters, the three types of magnetic material, measuring magnetic materials, Application of soft magnetic materials, Magnetic recording media, Hard (permanent) magnets, Ferrites, Samarium, Cobalt alloys, Neodymium Iron Boron (Nd Fe B).

UNIT- IV

Optical Properties of Materials: EM Radiation Spectrum, Optical properties in materials, Photo electric emission, Photo conductivity, Lasers, Optical fibres, Fibre cables.

UNIT -V

Materials for Direct Energy Conversion Devices: Solar cells, equivalent circuit of a solar cell, fuel cell, MHD generators, storage of hydrogen, thermoelectric generators, Nano applications in Electrical Engineering.

Text Books:

1. G.K Benergy, "Electrical and Electronic Engineering Materials", PHI, 2014
2. Ian P. Jones, "Materials Science for Electrical and Electronic Engineers", Oxford University Press, 2008.
3. R. K Sukhla, "Electrical Engineering Materials", McGraw Hill Education, 2013.

Suggested Reading:

1. Dhir, "Electronic Components & Materials", McGraw Hill Education, 2012.
2. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2014.

16EE E03

ELECTRONIC INSTRUMENTATION SYSTEMS

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course objectives: The objective of the course is

1. Understand the concept of transducers.
2. Know the principles of data converters.
3. Understand construction and working details of different signal generators & signal analyzers.
4. Describe various digital frequency and time related measurements.
5. Illustrate automatic instrumentation systems.
6. Know the fundamentals of different CRO's.

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

1. Choose appropriate transducer for a given application
2. Design data converters to the required specifications.
3. Estimate the distortion of a signal.
4. Construct different signal generators.
5. Explain the working of different subsystems of different CRO's
6. Develop/design the automatic instrumentation systems.

UNIT-I

Analog and Digital Measuring Systems: Interfacing Active and Passive Transducers, Amplifiers: Instrumentation amplifiers (Fixed and Programmable gain types and its specifications), Isolation amplifiers (Types and its specifications).
Digital to Analog Converters: R-2R ladder and Inverted ladder DACs. Main DAC specifications. Analog to Digital Converter: R-2R Ladder and Inverted Ladder DACs, Main DAC specifications, Analog to Digital Converters: Parallel (or Flash) ADC successive approximation, ADC Microprocessor compatibility, Dual slope ADC, Principal specifications of an ADC.

UNIT-II

Digital Voltmeters and Multimeters: Simple D.C Voltage attenuator, Current to Voltage converter, Resistance to Voltage Converter, Automatic ranging and Automatic zeroing, RMS detector in DMM and RMS and True RMS, Digital Frequency and Time measurements, Frequency Measurements, Frequency ratio time interval and Pulse width measurements, Scaling and Checking modes. Counting errors, Input signal conditioning, Trigger level, Hysteresis.

UNIT-III

Signal Analysis: Wave Analyzers: Signal analysis and wave Analyzer, Type and Applications. Harmonic Distortion Analyzers: harmonic Distortion, heterodyne

harmonic Analyzer or Wave meter, Tuned circuit, Fundamental Suppression. Spectrum Analysis: Block Diagram, Phase locked circuit for the local oscillator, Successive limiting type of Log IF amplifier.

UNIT-IV

Signal Generators: Fixed and variable Audio frequency oscillator, Audio frequency sine and square wave generator, function generator, square wave pulse generator, random noise generator, TV sweep generator, marker generator and beat frequency oscillator(BFO). synchronized signal generator interfaced with 488 Bus, relay switched attenuator, IEE 488 Electrical interface.

UNIT-V

Cathode Ray Oscilloscope: Block Diagram, Basic Concepts, Vertical amplifier, Time Base, Trigger Delay line and their role in a CRO, Digital storage Oscilloscope, Magnetic Re orders, Digital Interface for Programmable Instrumentation, Description and Sample examples of Automatic Instrumentation.

Text Books:

1. H .S. Kalsi, "Electronic Instrumentation", TMH publications, 2nd Edition, 2007.
2. A.K.Sawhney, "A Course in Electrical and Electronics Measurements and Instrumentation", Dhanpat Rai & Sons, 4th Edition, 2012.

Suggested Reading:

1. E.W Golding "Electrical Measurements and Measuring Instruments", TMH publications, 2011.
2. Helfrick, Albert D. Cooper, William D, "Modern Electronic Instruments & Measuring Instruments", PHI, 1992.

16MT E01

STATISTICAL AND NUMERICAL METHODS

Instruction	3L Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits:	3

Course Objectives:

1. To compute the statistical averages& different properties.
2. To study the probability distributions for stochastic data.
3. To understand for finding solution of non-linear equations.
4. To study the process of calculating the value of the numerical derivative of a functions & numerical integration of a given data.
5. To identify the solution for initial value problem numerical differential equations.
6. To compute and analyse the physical data.

Course Outcomes: On the successful completion of this course, the student shall be able to

1. Analyse the statistical averages and different properties for probability function.
2. Fit the probability distribution for the random data.
3. Solve the non-linear equations for finding the roots.
4. Solving the Differentiation & Integration for numerical data.
5. Solving the ordinary differential equations using single & multi-step methods.
6. Solving the multivariable problems.

UNIT-I

Random Variables: Mathematical Expectation, Variance, Co-Variance and its properties, Probability function, Moments, mgf, cgf and its properties**.**

UNIT-II

Probability Distributions: Discrete distribution: Binomial, Poison distributions, finding Mean and Variance through mgf. Continuous distribution: Normal distribution, Exponential & Uniform distributions**.**

UNIT-III

Solution for Non-linear Equations: Algebraic & transcendental equations**,** Bisection method, Regular False Method and Newton Raphson method, interpolation, Newton's forward and backward formulas.

UNIT-IV

Numerical Differentiation & Integration: Numerical differentiation using numerical forward & backward interpolation formula, Numerical integration: Simpson's 3/8th rule, Weddle's rule.

UNIT-V

Numerical Solution of Ordinary Differential Equations: Picard's method, Euler's method, R.K method (fourth order) and Milne Thompson's method (predictor & corrector).

Text Books:

1. S.C Gupta and V.K.Kapoor, "Fundamentals of Mathematical statistics", S.Chand &Co.2006 Publishers.
2. M.K.Jain, S.R.K Iyengar and R.K.Jain, "Numerical methods for Scientific & Engineering Computation", New Age International publications, 2008.

Suggested Reading:

1. Miller and Freund, "Probability and Statistics for Engineers", Pearson, 2005.
2. S.S.Shastry, "Introductory methods of Numerical Analysis", PHI publication, 5th Edition.

Core Courses offered to other Departments

SEMESTER – V

S.No	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per week		Duration of SEE in Hours	Maximum Marks		
			L/T	P/D		CIE	SEE	
PRACTICALS								
1	**16EE C22**	Electrical Machines and Microcontroller Applications Lab (Core) (for BE3/4, Mech & Prod, V-SEM)	0/1	2	3	25	50	2
TOTAL			**1**	**2**	**-**	**25**	**50**	**2**

Elective Courses offered to other Departments

SEMESTER – V

S.No	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per week		Duration of SEE in Hours	Maximum Marks		
			L/T	P/D		CIE	SEE	
PRACTICALS								
1	**16EE E04**	Electrical Technology (for BE3/4, ECE, V-SEM)	3/0	0	3	30	70	3
TOTAL			**3**	**0**	**-**	**30**	**70**	**3**

L: Lecture T: Tutorial P: Practical D: Drawing
CIE - Continuous Internal Evaluation SEE - Semester End Examination

16EE C22

ELECTRICAL MACHINES AND MICRO CONTROLLER APPLICATIONS LAB

(Common to BE3/4, Mech. & Prod, V- SEM)

Instruction	1T + 2 Periods per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives:

1. To understand the testing of 1-phase transformers.
2. To comprehend various characteristics of DC machines.
3. To understand the characteristics of different AC machines.
4. To learn operations on 8051 microcontroller.
5. To understand basics of interfacing devices with 8051 microcontroller.

Course Outcomes: The student will be able to

1. Test the 1-phase transformer.
2. Know the right instrument and its usage for the given circuit.
3. Identify the suitable machine for required application.
4. Process the data using 8051 microcontroller
5. Interface the given device with 8051 microcontroller.

List of Experiments:

Cycle -I

1. Magnetization characteristics of a separately excited DC generator.
2. Load characteristics of a shunt generator.
3. Performance characteristics of a shunt motor.
4. Performance characteristics of a compound motor.
5. Speed control of DC shunt motor.
6. O.C. and S.C. tests on single phase transformer.
7. Load test on a three phase induction motor. .
8. Speed control methods of induction motor.
9. To determine the load characteristics of a DC series motor.

Note: At least **SIX** experiments should be conducted in the semester from cycle - I.

Cycle -II

1. 8051 Microcontroller Experiments.
2. Data Transfer - Block move, Exchange, sorting, Finding largest element in an array.
3. Arithmetic Instructions : Multi byte operations.
4. Boolean & Logical Instructions (Bit manipulations).
5. Use of JUMP and CALL instructions.
6. Control of stepper Motor using 8051.
7. A/D converter interface with 8051 Microcontroller.
8. D/A converter Interface with 8051 Microcontroller.

Note: At least **FOUR** experiments should be conducted in the semester from cycle - II.

16EEE04

ELECTRICAL TECHNOLOGY
(BE 3/4 ECE, V Sem.)

Instruction	3Hours per week
Duration of Semester Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The objective of the course is to

1. Know the fundamentals of DC Generators and DC motors.
2. Study AC generators & Transformers.
3. Understand the concepts of poly phase systems.
4. Know the concepts of Single - Phase and Three - Phase Induction motors.
5. Understand fundamentals of Power system.
6. Understand basics of Non - Conventional Energy Sources.

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

1. Know the fundamentals of DC Generators and DC motors.
2. Study AC generators & Transformers.
3. Understand the concepts of poly phase systems.
4. Know the concepts of Single - Phase and Three - Phase Induction motors.
5. Understand fundamentals of Power system.
6. Know the difference between Conventional and Non - Conventional Energy Sources.

UNIT-I

D.C. Generators: Constructional details, Simple lap & wave windings, Methods of excitation, Induced EMF, Basic ideas of armature reaction and commutation, Characteristics of shunt, series and compound generators and their applications.

DC Motors: Significance of back EMF, Torque developed in motors, three point starter, Characteristics of shunt, series and compound motors, Speed control of DC motors.

UNIT-II

Poly Phase System: Advantages of three phase system, Star and delta connections, Relationship between line and phase quantities, Measurement of power by Two Wattmeter method.

A.C. Generators: Construction, EMF equation, Armature reaction, -Synchronous impedance, Regulation.

UNIT-III

Transformers: Single Phase transformer, Construction, Working principle, EMF equation, Ideal transformer, Phasor diagram under no load and loaded conditions, OC and SC tests on transformer, Efficiency and regulation.

UNIT-IV

Induction Motors: Construction, Production of rotating magnetic field, Slip, Slip-torque characteristics, Starting methods of Induction motors.

Single-Phase Induction Motors: Construction, Theory of operation, Characteristics of shaded pole, Split phase and capacitor motors, Applications.

UNIT-V

Power Systems: Basic ideas of thermal, hydro, nuclear and non-conventional generating systems and layout, Block diagram of power systems, advantages of non conventional generation systems.

Text Books:

1. H. Cotton, "Electrical Technology", CBS Publishers and distributors, 7th Edition, 2005.
2. V.K.Mehta, "Principles of Electrical Engineering", S. Chand and Co, 2nd Edition, 2004.
3. M.L.Soni, PV Gupta, VS Bhatnagar, "A course in Electrical Power", Dhanpat Rai and Sons, 4th Edition,2008.

Suggested Reading:

1. P.V. Prasad, S. Siva Nagaraju, "Electrical Engineering, Concepts & Applications", Cengage Learning, 1st Edition, 2012.
2. B.L.Theraja, "Electrical Technology", Vol.I and Vol.II, S.Chand and Co, 23rd Edition.
3. M.S.Naidu, Kamakshaiah, "Electrical Technology", TMH Publications,1st Edition,2007.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)
Choice Based Credit System (with effect from 2018-19)
B.E (Electrical and Electronics Engineering)

SEMESTER-VI

S. No	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			
			Hours per week		Duration in Hours	Maximum Marks		Credits
			L/T	P/D		CIE	SEE	
THEORY								
1.	**16EEC23**	Electrical Machinery – III	3/1	-	3	30	70	4
2.	**16EEC24**	Switchgear and Protection	3	-	3	30	70	3
3.	**16EEC25**	Power Semiconductor Drives	3	-	3	30	70	3
4.	**16EEC26**	Microprocessor and Microcontrollers	4	-	3	30	70	4
5.	**16EEEXX**	Program Specific Elective- 2	3	-	3	30	70	3
6.	**16EEEXX**	Program Specific Elective - 3	3	-	3	30	70	3
PRACTICALS								
7.	**16EEC27**	Microprocessor and Microcontrollers Lab	0/1	2	3	25	50	2
8.	**16EEC28**	Power Systems Lab	0/1	2	3	25	50	2
9.	**16EEC29**	Mini Project	-	2	-	50	-	1
10.	**16EEC30**	Industrial Visit	Satisfactory / Unsatisfactory					
			22	**06**	**-**	**280**	**520**	**25**

L: Lecture T: Tutorial D: Drawing P: Practical
CIE - Continuous Internal Evaluation SEE - Semester End Examination

Course Code	Program Specific Elective-2
16EEE05	High Voltage Engineering (HVE)
16EEE06	Artificial Intelligence Techniques in Electrical Engineering (AITEE)
16EEE07	Switch Mode Power Converters (SMPC)
16EEE08	Optimization Techniques (OT)

Course Code	Program Specific Elective-3
16EEE09	Advanced Control System (ACS)
16EEE10	Electrical Distribution Systems & Automation (EDSA)
16EEE11	High Voltage DC Transmission (HVDC)
16EEE12	Simulation Techniques for Electrical Engineering(STEE)

Elective Courses offered to other Departments	
16EE E13	Industrial Electronics (BE ¾ ECE, VIth Sem)

16EEC23

ELECTRICAL MACHINERY-III

Instruction	3L+1T Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives:

1. To study the construction and operating principles of synchronous machines
2. To understand different types of alternator voltage regulation methods for cylindrical rotor, salient pole types.
3. To describe the synchronizing procedure with the grid and study the parallel operation of alternators.
4. To discuss about synchronous motor performance and its starting methods.
5. Impart knowledge about transient behavior of synchronous machines and their stability.-
6. To understand the construction details, principle of operation, prediction of performance of Electrical special machines.

Course Outcomes: After completion of the course, the student will be able to

1. Explain basic principles of synchronous machines
2. Estimate the voltage regulation of alternators by different methods.
3. Describe the various starting methods of synchronous motors.
4. Analyze the concepts of synchronous motor.
5. Examine the stability of synchronous machines under different operating conditions.
6. Explain and apply the concept of permanent magnet motor and special machines for a given load application.

UNIT-I

Synchronous Machines: Constructional Details, Types of windings, Winding factors, e.m.f. equation, Fractional pitch and fractional slot windings, Suppression of harmonics and tooth ripple, Armature reaction and reactance, Synchronous impedance.

UNIT-II

Synchronous Generator: Voltage Regulation, Phasor diagram of alternator with non-salient poles, O.C. and S.C characteristics, Synchronous impedance, Ampere-turn, ZPF methods for finding regulation, Principle of two reaction theory and its application for the salient pole synchronous machine analysis, Synchronism and parallel operation.

UNIT-III

Synchronous Motor: Theory of operation, Vector diagram, Variation of current and power factor with excitation, Hunting and its prevention, Current and power diagram Predetermination of performance, Methods of Starting and Synchronizing. Synchronizing Power, Synchronous Condenser.

UNIT- IV

Transient Stability Studies: Elementary ideas of transient behavior of an Alternator-Three phase short circuit of an Alternator, Analysis of symmetrical and asymmetrical short circuit current.

UNIT-V

Special Machines: Permanent Magnet Motors, Switched Reluctance Motors, Hysteresis Motors, Stepper motor and BLDC motor.

Text Books:

1. P.S. Bhimbra, "Electrical Machinery", Khanna Publications, 7th Edition, 2003.
2. Nagrath I.J and Kothari D.P, "Electrical Machines", Tata McGraw Hill Publications, Sigma series, 2006
3. J.B Gupta ,S.K. Kataria & Sons, "Theory and performance of electrical machines", 14th Edition, 2014.

Suggested Reading:

1. Juha Pyrhonen, Tapani Jokinen, Valeria Hrabovcova, "Design of Rotating Electrical Machines", John Wiley & Sons, Ltd. 2008
2. Fitzgerald, Kingsley, Umans, "Electric Machinery", Tata Mc-Graw Hill Publications, 6th edition, 2002
3. Ashfaq husain, "Electrical machines", Danpatrai and sons, 3rd Edition, 2012.

16EEC24

SWITCHGEAR AND PROTECTION

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The objective of the course is

1. To know the operation and types of fuses used in power system.
2. To analyze principles of operation of the different types of relays.
3. To comprehend the different principles of protective schemes in power system.
4. To understand the principles of operation of the different types of circuit breakers.
5. To be acquainted with different lightning arrestors and the appropriate circuit for the protection of the various components of power system.
6. To identify the importance of various grounding methods.

Course Outcomes: After completion of the course, the student will be able to

1. Classify various components used in power system protection.
2. Indicate the relay settings of over current and distance relays.
3. Recognize arc quenching mechanisms used in different circuit breakers.
4. Explain the concept of unit and non-unit protection, and how the various associated parameters affect it.
5. Distinguish types and testing of CBs and their applications
6. Review protection of transmission lines, equipment protection and types of lightening arrestors against over voltages.

Unit-I

Protective Relays: Need for protection, Backup protection, Zones of protection, Definitions of relay pickup, dropout and reset values, Classification of relays, Operating principles and construction of electromagnetic and induction relays, Over current, Over voltage and Power relays, Directional features, Universal relay torque equation. Over current protection for radial feeders and ring mains, Protection of parallel lines, Relay settings for over Current relays, Earth fault and phase fault protection.

Unit-II

Static phase and Amplitude Comparators: Characteristics of Dual input comparators, Distance protection, 3-step Distance relays, Characteristics of distance relays on the RX diagram, static over current relay (Block diagram approach). Basics

of digital relays. Need of numerical relays, Advantages of numerical relays over solid state relays.

Unit-III

Transformer and Generator Protection: Differential relays, Percentage differential relays, Protection of generator and transformer using percentage differential relays, Split phase, Inter turn protection, Overheating, Loss of excitation, Protection of generators, Buchholz relay, Protection of earthing transformers, Generator transformer unit protection.

Unit-IV

Circuit Breakers: Need for circuit breakers, Arc Properties, Principles of arc quenching theories, Recovery and Restriking voltages, Rated symmetrical, asymmetrical breaking current, Rated making current, Rated capacity, Voltage and Frequency of circuit breakers, Current chopping, Resistance switching, Derivations of RRRV, Types of circuit breakers, Oil, Air, SF6 and Vacuum circuit breakers, Testing of circuit breakers.

Unit-V

Over Voltage Protection: Protection of transmission lines against direct lightening strokes, Ground wires, Protection angle, Protection zones, Height of ground wire, Conductor clearances. Conductor heights, Tower footing resistance and its effects, Equipment protection assuming rod gaps, Arcing horns, Different types of lightening arrestors, construction, Surge absorbers, Peterson coil, Insulation coordination.

Text Books:

1. C.L. Wadhwa, "Electrical Power System", Wiley Eastern Ltd., 2nd Edition, 2013
2. Badriram & Viswakarma, "Power System Protection and Switchgear", Tata McGraw Hill, 2011
3. Sunil S. Rao, " Switchgear and Protection", Khanna Publications, 2008
4. J.B. Gupta, "Switchgear and Protection", S.K. Kataria& Sons, 3rd Edition, 2014.

Suggested Reading:

1. B. Ravindranath, M. Chander , "Power System Protection &Switchgear", New Age International, 2011
2. OZA, "Power System Protection and Switchgear", Tata McGraw Hill, 2010.
3. Y.G. Paithankar, "Power System Protection", PHI, 2nd Edition, 2010.

16EEC25

POWER SEMICONDUCTOR DRIVES

Instruction	3Hours per week
Duration of Semester End Examination	3 Hours
University Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The objective of the course is to

1. Deal with selection of a particular drive for a given application.
2. Comprehend D.C drive concepts and applications.
3. Assimilate the concepts and applications of Induction motor drives.
4. Assimilate the concepts and applications of synchronous motor drives.
5. Deal with adaptability of a particular drive (synchronous motor, BLDC, stepper motors and SRM) for given load requirements.
6. Deal with heating- cooling conditions, classes of duty and determine the motor rating.

Course Outcomes: After completion of the course: the student will be able to

1. Select a particular drive for a given application.
2. Design a proper controller for a D.C motor drive with the given detailed specifications.
3. Acquire knowledge in various speed control techniques of induction motor drives.
4. Acquire knowledge in various speed control techniques of synchronous motor drives.
5. Identify the adaptability of a particular drive (synchronous motor, BLDC, stepper motors and SRM) for given load requirements.
6. Discuss about heating- cooling conditions, classes of duty and determine the motor rating.

UNIT-I

Electrical Drives - Introduction: Advantages of Electrical Drives, Parts of Electrical Drives, Choice of Electrical Drives. Dynamics of Electrical Drives: Fundamental Torque Equations, Speed Torque Conventions and Multiquadrant Operation, Equivalent Values of Drives Parameters, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy, Loss in Transient Operations, Steady State Stability, Load Equalization. Selection of Motor Power Rating : Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating.

UNIT-II

DC Motor Drives: DC Motors and Their Performance, Starting, Braking, Controlled Rectifier Fed dc Drives, Single- Phase Fully-Controlled Rectifier Control of DC

Separately Excited Motor, Single- Phase Half-Controlled Rectifier Control of dc Separately Excited Motor, Three- Phase Fully-Controlled Rectifier Control of dc Separately Excited Motor, Three-Phase Half-Controlled Rectifier Control of dc Separately Excited Motor, Multi-quadrant Operation of dc separately Excited Motor Fed from Fully-controlled Rectifier, Supply Harmonics, Power Factor and Ripple in Motor Current, Chopper Controlled dc Drivers, Chopper control of separately Excited dc motors, Chopper control of series motor, Source current harmonics in Choppers, Converter ratings and closed-loop control.

UNIT- III

Induction Motor Drives*:* Braking, Regenerative braking, Plugging or reverse voltage braking, Dynamic (or rheostatic) braking, Transient Analysis, Stator Voltage Control, variable Frequency control from Voltage sources, Voltage Source Inverter (VSI) Control, Cycloconverter control, Closed loop speed control and converter Rating for VSI and Cyclo-converter, Induction Motor Drives, Variable Frequency Control from a Current Source, Rotor Resistance control, Slip Power Recovery, Static Kramer drive , Static Scherbius drive.

UNIT-IV

Synchronous Motor Drives : Operations from Fixed Frequency Supply, Synchronous Motor variable speed drives, Variable frequency control of Multiple Synchronous Motors, Self–controlled Synchronous Motor Drive Employing Load Commutated Thyristor Inverter, Starting Large Synchronous Machines, Self-controlled Synchronous Motor Drive Employing a Cyclo-converter, Permanent Magnet ac Motor Drives, Brushless dc Drives.

UNIT-V

Special Machines & Drives: Linear Induction Motor and its control, Stepper(or Stepping) Motors, Variable reluctance, permanent magnet, Important features of stepper motors, Torque versus stepping(or pulsing) rate characteristics, Drive circuits for stepper motors, Switched (or variable) Reluctance Motor, Operation and control requirements, Converter circuits, Modes of operation.

Text Books:

1. G.K.Dubey, “Fundamentals of Electric Drives”, Narosa Publishing House, 2nd Edition, 2016.
2. S.K.Pillai, “A Course in Electric Drives”, New Age International, 3rd Edition, 2015.

Suggested Reading:

1. VedamSubrahmanyam, “Electric Drives-Concepts and Applications”, TMH, 2nd Edition, 2010.
2. N.K.De & P.K.Sen, “Electrical Drives”, PHI, 1st Edition, 2006.

16EEC26

MICROPROCESSORS AND MICROCONTROLLERS

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: The objective of the course is to

1. Understand the Fundamentals of 8086 Microprocessors and its Programming.
2. Study the Interfacing of 8086 microprocessors using its various ports.
3. Understand the fundamentals of 8051 Microcontroller, programming and its interfacing.
4. Know about the data converters and their interfacing with 8086 Microprocessor.
5. Choose a suitable interrupt for a specific task while programming.
6. Make students know about the various day-to-day applications of Microcontroller.

Course Outcomes: After completion of the course, the student will be able to

1. Outline the Internal architecture of 8086 processor.
2. Summarize the instruction in set of 8086 processor.
3. Apply the knowledge of instruction set to write .
4. Review of different interfacing devices that are compatible with 8086 Microprocessor.
5. Outline the internal architecture of 8051 microcontroller.
6. Indentify different communicating devices that are compatible with 8051 Microcontroller.

UNIT- I

Introduction to Microprocessor and 8086 Microprocessor: Fundamentals of a microprocessor and its evolution, Architecture of 8086 Microprocessor- Segmented memory, Addressing modes, Instruction set, Pin diagram, Minimum and Maximum mode operations.

UNIT-II

Programming using 8086 Microprocessor: Assembly language programming, Assembler directives, simple programs using Assembler directives, strings, procedures, and Macros, Timings and delays.

UNIT-III

Interfacing with 8086 Microprocessor: Memory and I/O interfacing, 8255 (PPI) A/D and D/A interfacing, Programmable Interval Timer (8253), Keyboard / display controller 8279, interrupts of 8086.

UNIT-IV

Introduction to 8051 Microcontroller and its Programming: 8051 Microcontroller and its Architecture, I/O ports, Instruction set, Assembly language programming, connecting External memory.

UNIT-V

Interrupts, serial I/O, Timers, Counters, Applications of microcontrollers-Interfacing LEDs, Seven Segment display, Keyboard Interfacing,

Text Books:

1. A.K.Ray, K.M.Burchandi, "Advanced Microprocessors and peripherals", Tata McGraw Hill Co., 2006.
2. Mohammad Ali Mazidi, Janice Gillespie Mazidi, "The 8051 Microcontroller and Embedded Systems using assembly and 'C'", Prentice Hall of India, 2008.

Suggested Reading:

1. Douglas. V.Hall, "Microprocessors and Interfacing", Tata McGraw Hill, 2006.
2. Krishna Kant, "Microprocessors and Microcontrollers-Architecture, Programming and System Design 8085, 8086, 8051, 8096", Prentice Hall India, 2007.
3. K.J. Ayala, "The 8051 Microcontroller Architecture, Programming and Applications", Thomson publishers, 2nd Edition.

16EEC27

MICROPROCESSORS & MICROCONTROLLERS LAB

Instruction	1T + 2P Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: The objective of the course is to

1. Write and execute simple programs using MASM software tool.
2. Get the students acquainted with the processor kit and improve their Programming skills.
3. Make the students work with controller and understand how to program and get the desired output in different platforms.
4. Describe various instruction set of 8086 microprocessor used in programming.
5. Illustrate the need of interfacing experiments.
6. Aanalyze the processer and controller kits.

Course Outcomes: After completion of the course, the student will be able to

1. Use instruction set of 8086 Microprocessor to develop ALP's.
2. Write ALP programs of 8086 microprocessor that suits for MASM software.
3. Demonstrate the functioning of interfacing devices using 8086 programming.
4. Use instruction set of 8051 microcontroller to develop ALP's
5. Demonstrate the functioning of interfacing devices using 8051 programming through Keil software.
6. Relate the experiments done in laboratory for doing mini projects and academic project.

List of Experiments

For 8086Microprocessor:

Section 1: Using MASM/TASM (<u>Any 3</u> of the below mentioned Expts. are to be conducted in this Section).

1. Programs for signed/unsigned multiplication and division.
2. Programs for finding average of N 16-bit numbers.
3. Programs for finding the largest number in an array.
4. Programs for code conversion like BCD numbers to 7-Segment.
5. Programs for computing factorial of a positive integer number.

Section 2: Using 8086 Kit(Interfacing) (**Any 2 of** the below mentioned Expts. are to be conducted in this Section).

1. 8255-PPI: Write ALP's to generate triangular, saw-tooth and square waveforms using DAC.
2. 8279-Keyboard Display: Write a small program to display a string of characters.
3. Write an ALP to display some alpha-numeric characters on a seven-segment display module.
4. Traffic Signal Controller.

For 8051 Microcontroller:

Section 3: Using 8051 Kit (**Any 3 of** the below mentioned Expts. are to be conducted in this section).

1. Data Transfer - Block move, Exchange, sorting, Finding largest element in an array.
2. Arithmetic Instructions :Multi byte operations
3. Boolean & Logical Instructions (Bit manipulations).
4. Use of JUMP and CALL instructions.
5. Programs to generate delay and programs using serial port and on chip timer/counter.

Section 4: Program Development using 'c' cross compiler for 8051 (**Any 2 of** the below mentioned Expts. are to be conducted in this section).

1. DAC interfacing for Generation of Sinusoidal Waveform.
2. Stepper motor control(clockwise and anticlockwise directions).
3. Interfacing of Keyboard and 7-segment Display Module.
4. ADC interfacing for temperature monitoring.

Major Equipment required for the LAB:

1. 8086 Microprocessor trainer kit(s) with in-built assembler/disassembler.
2. 8051 Microcontroller trainer kit(s).
3. Interfacing Modules for both 8086 and 8051.
4. MASM Software and Kiel/Ride Cross-'c' compiler Software.

16EEC28

POWER SYSTEMS LAB

Instruction	1T + 2P Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: The objective of the course is to

1. Understand the power transfer to capability in terms of stability in transmission system.
2. Determine regulation & efficiency of short, medium and long transmission lines and to calculate A, B, C, D constants and study Ferranti effect in long lines.
3. Understand the importance of protective relays in power system such as different protection of transformer IDMT Characteristics of over current relay, Buchholz relay and static relays.
4. Understand steps involved in finding sequence parameter of Transformers and alternators.
5. Understand importance of di-electric strength of oil and efficiency of string of insulators.
6. View the significance of parallel operation of alternators and its practical importance.

Course Outcomes: After completion of the course: the student will be able to

1. Calculate ABCD constants of transmission lines and evaluate regulation, efficiency.
2. Examine relay setting for safe operating of power system.
3. Identity sequence parameters of transformer and alternator and draw its importance.
4. Calculate the time constant of an alternator.
5. Devise the dielectric strength of oil and calculate the efficiency of string insulators.
6. Appraise regulation and efficiency of transmission lines, calculate ABCD constants, importance of protective relays and calculation of parameters of transformers, alternators by conducing suitable tests.

List of Experiments

1. Determination of regulation & efficiency of 3-Phase transmission lines.
2. IDMT characteristics of Over-current relay.
3. Determination of A, B, C, D constants of 1-Phase transmission line.
4. Differential protection of 1-phase transformer.

5. Sequence impedance of 3-Phase Alternators by fault Analysis.
6. Determination of positive, negative and zero-sequence impedance of 3 - Phase transformers.
7. Synchronous machine reactance and time constant from 3-Phase S.C test.
8. Characteristics of Static relays.
9. Static excitation of Synchronous Generator.
10. Determination of dielectric strength of oil & Study of Buchholz relay.
11. Parallel operation of Alternators.
12. Measurement of capacitance of 3-core cables.
13. Fault location of Underground cables.
14. Determination of Voltage distribution and String efficiency of string of Insulators.
15. Study of Series- shunt compensation of a long transmission line.
16. Operation of relays in long transmission lines.
17. Ferranti effect in long lines.

Note: At least **TEN** experiments should be completed in the semester.

16EE C29

MINI PROJECT

Instruction	2 Hours per week
CIE	50 Marks
Credits	1

Course Objectives: The objective of the course is to

1. Understand the methods to carryout mini project in the area pertaining to Electrical and Electronics Engineering.
2. Understand the procedures/ methods to formulate the project scope of work and collect required literature.
3. Familiarizing the way to problem formulation and identify suitable techniques to solve.
4. Summarize the results and draw the conclusions.
5. Get exposure in report writing.
6. Discuss the practical application aspect of the project.

Course Outcomes: After completion of the course the student will be able to

1. Identify scope to carryout mini project in the area pertaining to Electrical and Electronics Engineering.
2. Formulate project scope and collect required information as literature survey.
3. Formulate problem to apply suitable techniques to solve.
4. Discuss the results and draw the conclusions
5. Discuss the practical aspects for suitable implementation.
6. Get exposure in report writing.

Mini Project is a course that a student has to undergo during his/her academic term, which involves the student to explore in a discipline that belongs to their research interest within their program area. It is a credit based course. The Mini Project shall be carried out during 6^{th} semester along with other lab courses by having regular weekly slots. Students will take mini project batch wise and the batches will be divided as per the guidelines. The topic of mini project should be so selected enabling the students to complete the work in the stipulated time with the available resources in the respective laboratories. The scope of the mini project could be handling part of the consultancy work, maintenance of the existing equipment, development of new experiment setup or can be a prelude to the main project with a specific outcome.

16EEC30

INDUSTRIAL VISIT

Instruction	Any one Industry Visit
Sessional /Examination	*Grade

Course Objectives: The objective of the course is to

1. Physically see the process of manufacturing procedure and steps involved.
2. Collect the information in respect of materials, sources of supply.
3. Understand the sequential stages involved in manufacturing process.
4. Understand the procedure to write the 'industry visit' technical report by compiling all the information collected during the visit.
5. Understand the safety procedures and pre-cautions followed in Industry, confidentiality of the process and the man power required.

Course Outcomes: After completion of the course the student will be able to

1. Know the importance of visiting an engineering industry from the point of view of process of manufactory procedures and set-up.
2. Summarize the required information with regard to materials, source of supply in respect of a product.
3. Know the stages in manufactory of a product.
4. Prepare the 'industry visit' technical report covering the details of visit and it importance.
5. Visualize the safety precautions to be follow in industry, confidentiality of the product processing as the man power required.

Students are expected to visit at least one industry during the semesters from 4^{th} to 7^{th} and submit a detailed technical report on the study -visit to the Department. The Department should evaluate the report through a Committee consisting of Head of the Department and two more faculty members to award the Grades *.

* Satisfactory /Unsatisfactory.

16EEE 05

HIGH VOLTAGE ENGINEERING

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The objective of the course is to

1. Determine the breakdown mechanism in gases, liquids and solid dielectrics.
2. Understand the methods of generation and measurement of high voltages and currents.
3. Know the steps involved procedure for testing of high voltage equipment.
4. Understand the procedure for generation of impulse voltages and current
5. Know the importance of testing of HV electrical equipment.
6. Know the procedure and methodology of
   (i) Breakdown mechanism in Gases, Liquids and solid dielectrics
   (ii) Methods of generation and measurement of High voltages and currents and
   (iii) Classify the procedure for testing of High voltage equipment.

Course Outcomes After completion of the course the student will be able to

1. Describe breakdown mechanism in Gases and specially pertaining to high voltage engineering and its importance.
2. Discuss different aspects of breakdown mechanism in liquids and solids specifically pertaining to high voltage aspect.
3. Distinguish in respect of generation of High Voltages and currents, generation of impulse voltage and currents. To Analyze multistage impulse generation of impulses voltages and current generation.
4. Explain relating to measurement of high AC currents, High DC currents measurement of impulse currents and associated measuring equipment.
5. Classify in testing of high voltage electrical equipment such as power capacitor, power transformers, circuit breakers, insulators, bushings, cables, surge arresters etc.
6. Summarize (i) Breakdown mechanism in Gases, Liquids and solid dielectrics.
   (ii) Methods of generation and measurement of High voltages and currents and
   (iii) Classify the procedure for testing of High voltage equipment.

UNIT-I

Breakdown Mechanism in Gases: Mechanism of breakdown, Types of collisions, Ionization processes, Townsend's First and second Ionization coefficients, Townsend's breakdown mechanism, Time lags for breakdown, Streamer theory of breakdown, Paschen's Law, Penning effect, Corona discharges.

UNIT II

Breakdown Mechanism in Liquids and Solids: Breakdown in liquid dielectrics: Classification of liquid dielectrics, Pure liquids and commercial liquids, conduction and breakdown in pure liquids and commercial liquids. Testing of transformer oil. Breakdown in solid dielectrics: Intrinsic breakdown, Electro-mechanical breakdown, Thermal breakdown, Breakdown due to treeing and tracking, Breakdown due to internal discharges.

UNIT-III

Generation of High Voltages and Currents: Generation of Hugh DC voltages: Half and full wave rectifier circuits, Voltage doubler circuits, Cockroft Walton voltage multiplier circuit. Generation of Hugh AC voltages: Electrostatic generator, Van de Graf generator, Cascaded transformers, Series resonant circuit. Generation of Impulse Voltages and Currents: Analysis of impulse generator circuit, Multistage Impulse generator circuit, Impulse current generation.

UNIT-IV

Measurement of High Voltage and Currents: Sphere gap, Uniform field spark gap, Rod gap, electrostatic voltmeter, Generating voltmeter, Chubb Fortescue method, Impulse voltage measurement using voltage dividers. Measurement of high D.C currents using Hall generators, Measurement of high A.C currents using current transformer and electro-optical system. Measurement of Impulse currents: Resistive shunts, Rogouuski coils, Faraday generator.

UNIT-V

Testing of High Voltage Equipment: Testing of Power capacitors. Testing of power transformers. Testing of circuit breaker. Testing of Insulators and bushings. Testing of Cables. Testing of Surge Arresters.

Text Books

1. M.S.Naidu and V.Kamaraju, "High Voltage Engineering", Tata McGraw Hill 4th Edition, 2009.
2. C.L. Wadhwa, "High Voltage Engineering", Wiley Eastern Ltd.., 2007.

Suggested Reading:

1. E.Kuffel and W.S. Zaengl, "High Voltage Engineering", Pergamon Press, 3rd Edition, 2016.

16EE E06

AI TECHNIQUES IN ELECTRICAL ENGINEERING

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
University Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The objective of the course is to

1. Practice the concepts soft computing techniques and comprehensive knowledge of fuzzy logic control and to design the fuzzy control.
2. Expose students to the basic ideas, challenges, techniques and problems in artificial intelligence.
3. Know different types of neural networks and training algorithms
4. Know the applications of AI Techniques in electrical engineering applications
5. Analyse the metaheuristic techniques in real-world problems.
6. Introduce to the basic concepts of Artificial Intelligence with illustrations of current state of the art research and applications.

Course Outcomes: After the completion of the course the student will be able to

1. Understand concepts of ANNs, Fuzzy logic and metaheuristic Techniques.
2. Remember difference between knowledge based systems and algorithmic based systems.
3. Understand operation of Fuzzy controller and metaheuristic algorithms
4. Apply soft computing techniques for real-world problems
5. Analyse critically the techniques presented and apply them to electrical Engineering problems.
6. Apply metaheuristic techniques to Electrical problems.

UNIT-I

Artificial Neural Networks: Introduction, Models of Neural Network, Architectures, Knowledge representation, Artificial Intelligence and Neural networks, Learning process, Error correction learning, Hebbian learning, Competitive learning, Boltzman learning, Supervised learning, Unsupervised learning, Reinforcement learning, learning tasks.

UNIT- II

Fuzzy Logic: Introduction, Fuzzy versus crisp, Fuzzy sets, Membership function, Basic Fuzzy set operations, Properties of Fuzzy sets, Fuzzy cartesion Product, Operations on Fuzzy relations, Fuzzy logic, Fuzzy Quantifiers, Fuzzy Inference, Fuzzy Rule based system, Defuzzification methods.

UNIT- III

Metaheuristic Techniques-1: Introduction, Particle Swarm Optimization- swarm intelligence, PSO algorithms,Accelerated PSO, Implementation- Multimodal Functions, Validation, Simulated Annealing-Annealing and Probability, Choice of Parameters, SA Algorithm, Implementation, Ant Algorithms- Behaviour of Ants, Ant Colony Optimization, Double Bridge Problem, Virtual Ant Algorithm.

UNIT-IV

Metaheuristic Techniques-2: Bee Algorithms- Behavior of Honey Bees, Bee Algorithms- Honey Bee Algorithm, Virtual Bee Algorithm, Artificial Bee Colony Optimization, Applications, Harmony Search algorithm, Music-Based Algorithms, Harmony Search, Implementation.

UNIT-V

Applications of AI Techniques: Economic load dispatch, Load frequency control, Single area system and two area system, Reactive power control, speed control of DC and AC Motors.

Text Books:

1. S.Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms",PHI, New Delhi, 2010.
2. Xin-SheYang, "Engineering Optimization: An Introduction with Metaheuristic Applications",Wiley publication, 2010.

Suggested Reading:

1. P.D.Wasserman,VanNostrandReinhold, "Neural Computing Theory & Practice", New York,1989.
2. Bart Kosko, "Neural Network & Fuzzy System" Prentice Hall, 1992.

16EEE07

SWITCH MODE POWER CONVERTERS

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
University Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The objective of the course is to

1. Understand various advanced power electronics devices.
2. Study basic converter topologies.
3. Comprehend the design of resonant converters.
4. Describe the operation of multilevel inverters with switching strategies. for high power applications.
5. Understand different kinds of DC/AC power supplies.
6. Make the students know about design of SMPS.

Course Outcomes: After completion of the course, the student will be able to

1. Outline various features of advanced power electronics devices.
2. Develop and analyze various converter topologies.
3. Analyze different resonant converter topologies.
4. Apply the knowledge of different Multilevel Inverters that suits for industrial applications.
5. Compare the AC and DC power supplies.
6. Design AC and DC switched mode power supplies.

UNIT-I

Modern Power Semiconductor Devices: Gate Turn Off- SCR(GTO-SCR), MOS Turn off Thyristor(MTO), Emitter Turn Off Thyristor (ETO), Integrated Gate-Commutated Thyristor(IGCTs), MOS-controlled thyristors(MCTs), symbol, structure and equivalent circuit, comparison of their features.

UNIT-II

Converter Circuits: DC/DC converters - buck, boost, buck-boost & Cuk converters and their principles of operation; continuous and discontinuous modes of operation, Design aspects of DC-DC converters.

UNIT-III

Resonant Converters: Introduction, Classification of Resonant Converters, Basic Resonant circuit concepts, Load Resonant Converters, Resonant switch converters, zero current and zero voltage resonant converters, comparison between ZCS and ZVS resonant converters.

UNIT-IV

Multilevel Inverters: Multilevel concept , Classification of multilevel inverters, Diode clamped Multilevel inverter, principle of operation , main features , improved diode Clamped inverter, principle of operation, Flying capacitors multilevel inverter, principle of operation, main features, cascaded multilevel inverter, principle of operation, main features, Multilevel inverter applications.

UNIT-V

DC & AC Power Supplies: DC power supplies, classification, switched mode DC power supplies, fly back Converter, forward converter, push-pull converter, half bridge converter, Full bridge converter, Resonant DC power supplies, bidirectional power supplies, Applications, AC power supplies, classification, switched mode AC power supplies, Uninterruptible Power supplies applications.

Text Books:

1. Mohammed H. Rashid, "Power Electronics", Pearson Education, Third Edition – first Indian reprint -2004.
2. Ned Mohan Tore M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 3rd Edition, 2007.

Suggested Reading:

1. H. W. Whittington, B. W. Flynn and D. E. MacPherson, "Switched Mode Power Supplies, Design and Construction", Universities Press, 2009 Edition.
2. Umanand L., Bhat S.R., "Design of Magnetic Components for Switched Mode Power Converters", Wiley Eastern Ltd., 1992
3. Robert. W. Erickson, D. Maksimovic, "Fundamentals of Power Electronics", Springer International Edition, 2005.

16EEE08

OPTIMIZATION TECHNIQUES

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The objective of the course is

1. To study about classical optimization techniques which include single variable and multi variable optimization with equality constraints.
2. To study about linear programming.
3. To study non linear programming with direct search methods.
4. To study different gradient methods.
5. To study about Genetic algorithms.
6. To Analyze Economic load dispatch with the application of Genetic algorithm.

Course Outcomes: After completion of the course, the student will be able to

1. Solve the classical optimization problems.
2. Formulate linear programming problem and get the solution with simplex method, Graphical method.
3. Solve the nonlinear programming problems with various search methods such as Fibonacci method, golden section method etc.
4. Solve the non-linear programming problem with gradient methods.
5. Explain different mechanisms in Genetic algorithms.
6. Estimate the Economic load dispatch using genetic algorithms.

UNIT- I

Introduction: Classical optimization techniques: Statement of optimization problem, Objective function, Classification of optimization problems, Single-variable & Multi-variable Optimization without constraints. Multi-variable optimization with equality Constraints. Lagrange multiplier method, Multi-variable optimization with inequality constraints, Kuhn- Tucker conditions.

UNIT-II

Linear Programming: Standard form, Formulation of the LPP, Solution of simultaneous equations by Pivotal condensation, Graphical method, Simplex algorithm.

UNIT-III

Non-Linear Programming-I: One dimensional Search method: Fibonacci method, Golden Section method.

Direct Search method: Univariate Search method, Hook and Jeeve's method, Powell's method.

UNIT-IV

Non Linear Programming-II:

Gradient methods: Steepest Descent, Conjugate Gradient, Newton method and Quasi Newton method.

UNIT-V

Genetic Algorithms: Introduction, Encoding, Fitness Function, Basic Operators, Single Point cross over, two point cross over, uniforms cross over, mutation operator, Selection Techniques, Tournament Selection, Roulette wheel selection, Application to Economic load dispatch.

Text Books:

1. S.S.Rao, "Engineering Optimization Theory and Applications", New Age International, 3rd Edition, 1998.
2. Jasbir S.Arora, "Introduction to Optimum Design", McGraw Hill International Edition,1989.

Suggested Reading:

1. Kalyanmoy Deb, "Multi Objective Optimization using Evolutionary Algorithms", Wiley publications, 2013.
2. S. Rajasekharam, G.A. Vijaya Lakshmi, "Neural networks, Fuzzy logic and Genetic Algorithms Synthesis and Applications", PHI publications, 2010.

16EE E09

ADVANCED CONTROL SYSTEMS

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The objective of the course is to

1. Understand the classical approach in designing compensators.
2. Gain the mathematical knowledge of z-transforms in representing sampled data control systems.
3. Understand the concepts of stability analysis in sampled data control system.
4. Uunderstand the concepts of controllability and observability tests for Discrete - time and time invariant systems.
5. Understand the importance of response of non-linear systems and construction of phase plane trajectories.
6. Understand the procedures to perform stability study using Liapunov's criteria and construction of Liapunov function.

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

1. Design different types of compensators.
2. Represent discrete time systems and obtain solution.
3. Calculate and analyze sample data control system stability.
4. Apply the concepts of controllability and observability - tests for discrete-time systems.
5. Analyze the response of non-linear systems and construction of phase plane trajectories.
6. Justify the stability study through Liapunov's criteria and construction of Lyapunov function.

UNIT-I

Introduction to Compensator Designs: Preliminary considerations of classical design, Realization of basic compensators, cascade compensation in time domain, cascade compensation in frequency domain using bode plots.

UNIT-II

Sampled Data Control Systems: Introduction, Spectrum analysis of sampling process, signal reconstruction, difference equations, Z-transform, Pulse transfer function, Inverse Z transform, Analysis of sampled data control systems, Z and S domain relationships, Stability analysis-Jury's stability test, bilinear transformation.

UNIT-III

State-space Analysis and Design: State space representation of discrete time systems, phase variable and canonical form of state model, solution of discrete time state equation using z-transform, concept of Controllability and Observability, Controllable and Observable phase variable form of state model, control system design through pole placement by state feedback.

UNIT-IV

Nonlinear Systems: Introduction, common physical nonlinearities, phase plane-method, Singular points, stability of non linear system, Construction of phase trajectories- Isoclines method, ä-method, The Describing Function-basic concepts, Derivation of describing functions- dead zone and saturation, relay with dead zone and hysteresis.

UNIT-V

Liapunov's Stability Analysis: Introduction, Liapunov's stability criterion, direct method of Liapunov and the linear system, Methods of constructing Liapunov function for non linear systems- Krasovskii's method, Variable gradient method.

Text Books:

1. I. J Nagrath, M. Gopal, "Control Systems Engineering", New Age International (P) Limited, 2017.
2. Ogata .K, "Discrete Time control Systems", PHI Publications, 2nd Edition 1995.

Suggested Reading:

1. M. Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill, 2/e, 2003.
2. K. Ogata, "Modern Control Engineering", Pearson Publications, 5th Edition, 2015.

16EEE10

ELECTRICAL DISTRIBUTION SYSTEMS AND AUTOMATION

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The objective of the course is to

1. Study the load characteristics of distribution systems.
2. Understand the substation schemes, voltage drop calculation of different service areas.
3. Know about primary and secondary distribution systems and their characteristics.
4. Study different voltage control methods.
5. Study the application of capacitors in distribution systems.
6. Study the distribution automation control functions.

Course Outcomes: After completion of the course, the student will be able to

1. Estimate the load factors, diversity factor etc. for different systems.
2. Describe the substation bus schemes and calculate the rating of substations.
3. Compute voltage drop and power losses of primary and secondary distribution systems.
4. Estimate the reactive power requirements of distribution systems.
5. Describe the voltage control methods used in Distribution Systems.
6. Explain the Distribution automation control functions and communication used in Distribution automation.

UNIT-I

Load Characteristics: Demand, demand curve, load duration curve, Diversified demand, Non-coincident Demand, Coincidence factor, Contribution factor problems, Relationship between load and loss factors load growth, Rate structure, Customer billing, Classification of loads (residential, commercial, agricultural, and industrial) and their characteristics.

UNIT-II

Sub-Transmission Lines and Substations: Types of sub-transmission lines, Distribution substations, Substation bus schemes, Rating of distribution substation, Service area with multiple feeders, Percent voltage drop calculations.

UNIT-III

Primary and Secondary Feeders: Types of primary systems, Radial type, Loop type and Primary network, Primary feeder loading, Radial feeder with uniformly distributed load, Secondary voltage levels, Secondary banking, Secondary networks.

UNIT-IV

Voltage Drop and Power Loss Calculations: Voltage drop and power loss calculations, 3-phase, Non 3-phase primary lines, Single phase two-wire laterals with ungrounded neutral, Single phase two wire unigrounded laterals, Two phase plus neutral lateral, Method to analyze distribution costs, Voltage control methods, Feeder voltage regulators.

UNIT-V

Application of Capacitors to Distribution Systems: Effects of series and shunt capacitors, Power factor correction, Economic justification for capacitors, Location and sizing of capacitors in distribution system. **Distribution System Automation**: Definitions, control functions, Level of penetration of DA, Types of communication systems, Supervisory control and data acquisition.

Text Books:

1. Turan Gonen, "Electric Power Distribution Engineering", TMH, 3rd Edition, 2016.
2. A.S.Pabla, "Electric Power Distribution", TMH, 6th Edition, 2012.

Suggested Reading:

1. M. K. Khed Kar, G.M. Dhole, "Electric Power Distribution Automation", University Science Press, 2010
2. William Kersting, "Distribution System Modeling and Analysis", 3rd Edition CRC Press, 2015.
3. S.Sivanagaraju, and V.Sankar, "Electric Power Distribution and Automation", Dhanpat Rai & Co, 2012.

16EEE11

HIGH VOLTAGE DC TRANSMISSION

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
University Examination	70 Marks
CIE	30 Marks
Credits	3

Course objectives: The objective of the course is to

1. Deal with the basics of HVDC Transmission and comparison between HVAC and HVDC.
2. Deal with power conversion between Ac to DC and DC to AC.
3. Deal with control of HVDC converters.
4. Deal with HVDC filters.
5. Deal with the protection of HVDC systems.
6. Deal with MTDC transmission systems.

Course outcomes: After completion of the course students will be able to

1. Compare between HVDC and HVAC Transmission systemsand discuss about basics of HVDC.
2. Analyze 6 pulse,12 pulse circuits and to calculate power conversion between Ac to DC and DC to AC.
3. Discuss about various control methods and also able to draw the control characteristics.
4. Discuss about the various filters used in HVDC/HVAC transmission systems.
5. Discuss about the protection of HVDC transmission systems.
6. Discuss about MTDC transmission systems and their control aspects.

UNIT-I

General consideration of DC and AC transmission systems: Comparison of AC and DC transmission systems, Application of DC transmission, Economic Consideration, Kinds of DC links, planning for HVDC transmission, Modem trends in DC transmission, Corona loss in AC & DC systems.

UNIT-II

Converter Circuits: Properties of Converter circuits, Different kinds of arrangements, Analysis of Bridge converters with grid control, with and without overlap angle, Equivalent circuit of rectifier. Inversion: Operation as Inverter, Equivalent circuit of Inverter.

UNIT-III

Control: Basic means of control, Limitations of manual control, Desired features of control, Combined characteristics of rectifier and inverter, Power reversal, constant minimum angle, Ignition angle control, Constant current control, Constant Extinction angle control.

UNIT-IV

Protection: Short circuit current, Arc-back, Commutation failure, Bypass valves, DC reactors, DC circuit breakers, Protection against over voltages, Harmonic filters.

UNIT-V

Multi-terminal DC Systems: Application of MTDC systems, Types of MTDC systems, Comparison of series and parallel MTDC systems, Control of MTDC system.

Text Books:

1. Padiyar KR., "HVDC Power Transmission Systems", New age, 2017
2. S.Kamakshaiah and V.Kamaraju., "HVDC transmission" , McGraw Hill 2017.

Suggested Reading:

1. Kimbark E.W., "Direct Current Transmission" Vol-I, JohnWtley, 1971. 1990.
2. Arrillaga J., "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., London, Pergamon Press, 1983.

16EEE12

SIMULATION TECHIQUES FOR ELECTRICAL ENGINEERING

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The objective of the course is to

1. Introduce various simulation techniques for electrical engineering graduates.
2. Provide a platform to know about modeling of components.
3. Create an environment to work with different software technologies.
4. Build confidence in writing programmes.
5. Make familiar about logical operations.
6. Become aware about the analysis of DC & AC circuits.

Course Outcomes: After completion of the course, the student will be able to

1. Classify software techniques based on application and system requirement.
2. Infer various logical operations.
3. Draw the graphs for analysis of data.
4. Identify the bug in the program and also procedure to debug the same.
5. Model circuit elements by distinguishing them AC and DC.
6. Simulate the given circuit and validate by conventional means.

UNIT-I

Basics: MATLAB environment, variables, Basic data types, Relational and Logic operators, Conditional statements, Input and Output, Loops and bracing.

UNIT-II

Matrices: Creating and Manipulating matrices, Matrix mathematics and Matrix functions, Colon operator, Line space, Cross product, Dot product, Logical functions, Logical indexing, 3 – dimensional arrays, Cell arrays, Structures, Plotting: 2-D and 3-D plots: Basic plots, subplots, Histograms, Bar graphs, Pie charts.

UNIT-III

M –file Scripts: Creating saving and running an M – file, creating and running of a function, function definition line, H1 and help text lines, Function body, Sub – functions, File I/O handling,

UNIT-IV

PSpice for Circuit Analysis: Introduction to PSpice, Description of circuit elements, nodes and sources, input and output variables, modeling of the above elements, types of DC analysis, types of AC analysis and Transient Analysis.

UNIT-V

PSpice for Electronic Devices and Circuits: Diode model, BJT model, MOSFET model, IGBT model, SCR model, Sub routines, diode rectifiers, controlled rectifiers.

Text Books:

1. Muhammad H. Rashid, "Power Electronics: Circuits, Devices, and Applications", Pearson Education India. 3rd Edition, 2009.
2. D Hanselman and B little field, "Mastering MATLAB 7", Pearson Education, 2005.
3. Y Kirani Singh and B BChaudhari, " MATLAB Programming", Prentice Hall of India, 2007.

Suggested Reading:

1. Muhammad H. Rashid, "Spice for Power Electronics and Electric Power", CRC Press 3rd Edition, 2012.
2. A Gilat, "MATLAB: An Introduction with Applications", John Wiley and Sons, 2004.
3. Steven T Karris, "Introduction to Simulink with Engineering Applications", Orchard Publication, 2nd Edition, 2008.

Elective Courses offered to other Departments

SEMESTER – VI

S.No	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per week		Duration of SEE in Hours	Maximum Marks		
			L/T	P/D		CIE	SEE	
PRACTICALS								
1	**16EE E13**	**INDUSTRIAL ELECTRONICS (BE 3/4 ECE, VI Sem)**	3/0	0	3	30	70	3
TOTAL			**3**	**0**	**-**	**30**	**70**	**3**

L: Lecture T: Tutorial P: Practical D: Drawing
CIE - Continuous Internal Evaluation SEE - Semester End Examination

16EE E13

INDUSTRIAL ELECTRONICS

(BE 3/4 ECE, VI Sem.)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
University Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objective: The objective of the course is to

1. Introduce the characteristics of various power semiconductor switches and their applications.
2. Know the importance of protection, triggering and commutation technique s of SCR.
3. Make acquainted with the operating principles of AC-DC, DC-DC, AC-AC and DC-AC converters.
4. Understand various voltage control techniques in power converters.
5. Comprehend quadrant operation of various power converters.
6. Recognize various application of power converters.

Course Outcomes: After completion of the course, the student will be able to

1. Analyze basic operation of various power semiconductor devices and to compare their characteristics.
2. Design protection circuit and control circuits for SCR.
3. Analyze the operation principles of different AC-DC, DC-DC, AC-AC, and DC-AC converters.
4. Identify different voltage control strategies in different converters.
5. Be acquainted with different quadrant operation of power converters.
6. Know the practical application of power electronic converters

UNIT-I

Power Diodes and Transistors: Power diode, characteristics, Recovery characteristics, Types of power diodes, General purpose diodes, Fast recovery diodes, their applications, Power MOSFET and IGBT.

UNIT-II

Silicon Controlled Rectifier (SCR): SCR-Static characteristics, Two transistor analogy, Protection of SCRs, Dynamic characteristics, ,SCR trigger circuits-R, RC and UJT triggering circuits, turn-off methods of SCR, GTO- SCR, Comparison between SCR and GTO-SCR.

UNIT-III

Phase controlled converters: Study of Single-phase half wave and full wave controlled rectifiers with R, RL, RLE loads, significance of freewheeling diode, Dual converters - circulating and non circulating current modes.

DC-DC Converters: Principles of Step-down, Step-up, Step UP/Down choppers, Time ratio control and current limit control, Types of choppers Type- A, B, C, D and E.

UNIT-IV

AC-AC Converters: Principle of operation of Single phase Cyclo-converters and their applications. Single-phase AC Voltage Controllers with R and RL loads.

Inverters: Principle of operation of Single-phase Inverters, Voltage control methods, Single pulse width modulation, multiple pulse width modulation, Sinusoidal pulse width modulation.

UNIT-V

Industrial Applications: Overview of Switched mode power supplies, Online and offline UPS (block diagrams), Thyristor controlled reactors, switched capacitor networks, Emergency light control, automatic water level control, resistance heating, induction and dielectric heating.

Text Books:

1. Singh.M.D and Khanchandani.K.B, "Power Electronics", Tata McGraw Hill, 2nd Edition, 2006.
2. Rashid.M.H. "Power Electronics Circuits Devices and Applications". Prentice Hall of India, 2003.
3. Bimbra.P.S, "Power Electronics", Khanna Publishers, 3rd Edition, 2013.

Suggested Reading:

1. Mohan, Undeland, Robbins, "Power Electronics", John Wiley, 1996.
2. P.C.Sen, "Power Electronics", Tata Mc-Graw Hill, 1st Edition, 2001.
3. G. K. Mithal, "Industrial Electronics", Khanna Publishers, Delhi, 2000.