BASIC ELECTRICAL ENGINEERING
(ELE 1001)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) When the frequency of the applied voltage (sine wave) across an inductor is increased then the current will
(a) decrease (b) increase (c) remain same (d) be zero.

(ii) As the frequency increases the power factor of a RL circuit will
(a) increase (b) decrease (c) remain unchanged
(d) may increase or decrease depending upon the value of L.

(iii) The full load copper loss and iron loss of a transformer are 50 W and 100 W respectively. The half load copper loss and iron loss will be
(a) 12.5 W and 25 W (b) 50 W and 25 W
(c) 12.5 W and 100 W (d) 50 W and 100 W.

(iv) During starting the slip of induction motor is
(a) 0 (b) 1 (c) 1.5 (d) 0.5.

(v) 3-phase induction motor with rotor circuit open will
(a) run normally (b) get over heated (c) not run (d) make noise.

(vi) Open circuit test in a transformer is performed with
(a) rated transformer voltage (b) rated transformer current
(c) direct current (d) high frequency current.

(vii) Flux in a magnetic circuit can be compared in an electric circuit to
(a) Resistance (b) Voltage (c) Current (d) Inductance.

(viii) 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) 0 A (b) 5 A (c) 8.66 A (d) 2.887 A.

(ix) 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) $\frac{1}{2}HB^2$

(x) For a coil with N-turns the self inductance will be proportional to
(a) 1/N (b) N^2 (c) N (d) $1/N^2$

Fill in the blanks with the correct word

(xi) Unit of reactive power is _____.

(xii) At resonance the power factor of a RLC circuit will be _____.

(xiii) A three phase 6 pole 50 Hz, induction motor is running at 5% slip. The speed of the motor is _____.

(xiv) If three resistances of each having 20 Ω resistance are connected in delta with 500 volt supply then line current in each resistance is _____.

(xv) Circuit model of a practical voltage source is an ideal voltage source with a _____ resistance.

Group - B

2. (a) Evaluate the current through the 2 Ω resistor in Fig. 1 using Superposition theorem.

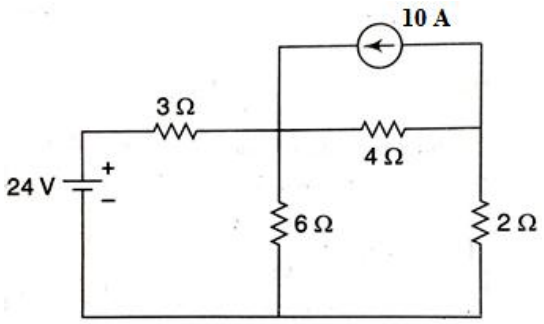

Fig. 1 *[(CO1)(Evaluate/HOCQ)]*

(b) State and prove Maximum Power Transfer theorem for a DC network. Also prove that the efficiency of the circuit under Maximum Power Transfer condition is 50%. *[(CO1)(Understand/LOCQ)]*

6 + 6 = 12

3. (a) A coil of 800 turns and of resistance of 20 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 20 V (DC). If relative permeability of the ring is 1600, find (i) the reluctance, (ii) the magnetic field intensity, (iii) the mmf and (iv) the flux. *[(CO3)(Remember/LOCQ)]*

(b) Define the self-inductance, mutual inductance and coefficient of coupling. Also derive the expression of coefficient of coupling in terms of self-inductances of two coils and mutual inductance between them. *[(CO3)(Understand/LOCQ)]*

8 + (2 + 2) = 12

Group - C

4. (a) In the circuit shown in Fig. 2, the resistance R is 15 Ω, the inductance L is 0.63 H and the capacitance C is 200 μF. A sinusoidal voltage of 200 V at 50 Hz is applied to the circuit. Find the (i) total current drawn by the circuit (ii) current drawn by each branch (iii) power factor of the circuit.

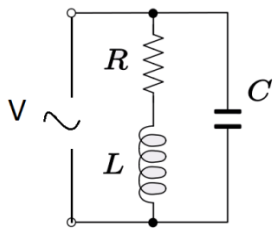

Fig. 2 *[(CO4)(Apply/IOCQ)]*

(b) Calculate the average value, r.m.s value, form factor and peak factor for the wave form shown in Fig. 3.

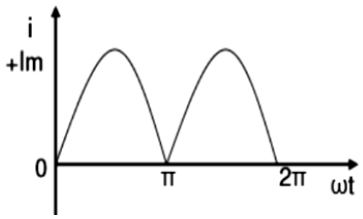

Fig. 3 *[(CO4) (Understand/LOCQ)]*

(c) Find the applied voltage across R-L series circuit if the voltage across R is 50 V and L is 60 V. *[(CO4)(Apply/IOCQ)]*

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

5. (a) Calculate the average value, r.m.s value, form factor and peak factor for the wave form shown in Fig. 4.

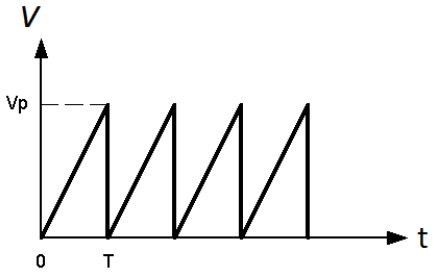

Fig. 4 *[(CO4)(Understand/LOCQ)]*

(b) In the circuit shown in Fig. 5, calculate the (i) current drawn by the circuit (ii) voltage across inductor (iii) power factor of the circuit (iv) the value of the capacitor for the maximum current at 60Hz

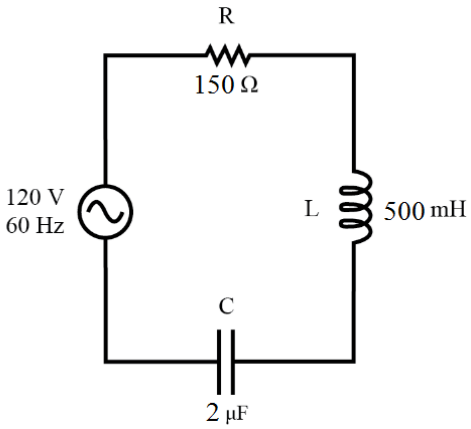

Fig. 5 *[(CO4)(Understand/LOCQ)]*

(c) Two impedance (2+j6) Ω & (8-j12) Ω are connected in series. What will be the resultant power factor? *[(CO4)(Apply/IOCQ)]*

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

Group - D

6. (a) Derive the relationship between the line voltage and phase voltage of a three-phase star-connected system with proper phasor diagram. *[(CO4)(Remember/LOCQ)]*

(b) A three-phase load consists of three similar inductive coils, each of resistance 50 Ω and inductance 0.3 H. The supply is 415 V, 50 Hz. Calculate: (i) the line current; (ii) the power factor and (iii) the total power when the load is star-connected and also when delta-connected. *[(CO4)(Apply/IOCQ)]*

4 + 8 = 12

7. (a) Derive the torque equation of dc motor. *[(CO2)(Analyse/IOCQ)]*

(b) A 250 V DC shunt motor on no load runs at 1000 rpm and takes 5 A. The total armature and shunt field resistance are respectively 0.2 Ω and 250 Ω. Calculate

the speed when loaded and taking a current of 50 A, if the armature reaction weakens the field by 3%. *[(CO2)(Evaluate/HOCQ)]*

6 + 6 = 12

Group - E

8. (a) A 6600/440 V, 50 Hz, single-phase 500 kVA transformer has 1000 high voltage turns. Find (i) Number of Low voltage turns (ii) Maximum core flux (iii) the current through high voltage winding of the transformer when it supplies a load of 250 kW at 0.8 power factor lagging in low voltage side. Neglect the no-load current. *[(CO5)(Understand/LOCQ)]*

   (b) A 10 kVA, 1000/250 V single phase transformer has resistance and leakage reactance as follows:
   HV winding: $R_1 = 6\Omega$, $X_1 = 12\Omega$
   LV winding: $R_2 = 0.5\Omega$, $X_2 = 1\Omega$
   Calculate (i) equivalent resistance and leakage reactance refer to LV side of the transformer (ii) full load copper loss. *[(CO5)(Understand/LOCQ)]*

   (c) Why should the rotor of 3-phase induction motor rotate in the same direction as that of rotating magnetic field? How can the direction of rotation of 3-phase induction motor be reversed? Explain. *[(CO6)(Understand/LOCQ)]*

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

9. (a) In a 20 kVA 2000/200 V transformer the iron and full load copper losses are 200 W and 350 W respectively. Calculate the maximum efficiency at 0.8 p.f lagging and the corresponding load. *[(CO5)(Evaluate/HOCQ)]*

   (b) A 1000 kVA single phase transformer working at 0.8 p.f lagging has an efficiency of 90% at both ¾ th load and full load. Determine the (i) full load copper loss (ii) core loss (iii) ½ load efficiency at unity power factor. *[(CO5)(Apply/IOCQ)]*

   (c) A 3-phase, 4-pole induction motor is supplied from 3-phase, 50Hz ac supply. Calculate
   (i) the synchronous speed
   (ii) the rotor speed when slip is 4%
   (iv) the rotor frequency when rotor runs at 650 rpm.
   [(CO6)(Remember/LOCQ)]

(2 + 2) + (1.5 + 1.5 + 2) + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	49	34	17

Course Outcome (CO):

After the completion of the course students will be able to

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

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