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) What is the magneto-motive force (mmf) of a wire with 100 turns carrying 4 A current?
(a) 400 AT (b) 25 AT (c) 40 AT (d) 2.5 AT.

(ii) Kirchoff's voltage law is used for
(a) mesh analysis (b) finding out equivalent current
(c) finding out equivalent resistance (d) nodal analysis.

(iii) The superposition theorem is applicable to
(a) current only (b) voltage and power
(c) voltage and current (d) voltage, current and power.

(iv) 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°

(v) Calculate the power factor of a circuit with parameters R = 3Ω and XL = 4Ω.
(a) 0.6 (b) 1 (c) 0.5 (d) 0.8

(vi) A d.c series motor should always be started with load, because at no-load it
(a) will not develop high starting torque
(b) draws small current
(c) cannot start
(d) will rotate at dangerously high speed

(vii) The number of parallel paths in wave connected armature winding of a 4 pole dc machine is
(a) 6 (b) 8 (c) 4 (d) 2.

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

(ix) A transformer steps up the voltage by a factor of 100. The ratio of current in the primary to that in the secondary is
(a) 1 (b) 100 (c) 0.01 (d) 0.1

(x) A 10 kW, 6P, 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) Maximum power will be transferred when load resistance is equal to_____.

(xii) At resonance the current through a RLC series circuit will be _____.

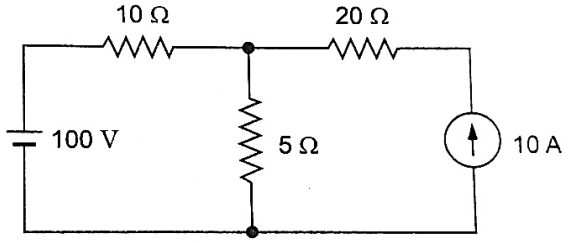
(xiii) A shunt generator is running at 1000 rpm and has a generated emf of 200V. If the speed increases to 1200 rpm the generated emf will be nearly _____ volt.

(xiv) Electric power in a Three Phase Circuit = _____.

(xv) The loss which can be calculated from an open circuit test on a transformer is _____.

Group - B

2. (a) Find the current through 5Ω resistance in the circuit shown in following figure using Norton's Theorem. *[(CO1)(Analyse/HOCQ)]*

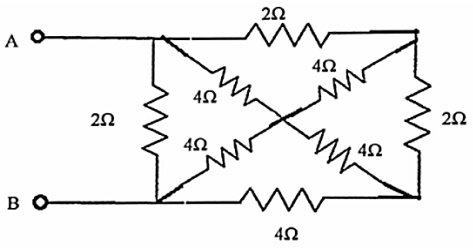


(b) State Norton's theorem. Draw the Norton's equivalent circuit. *[(CO1)(Remember/LOCQ)]*

(c) The combined inductance of the two coils connected in series is 0.8H and 0.3H, depending on the relative directions of currents in the coils. If one of the coils, when isolated, has a self-inductance of 0.15H, then Calculate (i) mutual inductance (ii) coefficient of coupling. *[(CO3)(Apply/IOCQ)]*

5 + (2 + 1) + 4 = 12

3. (a) Find equivalent resistance across AB terminals in the following figure using star-delta conversion.



[(CO1)(Apply/IOCQ)]

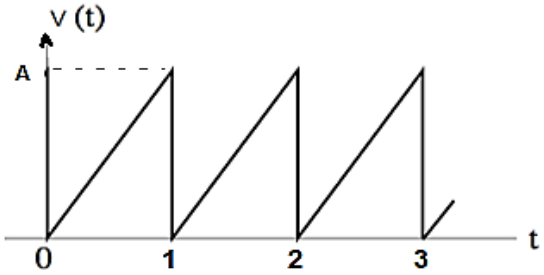
(b) An iron ring of 30 cm mean diameter, and circular section 2 cm in diameter has an air gap of 1 mm. It is wound uniformly with 600 turns of wire, carrying a current of 2.5 A. Neglect the magnetic leakage. If the relative permeability (μ_r) of the iron is 300 and $\mu_0 = 4\pi \times 10^{-7}$ H/m,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

[(CO3)(Evaluate/HOCQ)]

4 + 8 = 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 inductor is zero when a.c. voltage is applied. *[(CO4)(Apply/LOCQ)]*

(c) An ac series circuit has R = 10Ω; L = 0.05H and C = 100μF and is connected across 200V, 50 Hz sinusoidal supply. Determine impedance, current, power factor of the circuit, power consumed by the circuit and maximum current of the circuit.

[(CO4)(Apply/IOCQ)]

4 + 3 + 5 = 12

5. (a) A choke coil is connected in series with a 20μF capacitor. With a constant supply voltage of 200V the circuit takes its maximum current of 50A at 50Hz frequency. Calculate (i) the resistance and inductance of the choke coil; (ii) the voltage across the capacitor. *[(CO4)(Analyse/HOCQ)]*

(b) Draw and explain the phasor diagrams of series R-L and series R-C circuits.

[(CO4)(Remember/LOCQ)]

(c) A 320 V, 50 Hz voltage applied to a coil of L = 0.5 H and R = 200 Ω in series with a capacitor C. What value must C have in order that the total voltage across the coil shall be 250 V? *[(CO4)(Apply/IOCQ)]*

4 + 4 + 4 = 12

Group - D

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

(b) Derive the emf equation of a DC generator. *[(CO2)(Remember/LOCQ)]*

(c) A three-phase 220 V load has a power factor of 0.9. Two wattmeters are connected to measure the power which shows the input to be 10 kW. Find out the reading of each wattmeter. *[(CO4)(Analyse/HOCQ)]*

5 + 2 + 5 = 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 0.3 Ω and 0.2 Ω respectively. What will be the speed if (i) the load torque is increased by 40%, (ii) the motor current is 10A? The magnetic circuit can be assumed unsaturated. *[(CO2)(Analyse/HOCQ)]*

(b) Why does the dc series motor not start at no-load condition? *[(CO2)(Remember/LOCQ)]*

(c) Three similar series circuits each having resistance of 20 Ω and capacitance of 100 μF are connected in star to a 3-phase, 400V, 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) Draw the equivalent circuit and phasor diagram of a single phase transformer under lagging power factor load. *[(CO5)(Understand/LOCQ)]*

(b) Define slip in 3 phase induction motor. What is its value at starting and at synchronous speed? Why does an induction motor normally run at the speeds below synchronous speed? How can the direction of rotation of the 3 phase induction motor be reversed? *[(CO6)(Analyse/IOCQ)]*

(c) The e.m.f per turn of a single phase 10 kVA, 2200/220 V, 50 Hz transformer is 10 V. Evaluate: (i) the number of primary and secondary turns, (ii) maximum value of flux, and (iii) net cross sectional area of the core for a maximum flux density of 1.5 Wb/m^2. *[(CO5)(Evaluate/HOCQ)]*

4 + 5 + 3 = 12

9. (a) A 50 kVA, 2400/120V, 50 Hz single phase transformer has the following test results:

O.C. Test (Low voltage side):	120 V	9.65 A	396 W
S.C. Test (High voltage side):	92 V	20.8 A	810 W

Determine the parameters of the equivalent circuit of the transformer and the efficiency of the transformer at half load and 0.85 power factor lagging. *[(CO5)(Apply/IOCQ)]*

(b) A 3-phase, 4 pole, 50 Hz induction motor has a slip of 1% at no load and 3% at full load. Determine (i) synchronous speed, (ii) no-load speed, (iii) full load speed, (iv) frequency of rotor current at full load, (v) frequency of rotor current at standstill. *[(CO6)(Evaluate/HOCQ)]*

7 + 5 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	23.96	30.21	45.83