BASIC ELECTRICAL ENGINEERING
(ELE1001)

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) The magnetic energy stored in a coil is given by
(a) $\frac{1}{2}LI^2$ (b) $\frac{1}{4}LI^3$ (c) LI^2 (d) $\frac{1}{2}IL^2$

(ii) In Thevenin's theorem, to find the Thevenin's equivalent resistance:
(a) All independent current sources are short circuited and independent voltage sources are open circuited.
(b) All independent voltage and current sources are open circuited.
(c) All independent voltage and current sources are short circuited.
(d) All independent voltage sources are short circuited and all independent current sources are open circuited.

(iii) An ideal voltage source should possess
(a) zero source resistance (b) infinite source resistance
(c) large value of current (d) small value of current

(iv) The r.m.s. value of a sine wave is 100A. Its peak value is
(a) 150 A (b) 282.8 A (c) 70.7 A (d) 141.4 A

(v) Power factor of an A.C. circuit is equal to:
(a) R/X_L (b) R/X_C (c) R/Z (d) $R/(X_L+X_C)$

(vi) In a series RLC circuit at resonance, the impedance is:
(a) Minimum and purely resistive (b) Maximum and purely resistive
(c) Minimum and purely reactive (d) Maximum and purely reactive

(vii) If the reading of the two wattmeters is equal while measuring power in a 3 phase induction motor then the power factor of the load will be?
(a) 0.8 leading (b) 0.8 lagging (c) zero (d) unity

(viii) Eddy current loss in a transformer can be reduced by using
(a) laminated core (b) silicon steel
(c) oil (d) solid steel

(ix) In dc series motor the field flux is
(a) proportional to the armature current
(b) is nearly constant
(c) inversely proportional to the armature current
(d) proportional to the square of the armature current

(x) A 10 kW, 4P, star connected 50 Hz IM has a full load slip of 5%. What is the synchronous speed of the Motor?
(a) 1200 rpm (b) 1500 rpm
(c) 1000 rpm (d) 3000 rpm

Fill in the blanks with the correct word

(xi) Current in electrical circuit is analogous to _____ in a magnetic circuit.

(xii) Unit of active power is _____.

(xiii) A shunt generator is running at 100 rpm and has a generated emf of 20V. If the speed increases to 120 rpm the generated emf will be nearly _____ volt.

(xiv) The loss which can be calculated from a short circuit test on a transformer is ____.

(xv) At start, the value of slip for a three phase induction motor is _____ .

Group - B

2. (a) State Superposition Theorem. *[(CO1)(Remember/LOCQ)]*

(b) Using Superposition Theorem find current through 20Ω resistance of the circuit given in Fig. 1.

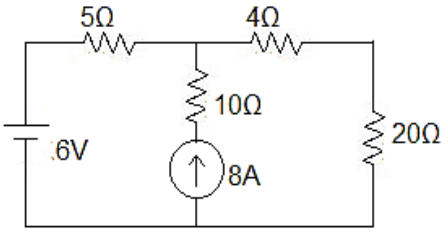


Fig. 1 *[(CO1) (Analyse/HOCQ)]*

(c) An iron ring is made up of three parts having l_1 = 10 cm, A_1 = 5 cm^2, l_2 = 8 cm, A_2 = 3 cm^2, l_3 = 6 cm and A_3 = 2.5 cm^2. It is wound with a coil of 250 turns. Calculate the current required to produce a flux of 0.4 mWb in the ring. Consider, μ_{r1} = 2670, μ_{r2} = 1050, μ_{r3} = 650, $\mu_0 = 4\pi \times 10^{-7}$ H/m *[(CO3) (Apply/IOCQ)]*

2 + 4 + 6 = 12

3. (a) Determine the value of load resistance R_L in Fig. 2 when maximum power will be transferred through the load resistance and also find the maximum power.

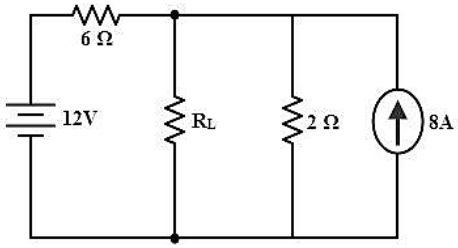


Fig. 2 *[(CO1)(Analyse/HOCQ)]*

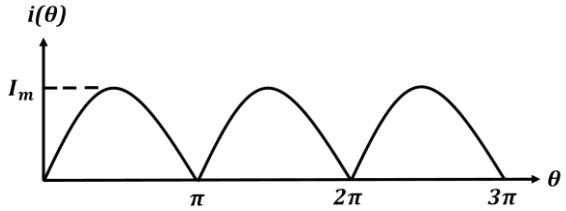
(b) Derive the expression of coefficient of coupling (K) in terms of self-inductances (L_1, L_2) and mutual- inductance (M). *[(CO3) (Remember/LOCQ)]*

(c) A coil of 300 turns and carrying current of 2 A is wound uniformly over a steel ring of mean circumference 30 cm and cross-sectional area 10 cm^2. It is connected to a supply of 20 V d.c. If the relative permeability of the ring is 1500. Find (i) reluctance, (ii) mmf and (iii) flux. *[(CO3) (Apply/IOCQ)]*

(2 + 3) + 3 + 4 = 12

Group - C

4. (a) Determine the rms value, average value, form factor and peak factor for the following waveform. *[(CO4)(Analyse/HOCQ)]*



(b) Prove that the average power consumption in a pure capacitor is zero when a.c. voltage is applied. *[(CO4)(Apply/LOCQ)]*

(c) Prove that the current through a pure inductor lags behind the applied alternating voltage by 90˚. *[(CO4)(Apply/IOCQ)]*

6 + 3 + 3 = 12

5. (a) A resistance of 15 Ω, inductance of 0.15 H and a capacitance of 130μF are connected in series across a 100 V, 50 Hz supply. Determine:
   (i) the impedance of the circuit
   (ii) the current
   (iii) power factor
   (iv) active, reactive and apparent power of the circuit
   (v) voltage across each element
   (vi) resonant frequency or the frequency at which maximum current flows
   (vii) circuit current at resonance or the amount of maximum current
   (viii) Draw the phasor diagram *[(CO4)(Evaluate/HOCQ)]*

(b) A parallel circuit consists of two branches, one consisting of a noninductive resistor of 150Ω in series with an inductor of inductance 318μH, the other consisting of a non-inductive resistance of 300Ω in series with a capacitor of 0.01μF capacitance. The circuit is connected across a 25V, 100 kHz supply. Determine (i) the current in each branch, (ii) the total current, (iii) overall power factor, (iv) the total impedance of the circuit. *[(CO4)(Analyse/HOCQ)]*

8 + 4 = 12

Group - D

6. (a) Describe the three-phase power measurement with the help of two Wattmeters. Draw the circuit diagram and phasor diagram. Also find the expression of the power factor of a 3-phase load. *[(CO4)(Remember/LOCQ)]*

(b) What is back emf? *[(CO2)(Remember/LOCQ)]*

(c) A 6-pole Lap wound dc shunt generator has a useful flux per pole of 0.03 Wb. The armature has 400 conductors and resistance of 0.4Ω. Calculate the terminal voltage when the armature is rotating at 1000 rpm and armature current is 40A. *[(CO2)(Apply/IOCQ)]*

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

7. (a) A 200V dc series motor runs at 800 rpm when operating at its full-load current of 20A. The armature and field resistance are 0.5 Ω and 0.1 Ω respectively. What will be the speed if (i) the load torque is increased by 20% (ii) the motor current is 10A. The magnetic circuit can be assumed unsaturated. *[(CO2)(Analyse/HOCQ)]*

(b) "DC series motor should not start at no-load condition"- Explain with suitable characteristics. *[(CO2)(Remember/LOCQ)]*

(c) Three similar series circuits each having resistance of 10 Ω and capacitance of 50 μF are connected in star to a 3-phase, 200V, 50 Hz balanced supply. Evaluate (i) line current, (ii) power factor, (iii) active power. *[(CO4)(Analyse/HOCQ)]*

5 + 3 + (1 + 1 + 2) = 12

Group - E

8. (a) Prove that for a single phase transformer

$$KVA_{max} = KVA_{rated}\sqrt{\frac{P_{core}}{P_{cu}}}$$

Where, KVA_{max} = KVA delivered by the transformer at which maximum efficiency occurs, KVA_{rated} = Rated KVA of the transformer, P_{core} = iron loss, and P_{cu} = full load copper loss. *[(CO5)(Understand/LOCQ)]*

(b) What is slip in a 3 phase induction motor? Why is slip always positive in case of a 3 phase induction motor? Show that the frequency of the rotor induced e.m.f (f_r) in an induction motor is slip times its stator frequency (f). *[(CO6)(Analyse/IOCQ)]*

(c) The short circuit test performed on a single phase, 8 kVA, 200/400 V, 50 Hz transformer gives the following test results: V_{sc} = 20 V, I_{sc} = 12.5 A, W_{sc} = 175 W
Estimate: (i) equivalent winding resistance, (ii) equivalent winding leakage reactance. *[(CO5)(Evaluate/HOCQ)]*

4 + 5 + 3 = 12

9. (a) The efficiency of a 400 kVA, single phase transformer is 98.77% at full load 0.8 p.f. and 99.13% at half load unity power factor. Find the iron and copper loss at full load. *[(CO5)(Evaluate/HOCQ)]*

(b) Draw and explain the torque-slip characteristics of three phase induction motor. *[(CO6)(Understand/LOCQ)]*

(c) An 8-pole alternator runs at 750 rpm and supplies power to a 4-pole induction motor. The frequency of the rotor current is 1.5 Hz. Determine the speed of the motor *[(CO6)(Apply/IOCQ)]*

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	29.2	26	44.8