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

(ii) If a source is delivering maximum power to the load, then efficiency of the circuit is
(a) 100% (b) 50% (c) 25% (d) 75%

(iii) 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) $\frac{1}{2}IL^2$

(iv) Readings of two wattmeter in three phase unity power factor load would be
(a) equal
(b) equal but in opposite direction
(c) unequal but in opposite direction
(d) unequal but in same direction

(v) The torque-speed characteristic of a series motor is
(a) linearly rising (b) a parabola
(c) a rectangular hyperbola (d) linearly decreasing

(vi) 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

(vii) In a pure inductive circuit
(a) The current is in phase with the voltage
(b) The current lags behind the voltage by 90°
(c) The current leads the voltage by 90°
(d) The current can lead or lag by 90°

(viii) A transformer will have maximum efficiency at a load such that _____
(a) copper loss > iron loss (b) cannot be determined
(c) copper loss = iron loss (d) copper loss < iron loss

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

(x) The rotor of an induction motor rotates at
(a) synchronous speed (b) less than synchronous speed
(c) greater than synchronous speed (d) slip speed

Group- B

2. (a) Identify the current through 10Ω resistance in the circuit shown in Fig.2(a) using Thevenin's Theorem.

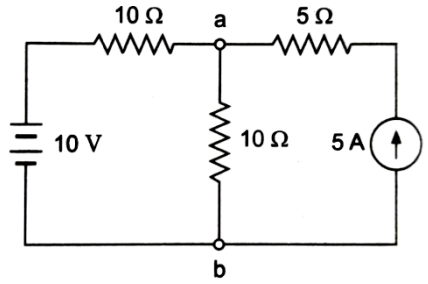

Fig. 2(a) *[(CO1) (Apply/IOCQ)]*

(b) The combined inductance of the two coils connected in series is 0.75 H and 0.25 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, then identify (i) mutual inductance (ii) coefficient of coupling. *[(CO3) (Apply/IOCQ)]*

6 + 6 = 12

3. (a) Find out the resistance across the A and B terminal of the circuit shown Fig. 3(a).

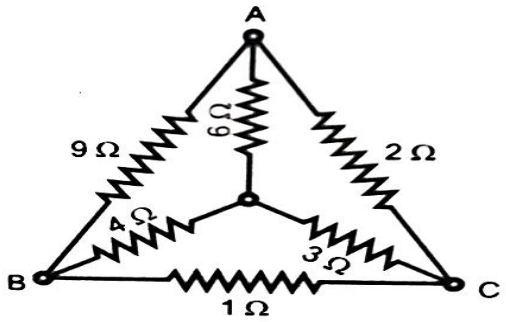

Fig. 3(a) *[(CO1)(Remember/LOCQ)]*

(b) An iron ring of 30 cm mean diameter, and circular section 2 cm in diameter has an airgap of 1 mm. It is wound uniformly with 600 turns of wire, carrying a current of 2.5 A. Neglect the magnetic leakage. If the relative permeability (μ_r) of the iron is 300 and $\mu_0 = 4\pi \times 10^{-7}$ H/m, then determine (i) the reluctance, (ii) the magneto motive force and (iv) magnetic flux. *[(CO3)(Evaluate/HOCQ)]*

6 + 6 = 12

Group - C

4. (a) Solve for the RMS and average values for the wave form given in Fig. 4(a). Also calculate the form factor.

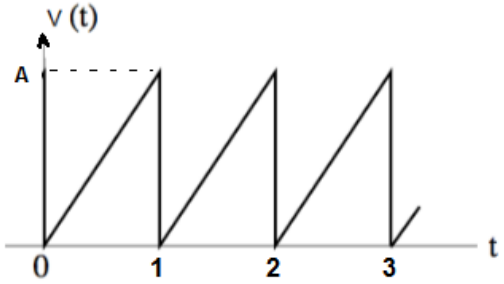

Fig. 4(a) *[(CO4) (Apply/IOCQ)]*

(b) A series circuit has R = 10Ω; L = 0.05H and C = 100μF and is supplied with 200V, 50 Hz. Solve for (i) impedance, (ii) current, (iii) power factor of the circuit, (iv) power consumed by the circuit and (v) maximum current of the circuit. *[(CO4) (Apply/IOCQ)]*

6 + 6 = 12

5. (a) Explain the phenomenon of series resonance in RLC circuits. Deduce the condition for series resonance and hence obtain the expression of resonating frequency. *[(CO4) (Apply/IOCQ)]*

(b) Two coils having impedance of $Z_1 = (10 + j5)$ ohm and $Z_2 = (8 + j6)$ *ohm* are connected in parallel across a voltage source of 200 V. Evaluate (i) the current flowing through each coil, (ii) the total current, (iii) the overall power factor and (iv) the total active power consumed by the circuit. *[(CO4) (Evaluate/HOCQ)]*

5 + 7 = 12

Group - D

6. (a) Derive the emf equation of dc generator. What do you mean by critical field resistance for a dc shunt generator? *[(CO4) (Understand/LOCQ)]*

(b) Three similar series circuit each having resistance of 20 Ω and capacitance of 100 μF are connected in star to a 3-phase, 400 V, 50 Hz balanced supply. Evaluate (i) line current, (ii) power factor and (iii) active power. *[(CO2)(Evaluate/HOCQ)]*

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

7. (a) A 200 V dc shunt motor runs at 500 rpm at rated full load condition and takes an armature current of 100 A. The armature resistance is 0.2 Ω. Identify the speed of motor when the field circuit resistance is increased such that the flux is reduced to 80% of the normal value and the motor is loaded for an armature current of 50 A. *[(CO4)(Apply/IOCQ)]*

(b) Describe the method of measurement of balanced three phase power by using 2 wattmeters. Draw the circuit diagram and phasor diagram. Also derive the expression of power factor. *[(CO2)(Understand/LOCQ)]*

6 + 6 = 12

Group – E

8. (a) Explain how a rotating magnetic field is produced in the air gap of a 3-phase induction motor. *[(CO6) (Understand/LOCQ)]*

   (b) A 5 kVA, 1000/200 V, 50 Hz single phase transformer has the following test results:
   O.C. Test (Low voltage side): 200 V 1.2 A 90 W
   S.C. Test (High voltage side): 50 V 5 A 110 W
   Solve for the parameters of the equivalent circuit of the transformer and the efficiency of the transformer at full load and 0.8 power factor.
   [(CO5) (Apply/IOCQ)]

5 + 7 = 12

9. (a) A 3-phase, 4 pole, 50 Hz induction motor operates with a slip of 3% at full load. Determine
   (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 when rotor rotates at 600 rpm and
   (v) the frequency of the rotor induced emf at standstill.
   [(CO6) (Evaluate/HOCQ)]

   (b) Draw phasor diagram of transformer at lagging pf load. *[(CO5)(Understand/LOCQ)]*

   (c) A single phase, 50 Hz transformer has 350 primary and 1050 secondary turns. The net cross- sectional area of the core is 0.055 m^2. If the voltage induced in the primary winding is 400 V, solve for the (i) maximum value of flux density in the core and the (ii) voltage induced in the secondary winding. *[(CO5)(Apply/IOCQ)]*

5 + 3 + 4 = 12

Cognition Level	*LOCQ*	*IOCQ*	*HOCQ*
Percentage distribution	*27*	*48*	*25*

Course Outcome (CO):

After the completion of the course students will be able to

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

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