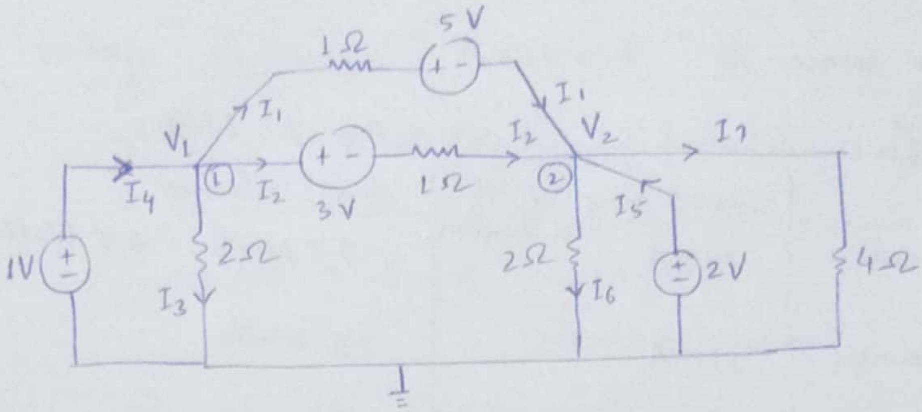
Name →

Roll no →

Test no → 02

Subject Name → Network + μP + Control + Digital

Sol^n: 1.a).



Applying Nodal analysis at node ①&②

From Circuit:- $V_1 = 1\,V$, $V_2 = 2\,V$

[By grounding one of the node]

By KCL at node 1:-

$I_4 = I_1 + I_2 + I_3$ [Incoming current = Outgoing current at a node.]

$\Rightarrow I_4 = \dfrac{1-5-2}{1} + \dfrac{1-3-2}{1} + \dfrac{1}{2}$

$= -6 - 4 + 0.5$

$\boxed{I_4 = -9.5\ A.}$

It means $I_4 = 9.5\,A$ is coming towards positive terminal of 1V source

$\therefore$ For 1 V Source $\Rightarrow$ Power absorbed $= 1V \times 9.5\,A = 9.5$ Watts.

For 3 V source $\Rightarrow I_2 = \dfrac{1-3-2}{1} = -4\,A$.

$\boxed{\text{Power dissipated} = 3V \times 4A = 12 \text{ Watts.}}$

For 5 V source $\Rightarrow I_1 = \dfrac{1-5-2}{1} = -6A$.

$\boxed{\text{Power dissipated} = 5V \times 6A = 30 \text{ Watts.}}$

KCL at Node 2:-

Σ incoming current $= \Sigma$ outgoing currents.

$I_1 + I_2 + I_5 = I_6 + I_7$

$\Rightarrow -6 + -4 + I_5 = \dfrac{2}{2} + \dfrac{2}{4}$

$\Rightarrow \boxed{I_5 = 1.5 + 10 = 11.5\ A} \rightarrow$ current going out of +ve terminal of 2V source

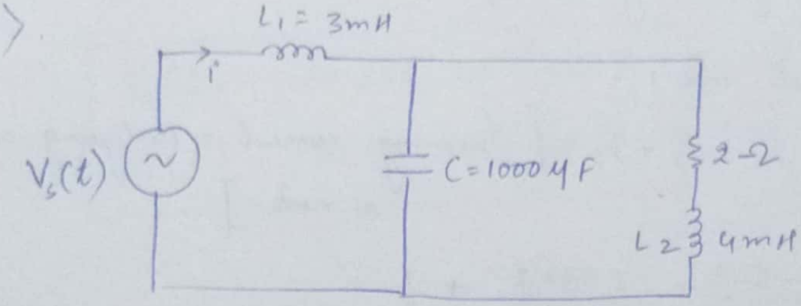
For 2V source ⇒ $I_S = 11.5\,A$

Power delivered = $2V \times 11.5\,A = 23$ Watts.

Result:-

	Current going out of +ve terminal	Power delivered
1V source	−9.5 A	−9.5 Watts = 9.5 Watts absorbed
2V source	11.5 A	23 Watts
3V source	4 A	12 Watts
5V source	~~[illegible]~~ 6 A	30 Watts.

Solⁿ:- 1.b)



Given:- $V_c(t) = 100\cos(500t + 45°)\,V$.

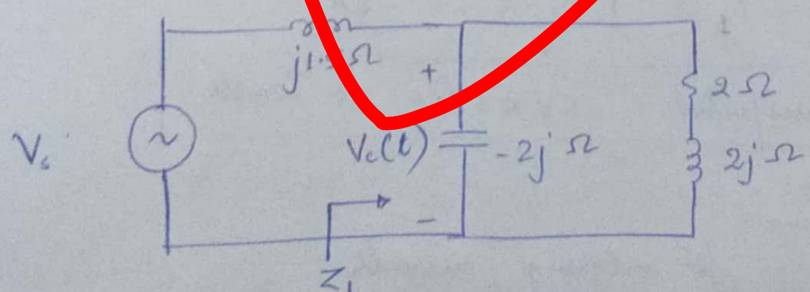
$V_c(t) = 100\angle 45°$ Volts, $\omega = 500$ rad/sec.

Converting the above circuit in ω domain

$X_{L_1} = j\omega L_1 = j\,500 \times 3\times10^{-3} = 1.5j\,\Omega$.

$X_{L_2} = j\omega L_2 = j\,500 \times 4\times10^{-3} = 2j\,\Omega$

$X_C = \frac{1}{j\omega C} = \frac{1 \times 10^6}{j \times 500 \times 1000} = -2j\,\Omega$.



$Z_1 = \frac{(2+2j)\times(-2j)}{2} = 2.828\angle -45°\,\Omega$.

By Voltage Division:-

$$V_c(t) = V_s \times \frac{Z_1}{Z_1 + j1.5}$$

$$\Rightarrow 100\angle 45^\circ = V_s \times \frac{2.828\angle -45^\circ}{2.828\angle -45^\circ + j1.5}$$

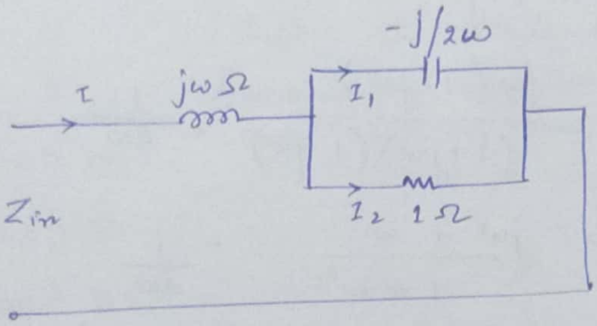
$$\Rightarrow V_s = 72.886\angle 75.96^\circ \text{ Volts}$$

$$i = \frac{V_s(t)}{Z_1 + j1.5} = \frac{72.886\angle 75.96^\circ}{2.828\angle -45^\circ + j1.5} = 35.36\angle 90^\circ \text{ A}$$

$$\therefore \boxed{\begin{array}{l} V_s(t) = 72.886\cos(500t + 75.96^\circ) \\ i(t) = 35.36\cos(500t + 90^\circ) = -35.36\sin(500t) \end{array}} \text{ Ans}$$

Sol^n:- 1.c).

Case-1



To find:- freq. of resonance.

$$Z_{in} = j\omega + \frac{\frac{-j}{2\omega} \times 1}{1 - \frac{j}{2\omega}} = j\omega + \frac{-j}{\cancel{2\omega}} \times \frac{\cancel{2\omega}}{2\omega - j}$$

$$= j\omega - \frac{j}{(2\omega - j)} \times \frac{2\omega + j}{(2\omega + j)}$$

$$Z_{in} = j\omega - \frac{(2j\omega - 1)}{4\omega^2 + 1}$$

For the circuit to be in resonance, the img part of Z_{in} must be zero.

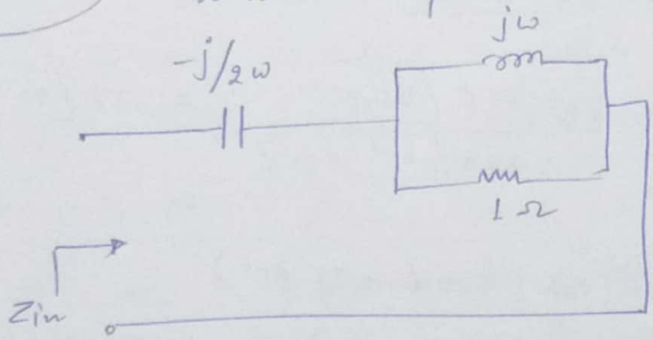
$$\therefore \cancel{j}\cancel{\omega} = \frac{2\cancel{\omega}}{4\omega^2 + 1} \Rightarrow 4\omega^2 + 1 = 2$$

$\Rightarrow 4\omega^2 = 1$

$\Rightarrow \omega^2 = \frac{1}{4} \Rightarrow \omega = \pm \frac{1}{2}$ rad/sec.

$$\boxed{f = \frac{\omega}{2\pi} = \frac{1}{4\pi} = 0.0795 \text{ Hz.}}$$

Case-2 when the capacitor and inductor are interchanged.



Now, $Z_{in} = \frac{1 \times j\omega}{1 + j\omega} - \frac{j}{2\omega}$

$= \frac{j\omega(1 - j\omega)}{(1 + j\omega)(1 - j\omega)} - \frac{j}{2\omega}$

$= \frac{j\omega + \omega^2}{1 + \omega^2} - \frac{j}{2\omega}$

For circuit to be in resonance, the imaginary part of Z_{in} must be zero.

Hence, $\frac{1}{2\omega} = \frac{\omega}{1 + \omega^2}$

$\Rightarrow 1 + \omega^2 = 2\omega^2$

$\Rightarrow \omega^2 = 1 \Rightarrow \omega = \pm 1$ rad/sec.

For resonance, $\omega = 1$ rad/sec.

$$\boxed{f = \frac{\omega}{2\pi} = 0.159 \text{ Hz}}$$

Conclusion:-

$f_1 = 0.0795$ Hz (without interchanging)

$f_2 = 0.159$ Hz (after interchanging)

* Frequency at which resonance occurs get increased after interchanging the inductor and capacitor.

Scanned with CamScanner

Solⁿ:- d). 1st 8 bit no. is present at C100H.

2nd 8 bit no. is present at C200H.

Program:-

LXI H, C100H : Load 1st 8 bit no from C100H memory adress to HL pair register

MOV E, H : Move the 8-bit no. in ~~lo~~ E register

MVI D, 00H : Making DE as a 16 bit number

LXI H, C200H : Loading 2nd 8 bit no from C200H memory address to HL pair register

MVI B, 08H : Loading count into register B.

Add: DAD H : Performing the addition of content of DE & HL registers

RAL : checking for the carry bit.

JNC shift : No carry present checking to perform further multiplication

DAD D : Shifting the content in D register

DCR B : Decrementing the count

JNZ Add → Count is not zero, then addition is to be performed again.

shift: DAD H

DAD D

DCR B

JNZ Add

~~HLT~~ HLT

This method of repeated addition is called shift and add technique which is used to multiply two 8-bit no. in 8085 microprocessor since 16 bit operation can't be performed in Accumulator of 8085 as it is a 8 bit register.

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Sol^n:- 1.c) <u>Interrupt Controller:-</u>

Interrupt controller is required to manage, acknowledge and control various types of interrupts in a microprocessor.
IC 8259 is PIC (Programmable Interrupt controller) which can handle 8 interrupts at a time.

→ Interrupt Controller is required to schedule the interrupt acknowledgement as per its priority order. But for interrupts such as TRAP which is non-maskable needs to be acknowledged with top priority by halting the current running instruction.
The order of priority of interrupts are as follows:-

TRAP > RST 7.5 > RST 6.5 > RST 5.5 > INTR.

INTR has the least priority among all.

→ Interrupt Controller is required to halt the current instruction and send the program control to the subroutine address of the interrupt introduced in the system. For interrupts like INTR, an interrupt controller is required to designate the address at which subroutine of the interrupt is present since INTR is a non-vectored interrupt.

→ <u>Polling:-</u>
It is a process of enabling or disabling the various types of hardware or software interrupts present for a microprocessor. It schedules or manages the priority ~~rule~~ with which each interrupt has to be acknowledged except for the TRAP interrupt which is a non-maskable interrupt.

Sol^n:- 3.a) 1) XCHG:-

* It is a 1 byte instruction with implied addressing mode.
* It is used to exchange the contents of DE and HL register pairs.

2) XTHL :-

* It is a 1 byte instruction with implicit addressing mode.
* It is used to exchange the contents of top of stack pointer and HL pair registers.

3) SPHL :-

* It is a 1 byte instruction with no operand in its formatting. It is an indirect mode of addressing.
* It is used to copy the content of HL pair to top of the stack pointer.

$$[SP] \longleftarrow [HL]$$

4) DAD SP :-

→ It is a 16 bit addition instruction in which content of ~~the~~ stack pointer ~~to~~ will get added to content of HL pair register and the result will be stored in HL pair only.

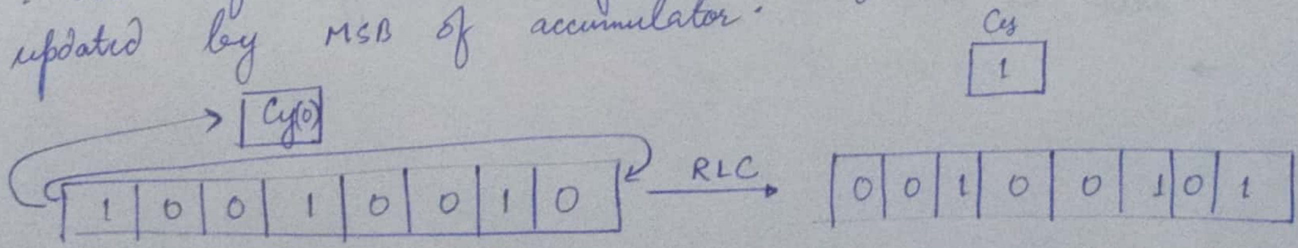
$$[HL] \longleftarrow [HL] + [SP]$$

5) RLC :-

→ It is a 1 byte instruction

→ It uses implicit addressing mode.

→ It is used to rotate the content of accumulator to 1 bit left without carry. The carry bit will be updated by MSB of accumulator.



Solⁿ:- 3 b) A is term given for accumulator of the microprocessor.

→ All the arithmetic and logical operations can be performed in an accumulator only.

→ Accumulator is a 8 bit register in 8085 and 16 bit register in 8086.

→ The result of any arithmetic and logical operation is stored in accumulator only. Without the use of accumulator, arithmetic operations are not possible for a microprocessor.

★ Use of B, C, D, E, H and L registers:-

1) The combined B, C register, D, E register and H, L register makes a 16 bit register pair.

2) Mostly they are used for temporary data storage or data switching or shifting applications.

3) Register B, C are used as a counter in many programms.

4) DE register acts as the base register for operation in many different programs.

5) These register are used to store address as well as 16-bit data for various programs.

Speciality of HL pair over the other register pairs in 8085 μP:-

→ It acts as a default memory pointer register.

→ All memory related addressing or retreival is done through HL pair.

→ Many instructions like XCHG, XTHL needs the content of HL pair for its functioning.

→ HL pair is used to store the default memory address as well as data also for data switching or exchanging programs.

→

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Sol^n:- 3.c) i) Initially

Power drawn by I.M = 20KW.

$p.f = 0.4$

After installing Δ Capacitors $p.f = 0.9$ lag.

KVAR supplied by Capacitor $= P(\tan\theta_1 - \tan\theta_2)$

where $\theta_1 = \cos^{-1} 0.4 = 66.422$

$\theta_2 = \cos^{-1} 0.9 = 25.842°$

KVAR supplied by Capacitor $= 20KW(\tan 66.422 - \tan 25.842)$

$= 36.14$ KVAR

KVAR per phase $= 12.05$ KVAR.

$$KVAR = \frac{V_{ph}^2}{X_{c\,ph}}$$

$$\Rightarrow X_{c\,ph} = \frac{V_{ph}^2}{(KVAR)_{ph}} = \frac{(415)^2}{3 \times 12.05} = 4.764\ \Omega.$$

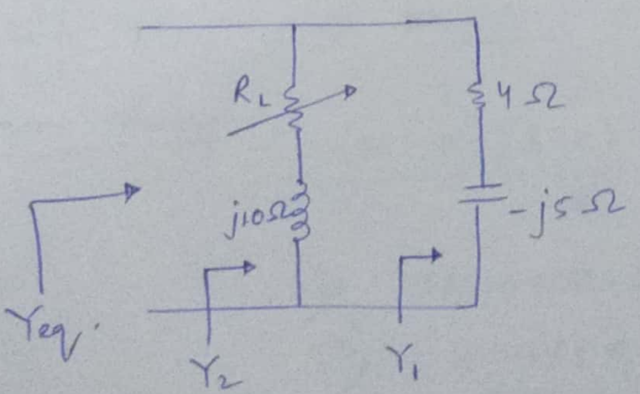
$$\Rightarrow \frac{1}{\omega C} = 4.764\ \Omega$$

$$\Rightarrow C_{ph} = \frac{1}{2\pi \times 50 \times 4.764} = 668.156\ \mu F.$$

$$\therefore \boxed{\text{Capacitance} = \frac{668.156}{3} = 222.7\ \mu F}$$

Total KVAR supplied by shunt capacitors = 36.14 KVAR

3.C ii).



$$Y_1 = \frac{1}{4 - j5}$$

$$Y_2 = \frac{1}{R_L + j10}$$

$$Y_{eq} = Y_1 + Y_2$$

$$Y_{eq} = \frac{1}{4-j5} + \frac{1}{R_L+j10}$$

$$= \frac{1}{4-j5} \times \frac{(4+j5)}{(4+j5)} + \frac{1}{(R_L+j10)} \times \frac{(R_L-j10)}{(R_L-j10)}$$

$$= \frac{4+j5}{16+25} + \frac{R_L-j10}{R_L^2+100}$$

For circuit to be resonant,

The imaginary part of Y_{eq} must be zero.

Hence, $\frac{\cancel{5}}{16+25} = \frac{\cancel{10}\,2}{R_L^2+100}$

$\Rightarrow R_L^2 + 100 = (41 \times 2)$

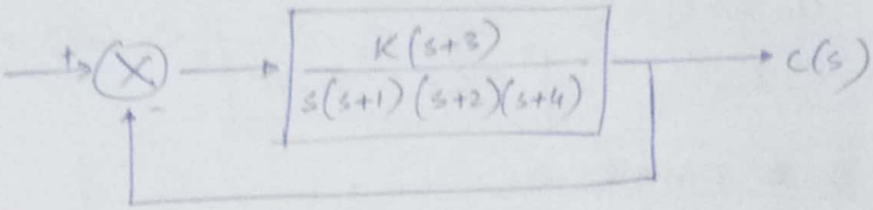
$\Rightarrow R_L^2 = 82 - 100 = -18$

$\Rightarrow R_L = \sqrt{-18}$

which is not a real value.

So, no real value or any value of R_L exists for which the circuit can be resonant.

Sol:- 5.a)



From block diagram,

$$G(s)\,H(s) = \frac{K(s+3)}{s(s+1)(s+2)(s+4)}$$

characteristic equ: $1 + G(s)H(s) = 0$

$$\text{or} \quad 1 + \frac{K(s+3)}{s(s+1)(s+2)(s+4)} = 0$$

$$\Rightarrow (s^2+s)(s^2+6s+8) + K(s+3) = 0$$

$$\Rightarrow (s^4 + 6s^3 + 8s^2 + s^3 + 6s^2 + 8s) + Ks + 3K = 0$$

$$\Rightarrow s^4 + 7s^3 + 14s^2 + s(8+K) + 3K = 0$$

Constructing Rouths array:-

s^4	1	14	$3K$
s^3	7	$(8+K)$	
s^2	$\frac{98-(8+K)}{7}$	$3K$	
s^1	$\frac{\frac{98-(8+K)}{7} \times (8+K) - 21K}{\frac{98-(8+K)}{7}}$		
s^0	$3K$		

$\Rightarrow \frac{98-(8+K)}{7} = 0$

$\Rightarrow 8+K = 98 \Rightarrow \boxed{K = 90}$

and, $98-8-K > 0$

$\Rightarrow \boxed{K < 90} \rightarrow (1)$

~~for stab~~

s^0: $3K \Rightarrow 3K > 0 \rightarrow (2)$

From Array:-

$$\frac{(90-K)(8+K) - 147K}{\cancel{7}} \times \frac{\cancel{7}}{(90-K)} > 0$$

$$\Rightarrow 720 + 90K - 8K - K^2 - 147K > 0$$

$$\Rightarrow K^2 + 65K - 720 < 0$$

$$\Rightarrow \boxed{-74.65 < K < 9.645} \rightarrow (3)$$

For Stability :-

From ①, ② & ③, $\boxed{0 < K < 9.645}$

At K = 9.645
↳ Root locus crosses imaginary axis

Now,

$$\frac{98-(8+K)}{7} s^2 + 3K = 0 \qquad [K = 9.645]$$

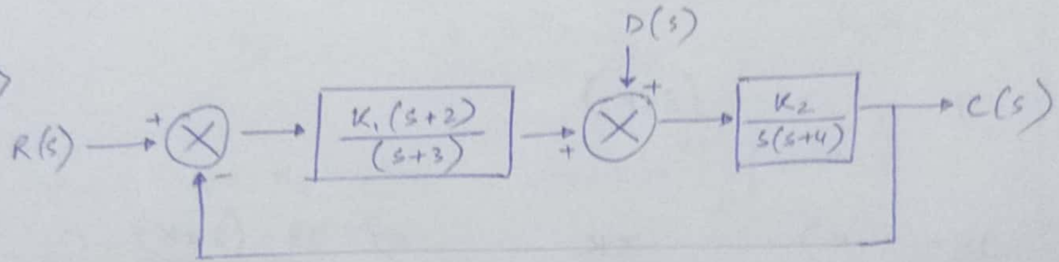
$$\Rightarrow \frac{90-K}{7} s^2 + 3K = 0$$

$$\Rightarrow 11.48 s^2 + 28.935 = 0$$

$$\Rightarrow s = j\omega = \sqrt{\frac{-28.935}{11.48}} = \pm j\, 1.5876$$

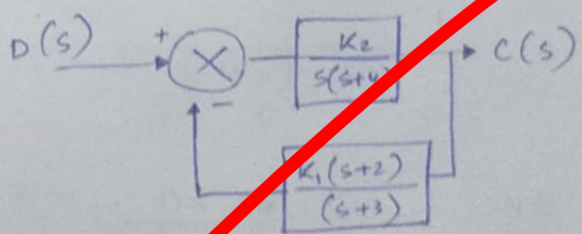
$$\Rightarrow \boxed{\begin{aligned} \omega &= 1.5876 \text{ rad/s} \\ K &= 9.645 \end{aligned}}$$ → At these values, root locus crosses the imaginary axis.

Sol :- 5.b)



e_{ss} due to unit step disturbance $= -12 \times 10^{-6}$

For $\left.\dfrac{C(s)}{D(s)}\right|_{R(s)=0}$



This is a non-unity feedback system.

For converting it into an unity feedback system.

$$\frac{C(s)}{D(s)} = \frac{K_2/s(s+4)}{1 + \dfrac{K_1 K_2 (s+2)}{s(s+4)(s+3)}}$$

$$\frac{C(s)}{D(s)} = \frac{K_2(s+3)}{s(s^2+7s+12) + K_1K_2 s + 2K_1K_2}$$

$G(s)H(s)$ = Open loop T.F for given system

$$\frac{C(s)}{D(s)} = \frac{K_2(s+3)}{s^3+7s^2+12s+K_1K_2s+2K_1K_2-K_2s-3K_2}$$

$$G(s)H(s)\Big|_{D(s)} = \frac{K_2(s+3)}{s^3+7s^2+s(12+K_1K_2-K_2)+2K_1K_2-3K_2}$$

For unit step disturbance:-

$$K_p = \lim_{s\to 0} G(s)H(s)$$

$$= \lim_{s\to 0} \frac{K_2(s+3)}{s^3+7s^2+s(12+K_1K_2-K_2)+2K_1K_2-3K_2}$$

$$K_p = \frac{3K_2}{2K_1K_2-3K_2}$$

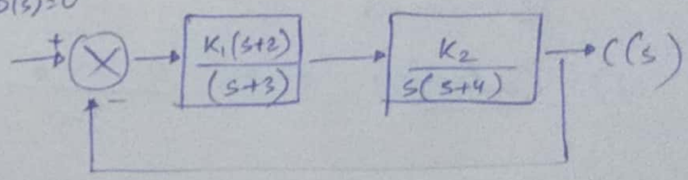
$$e_{ss} = \frac{1}{1+K_p} = \frac{1}{1+\frac{3K_2}{2K_1K_2-3K_2}} = \frac{2K_1K_2-3K_2}{2K_1K_2-\cancel{3K_2}+\cancel{3K_2}}$$

$$e_{ss} = \frac{2K_1K_2-3K_2}{2K_1K_2} = -12\times10^{-6} \quad \text{[Given]}$$

$$\Rightarrow \frac{2K_1K_2-3K_2}{-12\times10^{-6}} = 2K_1K_2 \longrightarrow (1)$$

For unit ramp unit $\Big|_{D(s)=0}$

This system is a unity F.B system.



Hence, $K_v = \lim_{s\to 0} sG(s)H(s)$

$$= \lim_{s\to 0} \cancel{s} \times \frac{K_1(s+2)}{(s+3)} \times \frac{K_2}{\cancel{s}(s+4)}$$

$$K_v = \frac{2K_1K_2}{3\times 4} = \frac{K_1K_2}{6}$$

e_{ss} due to unit ramp input $= 0.003$ [Given]

$$\Rightarrow \frac{1}{K_v} = 0.003$$

$$\Rightarrow \frac{1\times 6}{K_1 K_2} = 0.003$$

$$\Rightarrow K_1 K_2 = 2000 \longrightarrow (2)$$

Putting $\rightarrow (2)$ in $\rightarrow (1)$, we get:

$$\Rightarrow \frac{2\times 2000 - 3K_2}{-12\times 10^{-6}} = 4000$$

$$\Rightarrow 3K_2 = 4000 + 48\times 10^{-6} \Rightarrow \boxed{K_2 = 1333.35}$$

Using eq $\rightarrow (2)$ $\Rightarrow 1333.35 \times K_1 = 2000$

$$\Rightarrow \boxed{K_1 = 1.5}$$

$$\therefore \boxed{K_1 = 1.5 \text{ and } K_2 = 1333.35}$$

Soln:- 5.c) Given open loop transfer function is:-

$$G(s)H(s) = \frac{K}{s(s+3)(s+6)}$$

Poles : $s=0,\ s=-3,\ s=-6$.

No Zeroes.

i) Centroid : $\sigma = \dfrac{0-3-6}{3-0} = \dfrac{-9}{3} = -3$

ii) Angle of asymptotes : $\theta = \dfrac{(2q+1)\,180^\circ}{P-Z}$

For $q=0$ $\Rightarrow \theta_1 = \dfrac{180^\circ}{3} = 60^\circ$

For $q=1$ $\Rightarrow \theta_2 = \dfrac{3\times 180^\circ}{3} = 180^\circ$

For $q=2$ $\Rightarrow \theta_3 = \dfrac{5\times 180^\circ}{3} = 300^\circ$

Breakaway point:-

$1 + G(s)H(s) = 0$

$\Rightarrow 1 + \dfrac{K}{s(s+3)(s+6)} = 0$

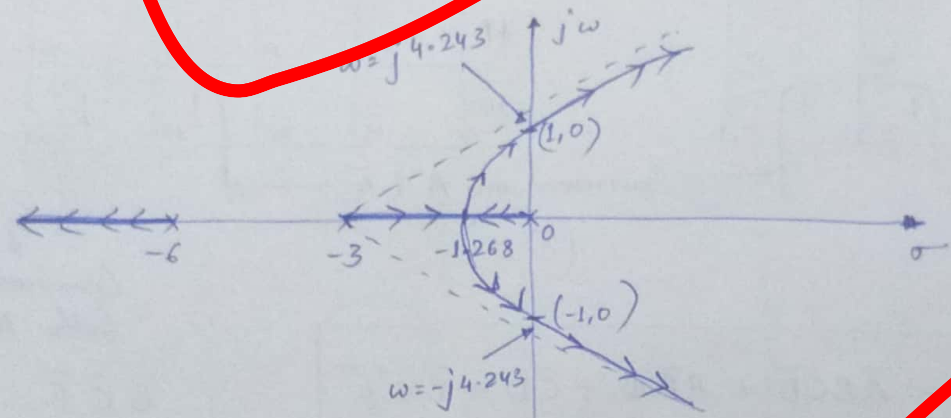
$\Rightarrow s(s^2+9s+18) + K = 0 \Rightarrow s^3 + 9s^2 + 18 + K = 0 \longrightarrow (1)$

$\Rightarrow -K = s^3 + 9s^2 + 18s$

$\Rightarrow -\dfrac{dK}{ds} = 0 = 3s^2 + 18s + 18 = s^2 + 6s + 6$

$\Rightarrow \boxed{s = -1.2679}, -4.73$

→ valid breakaway point [since it lies on root locus]



For point of intersection with jω axis:- [Constructing routh array for eq → (1)]

s^3	1	18
s^2	9	K
s^1	$\dfrac{18\times9-K}{9} = 0 \Rightarrow K = 162$	

$9s^2 + 162 = 0 \Rightarrow \boxed{\omega = \pm j4.243 \text{ rad/sec}}$

At this frequency it cuts the imaginary axis.

~~|G(s)H(s)| /~~

$|G(s)H(s)|_{s=j4.243} = \dfrac{K = 162}{j4.243(j4.243+3)(6+j4.243)} = 1$

~~∴ G~~

Ans:

Centroid, $s = -3$

Angle of asymptotes $= 60°, 180°, 300°$

Breakaway point, $s = -1.2679$

Solⁿ:- d> $f(A,B,C,D,E) = \sum m(0,2,3,10,11,12,13,16,17,18,19,20,21,26,27)$

This is a 5 variable expression. Hence

For $\bar{A}$

BC \ DE	$\bar{D}\bar{E}$ 00	$\bar{D}E$ 01	DE 11	$D\bar{E}$ 10
$\bar{B}\bar{C}$ 00	1 (0)	(1)	1 (3)	1 (2)
$\bar{B}C$ 01	(4)	(5)	(7)	(6)
BC 11	1 (12)	1 (13)	(15)	(14)
$B\bar{C}$ 10	(8)	(9)	1 (11)	1 (10)

For A

BC \ DE	00	01	11	10
00	1 (16)	1 (17)	1 (19)	1 (18)
01	1 (20)	1 (21)	(23)	(22)
11	(28)	(29)	(31)	(30)
10	(24)	(25)	1 (27)	1 (26)

$A\bar{B}\bar{D}$

$\bar{A}BC\bar{D}$

Common in A & $\bar{A}$ $(\bar{C}D)$

Common to both A & $\bar{A}$ $\bar{B}\bar{C}\bar{E}$

$$\boxed{f(A,B,C,D,E) = \bar{A}BC\bar{D} + A\bar{B}\bar{D} + \bar{C}D + \bar{B}\bar{C}\bar{E}}$$

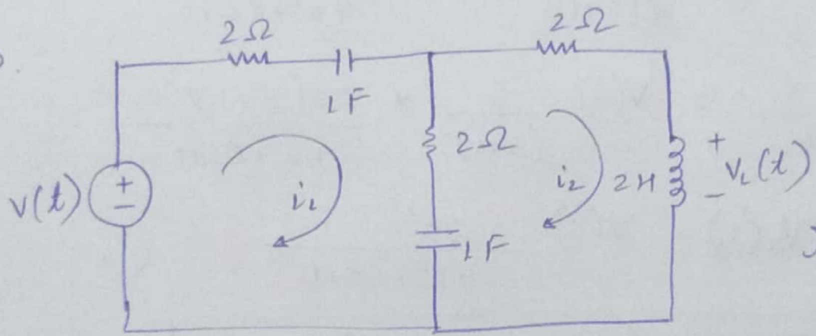
Solⁿ:- 1e>. $(267 - 175)$

```
 (0010 0110 0111) → 267 in BCD
  0011 0011 0011
 ----------------
  0101 1001 1000  → 267 in XS-3

  0001 0111 0101  → 175 in BCD
  0011 0011 0011
 ----------------
  0100 1000 1000  → 175 in XS-3  → 1's Complement  1011 0111 0111
                                                          +1
                                                  --------------
                                                   1011 0111 1000 → 2's Comp.

 267 →    0101 1001 1000
-175 →  - 1011 0111 1000
 -----------------------
      [1] 0000 0000 0000
                      +1
 -----------------------
          0000 0000 0001
```

Soln:- 6.a).

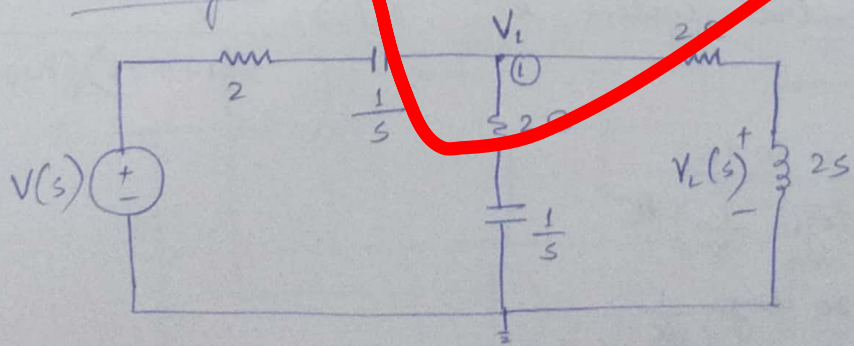


To find:- $\dfrac{V_L(s)}{V(s)}$

We have to use mesh analysis.

So Considering current I_1 & I_2 is mesh 1 and mesh-2 respectively.

Converting the above circuit in s-domain



Applying KCL at node 1:-

$$\frac{V_1 - V(s)}{2 + 1/s} + \frac{V_1}{2 + 1/s} + \frac{V_1}{2 + 2s} = 0 \longrightarrow (1)$$

$$\Rightarrow \frac{V_1}{2+\frac{1}{s}} + \frac{V_1}{2+\frac{1}{s}} + \frac{V_1}{2+2s} = \frac{V}{2+1/s}$$

$$\Rightarrow \frac{V_1 s}{2s+1} + \frac{V_1 s}{2s+1} + \frac{V_1}{2+2s} = \frac{sV}{2s+1}$$

$$\Rightarrow V_1\left[\frac{2s}{2s+1} + \frac{1}{2+2s}\right] = \frac{sV}{(2s+1)}$$

$$\Rightarrow V_1\left[\frac{2s(2+2s)+2s+1}{\cancel{(2s+1)}(2+2s)}\right] = \frac{sV}{\cancel{(2s+1)}}$$

$$\Rightarrow V_1 = \frac{sV(2+2s)}{4s+4s^2+2s+1} = \frac{V(2s^2+2s)}{4s^2+6s+1} \longrightarrow (2)$$

Also, $V_L(s) = \frac{V_1}{(2+2s)} \times 2s$ [By voltage division rule]

From → (2)

$$V_L(s) = \frac{\cancel{2}s}{\cancel{2}(s+1)} \times V(s)\frac{(2s^2+2s)}{4s^2+6s+1}$$

$$= V(s)\frac{s}{\cancel{(s+1)}} \times \frac{2s\cancel{(s+1)}}{4s^2+6s+1}$$

$$V_L(s) = V(s)\frac{2s^2}{4s^2+6s+1}$$

$$\boxed{G(s) = \frac{V_L(s)}{V(s)} = \frac{2s^2}{4s^2+6s+1}}$$

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Solⁿ:- 6. b) Given open-loop transfer function of an unity feedback control system is : $G(s) = \frac{K}{s(1+0.2s)(1+0.05s)}$

For G.M = 60 dB

$$G.M = \left(20\log_{10}\frac{1}{X}\right)dB$$

$$\Rightarrow 60 = 20\log_{10}\frac{1}{X}$$

$$\Rightarrow \frac{1}{X} = 10^3 = 1000 \Rightarrow \boxed{X = \frac{1}{1000}} \longrightarrow (1)$$

Obtaining phase crossover frequency (ω_{gc}):-

$$\angle G(j\omega) = -90^\circ - \tan^{-1}\frac{0.2\omega}{1} - \tan^{-1}\frac{0.05\omega}{1}$$

At $\omega = \omega_{gc} \Rightarrow \angle G(j\omega) = -180^\circ$

i.e. $-90^\circ - \tan^{-1} 0.2\omega_{gc} - \tan^{-1} 0.05\omega_{gc} = -180^\circ$

$$\Rightarrow \tan^{-1}\left[\frac{0.2\omega_{gc} + 0.05\omega_{gc}}{1 - (0.2\omega_{gc})(0.05\omega_{gc})}\right] = \tan^{-1} 90^\circ$$

$$\Rightarrow 1 - (0.2\omega_{gc})(0.05\omega_{gc}) = 0$$

$$\Rightarrow 0.01\,\omega_{gc}^2 = 1$$

$$\Rightarrow \boxed{\omega_{gc} = 10 \text{ rad/sec}}$$

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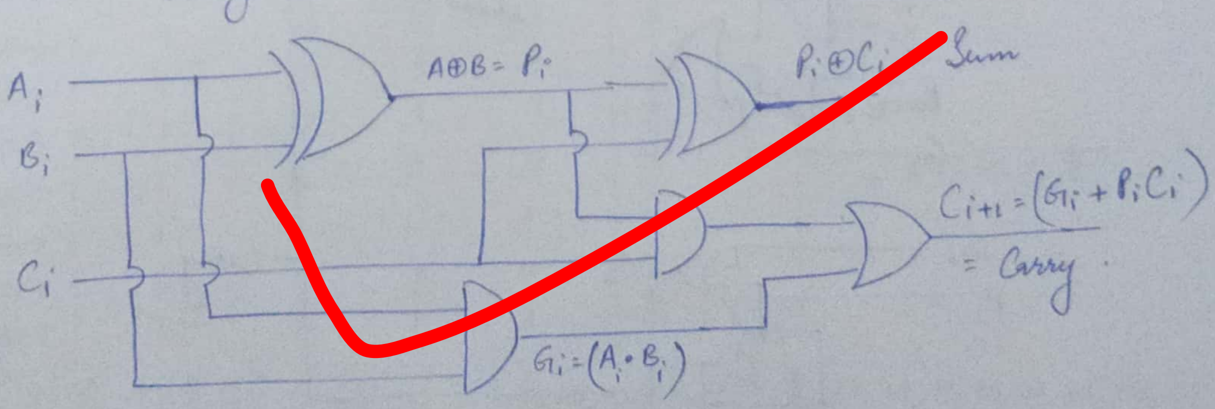
Now, $$|G(j\omega)| = \frac{K}{\omega\sqrt{1+(0.2\omega)^2}\sqrt{1+(0.05\omega)^2}} = \cancel{\tfrac{b}{b}}$$

$$\Rightarrow \frac{K}{10\sqrt{1+(2)^2}\sqrt{1+(0.5)^2}} = \frac{1}{1000} \quad [\text{From eq - 1}]$$

$$\Rightarrow K = \frac{10\sqrt{5}\sqrt{1.25}}{1000} = 0.025$$

$$\Rightarrow \boxed{K = 0.025 \quad \text{for} \quad G.M = 60\text{ dB}}$$

Solⁿ :- 6.c) Carry look-ahead adder:-



For $i = 1$

$$C_{i+1} = G_i + P_i C_i$$

$$C_2 = G_1 + P_1 C_1 \longrightarrow (1)$$

For $i = 2$

$$C_3 = G_2 + P_2 C_2 \longrightarrow (2)$$

$$= G_2 + P_2 (G_1 + P_1 C_1) \quad [\text{From } (1)]$$

$$= G_2 + P_2 G_1 + P_1 P_2 C_1 \longrightarrow (3)$$

For $i = 3$

$$C_4 = G_3 + P_3 C_3 = G_3 + P_3 (G_3 + P_2 C_2) \quad [\text{From } (2)]$$

$$= G_3 + P_3 G_3 + P_3 P_2 C_2$$

$$= G_3 + P_3 G_3 + P_3 P_2 (G_1 + P_1 C_1) \quad [\text{From } (1)]$$

$$= G_3 + P_3 G_3 + P_3 P_2 G_1 + P_1 P_2 P_3 C_1 .$$

~~Similarly for i=4~~

$$\cancel{C_5 = G_4 + P_4 G_4 + P_4 P_3 P_2 G_1 G_2 + P_4 P_3 P}$$

For $i = 4$

$$C_5 = G_4 + P_4 C_4$$

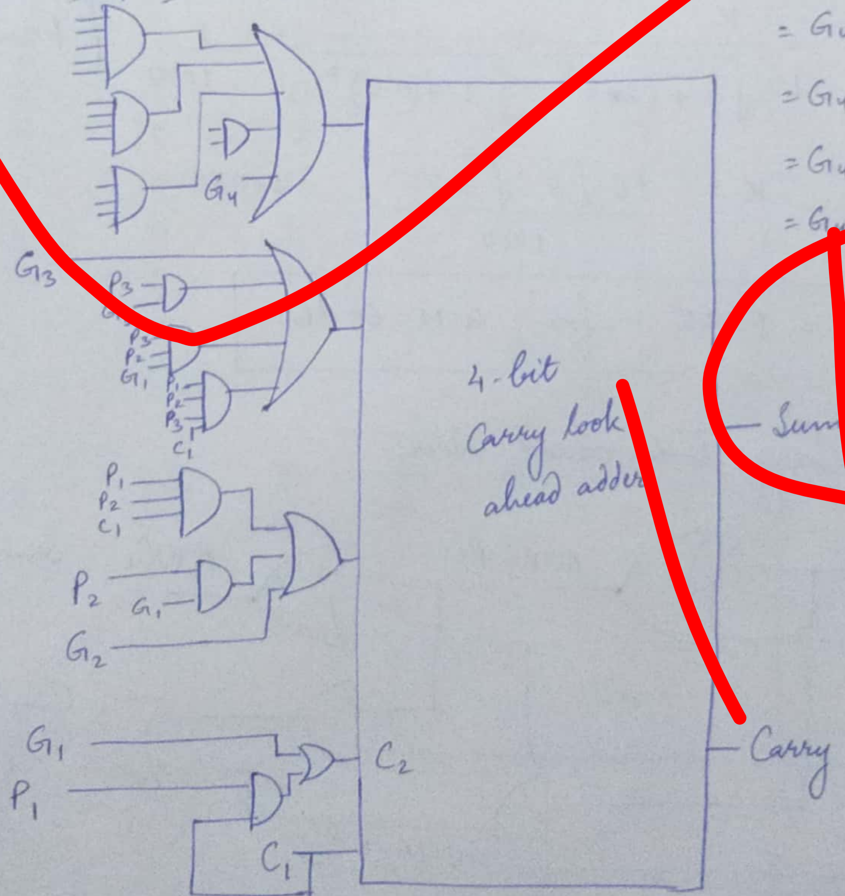
$$= G_4 + P_4 [G_3 + P_3 C_3]$$

$$= G_4 + P_4 G_3 + P_4 P_3 C_3$$

$$= G_4 + P_4 G_3 + P_4 P_3 (G_2 + P_2 C_2)$$

$$= G_4 + P_4 G_3 + P_4 P_3 G_2 + P_2 P_3 P_4 C_2$$

$$= G_4 + P_4 G_3 + P_4 P_3 G_2 + P_2 P_3 P_4 G_1 + P_2 P_3 P_4 P_1 C_1$$



Truth Table

Sol^n:- 7.a)

	Functional lines		Inputs			O/P
	X	Y	A	B	C	F
0 →	0	0	0	0	0	0
1 →	0	0	0	0	1	0
2 →	0	0	0	1	0	0
3 →	0	0	0	1	1	0
4 →	0	0	1	0	0	0
5 →	0	0	1	0	1	0
6 →	0	0	1	1	0	0
7 →	0	0	1	1	1	1
8 →	0	1	0	0	0	1
9 →	0	1	0	0	1	1
10 →	0	1	0	1	0	1
11 →	0	1	0	1	1	1
12 →	0	1	1	0	0	1
13 →	0	1	1	0	1	1
14 →	0	1	1	1	0	1
15 →	0	1	1	1	1	0
16 →	1	0	0	0	0	0
17 →	1	0	0	0	1	1
18 →	1	0	0	1	0	1
19 →	1	0	0	1	1	1
20 →	1	0	[illegible]	0	0	1
21 →	1	0	1	0	1	1
22 →	1	0	1	1	0	1
23 →	1	0	1	1	1	1
24 →	1	1	0	0	0	1
25 →	1	1	0	0	1	0
26 →	1	1	0	1	0	0
27 →	1	1	0	1	1	0
28 →	1	1	1	0	0	0
29 →	1	1	1	0	1	0
30 →	1	1	1	1	0	0
31 →	1	1	1	1	1	0

Rows 0–7 → AND $= A \cdot B \cdot C = F$

Rows 8–15 → NAND $= \overline{A \cdot B \cdot C} = F$

Rows 16–23 → OR $= A + B + C = F$

Rows 24–31 → NOR $= \overline{A + B + C} = F$

SOP ⇒ $F(X, Y, A, B, C) = \Sigma m(7, 8, 9, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 22, 23, 24)$

POS ⇒ $F(X, Y, A, B, C) = \Pi M(0, 1, 2, 3, 4, 5, 6, 15, 16, 25, 26, 27, 28, 29, 30, 31)$

Scanned with CamScanner

For SOP Expression:-

$\bar{X}$

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{Y}\bar{A}$	0	1	3	2
$\bar{Y}A$	4	5	1 (7)	6
YA	1 (12)	1 (13)	15	1 (14)
$Y\bar{A}$	1	1 (9)	1 (11)	1 (10)

$(\bar{X}Y\bar{B})$ $(\bar{X}Y\bar{A})$ $(\bar{X}Y\bar{C})$

X

$(X\bar{Y}C)$

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{Y}\bar{A}$	16	1 (17)	1 (19)	1 (18)
$\bar{Y}A$	1 (20)	1 (21)	1 (23)	1 (22)
YA	28	29	31	30
$Y\bar{A}$	1 (24)	25	27	26

$(X\bar{Y}B)$

$(\bar{Y}ABC)$

$(X\bar{Y}A)$

Common to both $\bar{X}$ & X

$(Y\bar{A}\bar{B}\bar{C})$

SOP:-

$$F(X,Y,A,B,C) = \bar{X}Y\bar{B} + \bar{X}Y\bar{A} + \bar{X}Y\bar{C} + X\bar{Y}C + X\bar{Y}B + X\bar{Y}A + Y\bar{A}\bar{B}\bar{C} + \bar{Y}ABC.$$

For POS expression:-

X

	$B+C$	$B+\bar{C}$	$\bar{B}+\bar{C}$	$\bar{B}+C$
$Y+A$	0	0	0	0
$Y+\bar{A}$	0	0		0
$\bar{Y}+\bar{A}$			0	
$\bar{Y}+A$				

$(X+Y+B)$ $(Y+A+X)$ $(X+Y+C)$ $(\bar{Y}+\bar{A}+\bar{B}+\bar{C})$

$(Y+A+B+C)$

$\bar{X}$

	0			
	0	0	0	0
		0	0	0

$(\bar{X}+\bar{Y}+\bar{A})$ $\bar{X}(\bar{C}+\bar{Y})$ $(\bar{X}+\bar{Y}+\bar{B})$

POS:-

$$F(X,Y,A,B,C) = (X+Y+A)\cdot(X+Y+C)\cdot(X+Y+B)\cdot(\bar{X}+\bar{Y}+\bar{A})\cdot(\bar{X}+\bar{Y}+\bar{B})\cdot(\bar{X}+\bar{Y}+\bar{C})\cdot(\bar{Y}+\bar{A}+\bar{B}+\bar{C})\cdot(Y+A+B+C).$$

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Solⁿ:- 6.b)

Input → XS-3 Code

A	B	C	D	Decimal eq.	Output
0	0	1	1	0	1
0	1	0	0	1	1
0	1	0	1	2	0
0	1	1	0	3	0
0	1	1	1	4	1
1	0	0	0	5	0
1	0	0	1	6	1
1	0	1	0	7	1
1	0	1	1	8	1
1	1	0	0	9	0

K-Map for Output:-

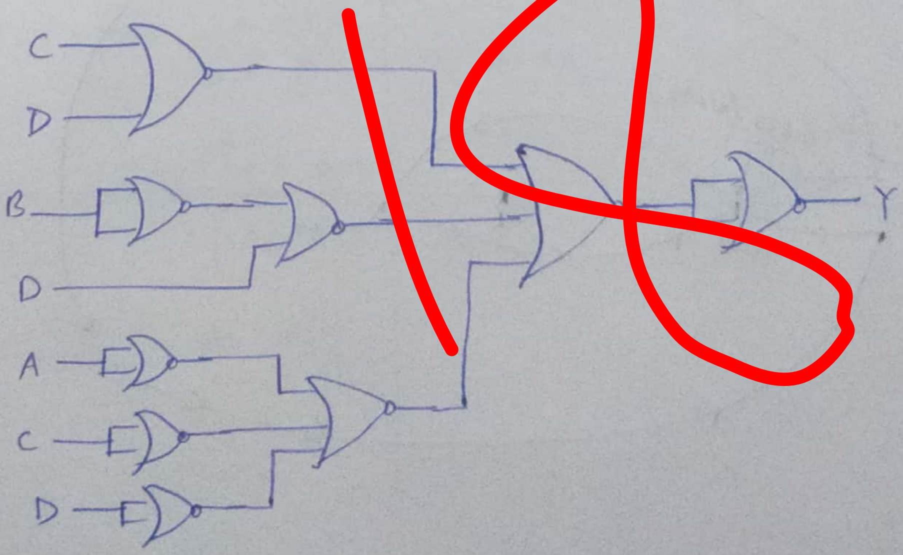
	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	X (0)	X (1)	1 (3)	X (2)
$\bar{A}B$	1 (4)	(5)	1 (7)	(6)
AB	(12)	X (13)	X (15)	X (14)
$A\bar{B}$	(8)	1 (9)	1 (11)	1 (10)

$\bar{A}\bar{C}\bar{D}$

CD

$\bar{B}D$

$$Y = CD + \bar{B}D + \bar{A}\bar{C}\bar{D}$$



Solⁿ:- 6.c) Given open loop transfer function is :

$$G(s)\,H(s) = \frac{6s+1}{s^2(s+1)(3s+1)}$$

$$G(j\omega)\,H(j\omega) = \frac{6j\omega+1}{-\omega^2(1+j\omega)(3j\omega+1)}$$

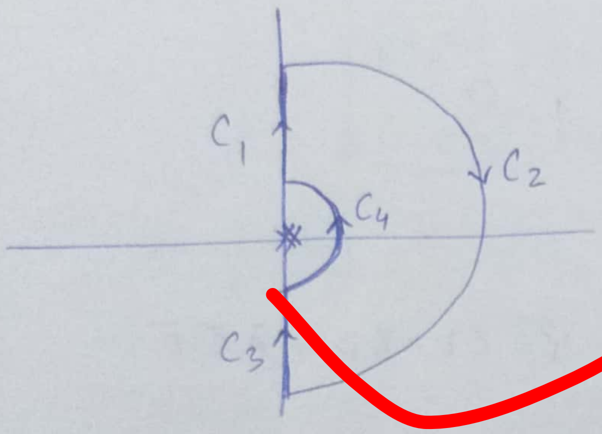
Magnitude.

$$|G(j\omega)\,H(j\omega)| = \frac{\sqrt{1+(6\omega)^2}}{\omega^2\sqrt{1+\omega^2}\,\sqrt{1+9\omega^2}}$$

Phase:-

$$\angle G(j\omega)H(j\omega) = \tan^{-1}6\omega - 180^\circ - \tan^{-1}\omega - \tan^{-1}3\omega$$

Nquist Contour:-



Corresponding to C_1

$s: j\omega$ where $\omega: 0 \to \infty$

$$|G(j\omega)\,H(j\omega)|_{\omega=0} = \frac{1}{0\times\sqrt{1}\times\sqrt{1}} = \infty.$$

$$\phi|_{\omega=0} = 0 - 180^\circ - 0 - 0 = -180^\circ$$

$$Mag|_{\omega=\infty} = \frac{1}{\infty} = 0$$

$$\phi|_{\omega=\infty} = +90^\circ - 180^\circ - 90^\circ - 90^\circ = 90^\circ.$$

$\omega = 0 \Rightarrow \infty\angle{-180^\circ}$

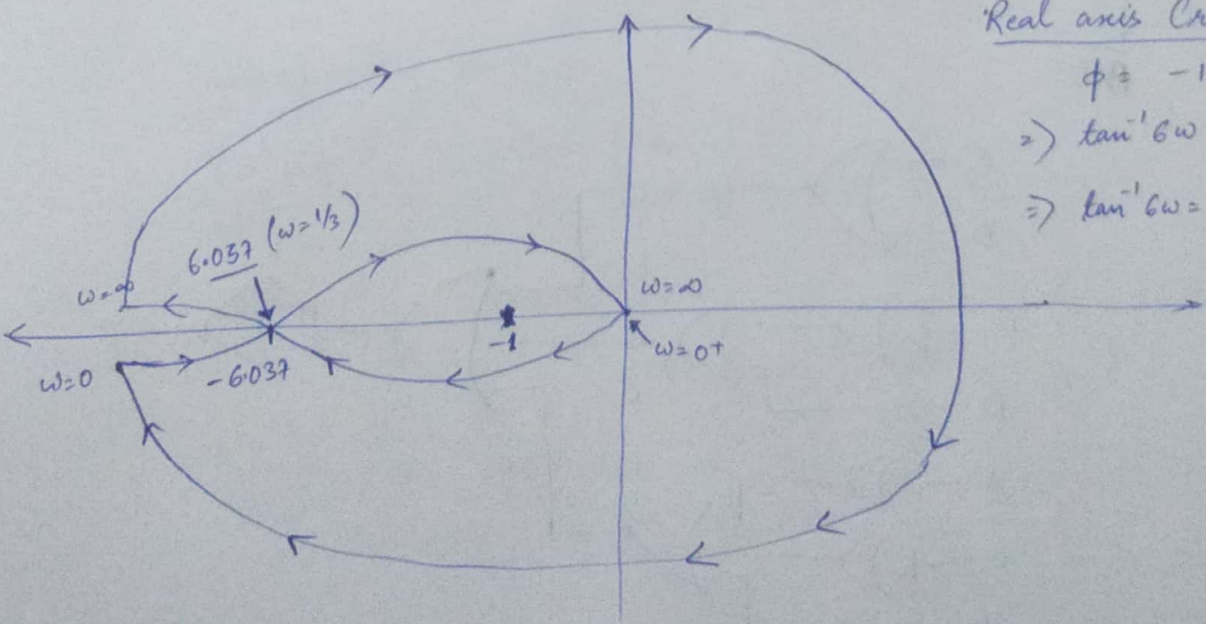
$\omega = \infty \Rightarrow 0\angle 90^\circ$

Real axis Crossover:-

$\phi = -180^\circ$

$\Rightarrow \tan^{-1}6\omega - \tan^{-1}\omega - \tan^{-1}3\omega = 0^\circ$

$\Rightarrow \tan^{-1}6\omega = \tan^{-1}\omega + \tan^{-1}3\omega$



For real axis Crossover:-

$$6\omega = \frac{\omega + 3\omega}{1-3\omega^2}$$

$$\Rightarrow 6\omega - 18\omega^3 = 4\omega$$

$$\Rightarrow 18\omega^3 - 2\omega = 0$$

$$\Rightarrow 2\omega(9\omega^2 - 1) = 0$$

$$\Rightarrow \omega = 0 \quad \text{and} \quad \omega = \pm\frac{1}{3}$$

At $\omega = 1/3$

$$|G(j\omega)H(j\omega)| = \frac{\sqrt{1+(6/3)^2}}{\left(\frac{1}{3}\right)^2\sqrt{1+\left(\frac{1}{3}\right)^2}\sqrt{1+\left(\frac{9}{3}\right)^2}}$$

Magnitude = 6.037

Corresponding to C_2:-

$s: Re^{j\theta}$ where $R \to \infty$

and $\theta: +\frac{\pi}{2}$ to $-\pi/2$

$$G(Re^{j\theta}) = \frac{6Re^{j\theta}+1}{R^2e^{2j\theta}(Re^{j\theta}+1)(3Re^{j\theta}+1)} = \frac{6R}{3R^4}\frac{e^{j\theta}}{e^{4j\theta}} = \frac{2}{R^3}e^{-3j\theta}$$

$C_2: 0\angle -270°$ to $0\angle +270°$

Corresponding to C_3:-

$s = -j\omega$: ~~Inverse~~ Polar Plot mirror image.

$$G(-j\omega)H(-j\omega) = \frac{-6j\omega+1}{(-j\omega)^2(1-j\omega)(1-3j\omega)}$$

$C_3: 0°\angle -270°$ to $\infty\angle -180°$

Corresponding to C_4:-

$s = re^{j\phi}$ where $r \to 0$

and $\phi \to -\pi/2$ to $\pi/2$

$$\therefore G(re^{j\phi}) = \frac{6re^{j\phi}+1}{r^2e^{2j\phi}(re^{j\phi}+1)(3re^{j\phi}+1)} = \frac{1}{r^2}e^{-2j\phi}$$

$C_3: \infty\angle 180°$ to $\infty\angle -180°$

As we can observe from Nquist plot.

The point $(-1+j0)$ has two clockwise encirclements.

$\therefore \quad N = +2$

<u>According to Nquist Criteria</u>

$Z = P - N$ where P = open loop poles in RHS of s-plane

$N = \begin{cases} -\text{ve}, \text{ encirclement in clockwise} \\ +\text{ve}, \text{ encirclement in anticlockwise direction} \end{cases}$

$\Rightarrow Z = 0 - (-2)$

$\Rightarrow \boxed{Z = +2}$

$Z = 0$ [For stable system]

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Hence, the closed-loop system is not stable

Sol^n:- 7.b.ii)

<u>Truth Table for sprinkler system</u>

	S	M	T	H	Turn on	
Winter $S=0$	0	0	0	0	1	Condition i) [S=0, M=0]
	0	0	0	1	1	
	0	0	1	0	1	Condition v)
	0	0	1	1	1	
	0	1	0	0	0	
	0	1	0	1	0	
	0	1	1	0	1	Condition v)
	0	1	1	1	0	
$S=1$ (Summer)	1	0	0	0	1	Condition iv) [S=1, M=0, T=0]
	1	0	0	1	1	
	1	0	1	0	1	Condition ii) [S=1, T=1, M=0]
	1	0	1	1	1	
	1	1	0	0	0	
	1	1	0	1	0	
	1	1	1	0	1	Condition v) [T=1, H=0]
	1	1	1	1	1	Condition iii) [S=1, T=1, H=1]

<u>For turning on the sprinkler system:-</u>

$F(S,M,T,H) = \sum m\{0,1,2,3,6,8,9,10,11,14,15\}$

K-Map for turning on Sprinkler:-

	$\bar{T}\bar{H}$	$\bar{T}H$	TH	$T\bar{H}$
$\bar{S}\bar{M}$	1_{0}	1_{1}	1_{3}	1_{2}
$\bar{S}M$	$_{4}$	$_{5}$	$_{7}$	1_{6}
SM	$_{12}$	$_{13}$	1_{15}	1_{14}
$S\bar{M}$	1_{8}	1_{9}	1_{11}	1_{10}

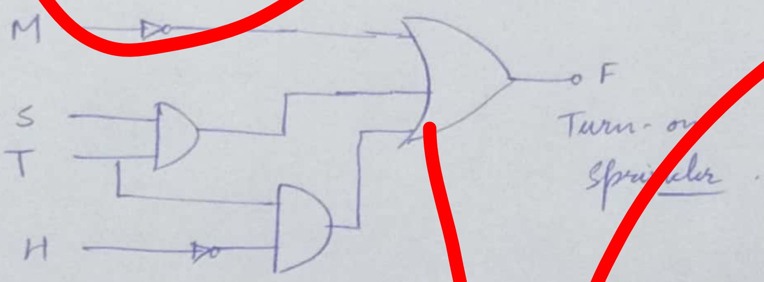
$\rightarrow T\bar{H}$

$\rightarrow ST$

$\downarrow \bar{M}$

$$F = \bar{M} + ST + T\bar{H}$$

Circuit Implementation:-



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