

**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 reluctance of magnetic circuit is analogous to _____ in an electric circuit
(a) Current (b) Voltage (c) Resistance (d) Power
- (ii) Kirchoff's current 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) A 230V, 50Hz AC supply is applied to a circuit with a 20Ω resistance and a 30Ω capacitive reactance in series. What is the circuit current?
(a) 4.5A (b) 5.2A (c) 6.4A (d) 7.1A
- (vi) The number of parallel paths in lap connected armature winding of a 4 pole dc machine is
(a) 6 (b) 8 (c) 4 (d) 2
- (vii) If the reading of one of the two wattmeters is zero while measuring power in a 3 phase induction motor then the power factor of the load will be
(a) 1 (b) 0.5 (c) 0.8 leading (d) 0.8 lagging
- (viii) The no-load current in a transformer is
(a) In phase with the applied voltage (b) Leads the applied voltage
(c) Lags the applied voltage (d) Zero

- (ix) A 10 kVA transformer has a primary voltage of 500 V and a secondary voltage of 250 V. What is the full-load current in the secondary winding?
 (a) 20 A (b) 40 A (c) 50 A (d) 25 A
- (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) Maximum power will be transferred when load resistance is equal to _____.
- (xii) For a series RLC circuit the current at resonance is _____.
- (xiii) A shunt generator is running at 800 rpm and has a generated emf of 200V. If the speed increases to 1000 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 and prove maximum power transfer theorem. [[CO1](Remember/LOCQ)]
 (b) Determine the equivalent resistance across DE terminals in Fig. 1 using star delta conversion. All the resistance values are given in Ω . [[CO1](Apply/IOCQ)]

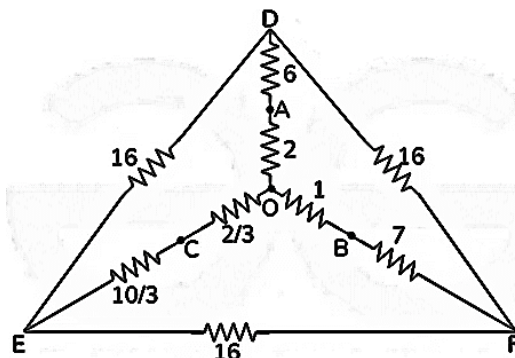


Fig. 1

- (c) An iron ring of 5 cm² cross section and 50 cm mean circumference has a 2 mm saw-cut made in it. Determine the current required in a magnetising coil having 800 turns to produce flux of 1mWb in the air gap. The relative permeability of iron $\mu_r = 400$. Consider no leakage is present. $\mu_0 = 4\pi \times 10^{-7}$ H/m. [[CO3](Evaluate/HOCQ)]
3 + 4 + 5 = 12
3. (a) Evaluate the current through 1.5 Ω resistance in the circuit shown in Fig. 2 using Norton's Theorem. [[CO1](Analyse/HOCQ)]

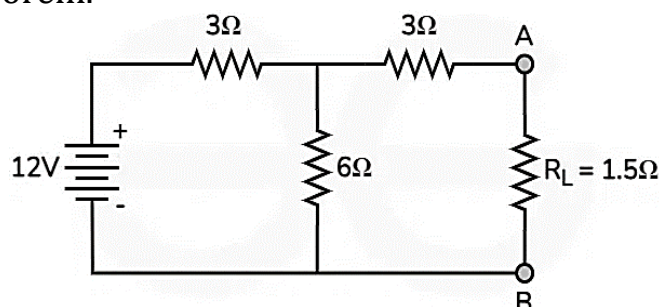
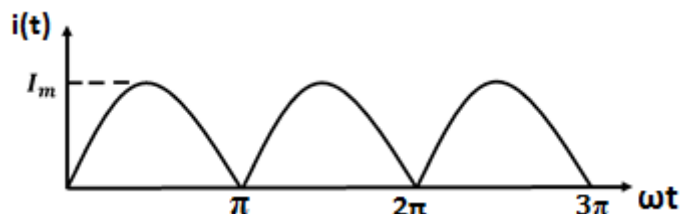


Fig. 2

- (b) State Thevenin's theorem. Draw the Thevenin's equivalent circuit. [[CO1](Remember/LOCQ)]
- (c) The combined inductance of the two coils connected in series is 0.6mH and 0.2mH, depending on the relative directions of currents in the coils. If one of the coils, when isolated, has a self-inductance of 0.10mH, then determine (i) mutual inductance (ii) coefficient of coupling. [[CO3](Apply/IOCQ)]
- 5 + (2 + 1) + 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) A resistance and an inductance are connected in series across a voltage $v = 282 \sin 314t$. An expression of current is found out to be $i = 4 \sin (314t - 45^\circ)$. Find the values of resistance, inductance and power factor. [[CO4](Apply/IOCQ)]
- (c) Prove that the current through a pure capacitor leads the applied alternating voltage by 90° . [[CO4](Understand/LOCQ)]
- 4 + 5 + 3 = 12**
5. (a) Derive the expression of resonance frequency in a parallel RLC circuit. What is the power factor of a parallel resonating circuit? Draw the phasor diagram of a parallel RLC circuit at resonance. [[CO4](Analyse/HOCQ)]
- (b) Two coils having impedances of $Z_1 = (12 + j6) \Omega$ and $Z_2 = (9 + j7) \Omega$ are connected in parallel across a voltage source of 220V. Evaluate (i) the current flowing through each coil, (ii) the total current, (iii) the overall power factor and (iv) the total active power and reactive power. [[CO4](Remember/LOCQ)]
- 5 + 7 = 12**

Group - D

6. (a) A 200V 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. [[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 0.8 (lagging). Two wattmeters are connected to measure the power which shows the input to be 10 kW. Evaluate the reading of each wattmeter. [[CO4](Analyse/HOCQ)]

5 + 2 + 5 = 25

7. (a) The power to a 3- phase load connected to a 400 V, 50 Hz supply was measured by two wattmeter methods and the readings were 2000 W and 500 W. The second reading is taken by interchanging the current coil terminal. Evaluate: (i) total input power (ii) power factor (iii) line current. [[CO4](Analyse/HOCQ)]
- (b) Why the starter is needed to start a DC motor? [[CO2](Remember/LOCQ)]
- (c) A 450 V DC series motor runs at 600 rpm taking a current of 40 A. Evaluate the speed when the load is reduced so that the motor is taking a current of 30 A. Total resistance of the armature and field circuit is 0.8 Ω . Assume the flux is proportional to the field current. [[CO2](Analyse/HOCQ)]
- 5 + 2 + 5 = 12**

Group - E

8. (a) Prove that for a single phase transformer
- $$kVA_{max} = kVA_{rated} \times \sqrt{\frac{P_{core}}{P_{cu}}}$$
- 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? Derive the expression of rotor induced EMF frequency (f_r) in terms of stator supply frequency (f). [[CO6](Analyse/IOCQ)]
- (c) A 230/110 V single phase transformer takes an input of 350 VA at no load and at rated voltage of HV side. The core loss is 110 W. Find (i) the iron-loss component of no-load current (ii) the magnetizing component of no-load current (iii) no load power factor. [[CO5](Evaluate/HOCQ)]
- 4 + 5 + 3 = 12**
9. (a) A 8 kVA, 400/2000V, 50 Hz single phase transformer has the following test results:
- | | | | |
|-------------------------------|-------|--------|-------|
| O.C. Test (Low voltage side) | 400 V | 0.75 A | 100 W |
| S.C. Test (High voltage side) | 50 V | 4 A | 120 W |
- Solve for the parameters of the equivalent circuit of the transformer and the efficiency of the transformer at full load and 0.85 power factor lagging. [[CO5](Apply/IOCQ)]
- (b) A 3-phase, 6 pole, 50 Hz induction motor has a slip of 2% 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	29	25	42