CIRCUIT THEORY & NETWORK ANALYSIS
(AEI2102)

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 RMS value of a sinusoidal current source is 12.25 A, its peak value is _____ A.
(a) 14.34 (b) 12.12 (c) 8.66 (d) none of the above

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

(iii) A network, described by Z- parameters, will be symmetrical if
(a) $Z_{11} = Z_{22}$ (b) $Z_{12} = Z_{21}$ (c) $Z_{11} = Z_{12}$ (d) $Z_{22} = Z_{21}$

(iv) When two inductive coils having self-inductance L1, L2 and mutual inductance M in between them are connected in series addition, the equivalent inductance of the configuration is ____.
(a) L1+L2+2M (b) L1+L2-2M (c) L1+L2+M (d) L1+L2-M

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

(vi) If a series connected R and L are connected through a switch to a supply voltage (V), the value of the current through the inductor will be___ , ____ at t=0 and infinity respectively.
(a) V/R, 0 (b) 0, V/R (c) ∞, 0 (d) 0, ∞

(vii) The damping ratio of an RLC circuit depends on
(a) R, L, and C (b) R and L (c) R and C (d) L and C

(viii) Lower and higher cut-off frequencies of a band-pass filter are 5 kHz and 15 kHz. Filter's bandwidth is _____ KHz.
(a) 5 (b) 10 (c) 15 (d) 75

(ix) A filter for which the input and output voltages are equal in amplitude for all input frequencies is typed as a ____ filter.
(a) Low pass (b) Band pass (c) Band stop (d) All-pass

(x) The gain of a filter is constant. The filter is a ____ pass filter.
(a) All (b) Low (c) High (d) Band elimination

Fill in the blanks with the correct word

(xi) The expression of power at lower half power frequency is _____.

(xii) A capacitor will act as _____ at t = α.

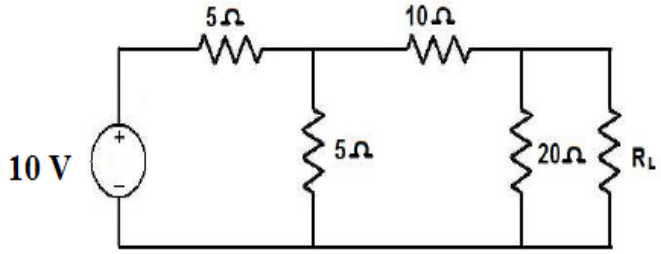
(xiii) An active low pass filter with RC passive components has the cut-off frequency _____.

(xiv) Phasor diagram is possible when all of the branch voltages and currents in an alternating circuit have the same _____.

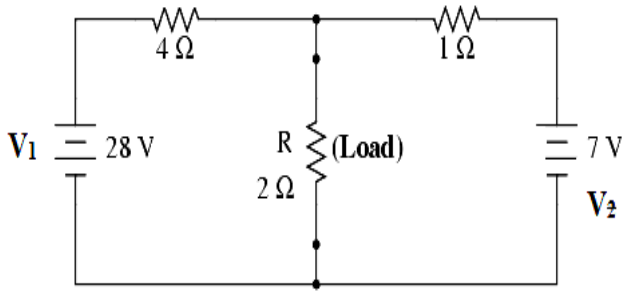
(xv) The CMRR of an operational amplifier is expressed as _____.

Group - B

2. (a) Find the value of R_L (shown in the following figure)when it receives maximum power. If the 10 V source is replaced by a 20V source, then what should be the new value of R_L for maximum power transfer? Justify. *[(CO2)(Apply/HOCQ)]*

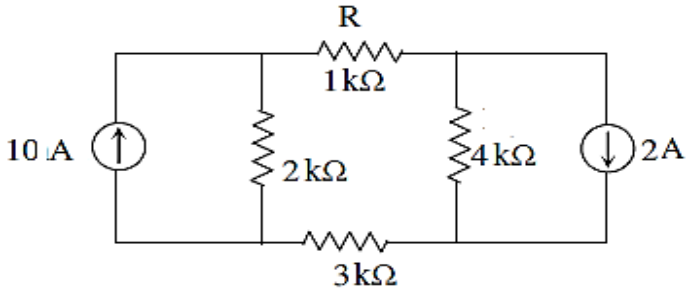


(b) Using Norton's theorem, find the current through the load resistor R in the following circuit. Draw the respective Norton's equivalent circuit. *[(CO2)(Apply/IOCQ)]*



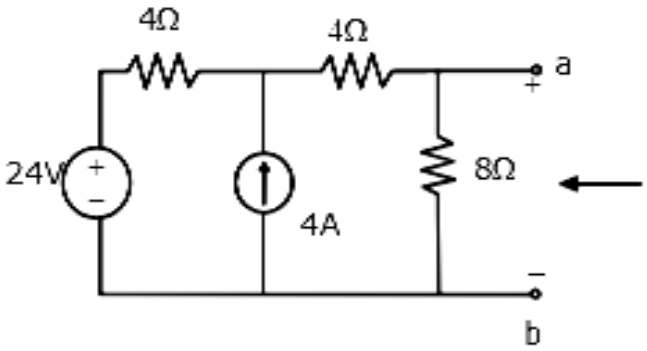
6 + (4 + 2) = 12

3. (a) Apply Superposition theorem to find the current through the resistor R (1 KΩ) in the following circuit. Crosscheck the answer using source transformation.



[(CO2)(Evaluate/IOCQ)]

(b) The following circuit has to provide the maximum amount of power to an industrial heater. Find the value of load resistance. Calculate the amount of maximum power transferred to the load. Under this condition, find the efficiency of the circuit. *[(CO2)(Apply/IOCQ)]*



6 + (4 + 2) = 12

Group - C

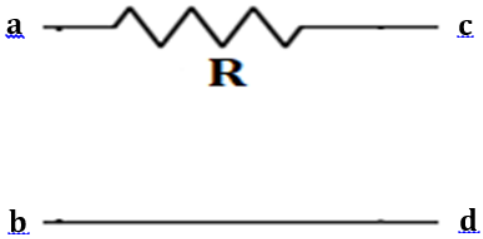
4. (a) A two–port network is described by the following equations:

$V_1 = 50\ I_1 + 20\ I_2$

$V_2 = 30\ I_1 + 10\ I_2$

Comment on the following information: $Y_{12} = 0.2$, $h_{12} = 2.0$, A = 25. *[(CO3)(Analyse/IOCQ)]*

(b) Find the admittance matrix for the following circuit. Take R = 10 Ω.

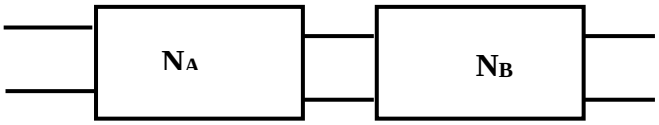


[(CO3)(Analyse/IOCQ)]

(3 + 3 + 3) + 3 = 12

5. (a) Write down the describing equation for h- parameters. Define the h-parameters. Draw the equivalent electrical circuit. *[(CO3)(Remember/LOCQ)]*

(b) Two 2-port networks N_A and N_B are connected in cascade as shown below.



$N_A = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$ & $N_B = \begin{pmatrix} 4 & 3 \\ 2 & 1 \end{pmatrix}$

The networks are described by T parameters as shown above. Find the overall T-parameters. *[(CO3)(Apply/IOCQ)]*

(2 + 2 + 2) + 6 = 12

Group - D

6. (a) Define "Transfer function". What are the different ways to represent a transfer function? What physical information one may have from the transfer function of an electrical circuit? *[(CO5)(Understand/LOCQ)]*

(b) The transfer function of an electrical circuit is given below. (i) Evaluate the poles and zeros (ii) Draw the corresponding pole–zero map. *[(CO5)(Understand/LOCQ)]*

$$T.F.= \frac{s^2 + 2s + 2}{s(s+1)(s^2+3s+4)}$$

(2 + 3 + 1) + (4 + 2) = 12

7. (a) A RLC series circuit is powered by a DC source. Derive expressions relating (i) damping ratio and (ii) natural frequency in terms of passive components of the circuit. *[(CO5)(Analyse/IOCQ)]*

(b) If R = 2 Ω, L = 4 H, and C = 1 F in a given RLC circuit, calculate the damping ratio and natural frequency of the circuit. *[(CO5)(Understand/LOCQ)]*

(c) What changes in damping ratio and natural frequency of the circuit will result from (i) doubling the source magnitude while maintaining components values same and (ii) if L and C are doubled keeping all other information same? *[(CO5)(Understand/LOCQ)]*

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

Group - E

8. (a) Design a high- pass active filter at a cut-off frequency of 1 KHz and a pass-band gain of 2. *[(CO6)(Analyse/IOCQ)]*

(b) Draw a scheme to realize a band pass filter. *[(CO6)(Understand/LOCQ)]*

8 + 4 = 12

9. (a) Draw a scheme to realize a band pass filter. *[(CO6)(Understand/LOCQ)]*

(b) Differentiate between a Butterworth filter and Chebyshev filter. *[(CO6)(Remember/LOCQ)]*

(c) What is the physical significance of the order of a filter? Draw the circuit of a second order low pass filter. *[(CO6)(Apply/IOCQ)]*

4 + 3 + (1 + 4) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	36.45	57.3	6.25