7.(a) Derive the torque equation for a dc motor.

(b) Draw and explain the torque vs. armature current and speed vs. torque characteristics of a dc series motor.

(c) A 20 kW, 200 V shunt generator has an armature resistance of 0.05 Ω, and a shunt field resistance of 200 Ω. Calculate the armature power developed, when it delivers rated output.

3 + 4 +5 = 12

Group – E

8. (a) Discus the various losses in a transformer. Derive the condition for maximum efficiency of a transformer.

(b) The following results were obtained on a 50 kVA, 2400/120V transformer:
Open Circuit Test: 120 V, 9.65 A, 396 W (from L.V. side)
Short Circuit Test: 92 V, 20.8 A, 810 W (from H.V. side)
Determine: a) the circuit constants, b) the efficiency at full load, 0.8 power factor lagging and c) the efficiency at half load, 0.8 power factor lagging.

(1 + 3) + 8 = 12

9. (a) Explain with the help of phasor diagram, how rotating magnetic field is produced in the air gap of a three phase induction motor.

(b) What do you mean by slip for a 3 phase induction motor? A 3 phase, 6 pole, 50 Hz induction motor has a slip of 1% at no load and 3% at full load. Calculate (i) synchronous speed (ii) no load speed (iii) full load speed (iv) frequency of rotor induced emf at full load and (v) frequency of rotor current at stand still.

6+ 1 + 5 = 12

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) Three resistors of 4 ohm, 6 ohm and 8 ohm are connected in parallel. In which resistor, power dissipation will be minimum?
(a) 4 ohm (b) 6 ohm (c) 8 ohm (d) equal in all resistors.

(ii) The efficiency in case of maximum power transfer is
(a) 100 % (b) 50 % (c) less than 50 % (d) 75%.

(iii) The reciprocal of reluctance is
(a) permeance (b) conductance
(c) susceptance (d) admittance.

(iv) Lamination in core is used to minimize
(a) Copper loss (b) Hysteresis loss
(c) Eddy current loss (d) All of the above.

(v) A circuit consists of a coil of 70Ω resistance and 2H inductance in series with a capacitor of 0.5μF capacitance. The resonant frequency is
(a) 147Hz (b)159Hz (c)171Hz (d)135Hz.

(vi) For an ac circuit, the voltage and current is given by $v = 200\sin(314t)$, $i = 8\sin(314t - \pi/6)$. Impedance and power factor of the circuit are
(a) 8Ω and 0.5 (b) 24Ω and 0.5
(c) 25Ω and 0.866 (d) 4Ω and 0.866.

(vii) In a balanced three phase delta connected system the relation between the rms value of line and phase currents is given by
(a) $I_L = I_{ph}$ (b) $I_{ph} = \sqrt{3}\, I_L$
(c) $I_L = \sqrt{2}\, I_{ph}$ (d) $I_L = \sqrt{3}\, I_{ph}$.

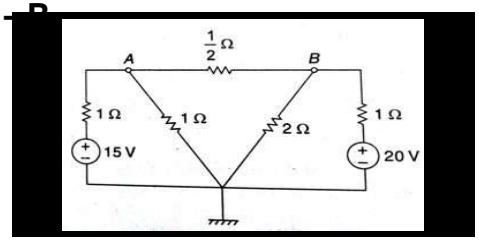
(viii) If a dc series motor is started at no load the speed will be
(a) rated speed (b) too high
(c) too low (d) fluctuating.

(ix) To perform short circuit test on a single phase transformer the instruments are connected in
(a) low voltage side only
(b) either low voltage or high voltage side
(c) high voltage side only
(d) both low voltage and high voltage side.

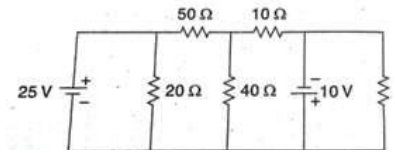
(x) The full load slip of a 60 Hz , 12 pole squirrel cage induction motor is 3%, its full load speed is
(a) 600 rpm (b) 470 rpm (c) 500 rpm (d)485 rpm.

Group – B

2.(a) Using nodal analysis find the unknown potential at node A and at node B. Also find the currents through 1/2Ω and 2Ω resistors.



(b) Find the current through 40Ω resistor using Superposition theorem.



6 + 6 = 12

3. (a) Deduce an expression for the force between two parallel current carrying conductors.

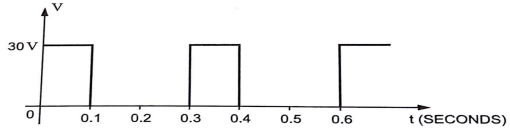
(b) A magnetic ring has a mean circumference of 1 metre and is of 5 cm^2 cross section. It is wound with a coil of 200 turns. A 5 mm wide air-gap is made in the ring. Calculate the magnetizing current required to produce flux of 1 mWb in the air gap. Assume μ_r of iron as 400.

(c) The combined inductance of the two coils connected in series is 0.60 H and 0.40 H, depending on the relative directions of currents in the coils. If one of the coils, when isolated, has a self-inductance of 0.15 H find i) the mutual inductance and ii) the co-efficient of coupling (K).

3+ 5 + 4 = 12

Group – C

4.(a) Find out the average value and the RMS value of the following wave form. Hence find out the peak factor of the given wave form.

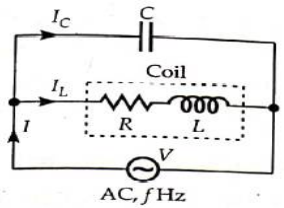


(b) A coil takes a current of 4 A when connected to a 240 V, 50 Hz alternating supply and consumes 200 W. Calculate the impedance, resistance and inductance of the coil. Also find out the reactive power of the circuit.

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

5.(a) Prove that the current through a pure inductor lags behind the applied alternating voltage by 90°. Also prove that the power consumed by a pure inductor is zero.

(b) Derive an expression of resonant frequency for the following parallel RLC circuit.



(c) Two impedances $\mathbf{Z_1}$ = (5 + j10) Ω and $\mathbf{Z_2}$ = (10 - j15) Ω are connected in parallel. If the total current is 20 A find out (i) current passing through each branch and (ii) power factor of the overall circuit.

(2 + 2) + 3+ 5 = 12

Group – D

6.(a) With the help of proper circuit and phasor diagram show that the power in a balanced three-phase circuit can be measured using two wattmeters. Hence deduce the expression for the power factor in terms of the wattmeter readings.

(b) Three similar coils each having series resistance of 20 Ω and capacitance 100 μF are connected in star to a 3-phase, 400 V, 50 Hz balanced supply. Find the line current, power factor, total KVA and total KW.

8 + 4 = 12