1. (a) The transistors in Figure P1a have same common emitter current gain $\beta$, and the small signal parameters include $g_{m1}$ to $g_{m4}$, $r_{n1}$ to $r_{n4}$, and $r_{o1}$ to $r_{o4}$. Determine the output resistance $R_{o1}$. (10%)

(b) The transistors in Figure P1b have small signal parameters include $g_{m1}$ to $g_{m4}$, and $r_{o1}$ to $r_{o4}$. Determine the output resistance $R_{o2}$. (10%)

2. The parameters of the transistors in the circuit in Figure P2 are $V_{TND} = V_{TNL} = 0.6 \text{ V}$, $K_{ND} = 0.5 \text{ mA/V}^2$, $K_{NL} = 2 \text{ mA/V}^2$, and $\lambda_D = \lambda_L = 0$. Plot the relationship of $V_o$ versus $V_I$ over the range $0 \leq V_I \leq 5 \text{ V}$. (10%)

3. For the circuit shown in Figure P3, the small signal parameters include $g_m$ and $r_w$, derive the expression of the 3dB frequency associated with coupling capacitor $C_{C1}$ and $C_{C2}$ respectively. (20%)
4. For the circuit in Figure P4, derive the expressions for the voltage transfer function \( T(s) = \frac{V_o(s)}{V_i(s)} \) and the cutoff frequency \( f_{cbb} \). (20%)

![Figure P4](image1)

5. Consider the oscillator circuit in Figure P5, find the loop gain function, the frequency of oscillation, and the \( R_2/R_1 \) required for oscillation. (20%)

![Figure P5](image2)

6. Consider a power MOSFET for which the thermal resistance parameters are: \( \theta_{dev-case} = 2^\circ \text{C/W} \), \( \theta_{case-sok} = 1^\circ \text{C/W} \), and \( \theta_{sink-amb} = 4^\circ \text{C/W} \). The ambient temperature is \( T_{amb} = 25^\circ \text{C} \), and the maximum junction or device temperature is \( T_{j,max} = T_{dev} = 150^\circ \text{C} \). Determine the maximum power dissipation in a transistor and determine the temperature of the transistor case and heat sink. (10%)