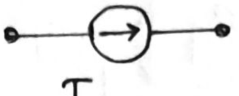
set-01

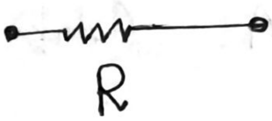
① (a) Region | Model | Parameter

AB



$I_o = -4\,mA$. (Ans)

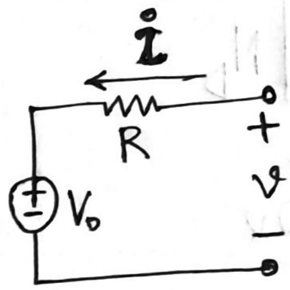
BC



$R = \frac{1}{m} = \frac{1}{\frac{\Delta y}{\Delta x}} = \frac{1}{\frac{(4-(-4))\times 10^{-3}}{2-(-2)}}$

$\Rightarrow R = 500\,\Omega$. (Ans)

CD



This region can be expressed by, $y = mx + c$; $m = 0.3$

$\therefore R = \frac{1}{0.3} = 3.33\,\Omega$

Again, this region goes through (2,4) point.

So, $4\times 10^{-3} = 0.3\times 2 + c$

$\Rightarrow c = 0.596$.

We know that,

$\frac{-V_o}{R} = c$

$\Rightarrow v_o = -R\times c$

$\Rightarrow v_o = -3.33\times 0.596$

$\Rightarrow v_o = -1.98468\,v$. (Ans)

(b) when, $v_s = 3v$, the operating region is → CD

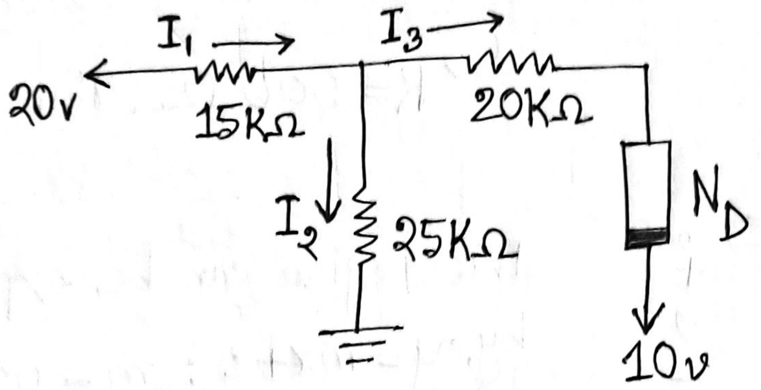
from part-(a), $y = mx + c$

$$\hookrightarrow i_s = m v_s + c$$

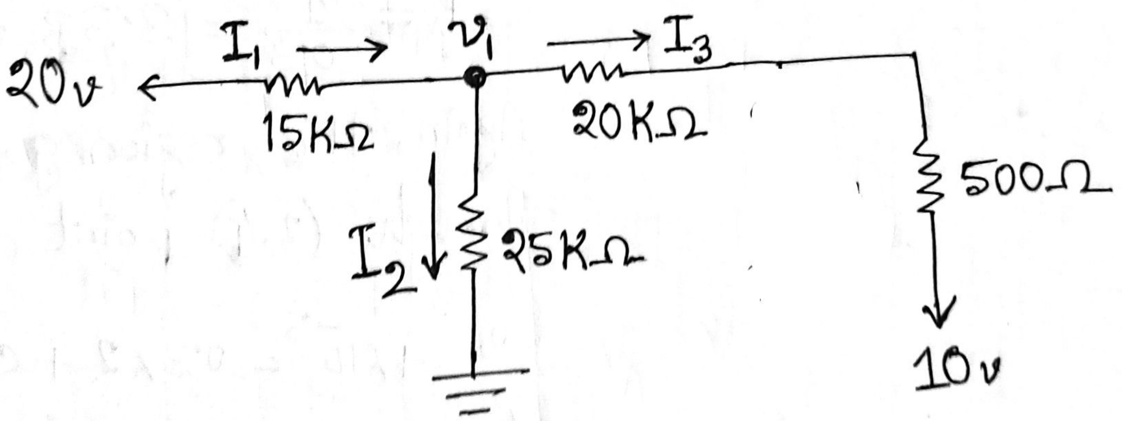
$$\hookrightarrow i_s = 0.3 \times 3 + 0.596$$

$$\hookrightarrow i_s = 1.496 \text{ A.} \quad \text{(Ans)}$$

(c)



(d)



(e) Applying KCL we get,

$$I_1 = I_2 + I_3$$

$$\hookrightarrow \frac{20 - v_1}{15\text{K}\Omega} = \frac{v_1 - 0}{25\text{K}\Omega} + \frac{v_1 - 10}{(20 + 0.5)\text{K}\Omega} \Rightarrow v_1 = 11.7155v.$$

$$\text{So, } I_1 = \frac{20 - 11.7155}{15\text{K}\Omega} = 0.5523 \text{ mA.} \quad \text{(Ans)}$$

$$I_2 = \frac{11 \cdot 7155 - 0}{25\,K\Omega} = 0 \cdot 46862 \text{ mA. (Ans)}$$

$$I_3 = \frac{11 \cdot 7155 - 10}{(20 + 0 \cdot 5)\,K\Omega} = 0 \cdot 0837 \text{ mA. (Ans)}$$

(2) Part-a

(a) ckt-1: let, the expression be, f_1

So, $f_1 = wx$. (Ans)

ckt-2: let, the expression be, f_2

So, $f_2 = y + z$. (Ans)

(b) from the given ckt, we get,

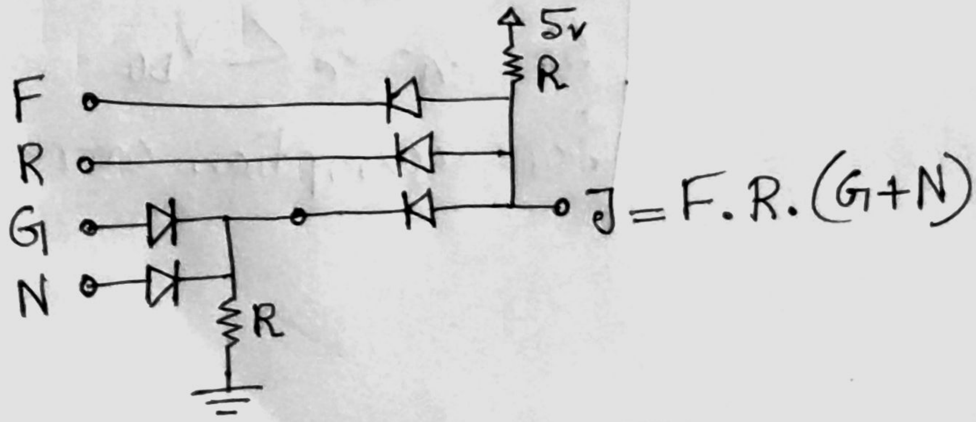
$$f = f_1 + f_2 = wx + y + z. \text{ (Ans)}$$

Part-b

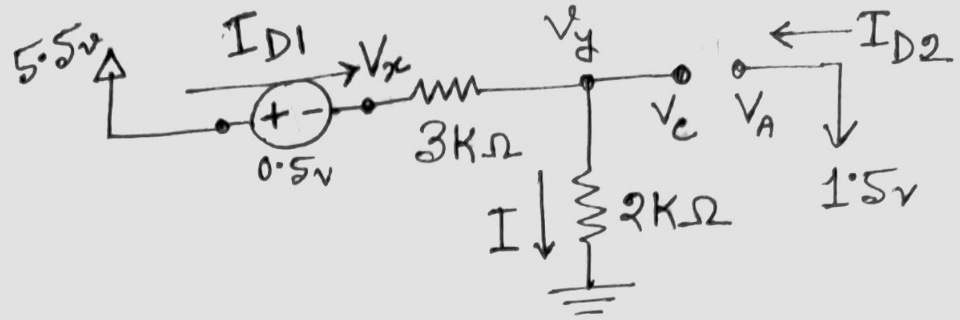
(c) Let, the boolean logic function of Juber's algorithm be, J.

$\therefore$ $J = F.R.(G+N)$. (Ans)

(d)



(3) Let, D_2 off, D_1 ON. So, the circuit will be,



here, $V_x = (5\cdot5 - 0\cdot5)v = 5v$; $I_{D2} = 0$.

$\therefore I_{D1} = I$

$\hookrightarrow \frac{V_x - 0}{(3+2)K\Omega} = I$

$\hookrightarrow \frac{5}{5K\Omega} = I$

$\hookrightarrow I = 1mA = I_{D1}$.

Now, $V_c = V_y = (2K\Omega)(I) = 2K\Omega \times 1mA = 2v$.

for D_1,

$I_{D1} = 1\ mA > 0$.

$\therefore$ Assumption Correct

Again, for D_2,

$V_A - V_c$

$= 1\cdot5 - 2$

$= -0\cdot5$.

So, $V_A - V_c < V_{DO}$.

So, assumption correct.

4 (a) Purpose: Conversion of AC to DC is done using rectifier.

Operation:

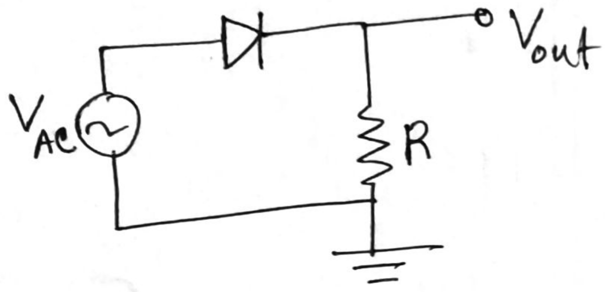


fig: Half-Wave Rectifier

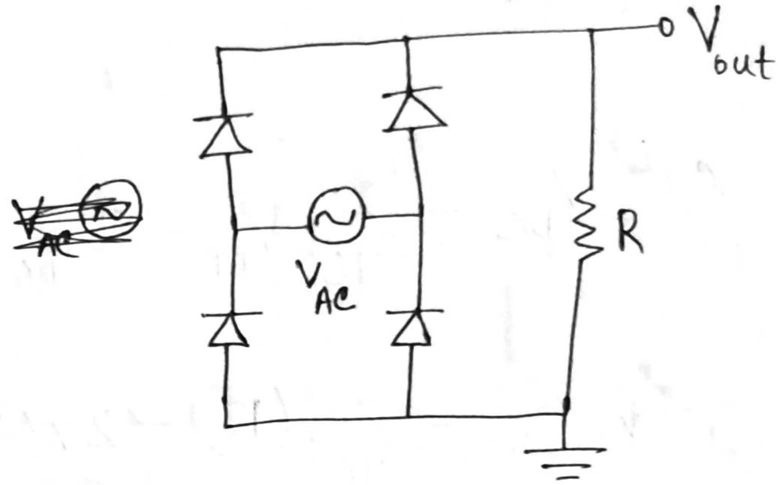


fig: Full-Wave Rectifier

Diode is used to rectify AC. In half-wave rectifier, negative half-cycle of AC voltage gets blocked by the diode. So, we get the positive half-cycle in the output. In full-wave rectifier, both half-cycles can be utilized by connecting the diodes in a smart way which can be seen in the figure above. So we get both half cycles in the output.

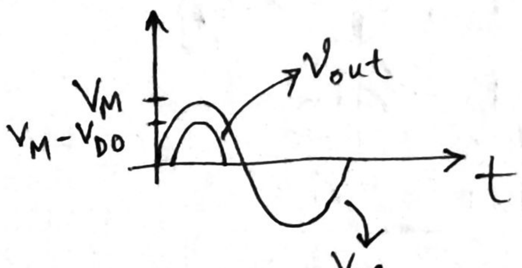


fig: Half-Wave Rectifier

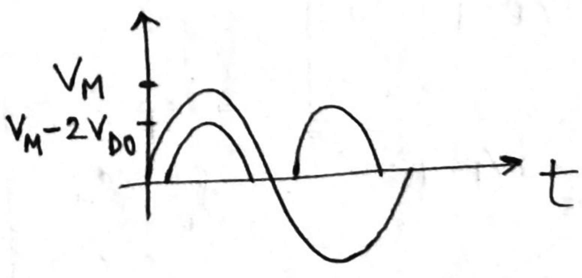
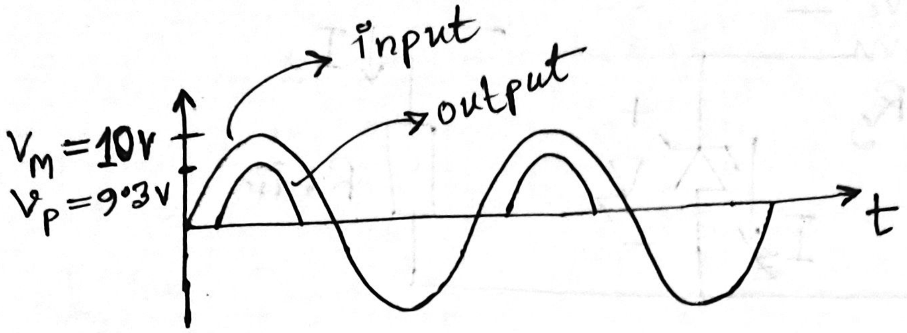


fig: Full-Wave Rectifier

4

(b)



$V_p = V_M - V_{DO}$
$= (10 - 0.7) v$
$= 9.3 v$

(c) $V_{DC} = \frac{1}{\pi} V_M - \frac{1}{2} V_{DO}$

$\hookrightarrow V_{DC} = \frac{1}{\pi} \times 10 - \frac{1}{2} \times 0.7$

$\hookrightarrow V_{DC} = 2.833 v$. (Ans)

(d) $V_{out} = (V_{DC} \pm 0.2) v$.

So, $V_{r(p-p)} = V_{out, max} - V_{out, min} = (V_{DC} + 0.2) - (V_{DC} - 0.2)$

$\hookrightarrow V_{r(p-p)} = 0.4 v$. (Ans)

Again, $V_{r(p-p)} = \frac{V_p}{f_r RC}$

here,
$V_p = 9.3 v$
$f_r = f_i = 60 Hz$
$R = 2 K\Omega$

$\hookrightarrow 0.4 = \frac{9.3}{60 \times 2 \times 10^3 \times C}$

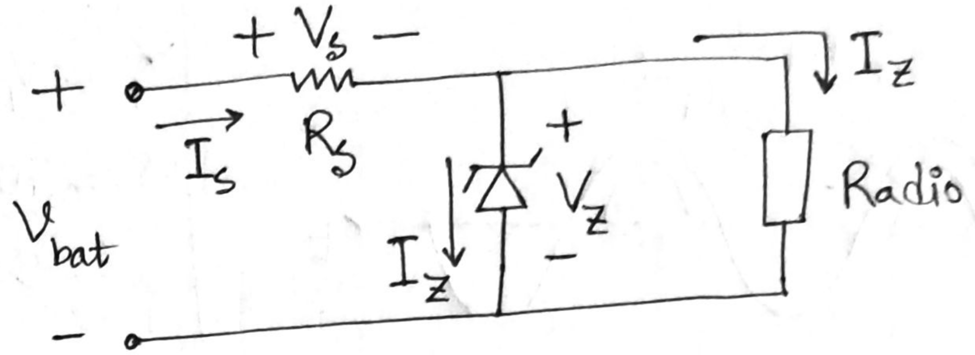
$\hookrightarrow C = 193.75 \mu F$. (Ans)

(e) $V_{DC} = V_p - \frac{1}{2} V_{r(p-p)}$

$\hookrightarrow V_{DC} = (9.3 - \frac{1}{2} \times 0.4) v$

$\hookrightarrow V_{DC} = 9.1 v$. (Ans)

5



Given that, $V_{bat} = 11v \sim 13.6v$

$I_L = 0 \sim 9\ mA$

$V_{ZO} = 9v$, $r_Z = 0.05\ K\Omega$, $I_{ZK} = 1\ mA$

(a) Worst case conditions:

(1) $V_{bat(min)} = 11v$.

(2) $I_{Z(min)} = I_{ZK} = 1\ mA$.

So, $I_Z = 1\ mA$. (Ans) $V_{bat} = 11v$. (Ans)

$V_Z = V_{ZO} + I_Z r_Z$

$\Rightarrow V_Z = 9 + 1 \times 10^{-3} \times 0.05 \times 10^{3}$

$\Rightarrow V_Z = 9.05v$. (Ans)

$I_L = I_{L(max)} = 9\ mA$.

(b) Applying KVL we get, $V_{bat} = V_s + V_Z$

$\Rightarrow V_s = V_{bat} - V_Z$

$\Rightarrow V_s = (11 - 9.05)v$

$\hookrightarrow V_s = 1.95 v.$ (Ans)

Applying KCL we get,

$I_s = I_Z + I_L$

$\hookrightarrow I_s = (1+9) mA$

$\hookrightarrow I_s = 10\ mA.$ (Ans)

(c) $R_s = \frac{V_s}{I_s} = \frac{1.95}{10 \times 10^{-3}} = 195\Omega.$ (Ans)

Line Regulation,

$$\frac{\Delta V_L}{\Delta V_{bat}} = \frac{r}{r+R}$$

$$= \frac{0.05 \times 10^3}{0.05 \times 10^3 + 195}\ V/V$$

$$= 0.20408\ V/V$$

$$= 204.08\ mV/V.\ (Ans)$$

here,

$r = r_z = 0.05\ K\Omega$

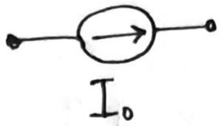
$R = R_s = 195\ \Omega$

Set-02

(1) (a)

Region | **Model** | **Parameter**

AB



$I_o = -2mA$. (Ans)

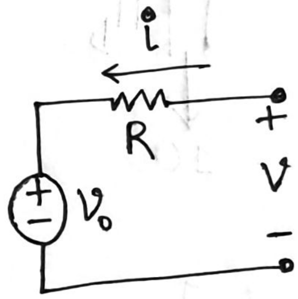
BC

$R = \frac{1}{m} = \frac{1}{\frac{\Delta y}{\Delta x}}$

$\hookrightarrow R = \frac{1}{\frac{(-2-1)\times 10^{-3}}{-4-2}}$

$\hookrightarrow R = 1{\cdot}67\ K\Omega$. (Ans)

CD



This region can be expressed by, $y = mx + c$; $m = 2$

$\therefore R = \frac{1}{m} = 0{\cdot}5\ \Omega$

Again, this region goes through (2,1) point.

So, $1\times 10^{-3} = 2\times 1 + c$

$\hookrightarrow c = -1{\cdot}999$.

We know that,

$\frac{-V_o}{R} = c$

$\hookrightarrow V_o = -R\times c$

$\hookrightarrow V_o = -(0{\cdot}5)\times(-1{\cdot}999)$

$\hookrightarrow V_o = 0{\cdot}9995\,v$. (Ans)

(b) when, $v_s = 3v$, the operating region is $\rightarrow$ CD

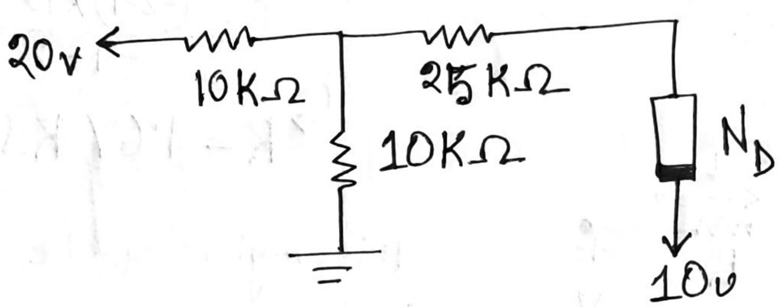
from part-(a), $y = mx + c$

$\hookrightarrow i_s = m v_s + c$

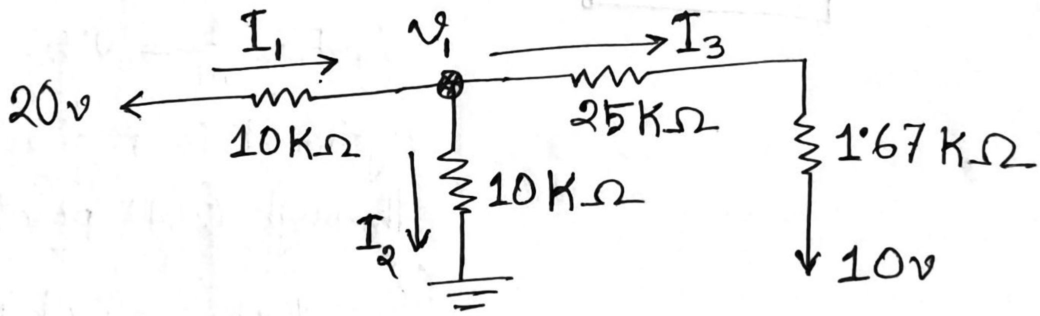
$\hookrightarrow i_s = 2 \times 3 + (-1.999)$

$\hookrightarrow i_s = 4.001$ A. (Ans)

(c)



(d)



(e) Applying KCL we get,

$I_1 = I_2 + I_3$

$\hookrightarrow \frac{20 - v_1}{10\,K\Omega} = \frac{v_1 - 0}{10\,K\Omega} + \frac{v_1 - 10}{(25 + 1.67)\,K\Omega}$

$\hookrightarrow v_1 = 10v$.

So, $I_1 = \frac{20-10}{10K\Omega} = 1\,mA$. $I_2 = \frac{10-0}{10K\Omega} = 1\,mA$. $I_3 = \frac{10-10}{26.67\,K\Omega} = 0$.

② Part-a

ⓐ ckt-1: Let the expression be, f_1.

So, $f_1 = wx$. (Ans)

ckt-2: Let the expression be, f_2.

So, $f_2 = y+z$. (Ans)

ⓑ from the given ckt, we get,

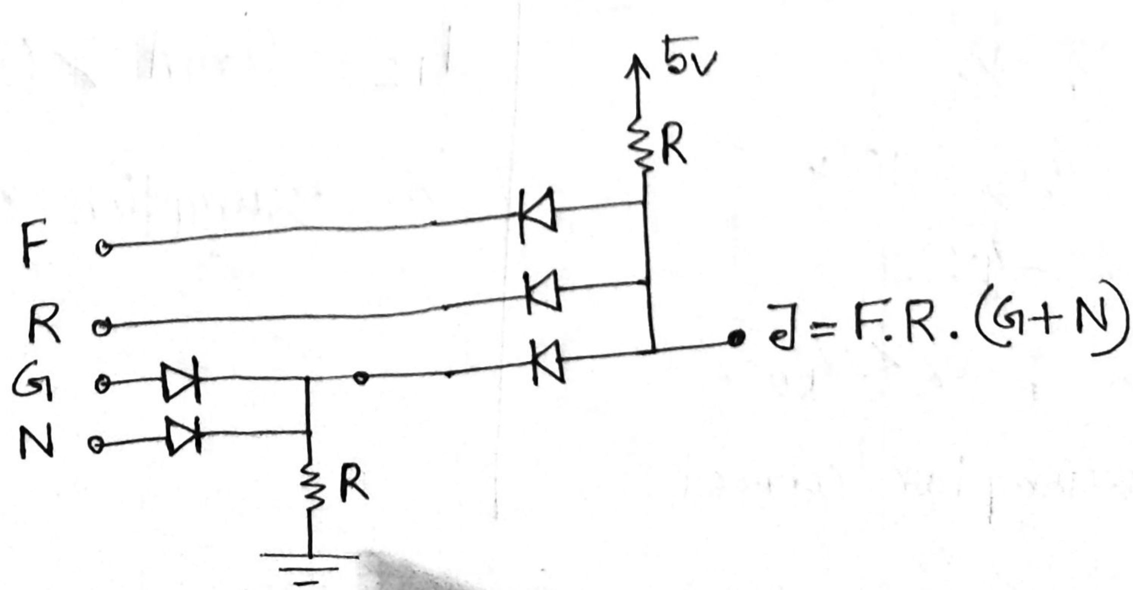
$f = f_1 f_2 = (wx)(y+z)$. (Ans)

Part-b

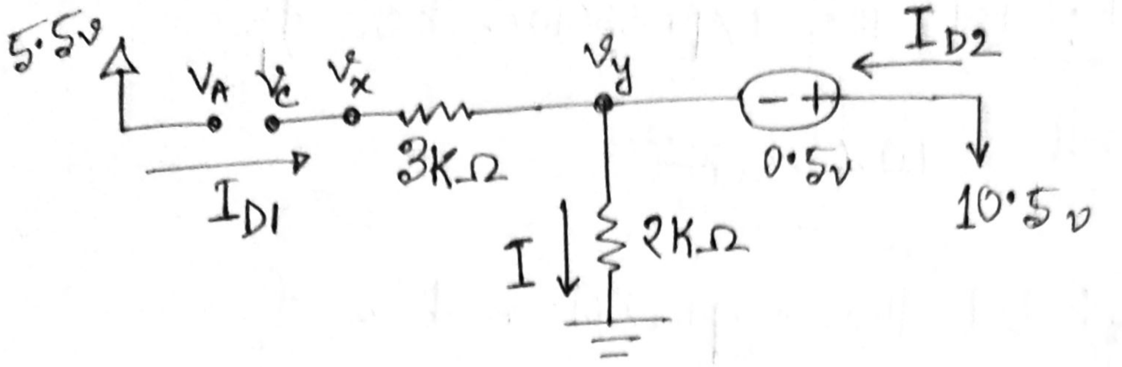
ⓒ Let, the boolean logic function of Juber's algorithm be, J.

$\therefore J = F.R.(G+N)$. (Ans)

ⓓ



③ let, D_1 off, D_2 ON. So, the circuit will be,



here, $V_y = (10.5 - 0.5)v = 10v$; $I_{D1} = 0$.

$\therefore I = I_{D2}$

$\hookrightarrow \frac{V_y - 0}{2K\Omega} = I_{D2}$

$\hookrightarrow I_{D2} = \frac{10 - 0}{2K\Omega}$

$\hookrightarrow I_{D2} = 5\,mA.$

$V_c = V_x = V_y = 10v.$

Now, for D_1,

$V_A - V_c$

$= (5.5 - 10)v$

$= -4.5v.$

$\because V_A - V_c < V_{D0}$,

assumption correct

Again, for D_2,

$I_{D2} = 5\,mA > 0.$

So, assumption correct.

(4) (a) Purpose: Conversion of AC to DC is done using rectifier.

Operation:

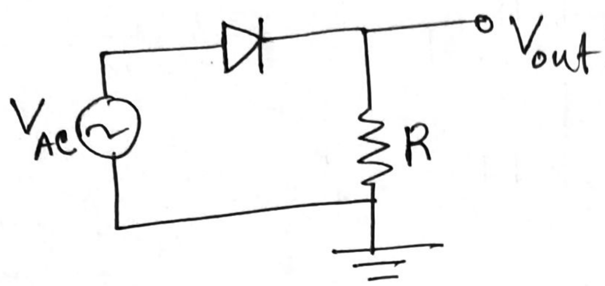


fig: Half-Wave Rectifier

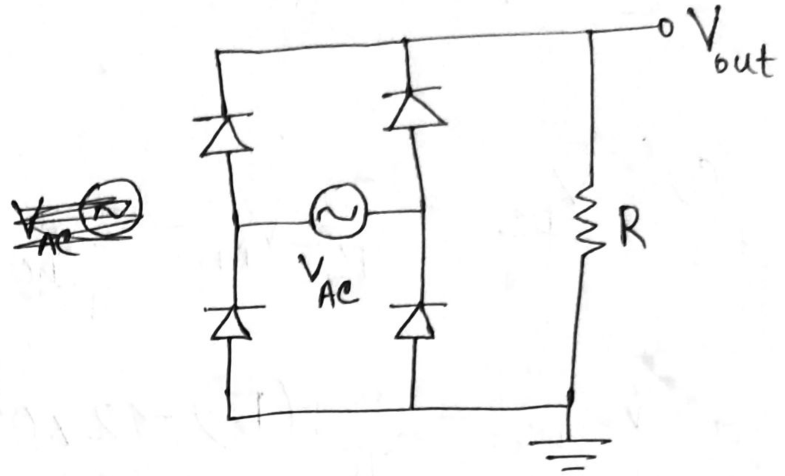


fig: Full-Wave Rectifier

Diode is used to rectify AC. In half-wave rectifier, negative half-cycle of AC voltage gets blocked by the diode. So, we get the positive half-cycle in the output. In full-wave rectifier, both half-cycles can be utilized by connecting the diodes in a smart way which can be seen in the figure above. So we get both half cycles in the output.

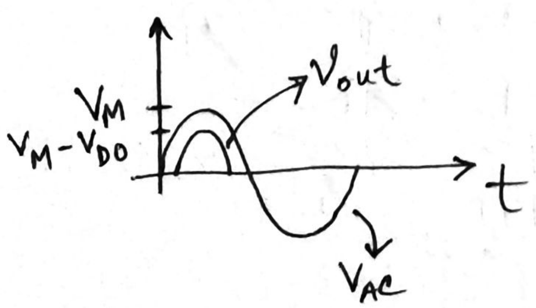


fig: Half-Wave Rectifier

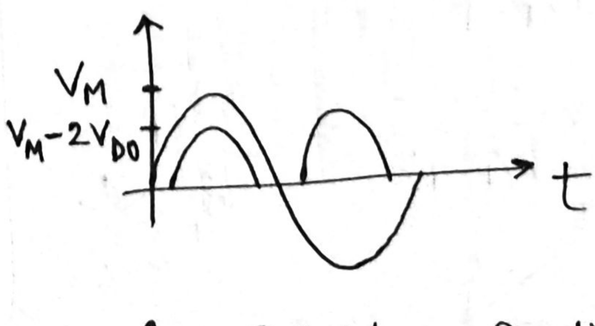
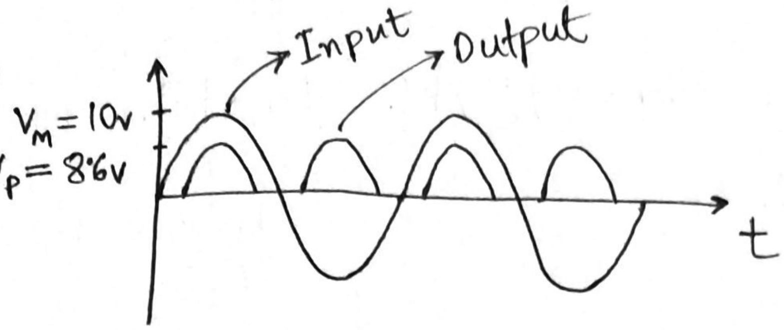


fig: Full-Wave Rectifier

(b)



$$V_p = V_M - 2V_{DO}$$
$$= (10 - 2 \times 0.7)v$$
$$= 8.6v$$

(c) $$V_{DC} = \frac{2}{\pi} V_M - 2V_{DO}$$

$$\hookrightarrow V_{DC} = \frac{2}{\pi}(10) - 2 \times 0.7$$

$$\hookrightarrow V_{DC} = 4.9662\ v.\ (\text{Ans})$$

(4) (d) $V_{out} = (V_{DC} \pm 0.2)\,v$

$\therefore V_{r(p-p)} = V_{out,max} - V_{out,min}$

$\hookrightarrow V_{r(p-p)} = (V_{DC} + 0.2) - (V_{DC} - 0.2)$

$\hookrightarrow V_{r(p-p)} = 0.4\,v$. (Ans)

Again, $V_{r(p-p)} = \dfrac{V_p}{f_p RC}$

$\hookrightarrow 0.4 = \dfrac{8.6}{2 \times 60 \times 2 \times 10^3 \times C}$

$\hookrightarrow C = 89.583\ \mu F$. (Ans)

here,

$V_p = 8.6\,v$

$f_p = 2f_i = 2 \times 60\,Hz$

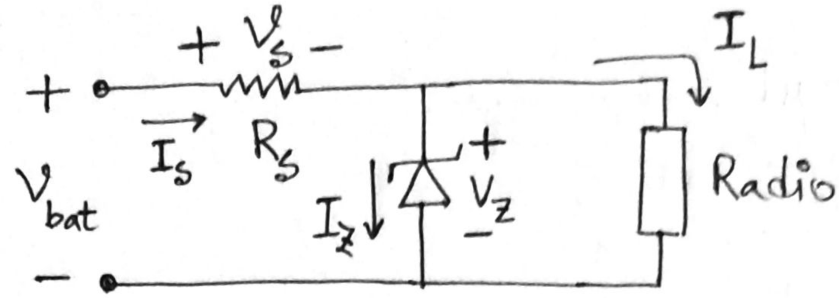
$R = 2\,K\Omega$

(e) $V_{DC} = V_p - \frac{1}{2} V_{r(p-p)}$

$\hookrightarrow V_{DC} = (8.6 - \frac{1}{2} \times 0.4)\,v$

$\hookrightarrow V_{DC} = 8.4\,v$. (Ans)

Q5



Given that, $v_{bat} = 11v \sim 13.6v$

$I_L = 0 \sim 9\,mA$

$v_{Z0} = 9v$, $r_z = 0.05\,K\Omega$, $I_{ZK} = 1\,mA$

ⓐ Worst case conditions:

① $v_{bat(min)} = 11\,v$.

② $I_{Z(min)} = I_{ZK} = 1\,mA$.

So, $I_Z = 1\,mA$. (Ans) $v_{bat} = 11v$. (Ans)

$v_Z = v_{Z0} + I_Z r_Z$

$\hookrightarrow v_Z = 9 + 1\times10^{-3} \times 0.05\times10^{3}$

$\hookrightarrow v_Z = 9.05\,v$. (Ans)

$I_L = I_{L(max)} = 9\,mA$. (Ans)

ⓑ Applying KVL we get, $v_{bat} = v_s + v_z$

$\hookrightarrow v_s = v_{bat} - v_z$

$\hookrightarrow v_s = (11 - 9.05)v$

$\hookrightarrow v_s = 1.95\,v$. (Ans)

Applying KCL we get,

$$I_s = I_Z + I_L$$

$$\hookrightarrow I_s = (1+9)\,mA$$

$$\hookrightarrow I_s = 10\ mA. \text{ (Ans)}$$

(c) $R_s = \dfrac{V_s}{I_s} = \dfrac{1.95}{10\times10^{-3}} = 195\,\Omega$. (Ans)

Load Regulation,

here, $r = r_z = 0.05\ K\Omega$

$R = R_s = 195\,\Omega$

$$\frac{\Delta V_L}{\Delta I_L} = \frac{-rR}{r+R}$$

$$= \frac{-(0.05\times10^3\times195)}{(0.05\times10^3+195)}\ mV/mA$$

$$= -39.796\ mV/mA. \text{ (Ans)}$$