AKGEC/IAP/FM/02

Ajay Kumar Garg Engineering College, Ghaziabad

Department of EN

Sessional Test -2

MODEL SOLUTION

Course : B.Tech

Semeseter: I

Session: 2017-18

Section : CS-1,2,3 EN-1,2 IT-1,2 EI

SUBJECT : Basis Elect. Engg.

Sub. Code : REE-101

Maximum Marks : 50

Time :2 Hours

Section A

A.

Q1. State Thevenin's theorem.

Ans. Any linear bilateral network consisting of 'N' number of active & passive elements can be replaced by its Thevenin's equivalent circuit consisting of a voltage source V_{TH} and a resistance (R_{TH}) connected in series with it.

Q2. Define quality factor and bandwidth.

Ans

Q-factor :- It is defined as the ratio of voltage across L or C to the supply voltage.

Bandwidth :- It is the band of frequencies lying on either side of resonant frequency where the current is $1/\sqrt{2}$ times the maximum value of current.

3 What are the causes of low power factor

Sol Causes of low power factor are as follows:-

1. Most of the ac motors are induction type. Three phase induction motors operate at a power factor of about 0.8 at full load.
2. Arc lamps, industrial heating furnaces, welding equipment operate at low lagging power factors.

Q4 Define phase sequence for a three phase system

Sol. Phase sequence :- It is defined as the order in which different phases attain their maximum values. Generally, RYB is the phase sequence that is followed in the power system.

Q5 Two wattmeter are used to measure three phase power. If one wattmeter reads zero, then what is the power factor of the load?

Sol.

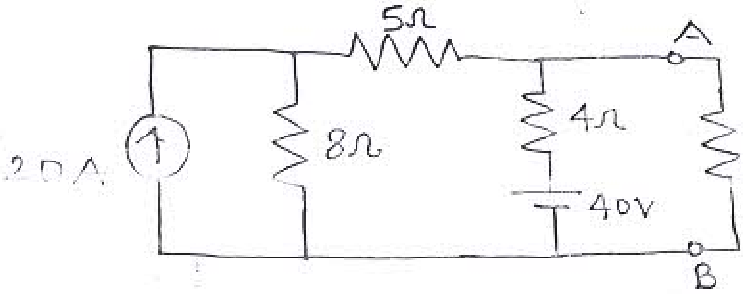
$$W_2 = V_L I_L \cos(30+\phi)$$

$\boxed{\text{If } \cos\phi = 0.5}$, $\phi = 60^\circ$.

$$W_2 = V_L I_L \cos(30+60) = 0.$$

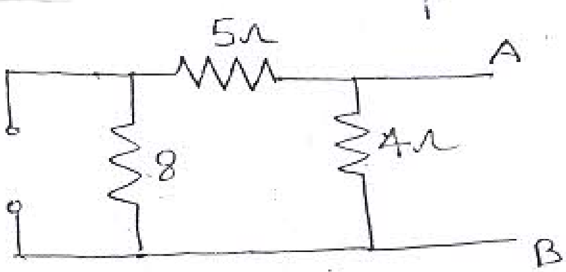
Attempt all parts Section - B (5×5=25)

Find the current flowing through 12Ω resistor using Norton theorem



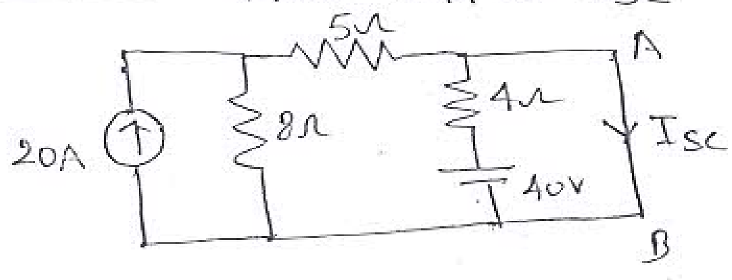
Solu^n:-

Step(1):- Find Req. or RN

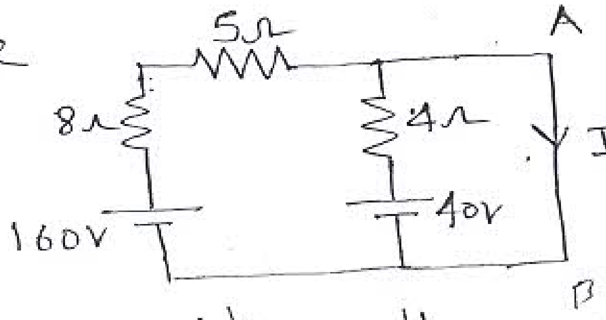


$R_{AB} = R_{eq} = 3.058\,\Omega$

Step-2:- Find I_N or I_{sc}



convert the current source into Voltage source



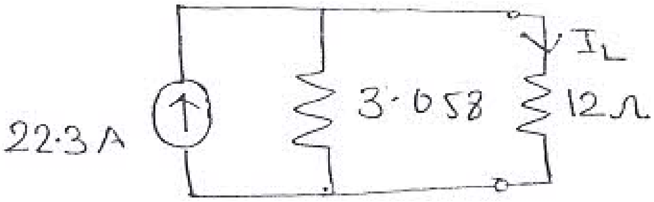
using super position theorem, current through branch AB is

$$I_1 = \frac{160}{13} = 12.3\,A$$

$$I_2 = \frac{40}{4} = 10\,A$$

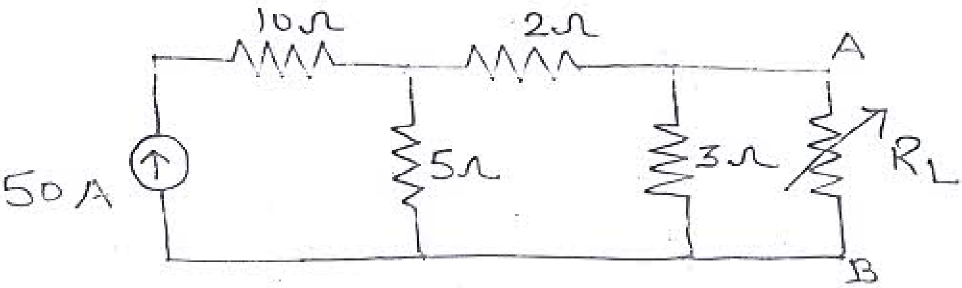
$$I_{sc} = I_1 + I_2 = 22.3\,A$$

Step-5:- Draw Norton's equivalent ckt



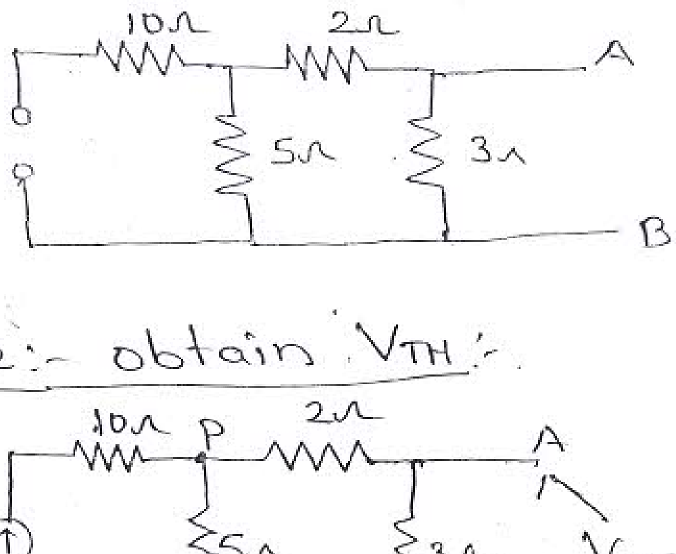
$$I_L = 22.3 \times \frac{3.058}{15.058} = 4.52\ A.$$ Ans

7/ Determine the maximum power delivered to load in the given ckt



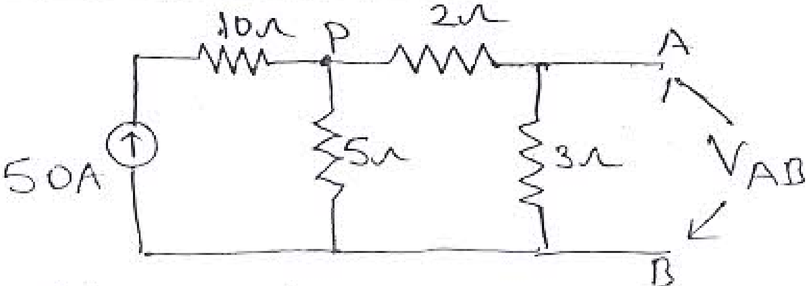
Soln:-

Step-1:- obtain R_{TH}



$R_{TH} = R_{AB} = 2.1Ω$

Step-2:- obtain V_{TH}:-



At point P equal current division takes place

$V_{AB} = 3 \times 25 = 75$ Volts.

Step-3:- Determine the P_{max}

$$P_{max} = \frac{V_{th}^2}{4R_L} = \frac{(75)^2}{4 \times 2.1} = 669.64\ W$$ Ans

A coil connected across a 250 V, 50 Hz supply takes a current of 10 A at 0.8 p.f (lagging). What will be power taken by choke coil when connected across 200 V, 25 Hz supply. Also calculate the resistance and inductance of the coil.

Soln:-

Given: $V_1 = 250V$, $f_1 = 50Hz$, $I_1 = 10A$, $\cos\phi = 0.8$ lag
$V_2 = 200V$, $f_2 = 25Hz$

To find: $P = ?$, $R = ?$, $L = ?$

Step 1:- calculate R_1 & L_1

$$Z_1 = \frac{V_1}{I_1} = \frac{250}{10} = 25\Omega$$

$$\phi = \cos^{-1} 0.8 = 36.87^\circ$$

$$Z_1 = 25\angle 36.87 = (20 + j15)\Omega$$

$$R_1 = 20\Omega \quad \& \quad X_{L1} = 15\Omega$$

$$L_1 = \frac{X_{L1}}{2\pi f_1} = \frac{15}{2\pi 50} = 0.0477 \text{ H}$$

Step-2:- calculate R_2 & L_2

$R_2 = 20\Omega$ (No change)

$$Z_2 = R_2 + jX_{L2}$$

$X_{L2} = 2\pi f_2 L_1$
$= 7.5\Omega$

$$= 20 + j7.5$$

$$= 21.36\angle 20.56^\circ \Omega$$

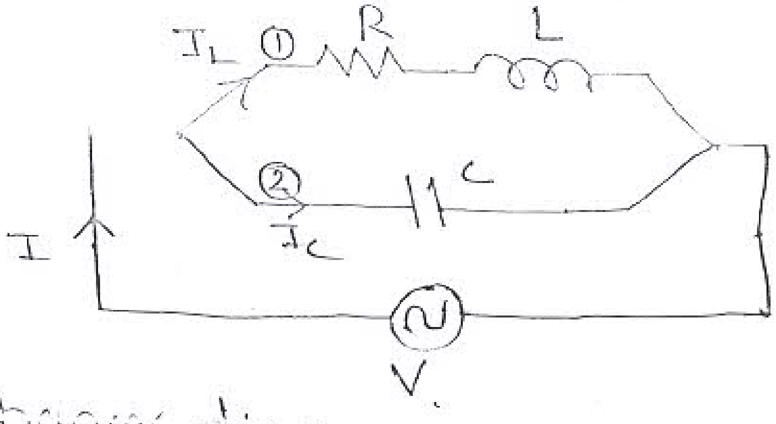
Step-3:- Calculate power

$$P = V_2 I_2 \cos\phi_2 = 200 \times \frac{200}{21.36} \cos(20.56^\circ)$$

$$= 1753.38 \text{ W.}$$

Derive the expression for resonant frequency and quality factor for parallel resonance:

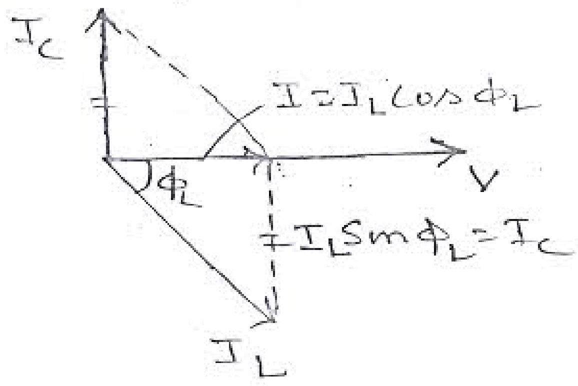
Sol^n:- Resonance in parallel circuit

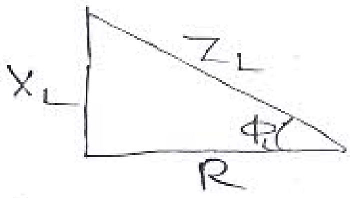


$I_L = \frac{V}{Z_L}$

$I_C = \frac{V}{X_C}$

Phasor diagram:-





At resonance, the value of current through branch-2 is given by

$$I_C = I_L \sin\phi_L$$

but $I_L = V/Z_L$ & $\sin\phi_L = \frac{X_L}{Z_L}$ & $I_C = \frac{V}{X_C}$

$$\frac{V}{X_C} = \frac{V X_L}{Z_L^2} \Rightarrow \boxed{Z_L^2 = X_L X_C}$$

but $Z_L^2 = R^2 + X_L^2$

$$R^2 + X_L^2 = \omega L \cdot \frac{1}{\omega C}$$

$$R^2 + \omega^2 L^2 = \frac{L}{C}$$

$$\omega^2 L^2 = \frac{L}{C} - R^2$$

$$f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}} \text{ Hz}.$$

Quality factor for parallel resonance

$$Q\text{-factor} = \frac{\text{current through inductive branch}}{\text{Resultant current}}$$

but $I_L = \frac{V}{Z_L} = \frac{V}{\sqrt{R^2 + \omega^2 L^2}}$

but we have, $R^2 + \omega^2 L^2 = \frac{L}{C}$

$$I_L = \frac{V}{\sqrt{L/C}} \quad \text{--- (i)}$$

&

$$I = \frac{V}{L/CR} \quad \text{--- (ii)}$$

$$Q = \frac{V}{\sqrt{L/C}} \Big/ \frac{V}{L/CR} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

$$\boxed{Q = \frac{1}{R}\sqrt{\frac{L}{C}}}$$

Q. Three identical coils, each of $(4.2 + j5.6)\Omega$ are connected in star across 415 V, three phase 50 Hz supply. Find (i) phase voltage (ii) phase current (iii) Two wattmeter readings when they are connected to measure three phase power.

Sol^n: Given:- $V_L = 415\ V$, $Z = 4.2 + j5.6$

Step-1: Find V_{ph}

$$V_L = \sqrt{3}\, V_{ph}$$

$$V_{ph} = \frac{415}{\sqrt{3}} = 239.6\ V$$

Step-2:- Find I_{ph}

$$Z_{ph} = 4.2 + j5.6$$

$$Z_{ph} = 7\,\Omega$$

$$I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{239.6}{7} = 34.33\text{ A}$$

$$\phi = \tan^{-1}\left(\frac{X_L}{R}\right) = \tan^{-1}\left(\frac{5.6}{4.2}\right) = 53.13^\circ$$

Step-4:- Find wattmeter readings

$$W_1 = V_L I_L \cos(30 - \phi)$$

$$= 415 \times 34.23 \cos(30 - 53.13^\circ)$$

$$= 13063.5\text{ W}$$

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

$$= 415 \times 34.23 \cos(30 + 53.13^\circ)$$

$$= 1699\text{ W}$$

$$\left.\begin{aligned} V_{ph} &= 239.6\text{ V} \\ I_{ph} &= 34.23\text{ A} \\ W_1 &= 13063.5\text{ W} \\ W_2 &= 1699\text{ W} \end{aligned}\right\} \quad \underline{\text{Ans}}$$

Section C

C.

Q11. Three similar choke coil are connected in star to three phase supply. If the line current is 15 A, total power consumed is 11 KW and volt-ampere input is 15 KVA, find line and phase voltages and reactance and resistance of each coil.
If these coils are now connected in delta, calculate phase and line current, active and reactive power.

Sol.

$$P = \sqrt{3}\, V_L I_L \cos\phi$$

$$11 \times 10^3 = \sqrt{3}\, V_L \times 15 \times \cos\phi$$

$$V_L \cos\phi = 423.39$$

$$S = \sqrt{3}\, V_L I_L$$

$$15 \times 10^3 = \sqrt{3}\, V_L \times 15$$

$$V_L = 577.35\text{ V}$$

$$\cos\phi = \frac{423.39}{577.35} = 0.733$$

$$V_P = 333.3\text{ V}$$

$$Z_{ph} = V_P / I_P = 333.3/15 = 22.22\,\Omega$$

$$R_{ph} = Z_{ph}\cos\phi = 16.29\,\Omega$$

$$X_{ph} = Z_{ph}\sin\phi = 15.11\,\Omega$$

Delta Connection:-

$$I_P = V_P / Z_P = 577.35/22.22 = 25.98\text{ A}$$

Active power $P = \sqrt{3}\, V_L I_L \cos\phi$

$= \sqrt{3} \times 577.35 \times 45 \times 0.73$

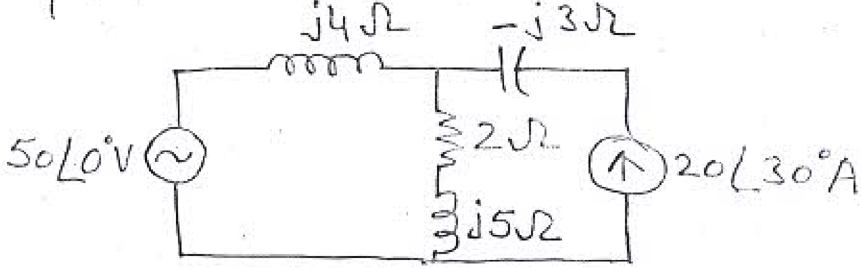
$= 33\,KW$

$Q = \sqrt{3}\, V_L I_L \sin\phi$

$= \sqrt{3} \times 577.35 \times 45 \times 0.68$

$= 30.61\,KVAR$

Q12 Determine the current through $(2+j5)\Omega$ impedance shown in fig. by using superposition theorem.



Sol. Consider $50\angle 0°V$ source,

$$I' = \frac{50\angle 0°}{2+j5+j4} = \frac{50\angle 0°}{9.21\angle 77.47°}$$

$$= 5.42\angle -77.47° A\ (\downarrow)$$

Consider $20\angle 30°A$ source,

$$I'' = \frac{20\angle 30° \times j4}{(2+j5+j4)}$$

$$= \frac{20\angle 30° \times 4\angle 90°}{9.22\angle 77.47°}$$

$$= 8.677\angle 42.53° A\ (\downarrow)$$

$$\tilde{I}_T = \tilde{I'} + \tilde{I''} = (1.176 - j5.294) + (6.39 + j5.87)$$

$$= 7.57 + j0.57A$$

$$= 7.59\angle 4.31° A\ (\downarrow)$$