CIRCUIT THEORY AND NETWORK ANALYSIS
(AEIE 2103)

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) Superposition theorem can be applied only to circuits having
(a) resistive elements (b) passive elements
(c) non-linear elements (d) linear bilateral elements.

(ii) An ideal voltage source should have
(a) large value of e.m.f. (b) small value of e.m.f.
(c) zero source resistance (d) infinite source resistance.

(iii) Kirchhoff s law is not applicable to circuits with
(a) lumped parameters (b) passive elements
(c) distributed parameters (d) non-linear resistances.

(iv) A passive network is one which contains
(a) only variable resistances (b) only some sources of e.m.f. in it
(c) only two sources of e.m.f. in it (d) no source of e.m.f. in it.

(v) The voltage and current in a circuit are given by $v(t) = 10\sin(t + 30^0)$ and $i(t) = 10\sin(t - 30^0)$. The power consumed in the circuit is
(a) 25 W (b) 50 W (c) 100 W (d) 12.5 W.

(vi) The maximum value of mutual inductance of 2 inductively coupled coils having self inductances of 49 H and 81 H respectively is
(a) 130 H (b) 32 H (c) 63 H (d) 65 H.

(vii) In an RC series circuit, when the switch is closed and the circuit is complete, the response
(a) does not vary with time (b) decays with time
(c) increases with time (d) first increases, then decrease.

(viii) In two-port networks the parameter h_{22} is called _____.
(a) short circuit input impedance (b) short circuit current gain
(c) open circuit reverse voltage gain (d) open circuit output admittance

(ix) If the RMS value of current is 12.25 A, its peak value is
(a) 17.3A (b) 8.66 A (c) 12.25A (d) 5.51A

(x) An active low pass filter with RC passive components has the cut-off frequency
(a) $\frac{1}{2\pi RC}$ (b) $2\pi RC$ (c) $2\pi\sqrt{RC}$ (d) $\frac{1}{2\pi\sqrt{RC}}$

Fill in the blanks with the correct word

(xi) The most elementary form of a loop which cannot be further divided into other loops is called _____.

(xii) Current division rule is valid for _____ circuit.

(xiii) Under maximum power transfer condition in a DC circuit, the load voltage is _____ the source voltage.

(xiv) The function of an Inductor is to oppose any change in _____.

(xv) The property of an electrical circuit that dissipates electric energy is called _____.

Group - B

2. (a) Determine the mesh currents for the following network.

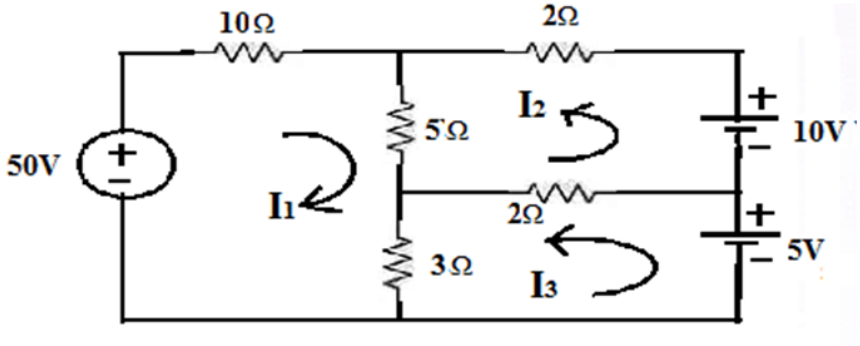

Fig. 1 *[(CO2)(Analyse/IOCQ)]*

(b) State Thevenin's theorem. List its applications. Indicate its limitations.
[(CO3)(Understand/LOCQ)]

6 + (2 + 2 + 2) = 12

3. (a) Determine the current in 10 Ω resistor for the following network by using nodal analysis.

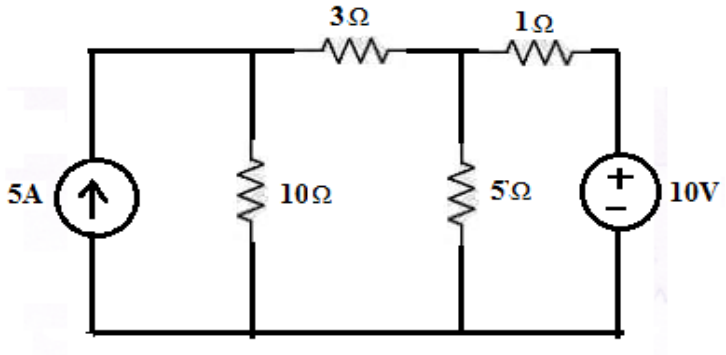

Fig. 2

[(CO3)(Analyse/IOCQ)]

(b) Determine the maximum power delivered to the load in the circuit shown in below figure.

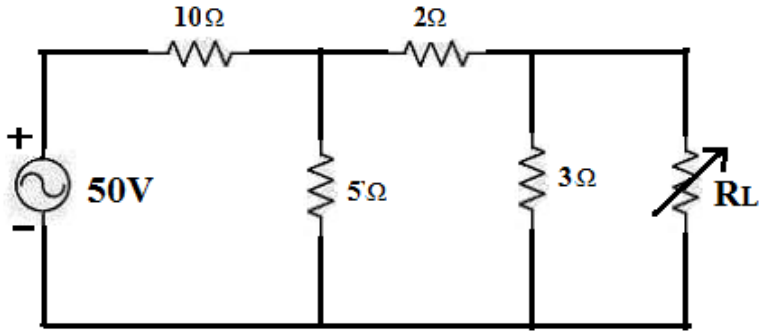

Fig. 3 *[(CO2)(Apply/IOCQ)]*

6 + 6 = 12

Group – C

4. (a) A circuit, having a resistance of 10 Ω with a capacitance of 0.1 μF and a variable inductance in series, is connected across a 200 V, 50 Hz supply. Calculate:
(i) the inductance required to attain resonance;
(ii) voltages across the inductance and the capacitance at resonance;
(iii) the *Q* factor of the circuit. *[(CO1)(Analyse/IOCQ)]*

(b) Two coils are mutually coupled, with L_1 = 20 mH, L_2 = 80 mH, and k = 0.6. Calculate the maximum possible equivalent inductance if the coils are connected in parallel. *[(CO1)(Analyse/IOCQ)]*

(3 + 3 + 2) + 4 = 12

5. (a) For the coupled coils in Fig. 4, show that $L_{eq} = \dfrac{L_1L_2 - M^2}{L_1 + L_2 - 2M}$

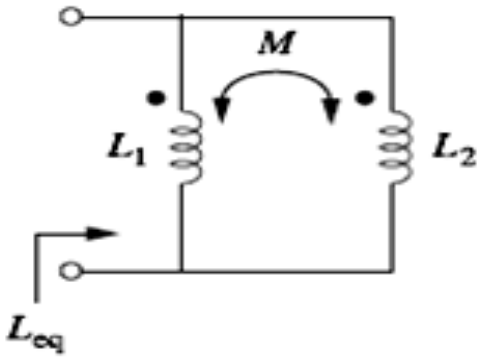

Fig. 4 *[(CO1)(Evaluate/HOCQ)]*

(b) A capacitor of capacitance 10 /π μF is connected across a 220 V, 50 Hz ac mains. Calculate the capacitive reactance, rms value of current and express the equations of voltage and current. *[(CO1) (Analyse/IOCQ)]*

6 + (1+1+2+2) = 12

Group - D

6. (a) Express Z parameters in terms of ABCD parameters. *[(CO5)(Remember/LOCQ)]*

(b) Determine Z-parameters of the network shown in the Fig. 4.

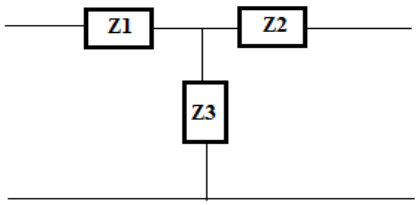

Fig. 4

Where, Z_1= (4+j5) Ω, Z_2= 5 Ω and Z_3= (4-j5) Ω. *[(CO5)(Analyse/IOCQ)]*

7 + 5 = 12

7. (a) A 0.1 μF capacitor charged to 10 V is discharged through a 1 KΩ resistor. Calculate the time required for the voltage across the capacitor to drop to 1V. *[(CO4)(Analyze/IOCQ)]*

(b) A current i(t) flows through the circuit of Fig. 5, when the switch is closed at t=0 sec. Derive the expressions of current i(t) for t>0.

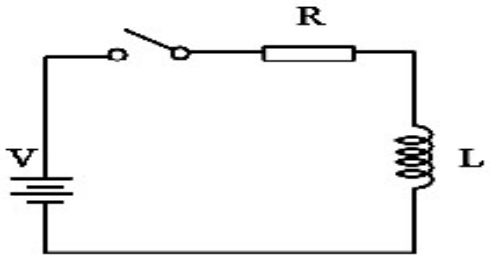

Fig. 5 *[(CO4)(Understand/LOCQ)]*

6 + 6 = 12

Group - E

8. (a) Design the scheme of realizing a band pass filter. *[(CO6)(Design/HOCQ)]*

(b) Draw the circuit and explain the operation of 1st order HP Butterworth filter. *[(CO6)(Understand/LOCQ)]*

5 + 7 = 12

9. (a) Explain about classification of filters. *[(CO6)(Understand/LOCQ)]*

(b) Design a low-pass active filter at a cut-off frequency of 1 KHz with a pass band gain of 2. *[(CO6)(Design/HOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	33.33	48.95	17.7

Course Outcome (CO):

After the completion of the course students will be able to

1. Apply knowledge of mathematics, science, and engineering to the analysis and design of electrical circuits.
2. Choose appropriate circuit laws and analysis tools to analyze the dc and ac networks.
3. Create dc and ac circuit equations using network theorems.
4. Analyze the transient and steady state responses of dc circuits.
5. Analyze two-port networks with series, parallel, cascade connections and evaluate port parameters and conditions.
6. Design and analyze LP, HP, BP, BS passive and active filters.

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