EE301N: AC MACHINES

Teaching Scheme	**:** 03 L + 00 T; Total: 03 hours/week	**Credits**	**:** 03
Evaluation Scheme	**:** 10 ISA + 30 MSE + 60 ESE	**Total Marks**	**:** 100
ESE Duration	**:** 3 Hrs.		

COURSE DESCRIPTION

The course on AC machines is designed to provide students with in-depth knowledge about the working principles, construction, analysis, and operation of alternating current (AC) machines, including induction motors, synchronous machines, and their applications in real-world electrical systems. Students will gain an understanding of machine performance, starting, speed control, and efficiency. The course will also cover practical aspects, fault analysis, and the use of these machines in various industrial applications.

DESIRABLE AWARENESS/SKILLS:

Knowledge of basic electrical engineering and basics of dc machines

COURSE OUTCOMES:

On the successful completion of this course, student will be able to:

1. analyze the performance of Induction motors.
2. select suitable fractional watt motors for industrial applications.
3. evaluate the working of Synchronous Machines.
4. analyze the performance of synchronous machines under different operating conditions.
5. illustrate the use of special motors.

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1		1	2	1		1	1	1	1	1	1	3	1	1
2	1	1		1	3	1	]		1	1		1	1		
3			1	1	2		1	1		1	1			2	1
4	1	1	1		1	2	1		1			1	1	2	
5	1		1	1	1	2		1	1	1	1	1	1	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Three Phase Induction Motor **[09 Hrs]**

Rotating magnetic field, principle of operation, torque equation, torque-slip characteristics, losses and efficiency, phasor diagram and equivalent circuit, no load test, blocked rotor test, circle diagram, speed control, starting and their types. Double Cage Induction Motor-construction, working principle and torque-slip characteristics. Induction Generator-principle of working and equivalent circuit.

Fractional Kilowatt Motors **[08 Hrs]**

Single phase induction motors, double field revolving theory, equivalent circuit, torque-slip characteristics, construction and working principle of resistance start induction run, shaded pole, repulsion type, universal motor, hysteresis motor.

Synchronous Generator **[09 Hrs]**

Construction, types, winding factors, emf equation, armature reaction, phasor diagrams, load characteristics, voltage regulation by synchronous impedance method, MMF method, Zero Power Factor method, slip test. Parallel operation of synchronous generators, methods of synchronization, synchronization power, synchronizing torque, Short Circuit Ratio and its importance, efficiency and losses, applications.

Synchronous Motor **[08 Hrs]**

Principle of operation, phasor diagrams, methods of starting, operation at constant power and fixed excitation, equivalent circuit, power and torque developed in cylindrical rotor and salient pole rotor, effect of change in load and effect of change in excitation, V and inverted V-curves, hunting and methods of suppression, synchronous condenser.

Special Machines **[06 Hrs]**

Constructional details and working of SRM motor, brushless DC motors, stepper motors, permanent magnet synchronous motor

Text Books:

1. Electrical Machines, Nagrath and Kothari, 4th Edtion,Tata McGraw Hill, 2010
2. Electrical Machines by S. K. Bhattacharya, 3rd edition, McGraw Hill, 2009
3. Electrical Machines by A. Chakrabarti and S. Debnath, McGraw Hill, 2015

Reference Books:

1. Performance and Design of A.C. Machines M.G. Say, 6th Edition, ELBS, 2006
2. Theory and performance of Electrical Machines, J. B. Gupta and S.K. Kataria Publications, 2003
3. Electrical Machines, Samarjit Ghosh Pearson Publication, 2001
4. Electrical Machinary and Transformer, Bhag S. Guru and Huseyin R.Hiziroglu,3rd edition,Oxford University Press, 2006
5. Special Electrical Machines, E G Janardanan, Prentice Hall of India, 2011

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

EE302N: POWER SYSTEM ANALYSIS

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course imparts knowledge about power system analysis. This course provides the knowledge of power flow through transmission lines, symmetrical faults and unsymmetrical faults and load flow study.

COURSE OUTCOMES:

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

1. analyze the performance of transmission line
2. draw the impedance diagram and understand the per unit system of power system
3. understand power system faults under symmetrical and unsymmetrical networks
4. apply different methods for load flow analysis
5. construct line diagram of AC distribution system

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	2	1		1		1	1	1	1	1	1	2	1
2	1		1	3	1	1	1				1	1	1		1
3		1	1		3		1		1	1	1			2	1
4	1			1	2	1		1	1	1		1	1	3	1
5	1	1		1		1	1	1		1	1	1	1	1	1

1-Weakly correlated 2– Moderately correlated 3–Strongly correlated

Course Content

Characteristics of Transmission Line **[9 Hrs]**

Characteristics and performance of short, medium and long transmission line, efficiency and voltage regulation of transmission line, surge impedance**,** Surge Impedance Loading, need of line compensators.

Representation of Power System Components **[08 Hrs]**

Representation of impedance and reactance diagram of transmission lines, synchronous machines, power transformers, motors, single line diagram and per unit system.

Symmetrical Faults Analysis **[4 Hrs]**

Symmetrical fault occurring on synchronous generator and power system, Fundamentals of symmetrical and unsymmetrical components. Sequence networks

Unsymmetrical Fault Analysis **[5 Hrs]**

Single line to ground fault (LG), line to line fault (LL), double line to ground fault (LLG) and three phase to ground fault (LLLG) or three phase to three phase fault (LLL) on a synchronous generator and power system, faults through impedance.

Load Flow Study **[08 Hrs]**

Introduction, bus classifications, Formation of Bus Admittance Matrix, Z-bus matrix, development of load flow equations, power flow in interconnected systems using Gauss – Seidel and Newton- Raphson method

Text Books:

1. Elements of Power System Analysis by William Stevenson, TMH, 6th edition, 2006
2. Modern Power System Analysis byJ. Nagrath and D.P. Kothari, TMH,3rd edition, reprint 2010
3. Power System Analysis by HadiSaadat, McGraw Hill,2003

Reference Books:

1. A course in Electrical Power by J. B.Gupta, S.K. Kataria andSons,1stedition, 2009
2. Electrical power by Soni, Gupta, Bhatnagar, Dhanpat Rai,4th, 1997

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

EE303N: MICROCONTROLLER AND ITS APPLICATIONS

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

The course explores knowledge of microcontroller and its applications. The course comprises of architecture of microcontroller, assembly language programming and interfacing of peripherals and their applications.

DESIRABLE AWARENESS / SKILLS

EE254N – Digital Circuit

COURSE OUTCOMES

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

1. understand architecture and basic concepts of 8051 Microcontroller
2. develop program in 8051 in assembly language for the given operation;
3. develop program using timers and interrupts..
4. interface the memory and I/O peripherals to 8051 microcontroller.
5. maintain microcontroller based applications.

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1	1	1	2	1	1	1	2	1	1	2	1	1	1
2	3		1		2		1	2	1	1	1		1	1	1
3		2	1	1		1	1		1		1	2	1		1
4	3	1		1	2		1	1	2	1		2	2	1	1
5	3	1	1		2	1		1	2	1	1	2		1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Introduction to Microcontroller [06 Hrs]

Evolution of microcontrollers, Comparison of Microcontroller and Microprocessor, Classification, Types of various architectures, internal block diagram/ architecture of 8051, Pin diagram, buses, Special function register, stack and use of stack pointer, subroutine , memory organization Microchip PIC family: Features, architecture, memory organization, instruction types.

8051 Programming [09 Hrs]

Software Development Cycle: Editor, Assembler, Compiler, Cross-Compiler, Linker, debugger, simulator, and emulator, Addressing Modes, Instruction set: Arithmetic instructions, Jump, Loop and Call instructions, Logic Instructions, Single bit instructions, Assembly language programming: arithmetic operation, data manipulation, stack operation, logical operation with their simple programming applications.

Interrupts, Timers/Counters and Serial Communication [10 Hrs]

Interrupts, interrupt execution sequence, programming with software and hardware interrupts.
Timers/Counters : Configuration and Programming of Timer/Counter using TMOD, TCON,TH_X, TL_X, Programs to generate the time delays operation, Basics of serial data communication, Serial communication SFR : SCON, SBUF, PCON, Modes of serial communication, Programs on serial communication.

I/O Parallel Interfacing [09 Hrs]

Configuration and programming of I/O Port: P0, P1, P2, P3, Interfacing Push Buttons, LED, Keyboard, Seven-Segment Display, LCD displays, Memory interfacing: Program and data memory, Interfacing ADC 0808/09 with 8051, Interfacing DAC 0808/09 with 8051

Interfacing with other devices [08 Hrs]

Square and Triangular waveform generation using DAC, Water Level controller design using 8051, Temperature sensor (LM35) interfacing using ADC to 8051, Stepper motor and DC motor interface, study of Arduino various boards applications (USB, Bluetooth, Serial Communication.), PIC applications,Study of datasheets of aurdino/PIC/raspberry PI/ARM based microcontroller.

Text Books:

1. The 8051 Microcontroller and Embedded Systems – using assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006
2. The 8051 Microcontroller, Kenneth J. Ayala 3rd edition, Thomson/Cengage Learning
3. PIC Microcontroller and Embedded Systems Using Assembly and C for PIC18 by Muhammad Ali Mazidi, Rolind D. Mckinlay, Danny Causey, Pearson Education
4. Fundamentals of Microcontrollers and Applications in Embedded Systems with PIC by Ramesh Gaonkar, Thomson and Delmar learning, 1st Edition

Reference Books:

1. Programming and Customizing the 8051 microcontroller by MykePredko, TMH, 1st edition
2. Microcontrollers: Architecture, Programming, Interfacing and System Design by Raj Kamal, TMH, 3rd edition

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1. Declared test
2. Surprise test
3. MCQ Test
4. Assignments
5. PPT presentation
6. Quiz
7. Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

PROGRAMME ELECTIVE - I

EE304NA: ELECTRICAL MEASUREMENT

Teaching Scheme	**:** 03 L + 00 T; Total: 03 hours/week	**Credits**	**:** 03
Evaluation Scheme	**:** 10 ISA + 30 MSE + 60 ESE	**Total Marks**	**:** 100
ESE Duration	**:** 3 Hrs.		

COURSE DESCRIPTION

Every engineer must have some basic knowledge electrical engineering as(s)he has to working different engineering fields and to deal with various electrical machines and equipment. This course provides knowledge about basics of electrical engineering to familiarize students with AC and DC measurements, electrical measuring systems. Learn about various measurement devices, their characteristics, and their operation.

DESIRABLE AWARENESS/SKILLS:

EE101N - Basic Electrical Engineering

COURSE OUTCOME:

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

1. classify different types of measuring instruments on the basis of principle of operation.
2. measure various electrical and physical quantities using transducers.
3. apply different methods to measure power and energy.
4. computer resistance, inductance and capacitance using different methods.
5. select proper technique and instrument for particular type of measurement.

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3		1	1	2		1	1	2	1	1		1	1	1
2	3	1		1		1			1	1		2	1		1
3		2	1		2		1	1	1		1			1	1
4	3		1	1		1			2	1	1	2	2	1	
5	3	1		1	2	1	1	1	2			2	1	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Measurement Basics **[08 Hrs]**

Definition and Significance of Measurements, Method of Measurements, Classification of Instruments-Absolute and Secondary Instruments, function of instruments and measurement systems, Static and Dynamic Characteristics, True value, Accuracy, Precision, Resolution, Drift, Hysteresis, Dead-band, Sensitivity. Limiting and Relative limiting Error, Types of Errors-Gross, Systematic and Random Errors

Measurement of Electrical Quantities **[03 Hrs]**

Permanent Magnet Moving Coil, Moving Iron meters, Digital voltmeters, Extension of range of meters. Digital Multi-meter, Digital counter, frequency meter, Digital Storage Oscilloscope

Measurement of power **[06 Hrs]**

Electrodynamometer type Wattmeter and Low Power Factor Wattmeters, Shunts and multipliers, Potential Dividers. Study of DC and AC Potentiometer, Construction, theory, operation and characteristics of Current Transformers and Potential Transformers, Errors, and Clamp-on meters, Measurement of power using Instrument transformers, measurement of power in three-phase circuits using one, two and three Wattmeter method.

Measurement of Resistance, Inductance and Capacitance **[06 Hrs]**

Measurement of low, medium and High resistance, Insulation Resistance, Earth resistance by using Megger, Kelvin's double Bridge, AC Bridges for Inductance by using Anderson's bridge, Capacitance measurements using Schering bridge

Sensors and Transducers **[06 Hrs]**

Definition, classification, selection of transducers, resistive, inductive, capacitive transducers. Hall Effect transducer, Potentiometers, frequency counters and displays.
Temperature-Thermistors, Resistance thermometers, Thermocouples, Pressure, Flow measurements, tachometer, Position Sensor, Resistance strain gauge, LVDT

Text Books:

1. A course in Electrical and Electronic Measurements and Instrumentation, A. K. Sawhney Dhanpat Rai andSons,11th, edition 1995.
2. Modern Electronic Instrumentation and Measurement Techniques, Helfrick and Cooper, PHI, 1st, edition, 2007.

Reference Books:

1. Modern Electronic Instrumentation and Measurement Techniques by Helfrick and Cooper, Prentice-Hall of India, Reprint 1988.
2. Instrumentation Measurement and Feedback by Barry E. Jones, Tata McGraw -Hill, 1986
3. Electrical Measurement and Measuring Instruments by E.W. Golding, 3rd Edition, Sir Issac Pitman and Sons, 1960.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1. Declared test
2. Surprise test
3. MCQ Test
4. Assignments
5. PPT presentation
6. Quiz
7. Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

PROGRAMME ELECTIVE - I

EE304NB: ELECTRICAL MATERIALS AND TRANSFORMER DESIGN

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03

Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100

ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course is based on basics and applications electrical and electronics engineering materials. It also gives students exposure to insulators, conductors, semi conductors, super conductors and nano-technology materials.

DESIRABLE AWARENESS / SKILLS

Knowledge of materials, and basics of transformers

COURSE OUTCOMES

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

1. analyze different types of electrical material.
2. understanding of the physics behind the electrical material.
3. learn about characteristics and application of various electrical materials.
4. innovate research and develop the structure and utilization of various material.

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1		1	2		1	1		1	1		2	
2		1	1	1		1	3	1		1	1		1		2
3	1			1	1		1	3	1		1	1		1	3
4	1	1	1		1	1		1	2	1		1	1	1	

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Fundamental Aspects of Electrical Machine Design [05 Hrs]
Design of machines, design factors, limitation in design. modern trends in design of electric machines, modem machine manufacturing Techniques, basic principles

Electrical Engineering Materials [06Hrs]
Electrical conducting materials - high conductivity materials, high resistivity materials, electrical carbon material, superconductivity, magnetic materials, types of magnetic materials Insulating materials, classification of insulating materials and applications of insulating materials

Constructional Details of Transformer [06 Hrs]
Constructional details, classification of transformers, comparison of core and shell type transformers, Distribution and power transformer, core, core cross section, construction, yoke, yoke cross section, transformer winding. method of cooling of transformer. Transformer tank, terminals, and leads Tapping, tap changing, conservator and breather, explosion vent, temper indicator, Buchholz Relay sealing materials

Transformer Design – Basics [08 Hrs]
Design details output equation, volt/turn ratio of iron loss to copper, relation between core area and weight of iron and copper, optimum design, variation of output and losses in transformer with linear dimensions, design of core, design of winding, design of insulation, window space factor, window dimension, design of yoke, overall dimensions

Transformer Design – Performance [08 Hrs]
Resistance of winding, Leakage reactance of winding, regulation, mechanical forces, calculation of mechanical forces, bracing of winding. No load current, change of parameters with change of frequency, Transformer oil as cooling media, design of tank with tubes.

Text Books:
1. A Course in Electrical Engineering Materials, by S. P. Seth, Dhanpat Rai and Sons publication.
2. Electrical Engineering Materials, T.T.T.I, Madras.
3. A course in Electrical Machine Design by A. K. Sawney

Reference Books:
1. Electrical Power Capacitors-Design and Manufacture, by D. M. Tagare, Tata McGraw Hill Publication.
2. Electrical Engineering Materials, by S. P. Chalotra and B. K. Bhatt, Khanna Publishers, Nath Market.
3. Electrical Engineering Materials, by C. S. Indulkar and S. Thiruvengadam, S. Chand and Com.Ltd
4. Performance of AC machines by M. G. Sen

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1. Declared test
2. Surprise test
3. MCQ Test
4. Assignments
5. PPT presentation
6. Quiz
7. Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

OPEN ELECTIVE - III

EE305NX: ENERGY AUDIT AND CONSERVATION

Teaching Scheme : 03 L + 00 T; **Total:** 03 hours/week **Credits** : 03

Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100

ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course focuses on assessing energy use within buildings, industrial systems, or infrastructure to identify opportunities for improving energy efficiency and reducing consumption.

DESIRABLE AWARENESS/SKILLS:

Knowledge of power system, electrical machines and their operating characteristics and tariff

COURSE OUTCOMES:

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

1. understand the global efforts toward sustainable energy development.
2. carry out energy audit and prepare energy audit report.
3. learn to assess and implement energy-saving measures.
3. apply proper energy conservation techniques for industrial applications.
4. analyze cost benefit and calculate payback period using various methods.

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1		1	1	1		2	1	1		1	1	1	2	1
2		1			1	1		3	1		1	1	1		3
3	1		1		1		1		3	1	1	1		1	3
4	1	1	1		1	1		1	1	3		1	1	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Energy and Environment: **[08 Hrs]**

Energy resources, world energy consumption, world fossil fuel reservoirs, per capita energy consumption, Global and national energy scenario and energy consumption patterns. Environmental and social concerns: the greenhouse effect, pollution, acid rain, effect of global warming, Electricity Act 2003, Energy conservation act 2001 and it's features.

Energy Management and Audit: **[08 Hrs]**

Principles and objectives of energy management systems, duties and responsibilities of energy management. Need of energy audit, types of energy audit, procedure of energy audit, ABC analysis, Energy Flow Diagram and its importance, Measurements in energy audit and various measuring instruments, Questionnaires for the energy audit, internal energy audit checklist. Energy audit report format, outcome of energy audit, action plan for implementation of energy audit options.

Tariff: **[08 Hrs]**

Electrical system: Electricity billing, electrical load management, energy cost and types of tariffs, recent MSEDCL tariffs, selection of tariff, maximum demand control, power factor improvement benefits, selection and location of capacitors energy conservation in industries by power factor improvement, automatic power factor correction, load factor, methods of improving load factor.

Energy Conservation in Industries: **[08 Hrs]**

Energy saving techniques in Distribution system, Heating – energy saving in furnaces, ovens and boilers. Cooling – energy saving in air conditioners and ventilating systems. Motive power – energy efficient motors, use of soft starters and variable frequency drives for efficient operation of motors, energy conservation in major utilities in pumps, fans, blowers, cooling Towers, DG sets.

Energy economics: **[08 Hrs]**

Introduction, fixed and variable costs, cost benefit risk analysis, simple payback period, straight line depreciation, sinking fund depreciation, reducing balance depreciation. Disadvantages of payback period method, net present value method, Internal Rate of Return method.

Text Books:

1. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 1, General Aspects
2. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 2 – Thermal Utilities
3. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 3- Electrical Utilities
4. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 4

Reference Books:

1. Success stories of Energy Conservation by BEE (www. Bee-india.org)
2. Utilization of electrical energy by S.C. Tripathi, Tata McGraw Hill.

3. Energy Management by W.R. Murphy and Mackay, B.S. Publication.
4. Generation and utilization of Electrical Energy by B.R. Gupta, S. Chand Publication.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

OPEN ELECTIVE - III
EE305NY: ENERGY STORAGE SYSTEMS

Teaching Scheme	**:** 03 L + 00 T; **Total:** 03 hours/week	**Credits**	**:** 03
Evaluation Scheme	**:** 10 ISA + 30 MSE + 60 ESE	**Total Marks**	**:** 100
ESE Duration	**:** 3 Hrs.		

COURSE DESCRIPTION

coverage of energy storage techniques involving electrochemical, mechanical and emerging options. Integration of the energy storage media, its effects on the bulk power system, and design tradeoffs to understand environmental impacts, cost, reliabilities, and efficiencies for commercialization of bulk energy storage.

COURSE OUTCOMES:

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

1. describe the need of energy storage systems - present and future
2. demonstrate working/ operational principles of various Electrochemical Energy Storage systems
3. analyze the characteristics of energy from various sources and need for storage
4. classify various types of energy storage and various devices used for the purpose.
5. demonstrate management of energy storage systems

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1		1	1	1	1	2	1	1	1	1	1	1	2	1
2	1	1	1		1		1			1			1		3
3			1	2		1	1	1	3		1	1	1	1	
4	1	1		1	1			1	1	3	1	1	1	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Necessity of Energy Storage **[06 Hrs]**

Storage Needs - Variations in Energy Demand - Variations in Energy Supply - Interruptions in Energy Supply - Transmission Congestion - Demand for Portable Energy - Demand and scale requirements - Environmental and sustainability issues, future prospect of storage

Electrochemical Energy Storage **[10 Hrs]**

Batteries-Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages- Li-ion battery and Metal hydride battery vs lead-acid battery. Supercapacitors- Working principle of supercapacitor, types of supercapacitors, cycling and performance characteristics, difference between battery and supercapacitors, Introduction to Hybrid electrochemical supercapacitors Fuel cell: Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-supercapacitor systems

Superconducting Magnetic Energy Storage **[08 Hrs]**

Introduction to Superconducting Magnetic Energy Storage (SMES) operation, theory of usage and emergent research. Focus will primarily be on large utility scale energy storage facilities

Mechanical Energy Storage and Thermal Energy Storage **[08 Hrs]**

Flywheel, Pumped hydro storage, compressed gas storage technologies, models for compressed gas capacity, efficiency and availability

Thermal Energy Storage- Phase Change Materials (PCMs); Selection criteria of PCMs; Stefan problem; Solar thermal LHTES systems; Energy conservation through LHTES systems; LHTES systems in refrigeration and air-conditioning systems

Applications **[08 Hrs]**

Present status of applications, Utility use (Conventional power generation, Grid operation and Service), Consumer use (Uninterruptible power supply for large consumers), New trends in application, Renewable energy generation, Smart grid, Electric vehicles,

Text Books:

1. Energy Storage for Power Systems, 2nd Edition, IET Publications (ISBN: 978-1849192194)

Reference Books:

1. Energy Storage, R.A Huggins,Springer, (ISBN: ISBN 978-1441910240)
2. Ultracapacitors, R. P. Deshpande, McGraw Hill Education Publication.
3. Energy Storage, Robert A. Huggins, Springer Publication.
4. Energy storage in power systems, Fransisco Diaz, published by Wiley.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test

2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

EE307N: AC MACHINES LAB

Teaching Scheme : 02 Total: 02 hours/week **Credits** : 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course is designed to provide students with practical, hands-on experience in the operation, testing, and performance analysis of AC electrical machines. The course covers both synchronous and asynchronous machines (induction and synchronous motors) used in industrial and power systems applications. Through a series of experiments, students will gain an understanding of the principles of operation, characteristics, and testing of various AC machines. The lab will enable students to connect theoretical concepts from lectures with real-world applications, such as performance under load, efficiency measurement, and the impact of different parameters on machine operation.

DESIRABLE AWARENESS/SKILLS:

Knowledge of basic electrical engineering and its concepts

COURSE OUTCOMES:

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

1. understanding of AC machine design and performance..
2. know the behavior of AC motors and analyze data to determine characteristics of machines by performing practical.
3. perform duties in industry, operation and maintenance with the sense of safety precautions.
4. apply knowledge for technological subjects such as utilization of electrical energy, switch gear and machine design for economical and sustainable developments.

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1		1	3	1	1	1		1	1		1	2		1
2		1	1		3		1	1	1		1		2	1	
3	1		1	1	2	1		2		1	1	1	1	2	1
4	1	1		1		2	1	1	1	1		1	1	2	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Minimum **eight** experiments from the list of experiments provided below shall be performed to cover entire curriculum of course EE.351N.

List of Experiments:

1. To obtain the performance characteristics of three phase induction motor by direct load test.
2. To obtain the performance of three phase induction motor by construction of circle diagram.
3. To study speed control of three phase induction motor.
4. To obtain the performance characteristics of single phase induction motor direct load test.
5. To determine the parameters of equivalent circuit of capacitor start single phase induction motor by no load and blocked rotor tests.
6. To determine voltage regulation of three phase alternator by direct load test.
7. To determine voltage regulation of three phase alternator by EMF method.
8. To determine voltage regulation of three phase alternator by MMF method.
9. To determine voltage regulation of three phase alternator by Potier triangle method.
10. Synchronizing alternators: lamp methods and use of synchroscope.
11. To determine direct axis and quadrature axis reactances on synchronous machine by slip test.
12. To obtain performance of synchronous motor at constant load and variable excitation.
13. To obtain performance of synchronous motor at constant excitation and variable load.
14. To plot V-curves of synchronous motor.
15. To study various types three phase induction motor starters.

Evaluation Methodology:

- **ICA –** It shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using the prescribed internal continuous assessment format.
- **ESE –** It shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners, out of which one examiner shall be external examiner.

EE309N: MICROCONTROLLERS AND APPLICATIONS LAB

Teaching Scheme : 02 Pr; Total: 02 hours/week **Credits** : 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

The course explores knowledge of microcontroller and applications. The course comprises of architecture of microcontroller, assemble language programming and interfacing of peripherals and their applications. To meet the challenges of growing technology, student will be conversant with the programmable aspect of microcontroller. The objective of course is to understand microcontroller principles, concept and develop skill in both hardware and programming.

DESIRABLE AWARENESS/SKILLS:

EE303N: Microcontroller and applications.

COURSE OUTCOMES:

On the successful completion of this course, student will be able to:

1. interpret architecture of 8-bit microcontrollers.
2. execute assembly language programs for solving arithmetic and logical problems using microcontroller
3. develop program using timers and interrupts.
4. interface the memory and I/O peripherals to 8051 microcontroller.
5. maintain microcontroller based applications.

Course Outcomes (COs) and Program Outcomes (POs) mapping with strength of co-relation

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1		1	1	2	1	1	1	1	1	1	1		2	1
2		1		1	3		1		1	1		1	1	2	
3	1		1	1		1	2	1	1		1		1		1
4	1	1	1		1		1	1		1	1	1		2	1
5	1		1	1	1	1	2	1	1	1		1	1	3	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Minimum **eight** experiments from the list of experiments provided below shall be performed to cover entire curriculum of course EE303N.

List of Experiments:

Part A (At least 4 experiments are mandatory)

1. Identification of various blocks of 8051 microcontroller development board
2. ALP to perform arithmetic operations on 8-bit data
3. ALP to perform arithmetic operations on 16- bit data
4. ALP to array data transfer from source locations to destination locations.
5. ALP to block exchange of data from source locations to destination location
6. ALP to finding the smallest/ largest number from the given data bytes
7. ALP to sorting (Ascending/Descending) of data.
8. ALP to sum of a series of 8 bit data.
9. ALP to square / cube / square root of 8 bit data.
10. ALP to code conversion – Hex to Decimal/ASCII to Decimal and vice versa.

Part B (At least 4 experiments are mandatory)

1. Write an ALP to generate delay using timer register.
2. Develop an ALP to transfer 8 bit data serially on serial port
3. Develop an ALP to generate pulse and square wave by using timer delay.
4. Interface 7-segment display to display the decimal number from 0 to 9
5. Interface LCD with 8051 microcontroller to display the characters and decimal numbers.
6. Interface the given keyboard with 8051 and display the key pressed.
7. Interface ADC with 8051 microcontroller and verify input/output.
8. Interface DAC with 8051 microcontroller to generate square / triangular / sawtoothed wave .
9. Interface stepper motor to microcontroller and rotate in clockwise direction at the given angles.
10. programming of PIC microcontrollers using MPLAB

Evaluation Methodology:

- **ICA –** It shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on

practical performed by him/her. The performance shall be assessed experiment wise using the prescribed internal continuous assessment format.

- **ESE –** It shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners, out of which one examiner shall be external examiner

Programme Elective – I Lab

Electrical Measurement Lab

Teaching Scheme : 02 Pr; Total: 02 hours/week **Credits** : 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

The Laboratory work should consist of minimum 8 experiments Based on theory EE304NA as per sample list given below Experiments involve performance /design of practical, result and conclusion based on it.The sample list is given is just a guideline.

DESIRABLE AWARENESS / SKILLS

Knowledge of basic electrical engineering and its concepts.

COURSE OUTCOMES:

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

1. learn about various measurement devices, their characteristics, their operation and Limitations.
2. design and validate DC and AC bridges.
3. analyze the dynamic response and the calibration of few instruments.
4. understand statistical data analysis.
5. understand computerized Data acquisition.

Course Outcomes (COs) and Program Outcomes (POs) mapping with strength of co-relation

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1		1	2	1	1	1	2	1	1	2	1	1	1
2		1	1	1		1	1	2	1		1			1	
3	3	2		1	2		1			1	1	2	1		1
4			1		2	1		1	2			2	2	1	1
5	3	1	1		2	1	1	1	2	1	1	2	1	1	

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Minimum **Eight** experiments provided below shall be performed to cover entire curriculum of course

List of Experiments:

1.Identification of the components of PMMC and PMMI instruments.

2.Usage of DSO to capture transients like a step change in R-L-C cicuit.

3.Extension of the range of the voltmeter/ammeter using shunt and multiplier.

4.Measurement of power in three phase circuits by conventional two wattmeter method.

5.Measurement of Low resistance using Kelvin's double bridge.

6.Measurement of High Resistance and Insulation resistance using Megger.

7.Calibration of single phase energy meter by direct Loading.

8.Measurement of supply voltage ,frequency, peak value in single phase circuit using CRO.

9.Current measurement using Shunt, CT and Hall sensor.

10.Measurement of Temperature using Thermocouple.

11.Measurement of Displacement using LVDT.

12.Measurement of Temperature using RTD.

13.Measurement of Pressure Using bourdon Tube.

Evaluation Methodology:

- **ICA –** It shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using the prescribed internal continuous assessment format.

- **ESE –** It shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners, out of which one examiner shall be external examiner.

Programme Elective – I Lab

EE310NB – Electrical Materials and Transformer Design Lab

Teaching Scheme : 02 Pr; Total: 02 hours/week **Credits** : 01

Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50

ESE Duration : 3 Hrs.

COURSE DESCRIPTION

The Laboratory work should consist of minimum five experiments based on theory **EE304NB** as per sample list given below. Experiments involve performance /design of practical, result and conclusion based on it. The sample list is given is just a guideline.

DESIRABLE AWARENESS / SKILLS

Knowledge of basic electrical engineering and its concepts.

COURSE OUTCOMES:

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

1. familiar with electrical material and selection of that with electrical machines
2. design the main dimensions of transformer
3. understand the performance parameters of the transformer
4. able to design tank dimensions and cooling system of the transformer

Course Outcomes (COs) and Program Outcomes (POs) mapping with strength of co-relation

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1	1	1	2	1	1	1	2	1	1	2	1	1	1
2		1	1		2	1		2	1	1		2	1	1	1
3	3	2		1		1	1	1		1	1	2	1	1	1
4	3		1	1	2	1	1	1	2	1	1	2	2	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Minimum **five** experiments provided below shall be performed to cover entire curriculum of course

List of Experiments:

1. To measure the high resistance of material by Megger
2. To measure the insulation of the material
3. To identify properties of magnetic and conducting material.
4. To draw constructional details of core cross section and windings
5. To design the transformer with cooling tubes and draw its details
6. To write a program of design of transformer on MATLAB software
7. To design the transformer on ANSYS software

DHC – I (Honors)

EE311N SPECIAL MACHINES

Teaching Scheme	**:** 03 L + 00 T; **Total:** 03 hours/week	**Credits**	**:** 03
Evaluation Scheme	**:** 10 ISA + 30 MSE + 60 ESE	**Total Marks**	**:** 100
ESE Duration	**:** 3 Hrs.		

COURSE DESCRIPTION

The objective of this course is to give exposure to the students of various special electrical machines, their operation, control and industrial applications. It also covers performance characteristics, and mathematical analysis of it.

DESIRABLE AWARENESS / SKILLS

DC and AC Machines, Engineering Mathematics

COURSE OUTCOMES

On the successful completion of this course, the students shall be able to

1. understandprinciples and operation of of special electrical machines, such as permanent magnet motors, stepper motors, and synchronous reluctance motors.
2. develop torque speed and performance characteristics of above motors
3. demonstrate various control strategies.
4. analyze the performance of Switched reluctance motor and identify applications
5. analyze and use thestepper motor and LIM for industrial applications

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)„

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1	2	1	3	1	1			2	1	1	1	1	
2		2	3	1	2			2	1	1	2	1	1	1	1
3			1			1	1		1	2	1	2			1
4	2	2	2	1	3	1	1			1	2	1	1	2	1
5			1	1	1	2	1	1	2	2	1	2	1	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Generalized Machine Theory [08 Hrs.]

Energy in singly excited magnetic field systems, determination of magnetic force and torque from energy. Determination of magnetic force and torque from co-energy, Forces and torques in systems with permanent magnets. MMF of distributed winding, Magnetic fields production of EMFs in rotating machines.

Permanent Magnet Synchronous and Brushless D.C. Motor Drives [08 Hrs.]

Synchronous machines with PMs, machine configurations. Types of PM synchronous machines Sinusoidal and Trapezoidal. EMF and torque equations Torque speed characteristics Concept of electronic commutation, Comparative analysis of sinusoidal and trapezoidal motor operations. Applications

Control of PMSM [08 Hrs.]

abc-αβ and αβ-dq transformations, significance in machine modeling, Mathematical Model of PMSM (Sinusoidal), Basics of Field Oriented Control (FOC), Control Strategies: constant torque angle, unity power factor.

Switched Reluctance Motor [10Hrs.]

Principle of operation and construction of Switched Reluctance motor, Selection of poles and pole arcs , Static and dynamics Torque production, Power flow, effects of saturation, Performance, Torque speed characteristics, Synchronous Reluctance, Constructional features; axial and radial air gap motors; operating principle; reluctance torque; phasor diagram; motor characteristics Introduction to control of Reluctance Drive. Applications.

Stepper Motor and Linear Electrical Machines: [10 Hrs.]

Construction and operation of stepper motor, hybrid, Variable Reluctance and Permanent magnet, characteristics of stepper motor, ; Static and dynamics characteristics, theory of torque production, figures of merit; Concepts of lead angles, micro stepping, Applications selection of motor. Introduction to linear electric machines. Types of linear induction motors, Constructional details of linear induction motor, Operation of linear induction motor. Performance specifications and characteristics Applications.

Text Books

1. Electromagnetism-Problems with solution ,A. Pramanik, Prentice Hall India, 2012
2. Engineering Electromagnetic, by W. Hayt, McGraw Hill Education, 2012

Reference Books

1. Electric machines and power systems,Toro V.D, Prentice Hall of India, 1985
2. Fractional horse power electric motors ,Veinott, McGraw Hill, 1948
3. Special Electrical Machines, K. Venkatraman, Orient Black swan/ Universities press, 2008
4. Electric Machinery, A. E. Fitzergerald, C.Kingsly, S. D. Umas, TMH

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

8) Declared test
9) Surprise test
10) MCQ Test
11) Assignments
12) PPT presentation
13) Quiz
14) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

EE351N: CONTROL SYSTEM

Teaching Scheme: 03 L + 00 T; **Total:** 03 hours/week **Credits :** 03
Evaluation Scheme: 10 ISA + 30 MSE + 60 ESE **Total Marks :** 100
ESE Duration: 3 Hrs.

COURSE DESCRIPTION

This course explores about the automation systems with various sensors, error detectors. This course also elaborates mathematical modeling, block diagram, signal flow graph. It also discusses time domain analysis, Routh's stability, and frequency domain analysis. Finally in state space approach modern control system is introduced.

DESIRABLE AWARENESS / SKILLS

Basic knowledge of basic electrical, dc machines, ac machines, mechanical engineering and their basic concept.

COURSE OUTCOMES

On the successful completion of this course, the students shall be able to

1. develop the mathematical model of linear time invariant systems.
2. analyze the response of the closed and open loop systems.
3. analyze the stability of the closed and open loop systems.
4. introduce the design of sampled data system using discrete system analysis.

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)„

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1	2	1	3	1	1			2	1	1	1	1	1
2		2	3	1	2		1	2	1	1	2			1	2
3	1	1			1	1			1	2	1	2	1	2	1
4	2	2	2	1	3	1	1	1	2	1	2	1	1	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Control System Components **[08 Hrs.]**

Basic components and classifications of general control systems, linear and nonlinear, open loop and closed-loop systems, mathematical models of physical systems, force-current and force-voltages, sensor, actuator, computational blocks, definition of sensitivity, effect of feedback on sensitivity it's analysis and roubustness.

Transfer Functions and Block Diagrams **[08 Hrs.]**

Definition of transfer function, block diagram representation of physical systems, block diagram reduction techniques, signal flow graphs and Mason's gain formula, transfer function of armature voltage control method and field current control method of DC shunt motor.

Time Domain Analysis **[08 Hrs.]**

Time response of second order systems, time domain specifications, steady state error and error coefficients, design specifications of second order systems, proportional, integral and derivative controllers, PID compensations, nature of system response from the location of roots in the s-plane of characteristic equation.

Root Locus **[08 Hrs.]**

Concepts of stability, Routh-Herwitz criterion, definition of root-locus, rules and procedure for plotting root-loci, stability analysis using root locus.

Frequency-Domain Analysis **[08 Hrs.]**

Frequency-domain specifications, Polar plot, Nyquist plot, Nyquist stability criterion, Bode plot, determination of gain and phase margin from Bode plot, determinations of transfer function from Bode plots, lead, lag, lead-lag compensation.

Text Books

1. Modern Control Engineering by Katsuhiko Ogata, PHI, 5th edition, 2009
2. Control system engineering by Norman Nise, John-Willey, 3rd edition, 2000
3. Control System Engineering by I. J. Nagrath and M. Gopal, Wiley Eastern Ltd, 3rd edition, 2000

Reference Books

1. Control systems-Principles and Design by M.Gopal, 2nd edition, TMH, 2002
2. Linear Control System Analysis and Design by John J. D'Azzo, C. H. Houpis, McGraw Hill International, ISE edition, 1988
3. Automatic Control System by Farid Golnaraghi Benjamin and C. Kuo, PHI, 10th edition, 2017

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

EE352N: POWER ELECTRONICS

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course consists of experiments and gives practical knowledge of power electronics devices. Various applications of rectifiers and inverters are studied which will help students for mini and major projects.

DESIRABLE AWARENESS / SKILLS

EE202N: Analog Circuit

COURSE OUTCOMES

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

1. describe the characteristics of power semiconductor devices
2. analyze single phase controlled rectifiers and its control circuit according to the specifications design controlled rectifiers
3. analyze dc-dc converters and their control techniques
4. acquire knowledge in voltage control in inverters
5. understand AC voltage controllers

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1	1	1	2		1	1	2	1	1	2	1		
2	3	1			2	1	1	2	1			2	1	1	1
3	3	2	1	1	2	1			1	1	1	2			1
4		1	1	1	2			1	2	1	1	2	2	1	1
5		1			2	1	1	1	2			2	1	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Power Semiconductor Devices **[09 Hrs]**

Introduction of power electronics, SCR Structure, Principle of operation, Two transistor analogy, Statics (V/I characteristics) and dynamic (turn on & turn off characteristics) of power semiconductor devices as Power MOSFET, DIAC, TRIAC, IGBT .

Gate triggering methods- R ,RC, UJT triggering, types of commutation, series and parallel operation, di/dt Protection, dv/dt Protection and Snubber circuit.

AC-DC Converters **[10 Hrs]**

Single phase half wave and full wave controlled converters with different types of load for R, R-L and RLE loads, circuit configurations, working, performance parameters, Effect of Source inductance Numerical Problems. Semi controlled rectifier with R load, Three phase half wave and full wave converters bridge connections with different types of load for R, R-L loads, circuit configurations, working, performance parameters, Numerical Problems. comparison uncontrolled and controlled rectifier, Use of freewheeling diode.

DC-DC Converters **[08 Hrs]**

Choppers, Classification, control strategies, Step down choppers, Derivation of load voltage and currents with R, RL loads, Step up Chopper and other class of chopper , load voltage expression, Numerical Problems.

DC-AC Converters **[08 Hrs]**

Inverter , Single Phase Half and Full Bridge Inverters, Basic Series Inverter , Three Phase VSI in 120^0/ 180^0 Modes of Conduction., Pulse-width modulation (PWM) techniques - single, multiple and sinusoidal . PWM Inverters: principle of operation, Numerical Problems.

Ac Voltage Controllers and Cyclo Converters **[07 Hrs]**

AC Voltage Controllers – Single Phase Two SCR's in Anti Parallel With R and RL Loads

Cyclo Converters – Single Phase Bridge Configuration of Cycloc onverter (Principle of Operation) – Waveforms

Text Books:

1. Power Electronics: Circuit, devices and applications by M.H. Rashid, PHI, 2nd edition, 1994
2. Fundamentals of Power Electronics by Robert W Erickson and Dragan Maksimovic, 2nd Edition 2001
3. Power Electronics by Singh M. D. and K. B. Khanchandani, Tata McGraw Hill, New Delhi, 2008

Reference Books:

1. Power Electronics by P. S. Bhimbra, Khanna Publisher, New Delhi.
2. Power Electronics by C. W. Lander, Tata McGraw-Hill Publications India 1993.
3. An Introduction to Thyristors and Their Applications by M. Ramamoorthy, East-West Press Pvt. Ltd., New Delhi

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

EE353N: SWITCHGEAR AND PROTECTION

Teaching Scheme: 02L+00T, Total: 02 **Credits**: 02

Examination Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100

Duration of ESE: 03 Hrs

COURSE DESCRIPTION

The course of switch gear and protection is covering various protection systems for various equipments/appliances. The course explores the various circuit breakers, their types and operation. It also discusses fault current protection methods for transformer, generator. With advances in protective relaying, numerical relays are also introduced.

DESIRABLE AWARENESS / SKILLS

Short circuit analysis on machines and transmission line

COURSE OUTCOMES:

On the successful completion of this course, student will be able to

1. knowledge about arc phenomenon
2. different types of circuit breaker
3. illustrate various protection schemes and terminology
4. recognize the appropriate relay
5. implement different protection scheme for protection of Electrical equipments and lines

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1	2	1	1			1	1	1	1	1	3	1
2	1			1	2	1	1	1	1			1	1	2	1
3		1			1	3			1	1	1			1	1
4		1			1	1	3	1	1	1	1			2	1
5	1	1	1	1			2	1	1	1	1	1	1	1	3

1-Weakly correlated 2– Moderately correlated 3–Strongly correlated

Course Content

Fundamentals of Power System Protection **[07 Hrs]**

Principle of circuit interruption and arc phenomenon, arc interruption methods, Arc voltage, restriking voltage, factors affecting TRV, Rate of Rise of Re-striking voltage, damping of TRV, resistance switching, current chopping, capacitive current breaking, auto reclosing protection principles,

Circuit Breakers **[07 Hrs]**

Circuit breaker ratings, classification and working principle and applications of C.B: HT CB: Air Break, Air Blast, Vacuum, Minimum Oil and Bulk Oil, SF6 C.B. L.T. CB:MCB, MCCB, HRC fuses

Fault Analysis and Over Current Protection **[07 Hrs]**

Fuse protection, fundamental of over current protection, PSM setting and TSM, earth fault protection using over current relays, introduction to directional over-current relays, non directional over-current relays directional power relays

Transmission System Protection Using Distance Relays: **[07 Hrs]**

Introduction to distance relaying, type of distance relay, characteristic of distance relay, relay response under power swings and effect of fault resistance, zones of protection

Protection of Transformer and Bus Bars **[07 Hrs]**

Transformer Protection: Percentage differential relay, restricted earth fault protection, Buchholz relay, protection against over fluxing, generator protection, stator phase and ground fault protection, loss of excitation, loss of prime mover. Bus bar protection: differential protection of bus bar, lightening and switching over voltages, need and types of lightening arresters, system grounding, methods of system grounding

Text Books:

1. Fundamentals of Power System Protection by Y. G. Paithankar, S. R. Bhide, PHI, 2nd edition, 1996
2. Solid State Protective Relaying by Madhav Rao, Tata McGraw Hill,1stedition, 2000
3. Computer relaying for power systems by A. G. Phadke, J. S. Thorp, Research studies press, John Wiley and sons Inc. New York, 1st edition, 2001

Reference Books:

1. A Web Course on Digital Protection of Power System by Prof. Dr.S.A.Soman,IIT Bombay
2. Switchgear Protection and Power Systems by Sunil S. Rao, Khanna Publishers,5th edition, 2004

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1. Declared test
2. Surprise test

3. MCQ Test
4. Assignments
5. PPT presentation
6. Quiz
7. Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

Programme Elective – II

EE355NA: ENERGY CONSERVATION AND MANAGEMENT

Teaching Scheme : 03 L + 01 T; **Total:** 04 hours/week **Credits** : 04

Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100

ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course explores inspection and survey of electrical energy. This course also imparts the analysis of energy flows in any building. It includes a process or system to reduce the amount of energy input into the system without negatively affecting the output.

DESIRABLE AWARENESS/SKILLS:

Knowledge of power system, electrical machines and their operating characteristics, tariff

COURSE OUTCOMES:

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

1. outline energy scenario consumption patterns and environmental impacts and mitigation method.
2. carry out energy audit and prepare energy audit report.
3. apply energy conservation policy, regulations in industrial practices.
4. analyze different types of demand side management techniques and tariffs usen in distribution systems
5. apply proper energy conservation techniques for industrial applications and evaluate economic feasibility

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1			2	1			1	1	1	1	3	1
2	1			1	1	1	2	1	1			1	1	2	1
3	1	1	1			1	1	3	1	1	1	1			2
4			1	1	1	1			3	1	1	1	1	1	2

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Contents

Energy Scenario: **[09 Hrs.]**

Classification of energy resources, commercial and non-commercial energy, primary and secondary sources, commercial energy production, final energy consumption, energy needs of growing economy, short terms and long terms policies, energy sector reforms, distribution system reforms and up-gradation, energy security, importance of energy conservation, energy and environmental impacts, emission check standard, United Nations frame work convention on climate change, global climate change treaty, Kyoto protocol, clean development mechanism, salient features of Energy Conservation Act 2001 and Electricity Act 2003. Indian and global energy scenario. Introduction to IE Rules. Study of Energy Conservation Building Code (ECBC), concept of green building

Energy Audit: **[09 Hrs.]**

Definition, need of energy audit, types of audit, procedures to follow, data and information analysis, energy audit instrumentation, energy consumption – production relationship, pie charts. Sankey diagram, Cusum technique, least square method and numerical based on it. Outcome of energy audit and energy saving potential, action plans for implementation of energy conservation options. Bench-marking energy performance of an industry. Energy Audit Report writing as per prescribed format. Audit case studies of sugar, steel, paper and cement, industries. Energy audit case study of educational institutes.

Energy Management: **[09 Hrs.]**

Definition and objective of energy Management, principles of energy management, energy management strategy, energy manager skills, key elements in energy management, force field analysis, energy policy, format and statement of energy policy. Organization setup and energy management. Responsibilities and duties of energy manager under Act 2001. Energy efficiency program, energy monitoring systems. Introduction to SCADA and automatic meter reading in utility energy management.

Demand Management: **[08 Hrs.]**

Supply Side Management (SSM), various measures involved such as use of FACTS, VAR Compensation, generation system up gradation, constraints on SSM. Demand side management (DSM), advantages and barriers, implementation of DSM, areas of development of demand side management in agricultural, domestic and commercial consumers. Demand management through tariffs (TOD). Power factor penalties and incentives in tariff for demand control, apparent energy tariffs. Role of renewable energy sources in energy management, direct use (solar thermal, solar air conditioning, biomass) and indirect use (solar, wind)

Energy Conservation: **[10 Hrs.]**

Motive power (motor and drive system). b) illumination c) heating systems (boiler and steam systems) c) ventilation(fan, blower, compressors) and air conditioning systems d) pumping system e) cogeneration and waste heat recovery systems f) utility industries (T and D sector) g) diesel generators.

Financial analysis and case studies. Costing techniques: cost factors, budgeting, standard costing, and sources of capital, cash flow diagrams and activity chart. Financial appraisals: criteria, simple payback period, return on investment, net present value method, and time value of money, break even analysis, and sensitivity analysis and numerical based on it, cost optimization, cost of energy, and cost of generation.

Text Books:

1. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book, 1, General Aspects
2. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 2 – Thermal Utilities
3. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 3- Electrical Utilities
2. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book

References Books:

1. Success stories of Energy Conservation by BEE (www.Bee-india.org)
2. Utilization of electrical energy by S.C. Tripathi, Tata McGraw Hill.
3. Energy Management by W.R. Murphy and Mackay, B.S. Publication.
4. Generation and utilization of Electrical Energy by B.R. Gupta, S. Chand Publication.
5. Energy Auditing made simple by Balasubramanian, Bala Consultancy Services.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1. Declared test
2. Surprise test
3. MCQ Test
4. Assignments
5. PPT presentation
6. Quiz
7. Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

Program Elective – II

EE355N B: UTILIZATION OF ELECTRICAL ENERGY

Teaching Scheme: 03L + 01T, **Total:** 04 **Credits:** 04

Evaluation Scheme: 10 ISA +30 MSE + 60 ESE **Total marks:** 100

Duration of ESE: 03 Hrs

COURSE DESCRIPTION:

This course provides brief description of laws of illumination, lighting design, and modern lighting technologies and in-depth understanding of the principles and applications of electrical energy utilization across various domains. Students will learn about electrical heating and welding methods used in industries, along with electrolytic processes and their applications. The course also explores the fundamentals of electrical traction, including existing traction systems and different rail services in India.

DESIRABLE AWARENESS/SKILLS:

Knowledge of basic electrical engineering, electric traction.

COURSE OUTCOMES

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

1. explain laws of illumination and different lighting scheme.
2. analyze different heating and welding methods in different industries.
3. estimation of tonnage capacity and motor power for cool storages.
4. explain existing traction system in India.
5. explain different services such as urban, sub-urban and mainline rail traffic.

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1			1	2			1	1	1	1	1	3	1
2			1	1	1		2	1			1			2	1
3		1	1			1		3	1	1	1			1	2
4				1	1	1	1	1	3			1	1	1	2
5	1	1	1	1	3	1	1			1	1	1	1	1	2

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Illumination **[09 Hrs]**

Introduction, definition, laws of illumination, polar curves, artificial sources of light, incandescent lamps, arc lamps, discharge lamps, filament lamps, fluorescent tubes, comparison between filament lamps and fluorescent tube, compact fluorescent lamps, LED lamps, types and design of lighting schemes, lighting calculations, factory lighting, street lighting and flood lighting.

Electric Heating and Welding **[09 Hrs]**

Introduction to electric heating, advantages, modes of transfer of heat, methods of electrical heating, resistance heating, induction heating, dielectric heating, high frequency heating, design of heating element, causes of failure of heating elements. Introduction electric welding, resistance welding, electric arc welding, submerged arc welding, electron beam welding, laser beam welding, types of welding electrodes, comparison between resistance and arc welding, comparison between AC and DC welding, electrical welding equipment.

Electrolyte Process and Refrigeration **[09 Hrs]**

Introduction to electrolytic process, principle of electrolysis, laws of electrolysis, application of electrolytic process- electroplating, metal extraction and metal processing, power supply for electrolysis process. Introduction to refrigeration cycle, refrigeration systems, refrigerant, domestic refrigerator, water coolers. Introduction to air conditioning.

Electrical Traction-I **[09 Hrs]**

Introduction, requirement of ideal traction system, types of traction systems, traction system in India, System of track electrification, comparison between DC and AC traction, types of services, speed time and speed distance curves for different services, definition crest speed, average speed, schedule time, dead weight, accelerating weight, adhesive weight, coefficient of adhesion. Factors affecting schedule speed of train, traction efforts, and specific energy conservation.

Electrical Traction -II **[09 Hrs]**

General features of traction motors, characteristics of traction motors, suitability of motors for traction, traction motors control, series parallel controlling, transition method, drum controller, braking of electrical motors, regenerative braking, and current collecting devices.

Text Books:

1. Utilization of electrical energy, by E. O. Taylor, The Orient Blackswan, 1971
2. Utilization of Electrical Energy and Power by J. B. Gupta, S. K. Kataria and Sons

Reference Books:

1. Art and Science of Utilization of Electrical Energy, by H. Pratab, Dhanpat Rai
2. Modern Traction Systems, H. Pratap, Dhanpat Rai, 2012

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1. Declared test
2. Surprise test
3. MCQ Test

4. Assignments
5. PPT presentation
6. Quiz
7. Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

Programme Elective – II

EE355N C: ELECTRICAL MAINTENANCE

Teaching Scheme: 03L + 01T, **Total:** 04 **Credits:** 04

Evaluation Scheme: 10 ISA +30 MSE + 60 ESE **Total marks:** 100

Duration of ESE: 03 Hrs

COURSE DESCRIPTION:

An electrical maintenance syllabus course typically covers fundamental electrical concepts, safety practices, troubleshooting techniques, and hands-on maintenance procedures for various electrical systems and equipment

DESIRABLE AWARENESS/SKILLS:

Knowledge of basic electrical engineering, physics, chemistry

COURSE OUTCOMES

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

1. identify and apply electrical safety practices, standards, and codes of conduct
2. learn to develop and implement preventive maintenance schedules for electrical systems, helping reduce the risk of system failure and extending equipment life.
3. develop practical skills in the maintenance of common electrical equipment such as motors, generators, transformers, circuit breakers, and more
4. gain practical experience working with electrical tools and systems, learning to maintain and repair components while adhering to safety standards.
5. learn techniques to enhance energy efficiency in electrical systems, ensuring systems run effectively while minimizing power consumption and costs.

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1			1	2	1	1	1		1	1	1	3	1
2			1	1		1	2			1	1			2	1
3	1	1	1	1			1	3	1			1	1	1	2
4	1			1	1	1	1	1	3	1	1	1			2
5		1	1	1	1			2	1	1	1		1	1	2

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Introduction to Electrical Maintenance **[09 Hrs]**

Importance of maintenance in electrical systems, Types of maintenance: Preventive, Predictive, and Corrective, Overview of electrical systems, Tools and Equipment for Electrical Maintenance, Hand tools: Multimeters, Insulation Resistance testers, Circuit testers, Power tools and testing instruments, Personal protective equipment (PPE)

Electrical Safety Standards **[09 Hrs]**

Safety regulations and codes (NEC, IEC, etc.), Lock-out/tag-out procedures, Grounding and bonding in electrical systems, First aid and emergency response, Maintenance of Electrical Circuits, Inspection, testing, and, troubleshooting of electrical circuits, Conducting insulation resistance tests and continuity checks, Maintaining circuit breakers, fuses, and relays

Maintenance of Electrical Machines **[09Hrs]**

Common faults in motors and generators, Motor testing: insulation resistance, earth fault, overload, and short-circuit testing, Motor maintenance: lubrication, alignment, and bearing replacement, Testing and Maintenance of Transformers, Types of transformers and their maintenance needs, Load testing, voltage regulation, insulation tests, Oil testing and filter maintenance, Maintenance of Electrical Panels and Switchgears, Function and components of electrical panels, Visual inspection and testing of switchgear, Transformer maintenance in substations

Predictive Maintenance Techniques **[09 Hrs]**

Vibration analysis and thermal imaging for motors and transformers, Use of SCADA systems for predictive maintenance, Power Quality Testing, Voltage sags, surges, and harmonics, Power factor correction, use of power analyzers and harmonic analyzers, Fault Diagnosis and Troubleshooting Techniques, Common faults in electrical systems (e.g., open circuits, short circuits), Use of fault detection systems and diagnostic tools, Hands-on troubleshooting case studies

Testing of Electrical Installations **[09 Hrs]**

Routine testing and certification of installations, Insulation resistance testing, Earth resistance testing, Automation in Electrical Maintenance, Role of automation in maintenance, Introduction to predictive maintenance software, Integration with IoT and cloud technologies, Legal and Regulatory Aspects, Electrical standards, codes, and regulations (NEC, IEEE, IEC), Industry best practices, Certification requirements for electrical systems, Case Studies

Text Books:

1. Electrical Maintenance Handbook, H. Wayne Beaty, James L. Kirtley, McGraw-Hill Professional
2. Operation and Maintenance of Electrical Equipment, Rao B. V. S. Vol. 2, Ist edition,
3. Practical Electrical Maintenance, H. S. Bedi, Khanna Publishers

Reference Books:

1. Electrical Systems and Equipment: Maintenance and Troubleshooting, Clifford L. Miller, Wiley
2. Devices, Circuits, and Materials, Robert L. Boylestad, Pearson Education

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1. Declared test
2. Surprise test
3. MCQ Test
4. Assignments
5. PPT presentation
6. Quiz
7. Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

Programme Elective – III

EE356N A: ROTATING MACHINE DESIGN

Teaching Scheme: 03L + 01T, **Total:** 04 **Credits:** 04

Evaluation Scheme: 10 ISA +30 MSE + 60 ESE **Total marks:** 100

Duration of ESE: 03 Hrs

COURSE DESCRIPTION:

The course consists of general factors of electrical machine design, material classification, temperature rise and rating of machines. It explores the design concept of transformer core, windings overall dimension, performance and cooling design of transformer. The course also provides sound understanding and basic concepts of rotating machine design.

DESIRABLE AWARENESS/SKILLS:

Knowledge of Electrical Machines -I and Electrical Machines –II

COURSE OUTCOMES

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

1. understand concept of main dimensions
2. design the stator of Induction Motor
3. design the rotor of Induction Motor
4. design the Induction Motor on computer
5. aware them about use of latest software in electrical machine design

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	2	1	1	1	1	1			1	1	2	1	1
2	1		3	1			1	1	1	1	1	1	1		
3	1	1	1	3	1			1	1			1	1	2	1
4			1	1	3	1	1			1	1	1	1	2	1
5	1	1	1			2	1	1	1	1	1			3	1

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

Course Content

General Concepts in Rotating Machine Design [09 Hrs]

Relation between rating and dimensions, main dimensions, total loading, output equation, factors affecting the size, choice of specific electric and magnetic loading, variation of output with linear dimensions, separation D and L

Design of Stator of Induction motor [09 Hrs]

Design of output equation, choice of flux density in air gap, ampere-conductors per meter, main dimensions, stator winding, shape of stators, number of stator slots, mean turn length, stator core, stator teeth

Design of Rotor of Induction motor [09 Hrs]

Rotor Design, number of rotor slots, design of rotor bars and slots, design of end ring, full load slip, design of wound rotor, rotor teeth and rotor core, No Load current, short circuit current and circle diagram for performance

Computer Aided Design [09 Hrs]

Limitations (assumptions) of traditional designs, need of CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation, flowchart of design of Induction Motor and programming code in MATLAB

Electrical Machine Design Software Packages [09 Hrs]

Introduction to **c**omplex structures of modern machines-PMSMs, BLDCs, SRM, LSPMSMs machines etc, need of commercial FEA based software, analytical design modules, 2D and 3D machine models, analyzing steady state and transient performance of the designs

Text books:

1. A Course in Electrical Machine Design, A.K. Sawhney, Dhanpat Rai and sons New Delhi.10th edition,
2. Theory and Performance and Design of A.C. Machines, M.G. Say, ELBS London 3rd edition,
3. Performance and Design of DC Machine A. E. Clayton, ELBS, ISAAC Pitman Sons.3rd edition,

Reference books:

1. "Principles of Electrical Machine Design with computer programmes", S. K. Sen, Oxford and IBH Company Pvt. Ltd., New Delhi
2. "Electrical Machine Design Data Book", A Shanmugasundaram, G. Gangadharan, R. Palani, , 3rd edition, 3rd reprint 1988 - Wiely Eastern Ltd., New Delhi

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1. Declared test
2. Surprise test

3. MCQ Test
4. Assignments
5. PPT presentation
6. Quiz
7. Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

Programme Elective – III

EE356N B: POWER QUALITY

Teaching Scheme: 04L + 00T, **Total:** 04 **Credits:** 04

Evaluation Scheme: 10 ISA +30 MSE + 60 ESE **Total marks:** 100

Duration of ESE: 03 Hrs

COURSE DESCRIPTION:

This course provides information about the power quality in electrical field and different terms related to it. This course also provides the information about various techniques to mitigate the poor power quality.

DESIRABLE AWARENESS/SKILLS:

Knowledge of power system, electrical machines and their operating characteristics

COURSE OUTCOMES:

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

1. characterize power quality events.
2. reproduce causes of voltage sag and estimate magnitude of voltage sag.
3. analyze the causes of transients occurring in power system
4. calculate harmonics in pure sign wave
5. design the circuits for harmonic reduction

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	2	1			1	1			1	1	2	1	1
2	1	1	3	2	1	1	2	1			1		1		
3			1	3	1			1	1			2	1	2	1
4	1	1			3	1	1	1			1	1		2	1
5			1	1	1	2			1	1	1	1	1	3	1

1-Weakly correlated **2 – Moderately correlated** **3 – Strongly correlated**

Course Contents

Basics of Power Quality and Standards **[09 Hrs]**

Introduction and importance of power quality, symptoms of poor power quality. Various power quality issues such as transients, short duration voltage variations, long duration voltage variations, voltage imbalance, voltage fluctuations, voltage flicker and waveform distortion, grounding power quality issues. Power Quality standards such as IEEE 1159- 2009 and IEEE 519- 2014.

Voltage Sag and Swell **[09 Hrs]**

Origin of voltage sags and interruptions, voltage sag characteristics- magnitude, duration, phase angle jump, point on wave initiation and recovery, missing voltage. Area of vulnerability, effect of voltage sag on system, Information Technology Industry Council (ITIC) curve, voltage sag monitoring and mitigation techniques.

Transient Over-Voltages and Flickers **[09 Hrs]**

Classification of transients, sources of transient over voltages, techniques for over voltage protection. Voltage flickers – sources of flickers, quantifying flickers and mitigation techniques like surge arresters, transient voltage surge suppressors (TVSS), and specialized equipment like CVTs and SVRs

Fundamentals of Harmonics **[09 Hrs]**

Harmonic distortion – voltage and current distortion, power system quantities under non sinusoidal condition – active, reactive and apparent power, power factor – displacement and true power factor, harmonic phase sequences and triple harmonics, harmonic indices, sources of harmonics, effect of harmonic distortion

Harmonics Mitigation **[09 Hrs]**

Effects of harmonics, concept of Point of Common Coupling and harmonic evaluation, principles of controlling harmonics, harmonic study procedures and computer tools for harmonic analysis, devices for controlling harmonic distortion, and passive filters, active filters, Harmonic Analyzer

Text Books:

1. Power System Quality Assessment by J. Arrillaga, M. R. Watson, S. Chan, John Wiley and Sons
2. Understanding Power Quality Problems, Voltage Sag and Interruptions by M. H. J. Bollen, New York: IEEE Press, 2000, Series on Power Engineering.
3. Electrical Power System Quality by R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, 2nd Edition, McGraw Hill Publication.

Reference Books:

1. Power System Harmonics: Computer Modeling and Analysis by EnriquesAcha, Manuel Madrigal, John Wiley and Sons Ltd.
2. Power Quality in Power Systems and Electrical Machines by Ewald F. Fuchs, Mohammad A. S. Masoum, Elsevier Publication
3. Electric Power Quality by G. J. Heydt, Stars in Circle Publications

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1. Declared test
2. Surprise test
3. MCQ Test
4. Assignments
5. PPT presentation
6. Quiz
7. Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

Programme Elective – III

EE356N C: ELECTRIC VEHICLES

Teaching Scheme: 04L + 00T, **Total:** 04 **Credits:** 04

Evaluation Scheme: 10 ISA +30 MSE + 60 ESE **Total marks:** 100

Duration of ESE: 03 Hrs

COURSE DESCRIPTION:

Electric drives are clean and easy to control. With advent of modern power electronic devices and due to increasing availability of energy from renewable sources; research is going on electric and hybrid electric vehicles. Storage of energy is a major problem for electric vehicles. This subject introduces about current development in this area at national and international level.

DESIRABLE AWARENESS/SKILLS:

Knowledge of power systems, electric drives and electric traction

COURSE OUTCOMES:

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

1. understand EV Fundamentals..
2. define the functionality and working principles of different types of automotive power trains
3. illustrate the working of various automotive transmission systems
4. explain vehicle fundamentals of various subsystem.
5. illustrate the working of motors and conversions.
6. identify and illustrate the various hybrid electric power trains and their different modes of operations

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	2	1	1	1	1	1	1			1	2	1	1
2			3			1			1	1	1	1	1	1	1
3	1	1	1	3	1	1	1	1	1			1	1	2	1
4			1	1	3	1			1	1	1	1	1	2	1
5	1					2	1	1	1	1			1	3	1

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

Course Content

Electric Vehicles **[08 Hrs]**

History, Basics of Electric Vehicles ,Components of Electric Vehicle, General Layout of EV, EV classification : Battery Electric Vehicles (BEVs), Fuel-Cell Electric Vehicles (FCEVs) Comparison with Internal Combustion Engine: Technology, Advantages & Disadvantages of EV, National Policy for adoption of EVs, Overview of Tesla car.

Vehicle Mechanics **[08 Hrs]**

History of Vehicle Development, General Configuration of Automobile, Body and Chassis Fundamentals: General Packaging, Types of Structural System, Backbone Construction; Body and Chassis Materials. Automotive Power train Mechanical, Suspensions system, Steering System, NVH, Control System Integration and Implementation. Front-Wheel Drive (FWD), Power trains, Rear-Wheel Drive Powertrains (RWD), Multi-Wheel Drive Power trains (AWD and 4WD).

Transmission Systems **[08 Hrs]**

Transmission gears, Manual Transmission (MT), Automatic Transmission (AT), Automated Manual Transmissions (AMT) and Continuously Variable Transmissions (CVT); Manual Transmissions Powertrain Layout and Manual Transmission Structure, Power Flows and Gear Ratios, Manual Transmission Clutch and its structure. Drive train and Differential.

Vehicle fundamentals **[08 Hrs]**

Vehicle resistance, Types: Rolling Resistance, grading resistance, Aerodynamic drag vehicle performance, Calculating The Acceleration Force, maximum speed, Finding The Total Tractive Effort, Torque Required On The Drive Wheel, Transmission: Differential, clutch &gear box, Braking performance.

Conversions and motors **[08 Hrs]**

Introduction of DC-DC, AC-AC, AC-DC, DC-AC, four-quadrant operation, Driver circuits. Principle and working of DC motor, Characteristics and Types of DC Motors- Overview (Speed torque characteristics) of Permanent Magnet motor, BLDC Motor, Induction motor. Comparison of all motors

Hybrid Power train **[08 Hrs]**

Series HEVs, Parallel HEVs, Series–Parallel HEVs, Complex HEVs, Operating Modes, Degree of Hybridization, Comparison of HEVs, Plug-in Hybrid Electric Vehicles (PHEVs) Real Life examples of HEVs, compare and contrast the performance of ICE vehicles, HEVs and EVs.

Text Books :

1. Vehicle Powertrain Systems by Behrooz Mashadi and David Crolla, Wiley, 2012
2. Automotive Aerodynamics by Joseph Katz, Wiley, 2016
3. Automotive Chassis Engineering, by David C. Barton and John D. Fieldhouse, Springer, 2018
4. Automotive Engineering Powertrain, Chassis System and Vehicle Body Edited by David A. Crolla, Elsevier,2009
5. Automotive Power Transmission Systems by Yi Zhang and Chris Mi, Wiley, 2018
6. Linear Electric Machines, Drives, and MAGLEVs Handbook, by Ion Boldea, CRC Press. 2013
7. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles by Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, and Ali Emadi, CRC Press 2005
8. Electric Vehicle Technology Explained by James Larminie and John Lowry, John Wiley, 2003
9. Electric and Hybrid Vehicles- Design Fundamentals by Iqbal Husain, CRC Press, 2005

Reference Books:

1.Encyclopaedia of Automotive Engineering edited by David Crolla et al, Wiley, 2014
2. Design and Control of Automotive Propulsion Systems by Zongxuan Sun and Guoming Zhu, CRC Press, 2015
3. The Automotive Transmission Book by Robert Fischer, Ferit Küçükay, Gunter Jürgens, Rolf Najork, and Burkhard Pollak, Springer, 2015
4. Noise and Vibration Control in Automotive Bodies by Jian Pang, Wiley, 2019

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1. Declared test
2. Surprise test
3. MCQ Test
4. Assignments
5. PPT presentation
6. Quiz
7. Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

EE357N: CONTROL SYSTEM LAB

Teaching Scheme : 02 Pr; Total: 02 hours/week **Credits** : 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION:

The laboratory course on feedback control system will help the students to study and plot characteristics of motors, find transfer function of various control system components. Further using any software(like MAT LAB, PSIM, etc) simulation of various controllers can be done.

DESIRABLE AWARENESS/SKILLS:

Knowledge of basic electrical and electronics, dc and ac machines, Laplace Transforms

COURSE OUTCOMES:

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

1. plot characteristics of all error detectors
2. learn torque speed characteristics of dc and ac servo motor
3. apply P, PD, PD, PID Controller to various systems
4. know the stability analysis using root locus, Nyquist Plot and Bode plot using MAT LAB

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION) :

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	1	2			1	1	1	1	3	1
2	1	1			1	1	1	3	1			1	1	1	2
3	1	1	1	1	1			2	1	1	1	1	1	1	2
4	1			1	1	1	1	1	2	1	1			1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

The laboratory work should consist of experiments based on theory syllabus of EE351U. Experiments should involve simulation/performance/design of practical, result and conclusion based on it. The sample list given below is just a guide line.

List of Experiments:

1. Study of potentiometers as error detectors.
2. Study of Synchros as error detector.
3. To study torque - speed characteristics of a dc servo motor
4. To study the torque-speed characteristic of ac servo motor.
5. Study of Control System Components like Actuators, Sensors, displays.
6. To study the time response of a second order system.
7. Stability Analysis of First, Second and higher order systems using MATLAB
8. To plot of root locus using MATLAB.
9. To plot the Bode plot using MATLAB.
10. To plot the Nyquist plot using MATLAB.
11. Study of Tuning of a PID controller using MATLAB/Simulink.
12. Determination of transfer function of dc motor using Simulink.

Guide lines for ICA: Internal Continuous Assessment (ICA) shall support for regular performance of minimum 10 practicals and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practicals performed by student. The performance shall be assessed experiment wise using internal continuous assessment format (S10).

Guide lines for ESE: The End Semester Examination (ESE) for the laboratory course of three hrs duration shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners out of which one examiner shall be out of institute.

EE358N: POWER ELECTRONICS LAB

Teaching Scheme: 02P; Total 02 **Credits**: 01
Examination Scheme: 30 ICA + 20 ESE **Total Marks**: 50
Duration of ESE: 03 Hrs

COURSE DESCRIPTION:

This course consists of experiments and gives practical knowledge of power electronics devices. Various applications of rectifiers and inverters are studied which will help students for mini and micro and major projects.

DESIRABLE AWARENESS / SKILLS

EE352N: Power Electronics

COURSE OUTCOMES:

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

1. compare performance of various Power semiconductor devices.
2. understand triggering methods, commutation methods of thyristor
3. demonstrate the performance characteristics of controlled rectifiers.
4. assess the performance of inverter circuits.
5. investigate the performance of chopper circuits.

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION) :

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1			3	1			1	1	1	1	2	1
2	1			1	1	1	3	1			1			1	1
3			1	1	1			3	1	1	1	2		1	2
4	1	1	1			1	1	2	1	1			1	1	2
5	1	1			1	1			2	1	1	1	1	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Minimum **eight** experiments from the list of experiments provided below shall be performed to cover entire curriculum of course EE352N.

List of Experiments:

List of experiments:

Any three/two from following

1. To study the SCR characteristics.
2. To study SCR turn-on methods.
3. To study of SCR Commutation methods.
4. To study IGBT / MOSFET characteristics, drivers.
5. To study TRIAC: Triggering modes

Any four/ three from following

1. To study single phase /three phase converter
2. To study dual converter
3. To study dc chopper
4. To study single phase / three phase thyristorised inverter
5. To study PWM inverter

Any two/three from following

1. Simulation of single phase /three phase converter
2. Simulation single phase / three phase thyristorised inverter
3. Simulation of PWM inverter
4. Simulation of Ac voltage controller.
5. design of uninterrupted power supply

Evaluation Methodology:

ICA – It shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using the prescribed internal continuous assessment format.

ESE – It shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners, out of which one examiner shall be external examiner.

EE359N: RELAY AND CIRCUIT BREAKER LAB

Teaching Scheme: 01T + 02 Pr; Total 02 **Credits** : 02

Examination Scheme: 30 ICA + 20 ESE **Total Marks** :50

Duration of ESE : 03Hrs

COURSE DESCRIPTION:

The course of switch gear and protection is covering various protection systems for various equipments/appliances. The course explores on understanding of various circuit breakers, their types and operation. It also discusses fault current protection methods for transformer, and bus bars. With advances in protective relaying, numerical relays are also introduced.

DESIRABLE AWARENESS/SKILLS:

Knowledge of basics of physics and chemistry, electrical, dc and ac machines

COURSE OUTCOMES:

On the successful completion of this course, student will be able to:

1. know the safety of electrical equipments
2. differentiate the relays
3. use various circuit breakers for specific applications
4. design the power system with proper protection

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1	1	1	1			1	1	1	1	1	1	1
2				1	1	1	2	1			1			2	1
3	1	1	1			1	1	3	1	1	1	1	1	3	1
4	1			1	1	1	1	1	3			1	1		

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

The laboratory work should consist of experiments based on theory syllabus of EE352U. Experiments should involve simulation, performance/design of practical, result and conclusion based on it. The sample list given below is just a guide line.

List of experiments:

1. Study of circuit breaker with their applications
2. Study of relaying components and control circuit developments.
3. To plot the characteristic of rewirable fuses
4. Study of MCB, ELCB used for household applications,
5. To plot operating characteristics of inverse time over current relay
6. To study over current and earth fault protection scheme for alternator
7. To study protection of 3-phase transformer using differential relay
8. To study protection of transmission line
9. Study of MHO distance relay to plot: R-X diagram B) Relay voltage Vs admittance characteristic
10. Visit to any sub-station

Guide lines for ICA: Internal Continuous Assessment (ICA) shall support for regular performance of minimum 10 practical's and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practicals performed by student. The performance shall be assessed experiment wise using internal continuous assessment format (S10).

Guide lines for ESE: The end semester examination (ESE) for the laboratory course of three hrs duration, shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners out of which one examiner shall be out of institute.

DHC - II

EE360N: COMPUTER AIDED POWER SYSTEM ANALYSIS

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03

Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100

ESE Duration : 3 Hrs.

COURSE DESCRIPTION

The present day power systems are characterized by large highly interconnected network. Simulation and analysis of such a large system is possible only with the help of digital computers. Load flow or power flow study is the most frequently carried out for steady state analysis, which determines system voltage profile and line flows/losses. A fault in the power system network results in excessive current flowing through its various components. This course will cover the modeling issues and analysis methods for the power flow, short circuit, contingency and stability analyses, required to be carried out for the power systems.

DESIRABLE AWARENESS / SKILLS

Knowledge of power system analysis, generation and transmission and distribution

COURSE OUTCOMES:

On the successful completion of this course, student will be able to:

1. describe the role of computer aided power system analysis in power flow, short circuit, contingency and stability analyses.
2. understand the network topology for the representation of power system components and networks.
3. determine bus impedance and admittance matrices by algorithms.
4. perform the short circuit studies for proper selection of protection scheme.
5. evaluate simultaneous faults by matrix transformations.

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3			1	2	1	1	1	2	1	1	2	1		
2	3	1	1	1	2			2	1	1			1	1	1
3		2			2	1	1			1	1	2	1		
4	3	1	1	1	2	1	1	1	2	1	1	2	2	1	1
5	3	1	1	1	2	1	1	1	2			2	1	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Network Topology **[08 Hrs]**

Modeling of power system components, basic concept, single phase, three phase models and matrix. Representation of network topology of electric power system: Network Graphs, incidence matrices, fundamental loop and cutest matrix, primitive impedance and admittance matrix, singular transformation of network matrix.

Incidence Matrix **[08 Hrs]**

Formation of bus impedance and admittance matrices by algorithm, modification of bus impedance and admittance matrix to account for change in network. Derivation of loop impedance matrixes, algorithm for formulation of 3 phase bus impedance matrix.

Short Circuit Studies **[10 Hrs]**

Three phase network, Symmetrical component, Thevenin's theorem and Short circuit analysis of multimode power system using bus impedance matrix. Short circuit calculation for balanced and unbalanced short circuit, bus impedance and loop impedance matrices.

Load Flow Studies **[08 Hrs]**

Slack bus, load buses, voltage control buses, load flow equations, power flow model using bus admittance matrix, power flow solution through Gauss-Seidel and N-R method sensitivity analysis, second order N-R method, fast decoupled load flow method, sparsity of matrix.

Fault Analysis **[06 Hrs]**

Bus Impedance Matrix formation using step-by-step algorithm, Sequence Networks of power system components. Computer method of fault calculations, Single Line-to-Ground Fault, Line-to-Line Fault, Double Line-to-Ground Fault

Text Books:

1. Power System Analysis, J. J. Gringer, W. D. Stevenson, McGraw Hill.1994
2. Modern Power System Analysis, I. J. Nagrath and D. P. Kothari, Tata McGraw Hill, 1980

Reference Book:

1. Computer aided power system analysis, G. L. Kusic, Prentice Hall, 1986
2. Power system analysis ,Hadi Sadat, Tata McGraw Hill
3. Computer method in power system analysis, G.W. Stagg and AL Ebiad, McGraw Hill

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments

5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

DHC - III

EE361N: ELECTRIC MACHINE MODELING AND ANALYSIS

Teaching Scheme	**:** 03 L + 00 T; Total: 03 hours/week	**Credits**	**:** 03
Evaluation Scheme	**:** 10 ISA + 30 MSE + 60 ESE	**Total Marks**	**:** 100
ESE Duration	**:** 3 Hrs.		

COURSE DESCRIPTION

To master the various fundamentals, machine design, machine modeling of various types of electrical machines. This will help you to gain knowledge and to do research in the area of electrical machine modeling.

COURSE OUTCOME

On the successful completion of this course, student will be able to:

1. learn about the basic concepts of AC/ DC machine modeling.
2. study about the dynamic modeling and phase transformation
3. analyze various methodologies in small signal machine modeling.
4. understand the modeling of synchronous machine modeling.
5. learn the performance and dynamic modeling of synchronous machines

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

6.

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1			2		1	1	2	1	1	2	1	1	1
2		1		1		1	1	2	1			2	1	1	1
3		2	1	1	2		1		1		1	2	1	1	
4	3	1	1		2	1	1	1	2	1		2		1	1
5	3	1		1	2	1	1	1	2	1	1	2	1	1	1

7. 1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Basic Concepts of Modeling **[08 Hrs]**

Basic Two pole Machine representation of Commutator machines, 3 phase synchronous machine with and without damper bars and 3 - phase induction machine, Kron's primitive Machine voltage, current and Torque equations. DC Machine modeling: Mathematical model of separately excited D.C motor Steady State analysis Transient State analysis Sudden application of Inertia Load Transfer function of Separately excited D.C Motor Mathematical model of D.C Series motor, Shunt motor Linearization Techniques for small perturbations

Reference Frame Theory **[08 Hrs]**

Reference frame theory Real time model of a two phase induction machine Transformation to obtain constant matrices three phase to two phase transformation Power equivalence. Dynamic modeling of three phase Induction Machine Generalized model in arbitrary reference frame Electromagnetic torque Derivation of commonly used Induction machine models Stator reference frame model Rotor reference frame model Synchronously rotating reference frame model -Equations in flux linkages per unit model

Small Signal Modeling **[08 Hrs]**

Small Signal Modeling of Three Phase Induction Machine Small signal equations of Induction machine derivation DQ flux linkage model derivation control principle of Induction machine. Symmetrical and Unsymmetrical 2 phase Induction Machine Analysis of symmetrical 2 phase induction machine voltage and torque equations for unsymmetrical 2 phase induction machine voltage and torque equations in stationary reference frame variables for unsymmetrical 2 phase induction machine analysis of steady state operation of unsymmetrical 2 phase induction machine single phase induction motor Cross field theory of single phase induction machine.

Modeling of Synchronous Machine **[08 Hrs]**

Synchronous machine inductances voltage equations in the rotor's dq0 reference frame electromagnetic torque current in terms of flux linkages simulation of three phase synchronous machine modeling of PM Synchronous motor.

Dynamic Analysis of Synchronous Machine **[08 Hrs]**

Dynamic performance of synchronous machine, three phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria.

Text Books:

1. Electric Motor Drives - Modeling, Analysisand control by R. Krishnan, Pearson Publications, First edition, 2002.
2. Analysis of Electrical Machinery and Drive systems, . P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff , IEEE Press, Second Edition.

References:

1. P.S.Bimbra, "Generalized Theory of Electrical Machines" Khanna publications, Fifth edition - 1995.

2. Dynamic simulation of Electric machinery using MATLAB / Simulink by, Chee Mun Ong Prentice Hall of India Publications
3. Online courses on Modeling of Electrical Machines -http://nptel.ac.in/courses/108106023/

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1. Declared test
2. Surprise test
3. MCQ Test
4. Assignments
5. PPT presentation
6. Quiz
7. Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

MDM - III

Multidisciplinary Minor (MDM) Courses offered by Department of Electrical Engineering (For Students of departments other than Electrical Engineering)

EEM306N: AC MACHINES

Teaching Scheme: 03L + 01T, **Total:** 04 **Credits :** 04
Evaluation Scheme: 10 ISA +30 MSE + 60 ESE **Total marks:** 100
Duration of ESE: 03 Hrs

COURSE DESCRIPTION:

The course is designed to provide students with the knowledge about the working principles, construction, analysis, and operation of alternating current (AC) machines, including induction motors, synchronous machines, and their applications in real-world electrical systems. Students will gain an understanding of machine performance, starting, speed control, and efficiency. The course will also cover practical aspects, fault analysis, and the use of these machines in various industrial applications.

DESIRABLE AWARENESS/SKILLS:

Basic knowledge of electromagnetic induction, dc machines, etc

COURSE OUTCOMES:

On the successful completion of this course, student will be able to:

1. analyze the performance of Induction motors
2. select suitable fractional watt motors for industrial applications
3. evaluate the working of Synchronous Machines.
4. analyze the performance of synchronous machines under different operating conditions.
5. illustrate the use of special motors

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	2	1	1	1		1	1	1	1	3	1	1
2	1	1	1		3		1		1		1	1	1	2	
3		1		1		1	1	1	1	1		1		2	1
4	1	1	1	1	1	2		1		1	1	1	1	2	
5	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Three Phase Induction Motor **[10 Hrs.]**

Rotating magnetic field, principle of operation, torque equation, torque-slip characteristics, losses and efficiency, phasor diagram and equivalent circuit, no load test, blocked rotor test

Fractional Kilowatt Motors **[10 Hrs.]**

Construction and working principle of Single phase induction motors, double field revolving theory, equivalent circuit, torque-slip characteristics, construction and working of resistance start induction run, series motor

Synchronous Generator **[10 Hrs.]**

Construction, types, winding factors, emf equation, armature reaction, phasor diagrams, load characteristics, voltage regulation by MMF method

Synchronous Motor **[10 Hrs.]**

Principle of operation, phasor diagrams, methods of starting, operation at constant power and fixed excitation, equivalent circuit, power and torque developed in cylindrical rotor and salient pole rotor.

Special Machines **[08 Hrs.]**

Construction and working principle of Stepper motor, brushless DC motors, permanent magnet DC motors, applications

Text Books:

1. Electrical Machines, Nagrath and Kothari, 4th Edtion,Tata McGraw Hill, 2010
2. Electrical Machines by S. K. Bhattacharya, 3rd edition, McGraw Hill, 2009
3. Electrical Machines by A. Chakrabarti and S. Debnath, McGraw Hill, 2015

Reference Books:

1. Performance and Design of A.C. Machines M.G. Say, 6th Edition, ELBS, 2006
2. Theory and performance of Electrical Machines, J. B. Gupta and S. K. Kataria Publications, 2003
3. Electrical Machines by Samarjit Ghosh Pearson Publication, 2001
4. Electrical Machinary and Transformer, Bhag S. Guru and Huseyin R.Hiziroglu,3rd edition,Oxford University Press, 2006
5. Special Electrical Machines, E G Janardanan, Prentice Hall of India, 2011

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1. Declared test
2. Surprise test
3. MCQ Test
4. Assignments
6. PPT presentation
7. Quiz
8. Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

MDM - IV

Multidisciplinary Minor (MDM) Courses offered by Department of Electrical Engineering (For Students of departments other than Electrical Engineering)

EEM354N: POWER SYSTEM – II

Teaching Scheme: 02L + 00T, **Total:** 02 **Credits :** 02
Evaluation Scheme: 10 ISA +30 MSE + 60 ESE **Total marks:** 100
Duration of ESE: 03 Hrs

COURSE DESCRIPTION

This course provides an introduction to generation, transmission and distribution of power system. This course also provides knowledge of different parts and auxiliaries in power plants. This course also provides introduction of different components of transmission system, concept and calculation of transmission line parameters.

DESIRABLE AWARENESS/SKILLS

EE252N: Power Generation, Transmission and Distribution

COURSE OUTCOMES

On the successful completion of this course, the students shall be able to-

1. demonstrate working of various power plants
2. compute various factors and economics of generation plants.
3. compute the conductor size and transmission voltage for the transmission line
4. knowledge about different type of cables
5. understanding the Characteristics of Transmission Line

RELEVANCE OF COURSE OUTCOMES(CO_s) WITH PO_s AND PSO_s (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1	2	1		3	1	1	1	2	1	1	1	1	1
2	3	2	2	2	2	1		1		1	1	1	1	2	
3		1		3	2	1	1	3		3	1			2	1
4	3	1	1	2		2	1		1	1	1	1	1	1	3
5	1	1	2	3	1	3	1		1			1	1		1

1-Weaklycorrelated 2–Moderatelycorrelated 3–Stronglycorrelated

Course content

(Numerical not expected)

Characteristics of Transmission Line **[08 Hrs]**

Classification of transmission line, characteristics and performance of short transmission line, efficiency and voltage regulation of short transmission line, surge impedance**,** Surge Impedance Loading, need of line compensators.

Representation of Power System Components **[08 Hrs]**

Representation of impedance and reactance diagram of transmission lines, synchronous machines, power transformers, motors, single line diagram and per unit system

Symmetrical Faults Analysis **[08Hrs]**

Symmetrical fault occurring on synchronous generator and power system, Fundamentals of symmetrical and unsymmetrical components.

Bus Bar arrangement **[06 Hrs]**

Single bus-bar system, single busbar system with sectionalisation, duplicate busbar system, key diagram of 66/11 kv substation, key diagram of 11 kv/400v substation, neutral grounding

Arrestors and Insulators **[05 Hrs]**

Lightning phenomenon, lightning arrestors and types, need of insulators and it's working, principle, types of insulators

Text Books:

1. Elements of Power System Analysis by William Stevenson, TMH, 6th edition, 2006
2. Modern Power System Analysis byJ. Nagrath and D.P. Kothari, TMH,3rd edition, reprint 2010
3. Power System Analysis by HadiSaadat, McGraw Hill,2003

Reference Books:

1. A course in Electrical Power by J. B.Gupta, S.K. Kataria andSons,1stedition, 2009
2. Electrical power by Soni, Gupta, Bhatnagar, Dhanpat Rai,4th, 1997

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

EV301N: AUTOMOBILE ENGINEERING FOR ELECTRIC VEHICLES

Teaching Scheme: 03L+01T, Total: 04 **Credits:** 04

Evaluation Scheme: 30 MSE+10ISA+60 ESE **Total marks:** 100

Duration of ESE: 03 Hrs

COURSE DESCRIPTION:

This course offers a foundational understanding of vehicle dynamics and systems, covering both conventional and electric vehicles. Topics include vehicle motion, traction, power train configurations, electric drive trains, chassis and steering systems, braking, and suspension. Students will learn to analyze performance, stability, and control systems, preparing them for roles in modern automotive engineering.

DESIRABLE AWARENESS/ SKILLS:

Knowledge of basic electrical engineering and basics of dc machines.

COURSE OUTCOMES:

On the successful completion of this course, student will be able to:

1. understand vehicle dynamics and performance.
2. gain knowledge of conventional vehicle systems and power trains.
3. comprehend electric vehicle systems and power train configurations.
4. analyze chassis and steering systems.
5. understand brake and Suspension Systems.

COURSE OUTCOMES (COS) AND PROGRAM OUTCOMES (POS) MAPPING WITH STRENGTH OF CO RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1		2	1	1	1		1	1	1	1	3	1	1
2		1	1		3	1		1	1		1	1		2	1
3	1		1	1		1	2	1	2	1	1		1		1
4	1	1		1	1	2		1	1	1		1	1	2	
5	1	1	1		1	2	1	1		1	1	1	1	1	1

1-Weakly correlated 2 –Moderately correlated 3–Strongly correlated

Course Content

Vehicle Fundamentals **[10 Hrs]**

Vehicle movement, Rolling Resistance, Aerodynamic Drag, Grading Resistance, Maximum tractive effort, Vehicle performance, Maximum speed, Grade ability, slip ratio, Calculation of normal tire forces, calculation of effective tyre radius, static forces, longitudinal forces cornering forces, Interaction between longitudinal and side forces.

Conventional Vehicle Systems and Configurations **[10Hrs]**

Engine Components, Operation of Four Stroke Engines, Engine Performance, Supercharging, Combustion in Spark Ignition Engines, Engine Emissions, Automotive Power train, Clutch, Transmission, Torque converter, Power train analysis, Rear-Wheel Drive Power trains, Front-Wheel Drive (FWD) Power trains, Multi-Wheel Drive Power trains.

Electrical Vehicle System and Configurations **[10Hrs]**

Power train configurations and components, Traction motor characteristics, Tractive effort, Drive cycles, Rear-Wheel Drive Power trains, Front-Wheel Drive (FWD) Power trains, Vehicle control unit, Vehicle Modeling Methodology, Range modeling of battery electric vehicle, Auxiliary system in electric vehicle, Power train Component Sizing, Auxiliary control functions (Anti-roll, start stop etc.)

Chassis and Steering System **[10Hrs]**

Vehicle and body Centre of gravity, Mass moments of inertia, Stiffness and strength, vibrational behavior, External loads, Chassis structure and components, Multi body models for vehicles, Ride comfort and NVH. Introduction to Steering System, Manual Steering System, Steering column, Power Steering System.

Braking and Suspension System **[10Hrs]**

Introduction to Brake System, Components of Brake System, Hydraulic Brake, Air Brake, Antilock Brake System (ABS), Regenerative braking, Braking Analysis. Introduction to Suspension System, Components of Suspension System, Dependent and Independent Suspension. Steering control, braking control and electronic brake distributor, Vehicle stability control, Brake assist system, Antis pin regulator, Suspension control, trim control, damping control, roll control.

Text Books:

1. Jazar, Reza N. Vehicle dynamics: theory and application. Springer 2017
2. Rajesh Rajamani, Vehicle Dynamics and Control, Springer 2012
3. Husain, Iqbal. Electric and hybrid vehicles: design fundamentals. CRC press 2010

Reference Books:

1. Ehsani, Mehrdad, et al. Modern electric, hybrid electric, and fuel cell vehicles. CRC press 2018
2. Genta, G., and L. Morello. "The Automotive Chassis, Volume 1: Components Design, Springer Nature, 2009

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1. Declared test
2. Surprise test
3. MCQ Test
4. Assignments
9. PPT presentation
10. Quiz
11. Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

EV302N: ELECTRICAL MACHINES AND MODELING

Teaching Scheme	**:** 02 L + 00 T; Total: 02 hours/week	**Credits**	**:** 02
Evaluation Scheme	**:** 10 ISA + 30 MSE + 60 ESE	**Total Marks**	**:** 100
ESE Duration	**:** 3 Hrs.		

COURSE DESCRIPTION

To master the various fundamentals, machine design, machine modeling of various types of electrical machines. This will help you to gain knowledge and to do research in the area of electrical machine modeling.

COURSE OUTCOME

On the successful completion of this course, student will be able to:

1. learn about the basic concepts of three phase induction motor.
2. learn about the basic concepts of special machines.
3. study about the dynamic modeling and phase transformation.
4. learn about reference frame theory.
5. analyze various methodologies in small signal machine modeling.

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITH STRENGTH OF CO-RELATION)

8.

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1		1	2	1		1	2	1	1	2	1	1	1
2	3		1	1		1	1	2	1	1		2		1	1
3		2	1		2		1	1		1	1		1	1	
4	3	1		1	2	1		1	2		1	2	2	1	1
5	3	1	1	1	2	1	1		2	1	1	2		1	1

9. 1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Three Phase Induction Motor **[4 Hrs.]**

Rotating magnetic field, principle of operation, torque equation, torque-slip characteristics, losses and efficiency, phasor diagram and equivalent circuit.

Special Machines **[04 Hrs.]**

Construction and working principle of brushless DC motors, permanent magnet DC motors, SRM motors and their applications

Basic Concepts of Modeling **[06 Hrs]**

Basic Two pole Machine representation of Commutator machines, 3 phase synchronous machine with and without damper bars and 3 - phase induction machine, Kron's primitive Machine voltage, current and Torque equations.

Reference Frame Theory **[06 Hrs]**

Reference frame theory Real time model of a two phase induction machine Transformation to obtain constant matrices three phase to two phase transformation Power equivalence. Dynamic modeling of three phase Induction Machine Generalized model in arbitrary reference frame Electromagnetic torque Derivation of commonly used Induction machine models Stator reference frame model Rotor reference frame model Synchronously rotating reference frame model -Equations in flux linkages per unit model

Small Signal Modeling **[06 Hrs]**

Small Signal Modeling of Three Phase Induction Machine Small signal equations of Induction machine derivation DQ flux linkage model derivation control principle of Induction machine. Symmetrical and Unsymmetrical 2 phase Induction Machine Analysis of symmetrical 2 phase induction machine voltage and torque equations for unsymmetrical 2 phase induction machine voltage and torque equations in stationary reference frame variables for unsymmetrical 2 phase induction machine analysis of steady state operation of unsymmetrical 2 phase induction machine single phase induction motor Cross field theory of single phase induction machine.

Text Books:

1. Electric Motor Drives - Modeling, Analysisand control by R. Krishnan, Pearson Publications, First edition, 2002.
2. Analysis of Electrical Machinery and Drive systems, . P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff , IEEE Press, Second Edition.

References:

1. Generalized Theory of Electrical Machines by P.S.Bimbra, Khanna publications, Fifth edition.

2. Dynamic simulation of Electric machinery using MATLAB / Simulink by Chee Mun Ong Prentice Hall of India Publications
3. Online courses on Modeling of Electrical Machines -http://nptel.ac.in/courses/108106023/

ASSESMENT:

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