PDHonline Course E172 (3 PDH)

Basic Electrical Theory - Overview of AC Motors, Transformers and Measuring Instruments

Instructor: A. Bhatia, B.E.

2012

PDH Online | PDH Center

5272 Meadow Estates Drive
Fairfax, VA 22030-6658
Phone & Fax: 703-988-0088
www.PDHonline.org
www.PDHcenter.com

An Approved Continuing Education Provider

Basic Electrical Theory – Overview of AC Motors, Transformers and Measuring Instruments

Course Summary

Remember these facts

1) A magnetic field is produced in an AC motor through the action of the three phase voltage that is applied.
2) Torque in an AC motor is developed through interactions with the rotor and the rotating magnetic field.
3) Slip is the percentage difference between the speed of the rotor and the speed of the rotating magnetic field.
4) In an AC induction motor, as slip increases from zero to ~10%, the torque increases linearly. As the load and slip are increased beyond full-load torque, the torque will reach a maximum value at about 25% slip. If load is increased beyond this point, the motor will stall and come to a rapid stop.
5) The typical induction motor breakdown torque varies from 200 to 300% of full-load torque. Starting torque is the value of torque at 100% slip and is normally 150 to 200% of full-load torque.
6) In a split-phase motor, a starting winding is utilized. This winding has a higher resistance and lower reactance than the main winding.
7) A synchronous motor is not a self-starting motor because torque is only developed when running at synchronous speed.
8) A synchronous motor may be started by a DC motor on a common shaft or by a squirrel-cage winding imbedded in the face of the rotor poles.
9) Keeping the same load, when the field excitation is increased on a synchronous motor, the motor operates at a leading power factor. If we reduce field excitation, the motor will operate at a lagging power factor.
10) Synchronous motors are used to accommodate large loads and to improve the power factor of transformers in large industrial complexes.
11) The induction of an EMF in a coil by magnetic flux lines generated in another coil is called mutual induction.
12) The turns ratio is defined as the ratio of turns of wire in the primary winding to the number of turns of wire in the secondary winding.
13) Efficiency of a transformer is the ratio of the power output to the power input.
14) In a delta connection, all three phases are connected in series to form a closed loop.
15) In a WYE connection, three common ends of each phase are connected together at a common terminal, and the other three ends are connected to a three-phase line.
16) In a Delta connected transformer:
    - $V_L = V\phi$
    - $I_L = \sqrt{3}\ I\phi$

17) In a Y connected transformer:
- $I_L = \sqrt{3}\ V\phi$
- $I_L = I\phi$

18) A motor will draw as much power and consume as much energy as it requires moving the load.
- Motor Energy = $\frac{\text{(Motor Load) x (Operating Time)}}{\text{(Motor Efficiency)}}$
- Where motor load (hp) = √3 x V x I x pf x Eff / 0.746

19) The speed of the motor's magnetic field (referred to as the synchronous speed), in revolutions per minute (RPM) is calculated using the following equation:

$$N = \frac{120f}{P}$$

- N = rotational speed of stator magnetic field in RPM (synchronous speed)
- f = frequency of the stator current flow in Hz
- P = number of motor magnetic poles

20) Distribution transformers are generally used in power distribution and transmission systems.

21) Power transformers are used in electronic circuits and come in many different types and applications.

22) Control transformers are generally used in circuits that require constant voltage or constant current with a low power or volt-amp rating.

23) Auto transformers are generally used in low power applications where a variable voltage is required.

24) Isolation transformers are normally low power transformers used to isolate noise from or to ground electronic circuits.

25) Voltmeter Measures voltage and connected in parallel with the load being measured

26) Ammeter measure circuit current flow and connected in series with the circuit

27) Ohm Meter measures circuit resistance and connected to a component removed from the circuit

28) Wattmeter measures real power delivered to the load; Single-phase AC or DC - voltage component (movable coil) connected in parallel with the load and the current component (fixed coil) connected in series with the load. Three-phase AC - summation of Phase A and B powers

29) Ampere-hour Meter measures current flow (either direction) through a given point and connected in series

30) Power Factor Meter measures power factor between phases in a 3-phase circuit and connected in series with one phase

31) Ground Detector measures conductor insulation and connected out of circuit to ground

32) Synchroscope measures relationship between generator frequencies and connected by a two-phase stator at right angles

33) Meggers measure insulation resistance and are connected out of circuit.

34) Neutral grounding - helps prevent accidents to personnel and damage to property by fire

35) Voltage class - high voltage > 15,000 volts, intermediate voltage is 600-15,000 volts, low voltage < 600 volts

36) Protective relays - cause prompt removal of any part of a power system that suffers a short circuit

37) Breakers - disconnect component from the power system

38) Fuse - protects component from over current

39) Motor controller - controls and protects the operation of a motor controller's protective features - fuses, thermal overloads, and magnetic overloads

40) Two methods to connect single-phase loads to a three-phase system are: 1) Phase-to-phase and 2) Phase-to-ground

41) 3-wire, single-phase Edison system - the only approved method of wiring single phase power

42) 3-wire, three-phase Delta system - normally used for transmission of power in the intermediate voltage class from approximately 15,000 volts to 600 volts

43) 4-wire, three-phase Delta system - combines the ungrounded Delta for three phase loads with the convenience of the Edison system for single-phase loads

44) 4-wire, three-phase Wye system - the safest possible multi-purpose distribution system for low voltage