CHAPTER No : 1

"BASIC CONCEPTS"

EXERCISE PROBLEMS

1.1 Unit & Notation

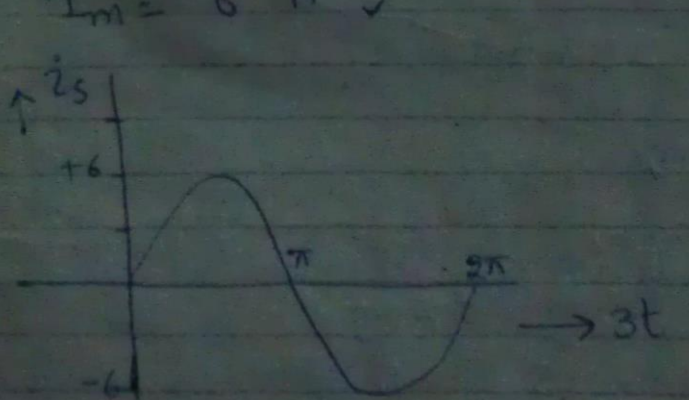
Q1) $i_S = 3[2\sin 3t - 1]\,A$
Sketch & label current signal versus t, and mark its dc component I_S & its ac component i_s.

$i_S = 3(2\sin 3t - 1)\,A$
$i_S = 6\sin 3t - 3\ A$
$i_S = \underbrace{-3}_{I_S} + \underbrace{6\sin 3t}_{i_s}\ A$

From here

$I_S = -3\,A$ d.c. Component
$i_s = \underline{6}\sin 3t\,A$ A.C. Component

$I_m = 6\ A$ ✓



Now,
After Adding d.c.

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$I_S = -3$ A d.c. Component
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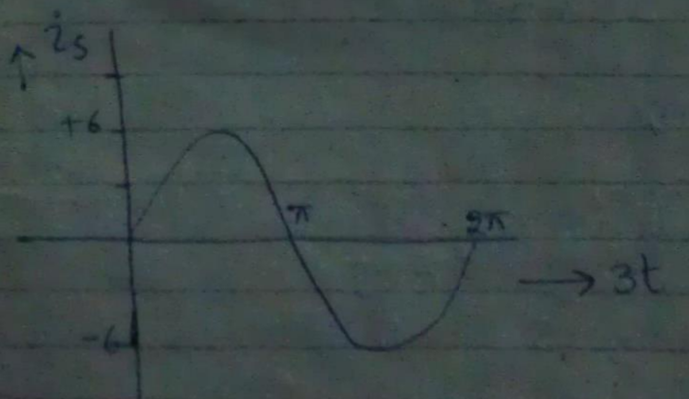


Now,
After Adding d.c.

From FV:

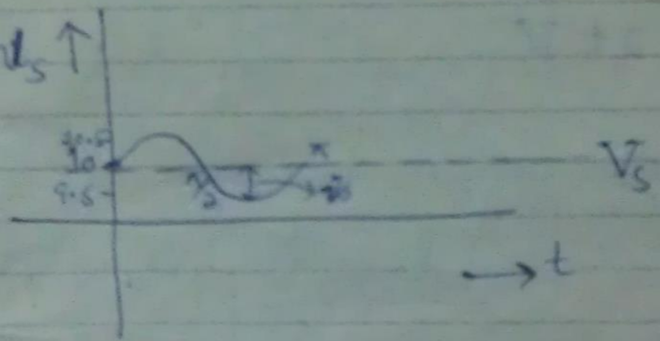
$v_s = V_m \sin 2\pi f t$

$2\pi f = 2$

$f = \frac{2}{2\pi}$

$f = \frac{1}{\pi}$

$\Rightarrow T = \pi$



b)

$V_S = -3V$

$v_S = V_S + v_s$
$= -3 + 0.5 \sin 2t$

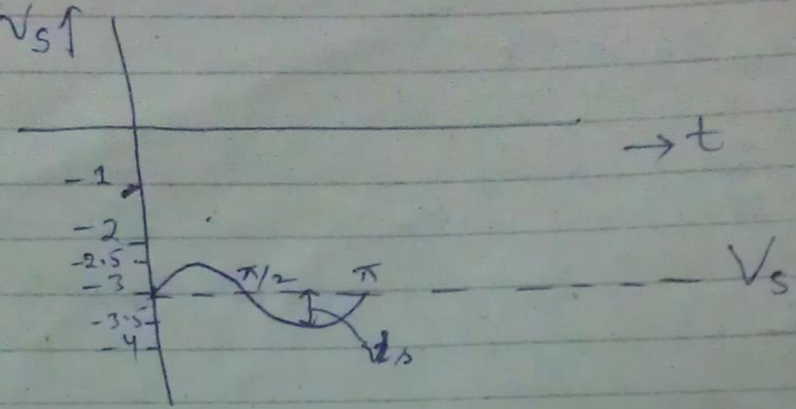
$\therefore V_m = 0.5V$

upper extreme is

$V_s + V_m = -3 + 0.5 = -2.5$

$V_s - V_m = -3 - 0.5 = -3.5$

$T = \pi$



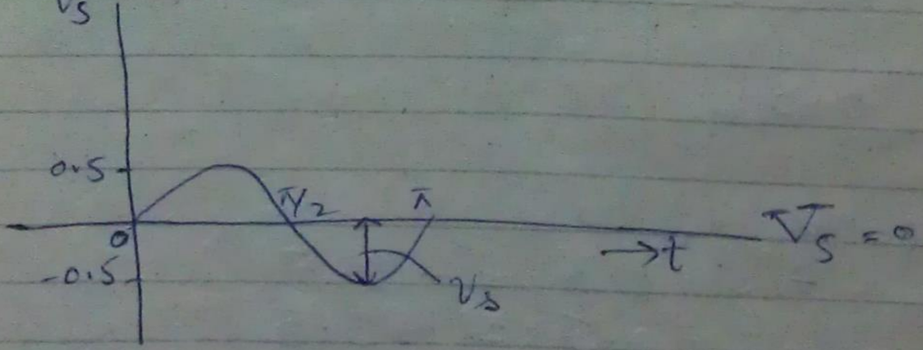
c) $V_S = 0$
$v_s = 0.5 \sin 2t\ V$

$v_S = V_S + v_s$
$= 0 + 0.5 \sin 2t$

$V_m = 0.5$

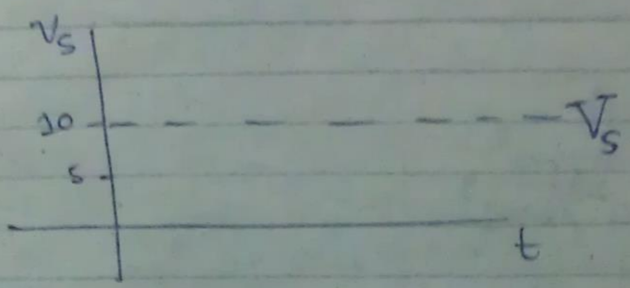
$T = \pi$

upper extreme = $0 + 0.5 = 0.5$
Lower extreme = $0 - 0.5 = -0.5$



d) $V_S = 10V$
$v_s = 0$

$v_S = V_s + v_s$
$= 10 + 0$



1.2) Electric Quantities:
$V = 12V$
Q3) Energy of electron = ?

Energy $= qV$
$= (1.6 \times 10^{-19}) \times 12$
Energy $= 1.92 \times 10^{-18}$ J

$P = VI$
$\frac{W}{t} = V\frac{Q}{t}$
$\boxed{W = VQ}$

* Does energy of electron increase or decrease?
As electron is to have moved from +ve terminal of battery to -ve terminal. & for it we have to do work & electron absorbs this energy so, energy of electron increases.

*Does battery absorb or release energy?

As current in the battery flows from -ve to +ve terminal so, according to the sign conventions battery releases energy.

Q4)

$I = 1\,A$

$A = 1\,mm^2$

$N = 10^{23}/cm^3 \Rightarrow n = N/V$

$n = \frac{1 \times 10^{23}}{10^{3}} = 1 \times 10^{20}/mm^3$

$V_{av} = ?$

$V_{av} = \frac{I}{nAe}$

$= \frac{1}{1 \times 10^{20} \times 1 \times 1.6 \times 10^{-19}}$

$= \cancel{62.5\,mm/s}$

$V_{av} = 0.00625\,mm/s$

Q5)

$q = 5te^{-10^3 t}$

a) $i = ?$

b) Find $t \geq 0$ at which i is min & find t_{min}.

$i = \frac{dq}{dt}$

$i = \frac{5t e^{-10^3 t}}{dt}$

$i = 5e^{-10^3 t} + 5t(-10^3) e^{-10^3 t}$

$i = 5e^{-10^3 t} . (1 - 10^3 t)$

For min. time we take derivative of i

$\frac{di}{dt} = (-10^3) 5e^{-10^3 t} (1 - 10^3 t) + 5e^{-10^3 t}(-10^3)$

$\Rightarrow -5 \times 10^3 e^{-10^3 t} + 5 \times 10^6 t e^{-10^3 t} - 5e^{-10^3 t} \times 10^3 =$

$5 \times 10^3 e^{-10^3 t} (-1 + 10^3 t - 1) = 0$

$10^3 t = 2$

$t = \frac{2}{10^3}$

$t = 2 \times 10^{-3}$ sec

$\boxed{t = 2 msec}$

$i_{min} = 5e^{-10^3 t} (1 - 10^3 t) \quad \because t = 2 \times 10^{-3}$

$= 5e^{-2} (1 - 2)$

$i_{min} = -5e^{-2} A = -0.676 A$

Q6)

$V = 12 V$

$I = 0.5 A$

$E = ?$

$V = ?$

$P = VI$

$P = 12 \times 0.5$

$$P = 6W$$

$$\text{Energy} = \int_{t_1}^{t_2} P \, d(t)$$

$$\text{Energy} = P \times (t_2 - t_1)$$
$$W = 6 \times (3600 - 0)$$
$$= 21 \times 10^3 W$$
$$W = 21 KW$$

$$Q = \int_{t_1}^{t_2} i \, dt$$

$$Q = i (t_2 - t_1)$$
$$Q = 0.5 (3600 - 0)$$
$$Q = 1800 C$$

Q7)

Cost of energy = 0.10/KWh

a) cost of running 100-W TV for 8h/day for a ~~day~~ week = ?

$$E = P \times t$$
$$E = 100 \times (8 \times 7) h$$
$$= 5600 Wh$$
$$= 5.6 KWh$$

Cost for TV = 0.1×5.6
$= 0.56$

b) Cost of running 25W bulb continuously for a year = ?

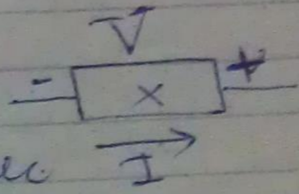
$$E = (25) \times (24 \times 365) h$$
$$E = 219000 Wh$$
$$E = 219 KWh$$

Cost of bulb = 0.1×219
$= 21.9$

Q8) $I = 5e^{-20t}$ A

$V = 3I$

$V = 3 \times 5e^{-20t} = 15e^{-20t}$



Find energy released or absorbed from 0 – 50msec

Energy is releasing.

$P = VI$

$= 15e^{-10t} \cdot 5e^{-10t}$

$P = 75e^{-20t}$ W

$$\text{Energy} = \int_0^{50\times10^{-3}} 75e^{-20t} \, dt$$

$$= \left| \frac{75e^{-20t}}{-20} \right|_0^{50\times10^{-3}}$$

$$= \frac{-75}{20}\left[e^{-1} - 1\right]$$

$$= \frac{75}{20}\left(1 - e^{-1}\right)$$

$$= \frac{75}{20} \times 0.63$$

Energy = 2.36 Wsec or J

Q9)

$V = 10e^{-5t}$

$i = 3V$

$= 3 \times 10e^{-5t}$

$= 30e^{-5t}$

$W = ?$

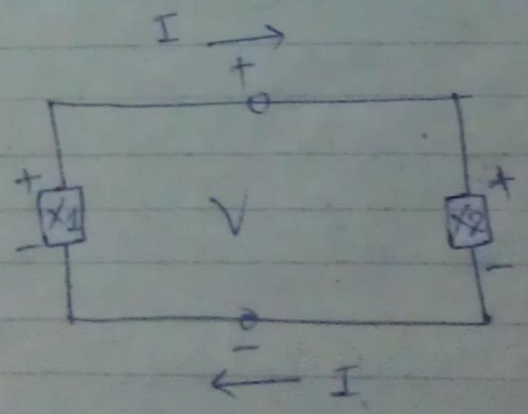
$t = 0.1s \rightarrow 0.5s$

$$P = VI$$
$$= 10e^{-5t} \times 30e^{-5t}$$
$$P = 300e^{-10t}\ W$$

$$W = \int_{0.1}^{0.5} 300e^{-10t}\, dt$$
$$= 300 \left| \frac{e^{-10t}}{-10} \right|_{0.1}^{0.5}$$
$$= -\frac{300}{10}\left[e^{-10(0.5)} - e^{-10(0.1)}\right]$$
$$= -30\left(e^{-5} - e^{-1}\right)$$
$$= -30 \times (-0.36)$$
$$W = 10.8\ J$$

Energy is absorbing

Q10)



$V = 10\ V$
$I = 2A$
$P = ?$

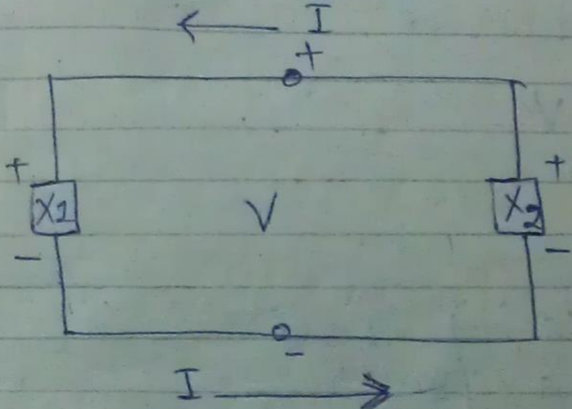
X_1 is releasing Power.
X_2 is absorbing power.

$P = VI$
$P = 10 \times 2$
$P = 20W$

X_1 enter from top =
X_2 → enter from bottom

Σ power released = Σ power absorbed.

Q11)



a)

$V = 5V$
$I = -2A$

X_2 is releasing power
X_1 is absorbing power.

$P = 5 \times (-2)$
$P = -10W$

b)

$V = 5V$
$i = 4V$

$P = 20W$

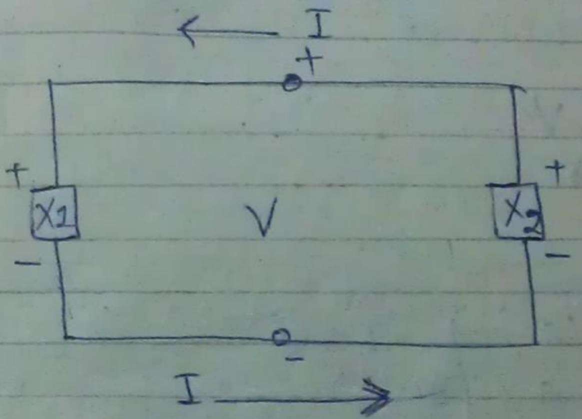
X_1 is releasing & X_2 is absorbing power.

$P = VI$
$P = 10 \times 2$
$P = 20\,W$

X_1 enter from top ⇒
X_2 → enter from bottom

Σ power released = Σ power absorbed.

Q11)



a)
$V = 5\,V$
$I = -2A$

X_2 is releasing power
X_1 is absorbing power.

$P = 5 \times (-2)$
$P = -10\,W$

b)
$V = 5V$
$i = 4V$

$P = 20W$

X_1 is releasing & X_2 is absorbing power.

c) $v = -24\,V$
$i = 5\,A$

$P = -120\,W$

X_2 is releasing & X_1 is absorbing power

d) $v = -12\,V$
$i = -2\,A$

$P = 24\,W$

X_1 is releasing power & X_2 is absorbing power

e) $v = 0\,V$
$i = 10\,A$
$P = 0\,W$

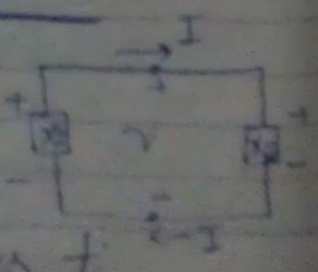
No power.

f) $v = 220\,V$
$i = 0\,A$
$P = 0\,W$

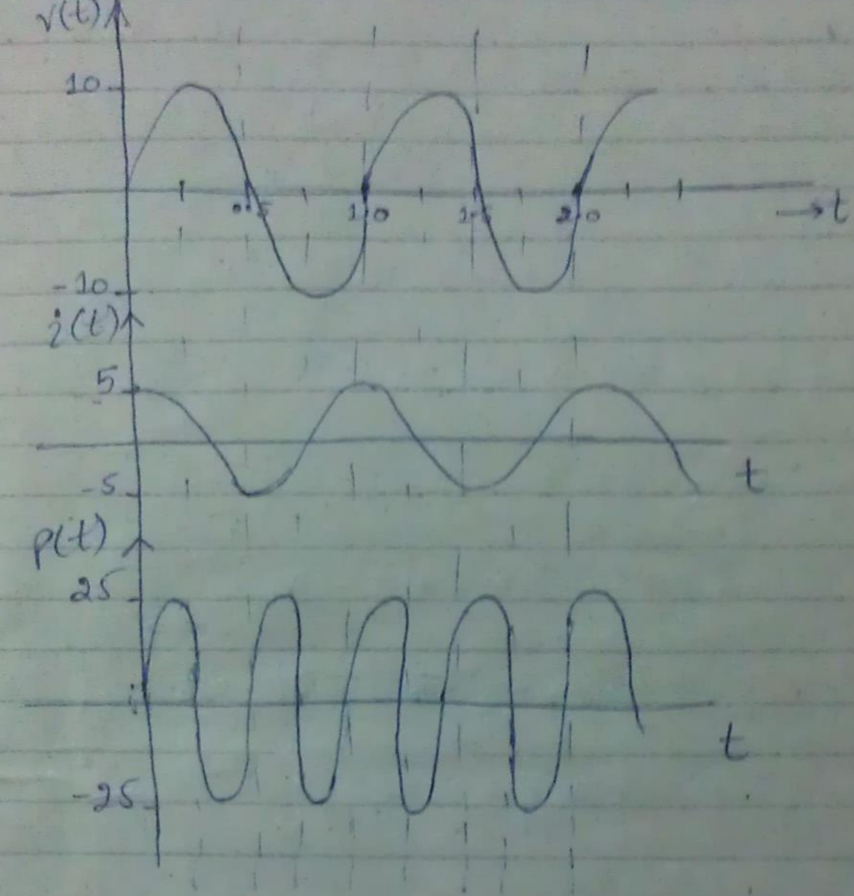
No power.

Q12)

$v = 10 \sin 2\pi 10^3 t \; V$
$i = 5 \cos 2\pi 10^3 t \; A$



Plot v, i, & p versus t.



$P = VI$

$P = 10 \sin 2\pi 10^3 t \cdot 5 \cos 2\pi 10^3 t$

$P = 50 \sin 2\pi 10^3 t \cdot \cos 2\pi 10^3 t \quad \because 2\sin\theta\cos\theta = \sin 2\theta$

$P = 25 \sin 2\pi 2 \times 10^3 t$ Watt

		Power	
From 0 ms → 0.25 ms	X_1	released →	X_2 absorbed
0.25 ms → 0.5 ms	X_2	→	X_1
0.5 ms → 0.75 ms	X_1	→	X_2
0.75 ms → 1 ms	X_2	→	X_1

Q13)

$v = 10 \sin 2\pi 10^3 t \ V$

$i = 5 \sin(2\pi 10^3 t - \pi/4) \ A$

$P = v i$

$= 10 \sin 2\pi 10^3 t \cdot 5 \sin(2\pi 10^3 t - \pi/4)$

$= 50 \sin(2\pi 10^3 t) \cdot \sin(2\pi 10^3 t - \pi/4)$

$= -25 \left[-2 \sin 2\pi 10^3 t \cdot \sin(2\pi 10^3 t - \pi/4)\right]$

$= -25 \left[-2 \sin \omega t \ \sin(\omega t - \pi/4)\right]_{\omega = 2\pi 10^3}$

$= -25 \left[\cos(\omega t + \omega t - \pi/4) - \cos(\omega t - \omega t + \pi/4)\right]$

$= -25 \left\{\left[\cos(2\omega t - \pi/4)\right] - \cos(\pi/4)\right\}$

$= -25 \cos(2\omega t - \pi/4) + 25 \cos \pi/4$

$P = 17.67 - 25 \cos(2 \cdot 2\pi 10^3 t - \pi/4)$

$\therefore P_s = 17.67$ (offset) $\qquad P_m = -25$

$P_s + P_m = 17.67 - 25 = -7.33$

$P_s - P_m = 17.67 + 25 = 42.67$

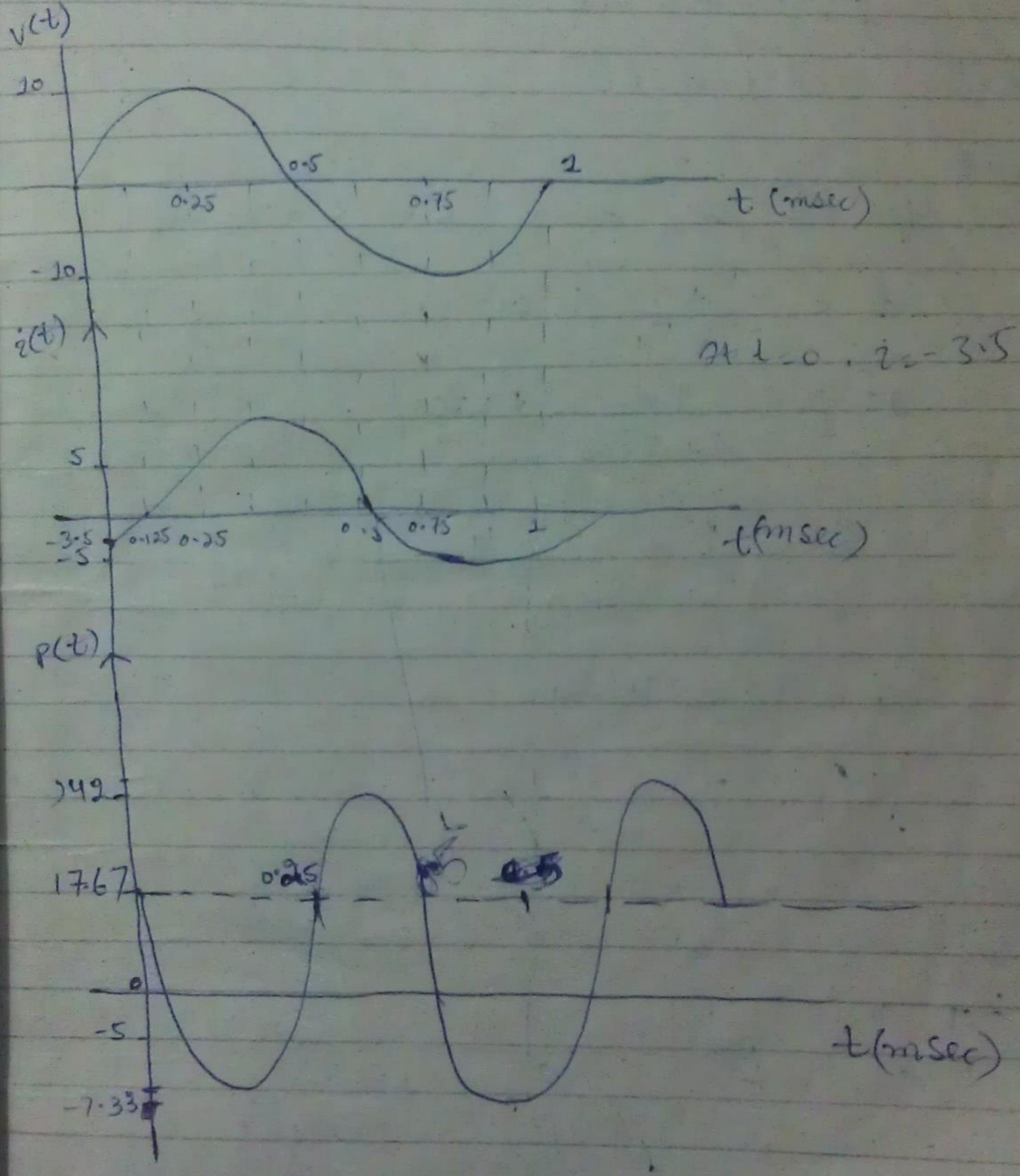
For v

$v_m = 10V \qquad f = 10^3 Hz$

$\Rightarrow t = 1 ms$

For i

$i_m = 5A$ $t = 1$ msec



$i = 0 \longrightarrow 1mA$

Q14) $d = 25\%$

$f = 1KHZ$

$f = 1\times10^3 HZ$

$\Rightarrow \quad t = 1\,msec$

Net charge $= ?$
transferred b/w $t=0 \longrightarrow t=5\,msec$

Sol

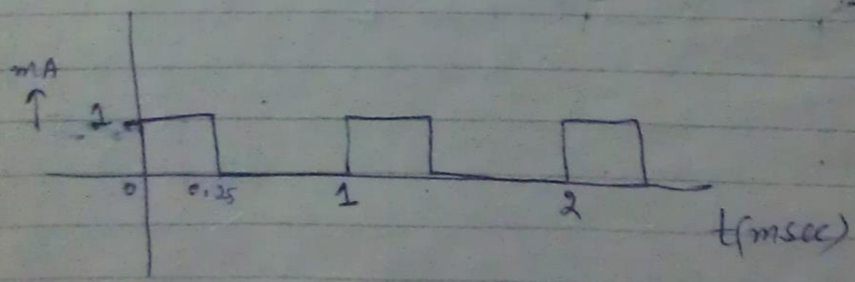
$$d = \frac{T_H}{T_L + T_H} \times 100\%$$

$$25\% = \frac{T_H}{T_H + T_L} \times 100\%$$

$$1 = \frac{T_H}{T_H + T_L} \times 4$$

$$T_H + T_L = 4T_H$$

$$\boxed{T_L = 3T_H}$$



From $0 \longrightarrow 0.25\,mS$

$$q_1 = \int_0^{0.25\times10^{-3}} 1\times10^{-3}\,dt$$

$$= 0.25\times10^{-6}\,C$$

$$q_1 = 0.25\,\mu C$$

From $0.25 \rightarrow 1$ msec

$$q_2 = \int_{0.25\times10^{-3}}^{1\times10^{-3}} 0\,dt$$

$$q_2 = 0\,\mu C$$

$$q_o = q_1 + q_2$$

$$q_o = 0.25\,\mu C$$

From $t=0 \longrightarrow t=5$ msec

$$q = (0.25\,\mu C)\times5\times10^{-3}$$

$$q = 1.25\,\mu C$$

Q.15)

$f = 1\,KHZ$

upper extreme $= -5\,mA$

Lower extreme $= 0\,mA$

$\Rightarrow$ ~~$V_s + V_m = 5\,mA$~~

~~$V_s - V_m = 0\,mA$~~

$\Rightarrow$ $I_s + I_m = -5\ mA$ — ①
$I_s - I_m = 0\ mA$ — ②

Adding ① & ②

$2I_s = -5$
$I_s = -2.5\ mA$

put in ①
$I_m = 2.5\ mA$

Now,

$i_s = I_s + i_s$
$= I_s + I_m \sin 2\pi f t$

$i_s = -2.5 \times 10^{-3} + 2.5 \times 10^{-3} \sin 2\pi 10^3 t$ (mA)

b) $T = 1\mu s \Rightarrow f = 10^6\ Hz$
$V_s + V_m = -10\ V$ — ①
$V_s - V_m = -15\ V$ — ②

① + ②

-12.5

$2V_s = -25$
$V_s = -12.5\ V$

① $\Rightarrow$ $V_m = 2.5\ V$

$v_s = V_s + V_m \sin 2\pi f t$
$= -12.5 + 2.5 \sin 2\pi 10^6 t$

Q16) $v = 100e^{-10^3 t}$ V

a) $t_1 = 0$ and $t_2 = 1$ msec

$$V_{av} = \frac{1}{t_2 - t_1}\int_{t_1}^{t_2} v\,dt$$

$$V_{av} = \frac{1}{1\times10^{-3}}\int_{0}^{1\times10^{-3}} 100e^{-10^3 t}\,dt$$

$$V_{av} = \frac{1}{1\times10^{-3}} \times \frac{100}{(-10^3)}\left[e^{-10^3 t}\right]_0^{1\times10^{-3}}$$

$$= -100\,(e^{-1} - e^{0})$$

$$\boxed{V_{av} = 63.2V}$$

b) $t_1 = 0$ and $t_2 = 2$ msec

$$V_{av} = \frac{1}{2\times10^{-3}}\int_{0}^{2\times10^{-3}} 100e^{-10^3 t}\,dt$$

$$= \frac{1}{2\times10^{-3}} \times \frac{100}{(-10^3)}\left[e^{-10^3 t}\right]_0^{2\times10^{-3}}$$

$$= -50\,(e^{-2} - e^{0})$$

$$= -50\,(0.13 - 1)$$

$$\boxed{V_{av} = 42.5\,V}$$

Q27) $V = 10 e^{-10^3 t}$ V ①
$V_1 = 9V$ & $V_2 = 1V$

put $V_1 = 9V$ in ①

$9 = 10 e^{-10^3 t_1}$

$\ln 9 = 10(-10^3) t_1$

$\ln \frac{9}{10} = -10^3 t_1$

$t_1 = -10^{-3} \ln \frac{9}{10}$

$t_1 = 1.05 \times 10^{-4}$

⇒ $\boxed{t_1 = 0.1 \times 10^{-3} \text{ sec}}$

put $V_2 = 1V$ in ①

$1 = 10 e^{-10^3 t_2}$

$\ln \frac{1}{10} = -10^3 t_2$

$t_2 = -10^{-3} \ln \frac{1}{10}$

⇒ $t_2 = 2.3 \times 10^{-3}$ sec

$$V_{av} = \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} 10 e^{-10^3 t} \, dt$$

$$V_{av} = \frac{1}{2.3 \times 10^{-3} - 0.1 \times 10^{-3}} \times \frac{10}{-10^3} \left[e^{-10^3 t} \right]_{0.1 \times 10^{-3}}^{2.3 \times 10^{-3}}$$

$$V_{av} = \frac{1}{2.2\times10^{-3}} \times \frac{10}{(-10^3)} \left[e^{-2.3} - e^{-0.1}\right]$$

$$= \frac{-10}{2.2\times10^{-6}} \left[0.10 - 0.90\right]$$

$$= -4.54\times10^{6} (-0.8)$$

$$V_{av} = 3.63 \text{ V}$$

Q18) $i = 20(1-e^{-500t})\, mA$

$t_1 = 1\, m\sec$ & $t_2 = 3\, m\sec$

$i_{av} = ?$

$$i_{av} = \frac{1}{3\times10^{-3} - 1\times10^{-3}} \int_{1\times10^{-3}}^{3\times10^{-3}} 20(1-e^{-500t})\, dt$$

$$i_{av} = \frac{1}{2\times10^{-3}} (20) \left[t - \frac{e^{-500t}}{-500}\right]_{1\times10^{-3}}^{3\times10^{-3}}$$

$$= \frac{20}{2\times10^{-3}} \left[(2\times10^{-3}) + \frac{1}{500}\left(e^{-1.5} - e^{-0.5}\right)\right]$$

$$= \frac{20}{2\times10^{-3}} \left[2\times10^{-3} + 4.4\times10^{-4} - 1.2\times10^{-3}\right]$$

$$= \frac{0.0248}{2\times10^{-3}}$$

$$i_{av} = 12.4\, mA$$

Q19) $i = 100(1 - e^{-500t})\,mA$ ---- (1)

$i_1 = 0\,mA$ & $i_2 = 50\,mA$

put $i_1 = 0\,mA$ in (1)

$0 = 100(1 - e^{-500t_1})$

$0 = 100(1 - e^{-500t_1})$

$0 = 1 - e^{-500t_1}$

$1 = e^{-500t_1}$

$\ln 1 = -500t_1$

$0 = -500t_1$

$t_1 = 0\,msec$

Put $i_2 = 50\,mA$ in (1)

$50 = 100(1 - e^{-500t_2})$

$\frac{1}{2} = 1 - e^{-500t_2}$

$e^{-500t_2} = \frac{1}{2}$

$-500t_2 = \ln\frac{1}{2}$

$t_2 = 1.3 \times 10^{-3}$

$$i_{av} = \frac{1}{1.3\times10^{-3}}\int_0^{1.3\times10^{-3}} 100\,(1 - e^{-500t})\,dt$$

$$= \frac{100}{1.3\times10^{-3}}\left[t - \frac{e^{-500t}}{-500}\right]_0^{1.3\times10^{-3}}$$

$$= \frac{100}{1.3\times10^{-3}}\left[(1.3\times10^{-3}) + \frac{1}{500}\left(e^{-0.65} - e^{0}\right)\right]$$

$$i_{av} = \frac{100}{1.3\times10^{-3}}\left(1.3\times10^{-3} + 1.04\times10^{-3} - 2\times10^{-3}\right)$$

$$i_{av} = 26.15\ mA$$

Q20)

Signal alternates b/w $-1V$ & $+2V$
full cycle average = ?

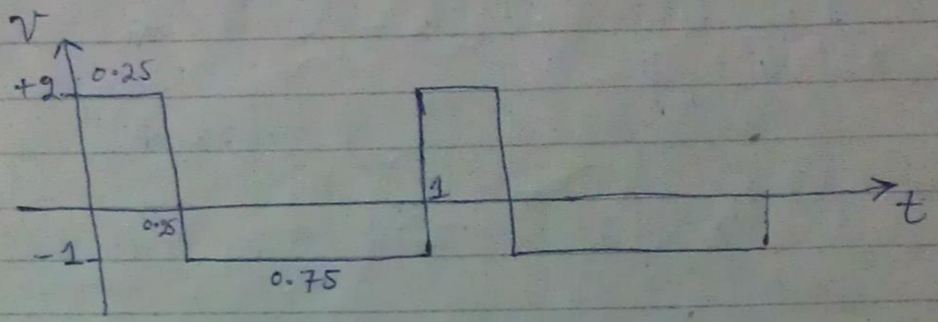
a) $d = 25\%$

$$d = \frac{T_H}{T_H + T_L} \times 100\%$$

$$25\% = \frac{T_H}{T_H + T_L} \times 100\%$$

$$T_H + T_L = 4T_H$$

$$T_L = 3T_H$$



$$V_{av} = \frac{1}{1}\left[\int_{0}^{0.25} 2\,dt + \int_{0.25}^{1} -1\,dt\right]$$

$$= 2\times(0.5) + (-1)(0.75)$$

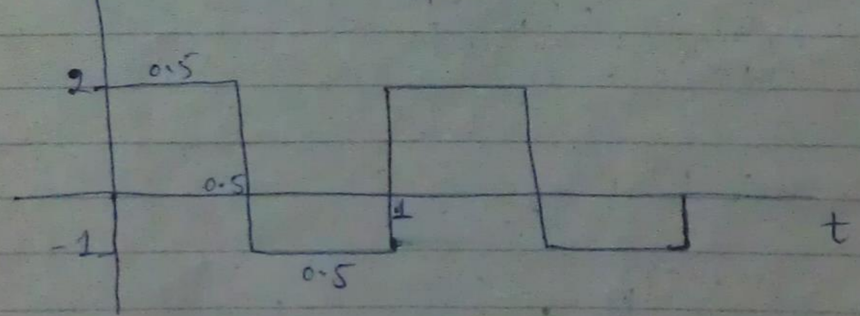
$$\boxed{V_{av} = -0.25V}$$

$d = 50\%$

$$50\% = \frac{T_H}{T_L + T_H} \times 100\%$$

$$T_H + T_L = 2T_H$$

$$T_L = T_H$$



$$V_{av} = \frac{1}{1}\left[\int_{0}^{0.5} 2dt + \int_{0.5}^{1} -1\;dt\right]$$

$$v_{avg} = 2 \times 0.5 + (-1)(0.5)$$

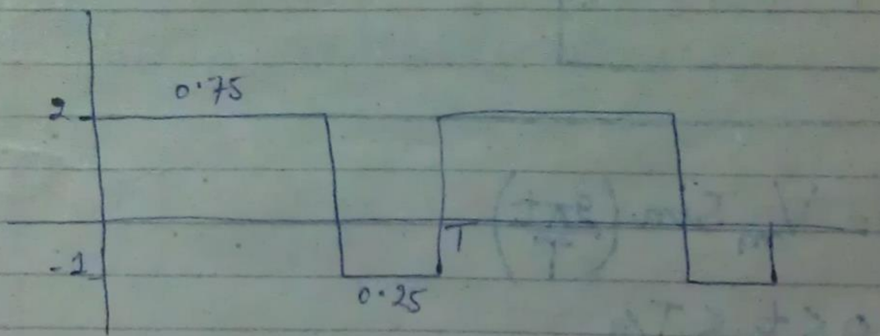
$$\boxed{v_{avg} = 0.5\ V}$$

$d = 75\%$

$$75 = \frac{T_H}{T_L + T_H} \times 100$$

$$3T_H + 3T_L = 4T_H$$

$$T_H = 3T_L$$



$$v_{av} = \frac{1}{1}\left[\int_0^{0.75} 2\,dt + \int_{0.75}^{1} -1\,dt\right]$$

$$= 2 \times 0.75 + (-1) \times 0.25$$

$$\boxed{V_{av} = 1.25\ V}$$

2) $V_{avg} = 0$, $d = ?$

$$0 = \frac{1}{1}\left[\int_0^d 2\,dt + \int_d^1 -1\,dt\right]$$

$$0 = 2(d) + (-1)(1-d)$$

$$0 = 2d - 1 + d$$

$$0 = 3d - 1$$

$$d = 1/3$$

$$d = 0.33$$

$$d = 0.33 \times 100\%$$

$$\boxed{d = 33.3\%}$$

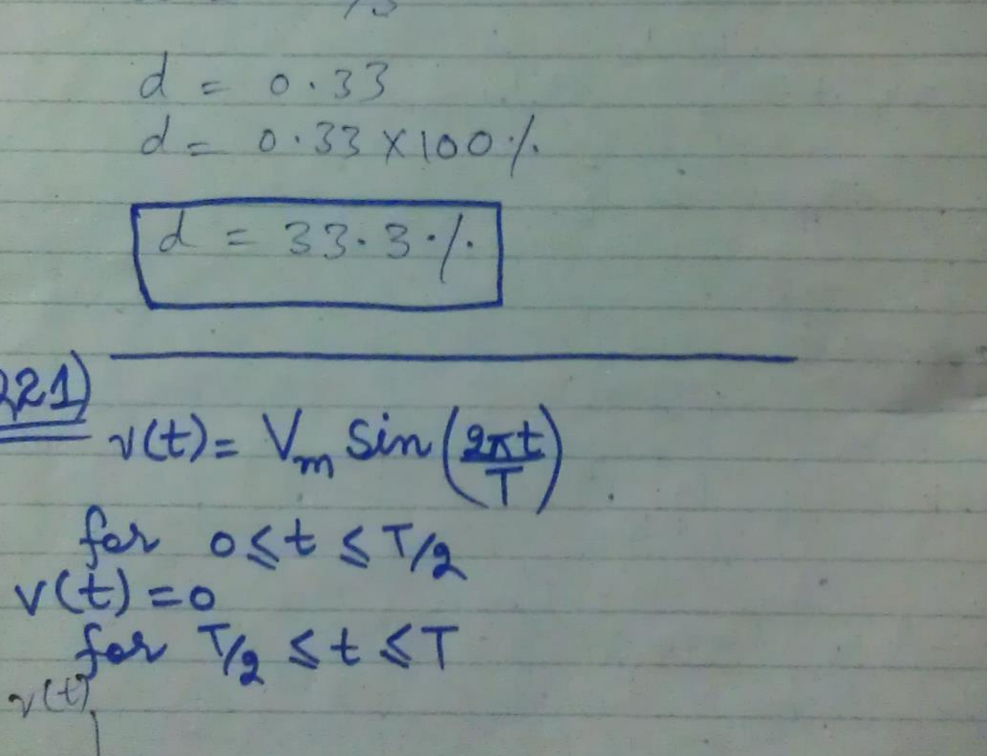
Q21)

$$v(t) = V_m \sin\left(\frac{2\pi t}{T}\right)$$

for $0 \leq t \leq T/2$

$$v(t) = 0$$

for $T/2 \leq t \leq T$



$$V_{av} = \frac{1}{T-0}\left[\int_0^{T/2} V_m \sin\frac{2\pi t}{T}\,dt + \int_{T/2}^{T} 0\,dt\right]$$

$$V_{av} = \frac{1}{T} V_m \left[\frac{-\cos \frac{2\pi t}{T}}{\frac{2\pi}{T}} \right]_0^{T/2}$$

$$= -\frac{1}{\cancel{T}} (V_m) \left(\frac{\cancel{T}}{2\pi} \right) \left[\cos \frac{2\pi}{\cancel{T}} \cdot \frac{\cancel{T}}{2} - \cos 0 \right]$$

$$= -\frac{V_m}{2\pi} (-1 - 1)$$

$$= -\frac{V_m}{2\pi} (-2)$$

$$\boxed{V_{av} = \frac{V_m}{\pi}}$$

Q.22)

$v(t) = 170 |\sin 120 \pi t|$

$T = ?$

$V_{av} = ?$

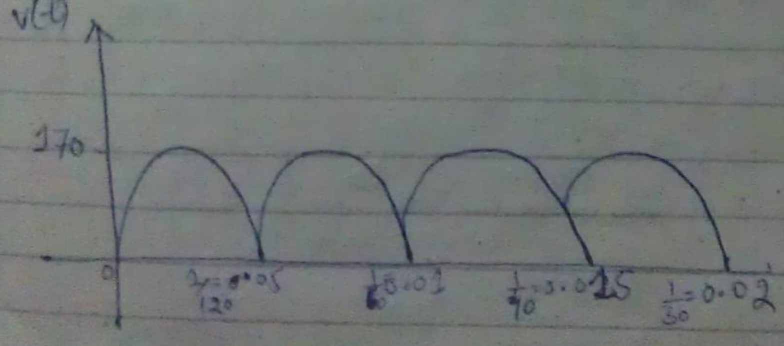
$V_m = 170$

$v(t) = 170 \sin 2\pi 60 t$

$\Rightarrow f = 60 \, HZ$

$T = \frac{1}{60}$

$T = 0.01$ Sec



From graph

$T = \frac{1}{120}$ sec

$$V_{av} = \frac{1}{T}\int_0^{1/120} 170\,(\sin 120\pi t)\,dt$$

$$= 120 \times 170 \left| -\frac{\cos 120\pi t}{120\pi} \right|_0^{1/120}$$

$$= -\frac{\cancel{120}\times 170}{\cancel{120}\times \pi}\,(\cos\pi - \cos 0)$$

$$= -\frac{170}{\pi}\,(-1-1)$$

$$V_{av} = 108.28\ V$$

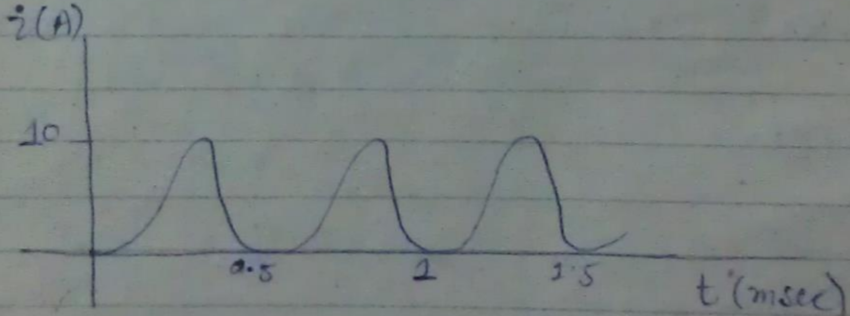
Q23)

$$i(t) = 10\sin^2 2\pi 10^3 t\ A$$

$f = 10^3$ HZ $\qquad i_m = 10$

$T = 1\times 10^{-3}$ sec

$T = 1$ msec



From graph $T = 0.5$ msec

$$i_{av} = \frac{1}{0.5\times 10^{-3} - 0}\left[\int_0^{0.5\times 10^{-3}} 10\sin^2 2\pi 10^3 t\,dt\right]$$

$$i_{av} = \frac{10}{0.5\times10^{-3}} \int_0^{0.5\times10^{-3}} \frac{1 - \cos 4\pi10^3 t}{2}\, dt$$

$$= \frac{10}{1\times10^{-3}} \int_0^{0.5\times10^{-3}} 1 - \cos 4\pi10^3 t \; dt$$

$$= 1\times10^4 \left[t - \frac{\sin 4\pi10^3 t}{4\pi\times10^3} \right]_0^{0.5\times10^{-3}}$$

$$= 1\times10^4 \left[(0.5\times10^{-3}) - \left(\frac{\sin 2\pi}{4\pi\times10^3} - \frac{\sin 0}{4\pi\times10^3} \right) \right]$$

$$= 1\times10^4 \left(0.5\times10^{-3} - 0 + 0 \right)$$

$$i_{av} = 5\ A$$

Q24)

$v(t) = 4e^{-t}\ V$

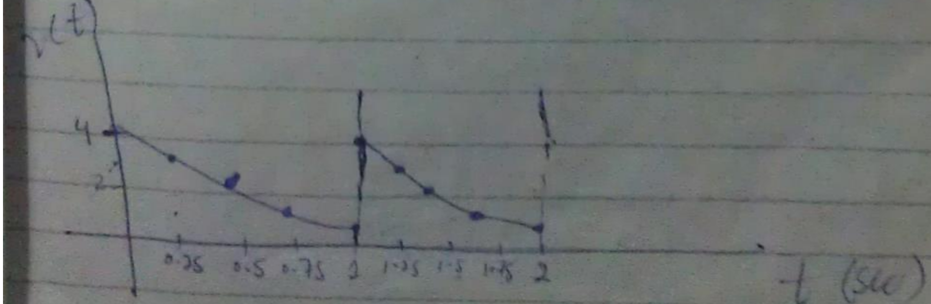
for $0 < t < 1S$

$V_{av} = ?$

$v(t \pm n1) = v(t)$

$T = 1\ Sec$

t	0	0.25	0.5	0.75	1
v	4	3.12	2.43	1.89	1.47



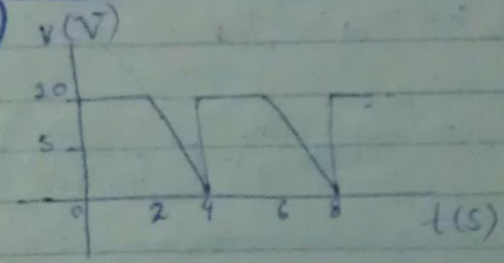
$$V_{av} = \frac{1}{1-0} \int_0^1 4e^{-t}\,dt$$

$$= 4 \left| \frac{e^{-t}}{-1} \right|_0^1$$

$$= -4\,(e^{-1} - e^{0})$$

$$V_{av} = 2.52\,V$$

Q25)



$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$m = \frac{10-0}{4-2} = 5$$

$$y = mt + c$$

$$y = -5t + 20$$

$T = 4\,sec$

$$V_{av} = \frac{1}{4}\left[\int_0^2 10\,dt + \int_2^4 20 - 5t\,dt\right]$$

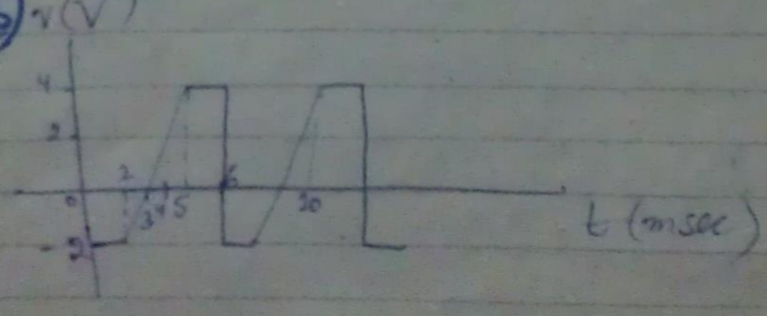
$$= \frac{1}{4}\, |10t|_0^2 + \left|20t - \frac{5t^2}{2}\right|_2^4$$

$$= \frac{1}{4}\left\{20 + 40 - [40 - 10]\right\}$$

$$= \frac{1}{4}(30)$$

$$V_{av} = 7.5\,V$$

Q26)



$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4-(-2)}{5-2} = \frac{6}{3} = 2$

$y = mt + c$

$y = 2t - 6$ $\boxed{\text{y-intercept}}$

$V_{av} = ?$

$T = 6\,msec$

$V_{av} = \frac{1}{T}\int_0^T v(t)\,dt$

$= \frac{1}{6\times10^{-3}}\left[\int_0^{2\times10^{-3}} -2\,dt + \int_{2\times10^{-3}}^{5\times10^{-3}} (2\times10^3 t - 6)\,dt + \int_{5\times10^{-3}}^{6\times10^{-3}} 4\,dt\right]$

$= \frac{1}{6\times10^{-3}} \left|-2t\right|_0^{2\times10^{-3}} + \left[\frac{2\times10^3 t^2}{2} - 6t\right]_{2\times10^{-3}}^{5\times10^{-3}} + \left[4t\right]_{5\times10^{-3}}^{6\times10^{-3}}$

$= \frac{1}{6\times10^{-3}}\Big[-2\times2\times10^{-3} + \{10^3(25\times10^{-3}) - 6\times5\times10^{-3} - 10^3(4\times$

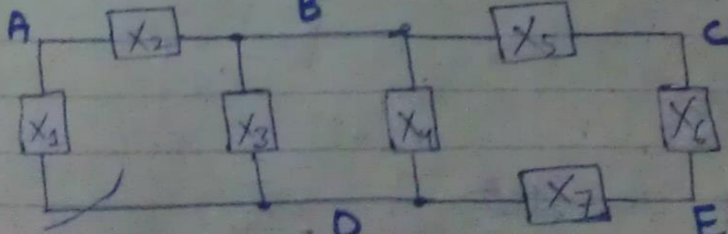
$+ (4\times6\times10^3) + (4\times6\times10^{-3} - 4\times5\times10^{-3})\}\Big]$

$= \frac{1}{6\times10^{-3}}\Big[-4\times10^{-3} + 25\times10^{-3} - 30\times10^{-3} - 4\times10^{-3} + 12\times10^{3}$
$+ 24\times10^{-3} - 20\times10^{-3}$

$= \frac{3\times10^{-3}}{6\times10^{-3}}$

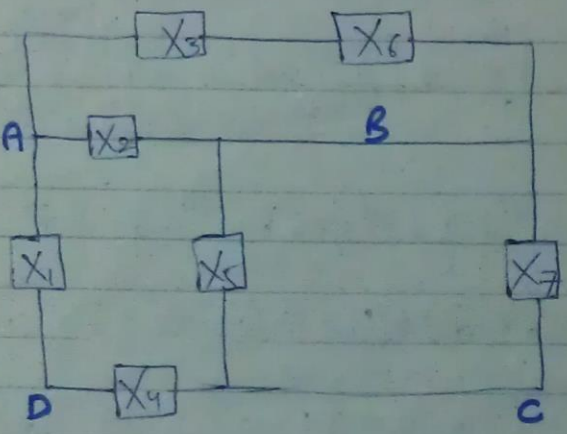
$V_{av} = 0.5\,V$

Q27)



A, B, C, D, E are Nodes.
Simple nodes: A, C, E
Meshes: $X_1X_2X_3$, X_3X_4, $X_4X_5X_6X_7$
Loops: $X_1X_2X_4$, $X_3X_5X_6X_7$, $X_1X_2X_5X_6X_7$
In Series: X_1X_2, $X_5X_6X_7$
In parallel: X_3X_4

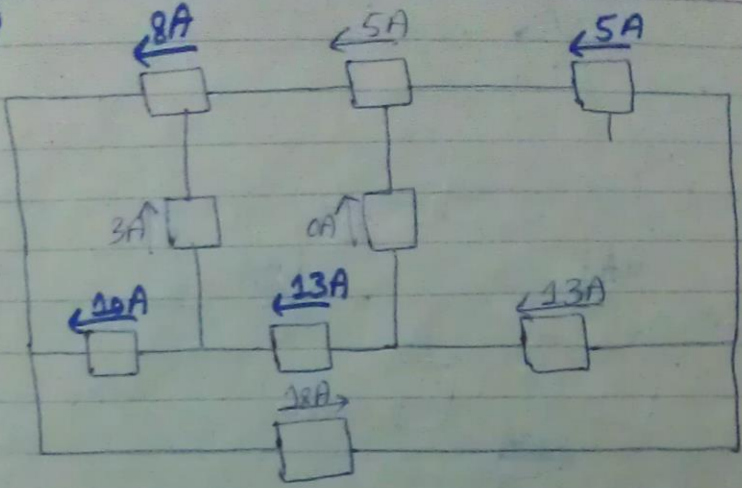
Q28)



Nodes: A, B, C, D
Simple Nodes: D
Meshes: $X_1X_2X_4X_5$, X_5X_7, $X_2X_3X_6$
Loops: $X_1X_4X_3X_6X_7$, $X_1X_2X_4X_7$
In Series: X_3X_6, $X_1\cancel{X_5}X_4$
In parallel: X_5X_7

Q29)

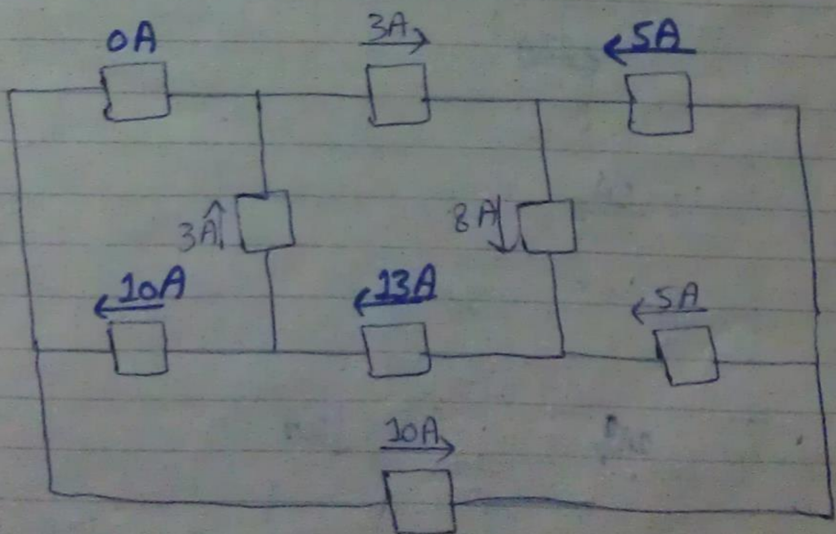
Q30) a)


8A
5A
5A
3A
0A
10A
13A
13A
18A

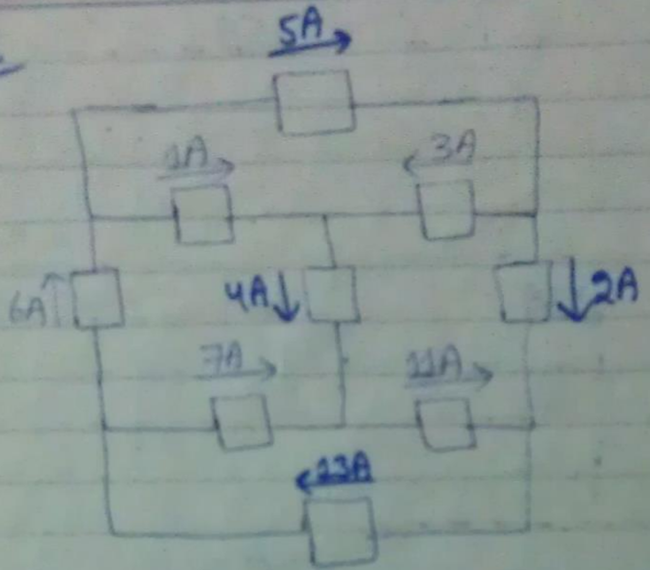
b)


2A
5A
5A
3A
10A
10A
13A
3A
8A

c)

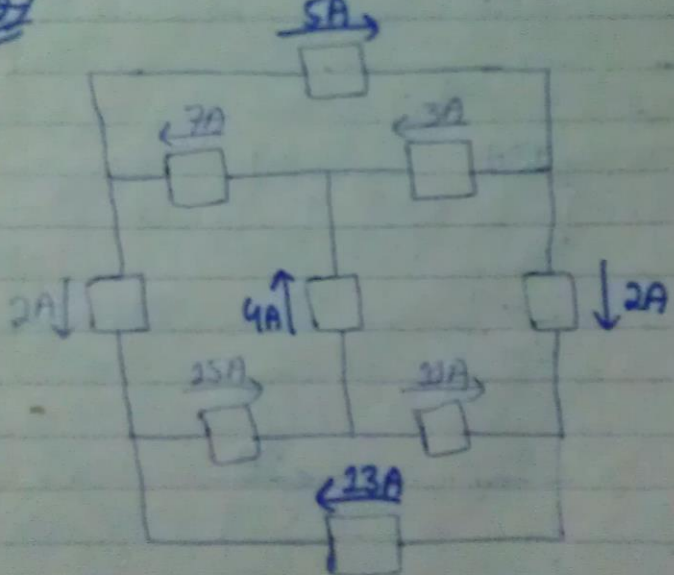

0A
3A
5A
3A
8A
10A
13A
5A
10A

Q31)

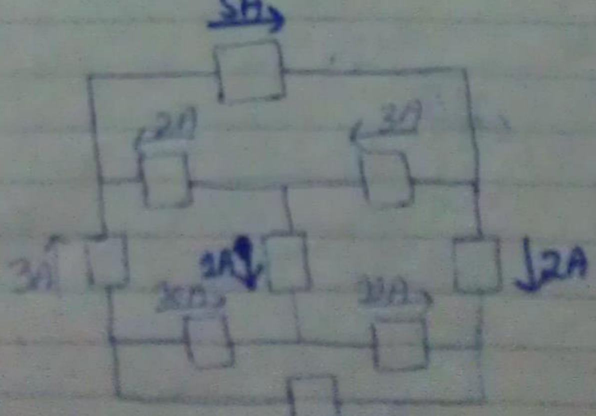

5A
1A
3A
6A
4A
2A
7A
11A
13A

Q32)

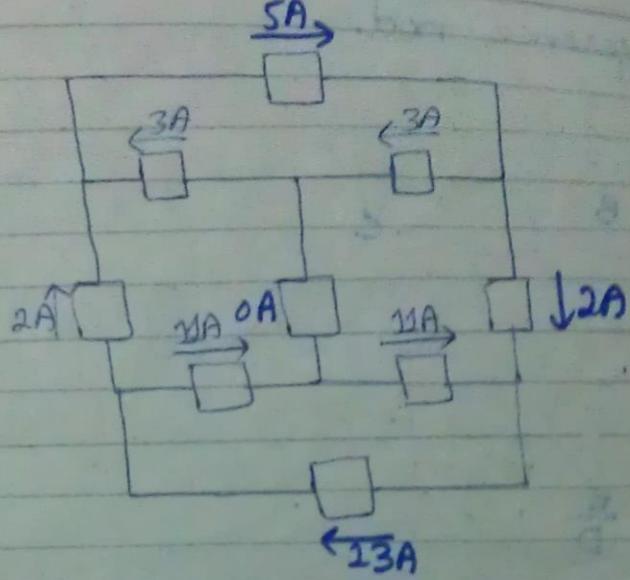
a)


5A
7A
3A
2A
4A
2A
15A
11A
13A

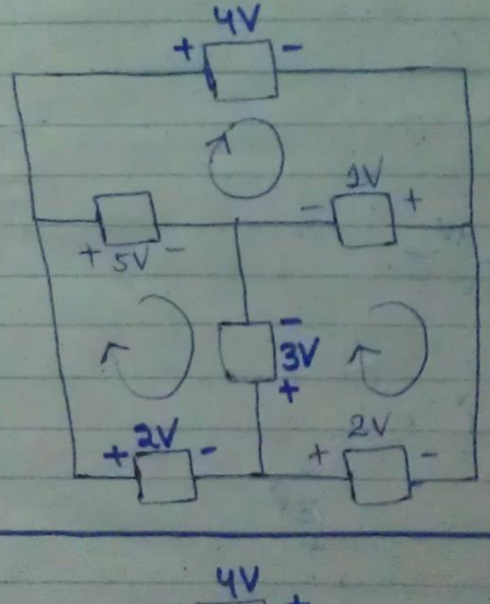
b)


5A
2A
3A
3A
2A

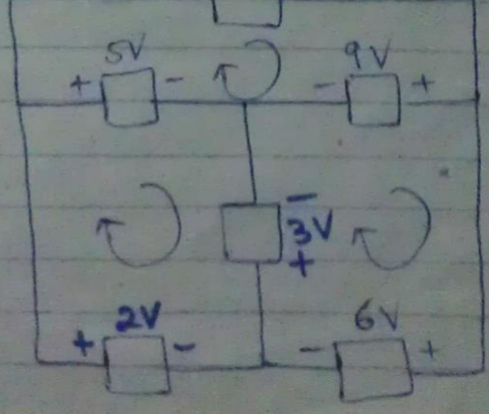
c)



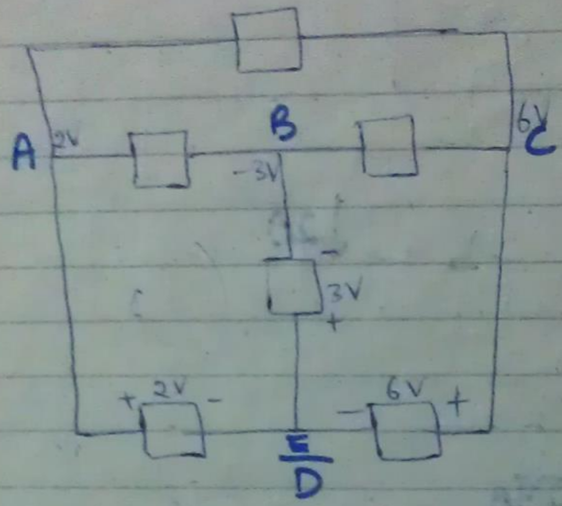
Q33)



Q34)
a)

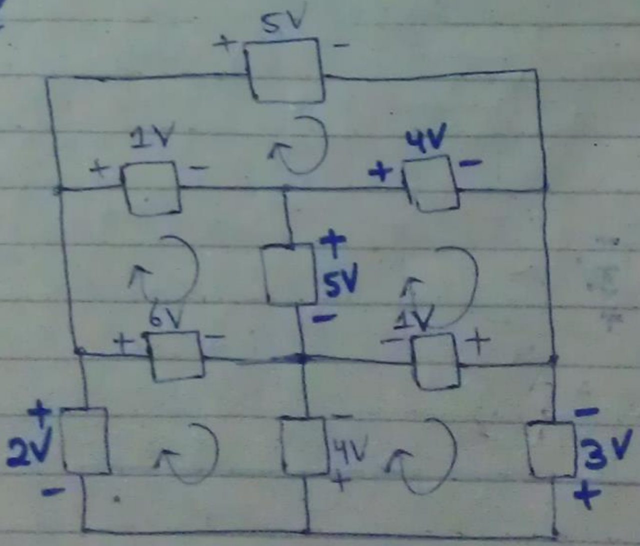


b) D is reference nod



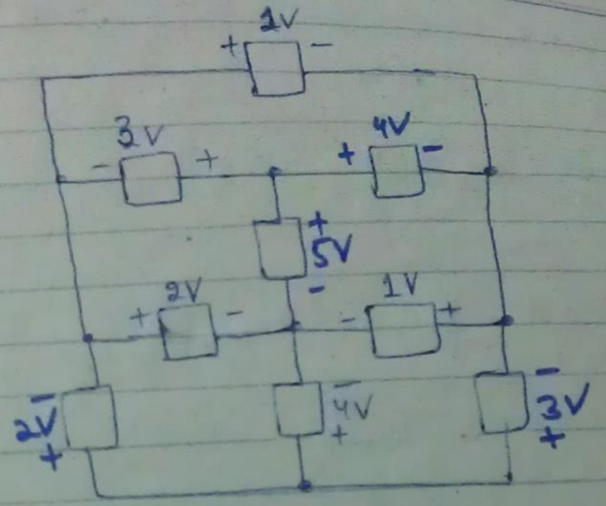
A = 2V , B = -3V , C = 6V

Q35)

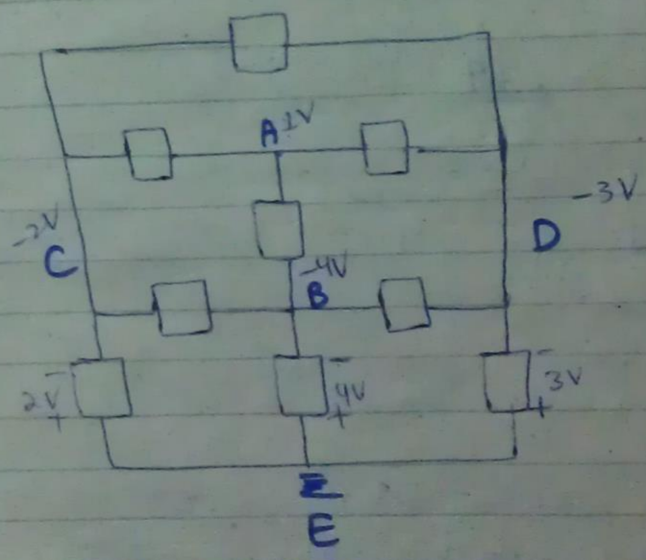


Q 36)

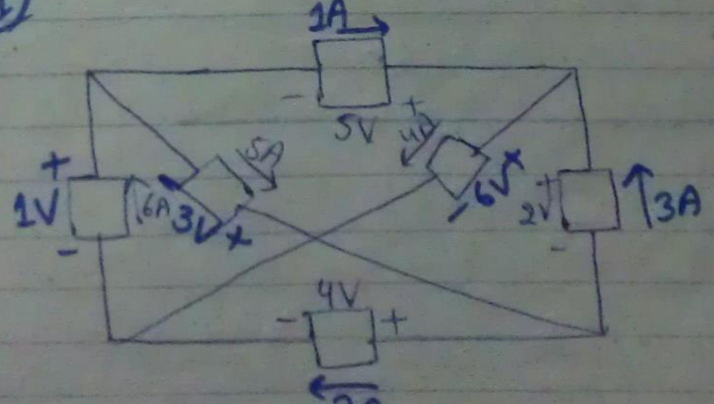
a)


1V
3V
4V
5V
2V
1V
2V
4V
3V

b)


A
1V
-3V
D
-2V
C
-4V
B
2V
4V
3V
E

Q 37)


1A
5V
5A
4V
6V
1V
6A
3V
2V
3A
4V
2A

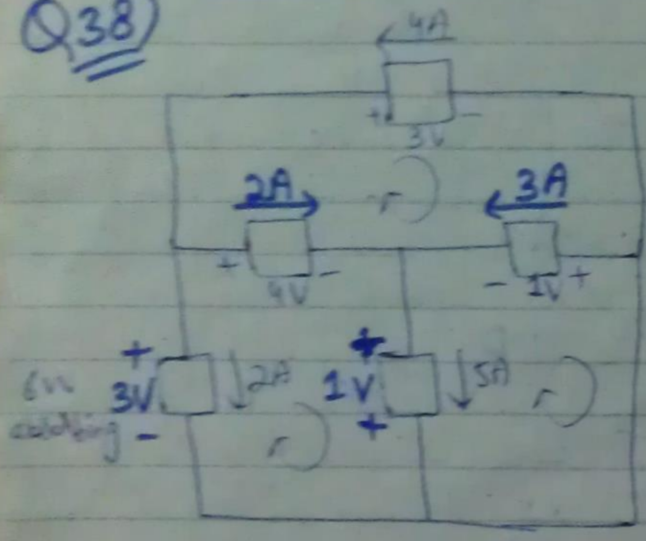
power released $= 1\times5 + 2\times3 + 1\times6 + 3\times5$
$= 32$

Power absorbed $= 6\times4 + 4\times2$
$= 32$

Power released = power absorbed

So, power is conserved.

Q38)

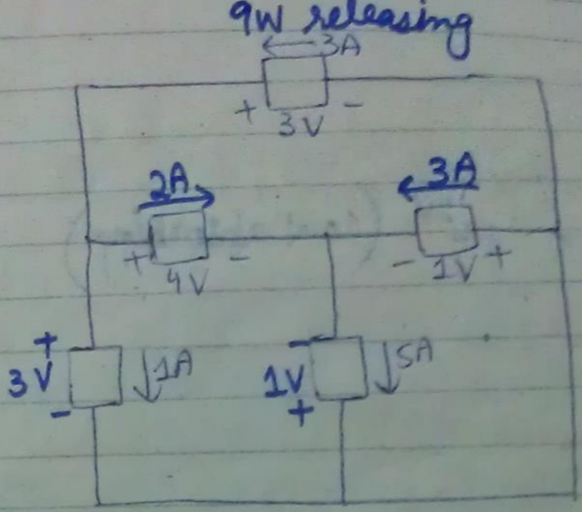


power released $= 4\times3 + 5\times1 = 17$

Power absorbed $= 3\times2 + 2\times4 + 3\times1 = 17$

So, power is conserved

Q39)

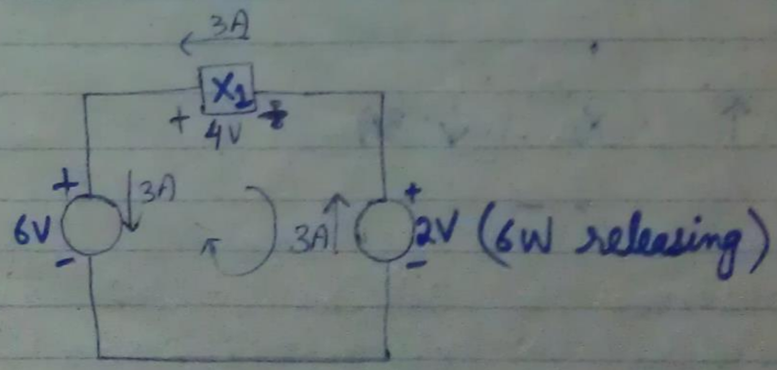


Power released = $3 \times 3 + 1 \times 5 = 14$

Power absorbed $= 2 \times 4 + 3 \times 1 + 1 \times 3 = 14$

So, Power is conserved.

Q49)



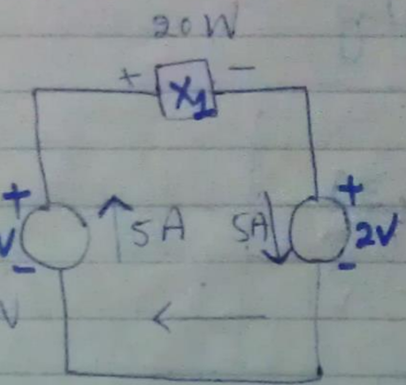
$i = 3A$ (counter clockwise)

b)

Power absorbed by 6V source $= 6 \times 3 = 18W$

Power released by X_1 compound $= 4 \times 3 = 12W$

Q50)



power released 6V
$6 \times 5 = 30W$

(10W absorbing)

$P = VI$

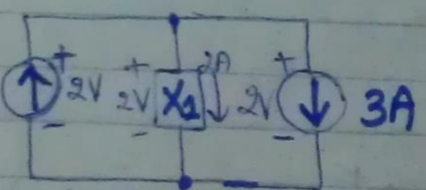
$10 = 2 \times I$

$I = 5A$

Power released $= VI$
$= 6 \times 5$
$= 30W$

Q51)

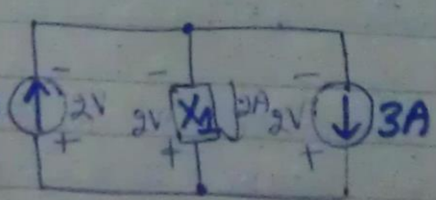
releasing 10W



power absorbed by 3A source $= 3 \times 2 = 6W$
power absorbed by X_1 compound $= 2 \times 2 = 4W$

Q52)

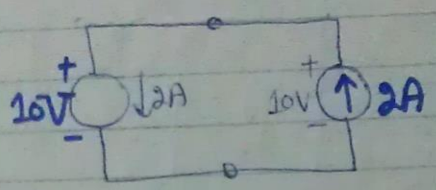
absorbing 10W



Power released by 3A source $= 3 \times 2 = 6W$
Power released by X_1 Compound $= 2 \times 2 = 4W$

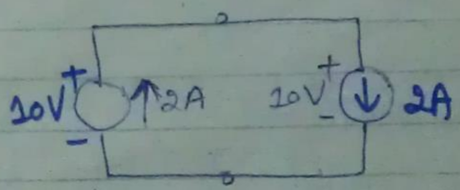
Q53)

a)



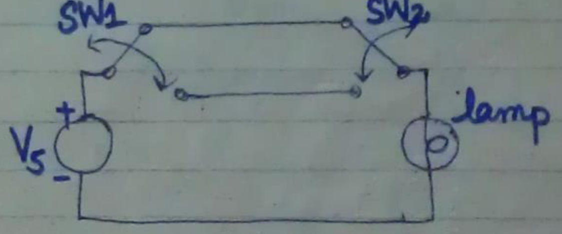
20W power is absorbed by 10V source.
20W power is released by 2A source.

b)



20W power is absorbed by 2A source.
20W power is released by 10V source.

Q54)



a)

i) The lamp will be off when switch 1 is on and switch 2 is off

ii) when SW1 is off and SW2 is on.

b)

i) The lamp will be on when SW1 is on & SW2 is on

ii) when SW1 is off and SW2 is off.