CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY(A)

AICTE MODEL CURRICULUM

B.E. (ELECTRICAL AND ELECTRONICS ENGINEERING)

SEMESTER-V

Sl. 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		CIE	SEE	
THEORY									
1	**18EEC14**	Electrical Machines-II	3	-	-	3	30	70	3
2	**18EEC15**	Power Systems-II	3	-	-	3	30	70	3
3	**18EEC16**	Power Electronics	3	-	-	3	30	70	3
4	**18EEEXX**	Core Elective -1	3	-	-	3	30	70	3
5	**18EEEXX**	Core Elective -2	3	-	-	3	30	70	3
6	**18MBC01**	Engineering Economics and Accountant	3	-	-	3	30	70	3
PRACTICALS									
7	**18EEC17**	Electrical Machines-II Lab	-	-	2	2	15	35	1
8	**18EEC18**	Power Systems-I Lab	-	-	2	2	15	35	1
9	**18EEC19**	Power Electronics Lab	-	-	2	2	15	35	1
		Total	**18**	**-**	**6**	**-**	**225**	**525**	**21**

L: Lecture **T: Tutorial** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

Course Code	Core Elective-1
18EEE01	Wind and Solar Energy
18EEE02	Optimization Techniques
18EEE03	Electrical Engineering Materials
18EEE04	Electronic Instrumentation

Course Code	Core Elective-2
18EEE05	Simulation Techniques in Electrical Engineering
18EEE06	Energy Conservation & Auditing
18EEE07	Industrial Electrical Systems
18EEE08	Electrical Estimation & Costing

With effect from the academic year 2020-21

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY(A)

AICTE MODEL CURRICULUM

B.E. (ELECTRICAL AND ELECTRONICS ENGINEERING)

SEMESTER-VI

Sl. No.	Course Code	Title of the Course	Scheme of Instruction: Hours per week			Scheme of Examination: Duration in Hours	Maximum Marks		Credits
			L	T	P		CIE	SEE	
THEORY									
1	**18EEC20**	Control Systems	3	-	-	3	30	70	3
2	**18EEC21**	Microprocessors and Microcontrollers	3	-	-	3	30	70	3
3	**18EEC22**	Power Systems Operation and Control	3	-	-	3	30	70	3
4	**18EEEXX**	Core Elective-3	3	-	-	3	30	70	3
5	**18EEEXX**	Core Elective-4	3	-	-	3	30	70	3
6	**18XXOYY**	Open Elective-1	3	-	-	3	30	70	3
PRACTICALS									
7	**18EEC23**	Control Systems Lab	-	-	2	2	15	35	1
8	**18EEC24**	Microprocessors Lab	-	-	2	2	15	35	1
		Total	**18**	**-**	**4**	**22**	**210**	**490**	**20**

L: Lecture T: Tutorial P: Practical

CIE - Continuous Internal Evaluation SEE - Semester End Examination

Course Code	Core Elective-3
18EEE09	Power Quality
18EEE10	Advanced Power Converters
18EEE11	Electrical Distribution Systems
18EEE12	HVDC Transmission Systems

Course Code	Core Elective-4
18EEE13	AI Techniques In Electrical Engineering
18EEE14	Electric Hybrid Vehicles
18EEE15	FACTS
18EEE16	Special Electrical Machines

Course Code	Open Elective-1
18ECO06	Principles of Embedded Systems (PES)
18CSO07	Basics of Cyber Security (BCS)
18BTO01	Basics of Biology
18PYO01	History of Science and Technology

V – SEMESTER

18EEC14 **ELECTRICAL MACHINES-II**

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 this course is to:
1. To understand the construction and operational features of ac Machines.
2. To familiarize with performance aspects of Induction Motor, Synchronous Machine.
3. To impart the knowledge of various starting methods and selecting a suitable method based on the application.

Course Outcomes: The student will be able to:
1. Identify the various parts and nomenclature related to ac Machine windings
2. Classify various ac Machines based on constructional and operational features.
3. Associate the concepts with characteristics of ac Machines.
4. Analyze various starting and speed control methods of ac Machine.
5. Sketch and analyze the Characteristics of ac Machine based on application.
6. Determine the performance parameters of ac machines.

UNIT-I
Fundamentals of AC machine windings : Slots for windings, Harmonics (slot and teeth Harmonics), Suppression of Harmonics, full-pitch and short pitch coils, concentrated winding, distributed winding, pitch factor, distribution factor, Integral and fractional slot windings, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, advantages of star connected winding.

UNIT-II
Three phase Induction Machines: Constructional features, types of rotors, production of rotating magnetic field, operation, slip, rotor current and frequency, equivalent circuit, torque expression, starting torque, maximum torque, torque-slip characteristics, parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency), cogging and crawling, power flow, losses and efficiency, no load and blocked rotor test, predetermination of performance characteristics using circle diagram, double cage induction motor, induction generator.
Starting methods: Primary resistors, auto-transformer, star-delta and DOL starting. Speed control methods from stator and rotor side.

UNIT-III
Single-phase Induction Motors: Constructional features double revolving field theory, split phase, shaded pole and capacitor type motors, equivalent circuit, applications.

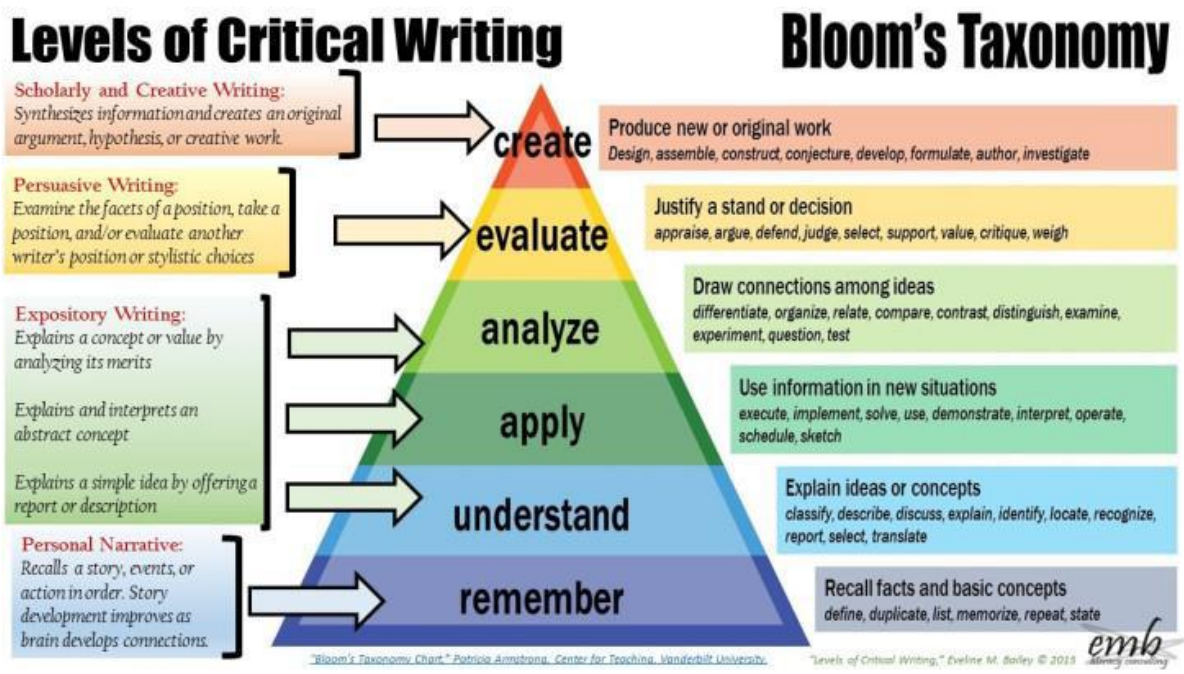
UNIT-IV
Synchronous Generators: Constructional features, cylindrical and salient pole rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, open circuit, short circuit and zero power factor characteristics, voltage regulation by EMF, MMF and ZPF method, Salient pole alternators two reaction theory, Phasor diagram, power angle characteristics. Parallel operation of alternators, synchronization and load division**.**

UNIT-V
Synchronous Motor: Theory of Operation, methods of starting, variation of current and power factor with excitation on no-load and on-load, Hunting and its prevention, synchronizing power, synchronous condenser.

Text Books:
1. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.
2. P. S. Bimbhra, “Electrical Machinery”, Khanna Publishers, 2011.
3. J.B Gupta, S.K. Kataria & Sons, “Theory and performance of electrical machines”, 14th Edition, 2014.
4. Ashfaq Hussain “Electrical Machines” Dhanapat Rai and sons, 3rd Edition 2012.

Suggested Readings:

1. A.E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
4. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.
5. Juha Pyrhonen, Tapani Jokinen, Valeria Hrabovcova, "Design of Rotating Electrical Machines", John Wiley &Sons, Ltd. 2008.



18EEC15 **POWER SYSTEMS -II**

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 this course is to:

1. To understand the modelling of transmission lines and their performance calculations
2. To understand per unit system representation and calculation of fault currents.
3. To understand the generation of over voltages and power flow analysis of given power system.

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

1. Analyse the performance of different types of transmission lines and evaluate the effect of corona on transmission lines
2. Understand the per unit quantities of the given power system
3. Classify different types of faults and apply symmetrical components to solve the power system problem when subjected to different fault conditions
4. Describe the causes of over voltages and analyse reflection and refraction coefficients of overhead lines and cables
5. Apply Gauss Seidel method and Newton-Raphson method to find power flows and voltages of the given power system.

UNIT-I

Modelling of Transmission Lines: Short, medium, long lines, Line calculations, Tuned Lines, Surge impedance loading, Travelling wave equations, series and shunt compensation of Transmission lines
Corona: Causes, Disruptive and Visual Critical Voltages, Power loss, minimization of Corona effects.

UNIT-II

Per Unit System of Representation: Use of per unit quantities in power systems, Advantages of per unitsystem.
Symmetrical Faults: Typical waveform under balanced terminal short circuit conditions: steady state, transientand sub transient equivalent circuits, Reactance of Synchronous Machines, fault calculations, Short circuit capacity of a bus.

UNIT-III

Unsymmetrical Faults: Symmetrical components of unsymmetrical Phasors, Power in terms of symmetricalcomponents, 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-IV

Transients in Power systems: Generation of Over-voltages: Causes of over voltages, lightning and SwitchingSurges, Travelling Wave Theory, Wave equation, Reflection and refraction coefficients, Junction of cable andoverhead lines, Junction of three lines of different natural impedances, Bewley Lattice diagram, Introduction to EMTP.

UNIT-V

Power Flow Analysis: Formation of Bus Admittance Matrix. Real and reactive power balance equations at anode. Load and Generator Specifications. Application of numerical methods for solution of non-linear algebraic equations- Gauss Seidel and Newton-Raphson methods for the solution of the power flow equation.

Text Books:

1. J.J Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.
3. C.L. Wadhwa, “Electric Power Systems Theory”, New Academic Science Limited, 2012

Suggested Reading:

1. A.R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.
2. D.P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.
3. B.M. Weedy, B.J. Cory, N. Jenkins, J. Ekanayake & G. Strbac, “Electric Power Systems”, Wiley, 2012

18EEC16 **POWER ELECTRONICS**

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

Course Objective:

1. To identify the characteristics of different static switches and their turn-ON & turn-OFF methods.
2. To know the principles of AC-DC, DC-DC, DC-AC and AC-AC energy conversions.
3. To study various methods of voltage control in power converters.

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

1. Understand the construction, operation and characteristics of various power semiconducting devices and to identify their selection in appropriate application.
2. Comprehend the driver/trigger circuits for various devices & also protection circuit, different turn-OFF methods, series & parallel operation of SCRs.
3. Illustrate the principle of working of AC-DC, AC-AC, DC-DC & DC-AC converters.
4. Analyse the performance for various power converters with different loads and modes of working.
5. Describe various voltage control techniques in power electronic converters with their applications

UNIT-I

Power Switching Devices: Power diode, characteristics, Recovery characteristics, Types of power diodes, General purpose diodes, Fast recovery diodes, their applications. Bipolar Junction Transistors(BJT), Power MOSFET, IGBT Basic structure and working, Steady state and switching characteristics, Gate drive circuits for MOSFET and IGBT, 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

Thyristors Rectifiers: 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, Voltage commutated chopper, Introduction to Buck, Boost and Buck-Boost regulators.

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

UNIT-V

DC-AC Converters: Principle of operation of Single-phase Bridge inverters, Voltage control methods, Single pulse width modulation, Multiple pulse width modulation, Sinusoidal pulse width modulation, Three-phase bridge Inverters, 180^0 & 120^0 modes of operation, switch states, instantaneous output voltages, average output voltages for single & three phase inverters, Current source inverters, Comparison of Voltage Source Inverters and Current Source Inverters,

Text Books:

1. Singh. M. D, Khanchandani.K. B, “Power Electronics”, Tata McGraw Hill, 2nd Edition, 2017.
2. Rashid. M. H., “Power Electronics Circuits Devices and Applications”, 4th Edition, Pearson India, 2017.
3. Bimbra. P. S, “Power Electronics”, Khanna Publishers, 3rd Edition, 2013.
4. R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2013

Suggested Reading:

1. N. Mohan, T.M. Undeland , "Power Electronics: Converters, Applications and Design", John Wiley & Sons,2007
2. P.C. Sen, "Power Electronics", Tata Mc-Graw Hill, 1st Edition, 2001.
3. L.Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009

There are only two mistakes one can make along the road to truth; not going all the way, or not starting at all; not doing anything can be worse than doing the wrong thing.

Vikasa Mantras- Vivekananda Institute of Human Excellence

18EEC17 **ELECTRICAL MACHINES-II LAB**

Instruction	2 Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	35 Marks
CIE	15 Marks
Credits	1

Course objectives:
1. To understand the practical connections of the machines.
2. To calculate the various parameters of induction motor and synchronous machine by performing the experiment.
3. To analyze the performance of the induction motor and synchronous machine by conducting suitable experiments.

Course Outcomes: After the completion of this course, students will be able to:
1. Identify the connections for Induction and synchronous machines for their applications.
2. Control the speed of the induction motor using different methods.
3. Estimate the voltage regulation of alternator by various regulation methods.
4. Illustrate the synchronization of alternator to bus bar.
5. Determine the performance characteristics of induction machines by conducting suitable tests.
6. Analyze the conversion principle employed in Scott connection of transformer.

LIST OF EXPERIMENTS

1. Three-phase to two phase conversion of transformer (Scott connection)
2. Performance characteristics of single-phase induction motor.
3. Speed control of 3 phase induction motor by rotor resistance control and by V/f control method.
4. 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.
5. No-load test, blocked rotor test and load test on 3-phase squirrel cage Induction motor.
6. Power factor improvement of induction motor using capacitors.
7. Line excited induction generator characteristics.
8. Voltage regulation of alternator by i) Synchronous impedance method ii) Ampere-turn method.
9. Voltage regulation of alternator by zero power factor method.
10. Measurement of Xd and Xq of 3 phase salient pole synchronous machine by conducting slip test.
11. Synchronization of three-phase alternator to bus bar using dark lamp method.
12. Variation in the active and reactive power of an alternator connected to an infinite bus by
    i) Varying excitation, ii) Varying mechanical-power input.
13. Separation of core losses in a single-phase transformer.

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

18EEC18 **POWER SYSTEMS-I LAB**

Instruction	2 Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	35 Marks
CIE	15 Marks
Credits	1

Course Objectives:

1. To understand the working of Generating Stations and calculations of line parameters
2. To 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. To calculate the sequence impedance of alternator and transformer

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

1. Analyze the working of various parts of Generating Station.
2. Experiment with string of insulators and 3 core cables.
3. Determine the dielectric strength of oil.
4. Evaluate the Line Constants, ABCD constants, regulation and efficiency of a transmission line.
5. Calculate the sequence parameters of the transformer and alternator.

LIST OF EXPERIMENTS

1. Visiting nearby Generating Plant and submitting the report.
2. Line Constants determination of 3-Phase Transmission Line.
3. Determination of Voltage distribution and String efficiency of string of Insulators.
4. Measurement of capacitance of 3-core cables.
5. Determination of dielectric strength of transformer oil & Study of Megger.
6. Evaluate the Power Factor Improvement methods in 3-Phase Transmission Line.
7. Determination of A, B, C, D constants of 1-Phase transmission line.
8. Determination of regulation & efficiency of 3-Phase transmission line.
9. Study of Series- shunt compensation of a long transmission line.
10. Design of Static excitation system of Synchronous Generator.
11. Determination of Synchronous machine reactance and time constant from 3-Phase S.C test.
12. Determination of Sequence impedance of 3-Phase Alternators by fault Analysis.
13. Determination of positive, negative and zero-sequence impedance of 3 -Phase transformers.

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

With effect from the academic year 2020-21

18EEC19 **POWER ELECTRONICS LAB**

Instruction	2 Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	35 Marks
CIE	15 Marks
Credits	1

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 and simulate the conversion principles of AC-DC, DC-DC, DC-AC and AC-AC conversion circuits.

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

1. Plot the characteristics of various controlled switches and identifies effect of variation of control signal on the regions of switching operation.
2. Demonstrate the effect of delay angle and nature of load on the performance of various power converters and able to plot the output voltage and current waveforms.
3. Simulate various types of power converters and discriminate between simulation models and practical models of various power converters.
4. Understand various voltage control techniques in different power converters.
5. Select proper equipment, precautions, implement connections keeping technical, safety and economic issues.

List of Experiments

PART-A

1. Study of static characteristics of S.C.R. and to measure latching & holding currents.
2. Study the characteristics of BJT, MOSFET and IGBT.
3. R, RC and UJT triggering circuits for SCR
4. Study of forced commutation techniques of SCR.
5. Single phase half-controlled bridge rectifier with R and RL loads.
6. Single phase fully controlled converter with R and RL loads and freewheeling diode
7. Single phase full converter as a controlled rectifier and inverter.
8. Three phase half-controlled bridge rectifier with R and RL loads.
9. Three phase fully controlled bridge rectifier with R and RL loads.
10. DC voltage control using Buck and Boost choppers.
11. Voltage commutated chopper with R&RL loads
12. Current commutated chopper with R&RL loads.
13. Single phase step down Cyclo converter with Rand RL loads.
14. Single phase A.C voltage controller with R and RL loads
15. Half and Full bridge inverters with R&RL loads.

PART-B

1. Simulation of Single-Phase Full converter and Semi converter with R & RL loads and freewheeling diode.
2. Simulation of Three Phase Full converter and Semi converter with R & RL loads.
3. Simulation of Single-phase AC voltage controller with R & RL loads
4. Simulation of single phase Cyclo converter with R & RL loads.
5. Simulation of single-phase half-bridge & full-bridge inverters.
6. Simulation of three phase bridge inverter in different modes.
7. Simulation of Single Phase Inverter with single, multiple and sinusoidal pulse width modulations.

Note: At least **SEVEN** experiments from PART-A and **THREE** from PART-B should be conducted in the semester.

18EEE01 WIND AND SOLAR ENERGY SYSTEMS (Core Elective - 1)

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

Course objectives:
1. To familiarize Non-Conventional energy sources for sustainable energy conversion.
2. To understand working of wind power generation and wind energy conversion systems.
3. To understand the working of solar energy systems and Explore the issues with integration of renewable energy sources.

Course Outcomes: After the completion of this course, students will be able to:
1. Understanding the significance of non-conventional energy sources
2. Apply the knowledge of physical requirement of wind power energy systems
3. Analyze the required parameters for generator, turbine and converter suitable for a specific wind-generation topology.
4. Understand solar thermal systems
5. Analyze the network integration issues

UNIT-I:
Fundamentals of Energy: Introduction, Classification of energy resources, importance of Non Conventional Energy Sources, Common forms of energy, Merits and Demerits of non-conventional energy sources over conventional energy sources.

UNIT-II
Physics of Wind Power: History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions. Review of modern wind turbine technologies, Fixed and Variable speed wind turbines.

UNIT-III
Wind generator topologies: Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power electronics converters, Generator-Converter configurations, Converter Control, Wind farm behavior during grid disturbances, Power quality issues, Power system interconnection experiences in the world, Hybrid and isolated operations of wind systems.

UNIT-IV
The Solar Resource: Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability. Peak Sun Hours (PSH) at a location
Solar photovoltaic: Technologies-Amorphous, mono crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Maximum Power Point Tracking (MPPT) algorithms, Balance of System Components, Solar PV Systems, Solar PV Applications
Solar Thermal Systems: Introduction, Solar Collectors, Solar Water Heater, Solar Passive Space Heating and Cooling Systems, Solar Industrial Heating Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers

UNIT-V
Network Integration Issues: Overview of grid code technical requirements, Fault ride-through for wind farms -real and reactive power regulation, voltage and frequency operating limits.

Text Books:

1. T. Ackermann, “Wind Power in Power Systems”, John Wiley and Sons Ltd., 2005
2. G. M. Masters, “Renewable and Efficient Electric Power Systems”, John Wiley and Sons, 2004.
3. S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 1984.

Suggested Reading:

1. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd., 2006
2. G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004
3. J. A. Duffie & W.A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley & Son

18EEE02 OPTIMIZATION TECHNIQUES (Core Elective - 1)

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

Course Objectives:
1. To study about classical optimization techniques which include single variable and multi-variable optimization with equality constraints
2. To study about linear programming and non-linear programming methods
3. To study about Genetic algorithms.

Course Outcomes: After completion of the course, students will be able to:
1. Solve the single variable and multi variable problems with and without constraints using classical optimization techniques
2. Determine the solution of linear programming problem using graphical method, simplex algorithm and revised simplex algorithm
3. Calculate the optimum of a nonlinear function using various elimination and search methods
4. Analyze Steepest Descent, Conjugate Gradient, Newton method, David-Fletcher-Powell methods in finding the optimum of given non linear function
5. Discuss the operators, selection techniques in genetic algorithm and apply the genetic algorithm to economic load dispatch problem

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 Pivotalcondensation, Graphical method, Simplex algorithm, Revised simplex method

UNIT- III

Non-Linear Programming-I: Unimodal function, Elimination methods: Fibonacci method, Golden Sectionmethod.

Direct Search methods: 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, David-Fletcher-Powell 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.

Text Books:
1. S.S.Rao, "Engineering Optimization Theory and Applications", New Age International, 3rd Enlarged Edition(in two colour), 2013
2. Jasbir S. Arora, "Introduction to Optimum Design", Academic Press, 4th Edition, 2016

Suggested Reading:
1. Kalyamoy, 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

18EEE03 **ELECTRICAL ENGINEERING MATERIALS (Core Elective -1)**

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

Course Objectives:
1. To study the conducting, insulating and magnetic properties of different materials
2. To know the optical properties for materials.
3. To categorize the materials used for Direct Energy Conversion

Course Outcomes: After the completion of this course, students will be able to
1. Classify the given conducting material based on its properties
2. Understand and select proper insulating material in the field of Electrical engineering
3. Investigate the suitability of material for the latest technological requirement
4. Select a suitable material for optical applications.
5. Illustrate the materials used in Direct Energy Conversion Devices.

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 of magnetic parameters, 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 Benarjee, “Electrical and Electronic Engineering Materials”, PHI, 2015
2. Ian P. Jones, “Material 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. “Electrical Engineering Materials”, McGraw Hill Education, TTTI Madras, 2004.

18EEE04 ELECTRONIC INSTRUMENTATION (Core Elective - 1)

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

Course Objectives:
1. To impart basic knowledge of International Standards for various physical quantities and understanding of measurement systems.
2. To familiarize with many varieties of transducers, measuring instruments, their construction and operating principles.
3. To introduce various types of spectrum analyzers, digital instrumentation with design and also an exposure to some of the prominent bio-medical Instrumentation systems.

Course Outcomes: After the completion of this course, students will be able to:
1. Understand the various standards available for the measurement process.
2. Acquire knowledge on various transducers with the analysis in their working principles.
3. Select an electrical transducer for a given physical quantity measurement.
4. Identify instruments like spectrum analyzer, DSO and other virtual instrumentation techniques such as SCADA for appropriate measurements.
5. Illustrate the applications of various Bio-medical instruments used in healthcare.

UNIT– I

Introduction to Instrumentation: Accuracy and Precision - Conformity and Significant figures, Resolution and Sensitivity, Types of Errors, Loading effect, Absolute errors and Relative errors, Measurement of error combinations, Statistical analysis, Probable error and Limiting errors, Calibration, IEEE standards, Elements of ISO 9001, Quality management standards.

UNIT–II

Transducers-I: Classification of transducers, factors for selection of a transducer, Passive electrical transducers: Strain gauges - gauge factor, types of strain gauges - bonded and un-bonded, rosettes, LVDT-construction and displacement measurement, Capacitive transducer and thickness measurement. Active electrical transducers: Piezo-electric transducer and different modes of operation, photo-conductive, photo-voltaic and photo - emissive transducers, semiconductor stain gauges.

UNIT–III

Transducers-II: Characteristics of sound, pressure, power and intensity levels. Microphones and their types. Temperature measurement, resistance wire thermometers, semiconductor thermometers and thermocouples. Introduction to Micro-Electro-Mechanical Systems (MEMS)

UNIT – IV

Digital Instruments: Block diagram, specification and design considerations of different types of DVMs. Spectrum analyzers. Delayed time base oscilloscope, Digital storage oscilloscope. Introduction to Virtual Instrumentation, SCADA. Data Acquisition System- block diagram

UNIT–V

Applications of Instrumentation: Human physiological systems and related concepts. Bio-potential electrodes Bio-potential recorders - ECG, EEG, EMG and CT scanners, magnetic resonance and imaging systems, Ultrasonic Imaging systems.

Text Books:

1. Albert D. Helfric, and William D. Cooper, “Modern Electronic Instrumentation and Measurement Techniques”, PHI, Jan-2015
2. H S Kalsi, “Electronic Instrumentation”, 3/e, TMH, July-2017
3. Nakra B.C, and Chaudhry K.K., “Instrumentation, Measurement and Analysis”, TMH, Dec-2017

Suggested Readings:

1. David A. Bell, “Electronic Instrumentation & Measurements” PHI, 2nd Edition, 2003.
2. Khandpur. R.S., “Handbook of Bio-Medical Instrumentation”, TMH, 2003.
3. Leslie Cromwell and F.J. Weibell, E.A. Pfeiffer, “Biomedical Instrumentation and Measurements”, PHI, 2^{nd} Ed, 1980.

18EEE05 SIMULATION TECHNIQUES FOR ELECTRICAL ENGINEERING (Core Elective-2)

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

Course Objectives:
1. To introduce basics of MATLAB and PSpice
2. To build knowledge about matrices and plots
3. To introduce various simulation techniques and computational methods using MATLAB and PSpice

Course Outcomes: After completion of the course, students will be able to:
1. Understand basic syntax of MATLAB and PSpice programming
2. Apply matrix mathematics, plots and functions for solving and visualization of the numerical solution
3. Determine DC, AC and transient analysis in PSpice environment
4. Design modelling parameters of Diode, BJT, MOSFET, IGBT and SCR
5. Analyse the response of uncontrolled and controlled rectifiers with different controlled parameters and loads

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, modelling 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 B Chaudhari, "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

18EEE06 **ENERGY CONSERVATION AND AUDITING (Core Elective-2)**

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

Course objectives:
1. To know the concept of energy conservation and auditing
2. To understand the formulation of efficiency for various electrical systems
3. To explore the different ways to design various technologies for efficient electrical systems.

Course Outcomes: After the completion of this course, students will be able to:
1. Understand about current energy scenario and importance of energy conservation
2. Apply the concepts of energy management
3. Analyze the performance of existing electrical and industrial systems
4. Understand different energy efficient systems in electrical and industrial systems
5. Apply the energy efficiency techniques in electrical systems

UNIT-I:
Energy Management & Audit: Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future.

UNIT-II:
Basics of Energy and its various forms: Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

UNIT-III
Energy Efficiency in Electrical Systems: Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

UNIT-IV
Energy Efficiency in Industrial Systems: Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers (elementary treatment)

UNIT-V
Energy Efficient Technologies in Electrical Systems: controllers, energy efficient motors, soft starters with Maximum demand controllers, automatic power factor energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

Text Books:

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)

Suggested Reading:

1. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991
2. Y. P. Abbi, Energy Audit: Thermal Power, Combined Cycle, and Cogeneration Plants, The Energy and Resources Institute, 2012, ISBN 978-81-7993-311-4
3. Tarik Al-Shemmeri, "Energy Audits: A Workbook for Energy Management in Buildings", August 2011.
4. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

If we have built castles in the air, our work need not be lost; that is where they should be. Now lay the foundation under them. But a fool is one who, having no goal, redoubles his efforts.

Vikasa Mantras- Vivekananda Institute of Human Excellence

18EEE07 INDUSTRIAL ELECTRICAL SYSTEMS (Core Elective-2)

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

Course Objectives:

1. Understand various components of industrial electrical systems and analyze and select the proper size of various electrical system components.
2. Understand the electrical wiring systems for residential and commercial consumers and analyze and select the proper size of various electrical system components.
3. Understand necessity of illumination for specified requirement

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

1. Understand various components of industrial electrical systems
2. Apply residential and commercial electrical wiring rules and guidelines for installation of electrical systems
3. Design various Illumination schemes and lighting systems
4. Understand HT connection, Industrial loads and LT panel components
5. Select the proper size of various electrical system components

UNIT-I

Electrical System Components: LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, single line diagram (SLD) of a wiring system, Electric shock and Electrical safety practices (Elementary treatment only)

UNIT-II

Residential and Commercial Electrical Systems: Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components. (Elementary treatment only)

UNIT-III

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

UNIT-IV

Industrial Electrical Systems I: HT connection, industrial substation, Transformer selection, Industrial loads, Earthing design, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components. (Elementary treatment only)

UNIT-V

Industrial Electrical Systems II: DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS & Battery Banks. (Elementary treatment only)

Text Books:

1. S. L. Uppal and G. C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna publishers, 2008.
2. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.

Suggested Readings:

1. S. Singh and R. D. Singh, “Electrical estimating and costing”, Dhanpat Rai and Co., 1997.
2. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008.
3. Hemant Joshi "Residential, Commercial and Industrial Electrical Systems: Equipment and selection Volume 1 of Residential, Commercial and Industrial Electrical Systems", Tata McGraw-Hill Education, 2008

18EEE08 ELECTRICAL ESTIMATION AND COSTING (Core Elective-2)

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

Course Objectives:
1. To emphasize the estimation and costing aspects of all electrical equipment, installation and designs on the cost viability.
2. To Estimate the Bill of Materials for Residential and commercial installations
3. To design overhead transmission and distribution lines, substations and illumination schemes

Course Outcomes: After completion of this course, student will be able to:
1. Define the principles related to electrical wiring and costing.
2. Summarize the electrical specifications of residential building and electrification requirements.
3. Distinguish between Residential and Commercial Installations.
4. Estimate the materials required to Design Electrical Installation of Substation, Transmission and Distribution Systems.
5. Identify and Design the various types of light sources for different applications.

UNIT-I

Electrical Wiring: Different types of wires, wiring system and wiring methods, Comparison of different types of wirings. Specifications of Different types of wiring materials, Accessories Different types of wiring appliances and tools. Domestic and industrial panel wiring. Different types of wiring circuits. I.E. rules for wiring, Electricity supply act-1948.

Principles of Costing: Purpose of Estimating and Costing, Recording of Estimates, Determination of Cost Material and Labour, Over Head Charges, Profit, Purchase System, Payment of Bills, Tender Forms

UNIT-II

Residential Building Electrification: General Rules, guidelines for wiring of residential installation and positioning of equipment**,** Principles of circuit design in lighting and power circuits Procedures for designing the circuits and deciding the number of circuits, Method of drawing single line diagram. Selection of type of wiring and rating of wires and cables Load calculations and selection of size of conductor, Selection of rating of main switch Distribution board, protective switchgear ELCB,MCCB and MCB and wiring accessories, Earthing of residential Installation.

UNIT-III

Electrification of Commercial Installation: Concept of commercial Installation, Differentiate between electrification of residential and commercial installation, Fundamental and Design considerations of electrical Installation system for commercial Building Load calculation and selection of size of service connection and nature of supply, Deciding the size of the cables, bus bar and bus bar chambers, Mounting arrangements and positioning of switchboards, distribution boards main switch etc, Earthing of the electrical installation, Selection of Earth wire, wiring system and layout.

UNIT-IV

Design and Estimation Of Overhead Transmission & Distribution Lines: Introduction, Typical AC electrical power system, Main components of overhead lines, Factors governing height of pole, Conductor materials, Determination of size of conductor for overhead transmission line, Cross arms, Guys and Stays, Conductors configuration spacing and clearances, Span lengths, Overhead line insulators, Lightning Arrestors, Phase plates, Danger plates, Anti climbing devices, Bird guards, Beads of jumpers. Points to be considered at the time of erection of overhead lines, Erection of supports, setting of stays, fixing of cross arms, fixing of insulators, Conductor erection, Repairing and jointing of conductor, Dead end clamps, Positioning of conductors and attachment to insulators Jumpers, Tee-offs, Earthing of transmission lines. Guarding of overhead lines, Clearances of conductor from ground Spacing between conductors, Testing and commissioning of overhead distribution lines.

UNIT-V

Design and Estimation of Substations: Introduction, Types of substations, Outdoor substation – Pole mounted type, Indoor substations – Floor mounted type.

Design and Estimation of Illumination Schemes: Introduction, Terminology in illumination, laws of illumination, various types of light sources, estimation and costing of lighting schemes.

Text Books:

1. "K. B. Raina, S. K. Bhattacharya", "Electrical Design Estimating and Costing", New Age International Publisher, 2010
2. "Gupta J. B., Katson, Ludhiana", "Electrical Installation, estimating and costing", S. K. Kataria and sons, 2013
3. "Surjit Singh", "Electrical Estimation and Costing". Dhanpatrai & Co. second edition, 2001.

Suggested Readings:

1. Code of practice for Electrical wiring installations (System voltage not exceeding 650 volts), Indian Standard Institution, IS: 732-1983.
2. Guide for Electrical layout in residential buildings, Indian Standard Institution, IS: 4648-1968.
3. Electrical Installation buildings Indian Standard Institution, IS: 2032

VI – SEMESTER

18EEC20 **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:

1. To understand different types of linear control systems and their mathematical modeling.
2. To study the stability analysis both in time and frequency domains.
3. To study the concepts of State space representation of Linear Time invariant systems (LTI).

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

1. Understand different mathematical models for any electromechanical LTI systems.
2. Analyze the given first and second order systems based on their performance parameters.
3. Analyze absolute and relative stability of an LTI system using time and frequency domain techniques.
4. Analyze the effects of controller on a given system and to understand the concepts of compensators.
5. Develop various state space models for LTI systems and to check the concepts of Controllability and Observability.

UNIT-I

Introduction to control Systems: Open loop, closed loop System with illustrations and other classification of control systems, Impulse response and Transfer Function, Mathematical modeling of Mechanical and Electrical Systems, Analogous systems, Feedback control characteristics - effects of feedback, D.C & A.C servo motors, Synchro pair as an error detector, Block diagram algebra, Signal flow graphs and problems on conversion from block diagram to signal flow graph.

UNIT-II

Time Response Analysis: Standard test signals, Time response of first and second order systems for standard test inputs, Application of initial and final value theorem, Static error coefficients and steady state error (for standard test input signals) Design specifications for second-order systems based on the time-response.
Concept of Stability, Routh-Hurwitz Criteria, Relative Stability analysis, Root-Locus technique, Construction of Root-loci.

UNIT-III

Frequency-response analysis: Design specifications in frequency-domain, Relationship between time and frequency response, bode plots, Polar plots, Nyquist stability criterion, Relative stability using Nyquist criterion . Stability analysis of plots based on gain and phase margin.

UNIT-IV

Introduction to Controllers and Compensators:
Introduction to Proportional, Integral and Derivative, Proportional plus derivative, Proportional plus integral, Proportional plus integral plus derivative controllers, Introduction to Lead, Lag, Lead-lag and Lag-lead compensators.

UNIT-V

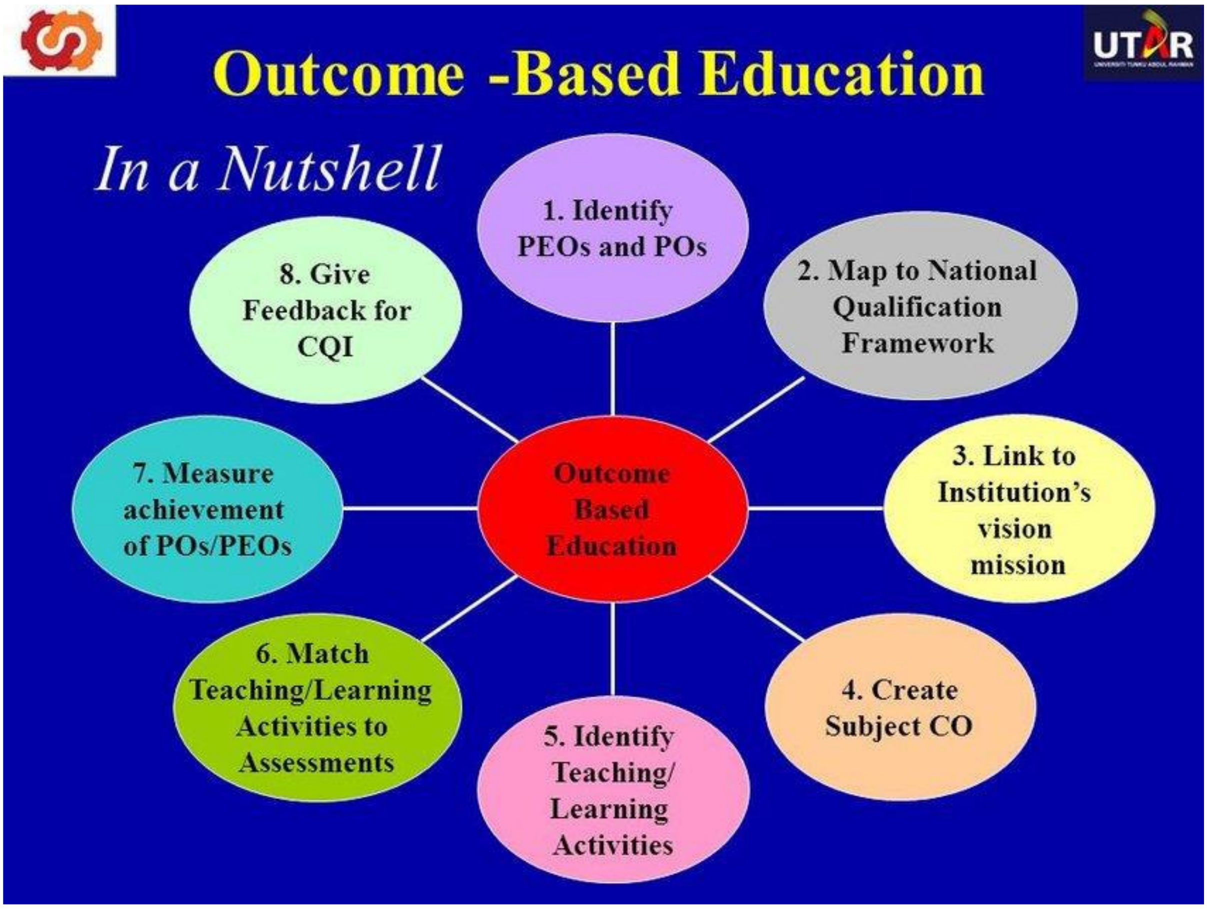
State variable Analysis and Nonlinear systems: Concepts of state variables, State space model, Diagonalization of State Matrix, State transition matrix and its properties, Solution of state equations, Eigenvalues and Stability Analysis, Concept of controllability and observability. Introduction to non-linear systems with suitable examples.

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.
4. A. Anand Kumar, Control Systems, 2nd Edition, PHI publications, 2014.

Suggested Readings:

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



18EEC21 MICROPROCESSORS AND MICROCONTROLLERS

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

Course Objectives:
1. To familiarise the fundamental concepts and Internal functions of microcontrollers & Embedded Systems
2. To demonstrate Programming using 8051 Microcontroller.
3. To illustrate interfacing of 8051 Microcontroller to external devices and various communication protocols.

Course Outcomes: After the completion of this course, students will be able to:
1. Understand the basic concepts of Microcontrollers and Embedded Systems
2. describe the architecture and different modes of operations of 8051 Microcontroller
3. Apply knowledge of instruction set and addressing modes for writing Assembly Language Programming using 8051 Microcontroller.
4. Develop application circuits by interfacing peripherals like A/D, D/A, display and motors to 8051 Microcontroller.
5. Develop Systems using 8051 Microcontroller with the help of Communication Protocols like blue-tooth.

UNIT- I
Fundamentals of Microprocessors: Fundamentals of Microprocessor, Basic Block Diagrams of Microprocessor and Microcontroller, Comparison of 8-bit Microcontrollers, 16-bit and 32-bit Microcontrollers. Role of Microcontrollers in IoT.

UNIT- II
The 8051 Architecture: Internal Block Diagram, Pin diagram CPU, ALU, address, data and control bus, working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, timers, counters Memory Structures, Data and Program Memory.

UNIT-III
Instruction Set and Programming: Introduction, Instruction syntax, Data types, Subroutines Addressing Modes. 8051 Instruction set, Instruction timings.. Assembly language programs, C language programs. Assemblers and compilers. Programming and debugging tools.

UNIT-IV
Memory and I/O Interfacing 6 Hours): Memory and I/O expansion. Interfacing of peripheral devices such as General Purpose I/O, ADC, DAC, memory devices. LED, LCD and keyboard interfacing. Stepper motor interfacing, DC Motor interfacing, sensor interfacing

UNIT-V
External Communication and Introduction to embedded systems: Synchronous and Asynchronous Communication. RS232, SPI, I2C. Introduction and interfacing to protocols like Blue-tooth and Zig-bee. Definition of embedded system and its characteristics, Role of Microcontrollers in embedded Systems. Functional building block of embedded system, Characteristics of embedded system applications.

Text Books:
1. M. A. Mazidi, J. G. Mazidi and R. D. McKinlay, “The8051Microcontroller and Embedded Systems: Using Assembly and C”, Pearson Education, 2007.
2. K. J. Ayala, “8051 Microcontroller”, Delmar Cengage Learning,2004.
3. D. V. Hall, “Microprocessors & Interfacing”, McGraw Hill Higher Education, 1991.

Suggested Readings:
1. R. Kamal, “Embedded System”, McGraw Hill Education,2009.
2. R. Kamal, “Embedded System”, McGraw Hill Education,2009.
3. R. S. Gaonkar, “Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing, 1996.

18EEC22 POWER SYSTEM OPERATION AND CONTROL

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

Course Objectives:

1. To understand the importance of Economic Operation and load frequency control of Power Systems
2. To understand the power system stability concepts
3. To get the knowledge of power system security and State Estimation

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

1. Determine the equal incremental cost with and without transmission losses and Bmn coefficients
2. Analyze the performance of primary Load frequency control loop and automatic voltage regulator loop
3. Calculate the steady state stability limit and transient stability when the synchronous machine connected to infinite bus is subjected to three-phase fault using Equal area criterion and step by step method.
4. Perform Security Analysis and Contingency Analysis for different Outage Conditions.
5. Elaborate different State Estimation techniques in Power Systems.

UNIT-I

Economic Operation of Power System: Input-Output curves, Heat rates and incremental cost curves, Equal Incremental cost criterion Neglecting transmission losses with and without generator limits, Bmn Coefficients, Economic operation including transmission losses.

UNIT-II

Control of Frequency and Voltage: Speed governor characteristics, turbine model, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control, single area, two area, Generation and absorption of reactive power by various components of a Power System. Automatic Voltage Regulators.

UNIT-III

Stability Constraints in Synchronous Grids: Power System Stability: Definitions Steady state stability and Transient stability, Steady state stability of a synchronous machine connected to infinite bus, calculation of steady state stability limit, Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three phase fault. Analysis using numerical integration of swing equations as well as the Equal Area Criterion.

UNIT-IV

Power System Security: Introduction, Factors Affecting Power System Security, Contingency Analysis: Detection of Network Problems, An overview of Security Analysis, Linear Sensitivity Factors, AC Power Flow Methods, Contingency Selection, Concentric Relaxation, Bounding

UNIT-V

State Estimation in Power System: Power System State Estimation, Weighted Least Square State Estimation: maximum likelihood concepts, matrix formulation, State Estimation of an AC Network, State Estimation by Orthogonal Decomposition, detection and identification of bad measurements, Network Observability and pseudo-measurements

Text Books:

1. I. J. Nagrath& D.P. Kothari, Modern Power System Analysis,4th Edition TMH Publication,2011
2. Allen J. Wood, Bruce.F.Woolenberg,Power Generation, Operation & Control, Wiley Publishers, 2006

Suggested Reading:

1. O. Elgard, Electric Energy Systems Theory, 2nd Edition. TMH Publication,2001
2. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.
3. CL Wadhwa, Electrical Power Systems, 3rd Edition New Age International Publications, 2014

18EEC23 **CONTROL SYSTEMS LAB**

Instruction	2 Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	35 Marks
CIE	15 Marks
Credits	1

Course Objectives:
1. To understand the characteristics of DC, AC Servo Motors, synchro pair and the frequency response of compensating networks.
2. To study the closed loop performance for given plant using i) P, PI and PID controllers, ii) ON/OFF controller.
3. To perform Simulation studies on for linear time invariant systems

Course Outcomes: After the completion of this course, students will be able to:
1. Demonstrate the characteristics of DC, AC Servo motors and Synchro pair.
2. Analyze the performance parameters for a given second order plant both in time and frequency domain.
3. Analyze the performance of different compensators through frequency response .
4. Design P, PI, PID and ON/OFF controller for a given system and to distinguish the merits and demerits of these controllers.
5. Apply different stability techniques for linear time invariant systems using simulation and then verify with the theoretical calculations

LIST OF EXPERIMENTS

Part A
1. Characteristics of D.C Servo motor.
2. Characteristics of A.C. Servo motor.
3. Characteristics of Synchro Pair.
4. Performance parameters of a second order system excited with step input for different damping ratios.
5. Frequency response of lag and lead compensating networks.
6. Performance of a temperature control system using P, PI and PID Controllers.
7. Temperature control of a system using relay (ON/OFF Control).
8. a) Characteristics of magnetic amplifier for series and parallel connections with different values of resistive load.
   b) Measurement of Step angle for Stepper motor.
9. Find the response of different components of a control system using Linear System Simulator.
10. Demonstration of damping effect on the plant using DC Position Control system.

Part B
1. Stability Analysis (Root locus, Bode and Nyquist) for Linear Time Invariant systems.
2. a) Time Domain specifications for a second order system.
   b) Frequency Domain specifications for a second order system.
3. State space model for a given classical transfer function and its verification.
4. Design and analyze different compensators (lag, lead and lag-lead).

Note: At least **EIGHT** Experiments from **Part A** and **TWO** from **Part B** should be conducted in the semester.

With effect from the academic year 2020-21

18EEC24 MICROCONTROLLERS AND ITS APPLICATIONS LAB

Instruction	2 Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	35 Marks
CIE	15 Marks
Credits	1

Course Objectives:
1. To explain instruction set of 8051 microcontroller
2. To demonstrate assembly language programming using 8051 microcontroller
3. To illustrate programming 8051 microcontroller with ‘embedded C’ Language.

Course Outcomes: After completion of the course, students will be able to:
1. Use instruction set of 8051 microcontroller to develop ALPs.
2. To write and execute simple programs using 8051 microcontroller.
3. Demonstrate the functioning of different instructions and subroutines using 8051 programming.
4. Create small application models by interfacing devices to 8051 programming through Keil/ Ride software.
5. Apply the knowledge of experiments done in the laboratory for doing mini projects and academic projects.

List of Experiments

PART-A

Using 8051 Microcontroller Kit:
1. Programs using Data Transfer Instructions- Block move, Exchange, Sorting, Finding Largest Element in an Array.
2. Programs using Arithmetic Instructions: Multi byte operations
3. Programs using Boolean and Logical Instruction (Bit manipulations).
4. Programs using JUMP and CALL Instructions
5. Programs to generate delay, programs using serial port and on chip timer/counter.
6. Programs using Look-up Table
7. Programs using interrupts.

PART-B

Program Development using ‘c’ cross compiler for 8051 Microcontroller

(Any 3 of the below mentioned experiments are to be Conducted)
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
5. Traffic signal light controller

18EEE09 **POWER QUALITY (Core Elective -3)**

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

Course Objectives:

1. Understand the theoretical concepts and standards of Power Quality (PQ), and methods to calculate and analyze voltage sag in distribution systems.
2. Understand PQ issues and sources of harmonics in Industrial systems and its mitigation.
3. Understand the problems and solutions to wiring and Grounding

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

1. Illustrate the basic concepts of power quality issues and power quality monitoring, standards and measuring instruments.
2. Determine the voltage sag magnitude in radial, Non-radial and Meshed systems
3. Analyze voltage sags effect on three-phase AC-ASD, DC-ASD for industrial applications.
4. Identify the sources of harmonics and its mitigation techniques in industrial systems.
5. Discuss the protection devices for transient over voltages and solutions for Wiring and Grounding problems

UNIT-I

Power Quality problems in distribution systems: Sag, Swells, Interruptions, and Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations, flicker and its measurement. Tolerance of Equipment: CBEMA curve. Power quality monitoring, standards and measuring instruments.

UNIT-II

Voltage Sags-Characterization: Voltage Sag Magnitude, Sag Magnitude in Radial and Non-Radial Systems, Voltage sag Calculations in Meshed Systems.

UNIT-III

PQ Consideration in Industrial Power Systems: Adjustable speed drive (ASD) systems and applications, Characterization of voltage sags experienced by three-phase AC-ASD, DC-ASD systems, Effects of momentary voltage dips on the operation of induction and synchronous motors.

UNIT-IV

Harmonics: Sources of power system harmonics, Harmonic distortion, Harmonic Indices, Odd and Even Order Harmonics, Causes of Voltage and Current Harmonics, Locating Harmonic sources, Effect of Harmonics on Power System Devices, Mitigation of harmonics.

UNIT-V

Transient Over-voltages & Wiring and Grounding: Sources of Transient Overvoltage's, Principles of Overvoltage Protection Devices, Definitions, Reasons for Grounding and wiring, Typical Wiring and Grounding Problems, Solutions to Wiring and Grounding Problems.

Text Books:

1. C.Sankaran, 'Power Quality', CRC Press, 2001.
2. R. Sastry Vedam, M. Sarma, "Power Quality- Var Compensation in Power Systems ", CRC Press, 2009.

Suggested Reading:

1. Math H.J. Bollen, 'Understanding Power Quality Problems', IEEE Press, 2000.
2. Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H. Wayne Beaty, 'Electrical Power Systems Quality', 3rd Edition, Tata McGraw-Hill, 2012

18EEE10 **ADVANCED POWER CONVERTERS (Core Elective -3)**

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

Course Objectives:
1. To study various modern power electronic devices and different power factor improvement techniques in converters.
2. To study the concepts of Multi pulse and Multilevel power electronic circuits.
3. To understand different applications of power converters.

Course Outcomes: After completion of the course, students will be able to:
1. Outline various features and electrical specifications for a chosen modern power electronic device.
2. Understand different power factor improvement techniques in converters.
3. Comprehend the operation of Multi-Pulse converters and design its performance parameters.
4. Apply the concepts of different Multilevel Inverters that suits for industrial applications.
5. Recognize the applications of power converters.

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
Power factor Improvement Techniques: Power factor improvements – extinction angle control- symmetrical angle control- PWM control- SPWM control.

UNIT-III
Multi-Pulse converters: Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase ac, 6-pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation

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
Applications of Power converters: AC power supplies, classification, switched mode AC power supplies, online and offline Uninterruptible Power supplies applications. DC circuit breakers

Text Books:

1. Mohammed H. Rashid, “Power Electronics, Devices, circuits and applications”, Pearson Education, 4th Edition, 2017.
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,2013

18EEE11 **ELECTRICAL DISTRIBUTION SYSTEMS (Core Elective -3)**

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

Course Objectives:

1. To study the load characteristics of distribution systems and understand the substation schemes, voltage drop calculation of different service areas.
2. To know about primary and secondary distribution systems and their characteristics.
3. To study different voltage control methods and applications of capacitors in distribution systems

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

1. Solve the problems on load factor, loss factor, coincidence factor and discuss the characteristics of loads along with load growth
2. Illustrate the substation bus schemes and determine the rating, voltage drop of substations
3. Determine the voltage drop and power losses of primary and secondary distribution systems
4. Analyze the distribution costs and voltage control methods in the distribution system
5. Calculate the reactive power requirements of the distribution system and summarize the functions and communications used in distribution systems

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 ungrounded 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, Laxmi Publications, 2010.
2. William Kersting, Distribution System Modelling and Analysis, 3rd Edition CRC Press, 2015.
3. S. Sivanagaraju, and V. Sankar, Electric Power Distribution and Automation, Dhanpat Rai & Co, 2012

18EEE12 **HVDC TRANSMISSION (Core Elective -3)**

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

Course Objectives:

1. To study the basics of HVDC and comparison between HVDC and HVAC and multi-terminal DC systems and their control methods.
2. To comprehend different converter circuits used in HVDC.
3. To familiarize with the control methods and protection methods of HVDC and its filter design techniques.

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

1. Understand the basics of HVDC and compare between HVDC and HVAC.
2. Analyze the converter circuits used in HVDC.
3. Understand the HVDC control methods and able to draw the control characteristics.
4. Understand the HVDC filter design technique and protection methods.
5. List out different MTDC links and their control.

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 (Basics).

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

18EEE13 AI TECHNIQUES IN ELECTRICAL ENGINEERING (Core Elective -4)

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

Course Objectives:
1. To locate soft computing methodologies, such as artificial neural networks and Fuzzy logic algorithms
2. To expose students to the basic ideas, challenges, techniques and learning algorithms in ANN and fuzzy logic techniques
3. To know the applications of AI Techniques in electrical engineering and to analyse the metaheuristic techniques in real-world problems.

Course Outcomes: After the completion of this course, students will be able to:
1. Understand the concepts of ANNs, Fuzzy logic and metaheuristic Techniques
2. Identify and describe Artificial Neural Network and Fuzzy Logic techniques in building intelligent machines
3. Apply Artificial Neural Network & Fuzzy Logic models to handle uncertainty and solve engineering problems
4. Understand how metaheuristics can be used to find good enough solutions for computationally hard optimization problems
5. Apply metaheuristic techniques to the optimization problems related to electrical Engineering
6. Develop fuzzy logic control and metaheuristic technique for applications in electrical engineering

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, learning tasks.

UNIT II

ANN Paradigms: Multilayer perception using Back Propagation Algorithm, Self organizing Map, Radial Basis Function Network, Functional link network, Hopfield Network, speed control of DC and AC motors using Neural Network.

UNIT- III

Fuzzy Logic: Introduction, Fuzzy versus crisp, Fuzzy sets, Membership function, Basic Fuzzy set operations, Properties of Fuzzy sets, Fuzzy Cartesian Product, Operations on Fuzzy relations, Fuzzy Quantifiers, Fuzzy Inference, Fuzzy Rule based system, De-fuzzification methods, Speed control of DC and AC motors using Fuzzy logic controller.

UNIT-IV

Metaheuristic Techniques-1: Introduction, Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Harmony Search (HS) algorithms, Implementation of algorithms with test functions for optimization, Economic load dispatch using PSO, ACO, HS algorithms

UNIT- V

Metaheuristic Techniques-2: Teaching Learning Based Optimization Algorithm, differential evolution algorithm, Artificial bee colony algorithm, Implementation of algorithms with test functions for optimization, Single area system and two area system, Reactive power control

Text Books:
1. S. Rajasekaran and G.A.V. Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms"- PHI, New Delhi, 2010.
2. Xin-She Yang, "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.
3. Yagna Narayana, " Artificial Nueral Networks" -PHI, New Delhi,2012

18EEE14 ELECTRIC AND HYBRID VEHICLES (Core Elective -4)

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

Course objectives:
1. To Know the Electric and Hybrid vehicles, and their advantages and disadvantages
2. To Understand the concept hybrid electric vehicles and energy management
3. To Develop and Optimize the design of propulsion motors for EV applications

Course Outcomes: After the completion of this course, students will be able to:
1. Be familiar to the models of describing hybrid vehicles and their performance.
2. Model the electric vehicles with different acceleration and range
3. Design Electric power train for Electric Vehicles
4. Analyze the different possible ways of energy storage
5. Illustrate the principle of Hybrid Electric Vehicle and Battery Electric Vehicle

UNIT-I

Introduction: Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, Air pollution and global warming, EV System – EV Advantages – Vehicle Mechanics – Performance of EVs, Introduction to Battery Electric Vehicle (BEV), Components and systems of Electric Vehicle, Policies and guidelines for electric mobility, Trends and challenges of implementation of mobility and start up opportunities.

UNIT-II

Hybrid Electric Vehicles: Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Electric Vehicle Modelling– Consideration of Rolling Resistance – Transmission Efficiency – Consideration of Vehicle Mass – Tractive Effort – Vehicle Acceleration – Modelling Electric Vehicle Range, Sizing of drive system, Plug-in electric vehicles, Hybrid electric drive for ship propulsion and military application,

UNIT-III

Electric Power Trains: Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybriddrive train topologies, different modes of operation, Power flow control in hybrid drive-train topologies, fuel efficiency analysis, Basic concept of electric traction, Components and systems of HEV, Selection and Sizingof the propulsion motor, Regenerative braking fundamentals, drive system efficiency

UNIT-IV

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage**,** High Energy (Nickel, Sodium and Lithium based) batteries, Metal Air batteries, battery sizing, Fuel Cell based energy storage system, Super Capacitor based energy storage and its analysis, Hybridization of different energy storage devices, Introduction to energy management strategies used in hybrid and electric vehicles.

UNIT-V

Design, Analysis, Testing & Qualification of Propulsion Motor: PM Materials, Basic concepts of Design and analysis of water cooled PM Motor for EV and HEV, Outer rotor PM Motor drive, Basic Design Aspects of Induction for EV and HEV, Testing methods and standards, Different types of EV charging stations, Wireless charging technology, Vehicle to grid (V2G) fundamentals, EMI & EMC mitigation

Text Books:

1. C. Mi, M. A. Masrur, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.

Suggested Reading:

1. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003
2. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016
3. Hybrid Vehicles and the future of personal transportation, Allen Fuhs, CRC Press, 2011.
4. Vehicle Power Management: Modeling, Control and Optimization, Xi Zhang, Chris Mi, Springer, 2011.
5. National Electric Mobility Mission Plan 2020 Released by DHI, Govt. of India
6. Zero Emission Vehicles (ZEV) Towards a Policy Framework, NITI Aayog
7. IEC and different IS and Eclectic Mobility Standards.

Time is what we need most, but what we use worst; Most of the misfortunes in our life are due to misused time.

Vikasa Mantras- Vivekananda Institute of Human Excellence

18EEE15 FLEXIBLE AC TRANSMISSION SYSTEMS (Core Elective -4)

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

Course Objectives:
1. To understand concepts of various FACTS devices and controllers
2. To study the various converter topologies used in FACTS
3. To study the principles of operation and control of shunt series and combined FACTS controllers

Course Outcomes: After completion of this course, students will be able to:
1. Choose the appropriate FACTS device/controller based on the needs of inter connected power transmission systems.
2. Analyze various converter circuits used in FACTS for harmonic reduction.
3. Illustrate the operation of shunt compensators (i.e. SVC, STATCOM) for the end of line voltage support and transient stability problems
4. Analyze the operation and control of GCSC, TCSC and SSSC.
5. Explain the principles, operation and control aspects of UPFC for P and Q control

UNIT-I

General System Considerations and FACTS: Transmission Interconnections, Flow of Power in an AC System, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, principles of series and shunt compensation, Basic Types of FACTS Controllers, Benefits from FACTS, Application of FACTS.

UNIT-II

Voltage-Source Converters: Review of Voltage-Sourced Converters basics, single-Phase Full-wave Bridge converter operation, single phase-leg operation, Square-Wave Voltage Harmonics for a single-phase bridge, Three-phase full-wave bride converter, sequence of valve conduction process in each phase-leg, three-level voltage-sourced converter, Pulse-Width Modulation (PWM) converter, Generalized Technique of Harmonic Elimination and voltage control.

UNIT-III

Shunt Compensators: Objectives of Shunt Compensation, Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, improvement of Transient Stability, Power Oscillation Damping, Static Var Compensators, SVC and STATCOM, The Regulation Slope, Transfer Function and dynamic Performance, Transient Stability Enhancement and Power Oscillation Damping

UNIT-IV

Series Compensators: Objectives of Series Compensation, concept of series capacitive compensation, voltage stability, improvement of transient stability, power oscillation damping, GTO thyristor controlled series capacitor, Thyristor controlled series capacitor, SSSC.

UNIT-V

Combined Compensators: Introduction, Unified Power Flow Controller (UPFC), basic operating principles, independent real and reactive power flow control, control structure, basic control system for P and Q control.

Text Books:

1. Narain G. Hingorani, Laszlo Gyugyi, ‘Understanding FACTS’, IEEE press, 1999.
2. Y.H.Song, A.T.Johns, ‘Flexible A.C.Transmission System’, IEE, London, 1999

Suggested Reading:

1. KR Padiyar, **‘**Facts Controllers In Power Transmission and Distribution’, 2nd edition, New Age Publications, 2016.
2. R. Mohan Mathur, Rajiv K. Varma, ‘Thyristor-Based FACTS Controllers for Electrical Transmission Systems’, Wiley Publications IEEE Press, 2002
3. Timothy J.E. Miller, ‘Reactive Power Control in Electric Systems’, 1982

18EEE16 SPECIAL ELECTRICAL MACHINES (Core Elective -4)

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

Course Objectives:
1. To study the operating principles different special machines
2. To make the learner to be aware of latest special machines which are in vogue.
3. To be familiar with salient features of special electrical machines

Course Outcomes: After the completion of this course, students will be able to:
1. Recognize application specific special electrical machines
2. Explain the working principle of various special electrical machines.
3. Develop equivalent circuit of a given special electrical machine.
4. Classify the special electrical machine based on construction
5. Choose the type of armature winding suitable for a given SEM.
6. Analyse the various control methods of a given Special Electric machine.

UNIT-I

Stepper Motors: Introduction, classification, single phase, Disc Magnet and Claw-tooth stepper motors, inference from Torque equation, (no derivation) static and dynamic characteristics, open loop and closed loop control, concepts of Microprocessor based control, comparison of conventional stepper motors with permanent magnet stepper motor, VR Stepper motor and Hybrid stepper motor and applications

UNIT-II

Switched Reluctance Motor (SRM):
Construction, Principle of working, constraints on pole arc and tooth arc, Inference from torque equation and Characteristics, Control of SRM, features of Microprocessor based control of SRM, Introduction to Synchronous Reluctance Motor (Sy R M)

UNIT-III

PMDC and BLDC motor: PMDC Motor: Construction, Principle of working Minor hysteresis loops and recoil line, Equivalent circuit of PM, Inference from Torque equation, performance Characteristics, moving coil motors Printed Circuit Motor

BLDC Motor: Construction, principle of working, types, and control types and differences among various controls such as Microprocessor based, DSP- based control and sensor less control,

UNIT-IV

Linear Electric Machines: Construction, equivalent circuit, characteristics, design aspects and control, Types such as – linear synchronous motor, DC Linear motor, Linear Reluctance motor and Linear Levitation Machines (elementary treatment only)

UNIT-V

Permanent Magnet Axial Flux (PMAF) Machines: Construction, Armature windings – Toroidal stator, Trapezoidal stator, Rhomboidal Stator winding, salient features of torque equation, EMF equations and Output equation [No derivations], Phasor diagram, Applications; **Introduction to Permanent Magnet Synchronous Motor,**

Textbooks:
1. E.G. Janardhan, "Special Electrical Machines", Prentice Hall India, 2014.
2. K. Venkatarathnam, "Special Electrical Machines", Universities Press (India) Pvt. Ltd., 2013

Suggested Reading:
1. H. Bülent Ertan, M. Yildirim Üçtug, Ron Colyer, Alfio Consoli, "Modern Electrical Drives" Springer Science+Bussiness Media, 2000