2021

Basic Electrical Engineering (ES/EE/T101B)

(Question Bank: Theory Questions)

Chapter 1: DC Network Theorems

1. Define
   a) Linear circuit
   b) Non-linear circuit
   c) Bilateral circuit
   d) Unilateral circuit
   e) Network.
2. State and explain Kirchhoff's laws applied to electric circuit.
3. State and explain superposition theorem.
4. State and explain Thevenin's Theorem.
5. State and explain Norton's Theorem.
6. Establish the equivalence between Thevenin's and Norton's Theorems.
7. State & prove Maximum Power transfer Theorem for D.C networks.

Chapter 2: AC Fundamentals

1. Derive the Expressions of
   a) Average value
   b) R.M.S. value of a half-wave rectified sine wave.
2. Derive a mathematical expression for R.M.S. value average value and form factor of a sinusoidal voltage $v = V_m \sin \omega t$
3. Explain what are meant by phase and phase difference of sinusoidal waves.
4. Draw the circuit diagram, waveform of voltage and current, phasor diagram of (i) purely resistive circuit. (ii) purely inductive circuit. (iii) purely capacitive circuit, supplied by sinusoidal voltage.
5. Prove that current in purely resistive circuit is in phase with applied AC voltage and current in purely capacitive circuit leads applied voltage by 90^0 and draw their waveforms.
6. Explain why power loss in a pure inductance / pure capacitance is equal to zero in an A.C. circuit.
7. Derive a mathematical expression for the average real power delivered by a single phase ac source with an emf of $e = \sqrt{2}E\sin\omega t$ when the source current is $i=\sqrt{2}I\sin(\omega t-\theta)$.
8. Define power factor of an AC circuit.
9. Write short notes on i) active & reactive power ii) power factor ii) apparent power.
10. What is resonance? Deduce the expression of frequency in a series RLC circuit at resonance.
11. What is meant by the term "resonance" in a series RLC circuit?
12. How do you define Q factor of such circuit?
13. Derive an expression for the resonant frequency of a parallel circuit, one consisting of a coil of inductance L and a resistance R and the other branch of capacitance C.

Chapter 3: Electromagnetism

1) Define the following terms related to electromagnetism
   a. Magnetic flux
   b. MMF
   c. Relative permeability
   d. Reluctance
2) Find an expression for the force between two parallel current carrying conductors. Comment on the direction of this force.
3) Compare between electric and magnetic circuits.

4) State and explain Faraday's law of electromagnetism.
5) State the laws of electromagnetic induction. Derive an expression for dynamically induced emf.
6) Explain self and mutual inductance. Derive expressions for them and write their units.
7) What do you mean by co-efficient of coupling? Derive an expression of co-efficient of coupling involving self inductance L1 and L2 and Mutual Inductance M.
8) Derive an expression for energy stored in a magnetic field.
9) Draw and explain the magnetization characteristics of a magnetic material when excited by an AC supply.
10) What do you mean by hysteresis and eddy current losses in a magnetic material? On what factors do they depend?

Chapter 4: Transformers

1. Show that for a single phase transformer, $E_p = 4.44 f \phi_m N_p$ where the symbols have their usual meanings.
2. Derive expressions for the emf induced in the transformer windings.
3. Explain with reasons as to why transformer core is made up of silicon-steel laminations.
4. Explain what will happen to a transformer if we give DC supply to it.
5. What are the different types of losses in a transformer?

Chapter 5: 3-Phase AC Circuits

1. What is a three-phase balanced A.C. system? Show that in a three-phase balanced a.c. circuit the sum of the current in the neutral is zero.
2. Show that power in a three-phase balanced system can be measured by two wattmeters.
3. Explain the method of measurement of balanced three phases power by two wattmeter method under different power factor conditions.
4. Derive the relationship between the line current and phase current, line voltage and phase voltage for a balanced three-phase delta connected lagging power factor load connected across the three-phase supply.
5. Prove that for a balanced star connected supply system connected to a balanced star connected load, the current through the neutral wire is zero.
6. Explain the power factor of a balanced three phase load can be determined with the help of two wattmeters.
7. Explain the method of measurement of balanced three phase power by two wattmeter method. Draw the neat circuit diagram.
8. How will you measure the power consumed by a balanced star connected three phase circuit with two wattmeters? Draw the circuit and necessary relation.
9. Derive the relation between phase and line voltages and currents for (i) star connected load (ii) delta connected load across a three-phase balanced system.
10. Show that sum of three emf's is zero in a three-phase balanced ac circuit.
11. What are the advantages of a poly-phase system over the single-phase system?
12. How a three-phase supply can be generated?

Chapter 7: Electric Machines

1. Why are field coils provided in a DC machine?
2. Why is the armature core of a DC generator laminated?
3. Derive EMF equation of DC machine
4. Derive the expression for torque developed in a DC motor
5. Why brush is made up of Graphite in DC machines?
6. Classify compound generator according to their mode of operation.

7. Explain with a neat sketch the principle of operation of a DC generator.
8. What is back EMF in a DC generator?
9. Give the principle of operation (or working principle) of 3-phase induction motor
10. Define 'slip' of a three-phase induction motor. Explain the importance of slip in 3-phase induction motor. Can the motor run at synchronous speed?
11. How frequency of the rotor is related to the slip in an induction motor?
12. Write down the equation for speed of an induction motor in terms of its slip, supply frequency etc.
13. Explain why the rotor of an induction motor rotates in the same direction as the stator magnetic field. Why the speed of the motor is less than the synchronous speed.
14. A 3-phase induction motor is supplied with 3-phase balanced supply .Explain how rotating magnetic field is produced in the motor.
15. What is the difference between cage rotor and wound rotor induction motor?
16. Explain the principle of operation of a 3-phase induction motor.

Ch 8: Electrostatics

17. State and explain Coulomb's law in Electrostatics and hence define "Coulomb", the unit for electric charge.
18. What is permittivity? What do you mean by relative permittivity of a medium? Why it does not have any unit?
19. What is meant by electric field intensity? Discuss the various factors on which it depends.
20. Find the expression of electric field intensity and electric potential of an isolated point charge in vector form.
21. Find a relationship between electric field strength and electric potential
22. State Gauss' Law and derive it from Coulomb's law.
23. Define electric capacitance and derive an expression for the capacitance of a parallel plate capacitor.
24. Find the capacitance of an isolated sphere.
25. Derive the expression to find capacitance of concentric spheres.
26. Deduce an equation capacitance of the parallel plate capacitor with (i) uniform dielectric medium, (ii) compound dielectric medium.
27. Derive an expression for capacitance of a cylindrical capacitor, assuming outer surface to be grounded
28. Derive an expression for the capacitance of a cylindrical capacitor consisting of the infinitely long axial cylinders of radii R_1 and R_2 ($R_2 > R_1$).
29. Explain the following terms: Electric field intensity, Potential difference.
30. Find an expression for potential at a point within an electric field. What is equipotential surface?
31. Derive expression for the equivalent capacitance for a number of capacitors connected in (i) series, (ii) parallel.
32. Derive an expression for the energy stored in a charged capacitor.
33. State and prove Gauss law
34. Define the following terms:
    i) Electric flux
    ii) Electric flux density
    iii) Electric potential
    iv) Electric potential difference
    v) Dielectric strength
    vi) Dielectric constant