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Q(a) For a modulo-6 counter $2^N \geq 6$ required & $N \geq 3$, so 3 FFs required,

1/4 for each row correct to add up to 2

Ck pulse	Q_{2n}	Q_{1n}	Q_{0n}	Q_{2n+1}	Q_{1n+1}	Q_{0n+1}	J_2	K_2	J_1	K_1	J_0	K_0
1 →	0	0	0	0	0	1	0	X	0	X	1	X
2 →	0	0	1	0	1	0	0	X	1	X	X	1
3 →	0	1	0	0	1	1	0	X	X	0	1	X
4 →	0	1	1	1	0	0	1	X	X	1	X	1
5 →	1	0	0	1	0	1	X	0	0	X	1	X
6 →	1	0	1	0	0	0	X	1	0	X	X	1
	0	0	0	0	0	1						

JK table

Q_n	Q_{n+1}	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

$J_1 = \bar{Q}_2 Q_0$ 1/2

Q_0 \ Q_2Q_1	00	01	11	10
0	0	X	*	0
1	1	X	*	0

1/2 $J_0 = 1$

1/2 $K_0 = 1$

X is Don't care.
* is Unused.

$K_2 = Q_0$ 1/2

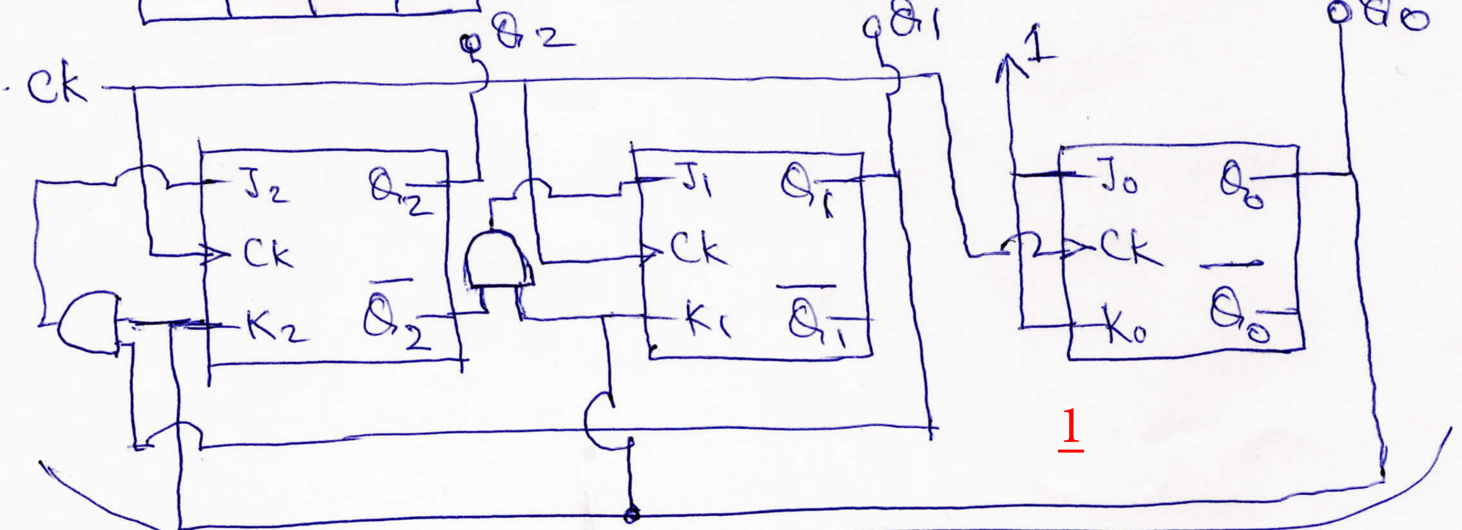
Q_0 \ Q_2Q_1	00	01	11	10
0	X	X	*	0
1	X	X	*	1

$J_2 = Q_1 Q_0$ 1/2

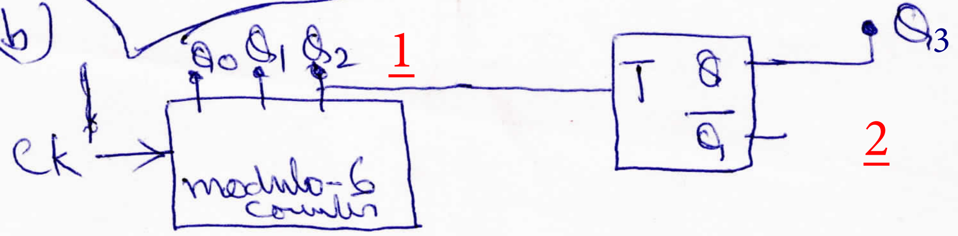
Q_0 \ Q_2Q_1	00	01	11	10
0	0	0	*	X
1	0	1	*	X

$K_1 = Q_0$ 1/2

Q_0 \ Q_2Q_1	00	01	11	10
0	X	0	*	X
1	X	1	*	X



Q(b)



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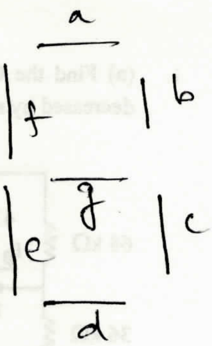
Q.7. Truth Table required.



No.	A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	0	1	1	1	1	1	1	0
1	0	0	0	1	1	1	1	1	0	0	0
2	0	0	1	0	1	1	1	1	0	0	0
3	0	0	1	1	1	1	1	1	0	0	1
4	0	1	0	0	1	1	1	1	0	0	0
5	0	1	0	1	1	1	1	1	0	0	0
6	0	1	1	0	1	1	1	1	0	0	0
7	0	1	1	1	1	1	1	0	0	0	0
8	1	0	0	0	1	1	1	1	1	1	1
9	1	0	0	1	1	1	1	0	0	1	1

1/4 for each row correct to add up to 2.5

All other combinations do not appear & therefore are Don't Cares. (*)

$\therefore a = b = c = 1$ always. 1

Minimizing d, e, f, and g

(d)

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

$d = \bar{D} + \bar{A}\bar{B} + \bar{A}\bar{C}$

(e)

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

$e = \bar{B}\bar{C}\bar{D}$

(f)

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

$f = \bar{B}\bar{C}\bar{D} + A$

(g)

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

$g = A + \bar{B}CD$

$d = \bar{D} + \bar{A}\bar{B} + \bar{A}\bar{C}$ (1/2 +1/2 + 1/2=1.5)

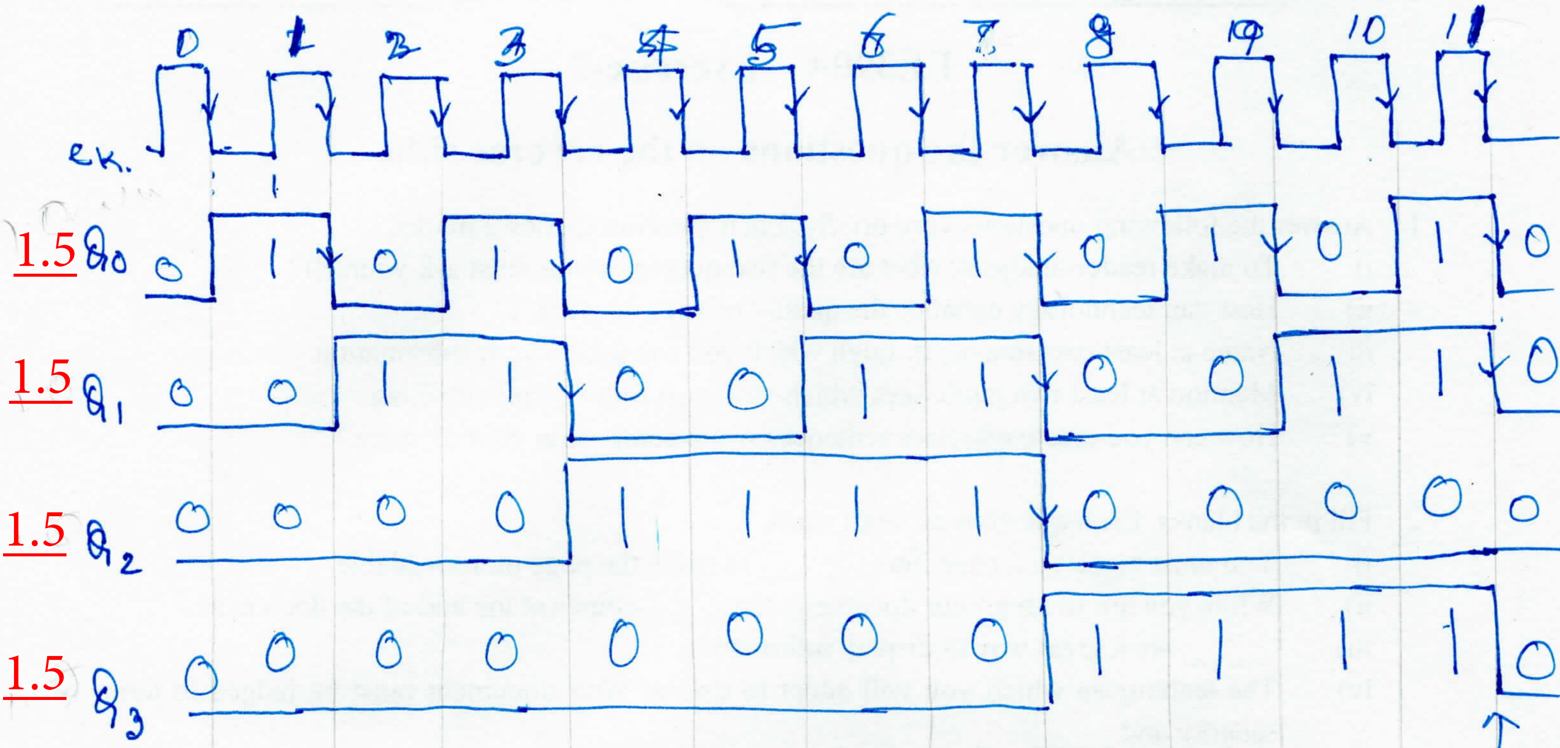
$e = \bar{B}\bar{C}\bar{D}$ 1

$f = A + \bar{B}\bar{C}\bar{D}$ (1+1/2)=1.5

$g = A + \bar{B}CD$.

1 1/2

6) Assume 0, 0, 0, 0 at start. ∴ Pr = 1, Cr = 1.
No change.



The And gate will be on when Q_3, Q_1, Q_0 are all 1's and Cr = 0, Pr = 1 at this time which will reset the FFs to 0, 0, 0, 0. 1

11 clock pulses have lapsed before the states comes back to 0, 0, 0, 0 again and the counter counts from 0000 to 1011.

∴ N = 11. (Count of 11). $\rightarrow (1011)_2 = (11)_{10}$.

1

Can be seen from the Cr = 0 from the NAND gate.

So if this justification is given with the answer '11' gets 4 pts without doing any sketch.

If one looks at the connection and can figure out that the NAND gate will only turn on when the output is 1011, which amounts to a count of 11, then directly 4 marks should be given. However, as the question asks for the sketch the rest of the point cannot be awarded. If one also shows that the Cr input sets it back to 0,0,0,0 then another 1 mark should be given.

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5) 85.125 → Register A

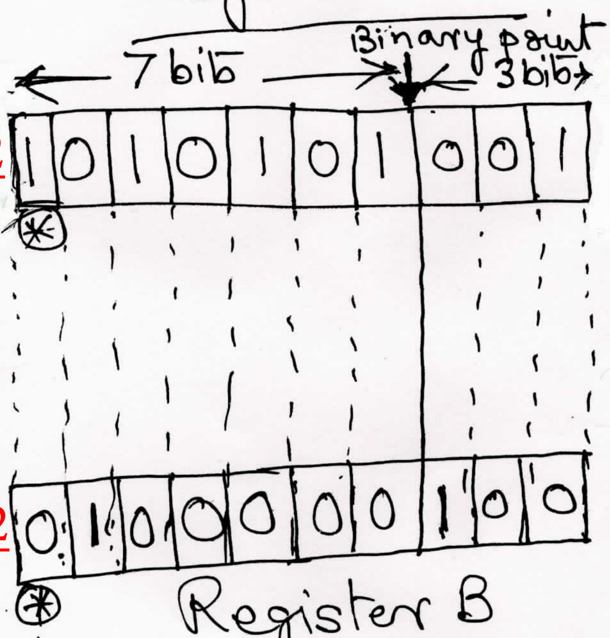
2	85
2	42 → 1 LSB
2	21 → 0
2	10 → 1
2	5 → 0
2	2 → 1
2	1 → 0
	0 → 1 MSB

1/2

0.125 × 2
MSB 0 ← 0.250 × 2
0 ← 0.500 × 2
1 ← 1.0
LSB.

binarypoint 1/2

Register A



32.5

2	32 LSB
2	16 → 0
2	8 → 0
2	4 → 0
2	2 → 0
2	1 → 0
	0 → 1 MSB

MSB 0.5 × 2
1 ← 1.0 × 2
0 ← .0 × 2
0 ← .0 × 2
LSB. 1/2

Binarypoint

1/2

In this case comparison is easy. Can be done by checking only the MSB of the 2 numbers.

1/2 can be given in either (a) or (b). This 1/2 should be there somewhere out of 7

∴ A > B. ∴ Need to take 1' compliment of B

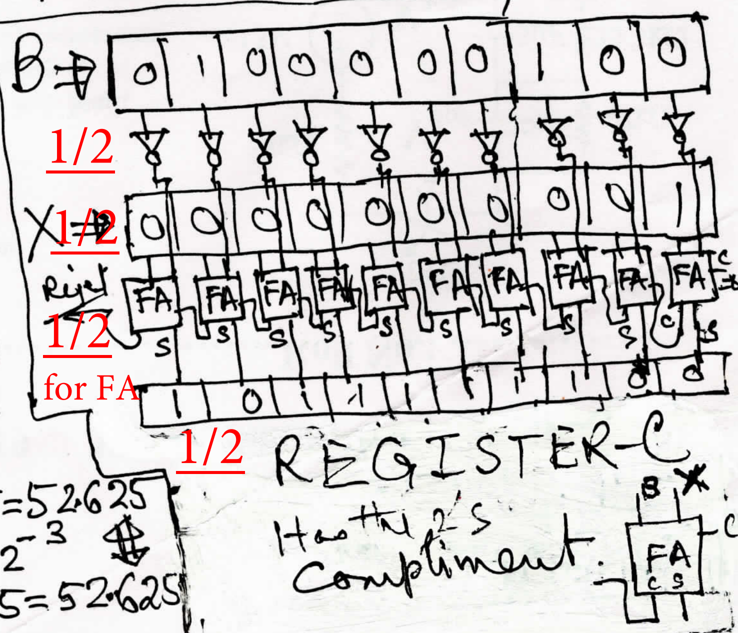
1	0	1	1	1	1	1	0	1	1

1/2

~~And~~ add 1 for 2' compliment of B Register C ⇒

1	0	1	1	1	1	1	1	0	0

1



Sum Registers A & C & Store in D register.

[A]	1	0	1	0	1	0	1	0	0	1
[C]	1	0	1	1	1	1	1	1	0	0
1 [D]	0	1	1	0	1	0	0	1	0	1

← 7 bits → ← 3 bits →

Reject overflow of 1 1/2

Check: $85.125 - 32.5 = 52.625$

$D \Rightarrow 2^5 + 2^4 + 2^2 + 2^{-1} + 2^{-3}$

$= 32 + 16 + 4 + 0.5 + 0.125 = 52.625$

gets 1/2 Extra for showing this

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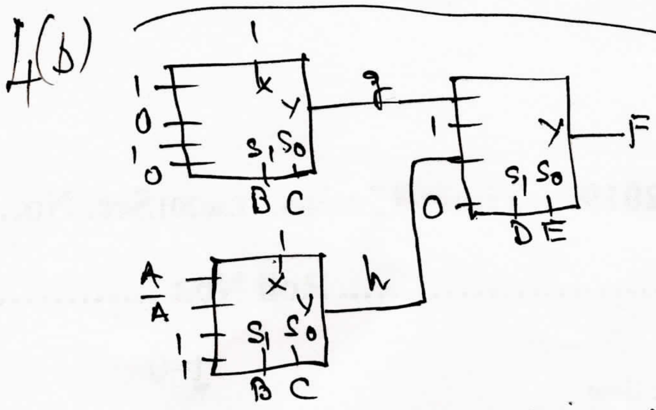
With Given Truth Table of MUX

4(b)



with given truth table

C S_0	B S_1	Y
0	0	I_0
0	1	I_1
1	0	I_2
1	1	I_3
E	D	

$$g = 1\cdot\bar{B}\bar{C} + 0\cdot B\bar{C} + 1\cdot\bar{B}C + 0\cdot BC$$
$$= \bar{B}\bar{C} + \bar{B}C = \bar{B}(\bar{C}+C) = \bar{B}$$

1/2

$$h = A\cdot\bar{B}\bar{C} + \bar{A}B\bar{C} + 1\cdot\bar{B}C + 1\cdot BC$$
$$= A\bar{B}\bar{C} + \bar{A}B\bar{C} + C = \left[(A\bar{B}+\bar{A}B)\bar{C} + C\right] = (A\bar{B}+\bar{A}B+C)$$

1/2

1/2 $F = \bar{B}\bar{D}\bar{E} + 1\cdot D\bar{E} + \underbrace{(A\bar{B}\bar{C}+\bar{A}B\bar{C}+C)}_{(A\bar{B}+\bar{A}B+C)}\bar{D}E + 0\cdot DE.$

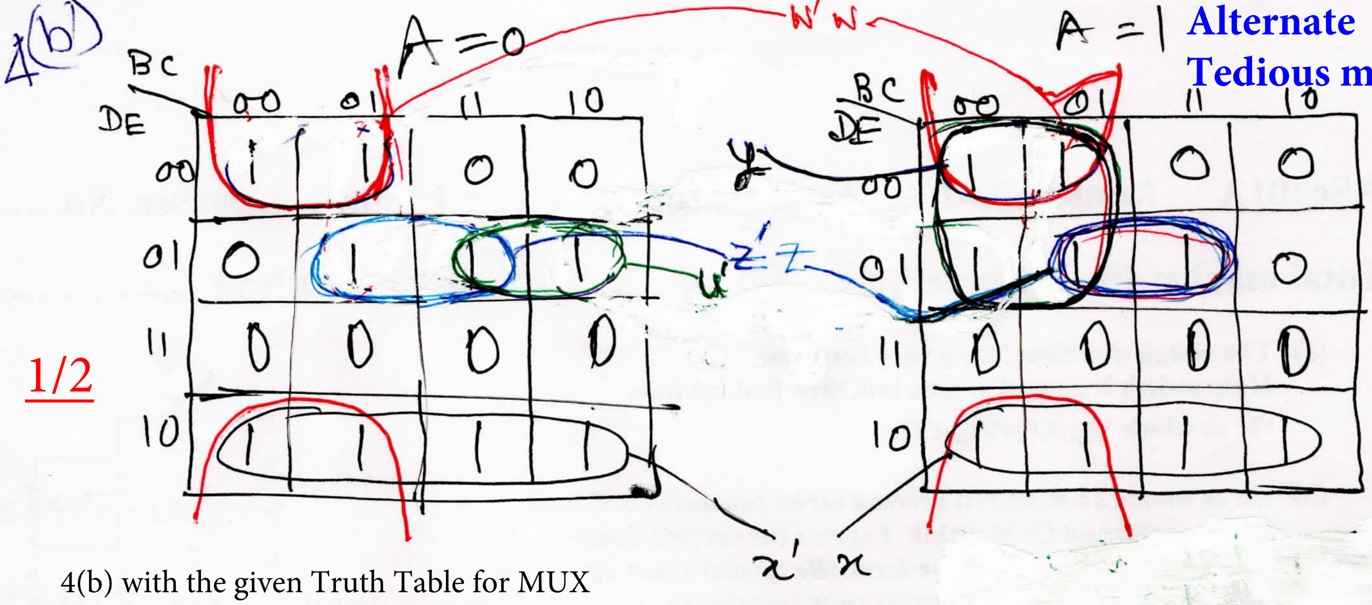
$$= \bar{B}\bar{D}\bar{E} + D\bar{E} + (A\bar{B}+\bar{A}B+C)\bar{D}E$$
$$= (\bar{B}\bar{D}+D)\bar{E} + (A\bar{B}+\bar{A}B+C)\bar{D}E$$
$$= (\bar{B}+D)\bar{E} + (A\bar{B}+\bar{A}B+C)\bar{D}E$$
$$= \bar{B}\bar{E} + D\bar{E} + A\bar{B}\bar{D}E + \bar{A}B\bar{D}E + C\bar{D}E$$

$$\bar{B}(\cancel{A}\bar{D}E + \bar{E}) = A\bar{B}\bar{D} + \bar{B}\bar{E}$$

$$= \bar{B}\bar{E} + D\bar{E} + A\bar{B}\bar{D} + \bar{A}B\bar{D}E + C\bar{D}E$$

1/2 for each term correct

1/2 mark extra for doing what was instucted



Alternate more Tedious method

1/2

1/2

4(b) with the given Truth Table for MUX

A	B C	D E	F
X	0 0	0 0	1
X	1 0	0 0	0
X	0 1	0 0	1
X	1 1	0 0	0
X	X X	1 0	1
1	0 0	0 1	1
0	0 0	0 1	0
1	1 0	0 1	0
0	1 0	0 1	1
X	0 1	0 1	1
X	1 1	0 1	1
X	X X	1 1	0

1/2

$$F = \underbrace{D\bar{E}}_{x'x} + \underbrace{A\bar{B}\bar{D}}_{y} + \underbrace{C\bar{D}E}_{z'z} + \underbrace{\bar{B}\bar{E}}_{w'w}$$

$$\underbrace{\bar{A}B\bar{D}E}_{u'}$$

1/2 for each term correct

4(b) with given truth table.

1/2 mark extra for doing what was instucted

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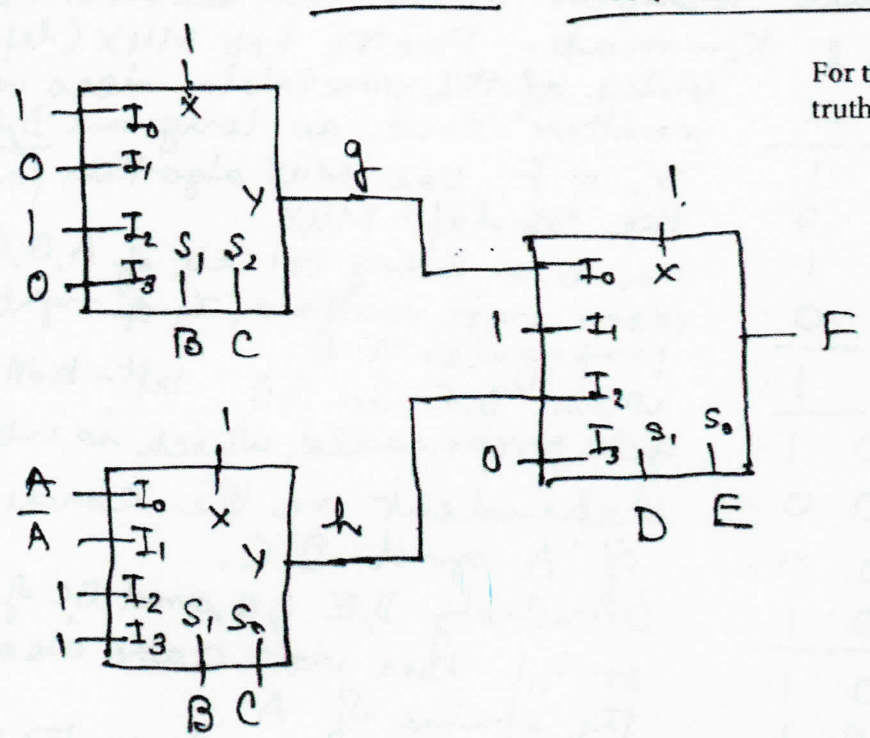
4(b)

For those who have assumed normal truth table for BC and DE



$$g = 1.\bar{B}\bar{C} + 0.\bar{B}C + 1.B\bar{C} + 0.BC$$

$$= \bar{B}\bar{C} + B\bar{C} = (\bar{B}+B)\bar{C} = \bar{C}$$ 1/2 by absorption theorem

$$h = A.\bar{B}\bar{C} + \bar{A}\bar{B}C + 1.B\bar{C} + 1.BC$$

$$= (A\bar{B}+B)\bar{C} + (\bar{A}\bar{B}+B)C =$$

$$= (A+B)\bar{C} + (\bar{A}+B)C$$ by absorption theorem.

$$= A\bar{C} + B\bar{C} + \bar{A}C + BC \rightarrow A\oplus C + B$$ 1/2

$$B\bar{C} + BC \rightarrow B(\bar{C}+C) = B$$

$$F = g.\bar{D}\bar{E} + 1.\bar{D}E + h.D\bar{E} + 0.DE$$ 1/2

$$= \bar{C}\bar{D}\bar{E} + \bar{D}E + (A\oplus C+B)D\bar{E}$$

$$= \bar{D}(\bar{C}\bar{E}+E) + (A\oplus C+B)D\bar{E}$$

$$= \bar{D}(\bar{C}+E) + (A\oplus C+B)D\bar{E}$$

$$= \bar{C}\bar{D} + \bar{D}E + [(A\bar{C}+\bar{A}C)+B]D\bar{E}$$

$$= \bar{C}\bar{D} + \bar{D}E + A\bar{C}D\bar{E} + \bar{A}CD\bar{E} + BD\bar{E}$$

1/2 for each correct term

$$= \bar{C}(\bar{D}+(A\bar{E})D) + \bar{D}E + \bar{A}CD\bar{E} + BD\bar{E}$$

$$= \bar{C}(\bar{D}+A\bar{E}) + \bar{D}E + \bar{A}CD\bar{E} + BD\bar{E}$$

$$= \bar{C}\bar{D} + \bar{D}E + BD\bar{E} + A\bar{C}\bar{E} + \bar{A}CD\bar{E}$$

For those using normal MUX truth table

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4(b) Alternate tedious mode of solution by truth table & K-map. For the top MUX (left) the value of the variable does not matter and as long as D, E is 0,0 $Y_1 = F$. Use MUX algorithm for the top-left MUX.

For D, E being 0,1 all of A, B, C does not matter, I_1 of right MUX propagates to F when D, E is 1,0 left-bottom MUX gets propagated, which is now dependent on the conditions of A and B, C.

Similarly D, E 1,0, and BC of 1,0 or 1,1 does not care about the status of A

For D, E being 1,1 on the right hand MUX, it doesnot care about the left hand MUXs.

1/2 for table

A	B	C	D	E	F
x	0	0	0	0	1
x	0	1	0	0	0
x	1	0	0	0	1
x	1	1	0	0	0
x	x	x	0	1	1
1	0	0	1	0	1
0	0	0	1	0	0
1	0	1	1	0	0
0	0	1	1	0	1
x	1	0	1	0	1
x	1	1	1	0	1
x	x	x	1	1	0

Now minimize F interms of A, B, C D E → 5 variables needs 2 4X4 maps.

1/2 for each correct entry of K-Map.

A=0

DE \ BC	00	01	11	10
00	1	0	0	1
01	1	1	1	1
11	0	0	0	0
10	0	1	1	1

x′ y′ z′ u′

A=1

DE \ BC	00	01	11	10
00	1	0	0	1
01	1	1	1	1
11	0	0	0	0
10	1	0	1	1

W X Y Z U

For A ≡ X same value enters the same location in both the maps.

1/2 for each term correct

$$\therefore F = \underbrace{\bar{C}\bar{D}}_{XX'} + \underbrace{\bar{D}E}_{YY'} + \underbrace{BD\bar{E}}_{ZZ'} + \underbrace{\bar{A}CD\bar{E}}_{V} + \underbrace{A\bar{C}\bar{E}}_{W}$$

Compare with previous method is same

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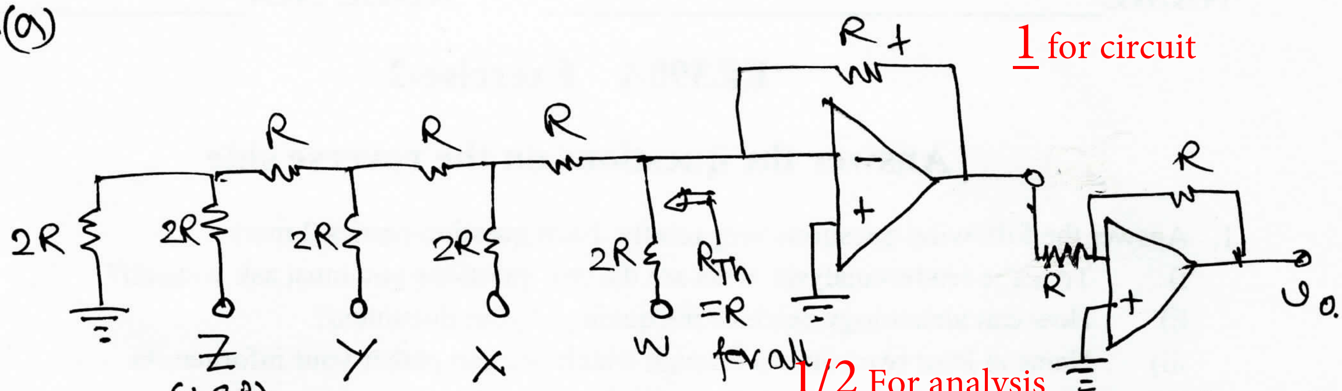
4(a)



1 for circuit

1/2 For analysis

W	X	Y	Z	
1	0	0	0	$v_o = \frac{V_{ref}}{2}$
0	1	0	0	$v_o = \frac{V_{ref}}{4}$
0	0	1	0	$v_o = \frac{V_{ref}}{8}$
0	0	0	1	$v_o = \frac{V_{ref}}{16}$

By superposition with $R_f = R$

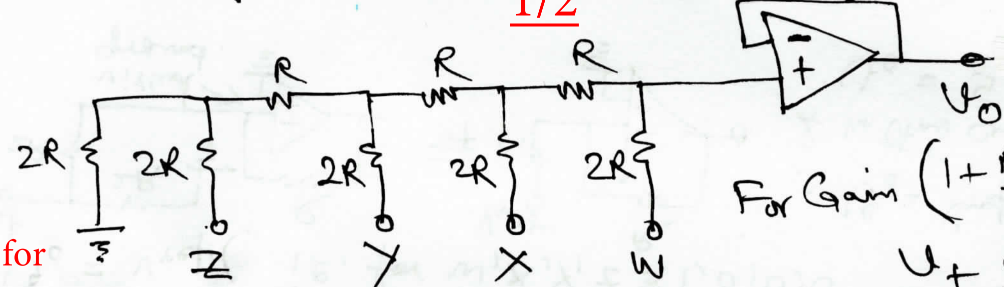
$$v_{o_{all}} = \frac{V_{ref}}{2}\left(W \times 2^0 + X \times 2^{-1} + Y \times 2^{-2} + Z \times 2^{-3}\right)$$

W, X, Y, Z can be 0 or 1.

With $R_f = 2R$, $v_{o_{all}} = V_{ref}\left(W + \frac{X}{2} + \frac{Y}{4} + \frac{Z}{8}\right)$

$R_f = R$ For $V_{ref} = 5V$, $v_o = 5\left(W + \frac{X}{2} + \frac{Y}{4} + \frac{Z}{8}\right)$ 1/2 for each term

1/2



1 for circuit

1/2 for analysis

For Gain $\left(1 + \frac{R_f}{R}\right)$ with $R_f = 0$

v_+ appears at the output.

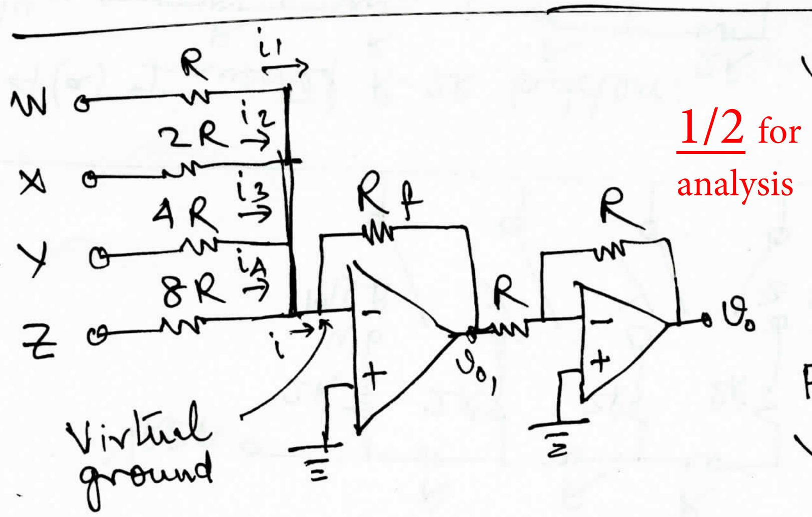
$$\therefore v_o = \frac{V_{ref}}{2}\left(W \times 2^0 + X \times 2^{-1} + Y \times 2^{-2} + Z \times 2^{-3}\right)$$

$$V_o = N_{REF} \sum_{i=0}^{i=N-1} \frac{B_i}{2^{N-i}}$$

$$v_{o_{all}} = \frac{V_{ref}}{2}\left(W + \frac{X}{2} + \frac{Y}{4} + \frac{Z}{8}\right)$$

for $V_{ref} = 5V$ $v_o = \frac{5}{2}\left(W + \frac{X}{2} + \frac{Y}{4} + \frac{Z}{8}\right)$

1/2 for factor 1/2 for each term



1 for circuit

1/2 for analysis

$$v_{o_1} = -iR_f$$
$$= -R_f(i_1 + i_2 + i_3 + i_4)$$
$$= -R_f\left(\frac{W}{R} + \frac{X}{2R} + \frac{Y}{4R} + \frac{Z}{8R}\right)V_{ref}$$
$$= -\frac{R_f}{R}\left(W + \frac{X}{2} + \frac{Y}{4} + \frac{Z}{8}\right)V_{ref}$$

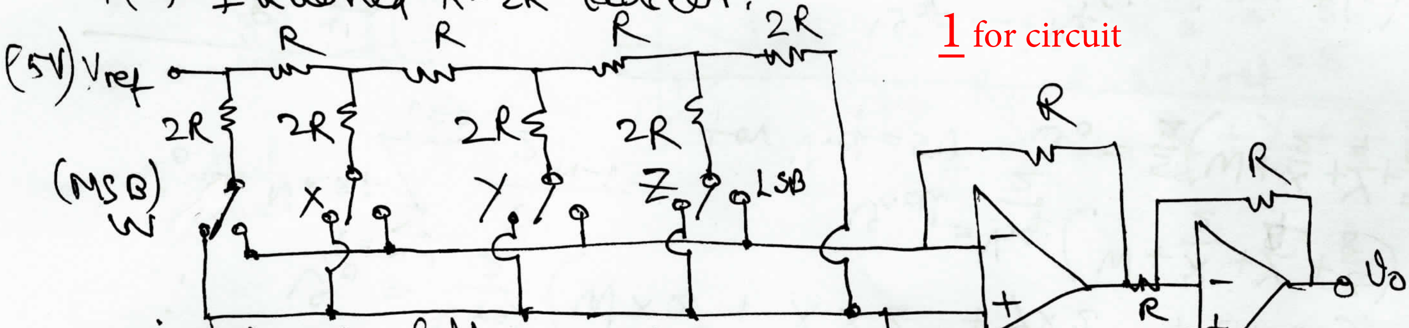
For $R_f = R$ & $V_{ref} = 5$

$$V_o = 5\left(W + \frac{X}{2} + \frac{Y}{4} + \frac{Z}{8}\right)$$

1/2 for factor 1/2 for each term

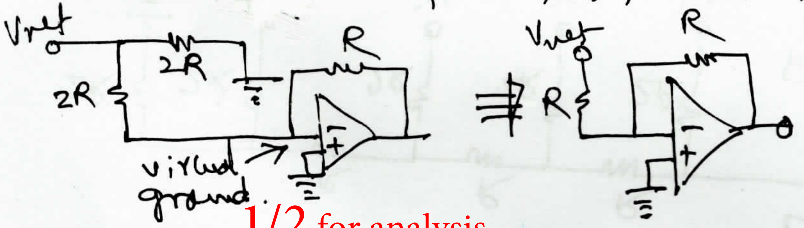
4(a) Inverted R-2R ladder:

1 for circuit



Looking from the left for each W, X, Y, Z going to 0 the $R_{Th} = R$

i.e. for W, X, Y, Z ≡ 1, 0, 0, 0



1/2 for analysis

$$\therefore V_0 = V_{ref}\left(W + \frac{X}{2} + \frac{Y}{4} + \frac{Z}{8}\right)$$

& in this case

$$V_0 = 5\left(W + \frac{X}{2} + \frac{Y}{4} + \frac{Z}{8}\right)$$

1/2 for factor

1/2 for each term

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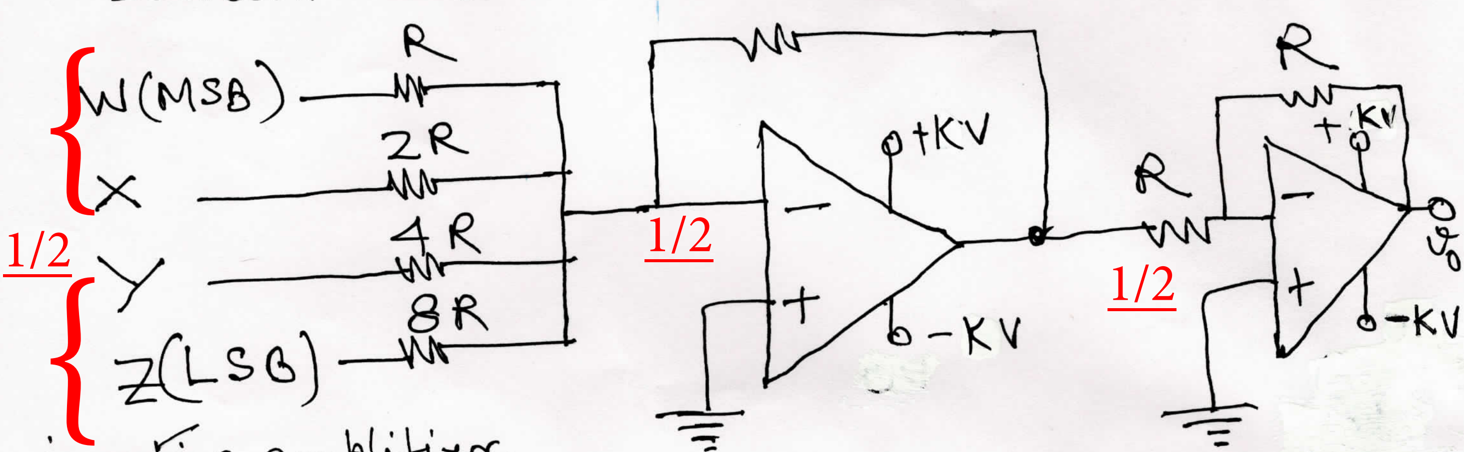
4(a) Consider an inverting amplifier with saturation voltages $\pm K$ V. Since this is an inverting amplifier, with an input digital levels of +5V it therefore requires another inverting amplifier of gain 1 with saturation voltages $\pm K$ V.
Assuming that for the MSB the output is +5V, this input should have a gain of 1 for the 1st stage. Therefore the circuit is as shown below.



inverting amplifier, gain for MSB = −1

$$\therefore v_0 = -1 \times -\left[W(5V)\frac{R}{R} + X \times (5V)\frac{R}{2R} + Y \times (5V) \times \frac{R}{4R} + Z \times (5V) \times \frac{R}{8R} \right]$$

$$= \left(W + \frac{X}{2} + \frac{Y}{4} + \frac{Z}{8} \right) \times 5V \quad \underline{1}$$

Maximum value is $W, X, Y, Z \equiv 1,1,1,1$ or $v_0 = 9.375$V

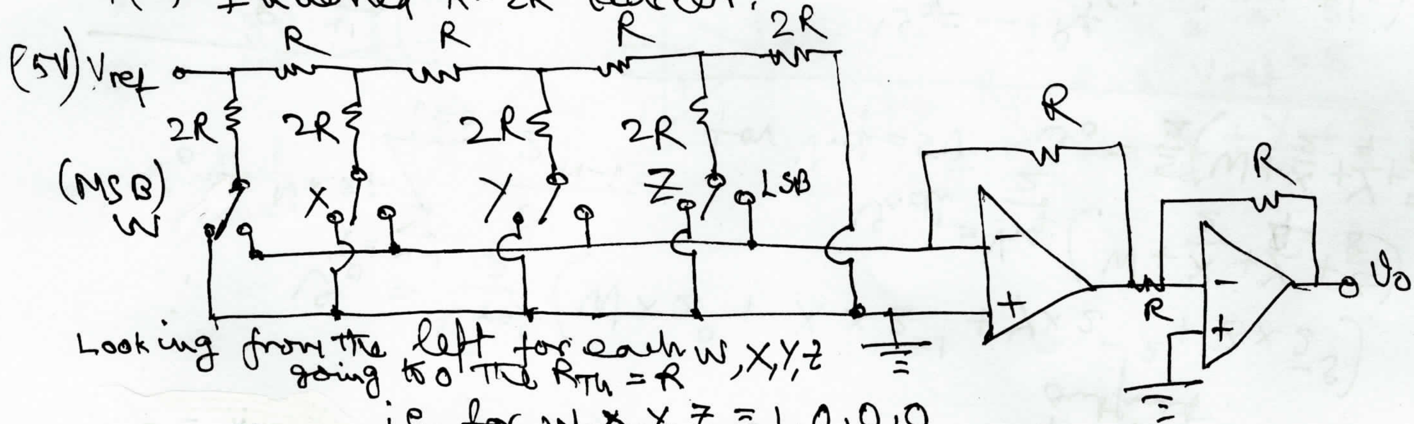
$\therefore K \geq 9.375$V, take $K = 10$V.

(b) Quantization error is given by the smallest change, which happens through the LSB.

$\therefore$ Quantization error $= \frac{1}{8} \times 5V = \underline{0.625V}$ $\underline{1}$

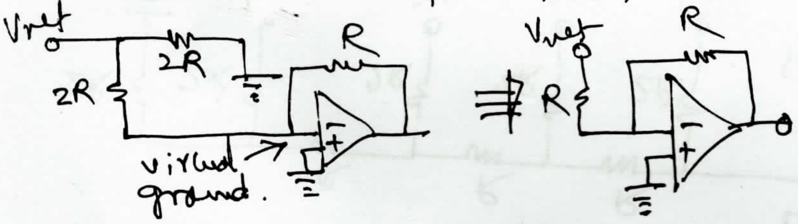
There is a problem with the question as it states to take supply as +5V and 0V. This will not work. If someone shows that the Supply should be above +9.375V and below -9.375V, then must be given and extra credit of $\underline{1}$.

4(a) Inverted R-2R ladder:



Looking from the left for each W, X, Y, Z going to 0 the $R_{Th} = R$

i.e. for W, X, Y, Z $\equiv$ 1, 0, 0, 0



$$\therefore V_0 = V_{ref}\left(W + \frac{X}{2} + \frac{Y}{4} + \frac{Z}{8}\right)$$

& in this case

$$V_0 = 5\left(W + \frac{X}{2} + \frac{Y}{4} + \frac{Z}{8}\right)$$

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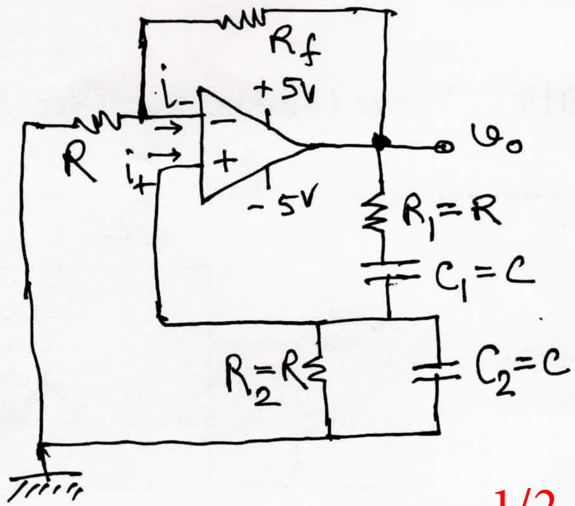
3) a)



$$A_v v_+ = v_o$$

$$\frac{v_o - v_-}{R_f} = \frac{v_- - 0}{R} \quad \because i_- = 0$$

$$v_o = R_f\left(\frac{1}{R_f} + \frac{1}{R}\right) v_-$$

$$= \left(1 + \frac{R_f}{R}\right) v_-$$

$$\simeq \left(1 + \frac{R_f}{R}\right) v_+ \text{, Ideal OpAmp.}$$

If someone shows this derivation, then an extra credit of 1/2 should be given.

1/2

$$\therefore A_v = \left(1 + \frac{R_f}{R}\right)$$ ⇐ Need not show derivation for full credit.

$$\beta = \frac{v_+}{v_o} = \frac{R_2 \| \frac{1}{j\omega C_2}}{R_1 + \frac{1}{j\omega C_1} + R_2 \| \frac{1}{j\omega C_2}} = \frac{R \| \frac{1}{j\omega C}}{R + \frac{1}{j\omega C} + R \| \frac{1}{j\omega C}}$$ 1/2

$$= \frac{1}{\dfrac{R + \frac{1}{j\omega C}}{\dfrac{R/j\omega C}{R + \frac{1}{j\omega C}}} + 1} = \frac{1}{1 + \dfrac{\frac{1 + j\omega RC}{j\omega C}}{\dfrac{R/\cancel{j\omega C}}{\frac{1 + j\omega RC}{\cancel{j\omega C}}}}}$$

$$= \frac{1}{1 + \dfrac{(1 + j\omega RC)^2}{j\omega RC}} = \frac{1}{1 + 2 + \dfrac{1 + j^2\omega^2 R^2 C^2}{j\omega RC}}$$

1 $$= \frac{1}{3 + j\left(\omega RC - \frac{1}{\omega RC}\right)} \quad \therefore A_v\beta = \left(1 + \frac{R_f}{R}\right) \frac{1}{3 + j\left(\omega RC - \frac{1}{\omega RC}\right)}$$ 1

(b) {At resonance $\omega_0 RC - \frac{1}{\omega_0 RC} = 0$, $|A_v\beta|$ is maximum} 1/2

or $\omega_0 = \frac{1}{RC}$. For $\omega_0 = 100\,kHz \times 2\pi$

1 $RC = \frac{1}{2\pi \times 10^5}$ [S] ⇒ For $C = 318.3 \times 10^{-12}$ F

$$R = \frac{1}{2\pi \times 10^5 \times 318.3 \times 10^{-12}} = 5{,}000.16\,\Omega \simeq \underline{5\,k\Omega}$$ 1

(c) For stable oscillation at resonance $|A_v \beta|_{\omega_0} \geq \frac{1 + R_f/R}{3}$ 1

& for $|A_v\beta| \geq 1$; $\frac{R_f}{R} \geq 2$ or $R_f \geq 2R = 10\,k\Omega$ 1

$$\therefore R_f = \underline{(10 + \delta)\,k\Omega}$$

where δ is a very small number.

Full marks even if one does not mention about Delta.

ESc 201A End Semester 2019-20-I

2) a) At $t=0^-$, $v_- = -4.9V$ and since sufficient time has lapsed no current is flowing through the resistance 'R'. $\therefore$ $v_+ = 0\ V$. 1

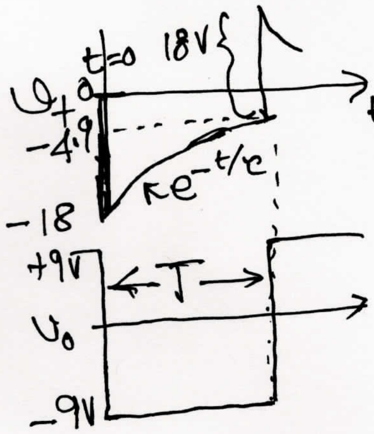
The infinite open loop comparator will send the output v_o to saturation level. But when v_o crosses the voltage of the Zener it is clamped at the voltage $(V_Z + V_{on})$. Since $V_{on} = 0$, $v_{o_{t=0^-}} = V_Z = +9V$. 1

(b) Since the input pulse is only for a short while (0.1ms), Cin acts as d.c. blocking and an a.c. short. 1/2

Since at $t=0^+$, v_+ is still at 0V 1/2 and v_- has become positive, $(5-4.9) = +0.1\ V$, the comparator will switch to the negative saturation value. 1/2 However, one of the Zeners work now and the voltage v_o will be clamped at $-V_Z = -9V$.

$\therefore$ $v_{o_{t=0^+}} = -9V$. 1.5

(c) Question is that when the input pulse is gone, what is the voltage v_+ or v_o?



As the capacitor 'C' has been charged to a voltage of +9V and its right terminal is at $-9V$, $v_+ = -18\ V$. 1

$\therefore$ v_o will continue to remain at $-9V$ till v_+ reaches $v_- = -4.9V$. 1

Note that the diode is reverse biased and will not conduct.

$\therefore$ v_+ will leak through R with a time constant $RC = \tau$

$\therefore$ $v_+ = -18\ e^{-t/\tau}$ where it is assumed that $v_+(\infty) = 0$. 1/2

$\therefore$ The time till which v_o holds at $-9V$ is T, the time till v_+ reaches $-4.9V$, or $-4.9 = -18 e^{-t/\tau}$ 1/2 or $T = RC \ln\left(\frac{18}{4.9}\right)$

For $R = 4k\Omega$, $C = 2\mu F$, $RC = 8ms = \tau$ $\therefore$ $T = 8m \times 1.3\ (s) = 10.41ms$ 1

ESc 201A End-Semester 2019-20-I

1) (a) In the base-emitter loop: assume $V_{BE_{active}} = 0.7V$

$5V = I_B \times 10k\Omega + 0.7V + I_E \times 1k\Omega$ 1/2

or $4.3 = 10 I_B(k) + (89+1) I_B(k) \Rightarrow I_B = \frac{4.3}{100}\,mA$

or $I_B = 43\,\mu A$ 1

$\therefore I_C = \beta_F I_B = 89 \times 43\,\mu A = 3.827\,mA$ 1/2

check for active region $V_C = -3.827V + 5 = 1.173V$, $V_B = -0.43V$ ∴ BC reverse biased.

(b) Assuming Cin and Cout are short at all frequencies, the a.c. equivalent circuit is:

R_E is shorted by the capacitance C_E in mid-band.

$R_L = R_C || R_L'$

$= 1k\Omega || 10k\Omega \cong 0.91k\Omega$ 1/2

$g_m = \frac{I_C}{V_T} = \frac{3.827}{26}$

$= 147.2\,mS$ 1

$\therefore A_{v_{mid}} = \frac{v_o}{v_i} = \frac{v_o}{v_{be}} = -\frac{g_m \cancel{v_{be}} R_L}{\cancel{v_{be}}} = -147.2 \times 0.91$

$= -133.95 \cong -134.$ 1

(c) $f_{L3dB} = \frac{1}{2\pi \tau_{CE}}$, $\tau_{CE} = R_{C_{E_{in}}} \cdot C_E$ 1/2 ⊛ No contribution to f_{L3dB}.

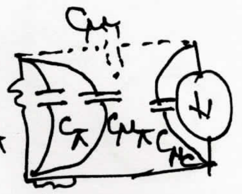
$R_{CE} = R_E || r_e$ $\boxed{\text{as } v_i = 0 \text{ for calculation and therefore the base would be grounded}}$

$r_e = \frac{V_T}{I_C} = 6.794\Omega$ $\therefore R_E || r_e = R_{C_{E_{in}}} = \frac{1000 \times 6.794}{1006.794} = 6.748\Omega$ 1/2

$\therefore \tau_{C_E} \cong 6.75\Omega \times 10 \times 10^{-6} F = 67.5\,\mu s$ 1/2

$\therefore f_{L3dB} = \frac{1}{2\pi\, 67.5\,\mu s} = 2.36\,kHz$ 1/2

f_{H3dB}



$C_{\mu\pi} = C_\mu(1 + |g_m R_L|) = 5pF(1 + 134)$

$= 675\,pF$ 1/2

$C_{\mu c} = C_\mu\left(\frac{1 + |g_m R_L|}{g_m R_L}\right) \simeq C_\mu\left(1 + \frac{1}{134}\right)$

$= (1.007) C_\mu$ very far off from upper cutoff (NEGLECT)

$\therefore C_{in} = C_\pi + C_{\mu\pi}$

$= 725\,pF$ 1/2

1/2 $R_{C_{in}} = 0$ surprising?? → $v_i = 0$ for R_{Th} → shorts both the $10k || r_\pi$

$\therefore f_{H3dB} = \frac{1}{2\pi \times 0}$ 1/2 ∞ (No)

or $\tau_{C_{in}} = 0$

Now $C_{\mu c}$ cannot be neglected $\tau_{C_{\mu c}} \cong 5pF \times 0.91k$ or $f_{H3dB} = 35\,GHz$

C(mu/c), which was unimportant now becomes dominant. Whoever shows this gets an extra mark of 1.