SOLUTION

H.W. #02

1.21.

$$R_{eq} = 2K + \left(\left((3K \parallel 4K) + 5K\right) \parallel 7K \parallel 6K\right)$$

$$= 2K + (6.71K \parallel 3.23K)$$

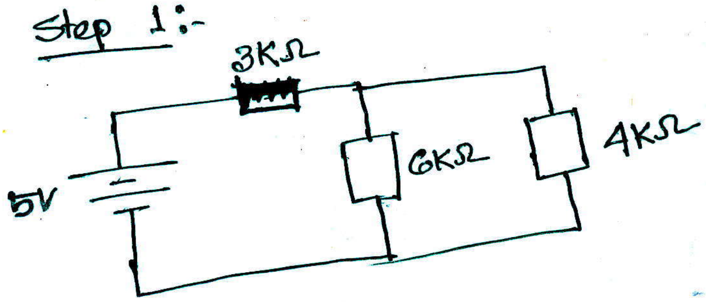
$$= 2K + 2.18K$$

$$= 4.18K$$

$$\therefore V_{2K} = \frac{2K \times 10V}{4.18K} = \boxed{4.78\ V}$$

1.22.

Step 1:-



$$R_{eq} = 3K + (6K \parallel 4K)$$

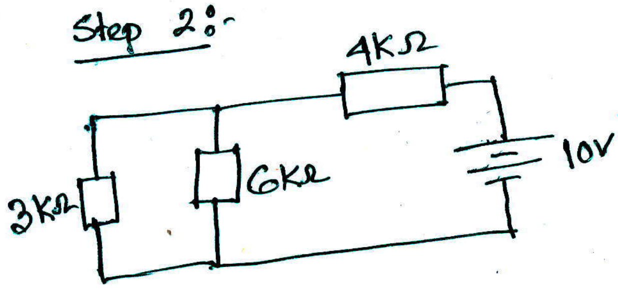
$$= 5.4K$$

$$I' = 5/5.4K = 0.925\,mA$$

$$\therefore I'_{6K} = \frac{4K}{6K+4K} \times 0.925\,mA$$

$$= 0.37\ mA$$

Step 2:-



$$R_{eq} = 4K + (6K \parallel 3K)$$

$$= 6K$$

$$I'' = 10/6K = 1.67\ mA$$

$$\therefore I''_{6K} = \frac{3K}{6K+3K} \times 1.67\,mA$$

$$= 0.55\ mA$$

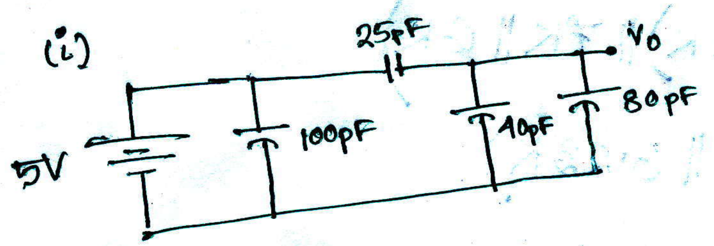
$$\therefore I_{6K} = I'_{6K} + I''_{6K} = 0.37\,mA + 0.55\,mA = \boxed{0.925\ mA}$$

1.25

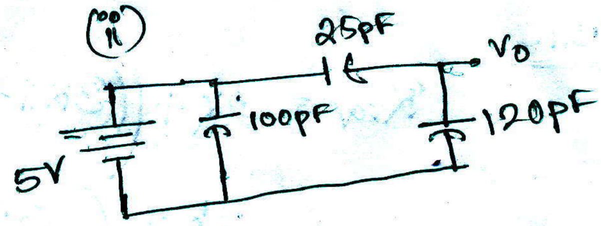
$C_{eq} = 100\,pF \parallel (25\,pF + (40\,pF \parallel 80\,pF))$

$= 100\,pF \parallel (25\,pF$

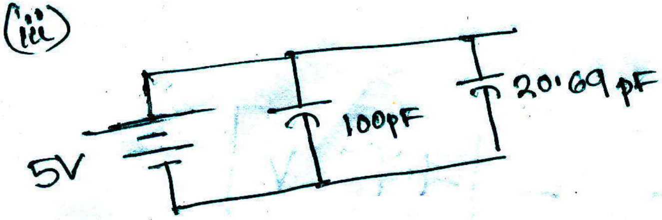
(i)



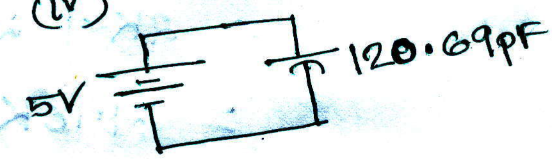
(ii)



(iii)



(iv)



(a)

$$W = \frac{1}{2} \times 120.69 \times 10^{-12} \times (5)^2$$

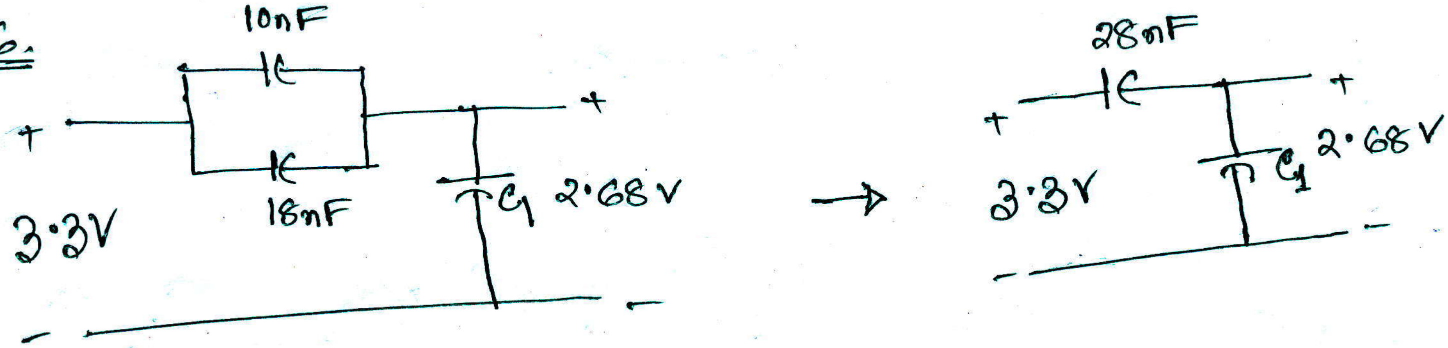
$$= \boxed{1.51\ nJ}$$

(b)

$$V_o = \frac{25\,pF}{(120+25)\,pF} \times 5V$$

$$= \boxed{0.862\ V}$$

1·26.



Now,

$$2.68 = \frac{28}{28+C_1} \times 3.3\ V$$

$$\Rightarrow \frac{28}{28+C_1} = \frac{2.68}{3.3}$$

$$\Rightarrow \frac{28+C_1}{28} = \frac{3.3}{2.68}$$

$$\Rightarrow 28+C_1 = 1.23 \times 28$$

$$\Rightarrow \boxed{C_1 = 6.48\ nF}$$

Now, $W = \frac{1}{2} \times 6.48 \times 10^{-9} \times (2.68)^2 = \boxed{23.27\ nJ}$

1·27.

Here,

$$Q_{T_{\text{before switching}}} = Q_{T_{\text{After switching}}}$$

$$\Rightarrow C_1 V_1 + C_2 V_2 = (C_1 + C_2) V$$

$$\Rightarrow (2+2)\times 10^{-9} \times 3 + 5\times 10^{-9} \times 1.2 = (2+2+5)\times 10^{-9} \times V$$

$$\Rightarrow \frac{(12+6)\times 10^{-9}}{9\times 10^{-9}} = V$$

$$\Rightarrow V = \boxed{2\ V}$$

1.28. $I_1 + I_3 = I_2$

$$\Rightarrow \frac{10 - V_0}{1K} + \frac{0 - (V_0 + 0.7)}{1.8K} = \frac{V_0 + 30}{1.5K}$$

$$\Rightarrow \frac{10 - V_0}{1} = \frac{V_0 + 0.7}{1.8} + \frac{V_0 + 30}{1.5}$$

$$\Rightarrow 27 - 2.7 V_0 = 1.8 V_0 + 54 + 1.5 V_0 + 1.05$$

$$\Rightarrow 6 V_0 = 27 - 54 - 1.05$$

$$= -28.05$$

$$\therefore \boxed{V_0 = -4.675 \text{ V}}$$

$$I_1 = \frac{10 + 4.675}{1K} = \boxed{14.675 \text{ mA}}$$

$$I_2 = \frac{-4.675 + 30}{1.5K} = \boxed{16.88 \text{ mA}}$$

$$I_3 = \frac{4.675 - 0.7}{1.8K} = \boxed{2.21 \text{ mA}}$$

1.29. (a) $V_{BB} = 1V$

KVL:-

$$-1 + 50K \times I_D + V_D + 80K \times I_D = 0$$

$$\Rightarrow V_D = 1 - 130K \times I_D$$

Now,

$$I_D = I_S \left(e^{V_D/V_{th}} - 1\right)$$

$$= 10 \times 10^{-9} \left(e^{\frac{1 - 130K \times I_D}{0.026}} - 1\right)$$

$$= f(I_D)$$

I_D	$f(I_D)$
5μA	7.01 mA
6μA	47.28 μA
6.4μA	6.4 μA

Solving Analytically, $\boxed{I_D = 6.4 \, \mu A}$

$$\therefore \boxed{V_D = 0.168 \text{ V}}$$

(b) $V_{BB} = 10\ V$

KVL:

$$V_D = 10 - 130K \times I_D$$

Now.

$$I_D = 10 \times 10^{-9} \left(e^{\frac{10 - 130K \times I_D}{0.026}} - 1 \right)$$

$$= f(I_D)$$

Solving Analytically

$$\therefore \boxed{I_D = 75.138\ \mu A}$$

$$\therefore \boxed{V_D = 0.232 V}$$

I_D	$f(I_D)$
~~75~~ μA	1.5×10^{-4} A
75.1 μA	78.2 μA
75.138 μA	75.13 μA

I_D	$f(I_D)$
~~40~~	
~~5 μA~~	
~~75 μA~~	~~33.44 μA~~