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ESE 2024 : Mains Test Series

UPSC ENGINEERING SERVICES EXAMINATION

Electronics & Telecommunication Engineering

Test-2 : Signals and Systems + Microprocessors and Microcontroller [All topics]
Network Theory-1 + Control Systems-1 [Part Syllabus]

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Roll No : E C 2 4 M B D L A 0 1 2

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Instructions for Candidates

1. Do furnish the appropriate details in the answer sheet (viz. Name & Roll No).
2. There are Eight questions divided in TWO sections.
3. Candidate has to attempt FIVE questions in all in English only.
4. Question no. 1 and 5 are compulsory and out of the remaining THREE are to be attempted choosing at least ONE question from each section.
5. Use only black/blue pen.
6. The space limit for every part of the question is specified in this Question Cum Answer Booklet. Candidate should write the answer in the space provided.
7. Any page or portion of the page left blank in the Question Cum Answer Booklet must be clearly struck off.
8. There are few rough work sheets at the end of this booklet. Strike off these pages after completion of the examination.

FOR OFFICE USE

Question No.	Marks Obtained
Section-A	
Q.1	8
Q.2	10
Q.3	—
Q.4	—
Section-B	
Q.5	29
Q.6	17
Q.7	3
Q.8	
Total Marks Obtained	67

Signature of Evaluator: Shiva

Cross Checked by ....

- Practice more Question to get accuracy & speed.

- Attempt more.
- Try to write clean. Don't overwrite too much.

IMPORTANT INSTRUCTIONS

CANDIDATES SHOULD READ THE UNDERMENTIONED INSTRUCTIONS CAREFULLY. VIOLATION OF ANY OF THE INSTRUCTIONS MAY LEAD TO PENALTY.

DONT'S

1. Do not write your name or registration number anywhere inside this Question-cum-Answer Booklet (QCAB).
2. Do not write anything other than the actual answers to the questions anywhere inside your QCAB.
3. Do not tear off any leaves from your QCAB, if you find any page missing do not fail to notify the supervisor/invigilator.
4. Do not leave behind your QCAB on your table unattended, it should be handed over to the invigilator after conclusion of the exam.

DO'S

1. Read the Instructions on the cover page and strictly follow them.
2. Write your registration number and other particulars, in the space provided on the cover of QCAB.
3. Write legibly and neatly.
4. For rough notes or calculation, the last two blank pages of this booklet should be used. The rough notes should be crossed through afterwards.
5. If you wish to cancel any work, draw your pen through it or write "Cancelled" across it, otherwise it may be evaluated.
6. Handover your QCAB personally to the invigilator before leaving the examination hall.

Section A : Signals and Systems + Microprocessors and Microcontroller

.1 (a) Determine the order of a low-pass Butterworth filter that is to provide 40 dB attenuation at $\omega = 2\omega_0$. (Here, ω_o is the cut-off frequency)

[12 marks]

Q.1 (b) Write a 8085 program to generate continuous square wave with a period of 560 μs. Assume the system clock period is 350 ns and use bit D_0 to output the square wave. Use register B as delay counter. Display the square wave at PORT 0.

[12 marks]

.1 (c) (i) Enumerate all internal registers present in 8259 programmable interrupt controller. Write short notes on their individual functionality.

(ii) Draw the timing diagram for 8085 instruction DAD B.

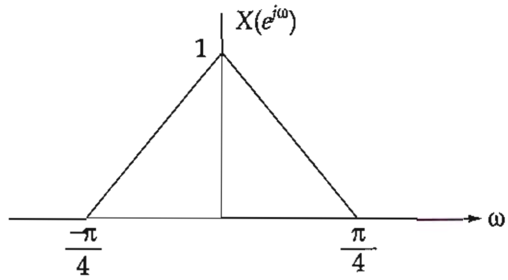
[6 + 6 marks]

.1 (d) $X(e^{j\omega})$ is the Discrete time Fourier transform of a discrete time sequence $x(n)$.

Assume $x_1(n) = \begin{cases} x(n/2); & n\text{-even} \\ 0 \quad ; & n\text{-odd} \end{cases}$

$x_2(n) = x(2n)$

The $X(e^{j\omega})$ is shown in below figure,



Sketch $X_1(e^{j\omega})$ and $X_2(e^{j\omega})$

[12 marks]

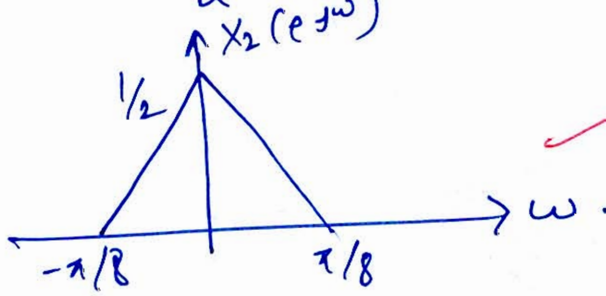
$X(e^{j\omega}) \xleftrightarrow{DTFT} x(n)$

$x_1(n) = \begin{cases} x(n/2) & ; n = \text{even} \\ 0 & ; n = \text{odd.} \end{cases}$

~~$X_2(n)$ =1~~

$X_2(e^{j\omega}) = \frac{1}{2} X(e^{j\omega/2})$

$\therefore$



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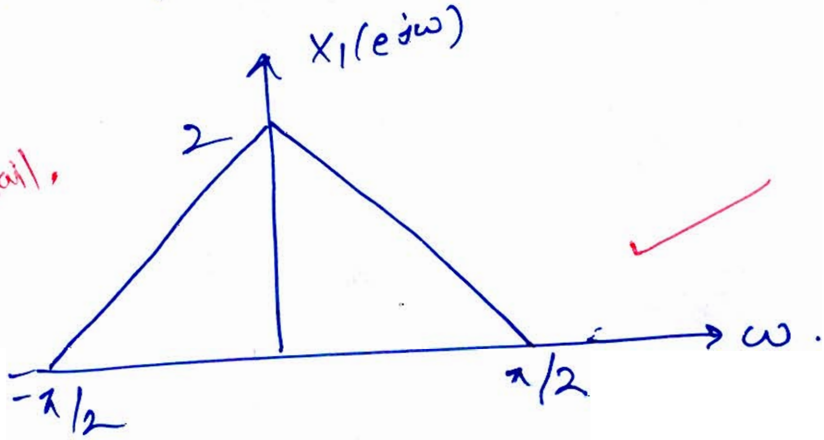
$X_1(e^{j\omega}) = 2X(e^{j2\omega})$; for $n = \text{even}$.



Write answer in detail.

(~~for more~~

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.1 (e) Write a 8086 program to find the number of positive and negative data items in an array of 100 bytes of data stored from the memory location 3000 H: 4000 H. Store the result in the offset addresses 1000 H and 1001 H in the same segment. Assume that the negative numbers are represented in 2's complement form.

[12 marks]

Q.2 (a) **(i)** Find the convolution of two sequences:

$y[n] = x[n] * h[n]$

where $x[n] = (0.8)^n u[n]$ and $h[n] = (0.2)^n u[n]$. Find the value of $Y(e^{j\pi})$.

(ii) The differential equation of a stable system with zero initial conditions is given as

$$\frac{d^2y}{dt^2} + \frac{dy}{dt} - 2y(t) = x(t) - 2\frac{dx}{dt}$$

Find the impulse response of the system and the initial value of impulse response.

[10 + 10 marks]

Q.2) a.) (i)

$x(n) = (0.8)^n u(n)$ & $h(n) = (0.2)^n u(n)$

$Y(e^{j\pi}) = ?$

$y(n) = x(n) * h(n) = ?$

Let us take z-transform both side :-

$Y(z) = X(z) \cdot H(z)$

we know ; $a^n u(n) \xleftrightarrow{Z.T} \frac{z}{z-a}$; $|z| > a$

$\therefore Y(z) = \frac{z}{z-0.8} \times \frac{z}{z-0.2}$

$\frac{Y(z)}{z} = \frac{z}{(z-0.8)(z-0.2)} = \frac{A}{(z-0.8)} + \frac{B}{(z-0.2)}$

$\Rightarrow Az - 0.2A + Bz - 0.8B = z$

$A = 4/3$ & $B = -1/3$

$$\frac{Y(z)}{} = \frac{4}{3}\frac{z}{z-0.8} - \frac{1}{3}\frac{z}{z-0.2} \quad ; |z| > 0.8$$

$$\therefore \boxed{y(n) = \frac{4}{3}(0.8)^n u(n) - \frac{1}{3}(0.2)^n u(n)}$$

8

for $Y(e^{j\pi}) \Rightarrow$

let $z = e^{j\omega}$.

$$Y(e^{j\omega}) = Y(z) = \frac{4}{3}\frac{e^{j\omega}}{e^{j\omega}-0.8} + \frac{1}{3}\frac{e^{j\omega}}{e^{j\omega}-0.2}$$

$$Y(e^{j\pi}) = \frac{4}{3}\frac{e^{j\pi}}{e^{j\pi}-0.8} + \frac{1}{3}\frac{e^{j\pi}}{e^{j\pi}-0.2}$$

$$Y(e^{j\pi}) = \frac{4}{3}\times\left(\frac{-1}{-1-0.8}\right) + \frac{1}{3}\left(\frac{-1}{-1-0.2}\right)$$

avoid Calculation mistake

$$\boxed{\cancel{Y(e^{j\pi}) = 1.0185}}$$

(ii) Applying ~~Laplace~~ Transform both side in the given equation.

$$s^2 Y(s) + s Y(s) - 2Y(s) = X(s) - 2sX(s)$$

$$Y(s)[s^2 + s - 2] = X(s)[1 - 2s]$$

$$\cancel{\frac{Y(s)}{X(s)} = \frac{s^2+s-2}{1-2s}}$$

$$\cancel{H(s) = \frac{1}{2}\frac{(s-1)(s+2)}{-(s-1/2)}}$$

2

$$\frac{Y(s)}{X(s)} = H(s) = \frac{1-2s}{(s-1)(s+2)}$$

$$\Rightarrow H(s) = \frac{A}{(s-1)} + \frac{B}{(s+2)} = -\frac{1}{3}\frac{1}{s-1} - \frac{5}{3}\frac{1}{s+2}$$

~~taking inverse~~

$\therefore$ Impulse Response;

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$$\boxed{h(t) = -\frac{1}{3}e^{t}u(t) - \frac{5}{3}e^{-2t}u(t)}$$

For more idea, refer solution.

initial value of $h(t)$;

$$h(0) = -\frac{1}{3} - \frac{5}{3} = -\frac{6}{3} = -2$$

$$\boxed{h(0) = -2}$$

———— × ———— × ————

Q.2 (b) **(i)** Explain the concept of direct memory access with reference to 8085 microprocessor.

(ii) Describe briefly microprocessor instructions used for memory location called stack.

[10 + 10 marks]

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(ii) ~~To access For memory to~~. There are two instruction PUSH and POP used for memory allocation called stack.

PUSH → to put the data into the stack

POP → to read the data, or take the data from the stack.

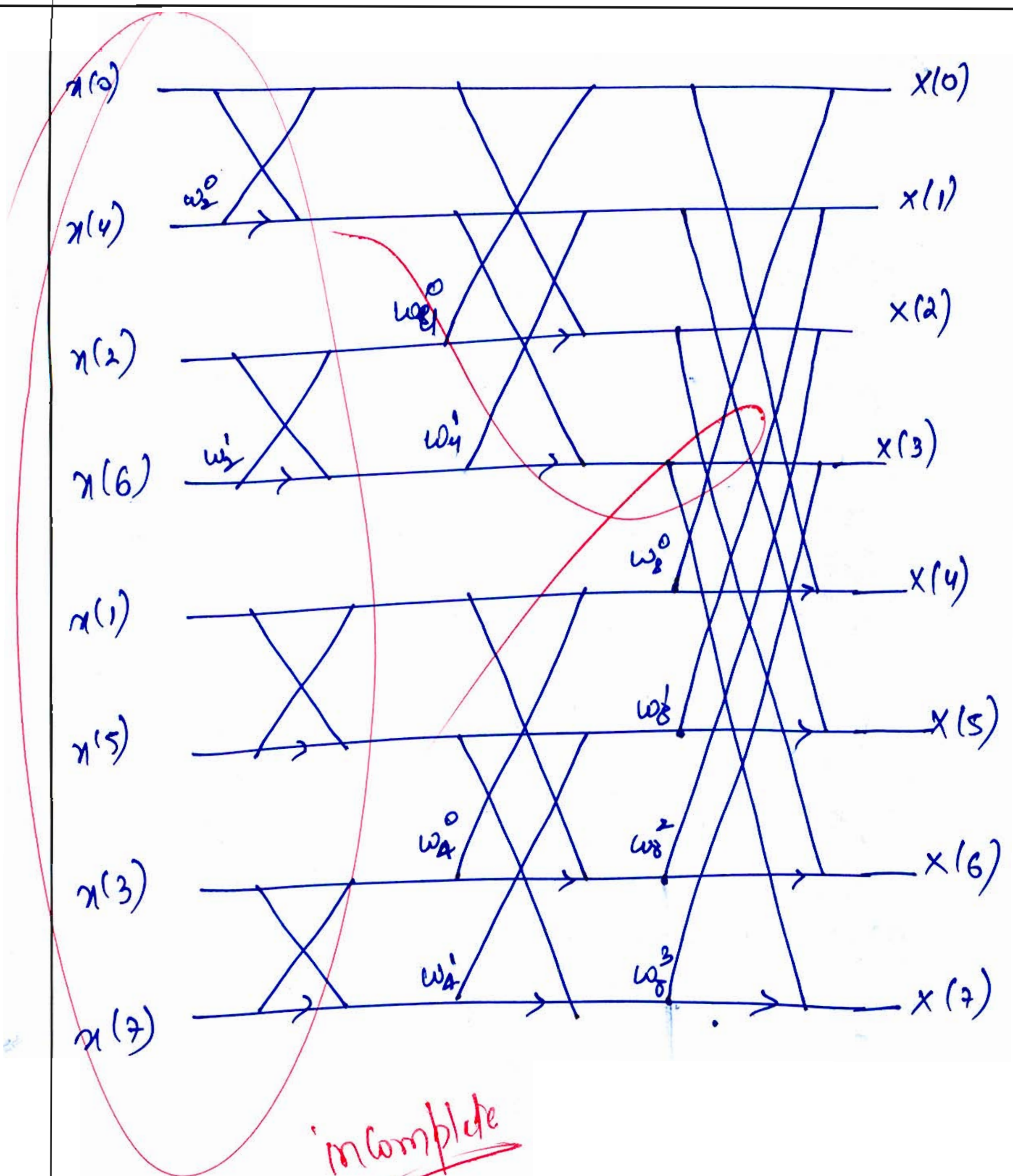
0

Q.2 (c) Determine the 8-point DFT $X(k)$ of a discrete sequence $x(n) = \{\underset{\uparrow}{0}, 1, 2, 3, 4, 5, 6, 7\}$ using the radix-2 DIT-FFT algorithm.

[20 marks]

Radix-2 DIT-FFT algorithm :-

$x(n) = \{\underset{\uparrow}{0}, 1, 2, 3, 4, 5, 6, 7\}$ for calculating the value of $X(k)$



incomplete

.3 (a) Let $g_1(t) = \{[\cos(\omega_0 t)]x(t)\} * h(t)$ and $g_2(t) = \{[\sin(\omega_0 t)]x(t)\} * h(t)$ where

$x(t) = \sum_{k=-\infty}^{\infty} a_k e^{jk100t}$ is a real valued periodic signal and $h(t)$ is the impulse response of a stable LTI system.

Find the value of ω_0 and any necessary constraints on $H(j\omega)$ to ensure that

$g_1(t) = \text{Re}\{a_5\}$ and $g_2(t) = \text{Img}\{a_5\}$

[20 marks]

.3 (b) (i) For an 8085 microprocessor, draw the lower and higher order address bus during the machine cycle.

(ii) Explain the RIM instruction format and how it is executed.

(iii) Write an assembly language program for an 8085 microprocessor to find 2's complement of a 16-bit number. Write comments for selected instruction.

[5 + 5 + 10 marks]

Q.3 (c) Explain the all addressing modes of 8051 microcontroller with example for each addressing mode.

[20 marks]

Q.4 (a) (i) Consider the frequency response of an ideal high pass filter,

$$H(e^{j\omega}) = 1 \text{ for } \frac{\pi}{4} \le |\omega| \le \pi$$

$$= 0 \text{ for } |\omega| \le \frac{\pi}{4}$$

1. Find the value of $h(n)$ $\forall$ length of the filter, $N = 11$.
2. Find $H(z)$.

(ii) Write comparisons between IIR and FIR filters.

[15 + 5 marks]

Q.4 (b) A continuous time system has impulse response $h(t) = e^{2t}u(1 - t)$. If the input to the system is given by, $x(t) = u(t) - 2u(t - 2) + u(t - 5)$, then find the output $y(t)$ using convolution integral.

[20 marks]

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Q.4 (c) (i) Explain the control signals in handshake mode with 8155 I/O.

(ii) Explain the following instructions of 8085 microprocessor giving operand, number of T-states, description and flags affected.

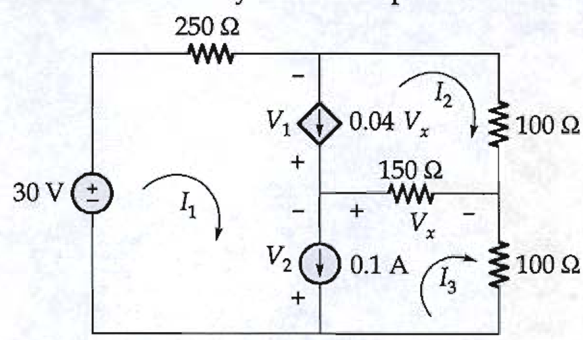
1. XTHL 2. SHLD 3. STAX

4. PCHL 5. SPHL

[10 + 10 marks]

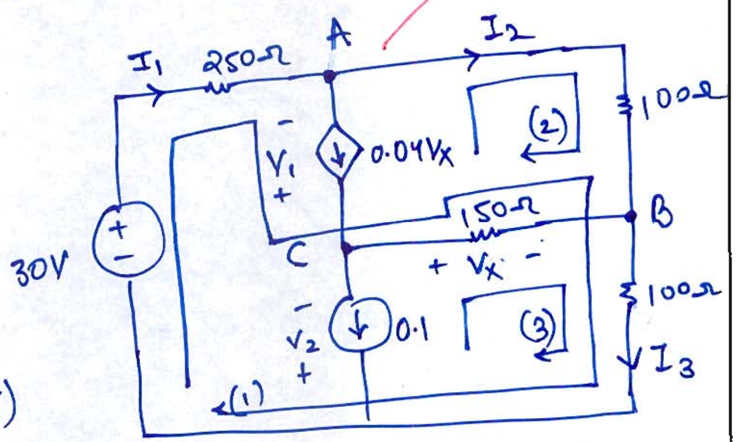
Section B : Network Theory-1 + Control Systems-1

Q.5 (a) Consider the circuit shown below, which contains a 0.1 A independent current source common to loop 1 and 3 as shown in circuit diagram. Find the value of loop currents I_1, I_2, I_3 and the power delivered by each independent and dependent sources.



[12 marks]

5.) a.) Re-drawing the circuit by ~~&~~ mentioning the ~~cur.~~ respective current in branch →



At node A :–

$$\boxed{I_1 = 0.04V_x + I_2} \quad \text{(i)}$$

At node B:–

$$\boxed{I_2 + \frac{V_x}{150} = I_3} \quad \text{– (ii)}$$

At node C :–

$$0.04V_x = 0.1 + \frac{V_x}{150}$$

$$\frac{V_x}{30} = 0.1 \Rightarrow \boxed{V_x = 3\,\text{Volt}} \quad \text{– (iii)}$$

putting (ii) in (i):—

$$\boxed{I_1 = 0.12 + I_2} \quad -\text{(iv.)}$$

putting (iii) in (ii):— $\boxed{I_3 = 0.02 + I_2}$ — (v)

* Applying KVL at outer loop —

$$-30 + 250 I_1 + 100 I_2 + 100 I_3 = 0.$$

$$50 I_1 + 20 I_2 + 20 I_3 = 6$$

$$\boxed{25 I_1 + 10 I_2 + 10 I_3 = 3} \quad - \text{(vi)}$$

from (iv), (v) & (vi)

$$\begin{bmatrix} 1 & -1 & 0 \\ 0 & -1 & 1 \\ 25 & 10 & 10 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 0.12 \\ 0.02 \\ 3 \end{bmatrix}$$

Good 12

By using ~~cass~~ cramer's ~~f~~rule :—

$$\Rightarrow I_1 = \frac{\begin{vmatrix} 0.12 & -1 & 0 \\ 0.02 & -1 & 1 \\ 3 & 10 & 10 \end{vmatrix}}{\begin{vmatrix} 1 & -1 & 0 \\ 0 & -1 & 1 \\ 25 & 10 & 10 \end{vmatrix}} \Rightarrow I_1 = \frac{-5.2}{-45}$$

$$I_1 = 0.1155\,A$$

or $\boxed{I_1 = 115.5\,mA}$

similarly, $\boxed{I_2 = -4.5\,mA}$ (using (iv))

$\boxed{I_3 = 15.5\,mA}$ (using (v))

Power delivered by 30V : $\boxed{P_{30V} = 30 \times I_1 = 3.465 \text{ watts.}}$

Power delivered by 0.1A source : $P_{0.1A} = V_2 \times 0.1$

Applying KVL at (1) :—

$$-30 + 250 I_1 - V_1 - V_2 = 0$$

$$-V_1 - V_2 = 30 - 249.8845$$

$$\boxed{V_1 + V_2 = 219.8845}$$

* Applying KVL at (2):— $+V_1 + 100(-4.5m) - 3 = 0$

$\boxed{V_1 = 3.45V}$

* Applying KVL at (3):— $+V_2 + 3 + 100(15.5m) = 0$

$\boxed{V_2 = -4.55V}$

∴ Power delivered by 0.1A : $\boxed{P_{0.1A} = -4.55 \times 0.1 = -0.455 \text{ watt}}$

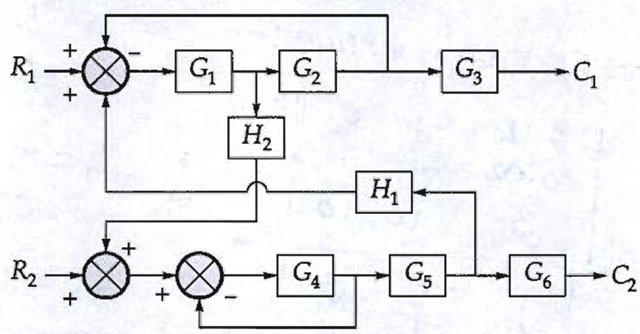
Power delivered by $0.04V_x$ source ⇒ $\boxed{P_{0.04V_x} = 0.414 \text{ watt}}$

∴ Summary

$I_1 = 115.5mA$; $I_2 = -4.5mA$; $I_3 = 15.5mA$

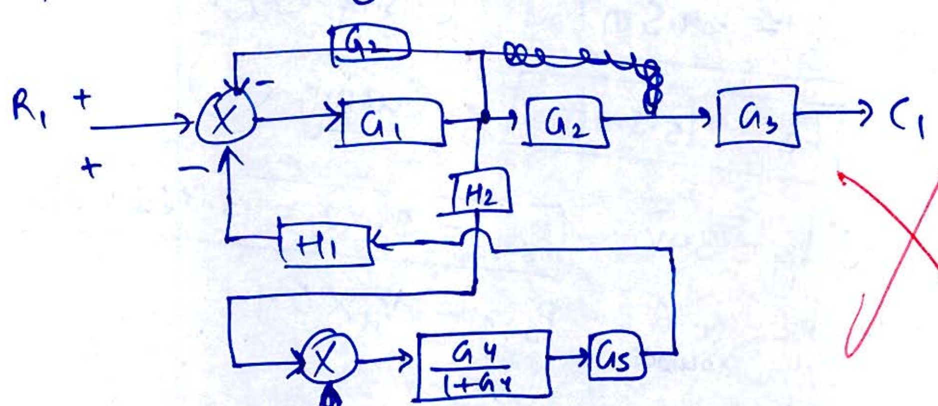
$P_{30V} = 3.465$ watt ; $P_{0.1A} = -0.455$ watt ; $P_{0.04V_x} = 0.414$ watt

Q.5 (b) Evaluate $\frac{C_1}{R_1}$ and $\frac{C_2}{R_1}$ for a system whose block diagram representation is shown in figure. Use block diagram reduction technique.



[12 marks]

5) b) C_1/R_1 ⇒ considering R_2 & $C_2 = 0$.



using Mason's gain formula:—

$$\frac{C_1}{R_1} = \frac{\sum P_k \Delta_k}{1 - (L_1 + L_2 + --) + (L_1 L_2 + --) - --}$$

Forward path : $P_1 = G_1 G_2 G_3$

Loops :- $L_1 = +\frac{G_1 H_2 G_4}{1+G_4} G_5 H_1$

$L_2 = -G_1 G_2$

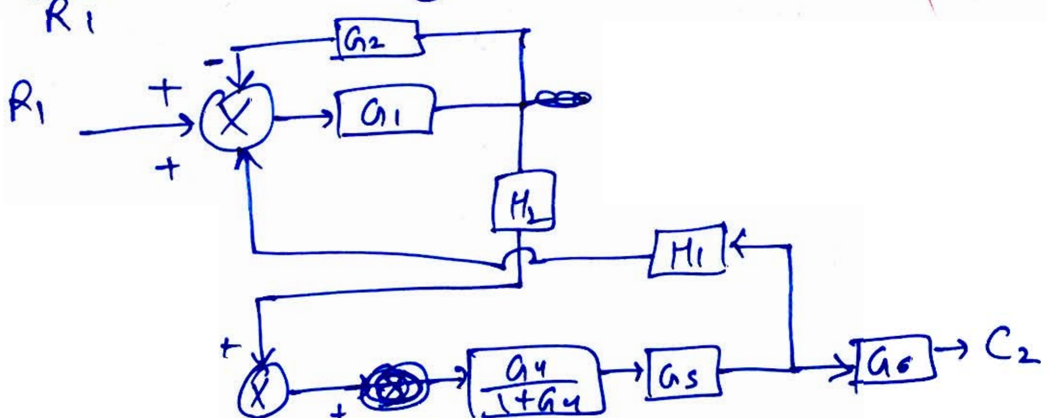
$$\therefore \frac{C_1}{R_1} = \frac{G_1 G_2 G_3}{1 - \frac{G_1 G_5 G_4 H_1 H_2}{1+G_4} + G_1 G_2}$$

Read the Question properly

Here you have to use block reduction technique

or
$$\boxed{\frac{C_1}{R_1} = \frac{G_1 G_2 G_3 (1+G_4)}{(1+G_4) - (G_1 G_4 G_5 H_1 H_2) + G_1 G_2 (1+G_4)}}$$

$\frac{C_2}{R_1}$ ⇒ considering R_2 & $C = 0$.



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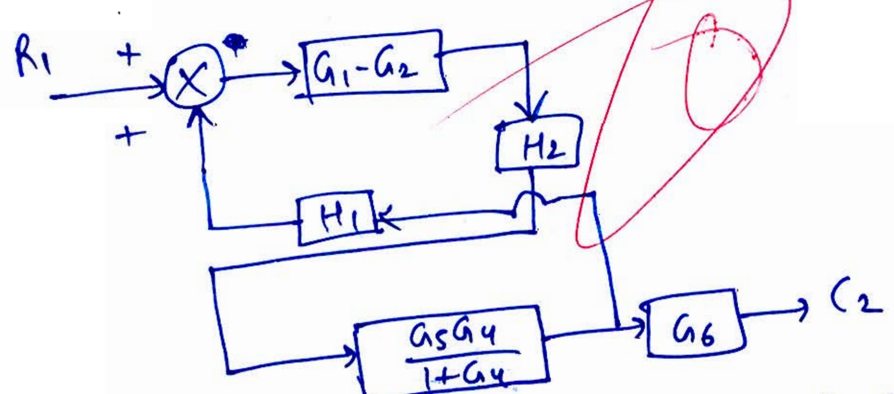

R_1 ≠ forward path ; $P_1 = (G_1 - G_2) \frac{H_2 G_5 G_4}{(1+G_4)} \times G_6$

Loop: $L_1 = (G_1 - G_2) H_2 \left(\frac{G_5 G_4}{1+G_4}\right) H_1$

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$$\therefore \frac{C_2}{R_1} = \frac{(G_1-G_2)\dfrac{G_4G_5G_6}{1+G_4}}{1-(G_1-G_2)\dfrac{G_4G_5H_1H_2}{(1+G_4)}}$$

$$\frac{C_2}{R_1} = \frac{G_1(G_4G_5G_6) - G_2G_4G_5G_6}{(1+G_4) - G_1G_4G_5H_1H_2 + G_2G_4G_5H_1H_2}$$

$$\Rightarrow \boxed{\frac{C_2}{R_1} = \frac{G_1G_4G_5G_6 - G_2G_4G_5G_6}{(1+G_4) - G_1G_4G_5H_1H_2 + G_2G_4G_5H_1H_2}}$$

X X

Q.5 (c) (i) The open loop transfer function of a feedback system is $G(s)H(s) = \frac{K(1+s)}{(1-s)}$.

Comment on stability of the feedback system using Nyquist plot.

(ii) A unity feedback system has the forward transfer function $G(s) = \frac{K_1(2s+1)}{s(5s+1)(1+s)^2}$.

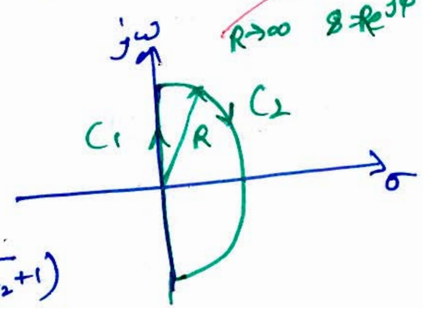
The input $r(t) = 1 + 6t$ is applied to the system. Determine the minimum value of K_1 if the steady state error is to be less than 0.1.

[6 + 6 marks]

5.(c) (i) $G(j\omega)H(j\omega) = \frac{k(1+j\omega)}{(1-j\omega)}$

$G(j\omega)H(j\omega) = \frac{k(1+j\omega)(1+j\omega)}{1+\omega^2} = \frac{k[1+2j\omega-\omega^2]}{1+\omega^2}$

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



Nyquist Contour

Contour C_1: $s = j\omega$

at $\omega = -\infty$; $G(j\omega)H(j\omega) = \frac{k(\frac{1}{\omega^2}-1)}{\frac{1}{\omega^2}+1} + j\frac{2k}{\omega(\frac{1}{\omega^2}+1)}$

at $\omega = -\infty$ $\quad = -k - j0$

at $\omega = +0 \Rightarrow k + j0$

at $\omega = -0 \Rightarrow k - j0$

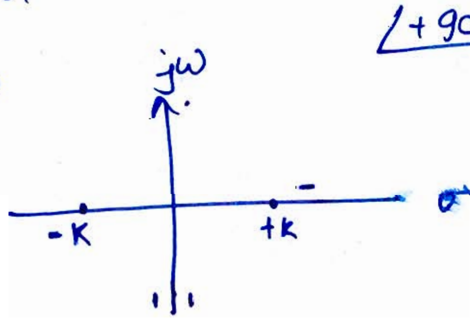
at $\omega = +\infty \Rightarrow -k + j0$

Contour C_2:- $s = Re^{j\phi}$; $R \to \infty$

$\Rightarrow \lim_{R\to\infty} \frac{k(1-Re^{j\phi})}{1-Re^{j\phi}}$ ~~$k(\ldots)$~~ $= \frac{k(1-0)}{(1-0)} = k$

$\angle +90^\circ \to 0^\circ \to -90^\circ$

* Nyquist Plot →



1

incomplete solution

5) (c) (ii) $r(t) = 1 + 6t$

$e_{ss} < 0.1$

$$e_{ss} = \lim_{s \to 0} \frac{s\,R(s)}{1 + G(s)} = \lim_{s \to 0} \frac{s\,R(s)}{1 + \frac{K_1(2s+1)}{s(5s+1)(1+s)^2}}$$

$$R(s) = \frac{1}{s} + \frac{6}{s^2} = R_1(s) + R_2(s)$$

Case (i): For $R_1(s)$

$$e_{ss_1} = \lim_{s \to 0} \frac{s(5s+1)(1+s)^2}{s(5s+1)(1+s)^2 + K_1(2s+1)} = 0$$

Case (ii): For $R_2(s)$

$$e_{ss_2} = \lim_{s \to 0} \frac{6}{s} \times \frac{s(5s+1)(1+s)^2}{s(5s+1)(1+s)^2 + K_1(2s+1)}$$

$$= \frac{6(1)(1)^2}{0 + K_1(1)} = \frac{6}{K_1}$$

6

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Now, we have,

$$e_{ss} < 0.1$$

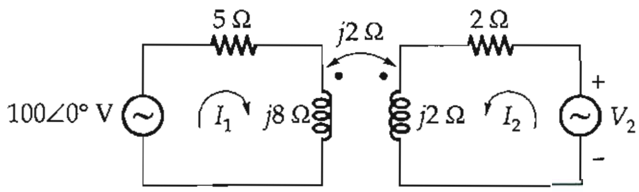
$$0 + \frac{6}{K_1} < 0.1$$

$$6 < 0.1 K_1$$

$\boxed{K_1 > 60}$; Required value of K_1.

—— X —— X ——

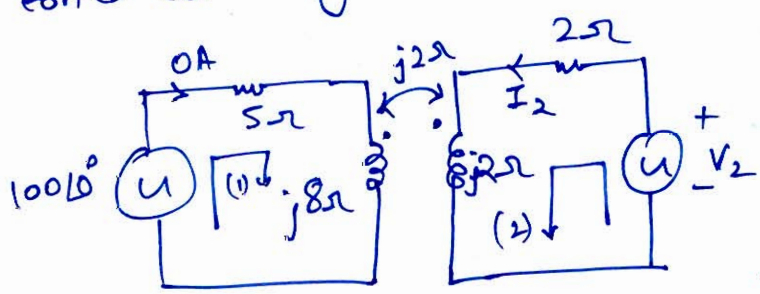
Q.5 (d) (i) In the magnetically coupled circuit shown in figure below, find V_2 for which $I_1 = 0$. What voltage appears at the $j8\Omega$ inductance under this condition?



(ii) In a series LCR circuit, the maximum inductor voltage is twice the maximum capacitor voltage. However, the circuit current lags the applied voltage by 30° and the instantaneous drop across the inductance is given by $V_L = 100 \sin 377t$ V. Assuming the resistance to be 20 Ω, find the values of the inductance and capacitance.

[6 + 6 marks]

Q.5 (d). (i) ~~Condi~~: Considering $I_1 = 0$.



* Applying KVL at (1) :-

$$-100\angle 0^\circ + 0 + j8(0) + j2(I_2) = 0.$$

$$I_2 = \frac{100}{2}\angle -90^\circ$$

$$\boxed{I_2 = 50\angle -90^\circ \text{ A}}$$

* Applying KVL at (2) :-

$$-V_2 + 2I_2 + j2I_2 + j2(0) = 0$$

Do not write in this margin

$V_2 = I_2(2+j2) = -50j\,(2+j2)$

$V_2 = 100 - 100j$

Good

or $\boxed{V_2 = 141.421\angle -45 \text{ Volts}}$

∵ ~~the~~ ~~at this condition the current if~~

* Applying KVL at loop(1), considering 'V_L' dropped across '$j8\Omega$' inductance, we get.

6

$-100 + 5(0) + V_L = 0$

$\boxed{V_L = 100 \text{ Volts}}$

∴ ~~then~~ When $I_1 = 0$; the voltage drop across $j8\Omega$ is 100 volts.

5.)d.) (ii) Series LCR circuit.

$|V_L|_{max} = 2|V_C|_{max}$

$\phi = 30°$.

$V_L = 100\sin(377t)$

$R = 20\Omega$.

$L \,\&\, C = ?$

incomplete solution

Q.5 (e) The closed loop transfer function of a feedback system is given by

$$T(s) = \frac{1000}{(s+22.5)(s^2+2.45s+44.4)}$$

(i) Determine the resonant peak M_r and resonant frequency ω_r of the system by drawing the frequency response curve.

(ii) Determine the bandwidth of the equivalent second order system.

[6 + 6 marks]

5.) e.) (i) The maximum value of $T(s)$ can be found by →

$$\frac{dT(s)}{ds} = 0.$$

$$\frac{dT(s)}{ds} = \frac{\cancel{(s+22.5)(s^2} \; 0 - 1000\left[(s+22.5)(2s+2.45) + (s^2+2.45s+44.4)(1)\right]}{\left[(s+22.5)(s^2+2.45s+44.4)\right]^2}$$

Read the Q carefully

0

$$0 = 1000\left[2s^2 + 2.45s + 45s + 55.125 + s^2 + 2.45s + 44.4\right]$$

$$\Rightarrow 3s^2 + 49.9s + 99.525 = 0$$

$$s = -2.3173$$

$$s = -14.3159.$$

For maximum value ; $\frac{d^2T(s)}{ds^2} < 0.$

⇒ ~~(s+22.5)(s^2~~ using which we get.

$$\boxed{\omega_r = 6.43 \text{ rad/sec}}$$

Now putting this value, we get M_p as.

$$\boxed{M_p = 2.766}$$

* Now the B.W is :-

$$B.W = \omega_n \sqrt{(1-2\xi^2) + \sqrt{4\xi^4 - 4\xi^2 + 1}}$$

from above we know;-

$$M_p = \frac{1}{2\xi\sqrt{1-\xi^2}} = 2.766$$

$$\Rightarrow \boxed{\xi = 0.1839}$$

& $\omega_r = \omega_n \sqrt{1-2\xi^2}$.

$$6.43 = \omega_n \sqrt{1-2(0.1839)^2}$$

$$\Rightarrow \boxed{\omega_n = 6.66 \text{ rad/sec}}$$

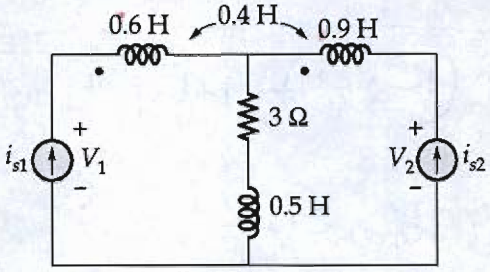
$$\therefore B.W = 6.66\sqrt{(1-2(0.1839)^2 + \sqrt{4(0.1839)^4 - 4(0.1839)^2 + 1}}$$

$$\boxed{B.W = 9.09 \text{ Hz.}}$$

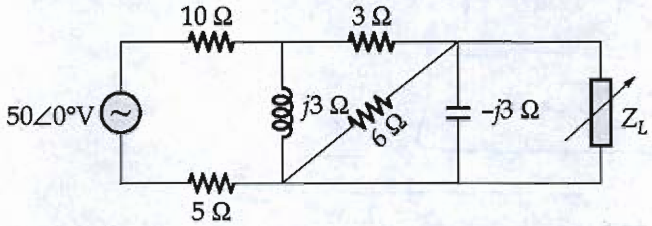
x ——— x

Q.6 (a) **(i)** Let $i_{s_1} = 10 \cos 10t$ A and $i_{s2} = 6 \cos 10t$ A in the circuit shown below.

Find: **1.** $V_1(t)$; **2.** $V_2(t)$; **3.** the average power being supplied by each source.

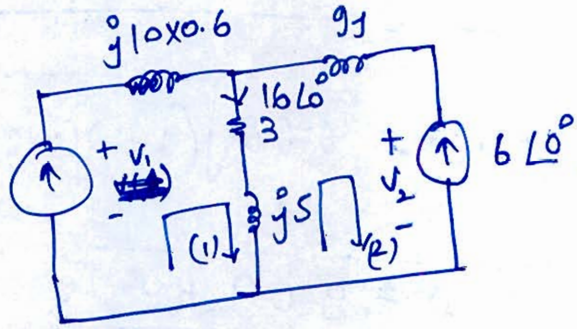


(ii) Find the impedance Z_L so that maximum power can be transferred to it in the network shown below. Also, find the maximum power delivered to load Z_L.



[10 + 10 marks]

6.) a.) (i.) Re-drawing ~~so~~ circuit :— (in $s = j\omega$ domain)



* Applying KVL at (1)

$-V_1 + j6(10) + 16 \times 3$
$+ j5 \times 16 = 0$

$V_1 = +(60+80)j + 48$

$V_1 = 140j + 48 \Rightarrow$ $\boxed{V_1 = 148 \angle 71.075^\circ \text{ volts}}$

* Applying KVL at (2) :-

$-3 \times 16 - j5 \times 16 - 6 \times 9j + V_2 = 0$

$\Rightarrow V_2 = 48 + j(134)$

or $\boxed{V_2 = 142.3376 \angle 70.29^\circ \text{ Volts}}$

0

Where is factor of 0.4H mutual indu

~~1.) $V_1(t) = 148\cos(10t + 71.075°)$ volts.~~

~~2.) $V_2(t) = 142.3376\cos(10t + 70.29°)$ volts.~~

~~3.) Average power supplied by each source.~~

~~we know; $P_{av} = V_{rms} I_{rms} \cos\phi$~~

~~By i_{s1}; $P_{av_1} = \frac{148 \times 10}{2}\cos(0° + 71.075°)$~~

~~$\boxed{P_{av_1} = 240.0043 \text{ watts}}$~~

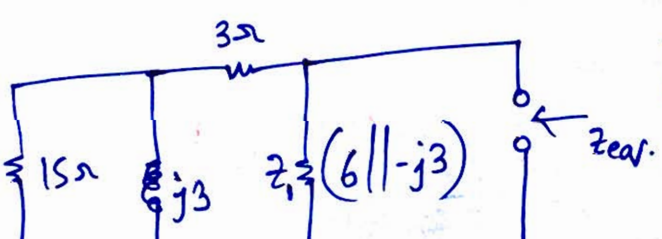
~~By i_{s2}; $P_{av_2} = \frac{142.3376 \times 6}{2}\cos(70.29°)$~~

~~$\boxed{P_{av_2} = 144.014 \text{ watts}}$~~

X

·) a.) (ii) For maximum power transfer, we have to find the equivalent Resistance across load Z_L in given circuit:–

Deactivating the independent source in given circuit:

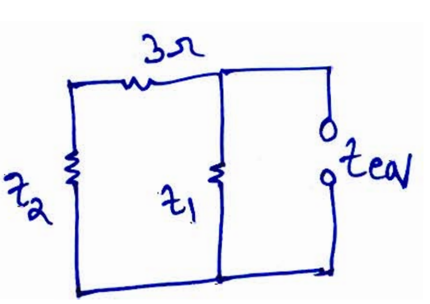


$$[6 \| (-j3)] = \frac{6 \times (-j3)}{6 - j3} = \frac{-j18}{6 - j3}$$

$$\boxed{Z_1 = 1.2 - 2.4j \ \Omega} \text{ —(ii)}$$

Also, parallel combination of 15Ω & $j3$ = $\frac{15 \times j3}{15 + j3}$

$$Z_2 = 0.5769 + j2.8846 \ \Omega$$



$$* \ Z_{eq} = (Z_2 + 3) \| Z_1$$

$$= (3.5769 + j2.8846) \| (1.2 - 2.4j)$$

* $Z_{eq} = (3.5769 + j2.8846) \,||\, (1.2 - 2.4j)$

$$= \frac{(3.5769 + j2.8846)(1.2 - 2.4j)}{4.7769 + 0.4846j}$$

$$= \frac{11.21532 - 5.12304j}{4.7769 + 0.4846j}$$

$$= \frac{12.33\angle -24.55^\circ}{4.8014\angle 5.79^\circ}$$

$$\boxed{Z_{eq} = 2.216 - 1.297j}$$

Now for maximum power transfer :—

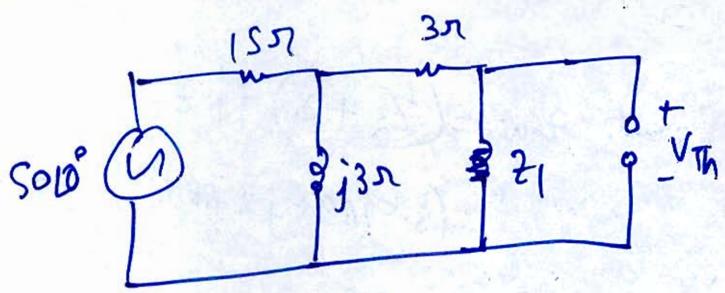
$$\boxed{Z_L = Z_{eq}^* = (2.216 + 1.297j)\,\Omega}$$

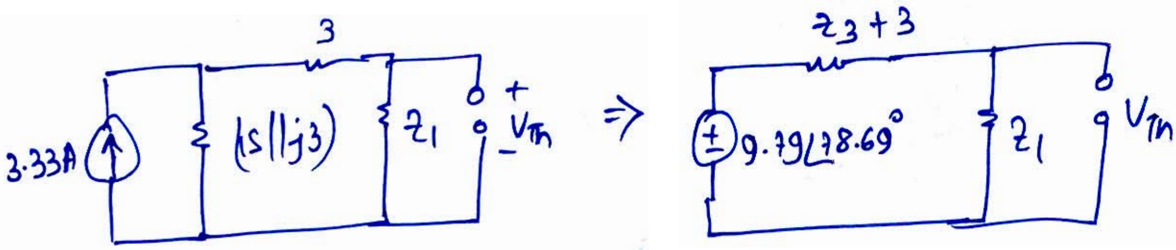
* The power delivered to Z_L i.e., maximum power P_{max} is given as :—

$$\boxed{P_{max} = \frac{V_{Th}^2}{8R_L} = \frac{V_{Th}^2}{8R_L}} \quad \text{—(i)}$$

where, $R_L = 2.216\,\Omega$

* For V_{Th} :—





$$(15 \| j3) = 0.5769 + 2.8846j$$
$$= 2.94\angle 78.69^\circ\,\Omega$$
$$= Z_3$$

Now, V_{Th} across Z_1 by using voltage divider rule:—

$$V_{Th} = \frac{Z_1}{Z_1 + Z_3 + 3} \times 9.79\angle 78.69^\circ$$

$$= \frac{1.2 - 2.4j}{1.2 - 2.4j + 2.94\angle 78.69^\circ + 3} \times 9.79\angle 78.69^\circ$$

$$= \frac{2.68\angle -63.4349^\circ}{4.8014\angle 5.79^\circ} \times 9.79\angle 78.69^\circ$$

~~V_{Th} = 5.39669~~

$$|V_{Th}| = 5.47 \text{ volts.}$$

4

So, from (i) :—

$$P_{max} = \frac{(5.47)^2}{8 \times \sqrt{(2.216)^2 + (1.297)^2}}$$

$$\boxed{P_{max} = 1.456 \text{ watts}}$$

∴ Z_L for maximum power transfer is:

$$\boxed{Z_L = (2.216 + 1.297j)\,\Omega}$$

& Maximum power transfer is

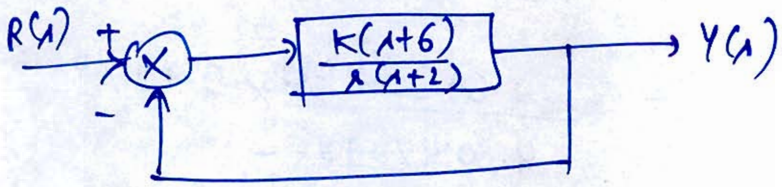
$$\boxed{P_{max} = 1.456 \text{ watts.}}$$

Q.6 (b) A unity negative feedback system has $G(s) = \frac{K(s+6)}{s(s+2)}$. When $K = 50$, find change in closed loop pole locations for a 10% change in the value of K.

[20 marks]

6.) b.)

Given:



where, $K = 50$.

At $K = 50$; the close-loop poles :-

$$T(s) = \frac{50(s+6)}{s(s+2) + 50(s+6)}$$

5

Poles ; $s^2 + 2s + 50s + 300 = 0$

$s^2 + 52s + 300 = 0$

$$\boxed{\begin{aligned} s_1 &= -6.60928 \\ s_2 &= -45.390719 \end{aligned}}$$ — (i)

* Let us consider +10% change in K i.e,

$K_1 = 50 + 5 = 55.$

$$T_1(s) = \frac{55(s+6)}{s(s+2)+55(s+6)}$$

Pole; $s^2 + 2s + 55s + 330 = 0$

$s^2 + 57s + 330 = 0$

$$\boxed{\begin{aligned} s_1' &= -6.539808 \\ s_2' &= -50.46019 \end{aligned}} \quad \text{— (ii)}$$

Similarly for −10% change i.e., $K_2 = 45$.

Poles; $s^2 + 2s + 45s + 270$

$$\boxed{\begin{aligned} s_1'' &= -6.699702 \\ s_2'' &= -40.30029 \end{aligned}} \quad \text{— (iii)}$$

∴ Δs_1 ~~$= +0.069472$~~

~~$= 0.090422$~~

change in $+s_1$ $= \dfrac{-6.60928 - (-6.539808)}{-6.60928}$

$$\boxed{+s_1 = 1.05\%}$$

$$-\Delta s_1 = \frac{-6.60928 - (-6.699702)}{-6.60928}$$

$$\boxed{-s_1 = -1.368\%}$$

∴ Chang in pole 1 = +1.368% to 1.05%

& change in pole 2 = −11.168% to 11.214%

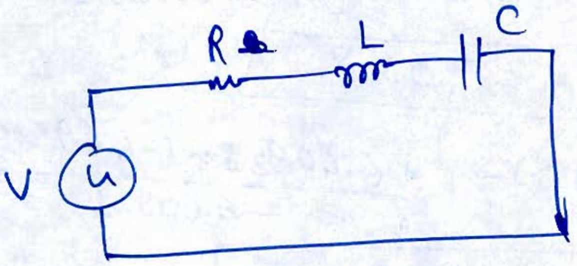
See solution to get better understanding of this Q.

Q.6 (c) (i) Prove that the bandwidth of a series RLC circuit is given as $\frac{R}{L}$ rad/sec.

(ii) A constant voltage at a frequency of 1 MHz is applied to an inductor in series with a variable capacitor. When the capacitor is set to 500 pF, the current has its maximum value while it is reduced to one-half when the capacitor is 600 pF. Find resistance, inductance and Q-factor of inductor.

[8 + 12 marks]

6.) (c.) (i) Series RLC circuit :-



We know that the Bandwidth is defined as

$$B.W = \frac{f_r}{Q}$$

where, f_r is ~~cutoff~~ resonant frequeny and Q is quality factor.

$$Q = \cancel{\text{Energy}}\ \frac{\text{Power } \cancel{\text{abs}} \text{ delivered}}{\text{Power absorbed.}}$$

$$\boxed{Q = \frac{\omega L}{R}} \quad -(i)$$

Now for Resonant frequency, the impedance of series RLC can be written as :-

$$Z = R + j\omega L + \frac{1}{j\omega C}$$

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

$$Z = \frac{+\omega CR + j\omega^2 LC - j}{j\omega C}$$

At resonance the imaginary component of impedance is zero, Hence.

$$\omega^2 LC - 1 = 0$$

$$\omega^2 = \frac{1}{LC} \Rightarrow \omega = \frac{1}{\sqrt{LC}} \text{ rad/sec}$$

$$\text{or } \boxed{f_r = \frac{1}{2\pi\sqrt{LC}}} \quad -\text{(ii)}$$

Now using (i) & (ii) :-

$$B.W = \frac{1}{2\pi\sqrt{LC}} \times \frac{R}{\omega L}$$

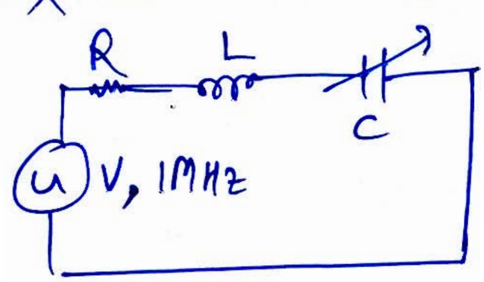
$$= \frac{1}{2\pi\sqrt{LC}} \times 2\pi\sqrt{LC} \times \frac{R}{L}$$

$$\boxed{B.W = \frac{R}{L} \text{ rad/sec}}$$

↳ Hence proved.

X X X

6.) c) (ii)



Given : At $C = 500pF$; $I_{max} = I$

at $C = 600pF$; $\frac{I_{max}}{2} = I'$

At resonance, current acquire ~~pea~~ maximum value.

$\therefore \quad Z_{eq} = R + j\omega L + \frac{1}{j\omega C}$

• at resonance; $f = \frac{1}{2\pi\sqrt{LC}}$

$\therefore \quad 1\times10^{6} \times 2\pi \times \sqrt{500\times10^{-12}} = \frac{1}{\sqrt{L}}$

or $L = \frac{1}{(140.49629)^2}$

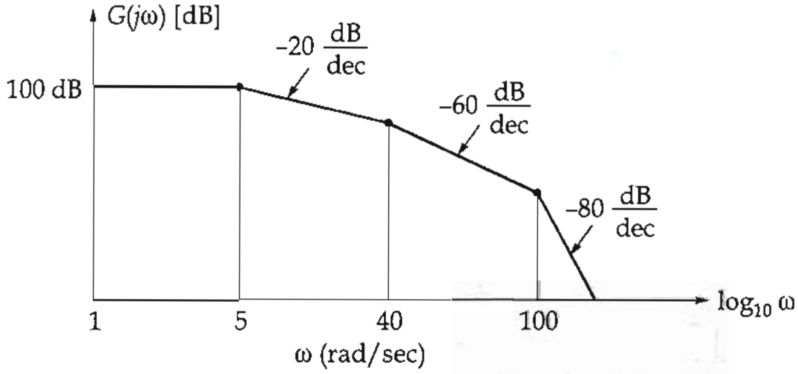
$\boxed{L = 50.66\,\mu H}$

1

incomplete solution

At resonance,

7 (a) The Bode magnitude plot of the open loop transfer function $G(s)$ of a certain unity feedback control system is given in figure.



Estimate the magnitude of transfer function at each of the corner frequencies and also calculate the phase margin.

[20 marks]

7) a) * Let the transfer function be :-

$$\cancel{G(s) = \frac{K}{s(\frac{1}{5}\ldots}}$$

1

$$G(s) = \frac{K}{s\left(\frac{1}{5}s+1\right)\left(\frac{1}{40}s+1\right)^2\left(\frac{1}{100}s+1\right)}$$

At ; 1 rad/sec ; the

$$20\log K = 100$$

$$\boxed{K = 10^5}$$

$$|G(j\omega)| = \frac{10^5}{s\left(\frac{1}{5}s+1\right)\left(\frac{1}{40}s+1\right)^2\left(\frac{1}{100}j\omega+1\right)}$$

$$|G(j\omega)| = \frac{10^5}{\omega\sqrt{1+\frac{\omega^2}{25}}\left(\frac{\omega^2}{1600}+1\right)\sqrt{1+\frac{\omega^2}{10^4}}}$$

at $\omega = 1$ rad/sec

$$|G(j1)| = \frac{10^5}{(1)(1.0198)(1.000625)(1.000049)}$$

$$\boxed{|G(j1)| = 97992.29}$$

at $\omega = 5$ rad/sec

$$|G(j5)| = \frac{10^5}{5\times\sqrt{2}\times 1.015625\times 1.001249}$$

$$\boxed{|G(j5)| = 13907.19}$$

similarly $$|G(j40)| = \frac{10^5}{40\times 8.06225\times\sqrt{2}\times 1.077}$$

$$\boxed{|G(j40)| = 203.58}$$

$$|G(j100)| = \frac{10^5}{100\times 20.0249\times 7.25\times\sqrt{2}}$$

$$\boxed{|G(j100)| = 4.8705}$$

The Phase margin can be calulated as:-

$$P.M = 180^\circ + \angle G(j\omega)\Big|_{\omega=\omega_{gc}}$$

$$|G(j\omega)| = 1 \quad \text{or} \quad \text{Img}\,|G(j\omega)| = 0.$$

$$\cancel{\frac{10^5}{\omega\sqrt{1+\frac{\omega^2}{25}}\left(\frac{\omega^2}{1600}+1\right)\sqrt{1+\frac{\omega^2}{10^4}}}} = 1$$

$$\cancel{G(j\omega) = \frac{-10^5 j}{\omega\left(\frac{1}{5}j\omega+1\right)\left(\frac{j\omega}{40}+1\right)^2\left(\frac{j\omega}{100}+1\right)}}$$

$$\cancel{(10^5)^2 = \omega^2\left(1+\frac{\omega^2}{25}\right)\left(\frac{\omega^2}{1600}+1\right)^2\left(1+\frac{\omega^2}{10000}\right)}$$

$$\cancel{\text{Let } \omega^2 = x}$$

$$\cancel{10^{10} = x\left(1+\frac{x}{25}\right)\left(\frac{x}{1600}+1\right)^2\left(1+\frac{x}{10000}\right)}$$

$$\cancel{10^{10} = \left(x+\frac{x^2}{25}\right)\left(1+\frac{x}{10000}\right)\left(\frac{x^2}{256\times10^4}+1+\frac{x}{800}\right)}$$

$$\cancel{= \left(x+\frac{x^2}{10^4}+\frac{x^2}{25}+\frac{x^3}{25\times10^4}\right)\left(\frac{x^2}{256\times10^4}+1+\frac{x}{800}\right)}$$

$$\cancel{= \frac{x^3}{256\times10^4} + x + \frac{x^2}{800} + \frac{x^4\,0.0401}{256\times10^4} + 0.0401x^2}$$

$$\cancel{+ \frac{x^3\,0.0401}{800} + \frac{x^5}{25\times10^8\times256} + \frac{x^3}{25\times10^4} + \frac{x^4}{25\times10^4\times800}}$$

from approximation, $\omega_{gc} \simeq 142$ rad/sec.

$$PM = \cancel{180^\circ - 90^\circ - \tan^{-1}(\ldots)}$$

$$180^\circ - 90^\circ - \tan^{-1}\left(\frac{142}{5}\right) - 2\tan^{-1}\left(\frac{142}{40}\right)$$

$$- \tan^{-1}\left(\frac{142}{100}\right)$$

$$\boxed{PM = -25.39^\circ}$$

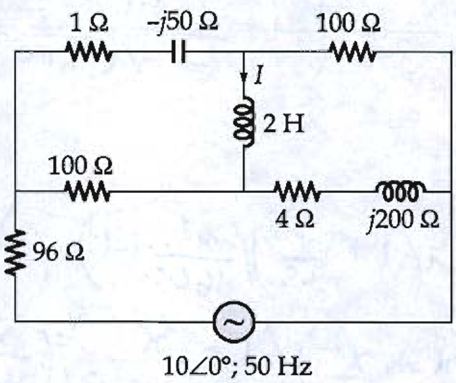
X ——— X

Do not write in this margin

Q.7 (b) Find current across 2 Henry inductor as shown in the network below using

(i) Thevenin's theorem;

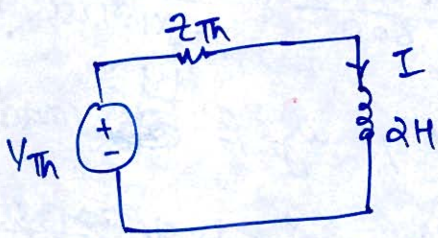
(ii) Draw the Norton's equivalent circuit.



[15 + 5 marks]

7.) b.) (i) Thevenin's theorem.

Equivalent circuit across '2H' will be :-

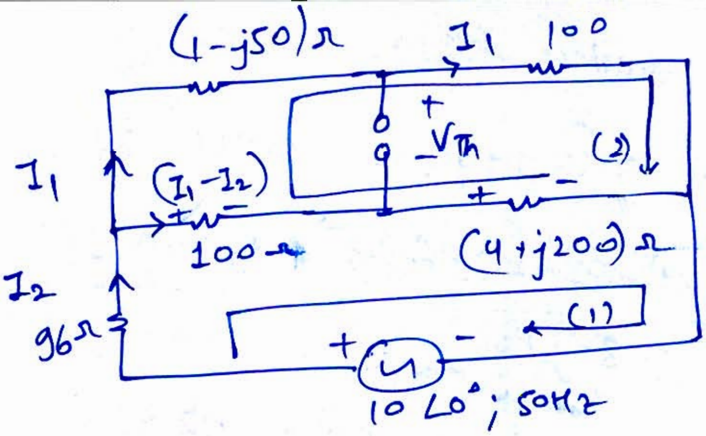


$2H = (j\,2\pi \times 50 \times 2)\,\Omega$.

~~Find~~ Finding the value of V_{Th} :-

* open circuiting the '2H' from circuit.

* Dealing the circuit in s-domain.



* KVL at (1) :—

$96I_2 + 100I_1 - 100I_2 + 4I_1 + j200I_1 - 4I_2 - j200I_2$
$-10 = 0.$

$\boxed{(-8-j200)I_2 + (104+j200)I_1 = 10}$ — (i)

Calculation error

* Applying KVL at (2) :—

$(1-j50+100)I_1 - (4+j200+100)(I_1-I_2) = 0$

$(101-j50)I_1 - (104+j200)I_1 + (104+j200)I_2 = 0$

$\boxed{(104+j200)I_2 + I_1(-j250-3) = 0}$ — (ii)

∴ By cramer's rule, using (i) & (ii) →

$$I_1 = \frac{\begin{vmatrix} 10 & -8-j200 \\ 0 & 104+j200 \end{vmatrix}}{\begin{vmatrix} 104+j200 & \cancel{104+j200}\ -8-j200 \\ -j250-3 & 104+j200 \end{vmatrix}}$$

$I_1 = \dfrac{1040+j2000}{20792+j39000} \Rightarrow I_1 = 0.051 + 5.24j$

or $\boxed{I_1 = 0.051 \angle 0.588^\circ}$ — (iii) putting ~~eq~~ 'I_1' in equation (ii) :-

$$\cancel{104}\ (-8-j200)I_2 + (104+j200)(0.051+5.24j) = 0$$

$$\Rightarrow I_2 = \frac{\cancel{-(-1042.69+555.16j)}\ -(5.99+10.28j)}{(-8-j200)}$$

$$I_2 = \cancel{2.563+5.316j}\ \ 0.052-0.0239j$$

$$\text{or}\quad \boxed{I_2 = \cancel{5.9\angle -115.71}\ 0.057\angle 155.40^\circ} \quad -(iv.)$$

* Now V_{Th} can be written by using KVL as follows:-

$$-100(I_1-I_2) + (1-j50)I_1 + V_{Th} = 0$$

$$\cancel{V_{Th} = 100[0.051+5.24j - 2.563-5.316j] - (1-j50) \times (0.051+5.24j)}$$

$$\cancel{= -251.2-7.6j - 262.051 - 269j}$$

$$\cancel{V_{Th} = -513.251-10.29j}$$

$$\text{or}\quad \cancel{\boxed{V_{Th} = 513.35\angle -178.85^\circ}}$$

$$\cancel{-100(0.051+5.24j - 0.052+0.0239j) + (1-j50)(0.051+5.24j)}$$

$$\cancel{+V_{Th} = 0}$$

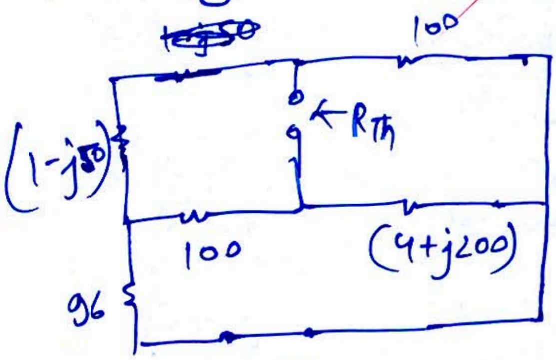
$$\Rightarrow \cancel{V_{Th} = -0.1+526.39j - 262.05 - 0.269j}$$

$$V_{Th} = \cancel{104\angle}\ 10.5409\angle -12.717^\circ \rightarrow 9.55\angle 88.26^\circ$$

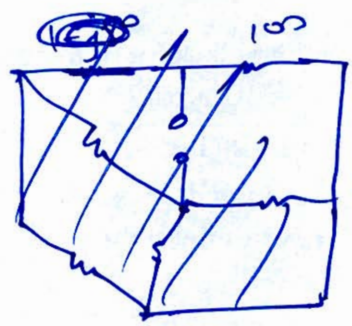
$$V_{Th} = 10.2048+0.228j$$

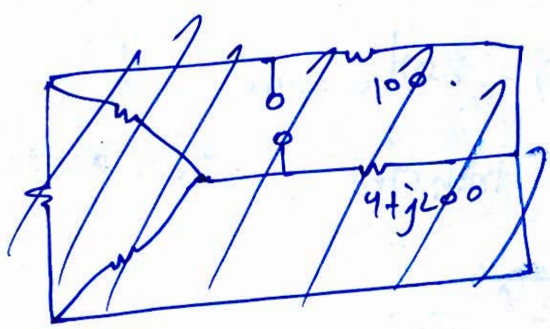
or $\boxed{V_{Th} = 10.207 \angle 1.28^\circ \text{ Volts}}$

* Finding R_{Th} :-



⇒





incomplete solution

Q.7 (c) **(i)** Derive the expression for gain margin and phase margin of a unity feedback second order system with transfer function,

$$\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$$

(ii) Sketch the polar plot of the transfer function given below:

$$G(s) = \frac{1+4s}{s(1+s)(1+2s)}$$

Determine whether the polar plot cuts the imaginary axis. If so, determine the frequency at which the plot cross the imaginary axis.

[10 + 10 marks]

7.c) (i) Gain margin is defined as :—

$$G.M = |G(j\omega)H(j\omega)|_{\omega=\omega_{pc}} \quad —(i)$$

~~when~~ The open-loop transfer function is →

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)H(s)}$$

$$\frac{R(s)}{C(s)} = \frac{1}{G(s)} + 1$$

$$\boxed{G(s) = \frac{\omega_n^2}{s(s+2\xi\omega_n)}}$$

∴ ~~For phase-cross over freq, ω_{pc}.~~

$$\cancel{-180^\circ = -90^\circ - \tan^{-1}\left(\frac{\omega}{2\xi\omega_n}\right)}$$

$$\cancel{-90^\circ = -\tan^{-1}\left(\frac{\omega}{2\xi\omega_n}\right)}$$

$$\cancel{\infty = \frac{\omega}{2\xi\omega_n} \Rightarrow 2\xi\omega_n = 0}$$

$$G(j\omega) = \frac{-j\omega_n^2}{\omega(j\omega+2\xi\omega_n)} = \frac{-j\omega_n^2(2\xi\omega_n - j\omega)}{\omega(\omega^2+4\xi^2\omega_n^2)}$$

$$G(j\omega) = \cancel{-j\omega} \; \frac{-j\omega_n^3 2\zeta - \omega_n^2\omega}{\omega(\omega^2+4\zeta^2\omega_n^2)}$$

$$G(j\omega) = \frac{-\omega_n^2}{\omega^2+4\zeta^2\omega_n^2} - j\frac{\omega_n^3 2\zeta}{\omega(\omega^2+4\zeta^2\omega_n^2)}$$

putting $Img|G(j\omega)| = 0$; will give ω_{pc}.

$$\frac{2\omega_n^3\zeta}{\omega(\omega^2+4\zeta^2\omega_n^2)} = 0$$

$$\therefore \boxed{G.M = -20\log\frac{\omega_n^2}{\omega\sqrt{\omega^2+4\zeta^2\omega_n^2}}}$$

and Phase margin :-

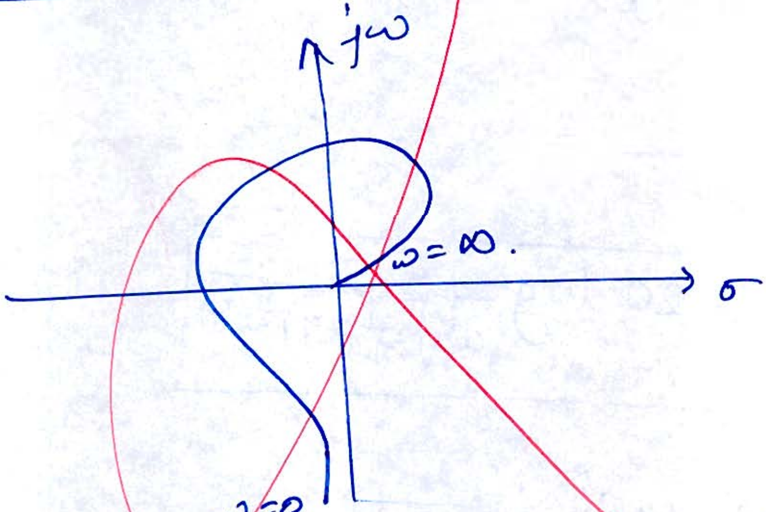
$$P.M = 180° - 90° - \tan^{-1}\left(\frac{\omega}{2\zeta\omega_n}\right)$$

$$\boxed{P.M = 90° - \tan^{-1}\left(\frac{\omega}{2\zeta\omega_n}\right)}$$

2

7.) (c.)(ii) $G(j\omega) = \dfrac{1+4j\omega}{j\omega(1+j\omega)(1+j\omega 2)}$

Polar plot →



Plot crossing imaginary axis :-

$G(j\omega) = \dfrac{-j(1+4j\omega)(1-j\omega)(1-j\omega 2)}{\omega(1+\omega^2)(1+4\omega^2)}$

$= \dfrac{-j\left[(1+4j\omega)(1-j\omega 3-\omega^2 2)\right]}{\omega(1+\omega^2)(1+4\omega^2)}$

$= \dfrac{-j\left[1-j\omega 3-\omega^2 2+4j\omega+12\omega^2-\omega^3 8j\right]}{\omega(1+\omega^2)(1+4\omega^2)}$

$= \dfrac{-j-\omega 3+j2\omega^2-4\omega+12\omega^2 j+\omega^3 8}{\omega(1+\omega^2)(1+4\omega^2)}$

$Re(G(j\omega)) = 0$

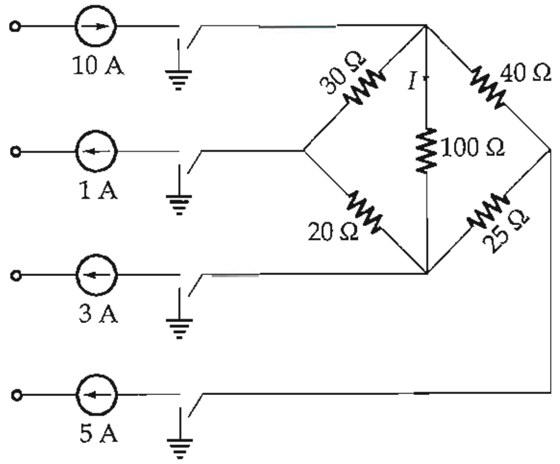
$-3\omega - 4\omega + 8\omega^3 = 0$

$\omega(-7+8\omega^2) = 0$

$8\omega^2 = 7$

$\boxed{\omega = 0.935 \text{ rad/sec}}$

(a) (i) Find the value of the current 'I' flowing through the 100 Ω resistor in the bridge shown below using Superposition Theorem. (Assume other sources are grounded, when one is used at a time)



(ii) A certain series RLC resonant circuit has resonant frequency, $f_0 = 200$ Hz, quality factor, $Q_0 = 7.5$ and inductive reactance, $X_L = 250\ \Omega$ at resonance.

1. Find the values of R, L and C
2. If the source voltage, $V_S = 5\angle 45°$ V is connected in series with the circuit, find exact value for magnitude of capacitor voltage, $|V_C|$ at $f = 300$ Hz.

[10 + 10 marks]

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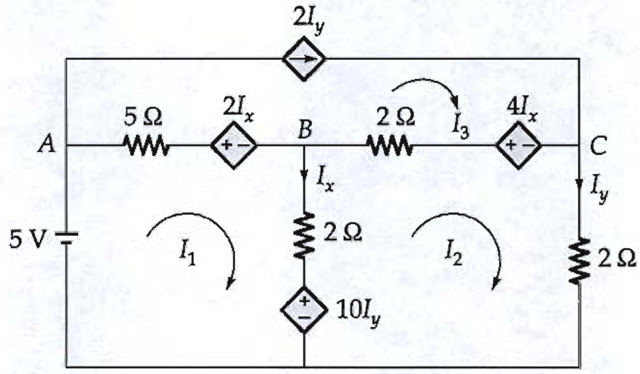
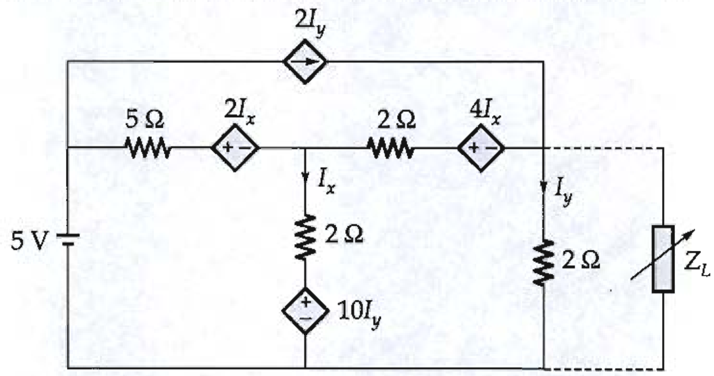
Q.8 (b) Consider the circuit shown below, which contain some dependent and independent sources.



Find

(i) Currents I_1, I_2 and I_3 using mesh analysis.

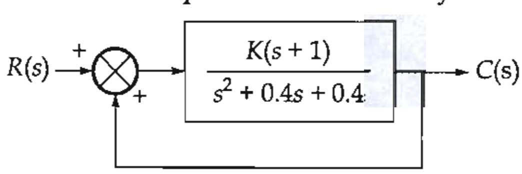
(ii) The maximum power transferred to the load, connected across $2\,\Omega$ as shown below:



[10 + 10 marks]

Q.8 (c) **(i)** A feedback control system has $G(s) = \dfrac{10}{s(s+10)}$ and $H(s) = e^{-T_1 s}$. Find T_1 for which system is marginally stable.

(ii) Sketch the root locus for the positive feedback system as drawn below for $0 < K < \infty$.



Also, comment on the stability of the system.

[10 + 10 marks]

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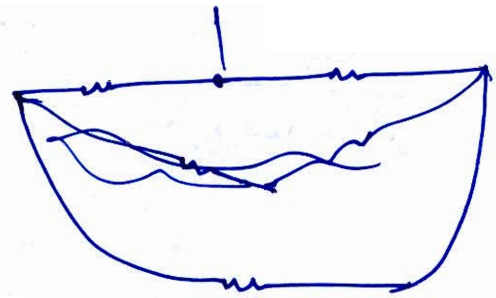
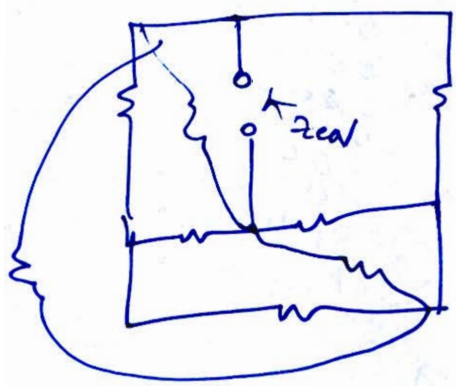
OOOO

Space for Rough Work

Space for Rough Work

Space for Rough Work





$$\frac{\sqrt{1+16\omega^2}}{\omega\sqrt{1+\omega^2}\;\sqrt{1+4\omega^2}}.$$

at $\omega = 0$

$$\frac{1}{0\,(1)\,(1)} = \infty$$

$\omega = \infty$

$$\frac{\cancel{\omega}\sqrt{\frac{1}{\omega^2}+16}}{\cancel{\omega}\,\omega^2\sqrt{\frac{1}{\omega^2}+1}\;\sqrt{\frac{1}{\omega^2}+4}} = 0.$$

Space for Rough Work

$$\frac{s^2+2\zeta\omega_n s+\omega_n^2}{\omega_n^2} - \frac{\omega_n^2}{}$$

$$\frac{\omega_n^2}{s^2+2\zeta\omega_n s}.$$

$1-2s = As+2A+Bs-B$

$A+B=-2$; $1=2A-B$

$B=2A-1$

$A+2A-1=-2$

$3A=-1$

$A=-1/3$

$B=2\left(\frac{-1}{3}\right)-1$

$=-\frac{2}{3}-1$

$=\frac{-2-3}{3}=\frac{-5}{3}$

24.0208 × 120 × 10 × 1.562049

000 → 0
001 → 4
010 → 2
011 → 6
100 → 1
101 → 5
110 → 3
111 → 7.

2.2209

120

150 →

30.016 × 150 × 15.06.

1.802

140

$2.45 = \zeta\omega_n 2$

$\omega_n = \sqrt{44.4}.$

$\omega_n = \cancel{6.66}\ 6.66$

$\zeta = 0.18839$

$6.66\sqrt{1-}$

$\omega_r = 6.4308$

$6.66\sqrt{1-}$

28.0178 × 140 ×

13.28

$A = 4/3$ $B=-1/3$

$\boxed{A+B=1}$; $-0.8A = 0.8B$

$A=-4B$

$-4B+B=1$

$-3B=1$