BASIC ELECTRICAL ENGINEERING
(ELEC 1001)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Hysteresis loss in a transformer can be reduced by using
(a) laminated core (b) silicon steel
(c) oil (d) solid steel.

(ii) In a series R-L-C circuit, current will lead the voltage if
(a) $X_L > X_C$ (b) $X_L < X_C$ (c) $X_L = X_C$ (d) $X_L = 0\Omega$.

(iii) For Lap wound dc machine number of parallel path is equal to
(a) P (b) 2 (c) 4 (d) 2P.

(iv) For additive flux of two coils connected in series the equivalent inductance can be expressed as
(a) $L_1 + L_2 - M$ (b) $L_1 + L_2 + 2M$
(c) $L_1 + L_2 + M$ (d) $L_1 + L_2 - 2M$.

(v) The reluctance of a magnetic circuit is given by
(a) $\frac{l}{\mu_r \mu_0 A}$ (b) $\frac{\emptyset}{NI}$ (c) $\frac{l}{\mu_0 A}$ (d) $\frac{l}{\mu_r A}$.

(vi) If the readings of the two wattmeter's are equal while measuring power in a balanced 3 phase circuit, then the power factor of the load will be
(a) 0.8 leading (b) 0 (c) 0.8 lagging (d) unity.

(vii) The efficiency of a transformer is maximum when
(a) copper loss is zero
(b) iron loss is zero
(c) copper loss is 50% of the iron loss
(d) copper loss is equal to iron loss.

(viii) AC voltmeter is normally calibrated in
(a) average value (b) instantaneous value
(c) peak value (d) RMS value.

(ix) If the peak value of a sine wave is 50 volts, then its rms value will be
(a) 35.35 V (b) 28.86 V (c) 50 V (d) 70.7 V.

(x) For maximum power transfer, the Thevenin's equivalent resistance of the network must be equal to
(a) half of the load resistance (b) the load resistance
(c) infinity (d) zero.

Group – B

2. (a) Determine the current passing through $R_L = 2\Omega$ resistor of the network of Figure 1, using Thevenin's theorem.

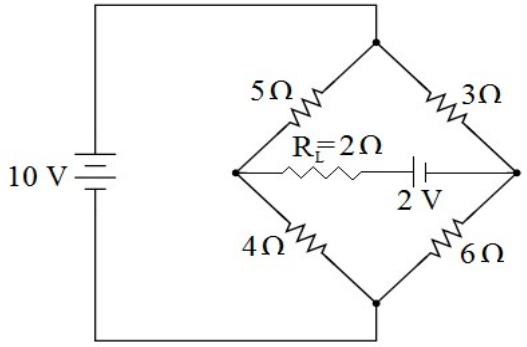

Figure 1

(b) State and prove Maximum Power Transfer theorem for a DC network.
6 + (2 + 4) = 12

3. (a) A long shunt compound wound D.C generator delivers load current of 100 A at 400 V. The armature, series and shunt field resistances are 0.04 Ω, 0.02 Ω and 200 Ω respectively. Find the armature current and the generated emf.

(b) Why are starters needed for DC motors?

(c) The armature resistance of a 220 V D.C series motor is 0.1 Ω and series field resistance is 0.1 Ω. When it is running at 500 rpm, it draws 80 A. Calculate the speed of the motor when it draws 40 A. Assume that the field is unsaturated.
4 + 3 + 5 = 12

Group – C

4. (a) State and prove Gauss's Law.

   (b) A parallel plate capacitor of plate area 0.1 m^2 has plate separation of 0.015 cm. The dielectric medium between the plates has relative permittivity 3. The capacitor retains a charge of 1.0 μC when placed across a dc voltage source. Find out the
   (i) flux density,
   (ii) electric field strength and
   (iii) voltage across the plates.
   (Assume the permittivity of free space as $\varepsilon_0 = 8.854 \times 10^{-12}$ F/m.)

(2 + 4) + (2 + 2 + 2) = 12

5. (a) State and prove Ampere's circuital law.

   (b) A solenoid of 400 turns is wound on a continuous ring of iron, the mean diameter of the ring being 10 cm. The relative permeability is 1250. What current is required in order that the flux density in iron shall be 1.2 Wb/m^2.

   (c) An air core coil has 500 turns. The mean length of magnetic flux path is 50 cm and the area of cross-section is 5×10^{-4} m^2. If the exciting current is 5 A, determine (i) the magnetic field intensity (ii) the flux density and (iii) the flux.

2 + 4 + (2 + 2 + 2) = 12

Group – D

6. An ac series circuit consisting of a pure resistance of 25 Ω, inductance of 0.15 H and capacitance of 80 μF is supplied from a 230 V, 50 Hz ac supply. Draw the phasor diagram.
   Find out
   (i) the impedance of the circuit
   (ii) the current
   (iii) the power drawn by the circuit and
   (iv) the power factor
   (v) resonant frequency and current at resonance condition for the same circuit.

3 + (2 + 1 + 1 + 1 + 4) = 12

7. (a) Explain how the power factor of a balanced three phase load can be determined with the help of two wattmeter method.

   (b) Three equal impedances of (8 + j12) Ω are connected in star across 415 V, 3 phase, 50 Hz supply. Calculate (i) line current (ii) power factor (iii) active and reactive power drawn by the total load.

5 + (2 + 1 + 2 + 2) = 12

Group – E

8. (a) Find the condition for maximum efficiency of transformer.

   (b) A 220/440 V 50 Hz transformer gave the following test results.
   No load test: 220 V, 0.7 A, 66 W
   Short circuit test: 9 V, 6 A, 21.6 W
   Calculate the full load efficiency at 0.8 lagging power factor.

   (c) Draw the phasor diagram of a single phase transformer at lagging power factor.

3 + 5 + 4 = 12

9. (a) Draw and explain the torque vs speed characteristic of 3-phase induction motor.

   (b) A 4-pole, 3-phase, 250 kW, 440 V, 50 Hz induction motor has a speed of 1450 rpm on full load. Calculate (i) the speed of the rotating magnetic field (ii) the slip at full load and (iii) the frequency of the rotor induced emf.

6 + (2 + 2 + 2) = 12