Exam-2, Electronics 2022 DCchang.

#1. $V_{CE} = V_{CC} - I_C \cdot R_L = 30 - 1.4 \times 20 = 2\ (V)$

$P_T = I_C \cdot V_{CE} = 1.4 \times 2 = 2.8\ (W)$

$\because T_{jun} - T_{amb} = P_T \cdot (\Sigma\theta)$

$\therefore 150 - 24 = 2.8\,(\theta_{jun-case} + 43)$ without sink.

$= 126$

$\Rightarrow \theta_{jun-case} = 45 - 43 = 2\ (°C/W)$

with heat sink,

$P_{snk}(2+1+3) = 126 \Rightarrow P_{snk} = 21\ (W)$

$V_{CE} = \frac{21}{1.4} = 15\ (V)$

$= 30 - 1.4 \cdot R_L'$, $R_L' = \frac{15}{1.4} \doteq 10.714\ (\Omega)$

#2. (a) $I_{DQ} = 20\% \times \frac{8}{25} = 64\ mA$

At the Q-point,

$I_{DQ} = K \cdot (V_{GSn} - |V_t|)^2$

$64 = 250\,(V_{GSn} - 1.2)^2 \Rightarrow V_{GSn} = 1.706\ (V)$

$\therefore V_{BB} = 2 \cdot V_{GSn} = 3.412\ (V)$ ※

(b) $V_O = -12$, $I_L = I_{DP} = \frac{12}{25} = 480\ (mA)$

$480 = K(V_{SGP} - 1.2)^2$

$\Rightarrow V_{SGP} = 1.2 + \sqrt{\frac{480}{250}} = 2.586\ (V)$

$V_I = -12 - 2.586 + 1.706 = -12.88\ (V)$ ※

$\because V_{SGP} > |V_t|$, Mp turns on

$V_{GSn} = 3.412 - V_{SGP} = 0.826 < |V_t|$

$\therefore$ Mn turns off.

#3. (a) $\frac{V_o}{V_i} = -\frac{Z_2}{R_1}$, $Z_2 = R_2 \parallel \frac{1}{sC_2}$

$$Z_2 = R_2 \parallel \frac{1}{j\omega C_2} = \frac{R_2}{1+j\omega R_2 C_2}$$

$$\therefore \frac{V_o}{V_i} = -\frac{R_2}{R_1} \cdot \frac{1}{1+j\omega R_2 C_2}$$

(b) as $\omega \to 0$, $\frac{V_o}{V_i} = -\frac{R_2}{R_1}$

as $\omega \to \infty$, $\frac{V_o}{V_i} = 0$

$\therefore$ lowpass filter.

(c) $\therefore \left.\frac{V_o}{V_i}\right|_{\omega \to 0} = -\frac{R_2}{R_1}$

$\therefore$ 3dB freq at $\left|\frac{1}{1+j\omega R_2 C_2}\right| = \frac{1}{\sqrt{2}}$

or $1+(\omega R_2 C_2)^2 = 2$

$\Rightarrow \omega = \frac{1}{R_2 C_2}$ or $f = \frac{1}{2\pi R_2 C_2}$ #

#4.

$$V_{o1} = \left(1+\frac{40}{12}\right)V_I$$

$$V_{o2} = -\frac{30}{12}V_I$$

$$\frac{V_o}{V_I} = \frac{V_{o1}-V_{o2}}{V_I} = 1+\frac{40}{12}+\frac{30}{12} = 1+\frac{70}{12} = 6.833$$ #

#5. (a) $V_{o1} = -\frac{R_2}{R_1}V_{cm}$

$$V_{o2} = \frac{R_4}{R_3+R_4} \cdot V_{cm}\left(1+\frac{R_4}{R_3}\right)$$

$$\frac{V_o}{V_{cm}} = \frac{V_{o1}+V_{o2}}{V_{cm}} = \frac{R_4}{R_3+R_4}\left(1+\frac{R_4}{R_3}\right) - \frac{R_2}{R_1} = \frac{\frac{R_4}{R_3}-\frac{R_2}{R_1}}{1+\frac{R_4}{R_3}}$$

(b) when $\frac{R_4}{R_3} = \frac{R_2}{R_1}$ or $R_1R_4 = R_2R_3$, $\frac{V_o}{V_{cm}} = 0$