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Roll No.: 1912160

Section: C.S.E. 'K'

ELECTRICAL ASSIGNMENT- II

1. A shunt generator has an induced emf of 200V. The terminal voltage is 180V. Find the load current if the field and armature resistances are 100Ω and 0.1 Ω, respectively.

Soln:

Induced Emf, $\mathcal{E} = 200V$

Terminal Voltage, $V_t = 180V$

Shunt field resistance, $R_s = 100\Omega$

Armature resistance, $R_a = 0.1\Omega$

Shunt field Current, $I_s = \frac{V_t}{R_s} = \frac{180}{100} = 1.8A$

$$\mathcal{E} = V_t + I_a R_a$$ (where, I_a is Armature Current)

Or, $I_a = \frac{\mathcal{E} - V_t}{R_a} = \frac{200-180}{0.1} = 200A$

∴ Load Current, $I_L = I_a - I_s = 200 - 1.8 = 198.2A$

2. A 4 pole DC shunt generator having a field and armature resistance of 100Ω and 0.2Ω, respectively, supplies parallel connected 100 number of 200V, 40W lamps. Calculate the armature ~~and~~ current and generated emf. Allow 1V/brush contact drop.

Soln:

Given,

$P = 4$

$R_s = 100\Omega$

$R_a = 0.2\Omega$

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Current drawn by each lamp $= \frac{40}{200}$ A

Total load current, $I_L = 100 \times \frac{40}{200} = 20$ A

Since $V = 200$ V,

$$I_S = \frac{200}{100} = 2\,A$$

$\therefore$ Armature Current, $I_a = I_L + I_S = 20 + 2 = 22$ A.

And, Generated Emf, $\mathcal{E} = V + I_a R_a$ + brush contact drop

$$= 200 + 22 \times 0.2 + 2 \times 1$$

$$\therefore \mathcal{E} = 206.4\,V$$

Q.3. A long shunt compound generator delivers a load current of X A at 500V and has armature, series field and shunt field resistances of 0.05 Ω, 0.03 Ω and 220 Ω, respectively. Calculate the generated voltage and the armature current. Allow 1V/brush for contact drop.

Soln:

Armature ~~Curre~~ Resistance, $R_a = 0.05\,\Omega$

Series field Resistance, $R_{series} = 0.03\,\Omega$

Shunt Resistance, $R_s = 220\,\Omega$

Load Current, $I_L = 60$ A

Voltage, $V = 500$ V

So, $I_f = \frac{500}{220} = 2.27$ A

$\therefore I_a = I_f + I_L = 2.27 + 60 = 62.27$ A

Voltage Drop across Series, $= I_a R_{series} = 62.27 \times 0.03$

$= 1.868$ V

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Armature Voltage Drop $= I_a R_a = 62.27 \times 0.05 = 3.113$ V

So, Generated Voltage $= V_t + I_a R_a$ + Series drop + brush drop

or, $\mathcal{E} = 500 + 3.113 + 1.868 + 2 \times 1$

$\therefore \mathcal{E} = 506.981$ V

Q.4. A short shunt compound generator delivers a load current of X A at 220V and has armature, series field and shunt field resistances of $0.05\,\Omega$, $0.02\,\Omega$ and $220\,\Omega$, respectively. Calculate the generated voltage, armature current and total power generated. Allow 1V/brush for contact drop.

Soln: Load Current, $I_L = 60$ A

Voltage drop across series $= I_L R_{series} = 60 \times 0.02 = 1.2$V

$$I_f = \frac{220}{220} = 1 \text{ V}$$

$\therefore$ Armature Current, $I_a = I_L + I_f = 60 + 1 = 61$ A

Armature Voltage Drop $= I_a R_a = 61 * 0.05 = 3.05$ V

$\therefore$ Generated Voltage, $\mathcal{E} = V_t + I_a R_a$ + Series drop + brush drop

$= 220 + 3.05 + 1.2\text{V} + 1 \times 2$

$\therefore \mathcal{E} = 226.25$ V

$\therefore$ Total Power generated, $P_t = E \times I_a$

$= 226.25 \times 61$

$= 13801.25$ W

$\therefore P_t = 13.801$ KW

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Q.5. A 500 KVA, 11KV/415V, 50Hz, single phase transformer has 100 turns on the secondary. Calculate:
(i) Primary and secondary ~~Turns~~ Currents.
(ii) Primary Turns.
(iii) Maximum flux.

Soln: Given, Apparant Power = 500 KVA
$= 5 \times 10^5$ VA

No. of Secondary turns, $n_s = 100$

$$\frac{E_p}{E_s} = \frac{11 \times 10^3}{415}$$

(i) $E_p = 11 \times 10^3$

Apparant Power = $E_p \times I_p$

or, $5 \times 10^5 = 11 \times 10^3 \times I_p$

$\therefore I_p = 45.45$ A

Also,
$$\frac{E_p}{E_s} = \frac{I_s}{I_p}$$

or, $I_s = \frac{E_p \times I_p}{E_s} = \frac{11 \times 10^3 \times 45.45}{415}$

$\therefore I_s = 1204.69$ A

(ii)
$$\frac{E_p}{E_s} = \frac{n_p}{n_s}$$

$\Rightarrow n_p = \frac{E_p \times n_s}{E_s} = \frac{11 \times 10^3 \times 100}{415} = 2650.60$

$\simeq 2650$ turns

$\therefore n_p = 2650$ complete turns

(iii) $\phi_{max} = \frac{E_s}{n_s \times f \times 4.44} = \frac{415}{100 \times 50 \times 4.44} = 0.0187$ Wb

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Q.6- Phase voltage and current of a star connected inductive load is 150V and X A. Power factor of the load is 0.6 (lagging). Assume that the system is 3 wire and the power is measured using 2 watt meters, find the readings of wattmeters.

Soln:- Phase Current, $I_p = 60$ A

$V_p = 150V$

$\cos\phi = 0.6$

$W_1 + W_2 = 3 V_p I_p \cos\phi$

$= 3 \times 150 \times 60 \times 0.6$

$\therefore W_1 + W_2 = 16200$ W —(i)

$\cos\phi = \frac{3}{5}$

$\tan\phi = \frac{4}{3} = \sqrt{3}\left(\frac{W_1 - W_2}{W_1 + W_2}\right)$

or $\frac{4}{3} = \sqrt{3}\left(\frac{W_1 - W_2}{16200}\right)$

$\therefore W_1 - W_2 = 12470.76$ W —(ii)

from (i) and (ii),

$W_1 = (16200 + 12470.76) \div 2$

$= 14335.38$ W

$\therefore W_1 = 14.335$ KW

And, $W_2 = 16200 - 14335.38$

$= 1864.62$

$\therefore W_2 = 1.864$ KW

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Q.7. In a balanced 3phase, 400V circuit the line current is 100A. When power is measured by two wattmeter method, one meter reads 40KW and the other reads zero. What is the power factor of the load? If the power factor were unity and the line current being the same, what would be the reading of each wattmeter?

Soln:- Since $W_2 = 0$, the whole power is measured by W_1,

$$\therefore W_2 = V_L I_L \cos(30^\circ + \phi)$$

$$\Rightarrow \phi = 60^\circ$$

$$\therefore \cos\phi = 0.5$$

If power factor is unity with line currents remaining the same,

$$\therefore \tan\phi = \sqrt{3}\left(\frac{W_1 - W_2}{W_1 + W_2}\right) = 0$$

$$\therefore W_1 = W_2 \quad -(i)$$

Also, $W_1 + W_2 = \sqrt{3} \times 400 \times 100 \times 1$

$$\therefore W_1 + W_2 = 69280 \quad -(ii)$$

from (i) and (ii),

$$W_2 + W_2 = 69280$$

$$\text{or, } 2W_2 = 69280$$

$$\therefore W_2 = 34640\,W$$

$$\therefore W_1 = W_2 = 34.64\,KW$$

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Q.80 The self inductance of a coil of 500 turns is 0.25 H. If 60% of the flux of the coil is linked with a second coil of 10000 turns, calculate
(i) mutual inductance of the two coils.
(ii) EMF induced in the second coil, when current in the first coil changes at a rate of 100 A/Sec.

Soln:- Given, $N_1 = 500$, $N_2 = 10000$

$$L = 0.25\,H$$

$$\phi_2 = 60\% \text{ of } \phi_1 = \frac{3}{5}\phi_1$$

(i) $L = 0.25\,H$

$$\Rightarrow N_1 \frac{\phi_1}{I_0} = 0.25$$

$$\therefore \frac{\phi_1}{I_0} = \frac{0.25}{500} \quad \text{—(i)}$$

$\therefore$ Mutual inductance of each coil,

$$M_{12} = M_{21} = N_2 \times \frac{\phi_2}{I}$$

$$= 10000 \times \frac{3}{5} \times \frac{0.25}{500}$$

$$= 3\,H$$

$\therefore$ Mutual inductance of each solenoid is 3H.

(ii) Induced emf in second coil,

Given, $\frac{dI}{dt} = 100$ A/sec

$$\therefore E_m = M\frac{dI}{dt} = 3 \times 100 = 300\,V$$

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Q.9. Two identical coils A and B each having 800 turns lie in parallel planes such that 60% of the flux produced by one coil links with the other. A current of 5 A in coil A produces in it a flux of 150 μWb. The current in coil A changes from 20A to -20A is 20ms. Calculate (i) the self inductance of each coil
(ii) the mutual inductance
(iii) the voltage induced in coil B.

Soln: Given,

$$N_1 = N_2 = 800 \text{ turns.} = N$$

$$K_1 = K_2 = \frac{60}{100} = 0.6$$

$$I_1 = 5A$$

$$\phi_1 = 150 \times 10^{-6} \text{ Wb}$$

$$\frac{dI}{dt} = \frac{-20-20}{20 \times 10^{-3}} = -2 \times 10^{3} \text{ A/s}$$

(i) Since the coils are identical and has the same numbers of turns N,

$$\therefore L_1 = L_2 = \frac{N^2 \mu a}{l}$$

$$= \frac{N_1 \phi_1}{I_1} = \frac{800 \times 150 \times 10^{-6}}{5}$$

$$\therefore L_1 = L_2 = 24 \times 10^{-3} H = 24 mH$$

$\therefore$ Self inductance of each coil is 24 mH

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(ii) Mutual Inductance,

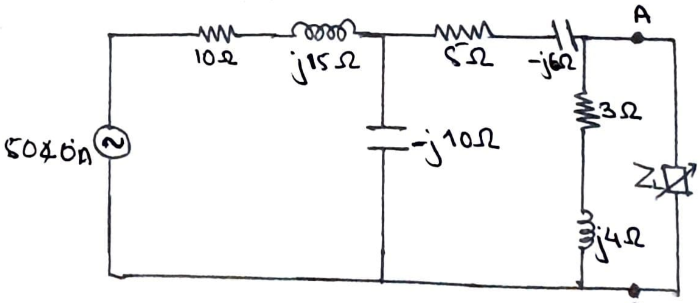
$$M = \sqrt{K_1 K_2}\,\sqrt{L_1 L_2}$$
$$= \sqrt{0.6 \times 0.6}\,\sqrt{24 \times 24}$$
$$= 0.6 \times 24$$
$$= 14.4\,mH$$

$\therefore$ Mutual Inductance of coils is 14.4 mH

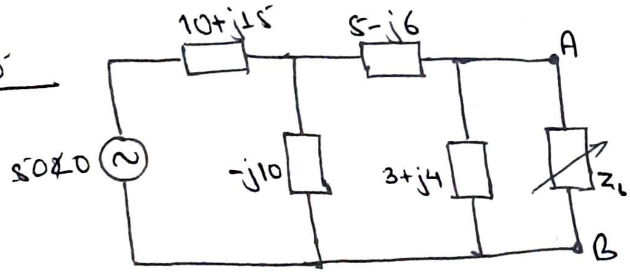
(iii) Voltage of coil B $= M\left|\frac{dI_1}{dt}\right|$

$$= 14.4 \times 10^{-3} \times 2 \times 10^{3}$$
$$\therefore V_B = 28.8\,V$$

Q. 10. Calculate the maximum power ~~pow~~ delivered to the load for the circuit shown below:



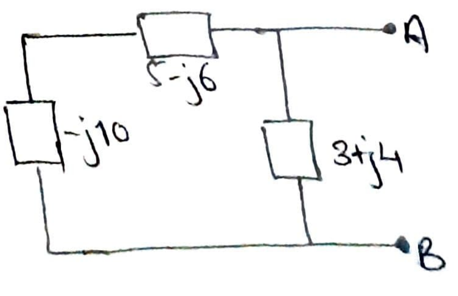
Soln:



To find Z_{th},

$$Z_{th} = \frac{(-j10+5-j6)(3+j4)}{(-j10+5-j6)+(3+j4)} = \frac{(5-j16)(3+j4)}{8-12j}$$

$$\therefore Z_{th} = 4.65 + j3.48\,\Omega$$



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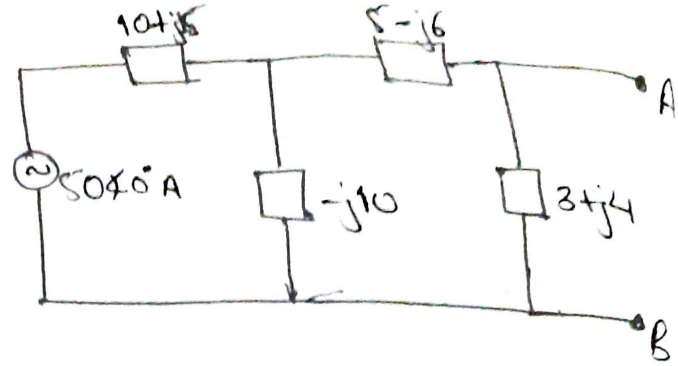
To find V_{th},



Total current in circuit

$= 50\angle 0^\circ A$

Current through $(3+j4)\Omega$

$$= 50\angle 0^\circ \times \frac{(-j10)}{5-j6+3+j4-j10}$$

$$= 50\angle 0^\circ \times \frac{(-j10)}{8-j12}$$

$$= 28.85 - j19.23 \ A$$

$\therefore V_{AB} = V_{th} = (3+j4)(28.85 - j19.23)$

$= 163.47 + j57.71 \ V$

$= 173.36 \angle 19.44^\circ V$

In maximum power transfer theorem,

$$P_{max} = \frac{V_{th}^2}{4R_{th}} \qquad (R_{th} = Z_{th})$$

$$= \frac{(173.36)^2}{4 \times 4.65}$$

$$= 1615.789 W$$