Solution & Marking scheme.

Total No. of Questions – [8]

Total No. of Printed Pages-6

G.R. No.	

U218-136 (ESE)

DECEMBER 2018/ENDSEM

S. Y. B. TECH. (E & TC) (SEMESTER - I)

COURSE NAME: NETWORK THEORY

COURSE CODE: ETUA21176

(PATTERN 2017)

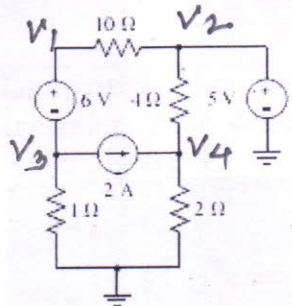
Time: [**2 Hours**]

[Max. Marks: **50**]

(*) Instructions to candidates:

1) **Answer Q.1, Q.2, Q.3, Q.4, Q.5 OR Q.6, Q.7 OR Q.8**
2) **Figures to the right indicate full marks.**
3) **Use of scientific calculator is allowed**
4) **Use suitable data wherever required**

Q1 a) For the circuit of Fig. below, determine all four nodal voltages. [6]



1.5 M for each node voltage

We define v_1 at the top left node; v_2 at the top right node; v_3 the top of the 1 Ω resistor; and v_4 at the top of the 2 Ω resistor. The remaining node is the reference node.

We may now form a supernode from nodes 1 and 3. The nodal equations are:

$$-2 = \frac{v_3}{1} + \frac{v_1 - v_2}{10} \qquad [1]$$

$$2 = \frac{v_4}{2} + \frac{v_4 - v_2}{4} \qquad [2]$$

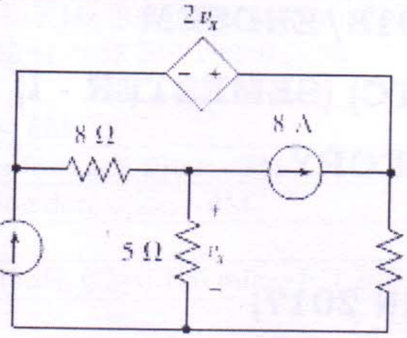
By inspection, $v_2 = 5$ V and our necessary KVL equation for the supernode is $v_1 - v_3 = 6$. Solving,

$v_1 = 4.019$ V
$v_2 = 5$ V
$v_3 = -1.909$ V
$v_4 = 4.333$ V

OR

Q1 b) Determine the voltage Vx in the circuit of following Fig, and the power supplied by the 1 A source. [6]

Vx=3M, Power= 3M



A strong choice for the reference node is the bottom node, as this makes one of the quantities of interest (v_x) a nodal voltage. Naming the far left node v_1 and the far right node v_3, we are ready to write the nodal equations after making a supernode from nodes 1 and 3:

$$1+8 = \frac{v_1 - v_x}{8} + \frac{v_3}{2} \qquad [1]$$

$$-8 = \frac{v_x - v_1}{8} + \frac{v_x}{5} \qquad [2]$$

Finally, our supernode's KVL equation: $v_3 - v_1 = 2v_x$

Solving, $v_1 = 31.76$ V and $\boxed{v_x = -12.4 \text{ V}}$

Finally, $P_{supplied|1\,A} = (v_1)(1) = \boxed{31.76 \text{ W}}$

Q2 a) Find the current through branch ab of the netwrok in figure 3 using thevenin's theorem. Let V=10 V [6]

Rth=3M Vth=3M

Obtain the voltage across open circuit called V_{TH} or V_{OC}.

Applying KVL to the loop we get,

$$-5I - 3I - j4I + 10 = 0$$

$$\therefore \quad -I(8 + j4) = -10$$

$$\therefore \quad I = \frac{10\angle 0^\circ}{(8+j4)} = \frac{10\angle 0^\circ}{8.944\angle 26.56^\circ} = 1.118\angle -26.56^\circ \text{ A}$$

The open circuit voltage is the voltage across the impedance 3 + j 4 Ω, hence

$$V_{TH} = I \times (3 + j4) = (1.118\angle -26.56) \times (5\angle +53.13^\circ)$$

$$= 5.59\angle +26.56^\circ \text{ V}$$

Step 3 :

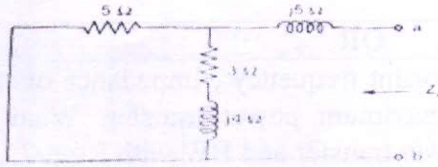


Fig. 2.29 (b)

Calculate the equivalent impedance across the terminals a-b, replacing the source by its internal impedance or short circuit.

Now the 5 Ω resistance and the impedance 3 + j4 are in parallel.

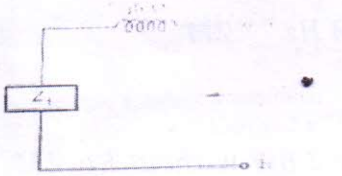


Fig. 2.29 (c)

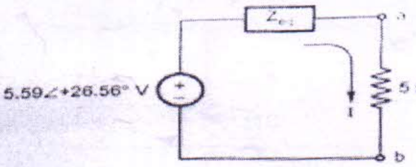
$$Z_1 = \frac{5 \times (3 + j4)}{(5 + j0 + 3 + j4)} = \frac{5\angle 0^\circ \times 5\angle 53.13^\circ}{(8+j4)}$$

$$= \frac{25\angle 53.13^\circ}{8.944\angle 26.56^\circ} = 2.795\angle 26.56^\circ$$

$$= 2.5 + j1.25 \ \Omega$$

$$\therefore \quad Z_{eq} = j5 + 2.5 + j1.25 = 2.5 + j6.25 \ \Omega$$

Step 4 : Thevenin's equivalent circuit is.



Hence the current through the branch a-b is,

$$I = \frac{V_{TH}}{5 + [Z_{eq}]} = \frac{5.59\angle 26.56^\circ}{5 + 2.5 + j6.25}$$

$$= \frac{5.59\angle 26.56^\circ}{7.5 + j6.25} = \frac{5.59\angle +26.56^\circ}{9.7628\angle +39.8^\circ}$$

$$= 0.5725\angle -13.24^\circ \text{ A}$$

This is the required current through branch a-b.

OR

Q2	b)	Determine the impedance to be connected at ab for maximum power transfer. Also determine power delivered to the load impedance at ab. Refer figure 4 **Impedance=3M, Power=3M**	[6]

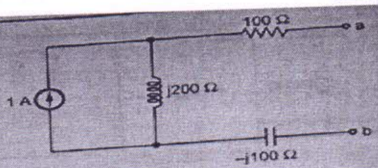


Fig. 2.70

Solution : To find load impedance for P_{max}, find Z_{eq}. So open the current source.

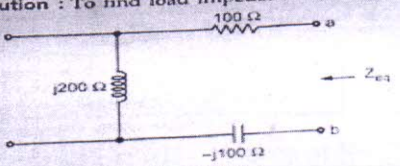


Fig. 2.70 (a)

$$\therefore \quad Z_{eq} = 100 + j200 - j100$$

$$= 100 + j100 \ \Omega$$

Hence Z_L for P_{max} is conjugate of Z_{eq} so,

$$Z_L = Z_{eq}^* = 100 - j100 \ \Omega \text{ for } P_{max}$$

Connecting $Z_L = Z_{eq}^*$, the circuit reduces as shown in the Fig. 2.70 (b).

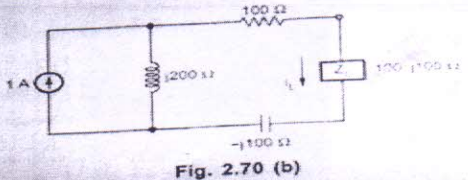


Fig. 2.70 (b)

The generator current is still 1 A at an angle 0°.

I_L can be calculated from the current division in parallel circuit,

$$I_L = 1 \times \frac{j200}{(j200 + 100 + 100 - j100 - j100)}$$

$$= \frac{j200}{200} = 1\angle 90^\circ \text{ A}$$

Power delivered to the load is,

$$P_{max} = I_L^2 \, R_L = (1)^2 \times (100) = 100 \text{ W}$$

Q3 a) An inductor coil having resistance 20 ohm and an inductance 0.02 H is connected in series with a capacitor of 0.02 micro farad. Determine Quality factor of the coil, Resonant Frequency and two half power frequencies. [6]

$F_0 = \frac{1}{2\pi\sqrt{LC}} = 7.957\ K\ Hz$ **2M** $\quad Q_0 = \frac{\omega_0 L}{R} = 50\ \ BW = \frac{R}{2\pi L} = 79.57\ Hz$ **--2M**

$F_1 = F_0 - \frac{BW}{2} = 7.87KHz$ - **1M**

$F_2 = F_0 + \frac{BW}{2} = 8.03\ KHz$ **1M**

OR

Q3 b) Refer following Fig 5. Determine resonant frequency , Impedance of the antiresonant circuit Zar and resistance Rg for maximum power transfer. What is the relation between BW of the circuit at Max.Power transfer and BW with Rg=0? [6]

$$F_{ar} = \frac{1}{2\pi\sqrt{LC}}\sqrt{1 - \frac{1}{{Q_0}^2}} = 1.05\ M\ Hz \quad \mathbf{2M} \qquad Q_0 = 7$$

$Zar = \frac{L}{CR} = 111.45Kohm = Rg$ **2M**

$Bwwith\ Rgmatched\ with\ Zar = 2\ BW\ without\ Rg$ **2M**

OR

Q4 a) [4]

$$i_L(0^-) = \frac{36}{10 + (4 \parallel 4)}$$

$$= \frac{36}{10+2} = 3\ A$$

$$i(0^-) = 3 \times \frac{4}{4+4} = 1.5\ A$$

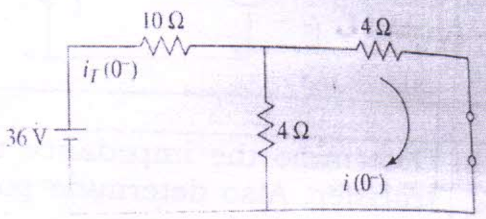


Fig. 9.42

Since current through the inductor cannot change instantaneously,

$$i(0^+) = 1.5\ A$$

For $t > 0$, the transformed network is shown in Fig. 9.43

Applying KVL to the Mesh for $t > 0$,

$$-4I(s) - 4I(s) - 2sI(s) + 3 = 0$$

$$8I(s) + 2sI(s) = 3$$

$$I(s) = \frac{3}{2s+8} = \frac{1.5}{[illegible]}$$

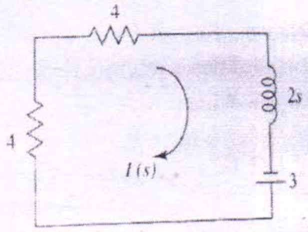
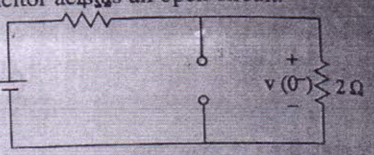
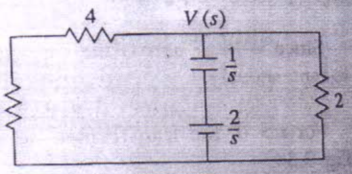
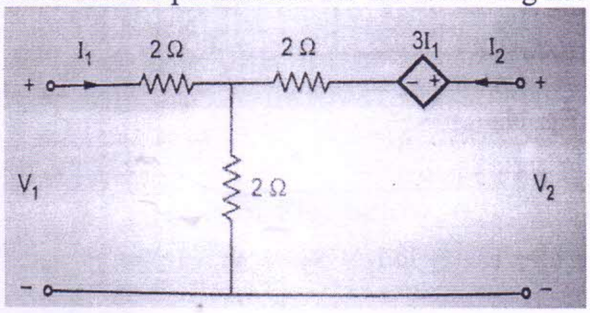
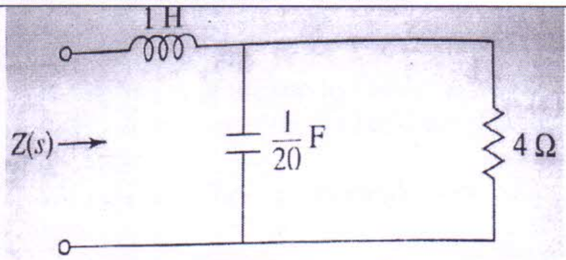
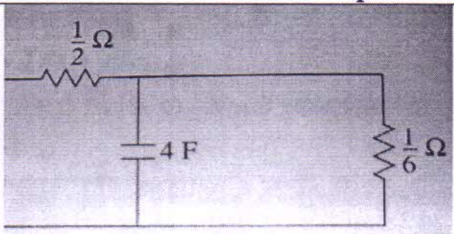


Fig. 9.43

Taking the inverse Laplace transform

$$i(t) = 1.5\,[illegible] \qquad \text{for } t > 0$$

OR

	b)	*Solution* At $t = 0^-$, steady-state condition is reached. Hence, the capacitor acts as an open circuit.  Fig. 9.36 $v(0^-) = 6 \times \frac{2}{4+2} = 2\text{ V}$ Since voltage across the capacitor cannot change instantaneously, $v(0^+) = 2\text{ V}$ For $t > 0$, the transformed network is shown in Fig. 9.37. Applying KCL at Node for $t > 0$,  Fig. 9.37 $\frac{V(s)}{6} + \frac{V(s) - \frac{2}{s}}{\frac{1}{s}} + \frac{V(s)}{2} = 0$ $V(s)\left[\frac{2}{3} + s\right] = 2$ $V(s) = \frac{2}{s + \frac{2}{3}}$ Taking the inverse Laplace transform, $v(t) = 2e^{-(2/3)t}$ for $t > 0$	[4]
Q5	a)	Determine Z parameters for the following network (Fig 8)  With port 2 open I2=0 **----- 3M** -2I1-2I1+V1=0 and V2 =3I1+2I1 Z11=V1/I1=4 ohms , Z21=V2/I1= 5 ohms With port1 open I1=0 **----- 3M** -2I2-2I2+V2=0 and V1=2I2 Z22= 4 ohms and Z12= 2 ohms	[6]
	b)	 Z(s)=(s^2+5S+20)/(S+5) Zeros at S= -2.5 +j3.71 and S= -2.5 -j3.71 Pole at S=-5 **----- 2M** **plot- 2M**	[4]
	c)	 Y(S)= (2S+3)/ (S+2) - **4M**	[4]
		OR	
Q6	a)	V1/I1= (2S^2+s+1)/S and V2/V1= 2s^2/(2S^2+s+1) – **3M each**	[6]

	b)	expressions for Z parameters in terms of Y parameters	[4]
	c)	transmission parameters for T network consisting of each series arm 100 ohm and shunt arm 200 ohm **each parameter – 1M** V1/V2=3/2 , I1/V2= 1/200 etc.	[4]
Q7	a)	fc = 2.0546 KHz, R0= 774.596 ohm, ZoT @ 1KHz= 676.596 ohm β@1K/ β@5k = 58.249/180=0.3236 **each 2*3= 6M**	[6]
	b)	**all curves for each filter – 2M**	[4]
	c)	Z0 equation derivation – 4M	[4]
		OR	
Q8	a)	L1=26.54 mH, C2=0.106 micro F, L2=5.968mH, C1 =0.023 micro F **each 1.5M**	[6]
	b)	$Z_0 = \sqrt{Z_{OC}Z_{SC}}$	[4]
	c)	R1/2= 490.90 ohm ----2M and R2 = 121.22 ohm ---- 2 M	[4]