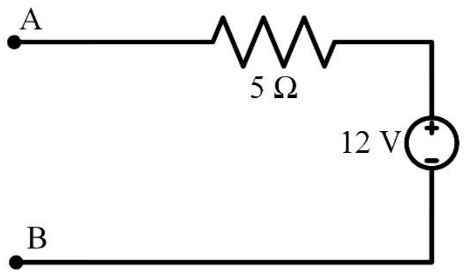
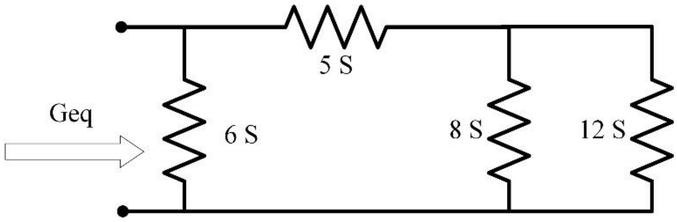
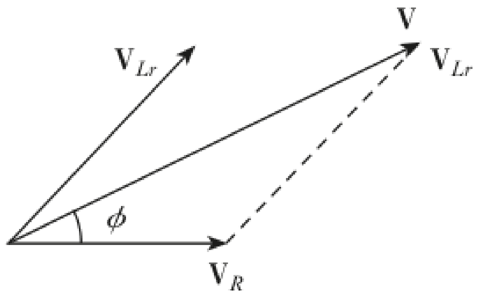
School of Electrical and Electronics Engineering
Second CIA Test – February 2021
Course Code: EEE104 (CSBS)
Course Name: Principles of Electrical Engineering
Duration: 90 minutes Max Marks: 50

<u>PART A</u> **10 x 2 = 20 Marks**

1.	A 20 μF capacitor is charged to a potential difference of 400 V and then discharged through a 100000 Ω resistor. Find the initial value of discharge current.
	Initial Value $I = \frac{V}{R}$ $= \frac{400}{100000}$ $\boxed{I = 0.004 A}$
2.	Compare active and reactive power in AC circuits.
	Points on power dissipation, energy storage, resistor drop, energy stored in reactive elements, air gap power.
3.	Write the condition for the underdamped voltage response in a series RLC circuit.
	If $\omega_o > \alpha^2$, the voltage response is underdamped
4.	How does a capacitor behave in a circuit excited by a DC source under steady-state conditions?
	Open-circuit.
5.	Draw the equivalent current source transformation for the following circuit. 
	$I = \frac{V}{R} = \frac{12}{5} = 2.4\ A$ $R = 5\ \Omega$
6.	The non-zero average value of an alternating sinusoidal current waveform always denotes half-cycle average. Substantiate this statement.

	For symmetric waveforms, the time-average over one cycle is zero. Hence, only half-cycle average is considered for sinusoidal waveforms.
7.	For a pure inductor, L = 10mH excited by a time-varying voltage $v = 100 sin\, \omega t$, calculate the current drawn when f = 50Hz and 50kHz.
	$I_{50} = \frac{V}{X_L} = \frac{100/\sqrt{2}}{3.14} = 22.5(A)$ $i_L(t) = 22.5\sqrt{2}\sin(\omega t - 90^\circ)A$ $I_{50k} = \frac{V}{X_L} = \frac{100/\sqrt{2}}{3.14} = 22.5(mA)$ $i_L(t) = 22.5\sqrt{2}\sin(\omega t - 90^\circ)mA$
8.	Distinguish between mesh and loop of a circuit.
	Mesh : A mesh is the most elementary form of a loop and cannot be further divided into other loops. **Loop :** A loop is any closed path of a network.
9.	Draw a delta circuit using resistors, write the required expressions to transform the circuit to a star circuit.
	$R_A = \frac{R_{AB}\, R_{CA}}{R_{AB} + R_{BC} + R_{CA}}$ $R_B = \frac{R_{BC}\, R_{AB}}{R_{AB} + R_{BC} + R_{CA}}$ $R_C = \frac{R_{CA}\, R_{BC}}{R_{AB} + R_{BC} + R_{CA}}$
10.	Find the equivalent conductance G_{eq} of the circuit shown below. 
	10S
	PART B 3 x 10 = 30 Marks
11.	**A.)** A coil, having both resistance and inductance, has a total effective impedance of 50 Ω and the phase angle of the current through it with respect to the voltage across it is 45° lag. The coil is connected in series with a 40 Ω resistor across a sinusoidal supply. The circuit current is 3A. Find (i) supply voltage and (ii) circuit phase angle. (5 Marks)
	$V_R = IR = 3 \times 40 = 120\text{ V}$ $V_{Lr} = IZ_{Lr} = 3 \times 50 = 150\text{ V}$



$$V^2 = V_R^2 + V_{Lr}^2 + 2V_R V_{Lr}\cos\phi_{Lr}$$
$$= 120^2 + 150^2 + 2\cdot120\cdot150\cdot0.707$$
$$= 62\,500$$
$$V = \mathbf{250\ V}$$
$$\cos\phi = \frac{V_R + V_{Lr}\cos\phi_{Lr}}{V} = \frac{120 + (150\times0.707)}{250}$$
$$= 0.904$$
$$\phi = \mathbf{25^\circ\ lag}$$

B.) It has been observed that two different circuits have the same time constant of 0·005 second. The first circuit is an R-L series circuit and the second one is an R-C series circuit with a known resistance of $2\ M\Omega$. With the constant DC supply of 10 V applied to the two circuits, it is found that steady-state current of the circuit is 2000 times the initial current of the circuit. Find unknown resistor, inductor and capacitor values. (5 Marks)

Solution. The time constant for both the circuits is 0·005 s.

$$\therefore \quad R_2C = 0{\cdot}005 \quad \text{or} \quad C = \frac{0.005}{R_2}$$

$$\therefore \quad C = \frac{0.005}{2\times10^6} = 0{\cdot}0025\times10^{-6}\ \text{F} = \mathbf{0{\cdot}0025\ \mu F}$$

Steady state current in Fig. 9.41 $(i) = V/R_1 = 10/R_1$

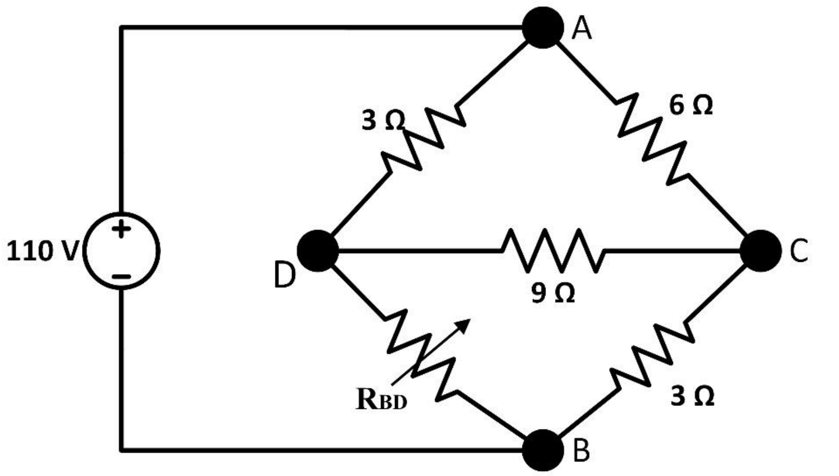
Initial current in Fig. 9.41 $(ii) = V/R_2 = 10/2\times10^6 = 5\times10^{-6}$ A

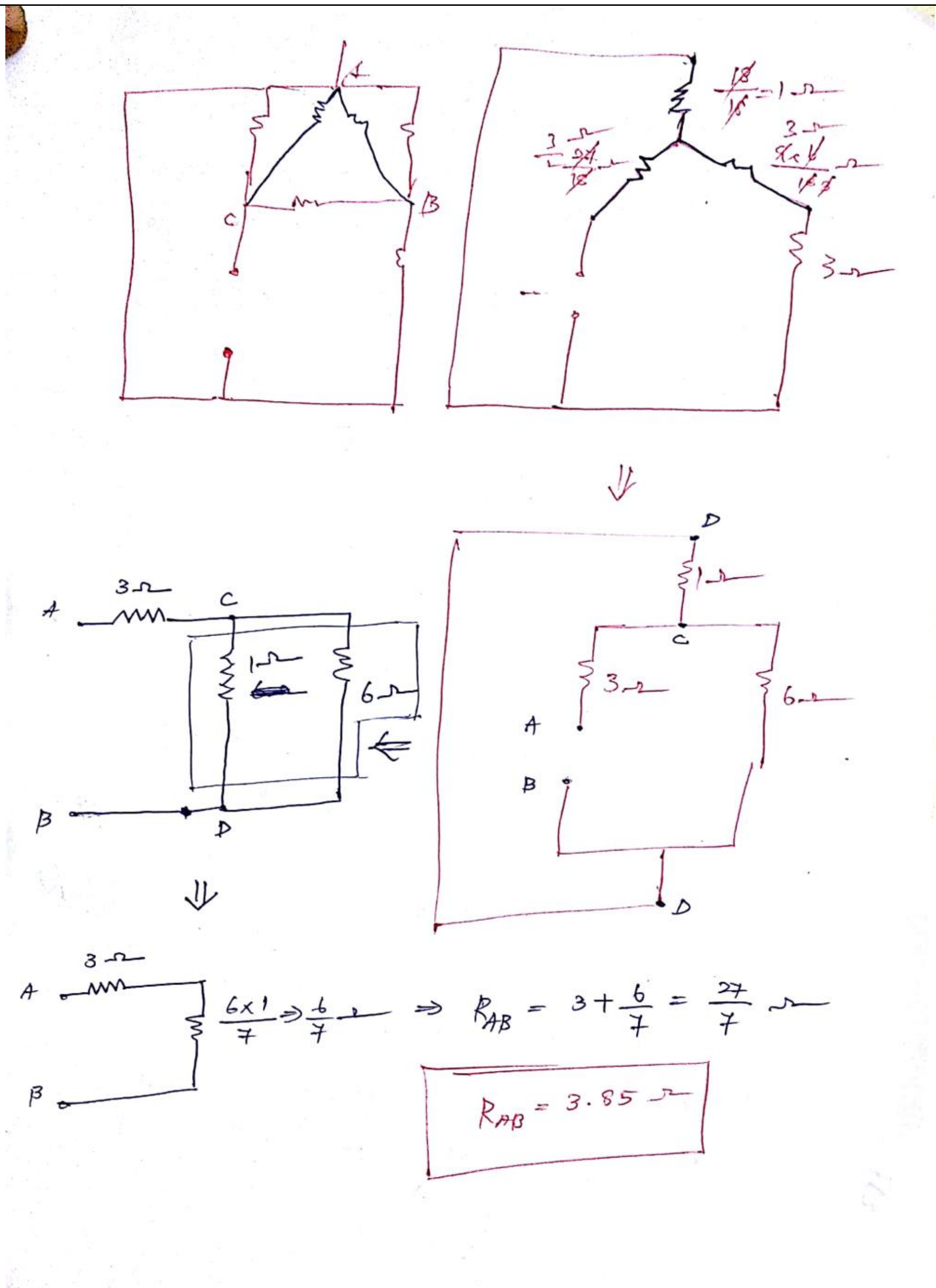
As per statement of the problem, we have,

$$10/R_1 = 2000\times(5\times10^{-6}) \quad \therefore \quad R_1 = \mathbf{1000\ \Omega}$$

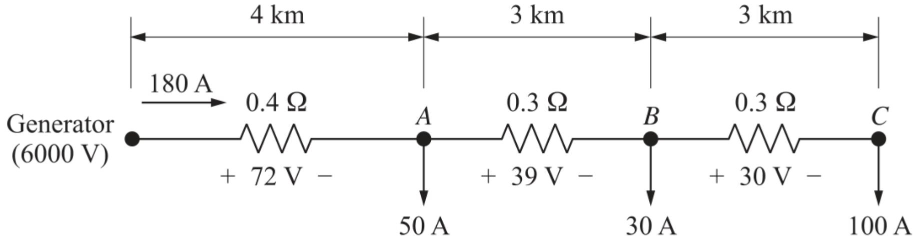
Now $$L/R_1 = 0{\cdot}005 \quad \therefore \quad L = 1000\times0{\cdot}005 = \mathbf{5\ H}$$

12. Find out the value of R_{BD} for maximum power transfer in the circuit given below and the actual power dissipated in R_{BD}. (10 Marks)





13. **A.)** A power transmission line carries current from a 6000-V generator to three loads, A, B, and C. The loads are located at 4, 7, and 10 km from the generator and draw 50, 30, and 100 A, respectively. The resistance of the line is 0.1 Ω/km. Find the voltage at loads A, B, C and the the maximum percentage voltage drop from the generator to a load. (5 Marks)



Ans:

At point A : $6000 - 72 = 5928\,V$

$$\% \text{drop} = \frac{6000-5928}{6000} \times 100\% = 1.2\%$$

At point B : $180 - 50 = 130\,A$

$$\text{drop} = 130 \times 0.3 = 39V$$

$$\% \text{drop} = \frac{6000 - (6000 - (72+39))}{6000} \times 100 =$$

$$= \frac{6000 - 5889}{6000} \times 100 = 1.85\%$$

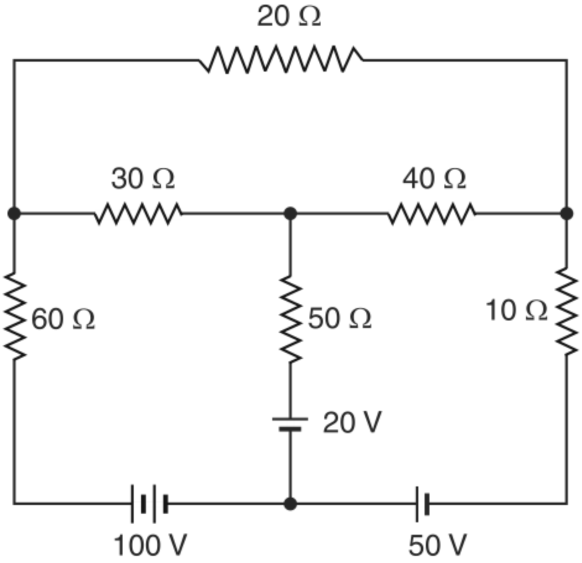
At point C :

$$\% \text{drop} = \frac{6000 - (6000 - 72 - 39 - 30)}{6000} \times 100\%$$

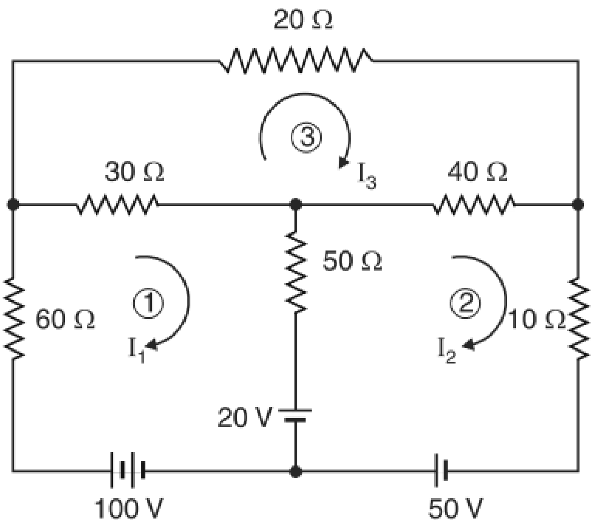
$$= \frac{6000 - 5859}{6000} \times 100\% = 2.35\%$$

Point C is having maximum drop.

B.) Find the current and power in each branch using mesh analysis. (5 Marks)



Ans:



$$\begin{bmatrix} R_{11} & R_{12} & R_{13} \\ R_{21} & R_{22} & R_{23} \\ R_{31} & R_{32} & R_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} E_1 \\ E_2 \\ E_3 \end{bmatrix}$$

or $$\begin{bmatrix} 140 & -50 & -30 \\ -50 & 100 & -40 \\ -30 & -40 & 90 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 80 \\ 70 \\ 0 \end{bmatrix}$$

Power $= I^2 R$

Current in 60 Ω $= I_1 = 1{\cdot}65$ **A in the direction of** I_1 $\Rightarrow$ 163.35W

Current in 30 Ω $= I_1 - I_3 = 0{\cdot}15$ **A in the direction of** I_1 $\Rightarrow$ 0.675W

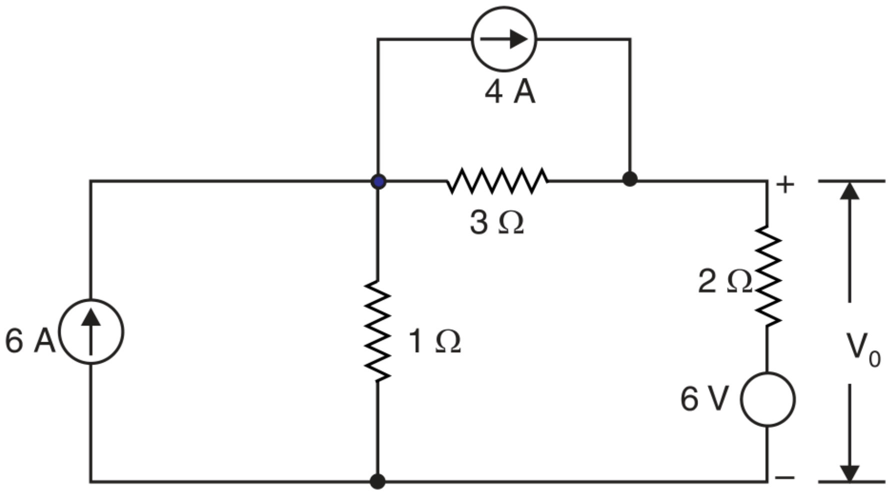
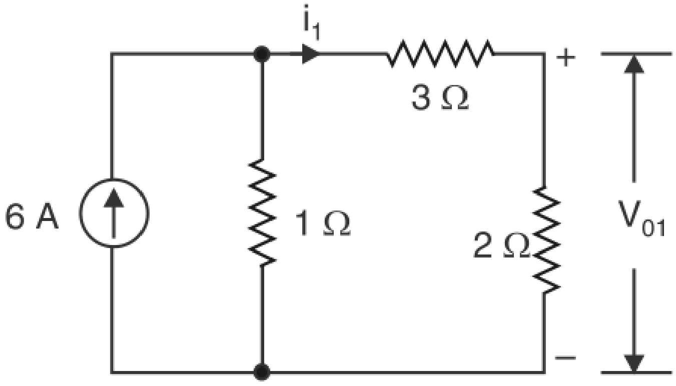
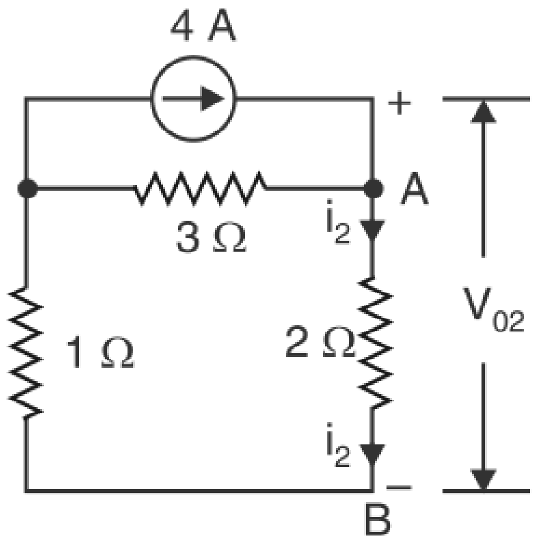
Current in 50 Ω $= I_2 - I_1 = 0{\cdot}47$ **A in the direction of** I_2 $\Rightarrow$ 11.045W

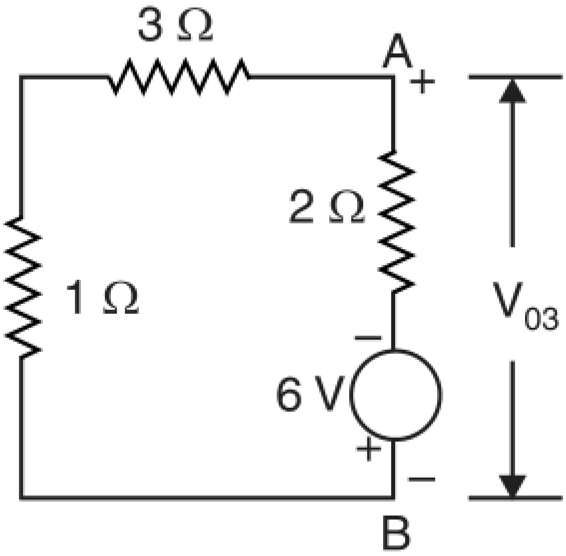
Current in 40 Ω $= I_2 - I_3 = 0{\cdot}62$ **A in the direction of** I_2 $\Rightarrow$ 15.376W

Current in 10 Ω $= I_2 = 2{\cdot}12$ **A in the direction of** I_2 $\Rightarrow$ 44.94W

Current in 20 Ω $= I_3 = 1{\cdot}5$ **A in the direction of** I_3 $\Rightarrow$ 45W

14. Using superposition theorem, find the value of output voltage V_0 in the circuit shown below. (10 Marks)

	
	 $i_1 = 6\times\dfrac{1}{1+2+3} = 1\text{A} \quad \therefore \quad V_{01} = 1\times 2 = 2\text{V}$  $i_2 = 4/2 = 2\text{A} \quad \therefore \quad V_{02} = 2\times 2 = 4\text{V}$



$$V_A - 2\text{V} + 6\text{V} = V_B \quad \therefore \quad V_A - V_B = V_{03} = -4\text{V}$$

$$V_0 = V_{01} + V_{02} + V_{03} = 2 + 4 - 4 = \mathbf{2V}$$