# CIRCUIT THEORY AND NETWORK ANALYSIS
## (AEIE 2103)

**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) The function of an inductor is to resist
(a) a current spike (b) a voltage spike
(c) both voltage and current spikes (d) None of the above.

(ii) Under maximum power transfer condition in a DC circuit, the load voltage is _____ the source voltage.
(a) equal to (b) half
(c) one third (d) double

(iii) Time constant of an RC series circuit is
(a) RC (b) 1/RC
(c) R/C (d) C/R

(iv) A voltage dependent current source is realized using a/an
(a) inductor (b) diode
(c) field effect transistor (d) bipolar junction transistor

(v) In an RLC series circuit, the power factor at resonance is
(a) lagging (b) leading
(c) unity (d) zero

(vi) The impedance of an element is given by (1+j 2)Ω. The element comprises of
(a) resistor and inductor (b) resistor and capacitor
(c) capacitor and inductor (d) all of the above.

(vii) Which of the followings is correct for $Z_{21}$ in a two-port network?
(a) $1/Y_{21}$ (b) $-Y_{21}/\det Y$
(c) $Y_{21}/\det Y$ (d) $Y_{11}/\det Y$

(viii) Thermocouple is an example of a _____ source.
(a) dependent voltage (b) dependent current
(c) dependent impedance (d) none of the above

(ix) To reject the power line interference that contaminates the signal from a displacement sensor, the best fit filter is
(a) Low pass filter with suitable cut-off frequency
(b) High pass filter with suitable cut-off frequency
(c) Band reject filter
(d) Narrow stop band filter

(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) $\frac{1}{2\pi\sqrt{RC}}$

## Group- B

2. (a) State Thevenin's Theorem. [(CO1) (Remember/LOCQ)]
(b) What are the limitations of Thevenin's theorem? [(CO2) (Remember/LOCQ)]
(c) In the circuit in Fig. 1, given, I = 1 A for Is = 0A. What is the value of I for Is = 2A? Justify. [(CO1)(Understand/IOCQ)]

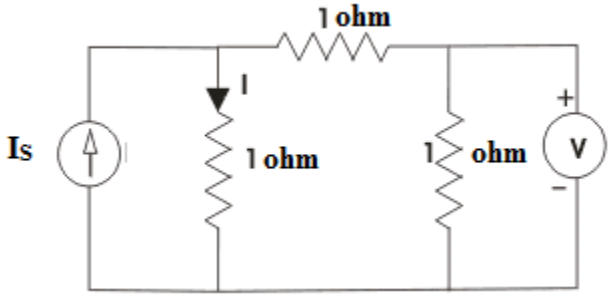


***Fig.1***

(d) In the circuit of Fig.1, if $I_s$ = 1 A and V = 5 V, then find the value of I. [(CO4) (Analyse/IOCQ)]

**2 + 2 + 2 + 6 = 12**

3. (a) In the circuit shown in Fig. 2, find the effective resistance across the terminals a and b. [( CO2) (Remember/ Understand/LOCQ)]

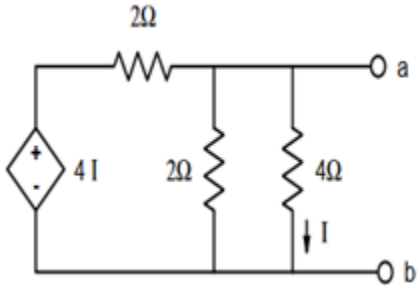


***Fig. 2***

(b) Find (i) Thevenin's voltage (ii) Thevenin's resistance (iii) Norton's current and (iv) Norton's
Resistance for the above circuit in Fig. 2. [(CO3) (Understand/IOCQ)]

(c) A current dependent voltage source has magnitude $\alpha I_0$. Say about $\alpha$ and $I_0$. [(CO4)(Remember/LOCQ)]

**6 + (1 × 4) + 2 = 12**

## Group - C

4. A series RLC circuit is excited with a 50V, 50 Hz sinusoidal source. The voltages across the resistance and the capacitance are shown in the fig. 3.
   (i) Justify the circuit condition.
   (ii) Find the voltage across the inductor ($V_L$).
   (iii) Find the resonant frequency of the circuit.
   (iv) Find the quality factor of the circuit. [(CO4) (Apply/IOCQ)]

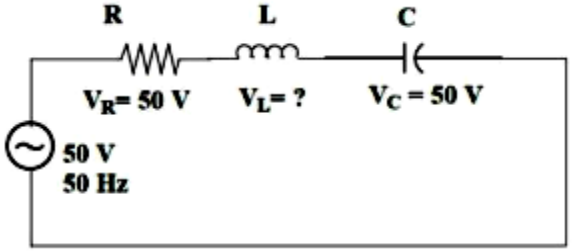


*Fig.3*

**(3 + 3 + 3 + 3) =12**

5. (a) For the circuit in Fig. 4, find the value of ώ so that the circuit current and source voltage are in phase. [(CO4) (Understand/LOCQ)]

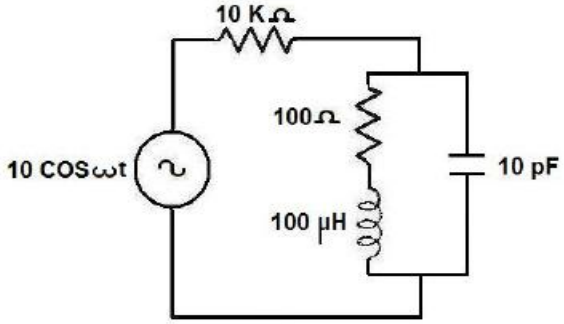


*Fig. 4*

(b) What are the features of a series resonating circuit? [(CO2) (Understand/LOCQ)]
(c) Calculate the impedance of the circuit at half power points?
[(CO1)( Analyze/HOCQ)]

**6 + 2 + 4 = 12**

## Group – D

6. (a) Express Y- parameters in terms of Z-parameters. [(CO4) (Understand/LOCQ)]
   (b) Find the two –port admittance matrix for the circuit in Fig.5. [(CO2)(Analyze/IOCQ)]

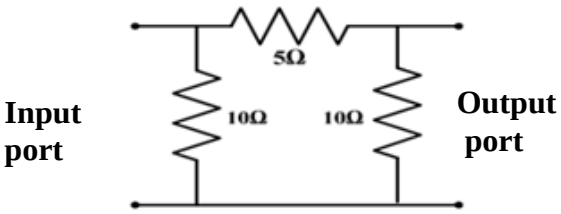


Fig. 5

**6 + 6 = 12**

7. (a) In the circuit of Fig.6, the switch SW was open for a long time. SW is closed at t=0, Find (i) $V_c$ (t= infinity), (ii) Time constant of the circuit, (iii) $V_c(t)$ at t = 1 second. [(CO1) (Analyze/IOCQ)]

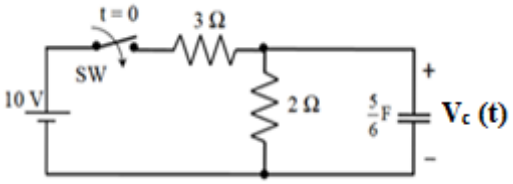


Fig.6

(b) A series RLC circuit is characterized by its damping ratio. Derive an expression relating damping ratio in terms of R, L and C. [(CO3) (Understand/LOCQ)]

(c) If each of the values of inductance, capacitance and resistance of a series LCR circuit are doubled, will there be any change in the characteristics of the circuit? Justify your answer. [(CO3) (Understand/LOCQ)]

**6 + 4 + 2 = 12**

## Group - E

8. (a) what conditions are to be met to realize a band pass filter? Draw the scheme to realize a band reject filter. [(CO6)(Understand/LOCQ)]

(b) Analyse the circuit to know the type of the filter shown in Fig.7. [(CO6) (Analyse/HOCQ)]

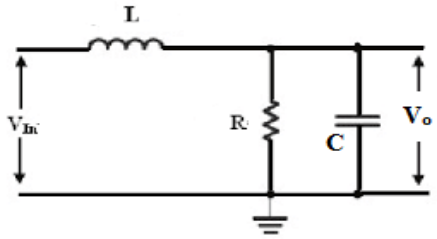


Fig.7

(c) State an application of the above filter circuit. [(CO1) (Analyse/IOCQ)]

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

9. (a) Design a low pass filter with cut-off frequency 50 Hz and pass gain 10. [(CO6)(Design/HOCQ)]

(b) A capacitive type paper thickness sensor is used to measure the thickness of a paper roll in the laboratory environment. Suggest a suitable type of filter to process the signal from the sensor. Justify your answer. [(CO6)(Justify/HOCQ)]

**8 + 4 = 12**

| Cognition Level | LOCQ | IOCQ | HOCQ |
|---|---|---|---|
| Percentage distribution | 44.79% | 36.46% | 18.75% |

**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. Identify, formulate, and solve engineering problems in the area circuits and systems.
3. Acquire skills in analyzing electrical measuring devices, analog electronic circuits, and power electronic circuits.
4. Analyze and synthesize RL, RC and RLC networks, passive and active filters.
5. Obtain circuit matrices of linear graphs and analyze networks using graph theory.
6. Design an electric system, components or process to meet desired needs within realistic constraints.

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

| Department & Section | Submission Link |
|---|---|
| AEIE | https://classroom.google.com/c/NDA1NjM3MzExNTEw/a/NDc1MTU5MTM4MDg4/details |