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) Kirchhoff's current law is used for
(a) Mesh analysis (b) Finding out equivalent current
(c) Finding out equivalent resistance (d) Nodal analysis.

(ii) For a wave connected dc machine, for number of poles = 4, the no. of parallel path is
(a) 4 (b) 2 (c) 8 (d) 16.

(iii) A 3 phase 4 wire system supplies a balanced star load. The current in each phase is 5 A. The current in the neutral wire will be
(a) 5 A (b) 0 A (c) 2.887 A (d) 8.66 A.

(iv) In a 3-phase power measurement by two wattmeter method the reading of one of the two watt meters was zero. The power factor of the load must be
(a) unity (b) 0 (c) 0.5 (d) 0.3.

(v) Under maximum power transfer condition the efficiency is
(a) 100% (b) 75% (c) 25% (d) 50%.

(vi) In a balanced 3-phase system, the phase currents are
(a) 30° apart (b) 60° apart (c) 90° apart (d) 120° apart.

(vii) The magnetic energy stored in a coil is given by
(a) $\frac{1}{2}LI^2$ (b) $\frac{1}{2}IL^2$ (c) $\frac{1}{2}BH^2$ (d) $\frac{1}{2}HB^2$

(viii) The open-circuit test in a transformer is used to measure
(a) Copper loss (b) Winding loss (c) Total loss (d) Core loss.

(ix) 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) $\frac{l}{\mu_r A}$

(x) The magnetic field produced in the stator of a three phase induction motor rotates at
(a) asynchronous speed (b) synchronous speed
(c) slip speed (d) 0.

Group – B

2. (a) Find the currents through the 4 Ω and 2 Ω resistance in the circuit shown in Fig. 1 using mesh analysis. [(CO1)(Apply/IOCQ)]

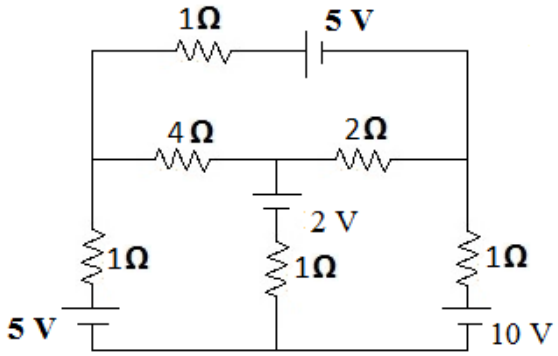

Fig. 1

(b) A coil of 500 turns and of resistance of 40 Ω is wound uniformly over a steel ring of mean circumference 30 cm and cross-sectional area 9 cm^2. It is connected to a supply of 30 V (DC). If the relative permeability (μ_r) of the ring material is 1600 and $\mu_0 = 4\pi \times 10^{-7}$, then identify (i) the reluctance, (ii) the magnetic field intensity, (iii) the m.m.f and (iv) the flux. [(CO3)(Apply/IOCQ)]

6 + 6 = 12

3. (a) Calculate the equivalent resistance across AB in the circuit shown in Fig. 2.

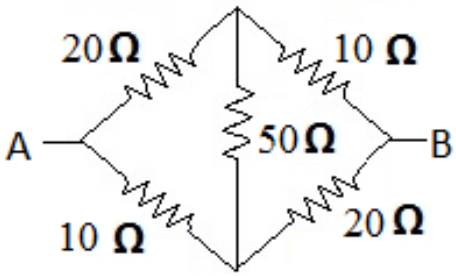

Fig. 2

[(CO1)(Evaluate/IOCQ)]

(b) The combined inductances of the two coils connected in series are 2 H and 0.4 H, depending on the relative directions of currents in the coils. If one of the coils, when isolated, has a self-inductance of 0.4 H, then identify (i) mutual inductance (ii) coefficient of coupling. [(CO3)(Apply/IOCQ)]

6 + 6 = 12

Group – C

4. (a) Find the RMS and Average values for the periodic wave form given in Fig. 3. Hence find the form factor. [(CO4)(Remember/LOCQ)]

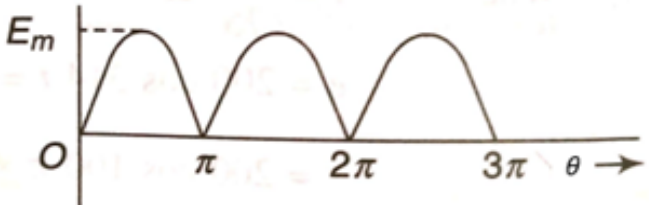

Fig. 3

(b) A coil of resistance of 20 Ω and inductance of 100 mH is connected in series with a capacitance of 40 μF across 100 V, 50 Hz ac supply. Solve for (i) the circuit current,

(ii) power factor, (iii) power consumed and (iv) the amount of maximum current. Also draw the phasor diagram. [(CO4)(Apply/IOCQ)]

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

5. (a) Find the resonance frequency of the circuit shown in Fig. 4.

[(CO4)(Remember/LOCQ)]

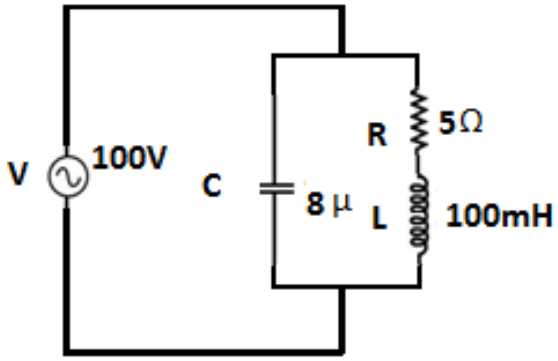

Fig. 4

(b) A 5 μF capacitor is connected in series with a variable inductor and a fixed resistor to a 100 V, 100 Hz source. Evaluate the value of inductance for which the current will be– (i) 3A, 0.8 lagging and (ii) 3A, 0.8 leading. [(CO4)(Evaluate/HOCQ)]

(c) A choke coil (R-L load) is connected to 240 V a.c. supply. When the frequency of supply is 50 Hz, an ammeter connected in series with the choke coil reads 60 A. On increasing the frequency to 80 Hz, the same ammeter reads 40 A. Solve the circuit to find out the value of inductance, resistance and p.f of the coil. [(CO4)(Apply/IOCQ)]

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

Group – D

6. (a) A 4-pole dc shunt motor working on 220 V dc supply takes a line current of 3 A at no load while running at 1500 rpm. Determine the speed when the motor takes a line current of 50 A. Assume armature and field resistances as 0.2 Ω and 400 Ω, respectively. [(CO2)(Evaluate/HOCQ)]

(b) Three coils, each having equal impedances of (10+j10) Ω, are connected in star across a 400 V, 50 Hz three-phase line. Calculate (i) phase current, (ii) line current, (iii) power factor and (iv) the active power and reactive power. [(CO4)(Understand/LOCQ)]

6 + (1 + 1 + 2 + 2) = 12

7. (a) Explain the method of power measurement of a balanced three phase system by two wattmeter method. Draw the neat circuit diagram. [(CO4)(Remember/LOCQ)]

(b) Derive the EMF equation of DC Machines. [(CO2)(Create/HOCQ)]

6 + 6 = 12

Group – E

8. (a) A 60 kVA transformer has an efficiency of 90% at full-load, 0.8 p.f., and an efficiency of 96% at ¼ th full load, unity p.f. Solve for the iron loss and full load copper loss. [(CO5)(Apply/LOCQ)]

(b) Explain why does the primary current in a transformer increase when a load is connected across the secondary? [(CO5)(Evaluate/HOCQ)]

(c) The open circuit (O.C.) and short circuit (S.C.) tests conducted on a 200/400 V, 4000 VA transformer gave the following readings:

O.C. Test : 200 V 1 A 100 W

S.C. Test : 15 V 10 A 85 W

Solve for (i) the efficiency of the transformer at 0.8 power factor at half load and (ii) the maximum efficiency at u.p.f. [(CO5)(Apply/IOCQ)]

4 + 4 + (2 + 2) = 12

9. (a) Explain how a rotating field is created in the air gap of a 3-phase induction motor when a balanced 3-phase ac supply is applied at the stator terminals. [(CO6)(Understand/LOCQ)]

(b) Develop the condition for maximum efficiency in transformer. [(CO5)(Apply/IOCQ)]

(c) A 3-phase, 6 pole, 50 Hz induction motor operates with a slip of 3% at full load. Find

(i) the synchronous speed.

(ii) the rotor speed at full load.

(iii) the frequency of the rotor induced emf at full load.

(iv) the frequency of the rotor induced emf at standstill. [(CO6)(Remember/LOCQ)]

5 + 3 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	34	43	23

Course Outcome (CO):

After the completion of the course students will be able to

- Analyse DC electrical circuits using KCL, KVL and network theorems like Superposition Theorem, Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem.
- Analyse DC Machines; Starters and speed control of DC motors.
- Analyse magnetic circuits.
- Analyse single and three phase AC circuits.
- Analyse the operation of single phase transformers.
- Analyse the operation of three phase induction motors.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question