LNMIIT
The LNM Institute of Information Technology

Electronics I (ECE 103)
End Term Exam

Date: 26th November 2016 | **Time: 180 Minutes** | **Max Marks: 100**

Notes:
This exam have **2 sections**, you have to **attempt at least 3** questions from each section.
Each complete question carries 10 marks. Attempt all the parts of a question together.
Start every solution on fresh page.
Highlight your answers by inboxing or underlining them.
Assumptions made should be written clearly.

Section A

1.a Apply source transformation repeatedly to transform the circuit shown in Figure 1.a on the left into the simplified circuit shown on the right. Determine the value of current I_X and resistance R_X and use it to obtain the voltage v_0. **[5]**

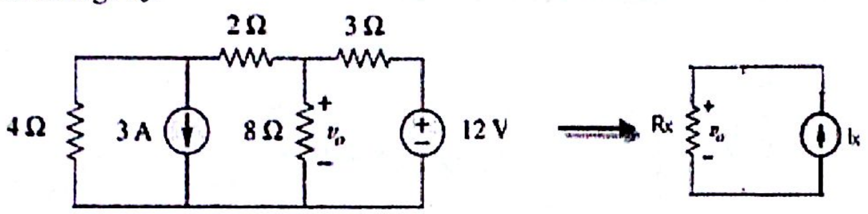


Figure 1.a

1.b Use nodal analysis to obtain the voltages V1 and V2 in the circuit shown in Figure. 1.b. **[5]**

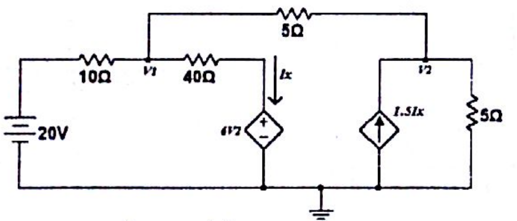


Figure 1.b

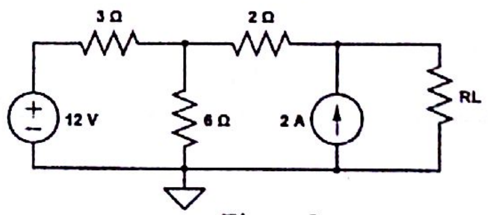


Figure 2.a

2.a For the circuit shown in Figure 2.a, determine the value of R_L for which power consumption across R_L, i.e. P_L, is maximum. Find the value of P_L as well. **[5]**

2.b Determine Norton's equivalent for the circuit shown in Figure 2.b. **[5]**

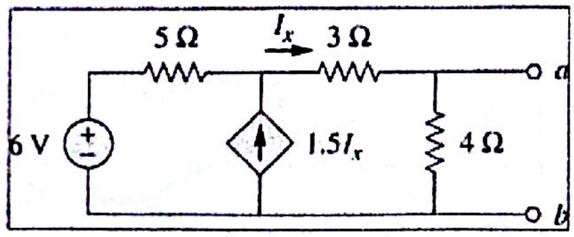


Figure 2.b

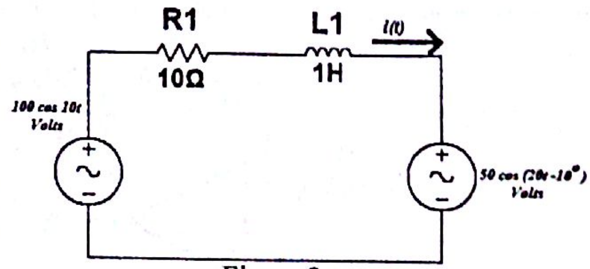


Figure 3.a

3.a Using superposition principle, find the function for current $i(t)$ from the circuit shown in Figure 3.a. **[5]**

3.b Consider the circuit shown in Figure 3.b.ii. The input function is the voltage pulse shown in Figure. 3.b.i. Assuming that the capacitor was completely discharged before time $t < 0$ (i.e., $V_c(0^-) = 0$), determine the expression for the output voltage $V_0(t)$ ***(without using Laplace transforms)***. Also draw the waveform for output voltage $V_0(t)$, for time $t > 0$. **[5]**

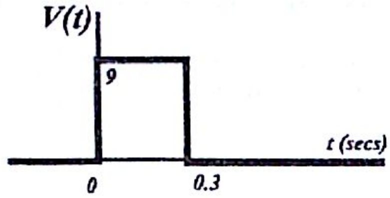


Figure 3.b.i

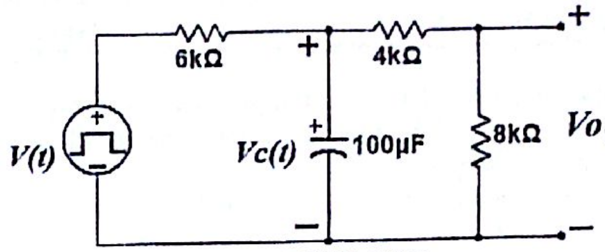


Figure 3.b.ii

4 For the series RLC circuit shown in Figure 4, suppose that $R = 1/3\ \Omega$, $L = 1/12$ H, $C = 3/5$ F and $V_s(t) = 0$V. Find the value of $v(t)$ and $i(t)$ when $i(0) = 4$A and $v(0) = 0$V. Use Laplace transform to evaluate the desired quantities. **[10]**

5.a For the circuit shown in Figure 5.a, find the average power absorbed by each element in the circuit. Value of Z_L is 1Ω in this figure. **[5]**

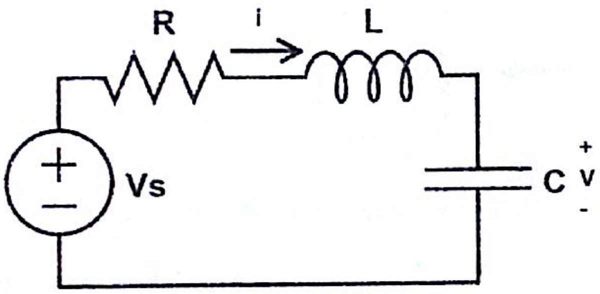


Figure 4

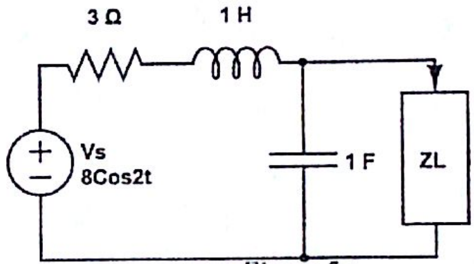


Figure 5.a

5.b An amplifier has a transfer function of the form: **[5]**

$$G(\omega) = \frac{V_O(\omega)}{V_{in}(\omega)} = \frac{100}{\{1+j(\omega/\omega_L)\}\{1+j(\omega/\omega_H)\}}$$

Sketch Bode plot of the transfer function and determine suitable values for corner frequencies such that the amplifier can amplify audio frequencies in the range 20Hz-20KHz equally well.

Section B

6.a Obtain the expression for the output voltage V_0 for the ideal op-amp shown in Figure 6.a. **[5]**

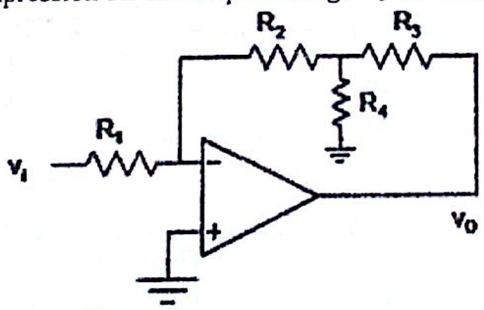


Figure 6.a

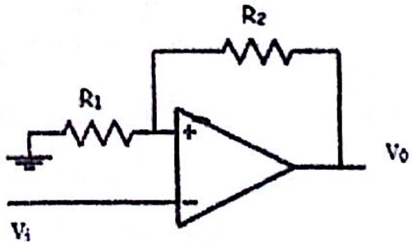


Figure 6.b

6.b A Schmitt Inverter is shown in Figure 6.b. The output voltage can either be $V_{OH} = 10$V or $V_{OL} = -10$V. Find the value of switching thresholds V_{IL} and V_{IH} for the circuit if, $R_2 = 4\text{k}\Omega$ and $R_1 = 2\text{k}.\Omega$. **[5]**

7.a Design an op-amp circuit that would generate the following output voltage: $V_0 = 2\ V_{S1} + 4\ V_{S2} - 8\ V_{S3} - 10\ V_{S4}$, where V_{S1}, V_{S2}, V_{S3}, and V_{S4} are the input voltages. **[5]**

7.b Sketch the output of the differentiator circuit for the indicated input in Figure 7.b. **[5]**

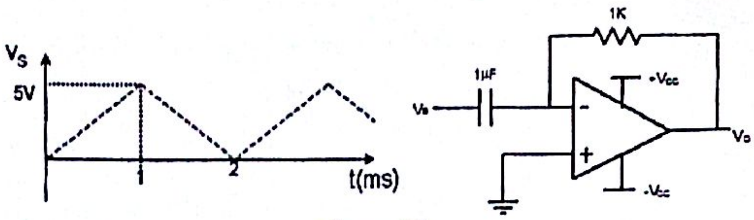


Figure 7.b

8 For the circuit shown in Figure. 8, derive an expression for the output voltage V_0 in terms of the two input voltage V_1 and V_2. **[10]**

9.a Find the output function of the circuit shown in Figure 9.a. **[5]**

9.b Consider a black box called **MinMax**. This black box have two inputs a and b, and two outputs Min and Max. Maximum of a and b will appear at output Max and minimum would appear at output Min. Use minimum number of such black boxes to sort four numbers P, Q, R and S. **[5]**

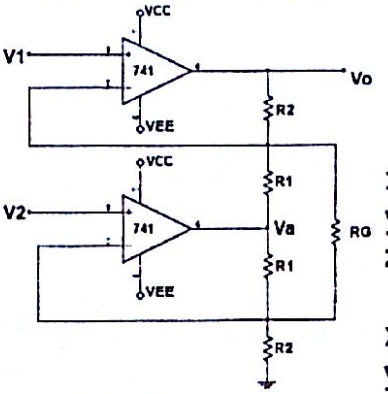


Figure 8

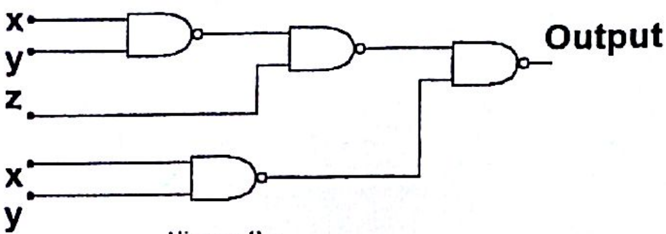


Figure 9.a

10.a Evaluate the unknown numbers with the base provided: **[6]**

i) $(444)_5$ to $(??)_{10}$
ii) $(111)_6$ to $(??)_{16}$
iii) $(1010)_{12}$ to $(??)_{08}$

10.b i) Find the 14's complement of $(DAD)_{14}$ **[4]**
ii) Find the 16's complement of $(BABE)_{16}$

11 Minimize the following expressions using K-Map method and realize them using given constraints: **[5]**

a) $A'B'C + AD + D'(B + C) + AC' + A'D'$ (using only NAND gates)
b) $F = \Sigma\,(8, 9, 10, 11, 13, 15)$ (using only NOR gates) **[5]**

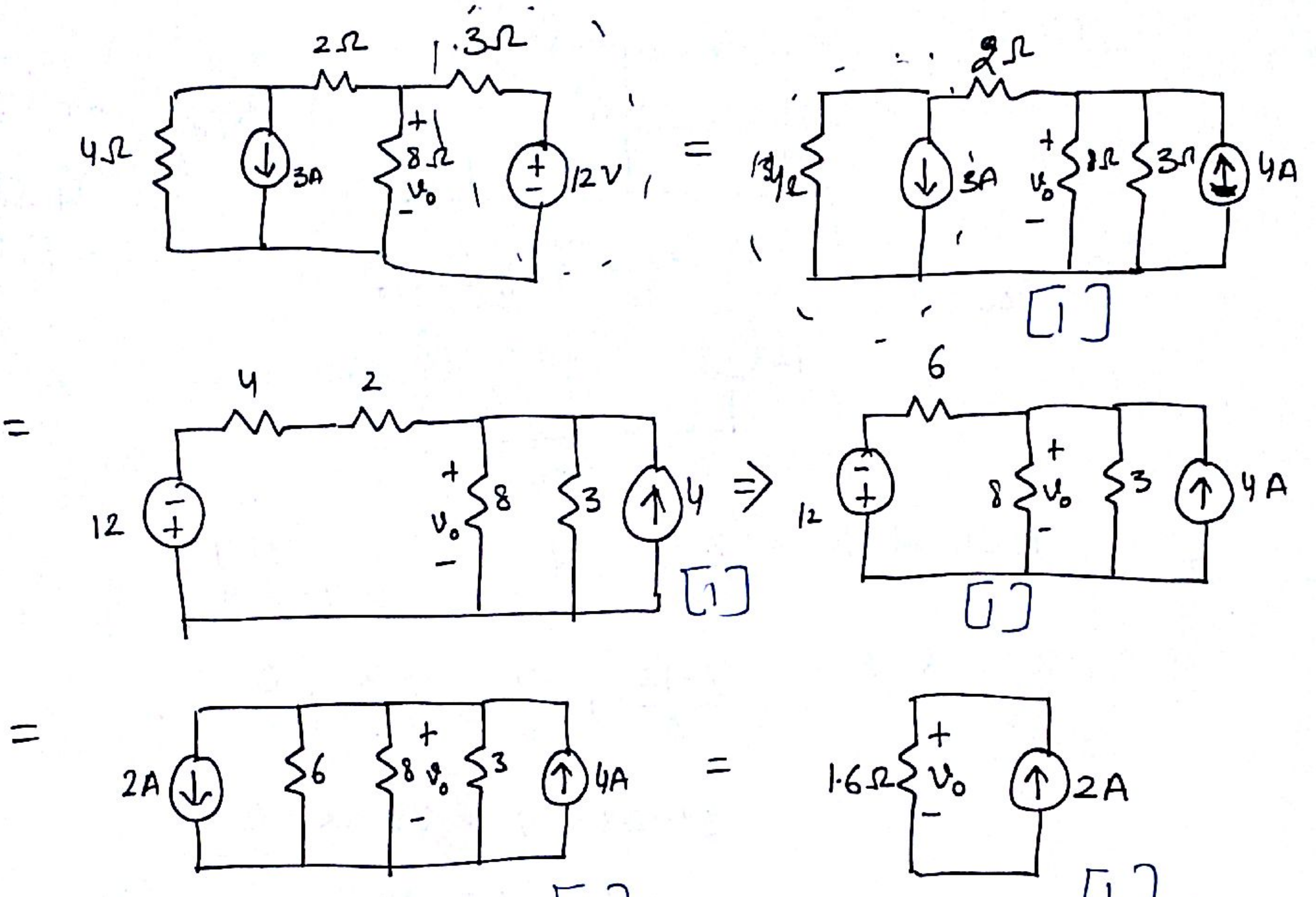
12.a Construct a 16x1 multiplexer with two 8x1 and one 2x1 multiplexers. Use block diagram representation with designated selection and data lines. **[5]**

12.b Design a 3 bit odd parity generator using a 2x1 MUX. **[5]**

13 Design a new flip flop which have 3 inputs A, B, C and output Q. If the combination of A, B, C is 000, then the output is reset to 0 and it is set to 1 when the combination is 111. For remaining combinations of A, B and C, Q remains same, if there are more number of 1's in the inputs and complements itself if there are more number of 0's in the inputs. Write down the characteristics table of this flip flop and determine the characteristics function. Determine the excitation table and comment whether this flip flop can be used in real time applications or not (If there are unique transitions for each excitation). **[10]**

Electronics. I
END TERM SOLUTIONS.

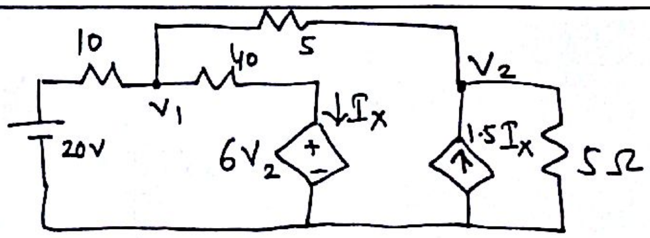
1a



$8 \| 3 \| 6 = 1.6\Omega$ [1]

$\therefore v_o = 2A \times 1.6 A = 3.2V$

1.b



$$I_x = \frac{V_1 - 6V_2}{40} \quad (I)$$

KCL at V_1

$$\frac{V_1 - 20}{10} + \frac{V_1 - V_2}{5} + \frac{V_1 - 6V_2}{40} = 0 \quad (II) \quad [1]$$

KCL at V_2

$$\frac{V_2 - V_1}{5} + \frac{1.5(V_1 - 6V_2)}{40} + \frac{V_2}{5} = 0 \quad (III) \quad [1]$$

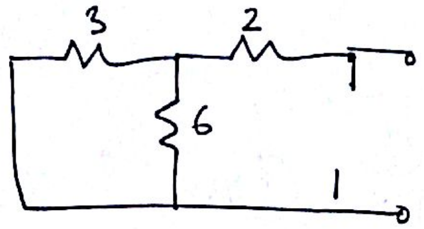
$$13V_1 - 14V_2 = 80$$

$$-9.5V_1 + 25V_2 = 0$$

$$\boxed{\begin{aligned} \therefore V_1 &= 10.4V \\ V_2 &= 3.96V \end{aligned}} \quad [3]$$

2.a We need to find Thevenin eq / Norton eq across R_L

For R_{TH}

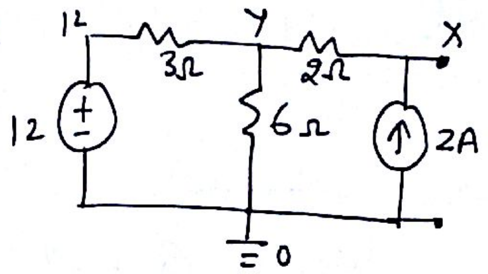


$\Rightarrow R_{TH} = 2 + 3 \| 6$

$= 4\,\Omega$

[1]

For V_{OC}



KCL at X $\quad \frac{X-Y}{2} = 2 \Rightarrow X = Y+4$

or $Y = X-4$

KCL at Y $\quad \frac{Y-12}{3} + \frac{Y}{6} + \frac{Y-X}{2} = 0$

$2Y - 24 + Y + 3Y - 3X = 0$

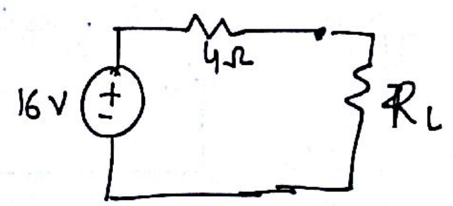
$6Y - 3X = 24$

$6X - 24 - 3X = 24$

$3X = 48 \Rightarrow \boxed{X = 16 = V_{TH}}$

[2]

$\therefore$



$\therefore$ for Max P_L, $\underline{R_L = 4\,\Omega}$

and $P_L = I^2 R$

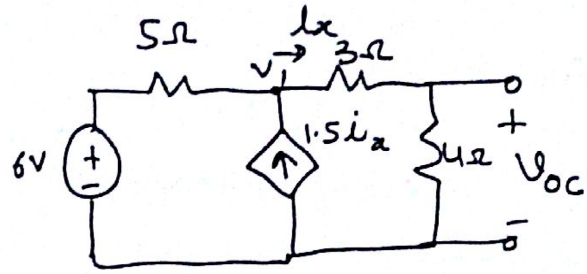
$I = \frac{16}{8} = 2\,A$

[2]

$P_L = 2^2 \times 4 = \cancel{32}\,W$

16 W

2.b



KCL at V_1

$$\frac{V_1-6}{5} - 1.5I_x + I_x = 0 \quad (i)$$

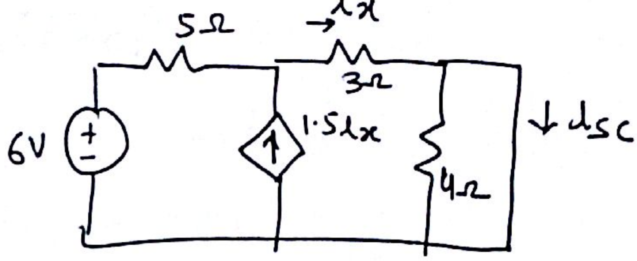
KCL at V_{oc}

$$\frac{V_{oc}-V_1}{3} + \frac{V_{oc}}{4} = 0 \quad (ii)$$

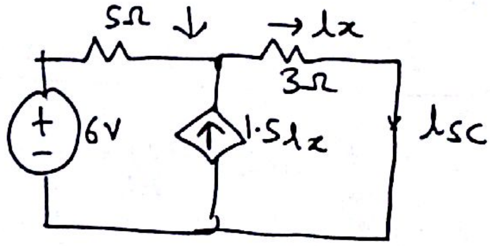
$$\cancel{I_x} = i_x = \frac{V_{oc}}{4} \quad (iii)$$

$$\Rightarrow V_{oc} = 5.33V \quad [2]$$

for I_{sc}



$$\frac{V_1-6}{5} - 1.5I_x + I_x = 0$$

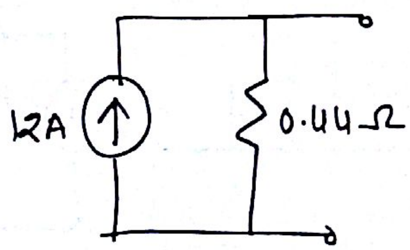


$$I_x = I_{sc} = \frac{V_1}{3}$$

$$I_{sc} = 12A \quad [2]$$

$$\therefore R_{NO} = \frac{V_{oc}}{I_{sc}} = \frac{5.33}{12} = 0.44\Omega$$

$\therefore$



[1]

3.a

First calculate the current $i'(t)$ for voltage source present in the left side.

$$I' = \frac{100\angle 0^\circ}{10+j10} = 7.07\angle -45^\circ$$

$$i'(t) = 7.07\cos(10t - 45^\circ)\ \text{A} \quad [2]$$

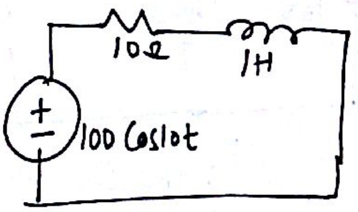
→ Response due to Right side source is

$$I'' = \frac{50\angle -10}{10+j20} = 2.24\angle -73.43^\circ$$

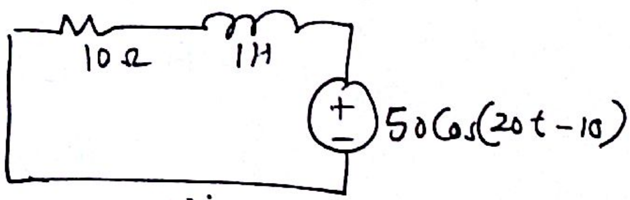
$$i''(t) = 2.24\cos(20t - 73.43^\circ) \quad [2]$$

$$\therefore i = i'(t) + i''(t) \quad [1]$$

$$\boxed{i(t) = 7.07\cos(10t - 45^\circ) + 2.24\cos(20t - 73.43^\circ)}$$

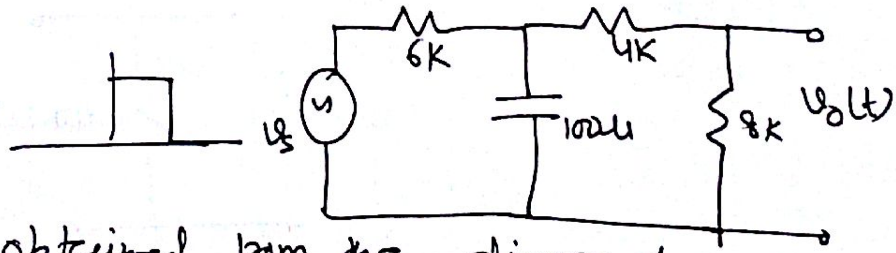


(i)



(ii)

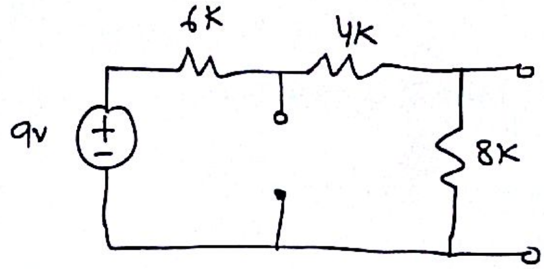
3.b



Voltage $v_o(t)$ is obtained from the division of voltage across capacitor among 4K and 8K resistors.

at $t=0$ $\quad v_c(t) = 0 \Rightarrow v_o(0) = 0\ \text{V}$ $\quad [1]$

Now at $t = 0^+$



$$v_o(\infty) = \frac{9 \times 8}{8+4+6} = 4\,V$$

$$R_{TH} = 6 \parallel 12 = 4k\Omega \quad [1]$$

$$\therefore \tau = RC = 4k\Omega \times 100\mu F = 0.4\,s$$

$\therefore$ For time $0 < t < 0.3\,s$

$$v_o(t) = v(\infty) + (v(0) - v(\infty))e^{-t/\tau}$$

$$= 4 - 4e^{-t/0.4}\ V \quad [1]$$

$$v_c(t) = \frac{3}{2} v_o(t)$$

$$\therefore v_c(t) = \frac{3}{2}\left(4 - 4e^{-t/0.4}\right] V$$

[1]

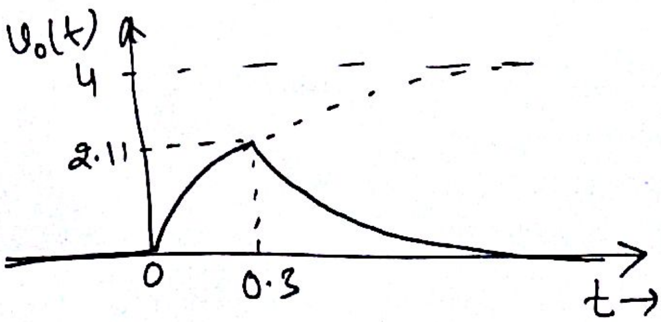
at $t = 0.3\,s$ $\quad v_o(0.3) = 4(1 - e^{-0.3/0.4}) = 2.11\,V$

$\therefore$ For $t > 0.3\,s$ to $t \to \infty$. $v_c(t)$ and $v_o(t)$ will discharge

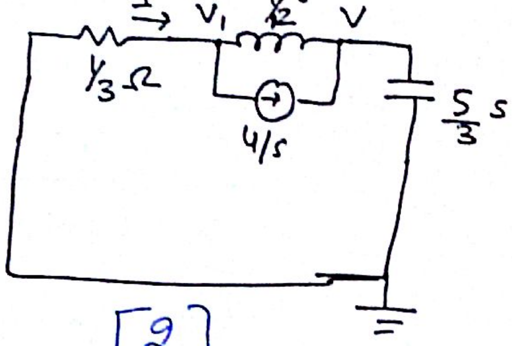
$$v_o(t) = 2.11e^{-(t-0.3)/0.4}\ V \quad [1]$$

Final Solution is

$$v_o(t) = \begin{cases} 0 & \text{for } t < 0 \\ 4(1 - e^{-t/0.4})\,V & 0 < t < 0.3s \\ 2.11e^{-(t-0.3)/0.4}\,V & t > 0.3s \end{cases}$$



4) Based on the initial Conditions given, the laplace domain circuit is



[2]

KCL at V_1

$$\frac{V_1}{1/3} + \frac{4}{s} + \frac{V_1 - V}{\frac{1}{12}s} = 0$$

$$3V_1 + \frac{4}{s} + \frac{12V_1 - 12V}{s} = 0$$

$$3sV_1 + 4 + 12V_1 - 12V = 0$$

$$(3s+12)V_1 - 12V = -4$$

$$3(s+4)V_1 - 12V = -4 \quad (I) \quad [1]$$

KCL at V

$$\frac{V_1 - V}{\frac{1}{12}s} + \frac{4}{s} = \frac{V}{\frac{5}{3}s}$$

$$\Rightarrow \frac{12V_1 - 12V}{s} + \frac{4}{s} = \frac{3sV}{5}$$

$$60V_1 = (3s^2+60)V - 20$$

$$V_1 = \frac{(3s^2+60)V}{60} - \frac{20}{60} \quad (II) \quad [1]$$

Sub. (II) in (I)

$$\Rightarrow 3(s+4)\left[\frac{(3s^2+60)V}{60} - \frac{20}{60}\right] - 12V = -4$$

$$\Rightarrow 3(s+4)(3s^2+60)V - 3(s+4)(20) - 720V = -240$$

$\Rightarrow$ Divide by 3 on both sides [2]

$$(3s^3 + 12s^2 + 60s + 240 - 240)V = 20(s+4) - 80$$

$$= 20s$$

$$V = \frac{20/3}{s^2+4s+20} = \frac{20/3}{(s+2)^2+4^2} = \frac{\frac{20}{3}\left(\frac{1}{4}\right)\times 4}{(s+2)^2+4^2}$$

[2]

$$= \frac{\frac{5}{3}\times 4}{(s+2)^2+4^2}$$

By inverse laplace transform.

$$v(t) = \frac{5}{3} e^{-2t} \sin(4t)\, u(t) \quad [2]$$

$$I = \frac{V}{5/3s} = \frac{3sV}{5} = \frac{\frac{3}{5}s \times \frac{20}{3}}{(s+2)^2+4^2} = \frac{4s}{(s+2)^2+4^2}$$

$$= \frac{4(s+2-2)}{(s+2)^2+4^2} = \frac{4(s+2)}{(s+2)^2+4^2} - \frac{2\times 4}{(s+2)^2+4^2}$$

By inverse laplace transform.

[2]

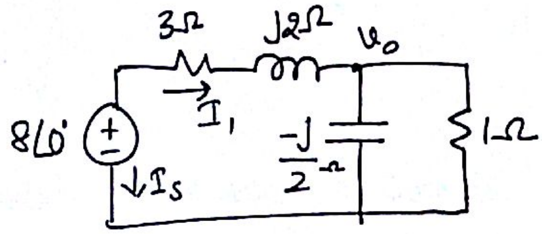
$$i(t) = 4e^{-2t}\cos 4t\, u(t) - 2e^{-2t}\sin 4t\, u(t)$$

8

5.a

The eq. circuit is

$\omega = 2$ radian.



KCL at v_o

$$\frac{v_o - 8}{3+j2} + \frac{v_o}{-j/2} + \frac{v_o}{1} = 0$$

$$\frac{v_o - 8}{3+j2} + j2v_o + v_o = 0$$

$$v_o - 8 + (3+j2)(2jv_o) + (3+j2)(v_o) = 0$$

$$v_o - 8 - 4v_o + j6v_o + 3v_o - j2v_o = 0$$

$$j8v_o = 8$$

$$v_o = \frac{1}{j} = -j = 1\angle -90°$$ [1]

$$\Rightarrow I_1 = \frac{V_s - v_o}{3+j2} = \frac{8+j}{3+j2} = \frac{\sqrt{65}\angle 7.63}{\sqrt{13}\angle 33.7}$$

$$= \sqrt{5}\angle -26.6°$$

$$I_s = -I_1 = \sqrt{5}\angle +153.4°$$ [1] [1]

→ For 3Ω Resistor $P_{3\Omega} = \frac{1}{2} R |I_1|^2 = \frac{1}{2} \times 3 \times (\sqrt{5})^2 = 7.5W$ [1]

For 1Ω resistor $P_{1\Omega} = \frac{1}{2}\frac{V_o^2}{R} = \frac{1}{2} \times 1 \times \frac{1^2}{1} =$ 0.5 W [1]

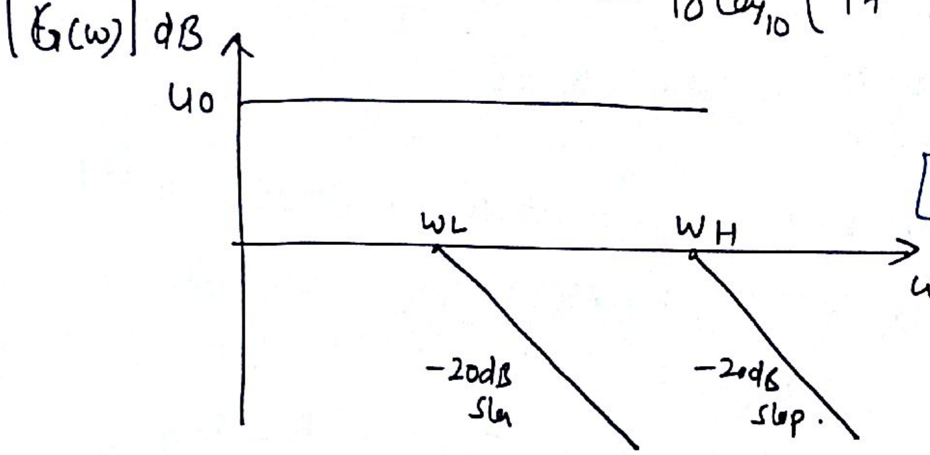
$$P_{1H} = P_{1F} = 0W$$

$$P_{V_s} = \frac{1}{2} V_s I_s = \frac{1}{2} 8 \times \sqrt{5} \cos(153.4°) = -8.0W$$ [1]

5.b

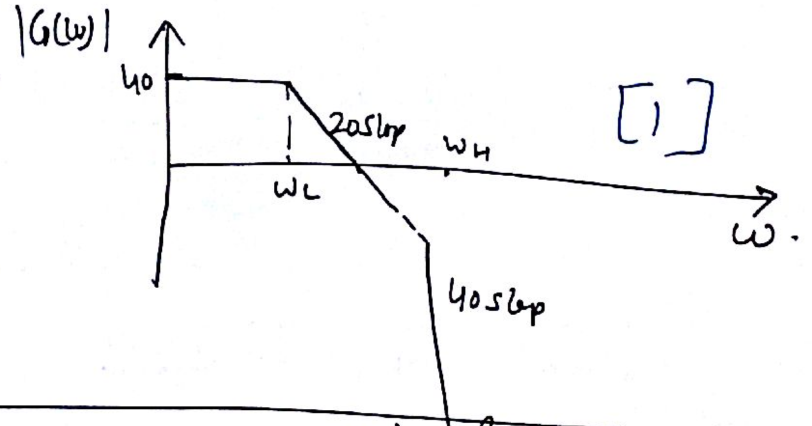
$$G(\omega) = \frac{100}{\left\{1 + j\left(\frac{\omega}{\omega_L}\right)\right\}\left\{1 + j(\omega/\omega_H)\right\}}$$

$$20\log_{10}|G(\omega)| = 40 + \underbrace{\cancel{10\log_{10}\left(\frac{\omega}{\omega_L}\right)}}_{\times} - 10\log_{10}\left(1+\left(\frac{\omega}{\omega_L}\right)^2\right) - 10\log_{10}\left(1+\frac{\omega}{\omega_H}\right)^2 \quad [2]$$



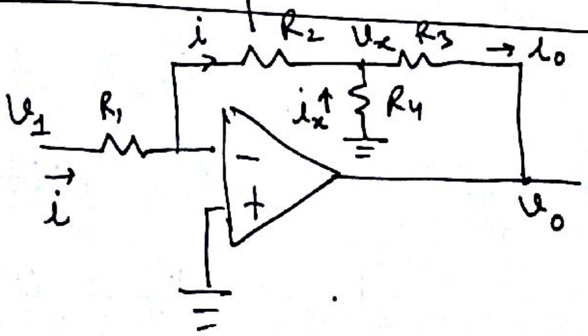
[2]

∴ Tota.



[1]

6.a



$$i = \frac{v_1 - 0}{R_1} = \frac{V_1}{R_1}$$

$$i_o = i + i_x$$

$$i_x = -\frac{v_x}{R_4} \quad [1]$$

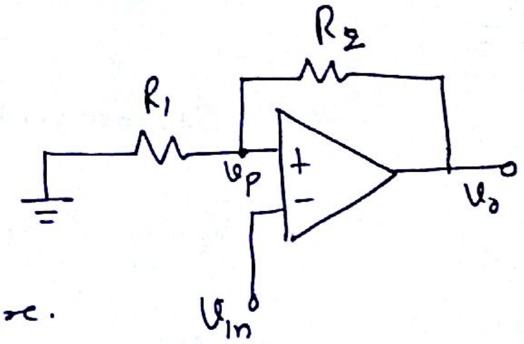
$$v_x = -iR_2 = -\frac{R_2}{R_1}v_1 \quad [1]$$

$$\therefore v_o = v_x - i_oR_3 = -\frac{R_2}{R_1}\left(1 + \frac{R_3}{R_4} + \frac{R_3}{R_2}\right)V_1$$

[3]

6.b

$v_p = \left(\frac{R_1}{R_1+R_2}\right) v_o$ [1]



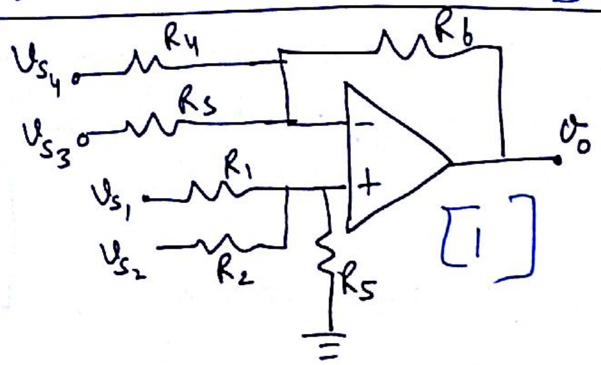
∴ Switching thresholds are.

$$v_+ = \left(\frac{R_1}{R_1+R_2}\right) v_{OH} = \left(\frac{2}{2+4}\right)10 = \frac{10}{3}\ V$$ [2]

$$v_- = \left(\frac{R_1}{R_1+R_2}\right) v_{OL} = \left(\frac{2}{2+4}\right)(-10) = -\frac{10}{3}\ V$$ [2]

---

7. a



[1]

$$v_o = 2v_{s_1} + 4v_{s_2} - 8v_{s_3} - 10v_{s_4}$$

$$R_p = R_1 \| R_2 \| R_5$$

$$v_o = -\left(\frac{R_f}{R_3}\right)v_{s_3} - \left(\frac{R_f}{R_4}\right)v_{s_4} + \left(1+\frac{R_f}{R_3\|R_4}\right)\frac{R_p}{R_1} v_{s_1} + \left(1+\frac{R_f}{R_3\|R_4}\right)\frac{R_p}{R_2} v_{s_2}$$

If $R_f = 10k\Omega$ 1 for each R_i

$\Rightarrow R_3 = 1.25k\Omega$

$R_4 = 1k\Omega$

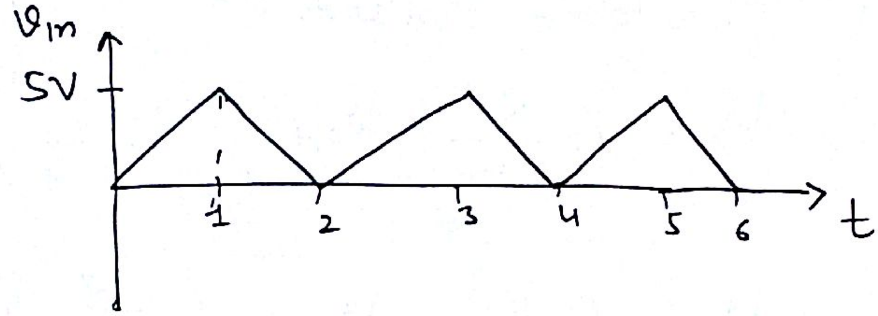
$\frac{R_p}{R_1} = 0.105 \Rightarrow \frac{R_p}{R_2} = 0.211, \quad \frac{R_1}{R_2} = 2$

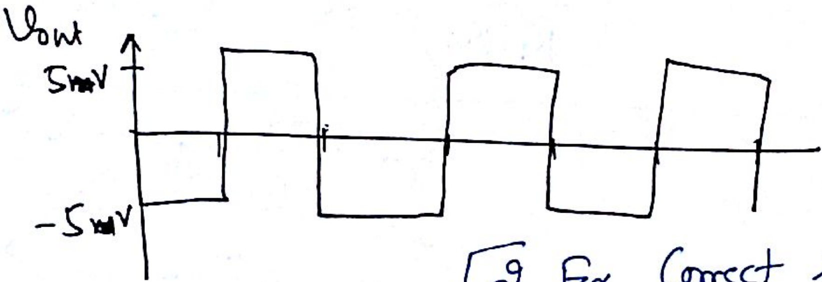
If $R_2 = 1k\Omega$, $R_1 = 2k\Omega$ $R_p = 0.211K \Rightarrow R_5 = 0.308k\Omega$

7. b

For differentiator

$$V_0 = -RC\frac{dv_s}{dt} = -10^{-3}\frac{dv_s}{dt}$$





E

[2 for Correct shape
3 for Correct values.]

$\therefore$ $v_{in} = 0$ to 5 V

$$\therefore \quad V_0(t) = -10^{-3}\frac{5-0}{10^{-3}} = -5V$$

$$V_0(t) = -10^{-3}\frac{0-5}{10^{-3}} = 5V$$

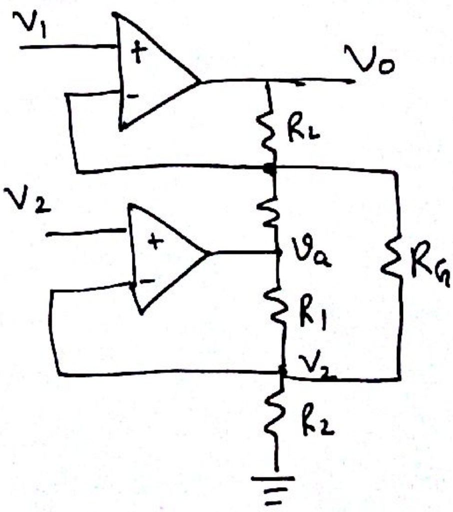
Q. 8

$$\frac{V_1 - V_0}{R_2} + \frac{V_1 - V_A}{R_1} + \frac{V_1 - V_2}{R_G} = 0 \quad [2]$$

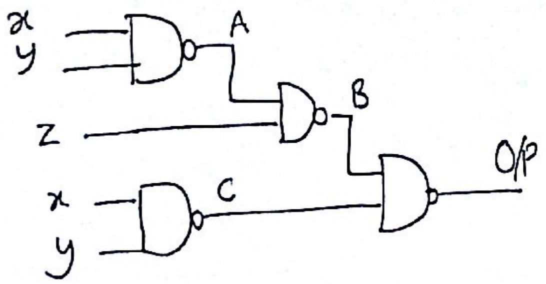
and $$\frac{V_2 - V_a}{R_1} + \frac{V_2 - V_1}{R_G} + \frac{V_2}{R_2} = 0 \quad [2]$$

$$V_0 = (V_1 - V_2)\left[1 + \frac{R_2}{R_1} + \frac{2R_2}{R_G}\right]$$

[6]



9.a



5 marks for optimized expression.

$A = \overline{x \cdot y}$

$B = \overline{(\overline{x \cdot y}) \cdot z}$

$C = \overline{x \cdot y}$

$o/p = \overline{B \cdot C} = \overline{B} + \overline{C}$

$= (\overline{x \cdot y}) z + x \cdot y$

$= (x \cdot y)(\overline{x \cdot y})(xy + z)$ $\because$ $A + B.C = (A+B)(A+C)$

$= 1 \cdot (x \cdot y + z)$

$o/p = x \cdot y + z$

OR

x	y	z	A	B	C	o/p
0	0	0	1	1	1	0
0	0	1	1	0	1	1
0	1	0	1	1	1	0
0	1	1	1	0	1	1
1	0	0	1	1	1	0
1	0	1	1	0	1	1
1	1	0	0	1	0	1
1	1	1	0	1	0	1

o/p

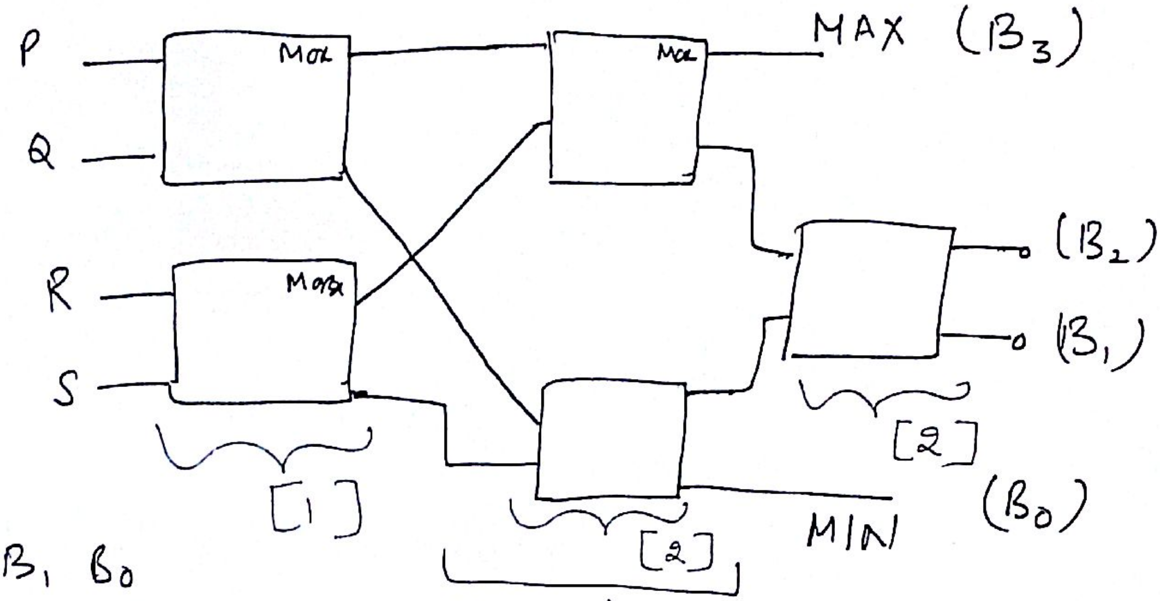
x \ yz	00	01	11	10
0	0	1	1	0
1	0	1	1	1

$= z + x \cdot y$

5 marks for Correct optimized exp.

Scanned by CamScanner

9.b



$B_3\ B_2\ B_1\ B_0$ is sorted order.

Max of two max gives total maxima.
Min of two min gives total minimum

10.a

(i) $(444)_5 = 4\times5^2 + 4\times5^1 + 4\times5^0$

[2] $= 100 + 20 + 4 = (124)_{10}$

(ii) $(111)_6 = 1\times6^2 + 1\times6^1 \times 1\times6^0$

[2] $= 36 + 6 + 1 = (43)_{10}$

$$\begin{array}{c|c} 16 & 43 \\ \hline & 11 \quad \cancel{22} \end{array} = (2B)_{16}$$

(iii) $(1010)_{12} = 1\times12^3 + 0\times12^2 + 1\times12^1 + 1\times12^0$

$= 1728 + 12 = (1740)_{10}$

$$\begin{array}{r|l}
8 & 1740 \\ \hline
8 & 217 \quad 4 \\ \hline
8 & 27 \quad 1 \\ \hline
 & 3 \quad 3
\end{array}$$

[2]

$(1010)_{12} = (3314)_8$

---

10. b (i) 14's Comp of $(DAD)_{14}$ is

13's Comp of $(DAD)_{14}$ +1

$$\begin{array}{r}
DDD \\
-\; DAD \\ \hline
030 \\
+\;1 \\ \hline
\boxed{031}
\end{array}$$

[2]

(ii) 16's Comp of $(BABE)_{16}$

$$\begin{array}{r}
FFFF \\
-\; BABE \\ \hline
4541 \\
+\;1 \\ \hline
4542
\end{array}$$

[2]

11 . a

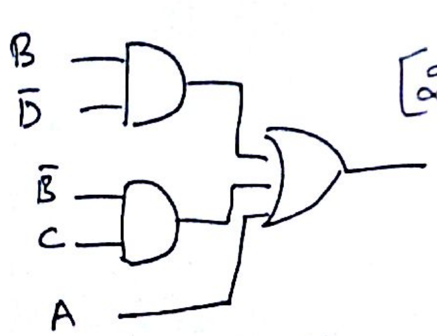
$F = A'B'C + AD + D'B + D'C + AC' + A'D'$

Mapping on K-map.

AB \ CD	00	01	11	10
00	0	0	1	1
01	1	0	0	1
11	1	1	1	1
10	1	1	1	1

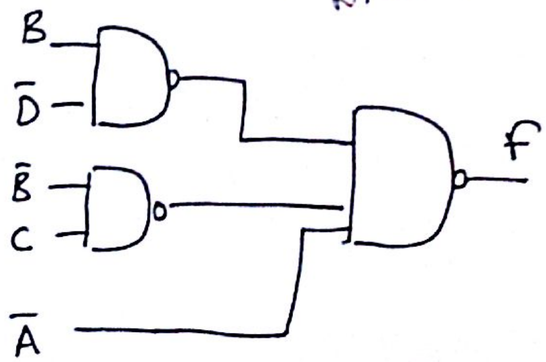
$F = A + B\bar{D} + \bar{B}C$ ~~2~~ [3]

Less marks for using more no of NAND gates.



[2]

=



11. b

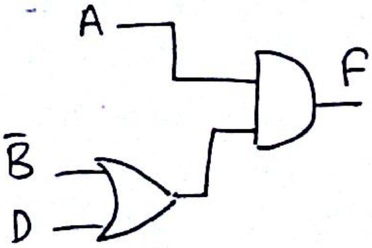
$F = \Sigma(8,9,10,11,13,15)$

Mapping on K-map.

Less marks for using max no of NOR gates

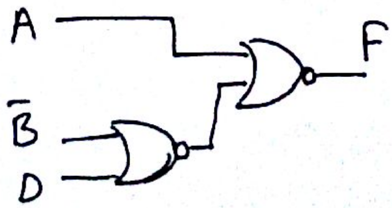
AB \ CD	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	0	1	1	0
10	1	1	1	1

$\Rightarrow F = (A)(\bar{B} + D)$ [2]



[3]

=



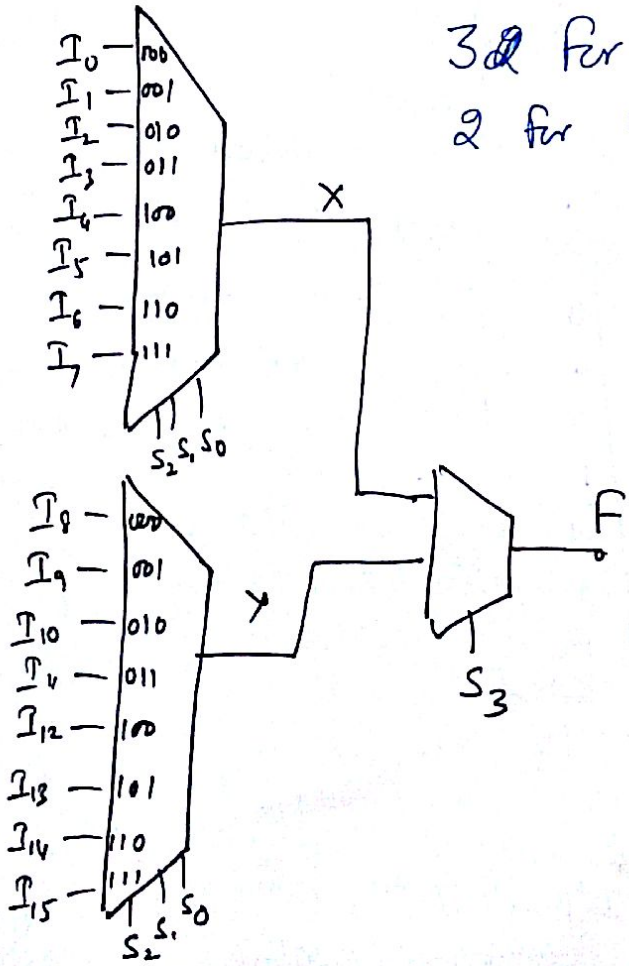
12) a Boolean Expression for 16×1 MUX is

$$F = \bar{S}_3\bar{S}_2\bar{S}_1\bar{S}_0 I_0 + \bar{S}_3\bar{S}_2\bar{S}_1 S_0 I_1 + \bar{S}_3\bar{S}_2 S_1\bar{S}_0 I_2 + \bar{S}_3\bar{S}_2 S_1 S_0 I_3$$
$$+ \bar{S}_3 S_2\bar{S}_1\bar{S}_0 I_4 + \bar{S}_3 S_2\bar{S}_1 S_0 I_5 + \bar{S}_3 S_2 S_1\bar{S}_0 I_6 + \bar{S}_3 S_2 S_1 S_0 I_7$$
$$+ S_3\bar{S}_2\bar{S}_1\bar{S}_0 I_8 + S_3\bar{S}_2\bar{S}_1 S_0 I_9 + S_3\bar{S}_2 S_1\bar{S}_0 I_{10} \quad S_3\bar{S}_2 S_1 S_0 I_{11}$$
$$+ S_3 S_2\bar{S}_1\bar{S}_0 I_{12} + S_3 S_2\bar{S}_1 S_0 I_{13} + S_3 S_2 S_1\bar{S}_0 I_{14} \quad S_3 S_2 S_1 S_0 I_{15}$$

$$F = \bar{S}_3 \left[\bar{S}_2\bar{S}_1\bar{S}_0 I_0 + \bar{S}_2\bar{S}_1 S_0 I_1 + \bar{S}_2 S_1\bar{S}_0 I_2 + \bar{S}_2 S_1 S_0 I_3 + S_2\bar{S}_1\bar{S}_0 I_4 + S_2\bar{S}_1 S_0 I_5 + S_2 S_1\bar{S}_0 I_6 + S_2 S_1 S_0 I_7\right]$$
$$+ S_3 \left[\bar{S}_2\bar{S}_1\bar{S}_0 I_8 + \bar{S}_2\bar{S}_1 S_0 I_9 + \bar{S}_2 S_1\bar{S}_0 I_{10} + \bar{S}_2 S_1 S_0 I_{11} + S_2\bar{S}_1\bar{S}_0 I_{12} + S_2\bar{S}_1 S_0 I_{13} + S_2 S_1\bar{S}_0 I_{14} + S_2 S_1 S_0 I_{15}\right]$$

$$F = \bar{S}_3 X + S_3 Y$$

3 for Correct structure
2 for Correct order of variables.

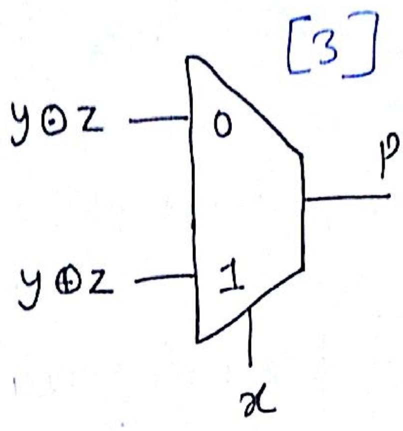


12.b

3 bit odd parity generator.

x y z	P (Parity)
0 0 0	1
0 0 1	0
0 1 0	0
0 1 1	1
1 0 0	0
1 0 1	1
1 1 0	1
1 1 1	0

[2]



13

A B C Q(t)	Q(t+1)	
0 0 0 0	0	reset to 0
0 0 0 1	0	
0 0 1 0	1	$\bar{Q}(t)$
0 0 1 1	0	
0 1 0 0	1	
0 1 0 1	0	
0 1 1 0	0	Q(t)
0 1 1 1	1	
1 0 0 0	1	$\bar{Q}(t)$
1 0 0 1	0	
1 0 1 0	0	Q(t)
1 0 1 1	1	
1 1 0 0	0	
1 1 0 1	1	
1 1 1 0	1	set to 1
1 1 1 1	1	

[3]

AB \ C Q(t)	00	01	11	10
00	0	0	0	1
01	1	0	1	0
11	0	1	1	1
10	1	0	1	0

$$Q(t+1) = \bar{A}\bar{B}C\overline{Q(t)} + \bar{A}B\bar{C}\overline{Q(t)} + A\bar{B}\bar{C}\overline{Q(t)} + ABQ(t) + ABC + BCQ(t) + ACQ(t)$$ [3]

Q(t)	Q(t+1)	A	B	C
0	0	X	X	X
0	1	X	X	X
1	0	X	X	X
1	1	X	X	X

[3]

This flip flop can't be used to design a real time problem/solution. [1]