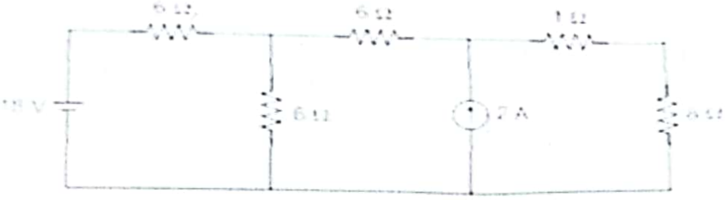
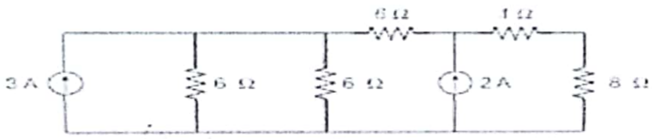
SOMAIYA
VIDYAVIHAR UNIVERSITY

Maximum Marks: 100	Semester: August 2022 – December 2022 Examination: ESE Examination	Duration:3 Hrs.
Programme code: 01,04 Programme:B.Tech.	Class: FY	Semester: I (SVU 2020)
Name of the Constituent College: K. J. Somaiya College of Engineering		Name of the department: COMP/IT
Course Code: 116U06C107	Name of the Course: Elements of Electrical and Electronics Engineering.	
Instructions: 1)Draw neat diagrams 2) All questions are compulsory 3) Assume suitable data wherever necessary		

Que. No.	Question	Max. Marks
Q1	Solve any **Four**	20
i)	Find the value of current flowing through the 8 ohm resistor using Source Transformation.	5

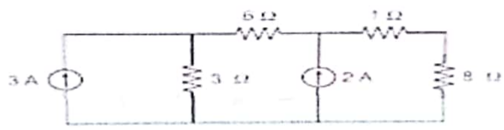


Solution Converting the series combination of the voltage source of 18 V and the resistor of 6 Ω in to equivalent current source and resistance.

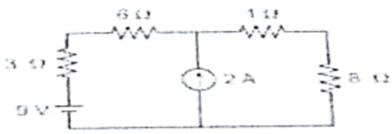


(a)

01

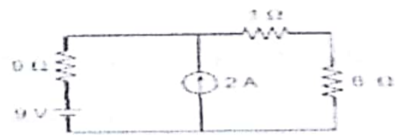


By source transformation,



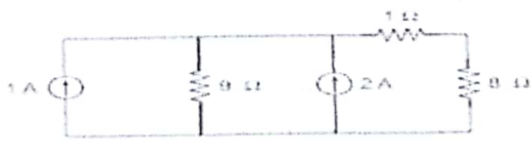
(a)

01



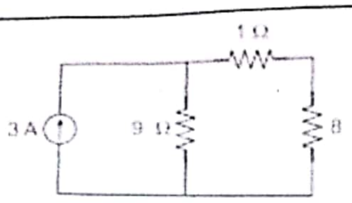
(b)
Fig. 2.166

By source transformation,



(a)

01



(b)
Fig. 2.167

01

By source transformation

Fig. 2.168

01

$$I_{8\Omega} = \frac{27}{9+1+8} = 1.5\ \text{A}$$

ii)	Explain current voltage characteristics of a PN junction diode.	5
iii)	Explain OPAM as an inverting amplifier.	5
iv)	A coil having a resistance of 20 ohm and an inductance of 0.1 H is connected in series with a 50 microFarad capacitor. An alternating voltage of 250 V is applied to the circuit. At what value of frequency will the current in the circuit be maximum? What is the value of this current ? Also find the voltage across the inductor and quality factor.	5

Ans.

$R = 20\ \Omega$
$L = 0.1\ \text{H}$
$C = 50\ \mu\text{F}$
$V = 250\ \text{V}$

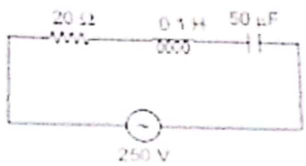


Fig. 8

(i) Resonant frequency

$$f_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{0.1\times 50\times 10^{-6}}} = 71.18\ \text{Hz}$$ — 01

(ii) Value of maximum current

$$I_0 = \frac{V}{R} = \frac{250}{20} = 12.5\ \text{A}$$ — 01

(iii) Voltage across inductor

$$X_L = 2\pi f_0 L = 2\pi\times 71.18\times 0.1 = 44.72\ \Omega$$
$$V_L = I_0 X_L = 12.5\times 44.72 = 559\ \text{V}$$

02

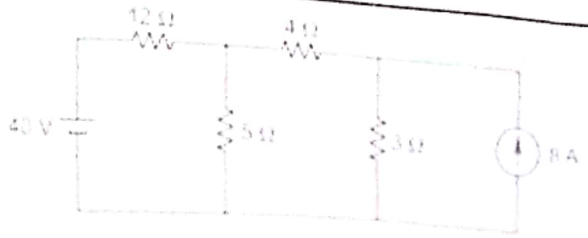
(iv) Quality factor

$$Q_0 = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{20}\sqrt{\frac{0.1}{50\times 10^{-6}}} = 2.24$$

01

v)	What are the classifications of DC motors? Specify one application for each one.	5
vi)	Explain the working principle of a single phase transformer.	5

Que. No.	Question	Max. Marks
Q2 A	Solve the following	10
i)	Find the value of current flowing through the 4 ohm resistor using the Superposition theorem.	5



Solution *Step I: When the 40 V source is acting alone*

— 01

Fig. 2.284

By series–parallel reduction technique.

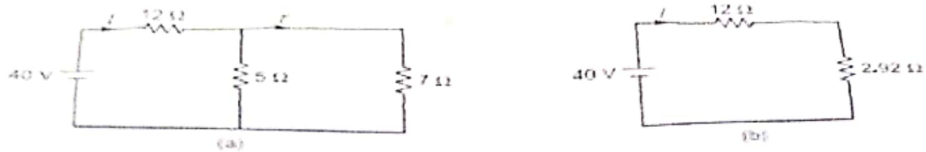


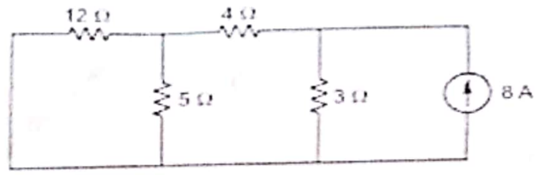
Fig. 2.285

$$I = \frac{40}{12 + 2.92} = 2.68 \text{ A}$$ — 01

From Fig. 2.285(a), by current-division rule,

$$I' = 2.68 \times \frac{5}{5+7} = 1.12 \text{ A} (\rightarrow) = -1.12 \text{ A} (\leftarrow)$$ — $\frac{1}{2}$

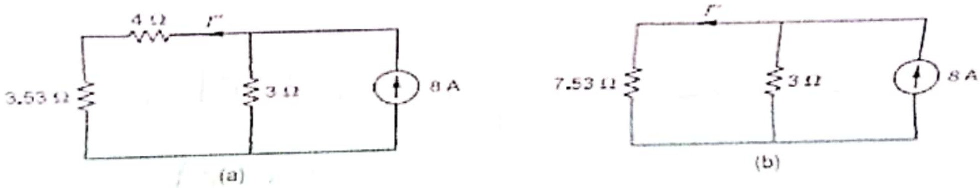
Step II: When the 8 A source is acting alone



01

Fig. 2.286

By series–parallel reduction technique.



From Fig. 2.287(b), by current-division rule,

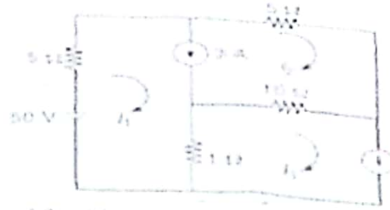
$$I'' = 8 \times \frac{3}{7.53 + 3} = 2.28 \text{ A} (\leftarrow)$$ — 01

Step III: By superposition theorem

$$\begin{aligned} I &= I' + I'' \\ &= -1.12 + 2.28 \\ &= 1.16 \text{ A} (\leftarrow) \end{aligned}$$ — $\frac{1}{2}$

		5
ii)	Compare BJT and FET	
	OR	10
Q2 A	Give the comparison between half wave, full wave rectifier and bridge rectifier.	**10**
Q 2 B	Solve any **One**	

i) Determine the power delivered by the voltage source and the current in the 10 ohm resistor of the below network using mesh analysis. 10



Solution Meshes 1 and 2 will form a supermesh.
Writing current equation for the supermesh,

$$I_1 - I_2 = 3 \qquad (1)$$ ← 01

Applying KVL to the outer path of the supermesh,

$$50 - 5I_1 - 5I_2 - 10(I_2 - I_3) - 1(I_1 - I_3) = 0$$
$$-6I_1 - 15I_2 + 11I_3 = -50 \qquad (2)$$ } 02

For Mesh 3,

$$I_3 = 10 \qquad (3)$$

Solving Eqs (1), (2) and (3),

$$I_1 = 9.76 \text{ A}$$
$$I_2 = 6.76 \text{ A}$$
$$I_3 = 10 \text{ A}$$ } 04

Power delivered by the voltage source $= 50\, I_1 = 50 \times 9.76 = 488$ W — 02

$$I_{10\Omega} = I_3 - I_2 = 10 - 6.76 = 3.24 \text{ A}$$ — 01

ii) Two impedances, 14 + j5 ohm and 18 + j10 ohm, are connected in parallel across 200 V, 50 Hz, single phase supply. Determine: (i) Admittance of each branch in polar form. (ii) Current in each branch in polar form. (iii) Power factor of each branch. (iv) Active power in each branch. (v) Reactive power in each branch 10

Ans.

$\overline{Z}_1 = (14 + j5)\ \Omega$

$\overline{Z}_2 = (18 + j10)\ \Omega$

$V = 200$ V

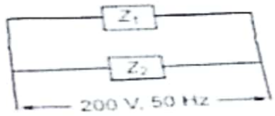


Fig. 10

(i) Admittance of each branch in polar form

$$\overline{Y}_1 = \frac{1}{\overline{Z}_1} = \frac{1}{14 + j5} = 0.067\angle{-19.65°}\ ℧$$ — 01

$$\overline{Y}_2 = \frac{1}{\overline{Z}_2} = \frac{1}{18 + j10} = 0.049\angle{-29.05°}\ ℧$$ — 01

(ii) Current in each branch in polar form

$$\overline{I}_1 = \overline{V}\,\overline{Y}_1 = 200\angle 0° \times 0.067\angle{-19.65°} = 13.4\angle{-19.65°} \text{ A}$$ — 01

$$\overline{I}_2 = \overline{V}\,\overline{Y}_2 = 200\angle 0° \times 0.049\angle{-29.05°} = 9.8\angle{-29.05°} \text{ A}$$ — 01

(iii) Power factor of each branch

$$\text{pf}_1 = \cos\phi_1 = \cos(19.65°) = 0.942 \text{ (lagging)}$$ — 01

$$\text{pf}_2 = \cos\phi_2 = \cos(29.05°) = 0.874 \text{ (lagging)}$$ — 01

(iv) Active power in each branch

$$P_1 = VI_1\cos\phi_1 = 200 \times 13.4 \times 0.942 = 2.52 \text{ kW}$$ — 01

$$P_2 = VI_2\cos\phi_2 = 200 \times 9.8 \times 0.874 = 1.7 \text{ kW}$$ — 01

(v) Reactive power in each branch

$$Q_1 = VI_1\sin\phi_1 = 200 \times 13.4 \times \sin(19.65°) = 0.901 \text{ kVAR}$$ — 01

$$Q_2 = VI_2\sin\phi_2 = 200 \times 9.8 \times \sin(29.05°) = 0.952 \text{ kVAR}$$ — 01

Que. No.	Question	Max. Marks
		20
Q3	Solve any **Two**	10
i)	Compare CE, CB and CC configuration of BJT	10
ii)	Explain the construction and working principle of the 3 phase induction motor.	10
iii)	A balanced load of phase impedance 100 ohm and power factor 0.8 (lag) is connected in delta to a 400 V, 3-phase supply. Calculate: (i) Phase current and line current. (ii) Active power and reactive power. If the load is reconnected in star across the same supply, find (iii) Phase voltage and line voltage. (iv) Phase current and line current. What will be the wattmeter readings for star connected load if the power is measured by two wattmeter methods ?	

Ans.

$$Z_{ph} = 100\ \Omega$$

$$pf = 0.8\ (\text{lag})$$

$$V_L = 400\ \text{V}$$

For a delta connected load,

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

(i) Phase current and line current

$$V_L = V_{ph} = 400\ \text{V}$$

$$I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{400}{100} = 4\ \text{A}$$

$$I_L = \sqrt{3}\, I_{ph} = \sqrt{3} \times 4 = 6.93\ \text{A}$$

02

(ii) Active power and reactive power

$$P = \sqrt{3}\, V_L I_L \cos\phi = \sqrt{3} \times 400 \times 6.93 \times 0.8 = 3.84\ \text{kW}$$

$$Q = \sqrt{3}\, V_L I_L \sin\phi = \sqrt{3} \times 400 \times 6.93 \times \sin(36.87^\circ) = 2.88\ \text{kVAR}$$

02

(iii) Phase voltage and line voltage for a star connected load

$$V_L = 400\ \text{V}$$

$$V_{ph} = \frac{V_L}{\sqrt{3}} = \frac{400}{\sqrt{3}} = 230.94\ \text{V}$$

02

(iv) Phase current and line current for a star connected load

$$I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{230.94}{100} = 2.31\ \text{A}$$

$$I_L = I_{ph} = 2.31\ \text{A}$$

02

(iv) Wattmeter readings for a star connected load

$$W_1 = V_L I_L \cos(30^\circ - \phi) = 400 \times 2.31 \times \cos(30^\circ - 36.87^\circ) = 917.37\ \text{W}$$

$$W_2 = V_L I_L \cos(30^\circ + \phi) = 400 \times 2.31 \times \cos(30^\circ + 36.87^\circ) = 362.96\ \text{W}$$

02

Que. No.	Question	Max. Marks
Q4	Solve any **Two**	**20**
i)	Draw and explain phasor diagram of a transformer for lagging power factor load.	10
ii)	Find the Average and RMS value of the waveform shown in figure.-	10

Solution $v = V_m \sin\theta \quad 0 < \theta < \pi$

$= 0 \quad \pi < \theta < 2\pi$

(i) Average value of the waveform

$$V_{avg} = \frac{1}{2\pi}\int_0^{2\pi} v(\theta)\,d\theta \longleftarrow 01$$

$$= \frac{1}{2\pi}\left[\int_0^{\pi} V_m \sin\theta\,d\theta + \int_{\pi}^{2\pi} 0\,d\theta\right]$$

$$= \frac{1}{2\pi}\int_0^{\pi} V_m \sin\theta\,d\theta$$

$$= \frac{V_m}{2\pi}[-\cos\theta]_0^{\pi}$$

$$= \frac{V_m}{2\pi}[1+1]$$

$$= \frac{V_m}{\pi}$$

$$= 0.318\,V_m$$

03

(ii) rms value of the waveform

$$V_{rms} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} v^2(\theta)\,d\theta} \longleftarrow 01$$

$$= \sqrt{\frac{1}{2\pi}\left[\int_0^{\pi} V_m^2 \sin^2\theta\,d\theta + \int_{\pi}^{2\pi} 0\,d\theta\right]}$$

$$= \sqrt{\frac{1}{2\pi}\int_0^{\pi} V_m^2 \sin^2\theta\,d\theta}$$

$$= \sqrt{\frac{V_m^2}{2\pi}\int_0^{\pi} \sin^2\theta\,d\theta}$$

$$= \sqrt{\frac{V_m^2}{2\pi}\int_0^{\pi}\left(\frac{1-\cos 2\theta}{2}\right)d\theta}$$

$$= \sqrt{\frac{V_m^2}{2\pi}\left[\frac{\theta}{2} - \frac{\sin 2\theta}{4}\right]_0^{\pi}}$$

$$= \sqrt{\frac{V_m^2}{2\pi}\left[\frac{\pi}{2} - \frac{\sin 2\pi}{4} - 0 + \frac{\sin 0}{4}\right]}$$

$$= \sqrt{\frac{V_m^2}{4}}$$

$$= \frac{V_m}{2}$$

$$= 0.5\,V_m$$

05

iii) Find the current through 10 ohm using Thevenin's theorem. 10

Ans. ***Step I:*** Calculation of V_{Th}

Removing 10 Ω resistor from the network.

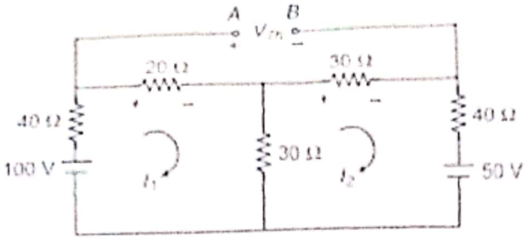


Fig. 14

Applying KVL to Mesh 1.

$$\left.\begin{aligned}100 - 40I_1 - 20I_1 - 30(I_1 - I_2) &= 0\\ 90I_1 - 30I_2 &= 100\end{aligned}\right\}\ 01$$

Applying KVL to Mesh 2.

$$\left.\begin{aligned}-30(I_2 - I_1) - 30I_2 - 40I_2 - 50 &= 0\\ -30I_1 + 100I_2 &= -50\end{aligned}\right\}\ 01$$

Solving Eqs (1) and (2),

$$\left.\begin{aligned}I_1 &= 1.05\ \text{A}\\ I_2 &= -0.185\ \text{A}\end{aligned}\right\}\ 02$$

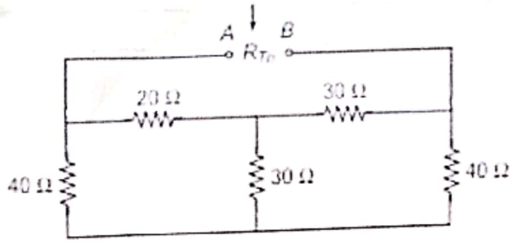
Writing V_{Th} equation,

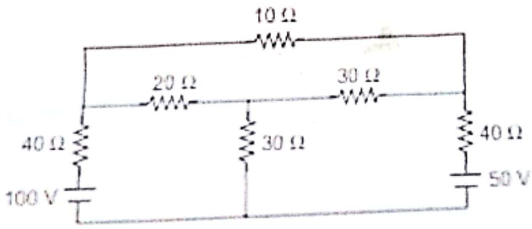
$$-V_{Th} + 30I_2 + 20I_1 = 0$$

$$V_{Th} = 30I_2 + 20I_1 = 30(-0.185) + 20(1.05) = 15.45\ \text{V} \text{ — } 01$$

Step II: Calculation of R_{Th}

Replacing voltage sources by short circuits.





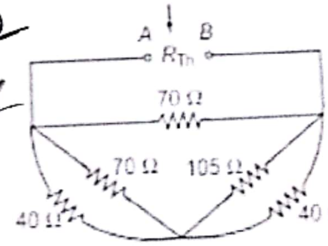
Converting the star network formed by resistors of 20 Ω, 30 Ω and 30 Ω into an equivalent delta network.

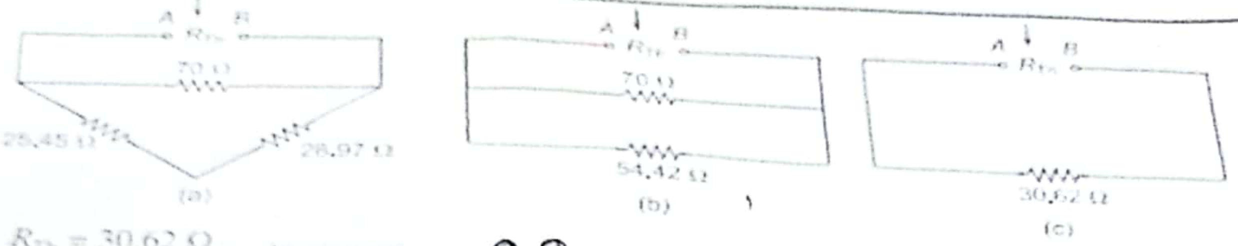
02

$$R_1 = 20 + 30 + \frac{20 \times 30}{30} = 70\ \Omega$$

$$R_2 = 20 + 30 + \frac{20 \times 30}{30} = 70\ \Omega$$

$$R_3 = 30 + 30 + \frac{30 \times 30}{20} = 105\ \Omega$$





$R_{Th} = 30.62\ \Omega$ ______ 02

Step III: Calculation of I_L

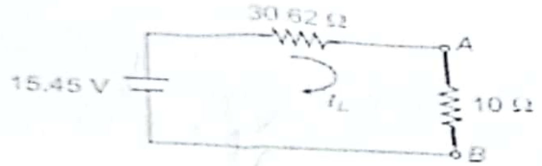


Fig. 17

$$I_L = \frac{15.45}{30.62+10} = 0.38\ A$$

01

Que. No.	Question	Max. Marks
Q5	(Write notes / Short question type) on any **four**	***20***
i)	Maximum Power Transfer Theorem.	5
ii)	Zener Diode as a Voltage Regulator.	5
iii)	Voltage Regulation of a transformer.	5
iv)	Q- Factor and Bandwidth in 1 phase AC Circuit.	5
v)	OPAM as a Comparator.	5
vi)	Capacitor Start Induction Motor.	5