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EE

Q1 (a) For mesh ADEFGA (using Kirchoff's voltage law)

$-(I_1-I_2)1 + V_x - (I_1-I_3)5 + 12 = 0$

or, $V_x+12 = (I_1-I_2) + (I_1-I_3)5$

$V_x+12 = 6I_1 - I_2 - 5I_3$ — ①

For mesh CHED

$-4I_3 - 5(I_3-I_1) - V_x - (I_3-I_2)3 = 0$

$-V_x = 4I_3 + 5I_3 - 5I_1 + 3I_3 - 3I_2 = 0$

or $-V_x = 12I_3 - 5I_1 - 3I_2 = 0$ — ②

In Mesh BCDA

$-2I_2 - 3(I_2-I_3) - (I_2-I_1)1 = 0$

$-6I_2 + I_1 + 3I_3 = 0$

or $I_1 - 6I_2 + 3I_3 = 0$ — ③

Adding ① and ② — ④

$12 = I_1 - 4I_2 + 7I_3$

The current relation between the source current and mesh current $I_s = I_1 - I_3$ → ⑤

or, $4 = I_1 - I_3$

eqn ③ is multiplied by ② and ④ is multiplied by three and then add

$2I_1 - 12I_2 + 6I_3 = 0$

$+36 = 3I_1 - 12I_2 + 21I_3$

$-\quad -\quad +\quad -$

$-I_1 - 15I_3 = -36$

or, $I_1 + 15I_3 = 36$ — ⑥

from ⑤ $I_1 + 15I_3 = 36$

$I_1 - I_3 = 4$

$-\quad +\quad -$

Sh

or, $16 I_3 = 32$

$I_3 = 2\,A$

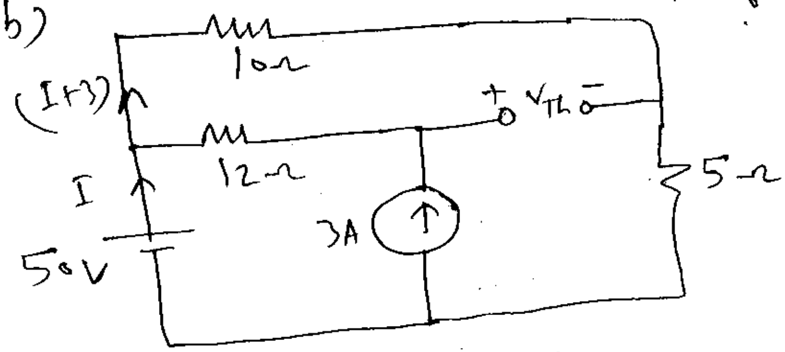
$I_1 = 6\,A$

putting I_1 and I_3 in above eqn (4)

$I_2 = 2\,A.$

For finding V_{Th} ckt will be as

1 (b)



using KVL in outer loop

$15(I+3) - 50 = 0$

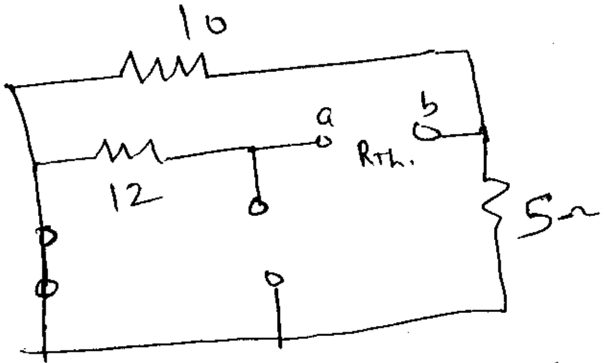
$I = 10/3 - 3 = 1/3\,A$

$10(I+3) - V_{Th} + 12\times 3 = 0$

$V_{Th} = 36 + 10(I+3) = 36 + 10(1/3 + 3)$

$= \frac{208}{3}$ volts $= V_{Th}$.

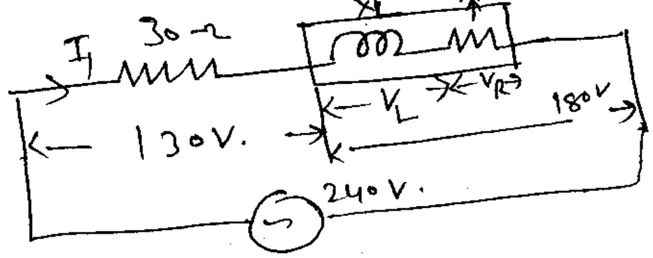
for R_{Th}

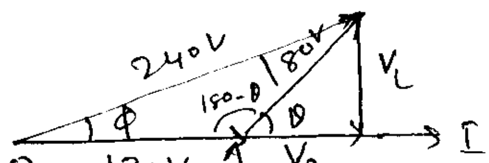


$R_{Th} = \left(\frac{10\times 5}{10+5}\right) + 12 = 46/3$

$I_L = \frac{208/3}{\frac{46}{3}+2} = 4\,A$

Q 2 (a)





Power absorbed by Coil

$P = 180\, I \cos\theta$

Soln (Part B)

Q2 Contd:

$= 180 \times 4.33 \times \cos\theta$

$\cos\theta$ from Laws of Δ

$$\cos(180-\theta) = \frac{130^2 + 180^2 - 240^2}{2 \times 130 \times 180}$$

$$-\cos\theta = \frac{130^2 + 180^2 - 240^2}{2 \times 130 \times 180}$$

$$\cos\theta = \frac{240^2 - 130^2 - 180^2}{2 \times 130 \times 180} = 0.177 \text{ lags}$$

$$V_L = 180 \sin\theta = 180\sqrt{1-\cos^2\theta} = 177.16$$

$$X_L = V_L/I = \frac{177.16}{4.33} = 40.9\,\Omega$$

$$L = \frac{X_L}{2\pi f} = \frac{40.9}{2\pi \times 50} = 0.13\text{ H.}$$

$$V_R = 180\cos\theta = 180 \times 0.177 = 31.86\text{ V}$$

$$R = V_R/I = \frac{31.86}{4.33} = 7.36\,\Omega$$

$$\text{pf } \cos\phi = \frac{130 + V_R}{240} = \frac{130+31.86}{240} = 0.674$$

Q2(b) For half cycle

$$V_{av} = \frac{\text{Area of Half cycle}}{\text{Base length of Half cycle}}$$

$$= \frac{\left(\frac{1}{2} \times 2 \times 4\right) + \frac{1}{2} \times 2 \times 4}{4} = 2\text{ V.}$$

Another Method.

$$V_{av} = \frac{1}{4}\left[\int_0^2 v_1(t)\,dt + \int_2^4 v_2(t)\,dt\right.$$

$v_1(t) = mt + c \Rightarrow 2t + 0 = 2t$

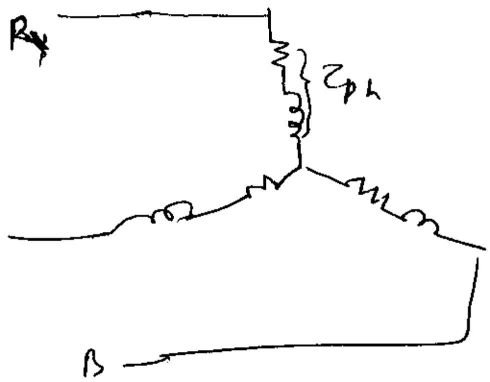
$v_2(t) = -2t + c$ for $t = 4$, $v_2 = 0$, $c = 8$

$v_2(t) = (-2t + 8)$

~~$V_{rms} =$~~

$$V_{r.m.s} = \sqrt{\frac{1}{4}\left[\int_0^2 v_1^2(t)\,dt + \int_2^4 v_2^2(t)\,dt\right.}$$

$= 2.30\ V.$



In λ.

Q3 (a) $Z_{ph} = \sqrt{10^2+10^2}$
$= 10\sqrt{2}$

$V_{ph} = 400/\sqrt{3} = 231V$

$I_L = I_{ph} = 231/10\sqrt{2} = 16.33A$

$\phi = \tan^{-1} X_{ph}/R_{ph} = \tan^{-1}\frac{10}{10} = 45°$

$pf = (\cos\phi) = \cos 45 = .707$

Total power $= \sqrt{3} V_L I_L \cos\phi = \sqrt{3} \times 400 \times 16.33 \times .707$
$= 8000W$

$W_2 + W_1 = 8000$ — (1)

$\tan\phi = \sqrt{3}\frac{W_2 - W_1}{W_2 + W_1}$ or $W_2 - W_1 = 4619$ watt — (2)

from (1) and (2) W_2 and W_1 can be obtained.

In Δ
$Z_{ph} = 10\sqrt{2}$
$V_{ph} = V_{ph}/Z_{ph} = \frac{400}{10\sqrt{2}} = 28.28A$
$I_L = \sqrt{3} I_{ph} = \sqrt{3} \times 28.28 = 48.98A$
$\cos\phi = \cos 45° = 1/\sqrt{2}$
Total power $= \sqrt{3} V_L I_L \cos\phi = 23995 W$
$W_2 + W_1 = 23995$ — (1)
$\tan 45° = \sqrt{3}\frac{W_2 - W_1}{W_2 + W_1}$ or $W_2 - W_1 = 13854$ — (2)
from (1) and (2) W_1 and W_2 can be obtained

3 (b) Energy consumed in 11 hrs $= \frac{150}{1000} \times 11 = 1.65$ kwh.
Revolution made by disc in 11 hr. = Speed of disc in rpm × time in min
$= 3.5 \times 11 \times 60 = 2310$
Energy Consumption recorded by meter $= \frac{\text{Revolution made by disc}}{\text{meter Constant}}$
$= \frac{2310}{1300} = 1.777$ kwh.

P.T.O

Recording error $= 1.777 - 1.65$
$= 0.127$ (Excess)

$$\%\ \text{error} = \frac{1.777 - 1.65}{1.65} \times 100$$

Q 4(a) $I_o = 3A$, $\cos\phi_o = 0.25$ $\quad \phi_m = ?$
$V_1 = 230V$, $f = 50Hz$ $\quad W_o$ = input power at no load = Core loss
$N_1 = 300$

$E_1 = 4.44 f \phi_m N_1$
$230 = 4.44 f \phi_m N_1$ $\quad [\because E_1 = 4.44 \phi_m f N_1]$

i) $$\phi_m = \frac{230}{4.44 \times 50 \times 300}$$
$= 3.453$ mWb.

ii) input power at no load = Core loss
$W_o = V_1 I_o \cos\phi_o = 230 \times 3 \times 0.25$
$= 172.5$ watt

iii) $I_m = I_o \sin\phi_o = 3\sqrt{1-\cos^2\phi_o}$
$= 3\sqrt{1-(0.25)^2} = 2.905A$.

Q 4 (b) Given
kVA $= 100$, $\frac{V_1}{V_2} = \frac{6600V}{400V}$ $\quad P_i = 600$ watt
$P_{c(fl)} = 900$ watt

p.f. $= 0.8$ lag

i) η at full load

$$\%\ \eta_{fl} = \frac{\text{kVA} \times \cos\phi \times 1000}{\text{kVA} \times \cos\phi \times 1000 + P_i + P_{cu(fl)}} \times 100$$

$$= \frac{100 \times 0.8 \times 1000}{100 \times 0.8 \times 1000 + 600 + 900} \times 100 = 98.15\%$$

ii) <u>η at half load:</u>
Cu loss at ½ load $= (\frac{1}{2})^2 \times 900 = 225$ watt
kVA at ½ load $= \frac{1}{2} \times 100 = 50$ kVA.

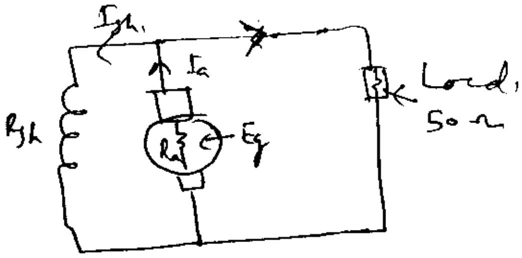
$$\%\ \eta_{at\ half\ load} = \frac{50 \times 0.8 \times 1000}{50 \times 0.8 \times 1000 + 600 + 225} \times 100 = 97.98\%$$

Load corresponding to max^m η = kVA $\times \sqrt{P_i / P_{cu(fl)}} = 100 \times \sqrt{\frac{600}{900}} = 81.64$ kVA

5(a) $R_a = 1\Omega$ $R_L = 50\Omega$

$R_{sh} = 200\Omega$

$\phi = 25\times10^{-3}$ wb, $N = 1000$ r.p.m



Z = No of conductors in armature wdg.

= no of slots X No of conductor per slot

$= 40\times12 = 480$

$E_g = V_t + I_a R_a$ — (1)

$$E_g = \frac{\phi PZN}{60A} = \frac{4\times25\times10^{-3}\times1000\times480}{60\times2} = 400V.$$

To calculate I_a [Total resistance to be find out]

$R_T = R_a + (R_{sh} \| R_L) = 41\Omega$

$I_a = E_g/R_T = \frac{400}{41} = 9.76A$

putting I_a in (1)

$E_g = V_t + 9.76\times1$

$V_t = 400 - 9.76 = 390.24$ volts

<u>for lap wound</u> $A = P = 4$

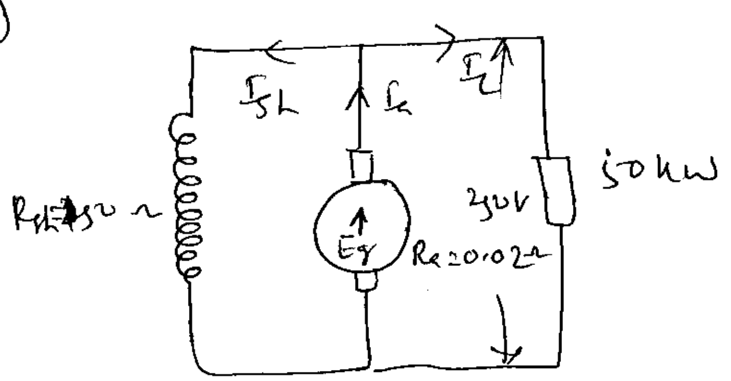
$$E = \frac{\phi PZN}{60A} = \frac{4\times25\times10^{-3}\times1000\times480}{60\times4.} = 200V.$$

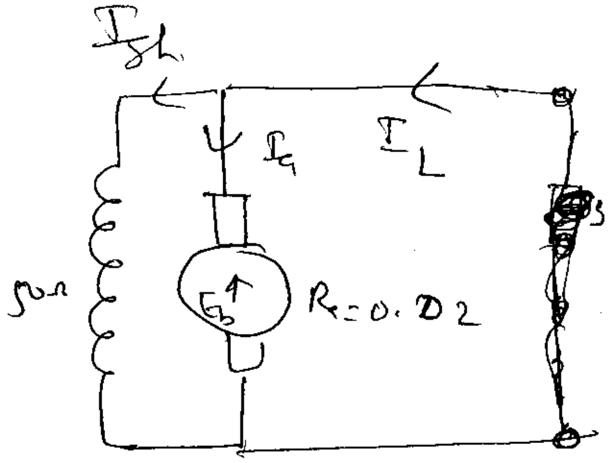
$I_a = \frac{200}{41} = 4.88$

$V_t = 200 - 4.88 = 195.12$

Sh

5 (b)





$N_g = 400$ r.p.m

Load = 50kW, $R_a = 0.02$, $R_{sh} = 50$, $I_L = \frac{50 \times 1000}{250} = 200$ A.

$V = 250$ V.

$I_{sh} = \frac{250}{50} = 5$ A

as gen

$I_a = I_L + I_{sh}$

$I_a = 205$ A

$E_g = V + I_a R_a$

$= 250 + .02 \times 205$

As motor

$I_a = I_L - I_{sh}$

$I_a = 195$ Amp.

$E_b = V - I_a R_a$

$= 250 - .02 \times 195$

Now for shunt M/c $N_g \propto E_g$ and $N_b \propto E_b$.

$\therefore \frac{E_g}{E_b} = \frac{N_g}{N_b}$

or, $\frac{250 + .02 \times 205}{250 - .02 \times 195} = \frac{400}{N_b}$ or, $\frac{254.1}{246.1} = \frac{400}{N_b}$

or, $N_b = 387.40$ r.p.m.

(6) I) $N_s = \frac{120 f}{P} = \frac{120 \times 50}{4} = 1500$ r.p.m.

II) $S = \frac{N_s - N}{N_s}$ or $S N_s = N_s - N$

or, $N = N_s(1 - S)$

$= 1500(1 - .04)$

$= 1440$ r.p.m.

III)

$S' = \frac{N_s - N}{N_s} = \frac{1500 - 600}{1500} = 0.6$

$f' = S' f = 0.6 \times 50 = 30$ HZ.