Image

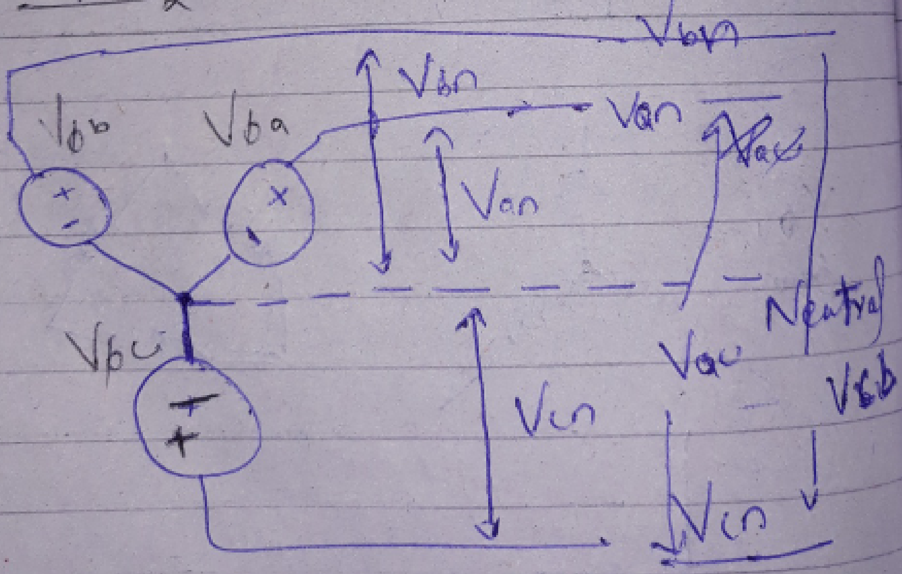
PMT ⇒ Pole Mount Transformer

If the voltages & angles of the three coils are same then it is called three phase.

Mathematical:

$V_a = V_m \angle 0^\circ$
$V_b = V_m \angle 120^\circ$
$V_c = V_m \angle -120$

• THREE PHASE SYSTEM



Balance Y-Three phase Source

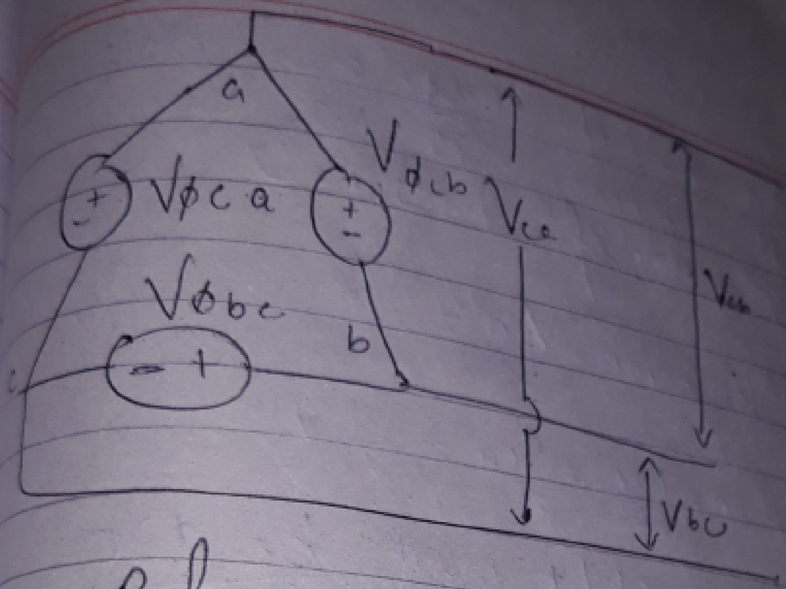
nt Transformer

gles
he
ffed

~~Vab~~

Neutral
Vab

Source



Belance Δ three phase source:

V_ϕ phase voltage = Voltage per phase (potential difference develop in phase winding)

V_L - Line voltage = potential diff b/w any two-phases-

Y:

- In Y- If there are balanced then there is no current in neutral. $\therefore I_N = 0$

- $V_{an} = V_{bn} = V_{cn} = V_\phi$

- $I_{bn} = I_{an} = I_{cn} = I_\phi$

- phase shift must be 120°

- If $\boxed{V_{\phi a} = 230\angle 0^\circ}$, $\boxed{V_{\phi b} = 230\angle 120^\circ}$, $\boxed{V_{\phi c} = 230\angle -120^\circ}$
  (V_{an}, V_{bn}, V_{cn})

- ~~$V_L = V$~~

- $V_L = V_{ab} = V_{bc} = V_{ca}$ in Y-connection

$$\boxed{I_L = I_\phi}$$

lanced
ent

$V_{ab} = ?$

$V_{ab} = V_{an} - V_{bn}$

$\boxed{V_{ab} = 398 \angle -30^\circ}$

$\boxed{V_L = 398 \angle -30^\circ}$

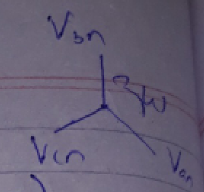
$V_{bc} = 398 \angle 90^\circ$

$V_{ca} = 398 \angle -150$

$V_{ab} + V_{bc} + V_{ca} = 0$

$$(398 \angle -30^\circ) + (398 \angle 90^\circ) + (398 \angle -150^\circ) = 0$$

$V =$



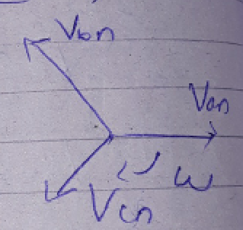
1. Phase sequence

- -ve phase sequence (abc)

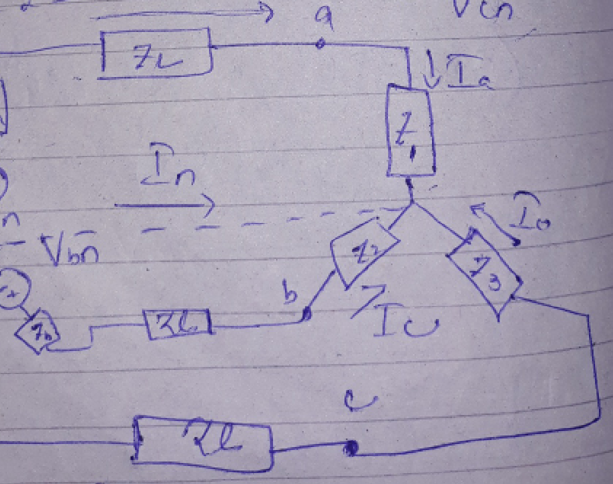
$V_{an} = V_m \angle 0^\circ, V_{bn} = V_m \angle 120^\circ, V_{cn} = V_m \angle -120^\circ$

- +ve phase sequence (acb)

$V_{an} = V_m \angle 0^\circ, V_{bn} = V_m \angle -120^\circ,$
$V_{cn} = V_m \angle 120^\circ$



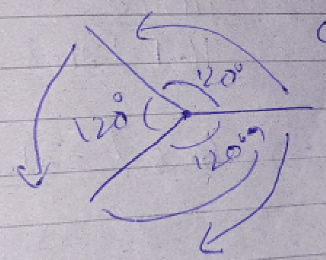
Y-Y connection:



Z_s = source winding Impedance
Z_L = line impedance
Z_1, Z_2, Z_3 (load impedance of each phase)

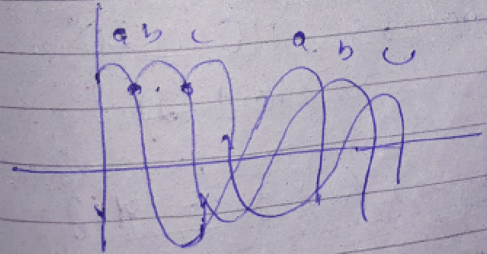
$Z_p = Z_s + Z_l + Z_1$

• ~~For Balanced phases~~
If phase in Balance means impedance of each phase are equal in magnitude in p



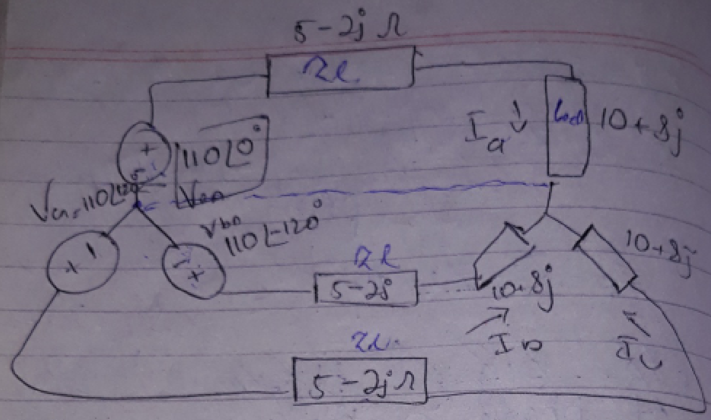
counter clockwise
abcabc
abc

acbacbacb



$I_a = \frac{V_{an}}{Z_y}$ $\qquad$ $\cancel{V_{ab} = V_{an}}$ $\qquad$ $V_{an} = \frac{V_{ab}}{\sqrt{3}} \angle -30$

$Y - \Delta$



$I_a = \frac{V_{an}}{Z_y} \Rightarrow \frac{110 \angle 0^\circ}{10 + 8j + 5 - 2j}$

$\Rightarrow \frac{110 \angle 0^\circ}{16.1 \angle 21.8}$

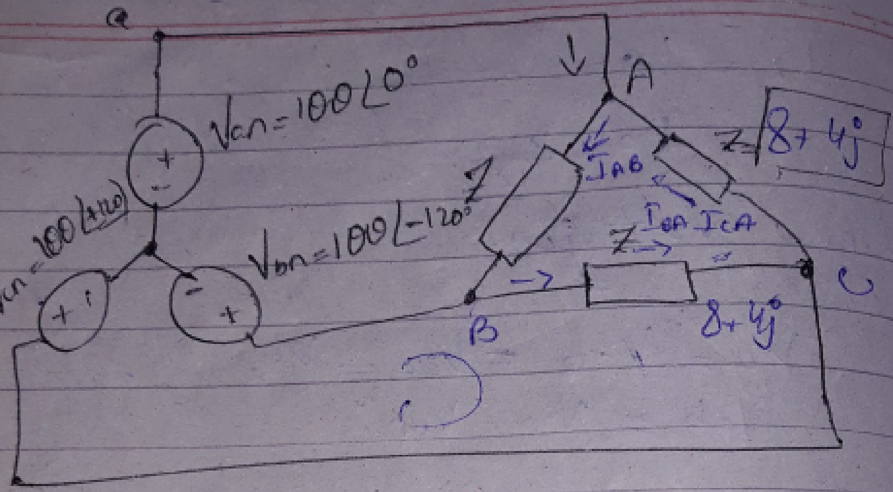
$\boxed{I_a \Rightarrow 6.8 \angle -21.80}$

$I_b = \frac{V_{bn}}{Z_y} \Rightarrow \frac{110 \angle -120^\circ}{16.1 \angle 21.8}$

$\boxed{I_b \Rightarrow 6.83 \angle -141.8}$

$\boxed{I_c = 6.83 \angle 98.2}$

BALANCE Y-Δ



Determine the value of V_{AB}, I_{AB}, I_{BC}, I_{CA}

$$\Rightarrow \boxed{Z = 8+4j}$$

$$V_{AB} = V_{an} - V_{bn}$$
$$\Rightarrow (100\angle 0°) - (100\angle -120°)$$

$$\boxed{V_{AB} \Rightarrow 173.20\angle 30°}$$

$$\boxed{I_{AB} \Rightarrow \frac{V_{AB}}{Z} \Rightarrow 19.37\angle 3.43}$$

BALANC
$\Delta - Y$

FREQUENCY RESPONSE

$H(\omega)$, the frequency Response is the variation in the behaviour of ckt with signal frequency

* The behaviour observe over frequency of i/p Signal without change in a amplitude -

$X(\omega) \longrightarrow$ $\boxed{H(\omega) \text{ Linear Network}}$ $\longrightarrow Y(\omega)$

$$H(\omega) = \frac{\text{Phasor output}}{\text{phasor input}}$$

$$H(\omega) = \frac{Y(\omega)}{X(\omega)}$$

This frequency dependent Ratio is called transfer fraction or Network function.

$H(\omega) =$

(1) Zero
The
numera
are
functio
• zero
m

(2) Pol

'ω

• T
P
of
fre

(1)

$H(\omega) = |H(\omega)| \angle \underline{\phi}$

(1) Zero:

The Roots of the ~~network~~ numerator polynomial of $H(\omega)$ are called zero of Transfer function.

- zero are the value of 'ω' that make $H(\omega) = 0$

(2) Poles:

- Poles are the value of 'ω' that make $H(\omega) = \infty$

- The roots of the denominator polynomial are called pole of transfer function.

Frequency Response:

(1) convert all element into frequency variable.

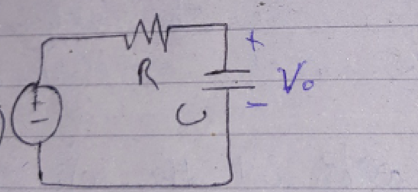
2. Determine $H(\omega) = \frac{Y(\omega)}{X(\omega)}$

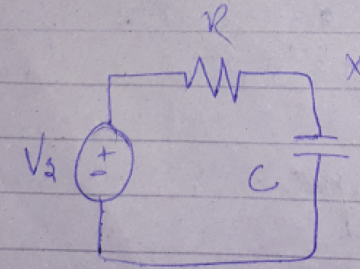
3. Determine $|H(\omega)|$

4. Determine ϕ of $H(\omega)$

5. Plot curves $|H(\omega)|$ vs ω
   ϕ vs ω

1. DETERMINE FREQUENCY Response of given ckt:





$X_C = 1/j\omega C$

(1)

$$\boxed{S = \sigma + j\omega}$$

(2) $H(\omega) = \dfrac{\cancel{Y}(\omega)}{X(\omega)}$

$$H(\omega) = \frac{V_o}{V_i}$$

$$V_o = V_{in}\left(\frac{Z_2}{Z_1 + Z_2}\right)$$

$$\Rightarrow V_{in}\left(\frac{1/j\omega C}{\frac{1}{j\omega C} + R}\right)$$

$$V_o \Rightarrow \left(\frac{1}{1 + j\omega CR}\right) V_{in}$$

$$\boxed{H(\omega) = \frac{1}{1 + Rj\omega C}}$$

$$H(\omega) = \frac{1}{1 + j\left(\omega/\omega_0\right)}$$

where

$$\omega_0 = \frac{1}{RC}$$

$$RC = \frac{1}{\omega_0}$$

$$H(\omega) = \frac{1 - j\left(\frac{\omega}{\omega_0}\right)}{1 + \left(\frac{\omega}{\omega_0}\right)^2}$$

$$|H(\omega)| = \frac{1}{1+\left(\frac{\omega}{\omega_0}\right)^2} - \frac{j\left(\omega/\omega_0\right)}{1+\left(\frac{\omega}{\omega_0}\right)^2}$$

$$|H(\omega)| = \sqrt{\left(\frac{1}{1+\left(\omega/\omega_0\right)^2}\right)^2 + \left(\frac{\left(\omega/\omega_0\right)}{1+\left(\omega/\omega_0\right)^2}\right)^2}$$

$$\Rightarrow \sqrt{\frac{1+\left(\omega/\omega_0\right)^2}{\left[1+\left(\omega/\omega_0\right)^2\right]^2}}$$

$$\boxed{|H(\omega)| \Rightarrow \frac{1}{\sqrt{1+\left(\frac{\omega}{\omega_0}\right)^2}}}$$

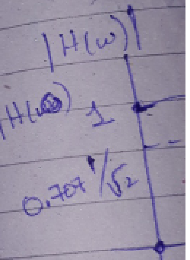
$$\phi = \tan^{-1}\left(\frac{-\left(\omega/\omega_0\right)/1+\left(\omega/\omega_0\right)^2}{1/1+\left(\omega/\omega_0\right)^2}\right)$$

$\phi = -\tan$

$\omega = 0$

$\omega = \infty$

$\omega = \omega_0$



0

−45°

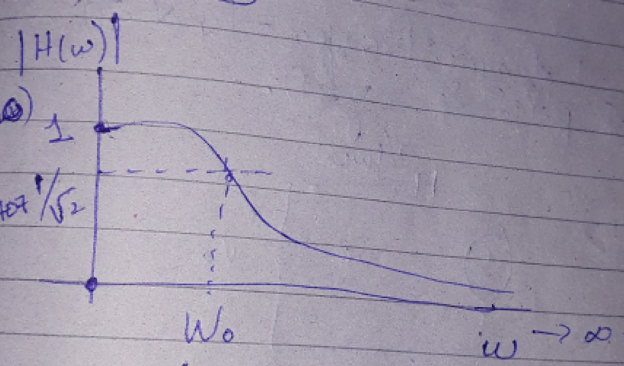
−90°

$$\boxed{\varphi = -\tan^{-1}\left(\omega/\omega_0\right)}$$

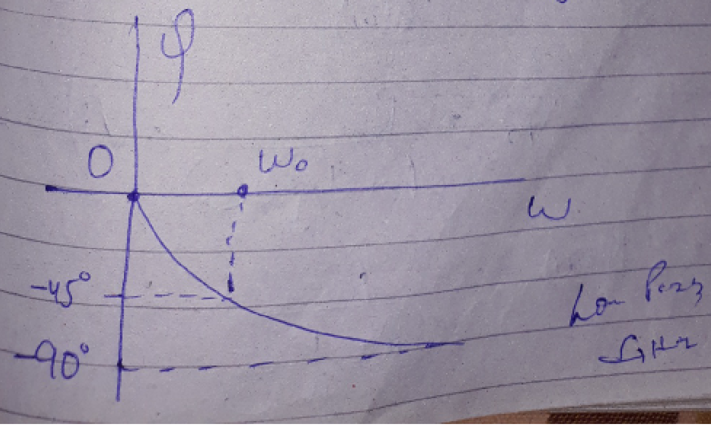
$\omega = 0$

$\omega = \infty$

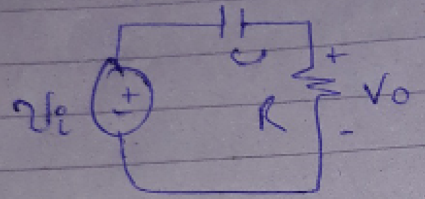
$\boxed{\omega = \omega_0}$



$\omega_0 =$ Critical frequency.

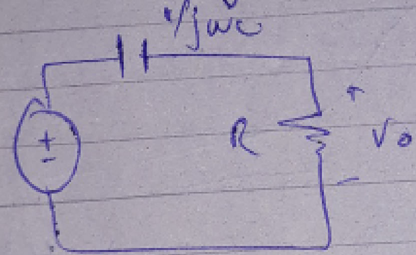


Frequency Response of CR, RL, LR:



Determine transfer function & poles & zero:

(1)



(2) $H(\omega) = \frac{Y(\omega)}{X(\omega)} = \frac{V_o}{V_i}$

$$V_o = \frac{R}{(R + 1/j\omega C)} \times (V_i)$$

$$H(\omega) \Rightarrow \frac{R}{R + \frac{1}{j\omega C}}$$

$H(\omega) \Rightarrow \frac{R}{Rj\omega}$

$|H(\omega)| \Rightarrow \sqrt{}$

$|H(\omega)| \Rightarrow$

LR:

$$\boxed{H(\omega) \Rightarrow \frac{Rj\omega C}{Rj\omega C+1}}$$

$$\Rightarrow \frac{\left(j\omega/\omega_0\right)}{\left(j\omega/\omega_0+1\right)}$$

$$\Rightarrow \frac{\cancel{1+}\left(\omega j/\omega_0\right)}{\left(1+j\omega/\omega_0\right)} \times \frac{\left(1-j\omega/\omega_0\right)}{\left(1-j\omega/\omega_0\right)}$$

$$\Rightarrow \frac{\omega j/\omega_0 + \omega^2/\omega_0^2}{1+\left(\frac{\omega}{\omega_0}\right)^2}$$

$$\Rightarrow \frac{\omega j/\omega_0}{1+\left(\omega/\omega_0\right)^2} + \frac{\omega^2/\omega_0^2}{1+\left(\omega/\omega_0\right)^2}$$

$$|H(\omega)| \Rightarrow \sqrt{\left(\frac{(\omega/\omega_0)^2}{1+(\omega/\omega_0)^2}\right)^2 + \left(\frac{\omega/\omega_0}{1+(\omega/\omega_0)^2}\right)^2}$$

$$|H(\omega)| \Rightarrow \sqrt{\frac{\left(\omega^2/\omega_0^2\right)^2 + \left(\omega/\omega_0\right)^2}{\left[1+\left(\omega/\omega_0\right)^2\right]^2}}$$

$$\Rightarrow \frac{(\omega/\omega_0)^2 \cancel{\sqrt{1+(\omega/\omega_0)^2}}}{\cancel{1+(\omega/\omega_0)^2}}$$

$$|H(\omega)| \Rightarrow (\omega/\omega_0)$$

$\omega = \infty$

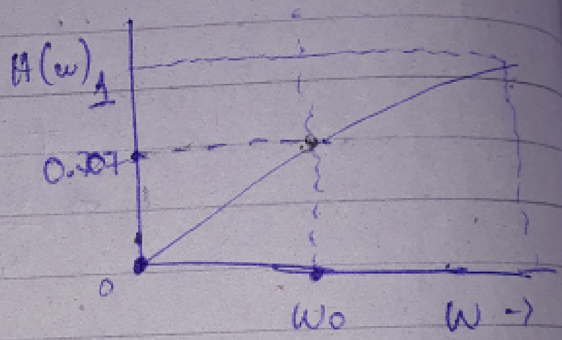
$$|H(\omega)| = \frac{\omega/\omega_0}{\sqrt{1+(\omega/\omega_0)^2}}$$

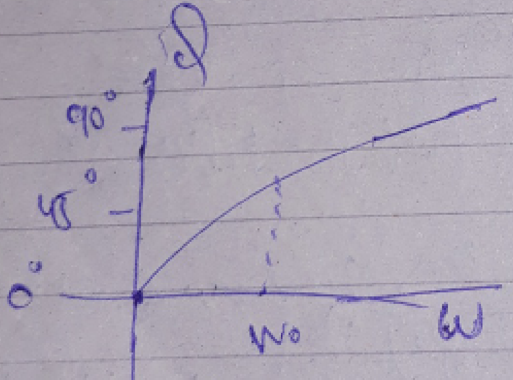
$$\frac{\omega/\omega_0}{\omega/\omega_0}$$

$\boxed{|H(\omega)| => 1}$

$$\theta => \tan^{-1}\left(\omega/\omega_0\right)$$

- $\omega = 0$
- $\omega = \infty$
- $\omega = \omega_0$





$\omega = 0$
$\omega = \omega_0$
$\omega = \infty$

High pass filter

$|H(\omega)| = 1$

$\left|\frac{V_0}{V_i}\right| = 1$

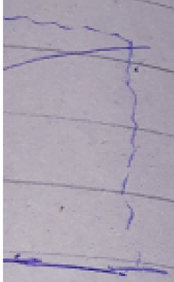
H.P.F

$V = \infty$

ω/ω_0

ω/ω_0

$\boxed{|H(\omega)| \Rightarrow 1}$



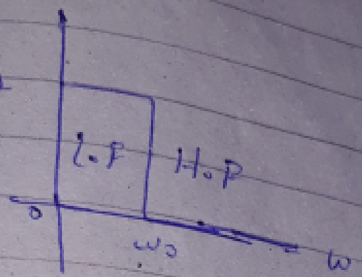
$\frac{1}{2}+\frac{1}{2}$

$\frac{1}{\sqrt{2}} = 0.707$

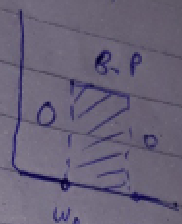
L.P.F

$|H(\omega)| = 1$

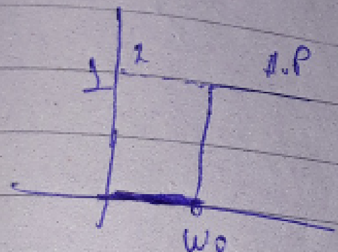
$\left|\frac{V_0}{V_i}\right| = 1$

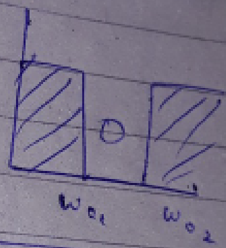


B.P.F



H.P.F





$\boxed{BW \Rightarrow \omega_{01} - \omega_{02}}$

$\omega/\omega_0 = 0$ $\omega = 0$ zero

$1 + j\,\omega/\omega_0 = 0$

$\omega_0 + \omega j = 0$

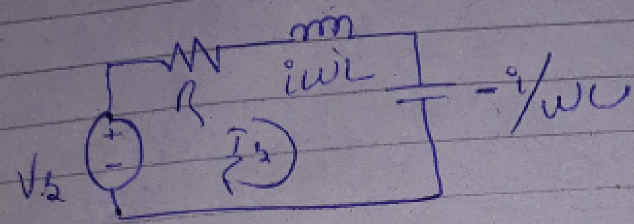
$\omega j = -\omega_0$

$\omega = -\omega_0/j$

$\Rightarrow -j\omega_0/j^2$

$\boxed{\omega \Rightarrow \omega_0}$ pole

Series RLC Response:



Resonance condition is occur at frequency $\omega = \omega_0$ where the $X_C = X_L$ & magnitude of impedance Z reduce to $Z = R$, the ckt current at Resonance frequency is max in ckt:

$$\frac{V_s(\omega)}{I_s(\omega)} = Z$$

$$= R + i\left(\omega L - \frac{1}{\omega C}\right)$$

at resonance frequency:

$$\omega L - \frac{1}{\omega C} = 0$$

$\frac{V_m}{\sqrt{2}R}$

$Z = R$

$$\omega L = 1/\omega C$$

$$\omega^2 = 1/LC$$

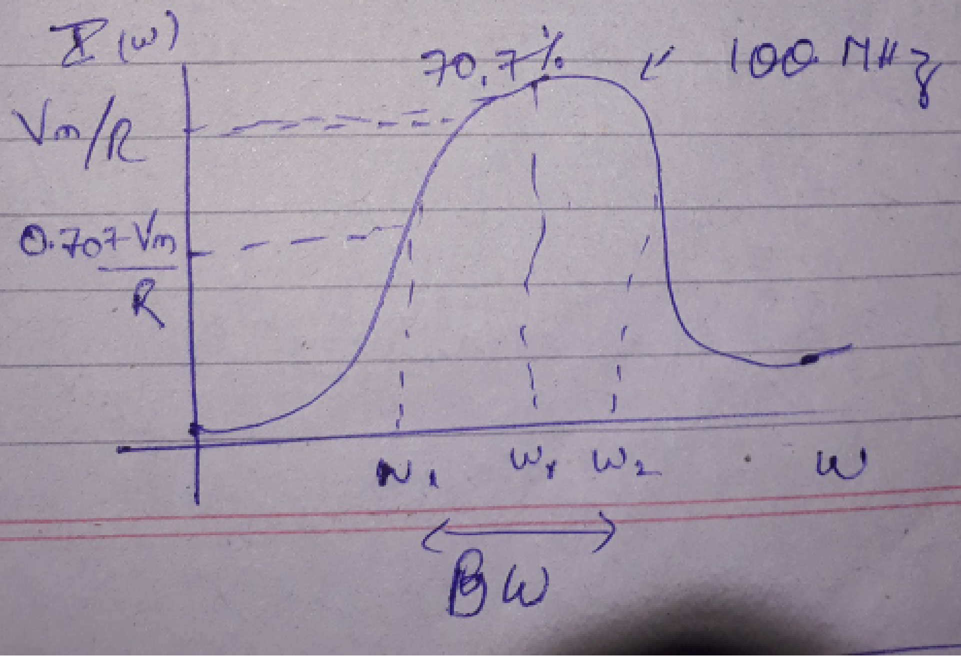
$$\boxed{\omega = 1/\sqrt{LC}}$$

$$\boxed{\omega_r = 1/\sqrt{LC}}$$

$$I(\omega) = \frac{V(\omega)}{Z}$$

$$= \frac{V(\omega)}{R + j\left(\omega L - \frac{1}{\omega C}\right)}$$

$$|I(\omega)| = \frac{|V(\omega)|}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$



∴ ω_1 & ω_2 are called cutoff ~~are called~~ ~~fa~~ or half power frequency

$$BW = \omega_2 - \omega_1$$

$$\boxed{\omega_r = \sqrt{\omega_1 \omega_2}}$$

- At ω_r the impedance is pure resistive so that the current & voltage are in phase & forms the power factor ~~is~~ to unity.

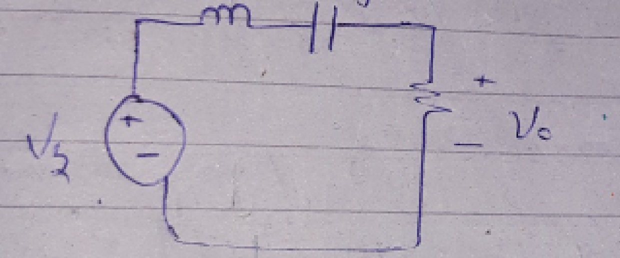
PASSIVE FILTER:

IDEAL RESPONSE

$\omega_0 = \sqrt{1/LC}$ $\omega_0 = 1/LC$

Filter type	$\|H(0)\|$	$\|H(\infty)\|$	$\|H(\omega_c)\|$
Low Pass	1	0	$1/\sqrt{2}$
High Pass	0	1	$1/\sqrt{2}$
Band pass	0	0	1
Band stop	1	1	0

1st order: Low Pass, High Pass
2nd order: Band pass, Band stop



$$\frac{V_o}{V_s} \Rightarrow \frac{R}{R + j\left(\omega L - \frac{1}{\omega C}\right)}$$

$$\Rightarrow \frac{R}{R + jL\left(\omega - \frac{1}{\omega LC}\right)}$$

$$\Rightarrow \frac{R}{R + jL\left(\omega - \frac{1}{\omega / \omega_0^2}\right)}$$

$$= \frac{R}{R + jL\left(\frac{\omega^2 - \omega_0^2}{\omega}\right)}$$

$$\Rightarrow \frac{1}{1 + j\,L/R\left(\frac{\omega^2 - \omega_0^2}{\omega}\right)}$$

$$\Rightarrow \frac{1 - j\,L/R\left(\frac{\omega^2 - \omega_0^2}{\omega}\right)}{1 + \left(L/R\left(\frac{\omega^2 - \omega_0^2}{\omega}\right)\right)^2}$$

$$\Rightarrow \frac{1}{1 + \left(\frac{L}{R}\left(\frac{\omega^2 - \omega_0^2}{\omega}\right)\right)^2} - \frac{j\,L/R\left(\frac{\omega^2 - \omega_0^2}{\omega}\right)}{1 + \left(\frac{L}{R}\left(\frac{\omega^2 - \omega_0^2}{\omega}\right)\right)^2}$$

$$|H(\omega)| = \sqrt{\left(\frac{1}{1 + \left(\frac{L}{R}\left(\frac{\omega^2 - \omega_0^2}{\omega}\right)\right)^2}\right)^2 + \left(\frac{L/R\,\frac{\omega^2 - \omega_0^2}{\omega}}{1 + \frac{L}{R}\left(\frac{\omega^2 - \omega_0^2}{\omega}\right)^2}\right)^2}$$

$$\sqrt{\frac{1 + \left(L/R\left(\frac{\omega^2 - \omega_0^2}{\omega}\right)\right)^2}{\left(1 + \left(\frac{L}{R}\left(\frac{\omega^2 - \omega_0^2}{\omega}\right)\right)^2\right)^2}}$$

$|H(\omega)| \Rightarrow \sqrt{1 \ldots}$

$\omega = 0$

$\omega = \omega_0$

$\omega = \infty$

$|H(0)| \Rightarrow 0$

$|H(\infty)| \Rightarrow 0$

$|H(\omega_0)| = \ldots$

$$|H(\omega)| \Rightarrow \sqrt{\frac{1}{1+\left(\frac{L}{R}\left(\frac{\omega^2-\omega_0}{\omega}\right)\right)^2}}$$

$\omega = 0$

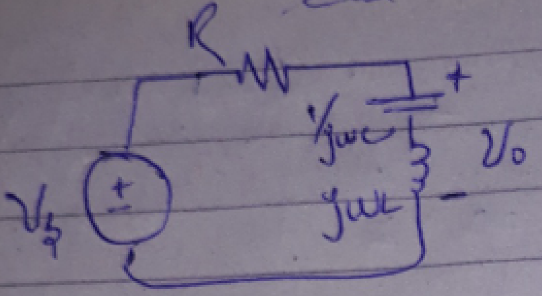
$\omega = \omega_0$

$\omega = \infty$

$|H(0)| \Rightarrow 0$

$|H(\infty)| \Rightarrow 0$

$|H(\omega_0)| \Rightarrow 1$

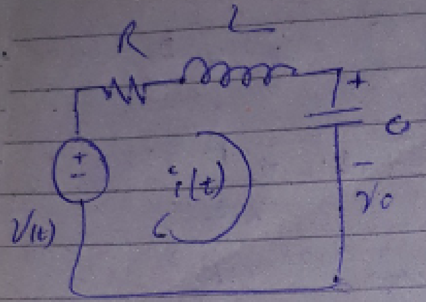


$$\frac{v_o}{v_s} = \frac{j(\omega L - 1/\omega C)}{R + j\left(\omega L - \frac{1}{\omega C}\right)}$$

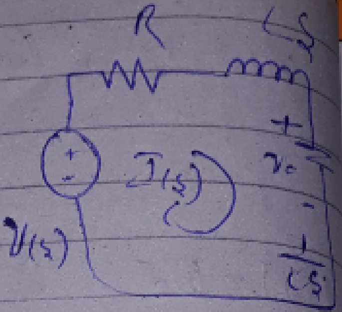
$$\Rightarrow \frac{j\left(\omega L - 1/\omega C\right)}{R + j\left(\omega L - \frac{1}{\omega C}\right)} \times \frac{R - j\left(\omega L - \frac{1}{\omega C}\right)}{R - j\left(\omega L - \frac{1}{\omega C}\right)}$$

$$\Rightarrow \frac{Rj\left(\omega L - \frac{1}{\omega C}\right) + \left(\omega L - \frac{1}{\omega C}\right)^2}{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

$$\Rightarrow Rj\left(\omega L - \frac{1}{\omega C}\right) + \left(\omega L - \frac{1}{\omega C}\right)^2$$



$\Rightarrow$



∴ Determine $V_o(t)$ when system is source free

$$-V(t) + iR + L\frac{di}{dt} + V_c = 0$$

$$L\frac{di}{dt} + iR + V_c = V(t) \qquad i_c = C\frac{dV}{dt}$$

$$LC\frac{d^2V_c}{dt^2} + RC\frac{dV_c}{dt} + V_c = V(t)$$

$$\frac{d^2V_c}{dt^2} + \frac{R}{L}\frac{dV_c}{dt} + \frac{1}{LC}V_c = \frac{1}{LC}V(t)$$

Source free

Part 2:

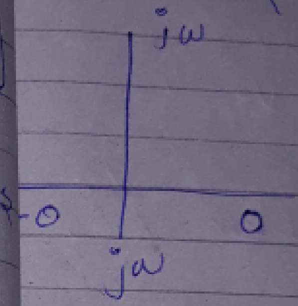
$$-V_s + I(s)R + I(s)LS + V_o = 0$$

$$I(s)(R + LS) + V_o = V_s$$

$\frac{\omega_o^2}{\omega_o^2} + \frac{\omega}{\omega_o}$

$\frac{\omega^2 + \omega_o}{\omega_o^2}$

· Circuit Ana...
Trans...

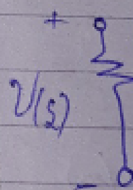


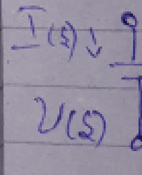
$$\boxed{S = \sigma + j\omega}$$

damping factor

complex

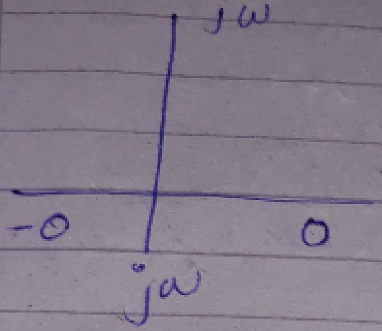
undamped natural freq

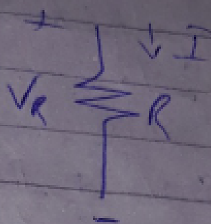




S-p

Circuit Analysis with Laplace Transfer:





$$\boxed{S = \sigma + j\omega}$$

damping factor

complex freq

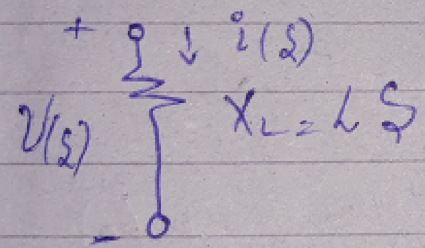
undamped natural freq

$V_R(t) = I(t) R$

$V(S) = I(S) R$

in Laplace

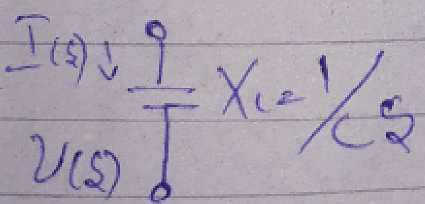
time signal ⇒ frequency signal



Initial condition are zero

$$V_L(t) = L\frac{di(t)}{dt} \xRightarrow{\mathcal{L}}$$

$$V_L(S) = \frac{LS}{I(S)}$$



$$i_C = C\frac{dV(t)}{dt} \xRightarrow{\mathcal{L}} I(S) = CSV(S)$$

$\therefore I_s = CsV_0$

$CsV_0(R+Ls) + V_0 = V_s$

$RCsV_0 + LCs^2V_0 + V_0 = V_s$

$\cancel{LC}\left(s^2V_0 + \frac{R}{L}sV_0 + \frac{V_0}{LC}\right) = \frac{V_s}{LC}$

$\frac{V_0}{V_s} = \left(s^2 + \frac{R}{L}s + \frac{1}{LC}\right) = \cancel{V_s}\frac{1}{LC}$

$\frac{V_0}{V_s} = \frac{1/LC}{\left(s^2 + \frac{R}{L}s + \frac{1}{LC}\right)}$

$\mathcal{L}\{d/d(t)\, f(t)\} = sF(s) + F(0)$

$\mathcal{L}\left\{\int f(t)\,dt\right\} = \frac{1}{s}F(s) + F(0)$

$i = C\frac{dv}{dt}$ $\qquad I(s) = CsV_0$

$\frac{V(t)}{I(t)} = X_L$ $\qquad \frac{V_L(s)}{I(s)} = Ls$

$X_L = j\omega L$ $\qquad X_C = 1/j\omega C$

$\mathcal{L}\{e^{-at}\} = \frac{1}{s+a}$ $\qquad e^{at} = \frac{1}{s-a}$

$H(s)$ = Transfer function.

$$H(s) = \frac{(s+Z_1)(s+Z_2)(s+Z_3)\ldots}{(s+P_1)(s+P_2)(s+P_3)\ldots}$$

$$= \frac{1}{(s+a_1)(s+a_2)} \Rightarrow \frac{A_1}{(s+a_1)} + \frac{A_2}{(s+a_2)}$$

Partial Fract

$$\Rightarrow \mathcal{L}^{-1}\left(\frac{A_1}{s+a_1}\right) + \mathcal{L}^{-1}\left(\frac{A_2}{s+a_2}\right)$$

$$\boxed{v_0 = A_1 e^{-a_1 t} + A_2 e^{-a_2 t}}$$

$$s = R/2L \pm \sqrt{\left(R/2L\right)^2 - \frac{1}{LC}}$$

$$s = \alpha \pm \sqrt{\alpha^2 - \omega_0^2}$$

$$v(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$$

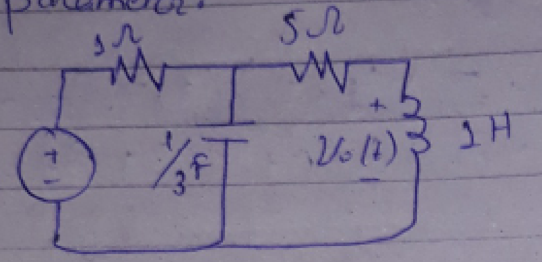
Laplace $\rightarrow s = \sigma + \omega j$ (continuous signals) (both)

Fourier $\rightarrow \omega = \omega j$

Z-Trans $\rightarrow Z = re^{j\omega}$ (Discrete signals)

• Determine the unknown ckt parameter:

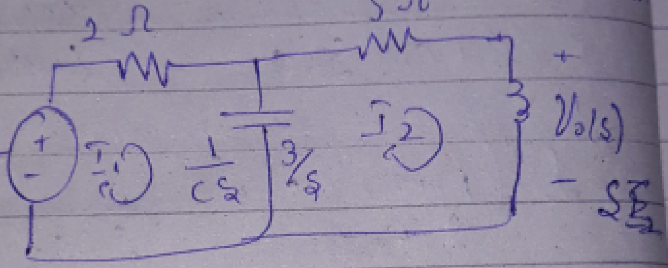
u(t)



time domain ⇌ freq domain

~~V_o~~ =

=> $\frac{1}{s}$



Applying KVL in loop 1:

$$-\frac{1}{s} + I_1 \times 1 + (I_1 - I_2)\frac{3}{s} = 0$$

$$\frac{1}{s} = I_1 + \frac{3}{s} I_1 - \frac{3}{s} I_2$$

$$\boxed{\frac{1}{s} = \left(1 + \frac{3}{s}\right) I_1 - \frac{3}{s} I_2} \longrightarrow (1)$$

App KVL in loop 2:

$$5I_2 + sI_2 + (I_2 - I_1)\frac{3}{s} = 0$$

$(5+s)I_2$

$\left(5+s+\frac{3}{s}\right.$

$s\left(s+5\right.$

$I_1 =$

$I_1 =$

Putting in

$\frac{1}{s} = ($

$\frac{1}{s} = \frac{5}{3}$

$\frac{1}{s} =$

$I_2 s$

• $V_L = L\frac{d}{}$

$V_L(s) = L s$

$V_L(s) = L$

$$(5+s)I_2 + \frac{3}{s}I_2 - \frac{3}{s}I_1 = 0$$

$$\left(5+s+\frac{3}{s}\right)I_2 = \frac{3}{s}I_1$$

$$s\left(s+5+\frac{3}{s}\right)I_2 = 3I_1$$

$$I_1 = \frac{s}{3}\left(s+5+\frac{3}{s}\right)$$

$$I_1 = \left(\frac{5}{3}s + \frac{s^2}{3} + 1\right)I_2$$

Putting in Eq (A)

$$\frac{1}{s} = \left(1+\frac{3}{s}\right)\times\left(\frac{5}{3}s + \frac{s^2}{3} + 1\right)I_2 - \frac{3}{s}I_2$$

$$\frac{1}{s} = \frac{5}{3}s + \frac{s^2}{3} + 1 + 5 + s + \cancel{\frac{3}{s}} - \cancel{\frac{3}{s}}\Big)I_2$$

$$\frac{1}{s} = \left(\frac{s^2+8s+18}{3}\right)I_2$$

$V_0 = I_2 s$

$$I_2 s = \frac{3}{s^2+8s+18}$$

$$\boxed{V_o = \frac{3}{s^2+8s+18}}$$

- $V_L = L\frac{di}{dt}$

$V_L(s) = Ls\,I(s) - L\,i(0)$ when $\boxed{i(0) = V}$

$V_L(s) = Ls$

$$v_0 = \frac{3}{s^2+8s+18}$$

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

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

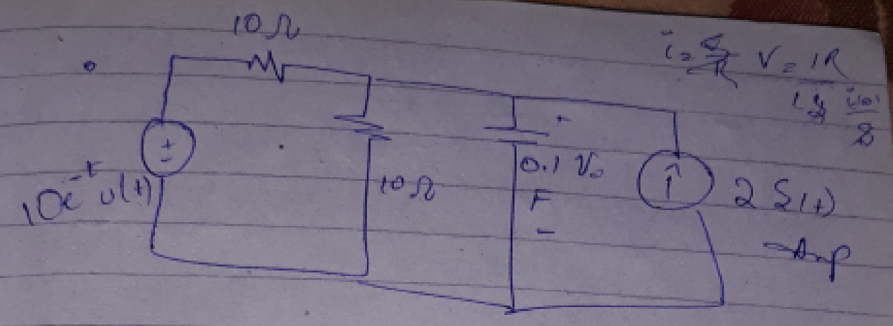
$$= \frac{3}{\sqrt{2}} \times \frac{\sqrt{2}}{(s+4)^2+(\sqrt{2})^2}$$

$$\because \mathcal{L}\{e^{-at}\sin bt\} \rightarrow \frac{b}{(s+a)^2+b^2}$$

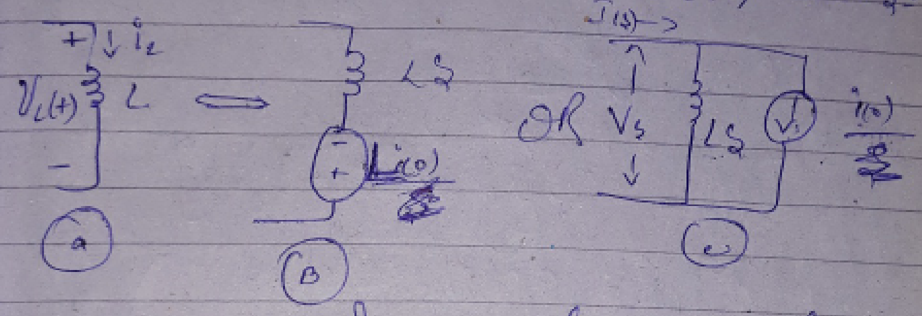
$$\mathcal{L}^{-1}\{v_0(s)\} = \mathcal{L}^{-1}\frac{3\sqrt{2}}{\sqrt{2}\,((s+4)^2+(\sqrt{2})^2)}$$

$$\boxed{v_0(t) = \frac{3}{\sqrt{2}} e^{-4t}\sin\sqrt{2}\,t}$$

Ans.



Determine V_0 when $V_c(0) = 5$ volts.



$$v_L = L\frac{di}{dt} \quad \therefore \quad \mathcal{L} v_L = L\mathcal{L}\frac{di}{dt}$$

$$V_L(s) = L\left[sI(s) - i(0)\right]$$

$$\boxed{V_L(s) = LsI(s) - Li(0)}$$

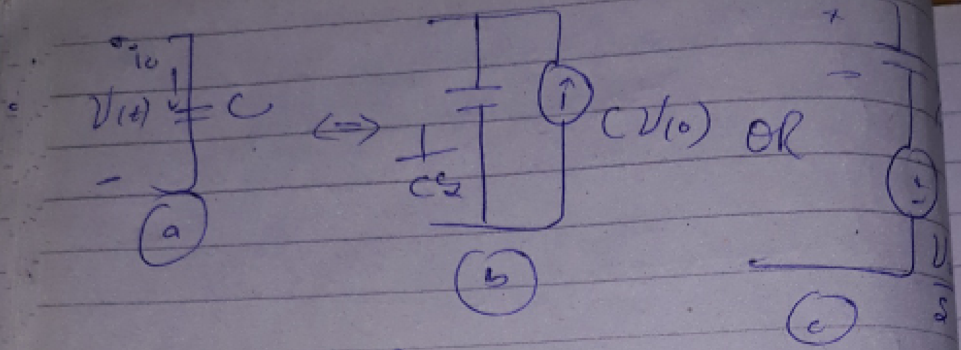
⇒ refer to fig (b)

Or:

$$V_L(s) + Li(0) = LsI(s)$$

$$\boxed{\frac{V_L}{Ls} + \frac{i(0)}{s} = I(s)}$$

reference to fig (c)



$$i_c = C\frac{dv}{dt}$$

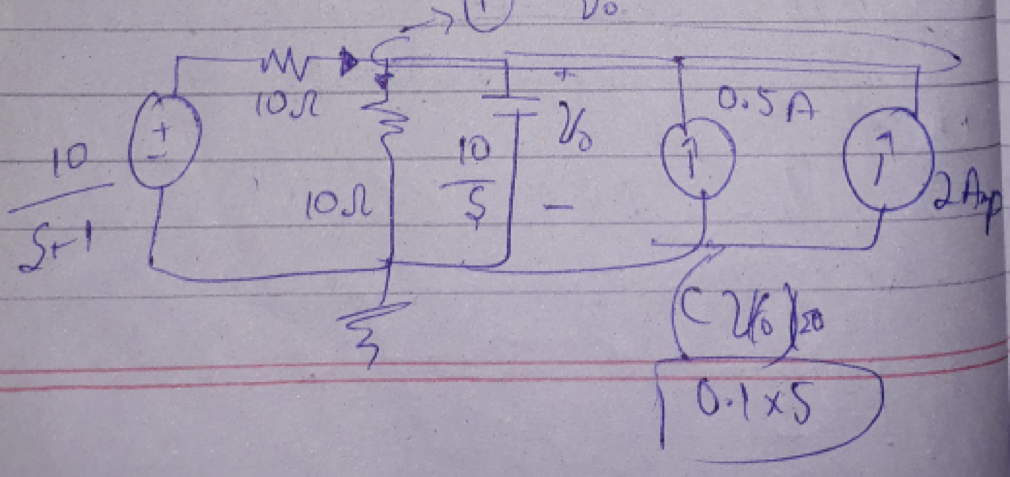
$$\mathcal{L}\, i_c = C\mathcal{L}\left\{\frac{dv}{dt}\right\}$$

$$I(s) = C\left[sV(s) - V(0)\right]$$

$$\boxed{I(s) = CsV(s) - CV(0)} \text{ OR } (b)$$

$$I(s) + CV(0) = CsV(s)$$

$$\boxed{\frac{I(s)}{Cs} + \frac{V(0)}{s} = V(s)} \rightarrow (c)$$



$\mathcal{L}$ Applying KCL at Node (1)

$$\frac{\frac{10}{s+1} - V_0}{10} + 0.5 + 2 = \frac{V_0}{10} + \frac{10}{s}$$

$$\frac{10/(s+1)}{10} - \frac{V_0}{10} + 0.5 + 2 = \frac{V_0}{10} + \frac{10}{s}$$

$$\frac{1}{s+1} + 0.5 + 2 - 10/s = \frac{V_0}{10} + \frac{V_0}{10}$$

$$1/(s+1) + 2.5 - 10/s = V_0/5$$

$$\Rightarrow \frac{s + 2.5s(s+1) - 10(s+1)}{(s+1)(s)} = \frac{V_0}{5}$$

$$\Rightarrow \frac{s + 2.5s^2 + 2.5s - 10s - 10}{(s+1)s} = \frac{V_0}{5}$$

$$\Rightarrow \frac{2.5s^2 - 6.5s - 10}{(s+1)s} = \frac{V_0}{5}$$

$$\Rightarrow V_0 = \frac{12.5s^2 - 32.5s - 50}{(s+1)s}$$

$$\Rightarrow \frac{5}{2}\left[\frac{5s^2 - 13s - 20}{(s+1)s}\right]$$

$$= \frac{5}{2}\left\{ s - \frac{(18s+20)}{s(s+1)} \right\}$$

$$\begin{array}{r|l} & 5 \\ s^2+s & 5s^2 + 13s - 20 \\ & \cancel{5s^2} \pm 5s \\ \hline & -18s - 20 \end{array}$$

$$\Rightarrow \frac{5}{2}\left[s - f(x) \right]$$

$$f(x) = \frac{A}{s} + \frac{B}{s+1}$$

$$\frac{18s+20}{s(s+1)} = \frac{A(s+1) + B(s)}{s(s+1)}$$

$$\boxed{18s + 20 = A(s+1) + B(s)}$$

when $s = 0$

$\Rightarrow \frac{5}{2}$

$\Rightarrow \frac{5}{2}$

$$\Rightarrow \frac{5}{2}\left[s - \left\{ \frac{20}{s} + \frac{2}{s+1} \right\} \right]$$

$$\Rightarrow \frac{5}{2}\left\{ 5\delta(t) - 20u(t) - 2e^{-t}u(t) \right\}$$

- I/f:
  - $1 \Rightarrow \delta(t)$
  - $1/s \Rightarrow u(t)$
  - $1/(s+a) \Rightarrow e^{at}u(t)$

ELECTRICAL NETWORK ANALYSIS

ELECTRIC CKT	MAGNETIC CKT
E.M.F	M.M.F
Current	magnetic flux
Resistence	Reluctance
$V = IR$	$mmf = \phi R$

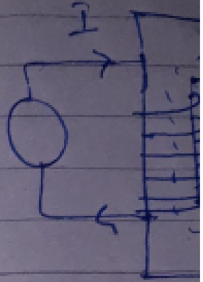
MMF:

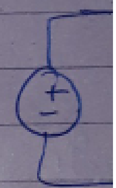
Magneto motive force - It is like emf, mmf is responsible to establish magnetic flux in core.

Mathematically

$$m.m.f = N.I$$

where "N" is the number of Turns of Coils 'I' amount of current (A) - unit of m.mf is A.T Ampere-Turns-





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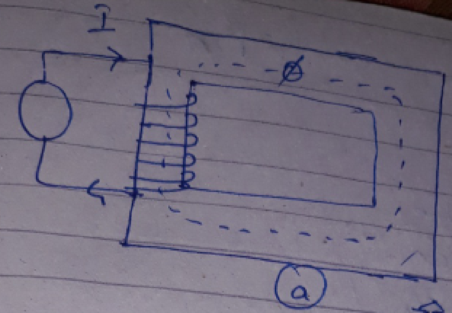
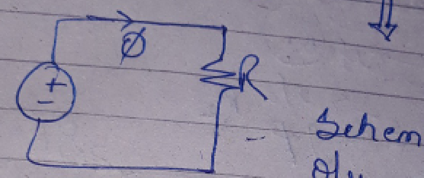


$\Updownarrow$



- Schematic Representation of diagram (a)

in terms of ohms law for magnetic ckt-

$$\boxed{mmf = \phi R}$$

where

ϕ is the magnetic flux (web)

R is Reluctance offered in establishment of magnetic flux Unit AT/web.

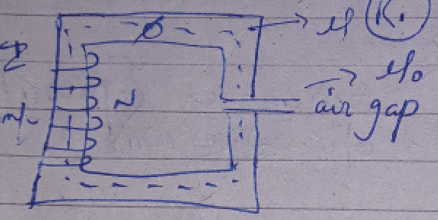
$R = \frac{l}{\mu A}$ $R = \rho l / A$, $C = \frac{\varepsilon A}{d}$

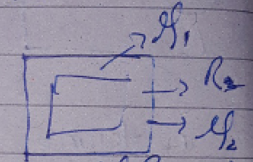
Permeability

μ_r = relative

μ_0 = free

$\boxed{\mu = \mu_0 \mu_r}$





$mmf = \phi (R_1 + R_2)$

* Magnetic flux density (B)

$B = \frac{\phi}{A}$ (web/m²)

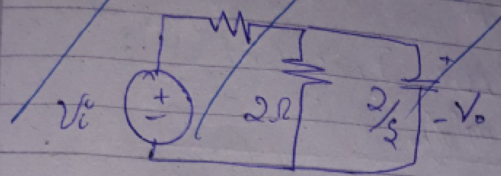
* MAGNETIC FLUX DENSITY (H)

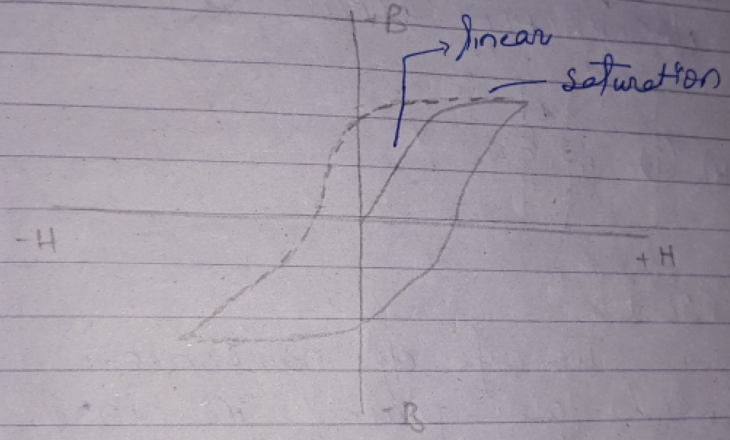
$H = \frac{mmf}{l}$ AT/m

$\boxed{B = \mu H}$

$C = \frac{\varepsilon A}{d}$

~~RESPONSE OF RLC CKT. USING LAPLACE~~





R_2

$1/2$

2)

• MAGNETIC FLUX DENSITY (B):

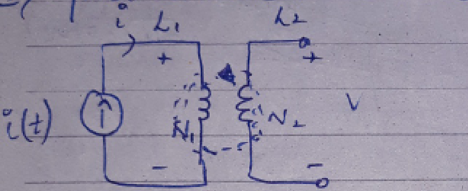
$$B = \Phi/A = wb/m^2$$

• MAGNETIC FLUX INTENSITY (H):

$$H = mmf/l$$

---x---

=> MAGNETICALLY COUPLED CKT:



CASE I:

Two coils of inductance L_1 & L_2 are placed in close ~~or~~ contact, first coil (Primary coil) excited with $i(t)$ time varying current causes magnetic flux in primary winding as secondary is very in close contact; the flux also energise secondary coil –

$$\phi_1 = \phi_{11} + \phi_{12}$$

ϕ_{11} is magnetic flux due to primary coil present in primary.

ϕ_{12} '' '' secondary

ϕ_1 is the

• Now A/c

$\therefore V_1 = N_1 \frac{d}{d}$

so $V_1 =$

$\therefore V_2 = N_2 \frac{d}{d}$

so V_2

(where

in se

coil fl

ϕ_{12} " " "secondary coil" " "

Secondary.

ϕ_1 is the total magnetic flux.

• Now A/c to FARADAY'S LAW:

$\therefore V_1 = N_1 \frac{d\phi_{11}}{dt}$ & $V_1 = \frac{d\phi_{11}}{di_1} \times \frac{di_1}{dt}$

So $V_1 = L \frac{di}{dt}$ where $L = N \frac{d\phi}{dt}$

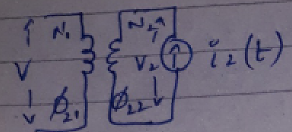
(Self Inductance)

$\therefore V_2 = \frac{N_2 d\phi_{12}}{dt}$ & $V_2 = \frac{d\phi_{12}}{di_2} \times \frac{di_2}{dt}$

So $V_2 = \frac{M_{21} di_2}{dt}$

(where M_{21} is the Mutual Inductance in Secondary coil due to primary coil flux)

(H):



$M = M_{12} = M_{21}$ called the Mutual inductance of two coils

CASE : II :

From the fig

$\therefore V_2 = N_2 \frac{d\phi_{22}}{dt}$ & $V_2 = N_2 \frac{d\phi_{22}}{di_2} \times \frac{di_2}{dt}$

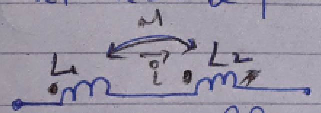
so $V_2 = L_2 \frac{di_2}{dt}$

$\therefore V_1 = N_1 \frac{d\phi_{21}}{dt}$ & $V_1 = N_1 \frac{d\phi_{21}}{di_2} \times \frac{di_2}{dt}$

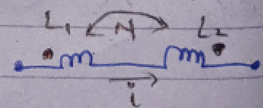
so $V_1 = M_{12} \frac{di_2}{dt}$

TOTAL INDUCTANCE:

$L_1 + L_2 = 2M$ = Total Inductance.



Series adding



Series opposing

$L_1 + L_2 = -2M$ = Total Inductance

Coupling

$M = K\sqrt{\ }$

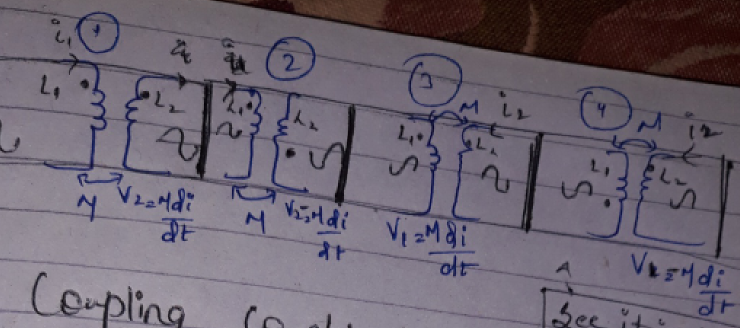
if $K < 0$

if $K = 1$

if $K > 1$

Q: Deter

$12\angle 0°$



See it in book clearly

Coupling co-efficient K

$M = K\sqrt{L_1 L_2}$ when $0 < K < 1$

If $K < 0.5$ (loose coupled coil)

If $K = 1$ (Perfect coupled coil)

If $K > 0.5$ (tightly coupled coil)

Q: Determine I_1 & I_2