Electronics II, Spring 2016 Exam2 Solution 2016/4/22

#1

(a) $T_{j,\max} - T_{amb} = P_T\left(\theta_{dev-case} + \theta_{snk-amb} + \theta_{case-snk}\right)$

$120 - 25 = P_T\left(1.5 + 2.8 + 0.6\right) \Rightarrow P_T = 19.39 \text{ W}$

(b) $T_{case} = 25 + (19.39)(0.6 + 2.8) = 90.9°C$

(c) $T_{snk} = 25 + (19.39)(2.8) = 79.3°C$

#2

(a) $V_{CEQ} = 6 = V_{CC} - I_{CQ}R_L = 12 - I_{CQ}(1) \Rightarrow I_{CQ} = 6 \text{ mA}$

$P_Q = I_{CQ}V_{CEQ} = (6)(6) = 36 \text{ mW}$

(b) (i) $\overline{P_L} = \frac{1}{2} \cdot \frac{V_P^2}{R_L} = \frac{1}{2}\frac{(4.5)^2}{1} = 10.1 \text{ mW}$

(ii) $\eta = \frac{10.1}{I_{CQ}V_{CC}} \times 100\% = \frac{10.1}{(6)(12)} \times 100\% = 14.1\%$

(iii) $\overline{P_Q} = 36 - 10.1 = 25.9 \text{ mW}$

#3

(a) For $\upsilon_O = 8 \text{ V}$, $i_L = \frac{8}{25} = 0.32 \text{ A}$

$I_{DQ} = (0.2)(0.32) \Rightarrow 64 \text{ mA}$

$I_{DQ} = K(V_{GS} - V_{TN})^2$

$64 = 250(V_{GS} - 1.2)^2 \Rightarrow V_{GS} = \frac{V_{BB}}{2} = 1.706 \text{ V}$

Then $V_{BB} = 3.412 \text{ V}$

#4

See textbook P642-643

#5

We have the general relation that

$$v_0 = \left(1+\frac{R_2}{R_1}\right)\left(\frac{[R_4/R_3]}{1+[R_4/R_3]}\right)v_{I2} - \frac{R_2}{R_1}v_{I1}$$

$$R_1 = R_3 = 10\ \text{k}\Omega,\ \ R_2 = 20\ \text{k}\Omega,\ \ R_4 = 21\ \text{k}\Omega$$

$$v_0 = \left(1+\frac{20}{10}\right)\left(\frac{[21/10]}{1+[21/10]}\right)v_{I2} - \left(\frac{20}{10}\right)v_{I1}$$

$$v_0 = 2.0323v_{I2} - 2.0v_I$$

$$A_{cm} = \frac{v_0}{v_{cm}} = 0.0323$$

$$CMRR_{dB} = 20\log_{10}\left(\frac{A_d}{A_{cm}}\right)$$

$$A_d = \frac{2.0323}{2} - (2.0)\left(-\frac{1}{2}\right) = 2.016$$

$$CMRR_{dB} = 20\log_{10}\left(\frac{2.016}{0.0323}\right) = 35.9\ \text{dB}$$

#6

See textbook

#7

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

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

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

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