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Slot/Code : EEE1001/E11+E12+E13

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Exam : Midsem 2021-22 Fall.

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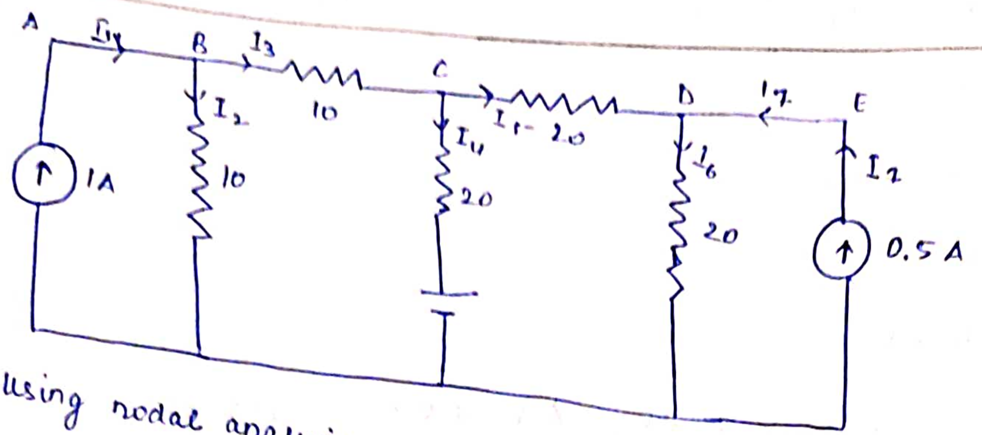


Using nodal analysis,

we will apply KCL on B, C and D nodes.

Let the voltages be V_B, V_C and V_D respectively.

$$I_1 = I_2 + I_3$$

$$1 = \frac{V_B}{10} + \frac{V_B - V_C}{10}$$

$$\therefore\ 2V_B - 10 - V_C = 0 \longrightarrow (1)$$

* now $I_3 = I_4 + I_5$ at node C

$$\frac{V_B - V_C}{10} = \frac{V_C - 12}{20} + \frac{V_C - V_D}{20}$$

$$= 2V_B - 4V_C + V_D + 12 = 0 \rightarrow (2)$$

* now, $I_5 + I_7 = I_6$

$$\frac{V_C - V_D}{20} + 0.5 = \frac{V_D}{20}$$

$$V_C - V_D + 10 = V_D$$

$$V_C + 10 - 2V_D = 0. \longrightarrow (3)$$

from the above eq^{n}s, 1, 2, 3,

$$2V_B - 10 - V_C = 0$$

$$2V_B - 4V_C + V_D + 12 = 0$$

$$V_C - 2V_D + 10 = 0$$

$$V_D = \frac{V_C + 10}{2}$$

$$\Rightarrow 2V_B = 10 + V_C$$

$\therefore$ in 2, $10 + V_C - 4V_C + \frac{V_C + 10}{2} + 12 = 0$

$$= 10 - 3V_C + \frac{V_C}{2} + 5 + 12 = 0$$

$$= 27 + \frac{V_C}{2} - 3V_C = 0$$

$$= 27 = 3V_C - \frac{V_C}{2} = \frac{6V_C - V_C}{2} = \frac{5V_C}{2}$$

$$= \frac{27 \times 2}{5} = V_C = \underline{10.8\ V}$$

$$\therefore 2V_B = 10 + V_C = 10 + 10.8 = 20.8$$

$$V_B = \underline{10.4V}$$

$$V_D = \frac{10.8 + 10}{2} = \underline{10.4V}$$

$$I_2 = \frac{V_B}{10} = \frac{10.4}{10} = 1.04A$$

$$I_3 = \frac{V_B - V_C}{10} = \frac{10.4 - 10.8}{10} = \frac{-0.4}{10} = 0.04\ A$$

$$I_6 = \frac{V_D}{20} = \frac{10.4}{20} = 0.52A$$

$$I_5 = \frac{V_C - V_D}{20} = \frac{10.8 - 10.4}{20} = \frac{0.4}{20} = 0.02\ A$$

$$I_6 = I_7 + I_5 = 0.5 + 0.02 = 0.52\ A$$

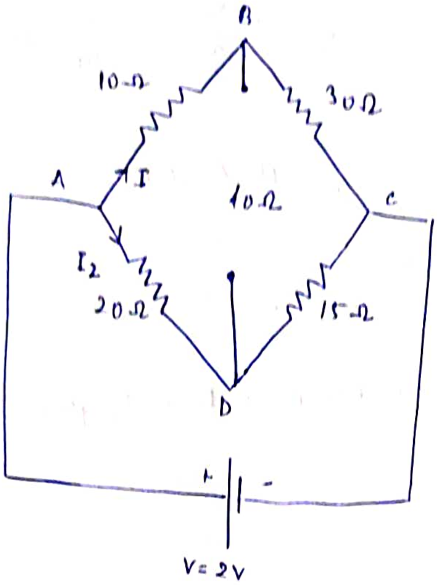
$$I_2 = I_1 + I_3 = 1.0 + 0.04 = 1.04\ A$$

4. NOW, $I_4 + I_5 = I_3$

$\therefore I_4 = I_3 - I_5 = 0.02\,A$

$= (0.04 - 0.02)$

2 (a)



* EMF of 2V

To use thevenin's theorem, we need to remove the load. 40Ω and calculate V_{BD} and V_{DC},

$V_{BC} = \frac{30 \times V}{10+30} = 30I_1$

$= \frac{30 \times 2}{40} = \frac{60}{40} = 1.5V$

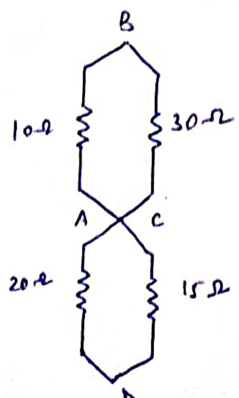
$V_{DC} = 15 I_2 = \frac{15 \times V}{20+15}$

$= \frac{15 \times 2}{20+15} = \frac{30}{35} = \frac{6}{7} V$

Potential difference between B & D $\Rightarrow V_B - V_D$

$= \frac{3}{2} - \frac{6}{7} = \frac{9}{14} V$

To find R_{TH}, we have to short circuit the voltage source and solve.



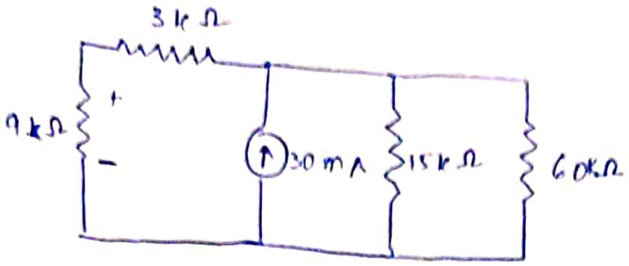
$$R_{TH} = \frac{20 \times 15}{20+15} + \frac{10 \times 30}{10+30} = \frac{300}{35} + \frac{300}{40} = \frac{225}{14}\ \Omega$$

$$\therefore I_L = \frac{V_{TH}}{R_{TH}+R_L} = \frac{\frac{7}{14}}{\frac{225}{14}+40} = 11.457\ mA$$

B is at a higher potential than point D, I_L flows from B to D.

5(a)

3



$$I_1 = I \frac{R_{eq}}{12k\Omega} \qquad I_2 = I \cdot \frac{R_{eq}}{15k\Omega}$$

$$\frac{1}{R_{eq}} = \frac{1}{60} + \frac{1}{15} + \frac{1}{12} = \frac{1}{60} + \frac{4}{60} + \frac{1}{12} = \frac{5}{60} + \frac{1}{12} = \frac{5}{60} + \frac{5}{60} = \frac{2}{12} = \frac{1}{6} = 6k\Omega$$

$$I_1 = 30\,mA \times \frac{\cancel{6}^{1}\,k\Omega}{{}_{2}\cancel{12}\,k\Omega} = 15\,mA$$

$$I_2 = \overset{6}{\cancel{30}}\,mA \times \frac{\overset{2}{\cancel{6}}\,k\Omega}{\underset{5}{\cancel{15}}\,k\Omega} = 12\,mA$$

(i) $V_1 = I_1 \times 3\,k\Omega = 15\,mA \times 3k\Omega = \underline{45\,V}$

$V_2 = I_2 \times 15\,k\Omega = 12\,mA \times 15\,k\Omega = \underline{180\,V}$

(ii) $P_{3k} = I_1^2 \times 3\,k\Omega = \frac{V_1^2}{3\,k\Omega} = \frac{\overset{15}{\cancel{45}} \times 45}{\cancel{3} \times 1000} = \underline{0.675\,W}$

$P_{15k} = I_2^2 \times 15\,k\Omega = \frac{V_2^2}{15\,k\Omega} = \frac{\overset{60\,12}{\cancel{180}} \times \cancel{180}}{\underset{5}{\cancel{15}} \times 1000} \Rightarrow \frac{\overset{6}{\cancel{180}} \times 180}{\underset{5}{\cancel{15}} \times 1000} = \underline{2.16\,V}$

(iii) $P_{30mA} = -I \cdot \times V_2 = -30 \times 180 = -5400\,mW = \underline{-5.4\,W}$

4 Ratio = 50:5

Input voltage = $V = 220 \sin \omega t$

diode forward R = 25 Ω

Load Resistance = 1.4 kW

To find, transformer R = 1.1 kΩ, (a) RMS value of load

(b) Rectification efficiency

(c) Ripple factor

Here, input $V_m = 220$.

turn ratio = 50:5

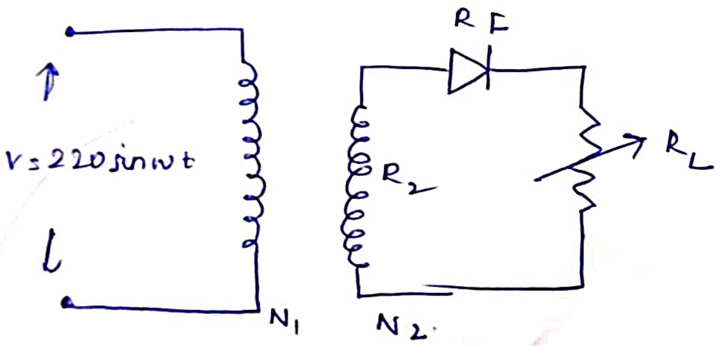
$\therefore$ output $V_m = \frac{220}{\cancel{50}\ 10} \times \cancel{5}\ 1 = 22V$.

$I_m = \frac{V_m}{R_2 + R_F + R_L}$

R_2 = winding resistance of transformer

R_F = Forward resistance

R_L = load resistance



$I_m = \frac{22}{1.1 \times 1000 + 25 + 1.4 \times 1000} = \frac{22}{1100 + 25 + 1400}$

$= \frac{22}{2525} A = 0.0087 A = 8.7 mA$

$I_{rms} = \frac{I_m}{2} = \frac{8.7}{2} = 4.35 mA = \frac{11}{2525} A$

$I_{dc} = \frac{I_m}{\pi} = \frac{\cancel{22}}{2525} \times \frac{7}{\cancel{22}} = \frac{7}{2525} A = 2.7 mA$

Output dc power $= I_{dc}^2 R_L = (0.0027 \times 0.0027) \times 1400$

$= 0.010 W$

AC input $= I_{rms}^2 (R_s + R_F + R_L)$

$= \frac{11}{2525} \times \frac{11}{\cancel{2525}} \times \cancel{2525} = 0.0479 W$

rectifier efficiency $= \frac{\text{Output dc power}}{\text{Input dc power}} \times 100$

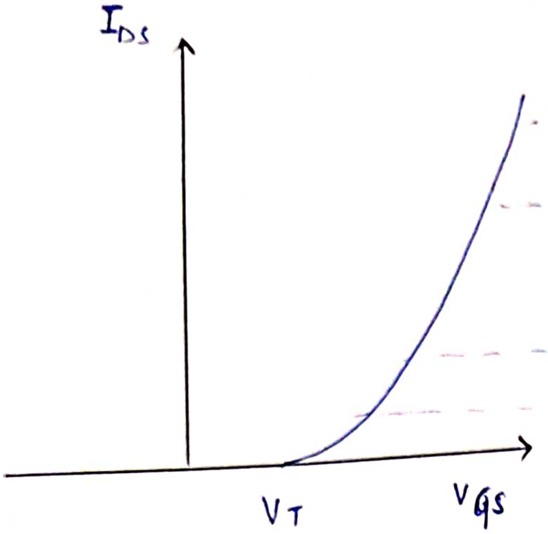
$= \frac{0.010 \times 100}{0.048} = \frac{10}{48} \times 100 = 20.83\%$

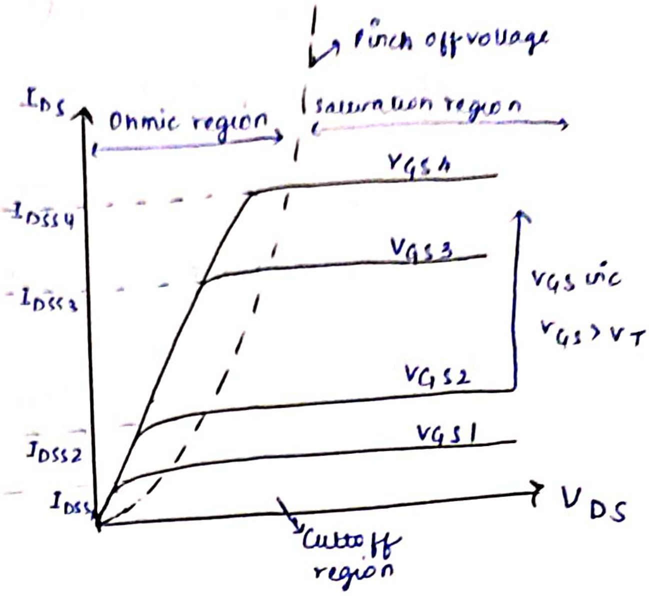
Ripple factor $= r = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1} = \sqrt{\left(\frac{\frac{11}{\cancel{2525}}}{\frac{7}{\cancel{2525}}}\right)^2 - 1}$

$= \sqrt{\left(\frac{11}{7}\right)^2 - 1} = \sqrt{\frac{121}{49} - 1}$

$= \sqrt{\frac{121-49}{49}} = \sqrt{\frac{72}{49}} = \frac{6\sqrt{2}}{7} = \frac{8.48}{7} = 1.212$

5 (a) **n-channel MOSFET**





* The figure shows drain to source current I_{DS} versus gate to source voltage V_{GS} of n-channeld enhancement-type MOSFETS.

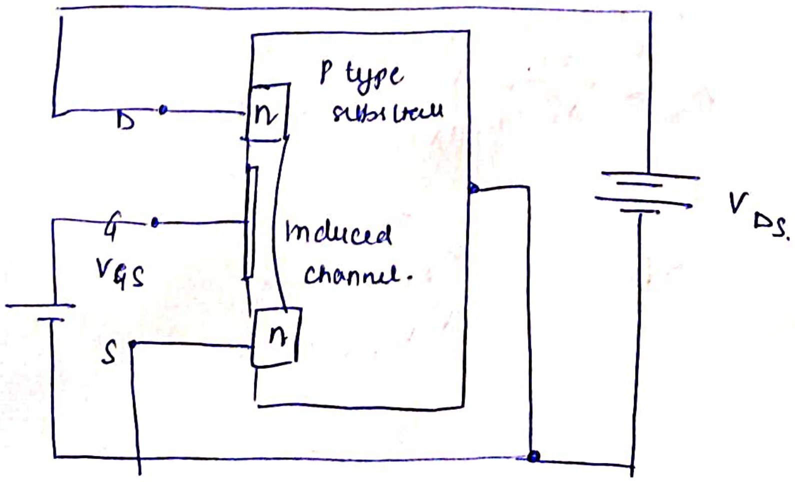
* It is pretty clear that the current will be zero until V_{GS} exceeds the threshold voltage V_T. It happens because under this state, the device will be void of channel which will be connecting the drain and source.

During this condition, if V_{DS} increase, no current will flow as shown by I_{DS} v/s V_{DS} graph. As a result, this state represents the cutoff region of MOSFET's operation.

Once V_{GS} crosses V_T, the current increases: I_{DS} increases initially in the ohmic region and then saturates.

By the graph, I_{DSS2} is greater than I_{DSS1} as $V_{GS2} > V_{GS1}$ and a similar pattern is observed further.

Pinch off voltage's locus is also visible, from which V_P increases with an increa in V_{GS}.



N channel MOSFET

5 (b) AC input signal = ± 50 mV

$\beta_{dc} = 90$, ac current = 120

$V_B = 0.7 V$, $I_B = 17 mA$

$V_i = \pm 50 mV$, $I_b = \pm 7 mA$

DC base current $I_B = 17 mA$

$V_B = 0.7 V$

$\beta_{dc} = 90$

$I_C = \beta_{dc} I_B = 90 \times 17 mA = 1530 \times 10^{-3} A$

The collector voltage V_{CE} is * R_L and V_{CC} missing

$V_{CE} = V_{CC} - I_C R_L$

$V_{CE} = V_{CC} - 1530 \times 10^{-3} \times R_L$

=

AC base current = $I_b = \pm 7 mA$ for $V_i = \pm 50 mV$

$I_c = \beta_{ac} I_b = 120 \times 7 mA$

$I_c = \pm 840 mA$

(i) AC output voltage across load resistance.

$V_o = I_C R_L = \pm 840 \times 10^{-3} \times R_L$ * R_L is missing

=

(ii) AC voltage amplification factor

$A_c = \frac{V_o}{V_i} = \frac{V_o}{\pm 50 \times 10^{-3}} = A_c$

=

(iii) $V_{CE} = V_{CC} - I_C R_L$ * R_L is missing

* V_{CC} is missing

=

— x ———— x ———— x —