Course Syllabi: UEE401 Alternating Current Machines (L : T : P :: 3 : 1 : 2)

1. **Course number and name:** UEE401; Alternating Current Machines

2. **Credits and contact hours:** Credits: 4.5; Hours: 6

3. **Text book, title, author, and year**

   - *Bimbhra, P.S., Electrical Machinery, Khanna Publishers (2008) 2nd ed.*
   - *Mukherjee, P.K. and Chakravorty, S., Electrical Machines, DhanpatRai and Co. (P) Ltd. (2004) 2nd ed.*
   - *Nagrath, I.J. and Kothari, D.P., Electric Machines, Tata McGraw Hill (2004) 3rd ed.*
   - *Bimbhra, P.S., Generalized Theory of Electrical Machines, Khanna Publishers (2007) 5th ed.*
   - *Toro, Vincert, Electromechanical Devices for Energy Conversion, Prentice Hall of India (2004) 2nd ed.*
   - *Fitzgerald, A.E., Kingsley, C. Jr., and Umans, Stephen, Electric Machinery, McGraw–Hill (2002) 6thed.*

   a. Other supplemental materials
      - Nil

4. **Specific course information**

   a. Brief description of the content of the course (catalog description)

   Synchronous Generators/Alternators: Introduction, Difference between DC generator and alternator, Advantages of rotating field over rotating armature, Construction, Stator, Rotor, Excitation system, Methods of ventilation, Working Principle, Armature winding, Types of armature winding: Single layer winding, Double layer winding, Full pitch and short pitch winding, Concentrated and distributed winding; EMF equation of an alternator: Pitch factor, Distribution factor, Winding factor, Generalized expression for emf in a full pitch and short pitch coil. Harmonics in generated emf parameters of armature winding, Armature resistance, Armature reaction: Unity power factor, Zero lagging power factor, Zero leading power factor, Armature reaction reactance, Equivalent circuit of an alternator, Voltage equation of an alternator, Phasor diagram of a loaded alternator for various types of loads, Voltage regulation of an alternator, Determination of voltage regulation, Load characteristic of alternators, Output power equation of an alternator, Input power equation of an alternator, Two reaction theory of salient pole alternator, Torque–angle characteristic of a salient–pole alternator, Maximum reactive power for a salient–pole alternator, Losses and efficiency, Determination of X_d and X_q, Capability curves, Prime mover characteristic, Infinite bus, Need for parallel operation of alternators, Synchronising procedures of alternator, Synchronising power and synchronising Torque co–efficient, Hunting, Oscillations of synchronous machines.

   Synchronous Motors: Introduction, Voltage equation of a synchronous motor, Phasor diagram of a loaded a synchronous motor for various types of loads; Operation at constant load with variable excitation, V–curves and Inverted V–curves, Complex power input and output of synchronous motor, Maximum output power, Characteristics and performance of synchronous motor, Torque of a synchronous motor, Salient pole synchronous motor, Two–reaction model, Power developed by salient pole Synchronous motor, Damper Windings, Methods of starting of synchronous motors, Applications of synchronous motors, Synchronous condensers.

Three–Phase Induction Motors: Introduction, Construction and working principle of a three–phase induction motor, Slip of an induction motor, Effect of slip on rotor parameters: Effect on rotor frequency, Effect on magnitude of rotor induced emf, Effect rotor resistance and reactance, Effect on rotor power factor, Effect on rotor current. Torque–slip characteristics, Torque ratios, Full load and maximum torque ratios, Starting torque and maximum torque ratio, Speed torque characteristics, Power flow diagram, Efficiency, Synchronous watt, Measurement of slip, Equivalent circuit, Starting of induction motors, No–load test or open circuit test, Blocked rotor test or short circuit test, Circle diagram, Speed control of induction motor, Crawling, Cogging, Deep cage rotors, Double cage rotors, Applications of induction motors.

Single Phase Motors and Special Machines: Classification, Production of rotating field, Working principle, Double revolving field theory, Rotor slip with respect to two rotating fields, Equivalent circuit of single–phase single winding induction motor, Determination of equivalent circuit parameters, Split phase induction motor, Capacitor motor, Permanent split capacitor motor; Shaded pole motor, Single–phase synchronous motor, Universal motor, Stepper motor.

Laboratory Work: Voltage regulation, Direct and quadrature axis reactances, Power angle characteristics, Operating characteristics, Synchronizing, Parallel operation and load division, Sudden short circuit analysis and determination of sub transient, Transient and steady state reactances and various time constants, Determination of positive, negative and zero sequence reactances, Synchronous motor starting, Efficiency. Three phase induction motors: starting methods, Equivalent circuit parameters, Load test, Polarity test, Single phasing, Efficiency, Schrage motor, Single-phase induction motors: Equivalent circuit parameters, Load test, and efficiency.

5. **Specific goals for the course**

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

- Simulate the steady-state and transient state performance of induction and synchronous machines to identify performance measures
- Validate and identify the machine parameters.
- Select the appropriate AC motor for different large power application.
- Analyse the stability of single machine – infinite bus system and form the grid to supply large load.
- Choose the appropriate fractional horse power motor as per the usage in daily life.

6. **Brief list of topics to be covered**

- Synchronous Generators/Alternators
- Synchronous Motors
- Three–Phase Induction Motors
- Single Phase Motors and Special Machines