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) In a network consisting of linear resistors and ideal voltage source, if all the resistive values are doubled, then voltage across each resistor _____
(a) Increases four times (b) Remains unchanged
(c) Doubled (d) Halved

(ii) An ideal voltage source is deactivated if its terminals are _____.
(a) Replaced by an inductor (b) Short circuited
(c) Replaced by its internal resistance (d) Left open

(iii) The impedance of an element is given by (2+j2) Ω. The element comprises of _____.
(a) Resistor and inductor (b) Resistor and capacitor
(c) Inductor and capacitor (d) All of the above

(iv) The value of coefficient of coupling in a practical magnetically coupled circuit
(a) Equal to 0 (b) Equal to 1
(c) Greater than one (d) Greater than zero but less than 1

(v) 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) $Z_{22} = Z_{21}$

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

(vii) A capacitor will act as an _____ at t= α
(a) Current source (b) Voltage source
(c) Open circuit (d) Short Circuit

(viii) 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

(ix) The roll off of the first order low pass filter is ___ dB/decade.
(a) -20 (b) +20 (c) -40 (d) +40

(x) An active filter differs from a passive filter because it can
(a) Provide voltage gain (b) Use only passive components
(c) Attenuate the signal (d) Work at high frequencies

Fill in the blanks with the correct word

(xi) The system is generally considered to reach its final value after about _____ time constants(s).

(xii) An inductor will act as _____ at t = α.

(xiii) The number of storage elements in a second order passive and active filters is _____ and _____ respectively.

(xiv) Differential equation for an electrical circuit is found when the circuit has at least _____

(xv) Maximum power transfer occurs when the load resistance is _____ to the internal resistance of the source.

Group - B

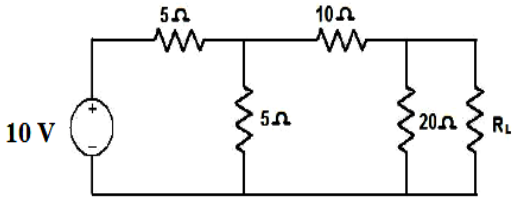
2. (a) In an AC circuit, the voltage and the current expressions are given by $v(t)=100\sin(100\pi t+30^0)$ and $i(t)= 10\sin(100\pi t+60^0)$ respectively. Determine the impedance of the circuit in phasor form. Find the RMS, average and form factor of the voltage source $v(t)=100\sin(100\pi t+30^0)$. *[(CO2)(Analyse/IOCQ)]*

(b) For the problem in (a), if frequency of the voltage source is doubled, then what will be changes in RMS, average and form factor? *[(CO2)(Remember/LOCQ)]*

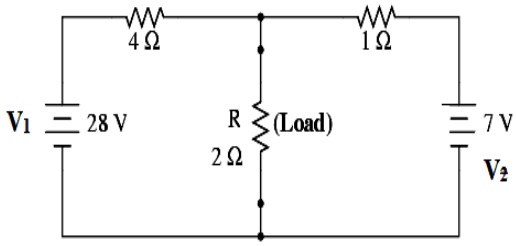
(c) For the problem in (a), Find the source and load power factors. *[(CO2)(Apply/IOCQ)]*

6 + 3 + 3 = 12

3. (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)]*



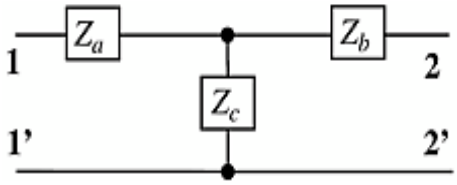
(b) Using Norton's theorem, find the current through the load resistor R in the following circuit. Draw the respective Norton's equivalent circuit. *[(CO2)(Apply/IOCQ)]*



6 + (4 + 2) = 12

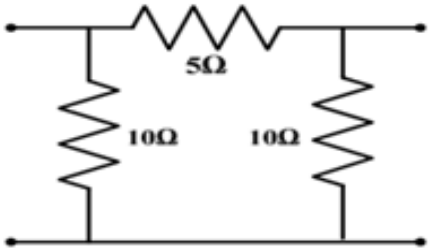
Group - C

4. (a) The elements in the Z-parameter matrix are: Z11= 2Ω, Z12 =1Ω, Z21 =1Ω, and Z22=4Ω. Find Za, Zb, and Zc in the following circuit.



[(CO3)(Analyse/IOCQ)]

(b) Find the admittance matrix for the following circuit.



[(CO2)(Apply/IOCQ)]

6 + 6 = 12

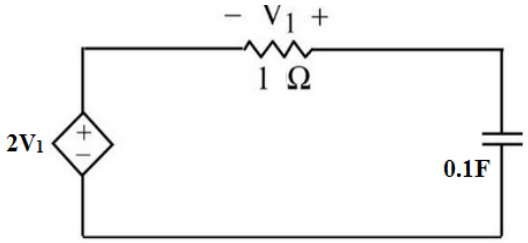
5. (a) Z- parameters of a two port network are Z_1=2 Ω, Z_{12} =2 Ω, Z_{21}=10 Ω, Z_{22} =11 Ω. Evaluate the corresponding ABCD- parameters. *[(CO3)(Analyse/IOCQ)]*

(b) Check the symmetry and reciprocity of that network. *[(CO3)(Apply/IOCQ)]*

(6 + 2) + 4 = 12

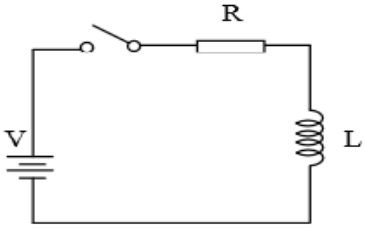
Group - D

6. (a) Find the time-constant of the circuit shown in the following figure.



[(CO4)(Analyse/IOCQ)]

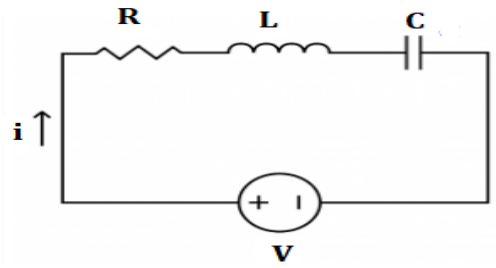
(b) Find an expression of current i(t), t> 0 in the RL-circuit as shown in the figure below.



[(CO4)(Analyse/IOCQ)]

6 + 6 = 12

7. (a) Write down the differential equation for the circuit shown below. Derive the transfer function of the circuit and hence write the characteristics equation. Locate the root (s) on the s-plane. *[(CO5)(Analyse/IOCQ)]*

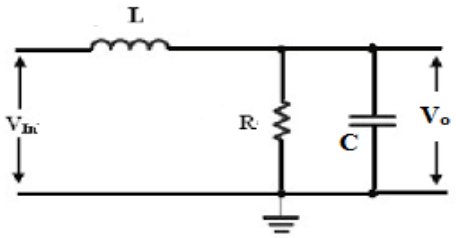


(b) Show the differential equation of a purely resistive DC powered circuit. What should the order of the circuit be? *[(CO5)(Apply/IOCQ)]*

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

Group - E

8. (a) Analyze the circuit shown in the following figure to determine the type of the filter.



[(CO6)(Analyse/IOCQ)]

(b) Draw the ideal and practical characteristics of a Band-pass filter and a Band stop filter. *[(CO6)(Remember/LOCQ)]*

8 + 4 = 12

9. (a) Draw an active band-reject filter using suitable number of operational amplifier(s). What condition must be met to realize such a filter? How do the op-amps contribute the cut- off frequencies? *[(CO6)(Apply/IOCQ)]*

(b) An ECG sensor typically requires a signal bandwidth in the range of 0.5 Hz – 100 Hz range for accurate disease diagnosis. Suggest a basic suitable filter type with proper reasons. *[(CO6)(Apply/HOCQ)]*

(4 + 2 + 2) + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	13.54	76.04	10.42