Assignment - 6

19MS15)
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PH3104.

1. Silicon diode 1N2615 - -

$I_s = 10\,\mu A$, $T = 22^\circ C = 295K$,

$i_D = i_s \left(\exp\left(\frac{V_D}{\eta V_T} \right) - 1 \right)$, $\eta = 2$ for silicon diode.

$V_T = \frac{T}{11600} = \frac{295}{11600} \approx 25.43\ mV$.

(a) ~~graph in~~ plot in zip.

(b) $i_{D\,max} = 750\ mA$.

$\ln\left(\frac{I_D}{I_S}\right) \approx \frac{V_D}{V_T} \Rightarrow (V_D)_{max} = V_T \times \ln\left(\frac{I_{D\,max}}{I_S}\right)$

$= 0.02543 \times \ln\left(\frac{750 \times 10^{-3}}{10^{-5}}\right)$

$= 570.8\ mV$

(c) $T = 22^\circ C = 295\ K$, $T = 72^\circ C = ?$

$i_s = 10^{-5}$

As it doubles every $10^\circ C$ rise.

$I_s' = I_s \times 2^{\frac{T_f - T_i}{10}} = 10^{-5} \cdot 2^5$

$= 320\ \mu A$.

2.

(a) ideal - half wave rectifier.

~~For~~ ideal half wave,

output

$$V(t) = \begin{cases} V_{in}(t), & V_{in}(t) > 0 \\ 0, & V_{in}(t) \leq 0 \end{cases}$$

$$V_{in} = A \sin(\omega t).$$

Fourier coefficients :-

$$a_k = \frac{1}{T}\int_0^T v(t) e^{-ik\omega t} dt = \frac{A}{T}\int_0^{T/2} \frac{e^{i\omega t} - e^{-i\omega t}}{2i} e^{-ik\omega t} dt$$

$$= \frac{A}{2iT}\int_0^{\pi/\omega} (e^{i\omega(1-k)t} - e^{-i\omega(1+k)t}) dt$$

$$= \frac{A}{2iT}\left[\frac{e^{i\omega(1-k)t}}{i\omega(1-k)} + \frac{e^{-i\omega(1+k)t}}{i\omega(1+h)}\right]_0^{\pi/\omega_0}$$

$$= \frac{-A}{4\pi}\left(\frac{e^{i(1+k)\pi} - 1}{(1-k)} + \frac{e^{-i(1+k)\pi} - 1}{(1+k)}\right)$$

$$a_k = \frac{A}{2\pi}\left(\frac{(-1)^k + 1}{1-k^2}\right) \quad \cancel{\text{for } k \neq \pm 1}$$

for ~~for k = 1 or +1. k = +1~~

~~$a_1 = A$~~

for $k = +1, -1$

$$a_1 = \frac{A}{2\pi}\left(\frac{\frac{d}{dk}(e^{-ik\pi} + 1)}{\frac{d}{dk}(1-k^2)}\right) = -\frac{iA}{4}$$

$$V(t) = \sum_{k=-\infty}^{\infty} \frac{A}{2\pi}\left(\frac{(-1)^k + 1}{1-k^2}\right) e^{ik\omega t}$$

(b) ideal full wave rectifier.

$V(t) = |V_{in}(t)|$ $\quad \omega = \frac{2\pi}{T}$

let $V_{in} = A \sin \omega t$

let $\omega = \frac{2\pi}{T}$, $\omega_0 = \frac{2\pi}{T_0}$, with $T_0 = \frac{1}{2}T$, $\omega_0 = 2\omega$

$$a_k = \frac{1}{T_0}\int_0^{T_0} V(t) \cdot e^{-ik\omega t}\, dt$$

$$= \frac{A}{2iT_0}\int_0^{T_0} \sin \omega t \cdot e^{-ik\omega t} \cdot dt = \frac{A}{2iT_0}\int_0^{T_0} \left(e^{i\omega(\frac{1}{2}-k)t} - e^{-i\omega(\frac{1}{2}+k)t}\right) dt$$

$$= \frac{-A\omega}{4\pi}\left[\frac{e^{2\pi \cdot (\frac{1}{2}-k)t}}{i\omega(\frac{1}{2}-k)} + \frac{e^{-i\omega(\frac{1}{2}+k)t}}{i\omega(\frac{1}{2}+k)}\right]_0^{2\pi/\omega_0}$$

$$= -\frac{A}{4\pi}\left(\frac{(1+e^{-2\pi ik})}{-k^2+\frac{1}{4}}\right)$$

$$= \frac{2A}{\pi(1-4k^2)}$$

$\cancel{a_0 = \frac{2A}{\pi}}$

$$V(t) = \sum_{k=-\infty}^{\infty} \frac{2A}{\pi(1-4k^2)} e^{ik\omega_0 t}$$

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3) (a) $I = i_{dc} + i_r$

$$\langle I^2 \rangle = \frac{1}{T}\int_0^T I^2(t)\,dt$$

$$= \frac{1}{T}\int_0^T (I_{dc}^2 + I_r^2 + 2 I_r I_{dc})\,dt$$

$$= \langle I_r^2 \rangle + \underbrace{I_{dc}^2}_{dc} + \frac{I_{dc}}{T}\int_0^T I_r\,dt$$

$$\int_0^T I_r\,dt = \int_0^T \sum \frac{\cos(2n\omega t)}{(1-4n^2)\pi}\,dt + \int_0^T \frac{I_p}{2}\sin\omega t\,dt$$

as abov

$$= \sum_{n=1}^{\infty} \frac{\sin 4n\pi}{(1-4n^2)\pi} - \underbrace{\frac{I_p}{2}\cos\omega t\Big|_0^T}_{0}$$

$$= 0$$

$$\Rightarrow \langle I^2 \rangle = \langle I_r^2 \rangle + I_{dc}^2$$

$$I_{ac}^2 = \langle I_r^2 \rangle$$

$$I = \sqrt{I_{dc}^2 + I_{ac}^2}$$

$$\gamma = \frac{I_{ac}}{I_{dc}} \quad \text{.. ripple factor.} \quad = \sqrt{\frac{I^2}{I_{dc}^2} - 1}$$

$$I_{dc} = \frac{1}{2\pi}\int_0^\pi I_p \sin\alpha\,d\alpha = \frac{I_p}{\pi}$$

$$I = \left(\frac{1}{2\pi}\int_0^\pi I_p^2 \sin^2\alpha\,d\alpha\right)^{1/2} = \frac{I_p}{2}$$

$$\Rightarrow \gamma = \sqrt{\frac{\pi^2}{4} - 1} = 1.21$$

for Half wave rectifier

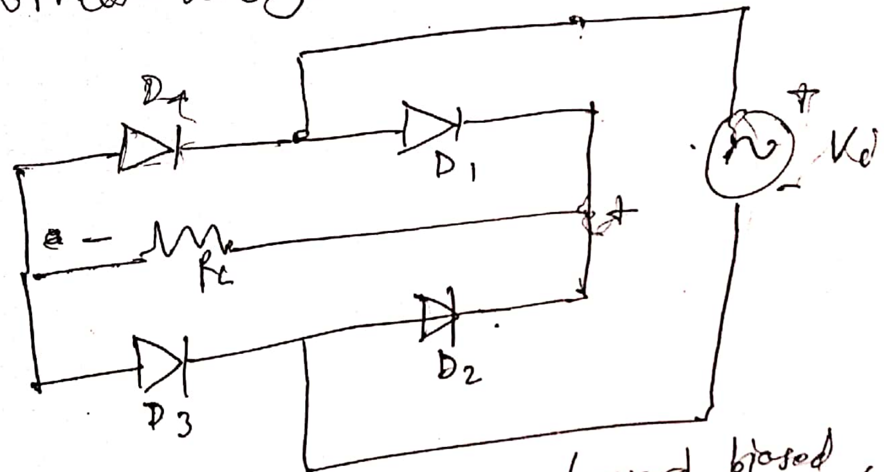
$$I = \left(\frac{1}{\pi}\int_0^{\pi} I_p^2 \sin^2\alpha \, d\alpha\right)^{1/2} = \frac{I_p}{\sqrt{2}}$$

$$I_{dc} = \frac{1}{\pi}\int_0^{\pi} I_p \sin\alpha \, d\alpha = \frac{2I_p}{\pi}$$

$$\Rightarrow r = \sqrt{\frac{\pi^2}{8} - 1} = 0.483$$

Full wave rectifiers

4. Correct configs



For $V_i > 0$, D_1 & D_3 are forward biased, we get DC output

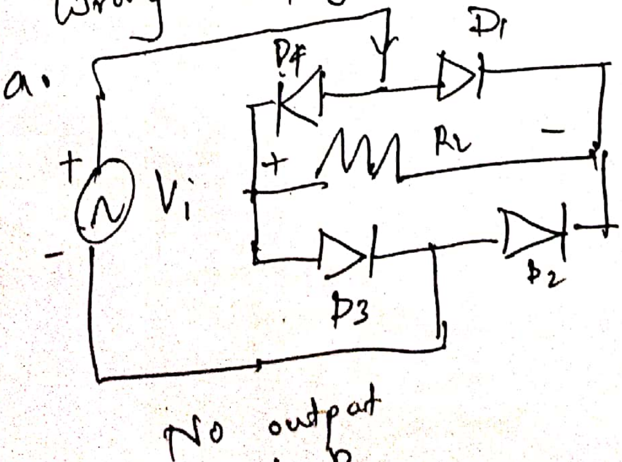
$V_o = \frac{2V_i}{\pi}$

For $V_i < 0$, D_2 & D_4 are forward biased and we get DC output in the other direction

$V_o = \frac{2V_i}{\pi}$

Wrong configs.

a.



Here current flows through both D_1 & D_4. D_2 is reverse biased, so no current through R.

Current through D_2 & D_3 with output

$V_o = 0$ for $V_i > 0$.

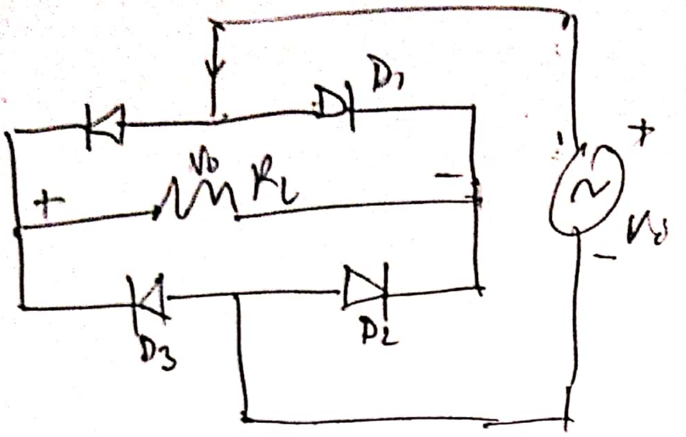
as current can't divide as ideal diodes offer no resistance.

$V_o = 0$, for $V_i < 0$

as current can't flow.

No output through R_L

b.

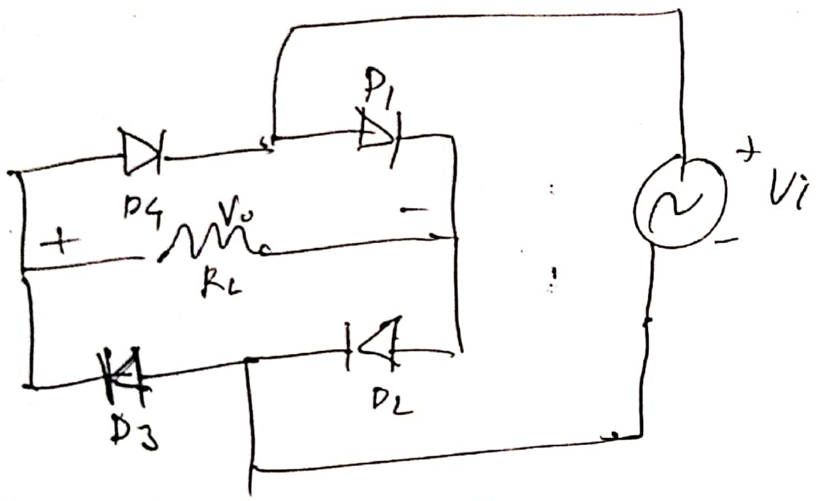


For $V_i > 0$,
D_1 & D_4 ⇒ foward biased
D_3 & D_2 ⇒ reverse biased
⇒ No current.

$V_o = 0$.
for $V_i < 0$
$V_o = 0$ too.

No output over R_L.

c.

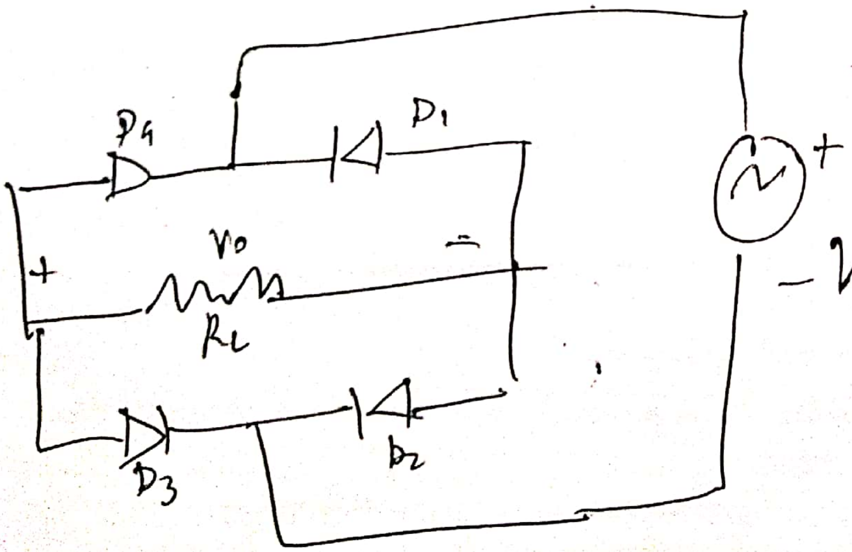


For $V_i > 0$.
current through D_1 & D_2.
⇒ $V_o = 0$

For $V_i < 0$.
current through D_3 & D_4.
⇒ $V_o = 0$

no output over R_L.

d)



For $V_i > 0$.
D_1 & D_4 → reverse biased

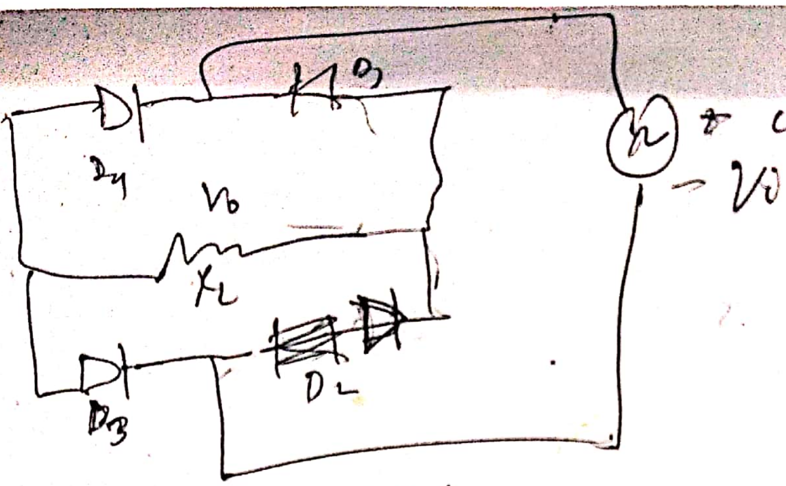
No output.

For $V_i < 0$.
D_2 & D_3 ⇒ reverse biased

No output

No output

e)

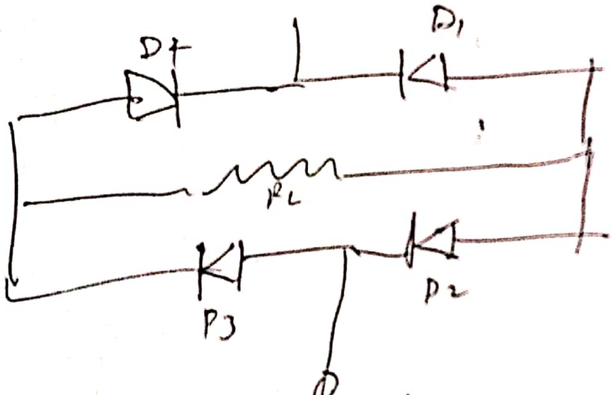


No output

$V_i < 0$.
current over D_4 & D_2 ~~⇒ reverse~~

$V_i > 0$
D_1 & D_4 ⇒ reverse

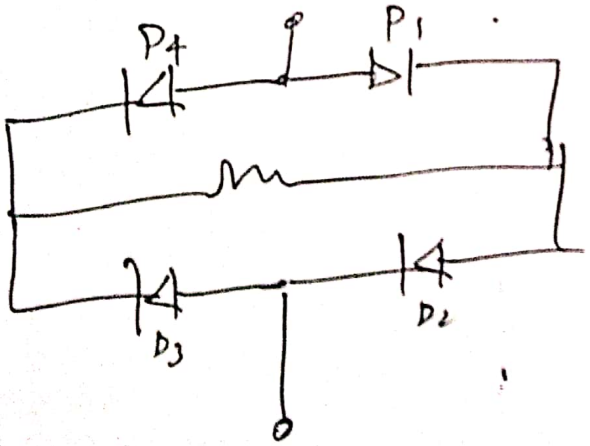
f)



No output

$V_i > 0$ ⇒ no current
$V_i < 0$ ⇒ current over D_3 & D_4 only.

g)



No output

$V_i > 0$.
current over D_1 & D_2.

$V_i < 0$
No current flow

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Q5 $V_1 = 220\,V$

max power = $220\sqrt{2}$ V.

$\frac{N_1}{N_2} = \frac{20}{1}$

secondary voltage, $V_o = \frac{220\sqrt{2}}{20} = 11\sqrt{2}$ V = ~~[illegible]~~

Centre taped — $V_m = \frac{11}{2}\sqrt{2}$ V.

$I_{dc} = \frac{2I_m}{\pi}$

$V_{DC} = \frac{2V_m}{\pi} = \frac{9.9}{2}$ V. $= \frac{22\sqrt{2}}{2\pi} = 4.95$ V.

$V_{rms} = \frac{V_M}{\sqrt{2}} = \frac{11}{2}V = 5.5\,V$

peak inverse voltage, $V_p = 22\sqrt{2} = \cancel{\frac{31.11}{2}}$ V. = $\underline{15.55\,V}$.