Electronics II Exam-2 Solution 2020

2020/5/8

(1)

(a) $T_{j,\max} - T_{amb} = P(\theta_{dev-case} + \theta_{case-amb})$

$150 - 25 = 30(2.8 + \theta_{case-amb}) \Rightarrow \theta_{case-amb} = 1.37°C/W$

(b) $T_{j,\max} = 25 + 20(2.8 + 1.37) = 108°C$

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(2)

(a)

$V_{DS} \geq V_{DS}(sat) = V_{GS} - V_{TN} = V_{GS}$

$V_{DS} = 10 - V_o(\max)$ and $I_D = I_L = K_n(V_{GS})^2$

$\frac{V_o(\max)}{R_L} = K_n(V_{GS})^2$

$V_{GS} = \sqrt{\frac{V_o(\max)}{R_L \cdot K_n}}$

So $10 - V_o(\max) = \sqrt{\frac{V_o(\max)}{R_L \cdot K_n}} = \sqrt{\frac{V_o(\max)}{(5)(0.4)}}$

$[10 - V_0(\max)]^2 = \frac{V_0(\max)}{2}$

$100 - 20V_0(\max) + V_0^2(\max) = \frac{V_0(\max)}{2}$

$V_0^2(\max) - 20.5V_0(\max) + 100 = 0$

$V_0(\max) = \frac{20.5 \pm \sqrt{(20.5)^2 - 4(100)}}{2} \Rightarrow \underline{V_0(\max) = 8\ \text{V}}$

$i_L = \frac{8}{5} \Rightarrow \underline{i_L = 1.6\ \text{mA}}$

$V_{GS} = \sqrt{\frac{i_L}{K_n}} = \sqrt{\frac{1.6}{0.4}} = 2V \Rightarrow \underline{V_I = 10\ \text{V}}$

b.

$\overline{P_L} = \frac{1}{2} \cdot \frac{(8)^2}{5} = 6.4\ \text{mW}$

$\overline{P_S} = \frac{20(1.6)}{\pi} = 10.2\ \text{mW}$

$\eta = \frac{\overline{P_L}}{\overline{P_S}} = \frac{6.4}{10.2} \Rightarrow \underline{\eta = 62.7\%}$

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(3)

Circuit is not in breakdown.

$\frac{10 - 0}{R_s + R_1} = i_2 = \frac{10}{5.6 + 1} \Rightarrow \underline{i_2 = 1.52\ mA}$

$v_O = -i_2 R_2 = -(1.52)(1) \Rightarrow \underline{v_O = -1.52\ V}$

$\underline{i_z = 0}$

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(4)

$v_{OB} = \left(1 + \frac{40}{12}\right) v_I$

$v_{OC} = -\frac{30}{12} v_I$

$v_O = v_{OB} - v_{OC}$

$\frac{v_O}{v_I} = \frac{3.417}{0.5} = 6.83$

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(5)

$i_1 = i_2$ and $i_2 = \frac{v_x}{R_2} + i_D$, $v_x = -i_2 R_F$

Then $i_1 = -i_1 \left(\frac{R_F}{R_2}\right) + i_D$

Or $i_D = i_1 \left(1 + \frac{R_F}{R_2}\right)$

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(6)

$v_{O1} = \left(\frac{\delta}{4}\right) V^+$

$V^+ = 7.5\ \text{V}$

$\frac{v_O}{v_{O1}} = \frac{R_4'}{R_3'} \left(1 + \frac{2R_2'}{R_1'}\right) = 266.7$

$v_O = 500\delta$