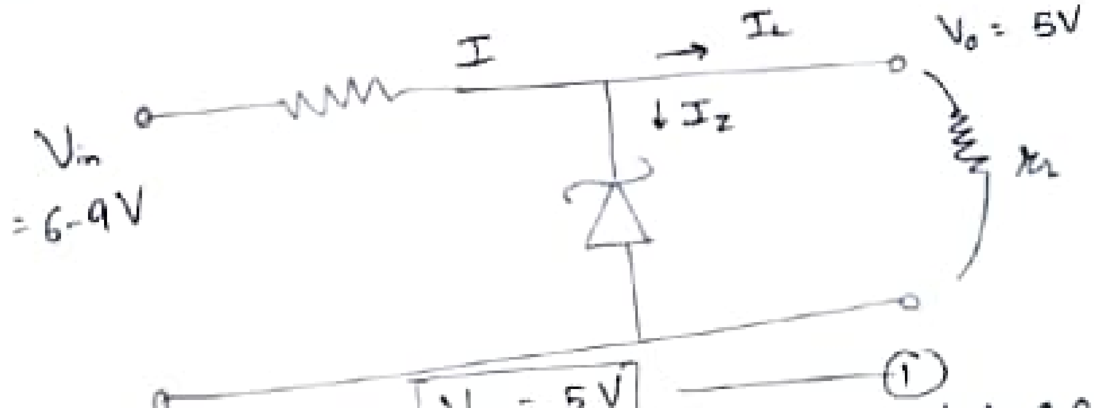
Q1.



We have $\boxed{V_z = 5V}$ —— (1)

For a 5V output, with 2A load current & 0.01 A Zener current, we have $I = 2.01$ A

This will lead to the value of $R_s = \dfrac{V_{in} - V_o}{I}$

$$= \frac{6-5}{2.01}$$

$$\boxed{R_s = 0.497\Omega} \text{ — (3)}$$

We take low value of V_{in} to find the highest R_s that can work for us

Now, for power ratings, worst case is $V_{in} = 9V$

$$P_s = \frac{(V_{in} - V_z)^2}{R_s}$$

$$= \frac{16}{0.497} \quad \boxed{= 32.16 \text{ W}} \text{ — (3)}$$

Worst case for Zener power is when $I_L = 0$.

$$P_z = I_z V_z$$

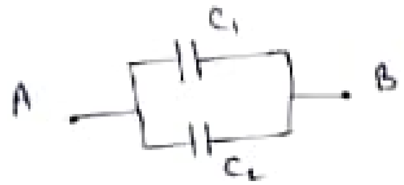
$$= I V_z$$

$$= \left(\frac{V_{in} - V_z}{R_s}\right) V_z$$

$$\boxed{P_z = 40.2 \text{ W}} \text{ —— (3)}$$

Q2. For $x = 0$, $C_0 = C_1 + C_2$

The equivalent circuit is :



— ②

$$C_0 = \frac{\epsilon A}{d} + \frac{\epsilon A}{d} = \boxed{\frac{2\epsilon A}{d}}$$

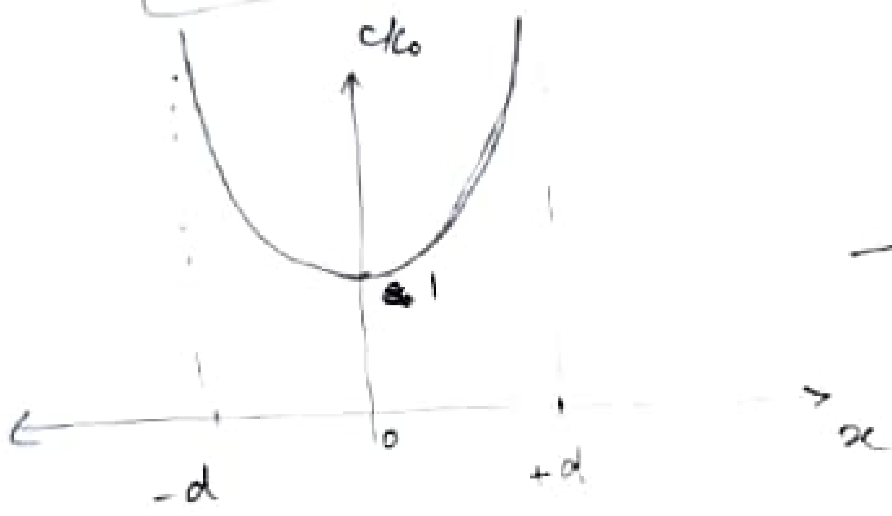
For any value of x:

$$C_1 = \frac{\epsilon A}{d-x} \quad \& \quad C_2 = \frac{\epsilon A}{d+x}$$

$$C = \epsilon A \left[\frac{1}{d-x} + \frac{1}{d+x}\right]$$

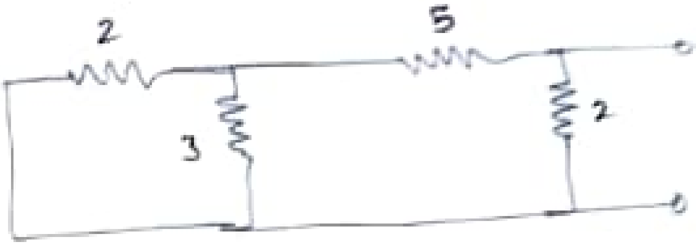
$$\boxed{C = \frac{2d\epsilon A}{d^2 - x^2}} \quad \text{— ④}$$

$$\boxed{\frac{C}{C_0} = \frac{d^2}{d^2 - x^2}} \quad \text{— ②}$$



— ②

Q3. To calculate R_{th}

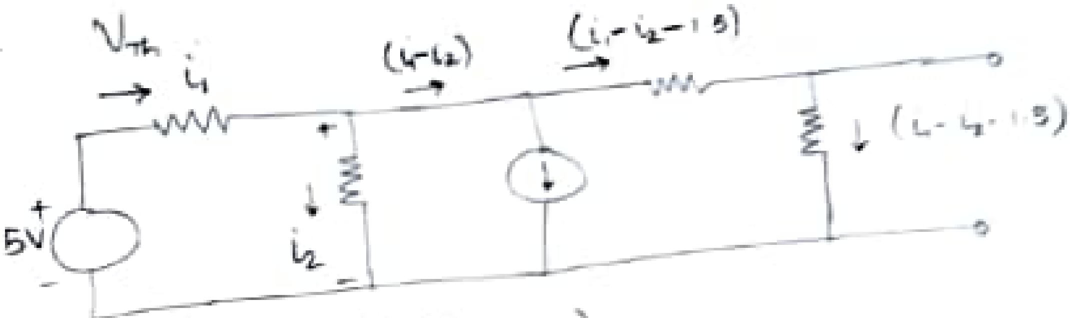


$$R_{th} = 2 \,\|\, \left(5 + (2 \| 3)\right)$$

$$= 2 \,\|\, \left(31/5\right)$$

$$= 62/41 = \boxed{1.51\ \Omega}$$ —— (4)

For V_{th}



$$V_{th} = 2(i_1 - i_2 - 1.5)$$

We have $2i_1 + 3i_2 = 5$

$$-3i_2 + 7(i_1 - i_2 - 1.5) = 0$$

$$\therefore -10i_2 + 7i_1 = 10.5$$

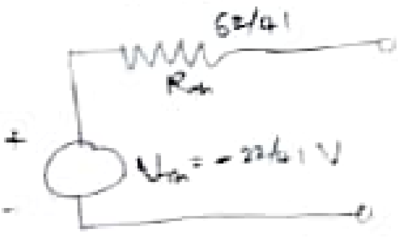
Then $20i_1 + 21i_1 = 50 + 31.5$

$$i_1 = 81.5/41 \text{ A}$$

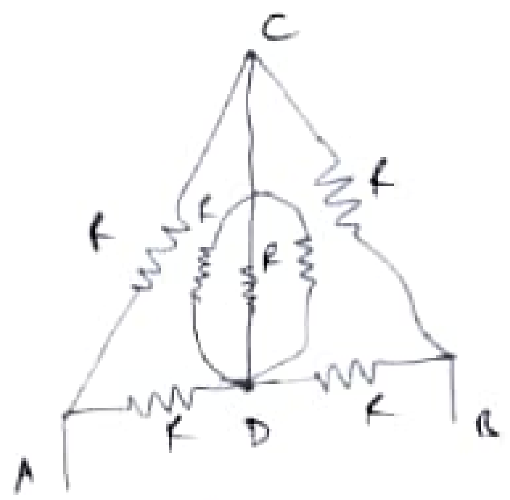
$$\therefore i_2 = 42/41 \text{ A}$$

$$\therefore \boxed{V_{th} = -22/41 \text{ V}}$$ —— (4)

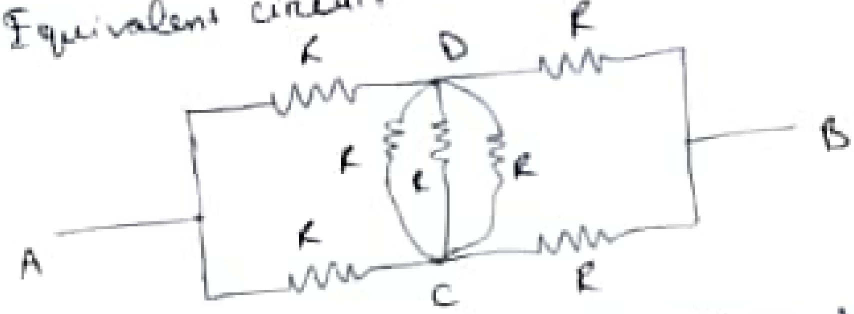
Equivalent Diagram. —— (2)



Q4



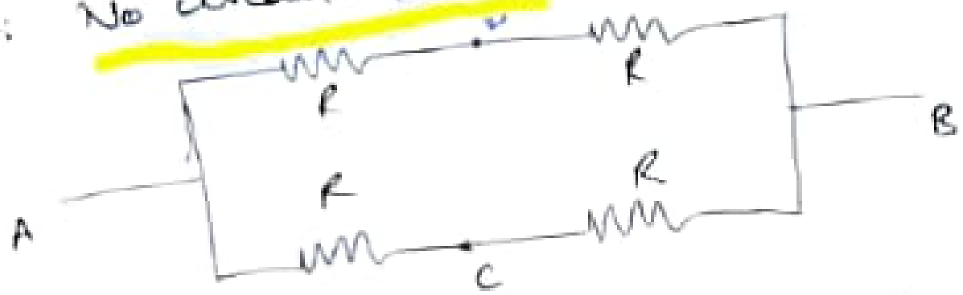
Equivalent circuit



1

This is a balanced Wheatstone bridge

$\therefore$ No current through the CD branch 3



2

Equivalent resistance $2R \parallel 2R$

$= R$ 4