Modified

CBCS SCHEME

USN | | | | | | | | | |

18EC32

Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
Network Theory

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Using source transformation technique find the current through 5Ω resistor for the circuit shown in Fig.Q.1(a) **(06 Marks)**

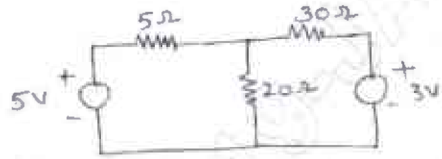

Fig.Q.1(a)

b. Use Mesh Analysis to determine the Mesh currents i_1, i_2 and i_3 for the network shown in Fig.Q.1(b). **(06 Marks)**

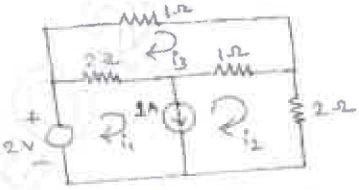

Fig.Q.1(b)

c. Find the power delivered by 1A current source using nodal analysis for the circuit shown in Fig.Q.1(c). **(08 Marks)**

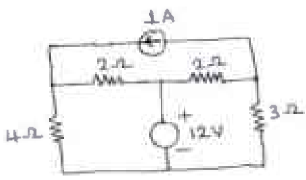

Fig.Q.1(c)

OR

2 a. Three Impedances are connected in delta, obtain the star equivalent of the network. **(06 Marks)**

b. Use Mesh Analysis to find the power delivered by the dependent voltage source in the circuit shown in Fig.Q.2(b). **(06 Marks)**

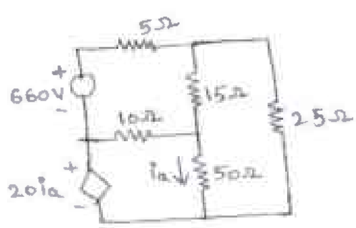

Fig.Q.2(b)

c. Determine all the node voltages for the circuit shown in Fig.Q.2(c) using nodal analysis. **(08 Marks)**

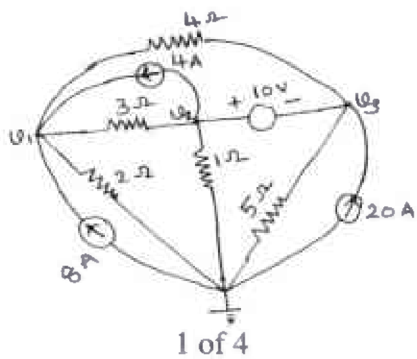

Fig.Q.2(c)

Module-2

3 a. State and explain superposition theorem **(06 Marks)**

b. Use Millman's Theorem to find the current flowing through $(2 + j3)\Omega$ impedance for the circuit shown in Fig.Q.3(b). **(08 Marks)**

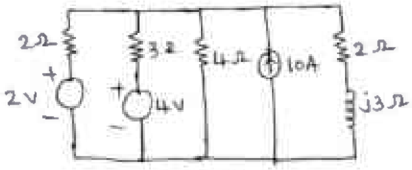

Fig.Q.3(b)

c. State and prove Norton's theorem. **(06 Marks)**

OR

4 a. Find the Thevenin's equivalent for the circuit shown in Fig.Q.4(a) with respect to terminals X-Y. **(08 Marks)**

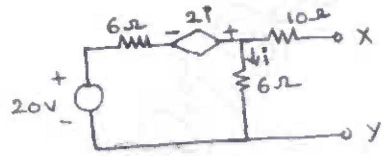

Fig.Q.4(a)

b. Find the condition for maximum power transfer in the AC circuit, where both R_L and X_L are varying. **(06 Marks)**

c. Determine the current through the load resistance using Norton's Theorem for the circuit shown in Fig.Q.4(c). **(06 Marks)**

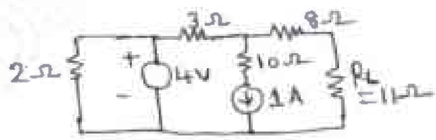

Fig.Q.4(c)

Module-3

5 a. Explain the behavior of R, L, C elements at the time of switching at $t = 0$, at $t = 0^+$ and $t = \infty$. **(07 Marks)**

b. In the network shown in Fig.Q.5(b). Find i, $\frac{di}{dt}$ and $\frac{d^2i}{dt^2}$ at $t = 0^+$. Assume that the capacitor is initially uncharged. **(07 Marks)**

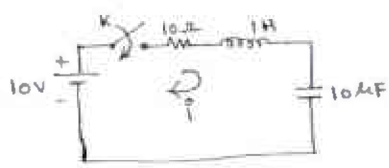

Fig.Q.5(b)

c. In the network shown in Fig.Q.5(c) find, i, $\frac{di}{dt}$ and $\frac{d^2i}{dt^2}$ at $t = 0^+$. The swich k is closed at $t = 0$ with zero current in the inductor. **(06 Marks)**

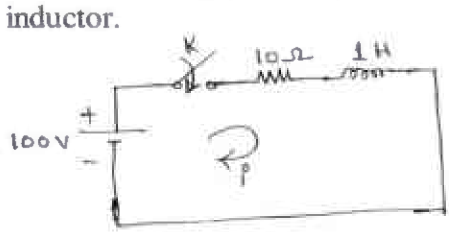

Fig.Q.5(c)

OR

6 a. In the network shown in Fig.Q.6(a). The switch k is changed from position a to b at t = 0, the steady state is reached at position a. Find i, $\frac{di}{dt}$ and $\frac{d^2i}{dt^2}$ at $t = 0^+$. Assume that the capacitor is initially uncharged. **(10 Marks)**

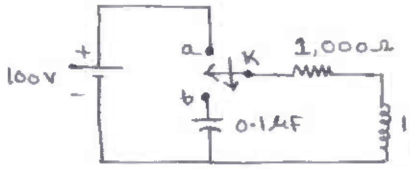

Fig.Q.6(a)

b. For the network shown in Fig.Q.6(b). The network is in steady state with switch k is closed. At t = 0, the switch is opened. Determine the voltage across the switch V_k and $\frac{d}{dt}V_k$ at $t = 0^+$. **(10 Marks)**

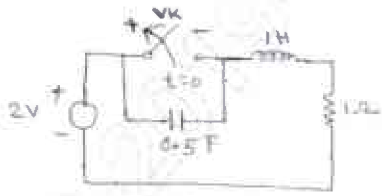

Fig.Q.6(b)

Module-4

7 a. Obtain Laplace transform of
   i) Step function
   ii) Ramp function
   iii) Impulse function. **(09 Marks)**

b. Find the Laplace transform of the periodic signal x(t) as shown in Fig.Q.7(b). **(11 Marks)**

Fig.Q.7(b)

OR

8 a. In the series RL circuit shown in Fig.Q.8(a), the source voltage is v(t) = 50 sin 250tV. Using Laplace transform determine, the current when switch K is closed at t = 0. **(10 Marks)**

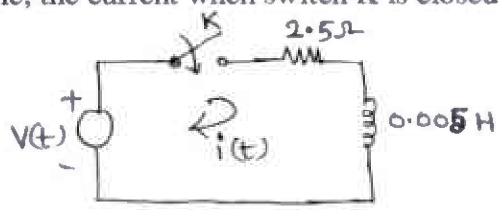

Fig.Q.8(a)

b. Find the Laplace transform of the non-sinusoidal periodic waveform shown in Fig.Q.8(b)

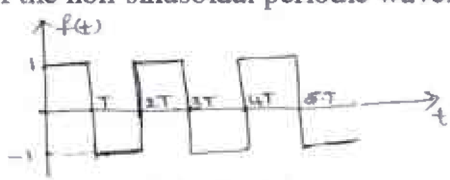

Fig.Q.8(b) **(10 Marks)**

Module-5

9 a. Define Z parameters. Determine Z parameters interms of Y parameters. **(06 Marks)**

b. Determine h parameters of the circuit shown in Fig.Q.9(b) **(07 Marks)**

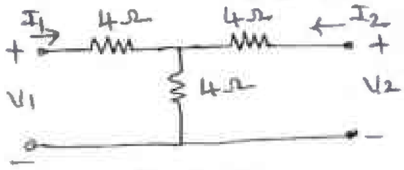

Fig.Q.9(b)

c. For the network shown in Fig.Q.9(c). Find the transmission parameters. **(07 Marks)**

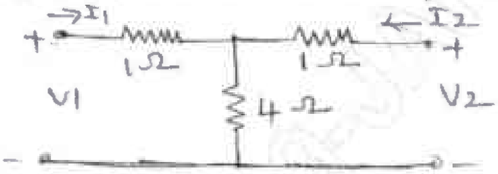

Fig.Q.9(c)

OR

10 a. Define Q-factor, selectivity and Band width. **(03 Marks)**

b. A series RLC circuit has a resistance of 10Ω, an inductance of 0.3H and a capacitance of 100μF. The applied voltage is 230V. Find: i) The resonant frequency ii) lower and upper cut off frequencies iii) current at resonance iv) currents at f_1 and f_2 v) Voltage across. the inductance at resonance. **(07 Marks)**

c. Derive the expression for the resonant frequency of the circuit shown in Fig.Q.10(c). Also show that the circuit will resonate at all frequency if $R_L = R_C = \sqrt{\dfrac{L}{C}}$. **(10 Marks)**

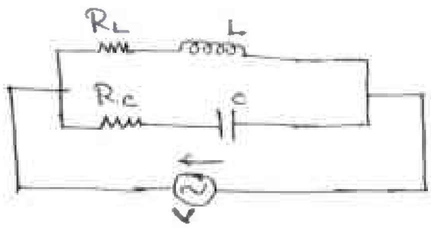

Fig.Q.10(c)

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Approved

Visvesvaraya Technological Universi

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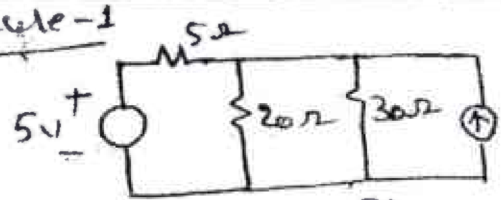
Signature of Scrutinizer

Scheme & Solution

Subject Title : Network Theory **Subject Code :** 18EC32

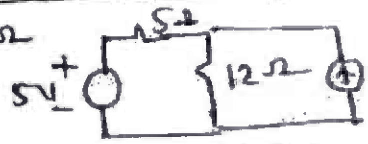
Question Number	Solution	Marks Allocated

1 a. Module-1 $1.5 \times 4 = 06$ Marks



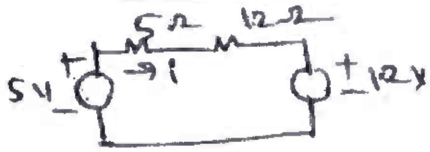
$3/30 = 0.1A$ → 1.5 marks

$20 \| 30 = 12\Omega$



→ 1.5 marks

$12 \times 0.1 = 1.2V$



→ 1.5 marks

$$i = \frac{1.2/5}{17} = \frac{5-1.2}{17} = 0.2235A$$ → 1.5 marks

b. $i_1 - i_2 = 1A$ constraint equation → 01 marks

Supermesh equation

$2(i_1-i_3) + (i_2-i_3) + 2i_2 - 2 = 0$

$2i_1 + 3i_2 - 3i_3 = 2 \rightarrow 2$ → 01 marks

KVL for mesh 3

$2(i_3-i_1) + i_3 + (i_3-i_2) = 0$

$-2i_1 + i_2 + 4i_3 = 0 \rightarrow 3$ → 01 marks

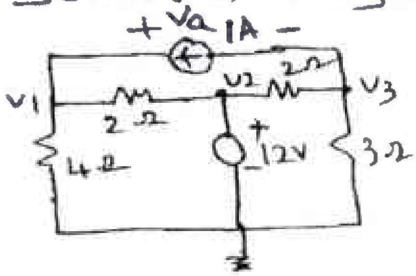
Solving 1, 2 & 3

$i_1 = 1.545A \quad i_2 = 0.545A \quad i_3 = 0.909A$ → 03 marks

Solving i_1, i_2, i_3 } 3 marks

6

c.



$V_2 = 12V$ → 1 marks

$V_a = V_1 - V_3$ → 1 marks

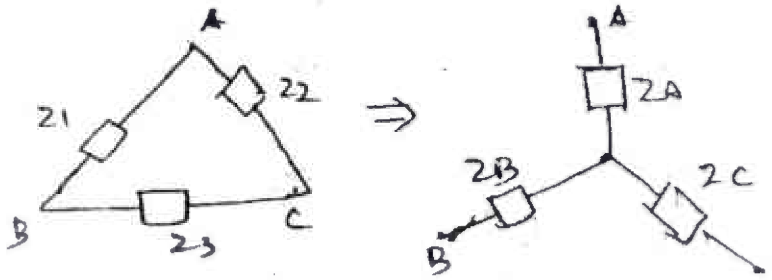
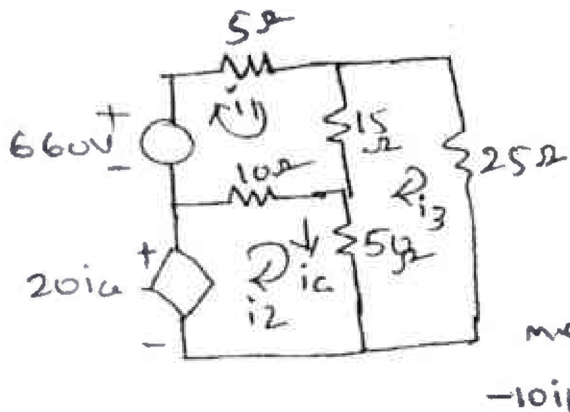
"APPROVED"

Registrar (Evaluation)

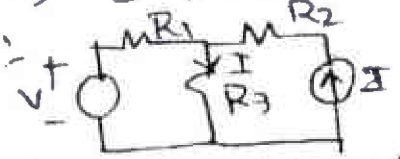
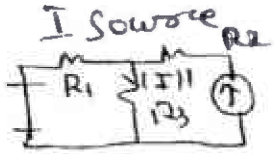
Visvesvaraya Technological University

BELAGAVI - 590018

Subject Title: Network Theory Subject Code: 18EC32

Question Number	Solution	Marks Allocated
	At node 1: $\frac{V_1-V_2}{2}+\frac{V_1}{6}-1=0$ $\frac{V_1-12}{2}+\frac{V_1}{6}-1=0$ $\quad V_1=9.33V$	02 Marks
	At Node 3 $\frac{V_3-V_2}{2}+V_3/3+1=0$ $\quad V_3=$ $V_2=12V$ $\quad V_3=6V$	02 Marks
	$V_a = V_1-V_3=3.33V$	01 Marks
	Power delivered by 1A current Source $=1\times V_a = 3.33W$	01 Marks 8
2(a)		Circuit → 1 Marks
	$Z_{AB}=Z_1 \parallel (Z_2+Z_3)$ $\quad Z_{AB}=Z_A+Z_B$ $Z_{BC}=Z_3 \parallel (Z_1+Z_2)$ $\quad Z_{BC}=Z_B+Z_C$ $Z_{AC}=Z_2 \parallel (Z_1+Z_3)$ $\quad Z_{AC}=Z_A+Z_C$	02 Marks
	$Z_A=\frac{Z_1Z_2}{Z_1+Z_2+Z_3}$ $\quad Z_B=\frac{Z_1Z_3}{Z_1+Z_2+Z_3}$ $\quad Z_C=\frac{Z_2Z_3}{Z_1+Z_2+Z_3}$ ~~→ 1 Mark~~ ~~→ 1 Mark~~ ~~→ 1 Mark~~ Z_A → 1 Mark $\quad Z_B$ → 1 Mark $\quad Z_C$ → 1 Mark	
b.		
	$i_a = i_2 - i_3$	~~02 Marks~~
	Mesh 1 $30i_1-10i_2-15i_3=660$ → (1)	→ 01 Marks
	Mesh 2 $-10i_1+60i_2-50i_3=20i_a$ → (2)	→ 01 Marks

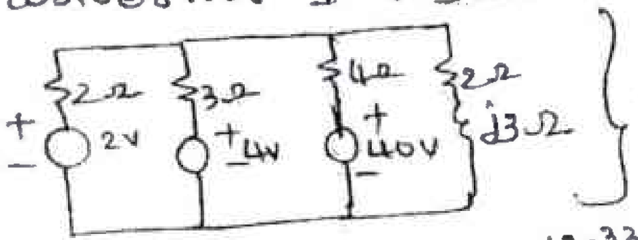
Subject Title: Network Theory **Subject Code:** 18EC32

Question Number	Solution	Marks Allocated
	mesh3 $-15i_1-50i_2+90i_3=0 \rightarrow (3)$	01Marks
	$i_1, i_2, i_3 \rightarrow$	02 Marks
	Solving eq 1,2 & 3 $i_1 = 42A$ $i_2 = 27A$ $i_3 = 22A$ $i_1 \rightarrow$ $i_2 \rightarrow$ $i_3 \rightarrow$	~~01Marks~~ ~~01Marks~~ ~~01Marks~~ 6
	$i_a = 5A$ power delivered by the dependent voltage source $= 20i_a \cdot i_2$ $= 100 \cdot 27 = 2700W$ (delivered)	01Marks
2 c	$v_2 - v_3 = 10V \rightarrow (1)$	01Marks
	node1 $\frac{v_1-v_3}{4}+\frac{v_1-v_2}{3}+\frac{v_1}{2}+8-4=0$ $1.083v_1-0.333v_2-0.25v_3=12 \rightarrow (2)$	02Marks
	super node $\frac{v_2-v_1}{3}+v_2+4-20+\frac{v_3-v_1}{4}+v_3/5=0$ $-0.583v_1+1.333v_2+0.45v_3=16 \rightarrow 3$	02Marks
	Solving 1,2,3 $v_1 = 18.15V$ $v_2 = 17.43V$ $v_3 = 7.43V$	03Marks
	03 $v_1 \rightarrow$ $v_2 \rightarrow$ $v_3 \rightarrow$	1Marks 8 1Marks 1Marks
	module-2	
3 a.	Statement $\rightarrow$ 03Marks Explanation:-  Considering V source   I source  $I = I' + I''$	Explanation $\rightarrow$ 03Marks 6

Subject Title : Network Theory Subject Code : 18EC32

Question Number	Solution	Marks Allocated
	Exp. calculation can also be done by consider -ing both the voltage sources.	

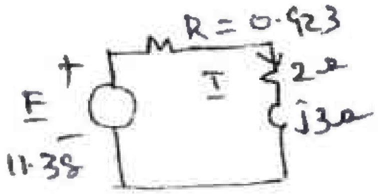
b. Converting I-V source



→ 02 Marks

$$E = \frac{2/2 + 4/3 + 40/4}{1/2 + 1/3 + 1/4} = \frac{12.333}{1.083} = 11.38\,V$$ → 02 Marks

$R = 1/1.083 = 0.923\,\Omega$ → 01 Marks



→ 01 Marks

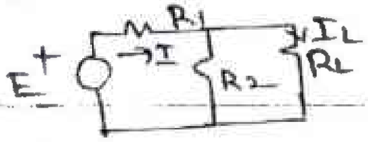
$$I = \frac{11.38}{0.923 + 2 + j3} = \frac{11.38}{2.923 + j3} = \frac{11.38}{\cancel{3.92}}$$

$$= \frac{11.38}{4.188 \angle 45.744}$$

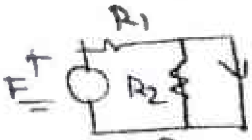
$$= 2.717 \angle -45.744\ A$$ → 02 Marks

c. Statement with circuit → 03 Marks

Proof:-



$$I_L = \frac{E R_2}{R_1R_2 + R_1R_L + R_2R_L}$$ → (1)

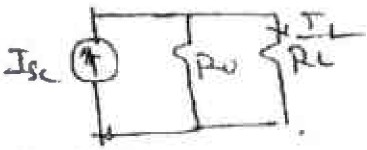


$I_{sc} = E/R_1$

$$R_o = \frac{R_1R_2}{R_1 + R_2}$$

Proof → 03 Marks

E = 0
Short E



$$I_L = \frac{I_{sc} \cdot R_o}{R_o + R_L} = \frac{E R_2}{R_1R_2 + R_1R_L + R_2R_L}$$ → (2)

eq (1) & 2 are same. Hence the theorem is proved.

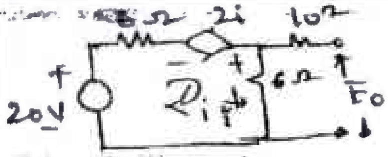
8

6

Subject Title : Network Theory Subject Code : 18EC32

Question Number	Solution	Marks Allocated

4a.

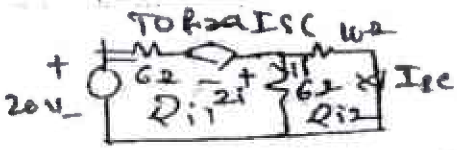


Apply KVL

$6i - 2i + 6i - 20 = 0$

$i = 2A \quad E_o = 2 \times 6 = 12V$ → 02 Marks

To find I_{SC}



$i = i_1 - i_2 \quad i_2 = I_{sc}$ → 01 Marks

KVL for mesh 1

$-20 + 6i_1 - 2(i_1 - i_2) + 6(i_1 - i_2) = 0$

$10i_1 - 4i_2 = 20 \rightarrow (1)$ → 01 Marks

KVL for mesh 2

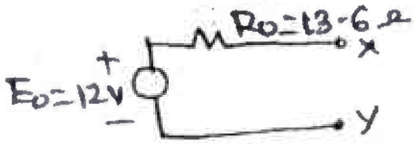
$6(i_2 - i_1) + 10i_2 = 0$

$-6i_1 + 16i_2 = 0 \rightarrow (2)$ → 01 Marks

Solving 1 & 2

$i_2 = I_{sc} = 0.8823A$ → 01 Marks

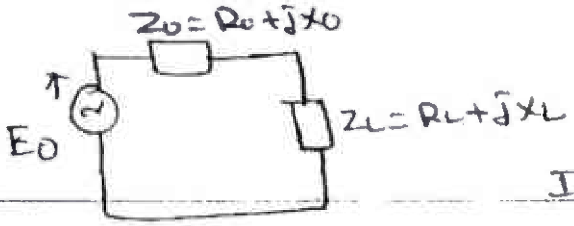
$R_o = \dfrac{E_o}{I_{sc}} = \dfrac{12}{0.8823} = 13.6\Omega$ → 01 Marks



→ 01 Marks

8

b.



$I_L = \dfrac{E_o}{R_L + R_o + j(X_L + X_o)}$

$I_L = \dfrac{E_o}{\sqrt{(R_L + R_o)^2 + (X_L + X_o)^2}}$

$P = I_L^2 \cdot R_L$

$= \dfrac{E_o^2 \cdot R_L}{(R_L + R_o)^2 + (X_L + X_o)^2} \rightarrow (1)$

$\dfrac{\partial P}{\partial X_L} = 0$ differentiating eq (1) → 02 Marks

$X_L = -X_o$

Substituting the condition (1)

$P = \dfrac{E_o^2 \cdot R_L}{(R_L + R_o)^2} \quad \dfrac{\partial P}{\partial R_L} = 0 \quad R_L = R_o$ → 02 Marks

$R_L + jX_L = R_o - jX_o \qquad Z_o = R_o + jX_o$

$Z_o^* = R_o - jX_o$

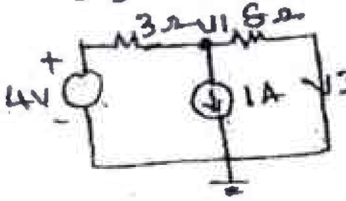
$Z_L = Z_o^*$ → $\boxed{\text{02 marks}}$

Load impedance is the complex conjugate of the source impedance

6

Subject Title: Network Theory   Subject Code: 18EC32

Question Number	Solution	Marks Allocated
4 c.	2Ω resistor connected in parallel with ideal voltage source can be ignored. 10Ω resistance in series with 1A can be ignored.	



Nodal equations

$$\frac{V_1}{8} + \frac{V_1 - 4}{3} + 1 = 0$$

$$\frac{V_1}{8} + \frac{V_1}{3} = 4/3 - 1 = 1/3$$

$0.4583 V_1 = 1/3$ $V_1 = 0.727V$

$I_{sc} = \frac{V_1}{8} = \frac{0.727}{8} = 0.0908A$ → 03 Marks

R_0 = open circuit resistance $= 8+3 = 11Ω$ → 01 Marks

Current through load resistance $= \frac{0.0908}{2}$

$= 0.0454A$ → 01 Marks

→ 01 Marks

6

Module-3

5 a.

Element	behaviour at $t=0^+$	behaviour at $t=\infty$	
R	R	R	→ 01 Marks
L	OC	SC	→ 1½ Marks
I_0	I_0	SC, I_0	→ 1½ Marks
C	SC	OC	→ 1½ Marks
V_0, C	$+ V_0 -$	$+ V_0 -$ OC	→ 1½ Marks

7

b. $i(0^+) = 0$ → 1 Marks

$V_C(0^-) = V_C(0^+) = 0V$

KVL immediately after closing the switch at 0^+: $V = Ri + L\,di/dt + V_C$

$V = R\,i(0^+) + L\,di/dt\,(0^+) + 0$ → ①

$di/dt\,(0^+) = \frac{V}{L} = 10A/sec$ → 3 Marks

Differentiating eq ①: $0 = R\frac{di}{dt}(0^+) + L\frac{d^2i}{dt^2} + i/C$

Subject Title: Network Theory **Subject Code:** 18EC32

Question Number	Solution -	Marks Allocated

$R\frac{d}{dt}i(0^+) + L\frac{d^2}{dt^2}i(0^+) + i/c = 0$

$10 \cdot 10 + L\frac{d^2}{dt^2}i(0^+) + 0 = 0$ $\quad \frac{d^2 i(0^+)}{dt^2} = \frac{-100}{L} = -100A/sec^2$

$\frac{d^2 i(0^+)}{dt^2} = -100A/sec^2 \rightarrow$ 3 marks — 7

c. KVL immediately closing the switch

$i(0^+) = 0 \rightarrow$ 01 marks

$V = Ri + L\,di/dt$

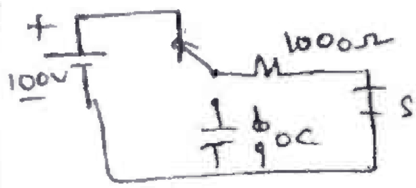
$di/dt\,(0^+) = \frac{V - R\,i(0^+)}{L} \rightarrow ① = \frac{V}{L} = 100A/sec \rightarrow$ 2½ marks — 6

differentiating eq ①

$\frac{d^2 i}{dt^2}(0^+) = -R/L\,\frac{d}{dt}i(0^+) = \frac{-10}{1} \cdot 100$

$= -1000A/sec^2 \rightarrow$ 2½ marks

6a.



switch kil position a

$i(0^-) = V/R = 0.1A$

$i(0^-) = i(0^+) = 0.1A$ $\rightarrow$ 02 marks

Switch is moved from a to b

$Ri + L\,di/dt + 1/c\int i\,dt = 0 \rightarrow ①$ $\quad V_c(0^+) = 0V \rightarrow$ 01 marks — 10

at $t = 0^+$ $\quad R\,i(0^+) + L\,di/dt\,(0^+) + 0 = 0$

$di/dt\,(0^+) = -\frac{R \cdot i(0^+)}{L} = \frac{-1000 \times 0.1}{1} = -100A/sec$ $\rightarrow$ 03 marks

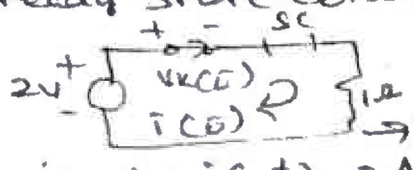
Differentiating eq 1

$R\,di/dt + L\,d^2i/dt^2 + i/c = 0$

at $t = 0^+$ $\quad R\frac{d}{dt}i(0^+) + L\frac{d^2}{dt^2}i(0^+) + \frac{i(0^+)}{c} = 0$

$\frac{d^2 i(0^+)}{dt^2} = -9 \times 10^5 A/sec^2 = -9 \times 10^5 A/sec^2 \rightarrow$ 04 marks

b. Under steady state condition circuit is shown inductor acts as open circuit

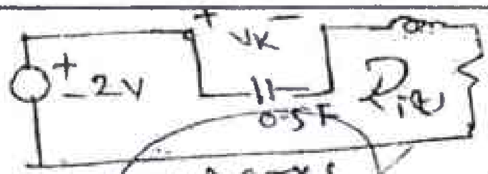
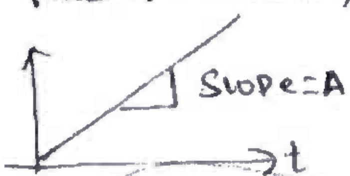


$\rightarrow$ 1 marks

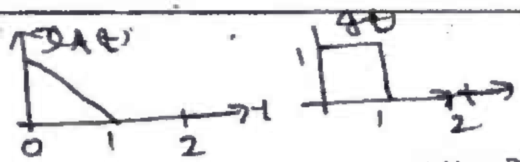
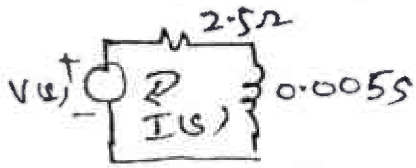
$V_L(0^-) = V_L(0^+) = 0V \rightarrow$ 02 marks

$i(0^-) = i(0^+) = 2A \rightarrow$ 02 marks

Subject Title: Network Theory **Subject Code:** 18EC32

Question Number	Solution	Marks Allocated
	 → 01 Marks	
	$i(t) = C\frac{d}{dt}v_K$ →	01 Marks
	at $t = 0^+$	
	$i(0^+) = C\frac{d}{dt}v_K(0^+)$ →	01 Marks
	$\frac{d}{dt}v_K(0^+) = \frac{i(0^+)}{C} = \frac{2}{0.5} = 4V/sec$ →	02 Marks
	Module-4	10
7 a.	(i) Step Function	
	 → 01 Marks	
	~~u(t) = A~~	
	$f(t) = A\,u(t)$	
	$L[A\,u(t)] = A/s$ →	02 Marks
	(ii) Ramp function	
	 → 01 Marks	
	$f(t) = A\,t\,u(t)$	
	$L[A\,t\,u(t)] = \frac{A}{s^2}$ →	02 Marks
	(iii) Impulse function	
	 → 01 Marks	
	$f(t) = K\,\delta(t)$	
	$L[K\,\delta(t)] = K$ →	02 Marks
b.	The Signal $x(t)$ considered over one period is denoted as $x_1(t)$ is shown	
		
	The Signal $x_1(t)$ may be viewed as $x_A(t)$ and $g(t)$ →	01 Marks

Subject Title: Network Theory Subject Code: 18EC32

Question Number	Solution	Marks Allocated
		02 Marks
	The signal $x_1(t)$ may be viewed as multiplication of $x_A(t)$ and $g(t)$ i.e. $x_1(t) = x_A(t) \cdot g(t)$	01 Marks
	$= [-t+1][u(t) - u(t-1)]$	
	$x_1(t) = -tu(t) + tu(t-1) + u(t) - u(t-1)$	
	$= -t\,u(t) + (t-1+1)\,u(t-1) + u(t) - u(t-1)$	03 Marks
	$= u(t) - r(t) + r(t-1)$	
	Taking Laplace Transformation	
	$X_1(s) = \frac{1}{s} - 1/s^2 + \frac{1}{s^2} e^{-s}$	
	$= \frac{s-1+e^{-s}}{s^2}$ $\quad T = 2\,sec$	
	$X(s) = \frac{X_1(s)}{1-e^{-sT}} = \frac{s-1+e^{-s}}{s^2(1-e^{-2s})}$	04 Marks
8 a	The switch is closed at $t=0$ and before it was open. Hence initial inductor current is zero $i(0^-) = 0A$	01 Marks
	$V(t) = 50\sin 250t$	
	$V(s) = \frac{50 \cdot 250}{s^2 + 250^2}$	01 Marks
	The s-domain Network is shown	
		
	$V(s) = 2.5I(s) + 0.005\,s\,I(s)$	
	$I(s) = \frac{V(s)}{2.5 + 0.005s}$	01 Marks
	Substituting V(s) & simplifying	
	$I(s) = \frac{2.5\times10^6}{(s+500)[s^2+(250)^2]}$	
	~~Taking inverse Laplace Transformation~~	
	$I(s) = \frac{8}{s+500} - 8\cdot\frac{s}{s^2+(250)^2} + \frac{4000}{250} \times \frac{250}{s^2+(250)^2}$	04 Marks
	Taking inverse Laplace Transformation	

11

Subject Title : Network Theory **Subject Code :** 18EC32

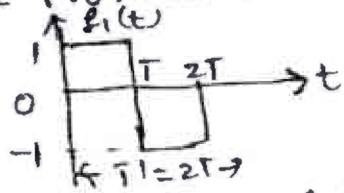
Question Number	Solution	Marks Allocated

$i(t) = 8 \cdot e^{-500t} - 8\cos(250t) + 16\sin 250t$

$= \left[8 \cdot e^{-500t} - 8\cos(250t) + 16\sin(250t)\right] A$ → 03 marks

10

8 b Consider the first cycle of the function $f(t)$ as shown



Let T' be the time period of $f(t)$ which is 2T → 02 marks

$f_1(t) = 1$ at $t = 0$ $f_a(t) = u(t)$

at $t = T$ instantaneous change from 1 to −1

-2 at $t = 2T$ $f_b(t) = -2u(t-T)$ → 02 marks

at $t = 2T$ $f_1(t)$ changes from −1 to 0

step of +1 at $t = 2T$ → 02 marks

$f_c(t) = u(t-2T)$

$f_1(t) = f_a(t) + f_b(t) + f_c(t) = u(t) - 2u(t-T) + u(t-2T)$ → 02 marks

$F_1(s) = \frac{1}{s} - \frac{2}{s} e^{-Ts} + 1/s\, e^{-2Ts}$

$F(s) = \frac{F_1(s)}{1 - e^{-T's}} = \frac{1}{s} \cdot \frac{1 - e^{-Ts}}{1 + e^{-Ts}} = \frac{1}{s} \tanh\left(\frac{Ts}{2}\right)$ → 02 marks

10

Module – 5

9 a.

$$\left.\begin{aligned} V_1 &= Z_{11} I_1 + Z_{12} I_2 \\ V_2 &= Z_{21} I_1 + Z_{22} I_2 \end{aligned}\right\} \rightarrow 02 \text{ marks}$$

$Z_{11} = \frac{Y_{22}}{\Delta Y}$ → 01 marks $\Delta Y = Y_{11}Y_{22} - Y_{12}Y_{21}$

$Z_{12} = \frac{-Y_{12}}{\Delta Y}$ → 01 marks $Z_{21} = \frac{-Y_{21}}{\Delta Y}$ → 01 marks

$Z_{22} = \frac{Y_{11}}{\Delta Y}$ → 01 marks

Subject Title : Network Theory Subject Code : 18EC32

Approved

Question Number	Solution	Marks Allocated
9 b.	$V_1 = h_{11} I_1 + h_{12} V_2$, $I_2 = h_{21} I_1 + h_{22} V_2$ →	01 marks
	$h_{11} = V_1/I_1 \vert_{V_2=0}$ $\quad V_1 = I_1 [4 + 4 \Vert 4]$	
	$h_{11} = \frac{V_1}{I_1} = 6\,\Omega$ →	1½ marks
	$h_{21} = \frac{I_2}{I_1} \vert_{V_2=0}$ $\quad -I_2 = \frac{I_1 \cdot 4}{4+4} = h_{21} = -1/2$ →	1½ marks
	$h_{12} = \frac{V_1}{V_2} \vert_{I_1=0}$ $\quad V_1 = \frac{V_2 \cdot 4}{4+4} = h_{12} = 1/2$ →	1½ marks
	$h_{22} = \frac{I_2}{V_2} \vert_{I_1=0}$ $\quad V_2 = (4+4) I_2$ $\quad h_{22} = \frac{1}{8}\,S$ →	1½ marks
c.	$V_1 = AV_2 - BI_2$ $\quad I_1 = CV_2 - DI_2$ →	01 marks
	$A = \frac{V_1}{V_2} \vert_{I_2=0} = 5/4$ →	1½ marks
	$D = -\frac{I_1}{I_2} \vert_{V_2=0} = 5/4$ →	1½ marks
	$C = \frac{I_1}{V_2} \vert_{I_2=0} = \frac{1}{4}\,\mho$ →	1½ marks
	$B = \frac{V_1}{-I_2} \vert_{V_2=0} = \frac{9}{4}\,\Omega$ →	1½ marks
10 a.	Q factor $= \frac{X_L}{R}$ or $\frac{X_C}{R}$ →	01 marks
	Selectivity $= \frac{f_r}{f_2 - f_1}$ →	01 marks
	Band width $= f_2 - f_1$ →	01 marks
b.	(i) $f_r = 1/2\pi\sqrt{LC} = 29.07$ Hz →	01 marks
	(ii) $f_1 = \frac{1}{2\pi}\left[\frac{-R}{2L} + \sqrt{(R/2L)^2 + 1/LC}\right] = 26.53$ Hz →	1½ marks

7

7

3

Subject Title : Network Theory   Subject Code : 18EC32

Question Number	Solution	Marks Allocated
	$f_0 = \sqrt{f_1 f_2}$	
	$f_2 = 31.82\,Hz$ →	1½ marks
	(iii) current at resonance $= 230/10 = 23\,A$ →	01 marks
	(iv) currents at f_1 & $f_2 = I_0/\sqrt{2} = 23/\sqrt{2} = 16.26\,A$ →	01 marks
	(v) Voltage Across inductance $= V_L = I \cdot X_L$ $= 1259.44\,V$ →	01 marks
		7
10 c	Admittance of R-L circuit $= 1/Z_L = \frac{1}{R_L + j\omega L} \cdot \frac{R_L - j\omega L}{R_L - j\omega L}$	
	$Y_L = \frac{R_L - j\omega L}{R_L^2 + \omega^2 L^2}$ →	01 marks
	Admittance of R-C circuit	
	$Y_C = \frac{1}{R_C - jX_C} \cdot \frac{R_C + jX_C}{R_C + jX_C} = \frac{R_C + j/\omega C}{R_C^2 + 1/\omega^2 C^2}$ →	01 marks
	$Y = Y_L + Y_C$	
	$= \frac{R_L}{R_L^2 + \omega^2 L^2} + \frac{R_C}{R_C^2 + 1/\omega^2 C^2} + j\left(\frac{\frac{1}{\omega C}}{R_C^2 + 1/\omega^2 C^2} - \frac{\omega L}{R_L^2 + \omega^2 L^2}\right)$ → (1)	
	equating j part to zero	
	resonant frequency $= \omega_0 = \frac{1}{\sqrt{LC}} \sqrt{\frac{R_L^2 - \frac{L}{C}}{R_C^2 - L/C}}$ rad/sec →	04 marks
	To prove that circuit will resonate at all frequency	
	$\frac{1/\omega C}{R_C^2 + 1/\omega^2 C^2} - \omega L / R_L^2 + \omega^2 L^2$	10
	Substituting $R_L = R_C = \sqrt{L/C}$ in above equation	
	$\frac{\frac{1}{\omega C}}{L/C + 1/\omega^2 C^2} - \frac{\omega L}{L/C + \omega^2 L^2}$	
	$\frac{1}{\omega L + 1/\omega C} - \frac{1}{\omega L + 1/\omega C} = 0$	
	∴ circuit resonate at all frequency when $R_L = R_C = \sqrt{L/C}$ →	04 marks
	" APPROVED " Registrar (Evaluation) Visvesvaraya Technological University BELAGAVI - 590018	