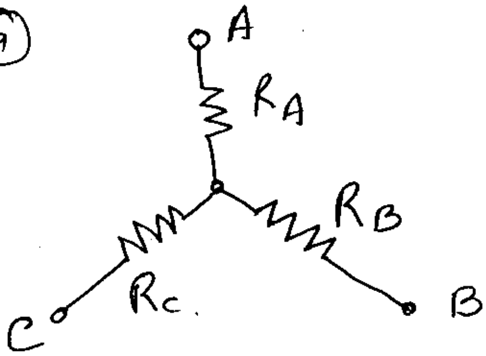
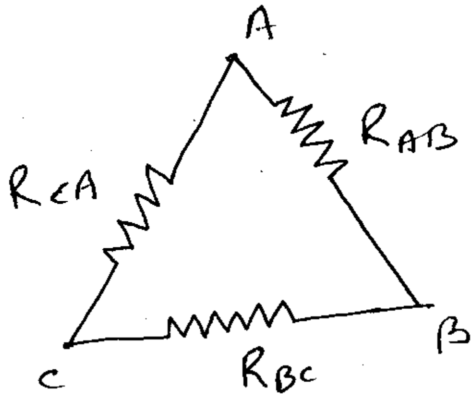
Ans. 3 (a)





The two systems will be equivalent if the resistances measured between any pair of lines is same in both the systems.

→ Resistances between terminals A & B,

$$R_A + R_B = \frac{R_{AB}(R_{CA} + R_{BC})}{R_{AB} + R_{BC} + R_{CA}} \quad \text{— (I)}$$

→ similarly, resistances b/w terminals B, C & C and A are

$$R_B + R_C = \frac{R_{BC}(R_{CA} + R_{AB})}{R_{AB} + R_{BC} + R_{CA}} \quad \text{— (II)}$$

and, $$R_C + R_A = \frac{(R_{AB} + R_{BC})R_{CA}}{R_{AB} + R_{BC} + R_{CA}} \quad \text{— (III)}$$

Add eqs. (I), (II) and (III), we get

$$R_A + R_B + R_C = \frac{R_{AB}R_{BC} + R_{BC}R_{CA} + R_{CA}R_{AB}}{R_{AB} + R_{BC} + R_{CA}}$$

On substracting eqs. (II), (III) and (I) we get

$$R_A = \frac{R_{AB}R_{CA}}{R_{AB} + R_{BC} + R_{CA}} \quad \text{— (a)}$$

$$R_B = \frac{R_{AB} R_{BC}}{R_{AB} + R_{BC} + R_{CA}} \quad \text{— (b)}$$

and $$R_C = \frac{R_{BC} R_{CA}}{R_{AB} + R_{BC} + R_{CA}} \quad \text{— (c)}$$

from eq. (a), (b) (c)

$$R_A R_B + R_B R_C + R_C R_A = \frac{R_{AB} R_{BC} R_{CA}}{R_{AB} + R_{BC} + R_{CA}} \quad \text{— (d)}$$

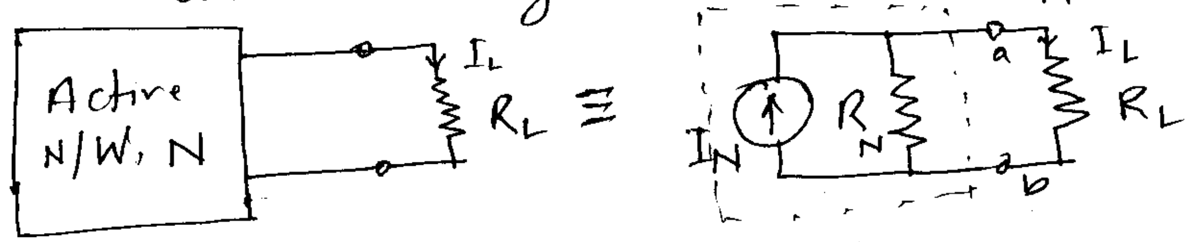
Dividing eq. (d) by eq. (c), (a) and (b) respectively, we get

$$R_{AB} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_C}$$

$$R_{BC} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_A}$$

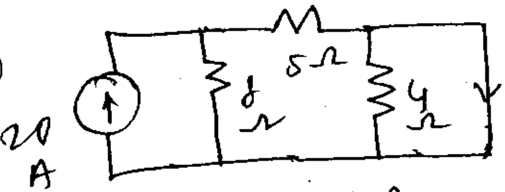
and $$R_{CA} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_B}$$

Norton's Theorem:- A linear 2- terminal active dc network N consisting of independent and or/dependent voltage and current source and resistors can be replaced at a pair of terminals a-b by equivalent network consisting of a single current source I_N in parallel with a single resistor R_N.



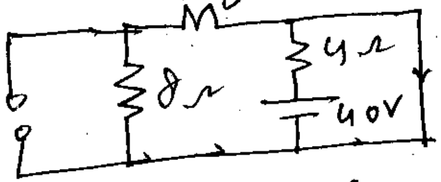
Ans 3 (b) Using superposition theorem.

(i)



$I_{sc1} = 20 \times \frac{8}{8+5} = \frac{160}{13}$ A

(ii)

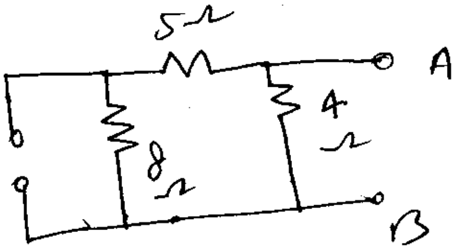


I_{sc2} $I_{sc2} = \frac{40}{4} = 10$A

[current through 5 Ω & 8 Ω resistors will be 0]

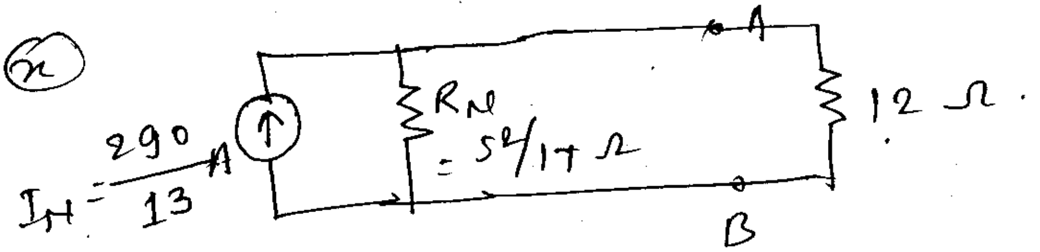
$\therefore$ $I_N = I_{sc1} + I_{sc2} = \frac{290}{13}$ A

for R_N :



$R_N = 4 \| 13$
$= \frac{52}{17}$ Ω

$\therefore$ (x)

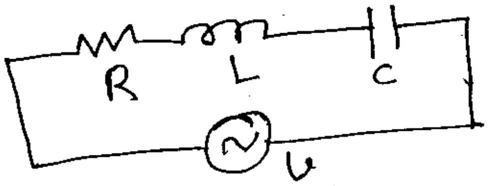


(y) Max. power provided to R

$= \frac{V_{Th}^2}{4 R_L}$ as $V_{Th} = \frac{290}{13} \times \frac{52}{17}$
and $R_L = R = 12$ Ω

$= 21.437$ KW

Ans 4 (a) Series resonance



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

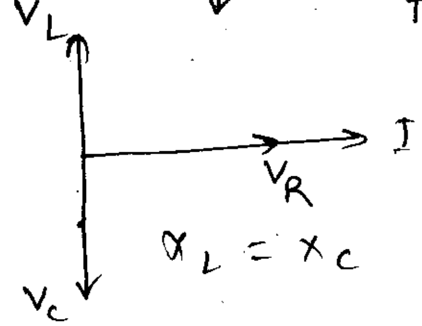
At freq. f_r of applied voltage v,

$X_L = X_C$

$\therefore 2\pi f_r L = \dfrac{1}{2\pi f_r C}$

<u>Phasor diagram</u> :

$\therefore f_r = \dfrac{1}{2\pi}\dfrac{1}{\sqrt{LC}}$ → resonant freq.



$X_L = X_C$

where $V = IR$

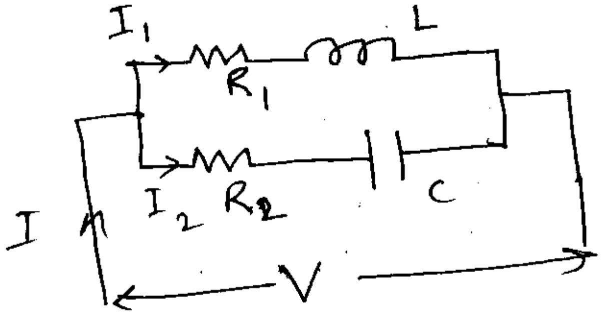
$V_C = IX_C$ & $V_L = IX_C$

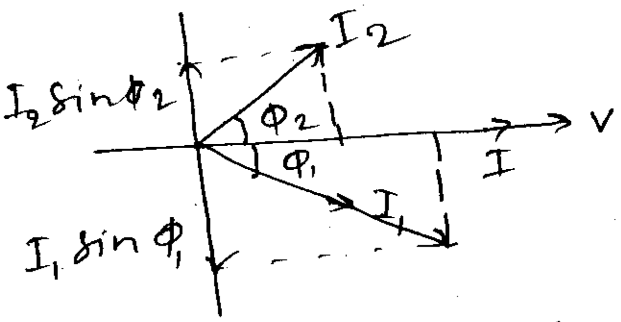
if $X_L > R$ or $X_C > R$

$V_L > V$ or $V_C > V$, applied volt.

∴ called Voltage Resonance.

<u>Parrallel Resonance</u> :→





CKt. will be in resonance when net Reactive component of current = 0.

$$\Rightarrow \quad I_1 \sin\phi_1 = I_2 \sin\phi_2 \qquad — (1)$$

as $I_1 = \dfrac{V}{\sqrt{R_1^2 + (\omega L)^2}}$, $\sin\phi_1 = \dfrac{\omega_r L}{\sqrt{R_1^2 + (\omega_r L)^2}}$

$I_2 = \dfrac{V}{\sqrt{R_2^2 + \left(\frac{1}{\omega_r C}\right)^2}}$, $\sin\phi_2 = \dfrac{1/\omega_r C}{\sqrt{R_2^2 + \left(\frac{1}{\omega_r C}\right)^2}}$

Putting these value in eq (1), we get

$$f_r = \frac{1}{2\pi\sqrt{LC}}\sqrt{\frac{CR_1^2 - L}{CR_2^2 - L}} \quad \text{as } \omega_r = 2\pi f_r$$

If $R_1 = R_2 = 0$. then $f_r = \frac{1}{2\pi\sqrt{LC}}$

Line current $I = I_1 \cos\phi_1 + I_2 \cos\phi_2$

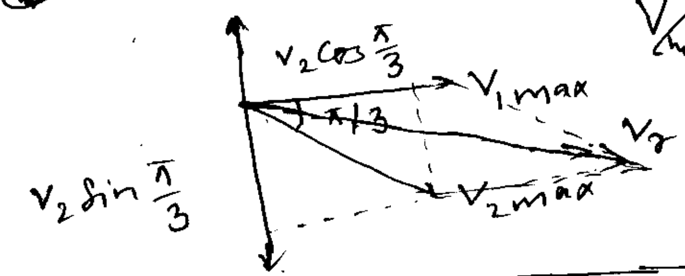
$= \frac{V}{(L/RC)}$

Similarities and dissimilarities:—

Under resonance condition:—

	Series Resonance	Parallel Resonance
(i)	$Z = R$, minimum,	$Z = L/CR$, maximum.
(ii)	$I = V/R$, max.	$I = \frac{V}{L/CR}$, min
(iii)	p.f = 1	p. f = 1
(iv)	$f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}$	$f_r = \frac{1}{2\pi\sqrt{LC}}\sqrt{\frac{CR_1^2 - L}{CR_2^2 - L}}$
(v)	Magnification in voltage	Magnf. in current
(vi)	Bandwidth $= \frac{R}{2\pi L}$ Hz	, B.W $= \frac{R}{2\pi L}$ Hz.

Ans 4 (b)



$V_{max} = \sqrt{60+}$

as $V_{1max} = 60$

$V_{2max} = 40$

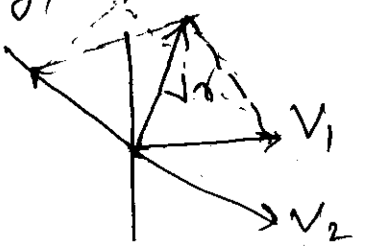
$V_{rmax} = \sqrt{\left(V_{1m} + V_{2m}\cos\frac{\pi}{3}\right)^2 + \left(V_{2max}\sin\frac{\pi}{3}\right)^2}$

$= 87.178\,V$

$$\phi = \tan^{-1}\left(\frac{-V_{2m}\sin\frac{\pi}{3}}{V_{1m} + V_{2m}\cos\frac{\pi}{3}}\right) = -0.13\,\pi \text{ radian}$$

$\therefore\ V_r = 87.178 \sin(\omega t - 0.13\pi)$

Similary, for diff. $V_r = 52.915 \sin(\omega t + 0.227\pi)$



Ans 5 (a) Principle depends upon Magnetic, electrostatic, Electromagnetic induction, chemical and thermal effects.

Torques. (i) Deflecting (ii) Controlling (iii) Damping.

(i) Deflecting torque → T_d

— In PMMC $T_d = B i l N r$

$\Rightarrow T_d \propto i$

— In M.I, $T_d = \frac{1}{2} I^2 \frac{dL}{d\theta}$

— In Dynamomt. Ins. $T_d \propto i_f\, i_m$.

(ii) Controlling → spring control, → Gravity control.

(iii) Damping → air friction, → fluid friction, → Eddy current

{Note: Explain every term in brief).

Ans 5 (b)

(i) $C = \frac{I_c}{2\pi f V}$ as $I_c = I\cos\phi_1(\tan\phi_1 - \tan\phi_2)$

as $\cos\phi_1 = 0.4$

& $\cos\phi_2 = 1$

$I = 0.75\,A$

$\therefore C = 8.752\ \mu F$ Ans

(ii) Similarly, for p.f = 0.92 lagging

$\cos\phi_1 = 0.4$

$\cos\phi_2 = 0.92$

$\therefore C = 7.125\ \mu F$ Ans.

Ans 6 (a) MMF: magnetic potential that drives or tends to drive flux. mmf = NI (AT)

(b) Flux density: magnetic flux passing per unit area $B = \frac{\Phi}{A}$; Wb/m^2 or T.

Reluctance - property of material opposes the creation of magnetic flux. $S = \frac{l}{\mu_0 \mu_r A}$

unit AT/Wb.

Permeability :- Receptiveness of the material of having magnetic flux developed.

$\mu = \frac{B}{H}$ $[\mu = \mu_0 \mu_r]$.

	Magnetic ckt	Electric ckt
(i) Driving force →	$MMF = \Phi S$	$emf = iR$
(ii) Response	$\Phi = \frac{mmf}{S}$	$i = \frac{emf}{R}$
(iii)	$S = \frac{l}{\mu_0 \mu_r A}$	$R = \rho \frac{l}{A}$
(iv)	$B = \mu H$	$J = \frac{E}{\rho}$
(v)	$H = \frac{mmf}{l}$	$E = \frac{V}{l}$
(vi)		

Ans 6 (b) $\eta = \dfrac{x V_2 I_2 \cos\phi}{x V_2 I_2 \cos\phi + P_i + x^2 P_c}$

at full-load $x = 1$.

$\therefore \quad 0.98 = \dfrac{200 \times 0.8}{200 \times 0.8 + P_i + P_c}$

$\therefore \quad P_i + P_c = 3.265$ KW — (I)

At max. eff. $x^2 P_c = P_i \Rightarrow \left(\frac{3}{4}\right)^2 P_c = P_i$ — (II)

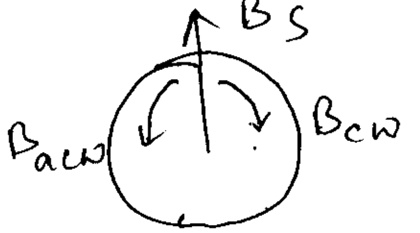
from (I) & (II) $P_i = 1.175$ KW

$P_c = 2.09$ KW

At half load, ($x = \frac{1}{2}$) $\eta_{1/2} = \dfrac{\frac{1}{2} \times 200 \times 0.8}{\frac{1}{2} \times 200 \times 0.8 + P_i + \frac{1}{4} P_c}$

$= 97.92\ \%$ Ans

Ans. 7 (a) Single phase induction motor has one phase on the stator winding. When supply is given, a pulsating magnetic field is produced. This pulsating magnetic field is not rotating. At zero speed net torque is ~~zero~~ zero.



$B_s \rightarrow$ Pulsating magnetic fd.

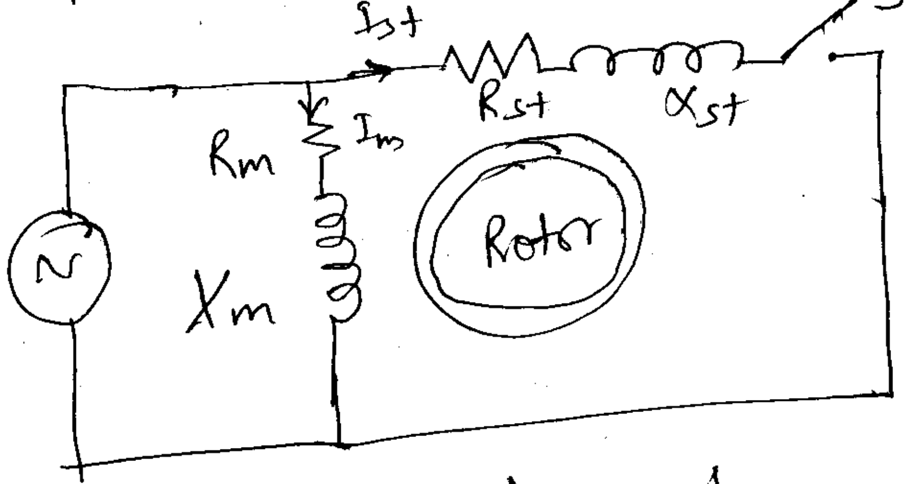
$B_{cw} \rightarrow$ clockwise magnetic fd

$B_{acw} \rightarrow$ Anticlockwise mag. fd.

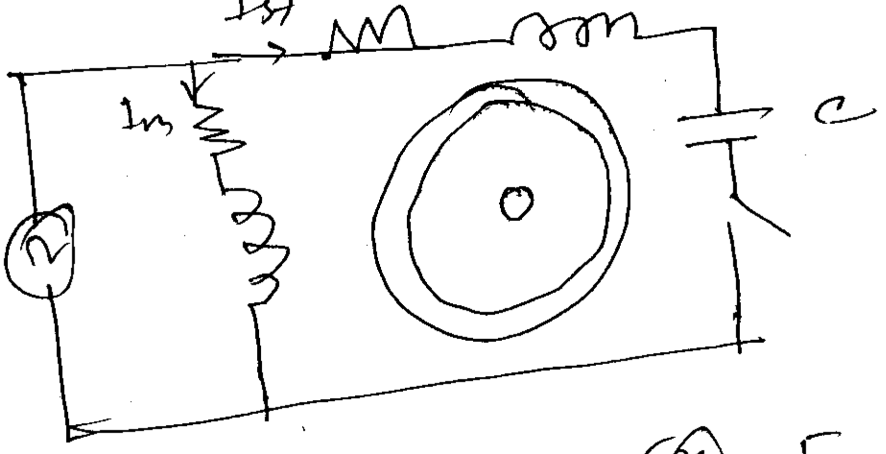
Continue .. 7 (a) (v)

Method of starting

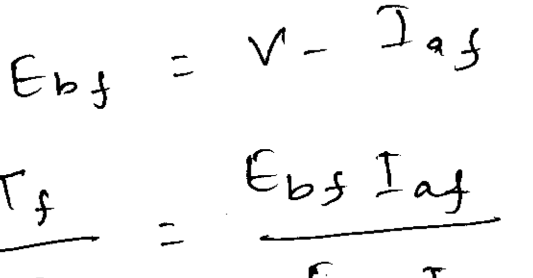
(i) split phase motor



(ii) capacitor start motor



Ans 7 (b)



(x) $E_{bo} = V - I_{ao} R_a$

$= 230 - 10 \times 0.1$

$= 229\,V$ Ans

$E_{bf} = V - I_{af} R_a = 230 - 100 \times 0.1$

$= 220\,V$ Ans

(y) $$\frac{T_f}{T_o} = \frac{E_{bf} I_{af}}{E_{bo} I_{ao}} \times \frac{N_o}{N_f}$$

$$= \frac{220 \times 100 \times 1500}{229 \times 10 \times 1470}$$

$= 9.8$ Ans

(g) $E_g = V + I_a R_a = 220 + 100 \times 0.1$

$= 230V$

$$\therefore N_g = N_f \frac{E_g}{E_{bf}} \times \frac{\Phi_m}{\Phi_g}$$

$$= 1470 \times \frac{230}{220} \times 1 =$$

$= 1536.8$ rpm.