Midterm Exam II

Name (print) ________________________________

Part 1: _______/ 5
Part 2: _______/ 15
Part 3: _______/ 25
Part 4: _______/ 30
Part 5: _______/ 25

Total: _______/ 100
The following equations might be useful for solving Parts 2 to 5.

- **n-channel MOSFET:**
  \[ i_D = \begin{cases} 
  K(V_{GS} - V_T)^2, & \text{if } V_{GS} \geq V_T \text{ and } V_{DS} \geq V_{GS} - V_T \\
  2K \left( V_{GS} - V_T - \frac{V_{DS}}{2} \right) V_{DS}, & \text{if } V_{GS} \geq V_T \text{ and } V_{DS} \leq V_{GS} - V_T \\
  0, & \text{if } V_{GS} < V_T 
  \end{cases} \]

- **BJT:** \[ i_C = \beta i_B \]

Part 1: I-V characteristics - 5 min

Describe the main differences between the I-V characteristics of npn BJTs and n-channel MOSFETs. (5 points)
Part 2: BJT (I) - 15 min -

In the circuit represented in the figure below assume that $V_f = 0.6 \, V$ and $V_{sat} = 0.2 \, V$. Over what range of $v_B$ (measured relative to the ground) will the transistor operate in the constant-current region? (15 points)
Part 3: BJT (II) - 15 min -

Consider the circuit represented in the figure below. Assume that you are given $R_1, R_2, R_3, R_4, V_{cc}, V_f$, and $\beta$. Also, suppose that the transistor is biased in the constant-current region.

1) Compute the base current. (10 points)
2) Compute the voltage between collector and emitter. (10 points)
3) Compute the power dissipated in the transistor. (5 points)
Part 4: MOSFET (I) - 20 min -

Consider the circuit represented in the figure below. Assume that \( V_{cc} = 5 \text{ V} \), \( R_1 = 100 \text{ k}\Omega \), \( V_T = 1 \text{ V} \), and \( k = 1 \text{ mA/V}^2 \).

1) Compute the drain current if \( R_2 = 1 \text{ k}\Omega \). Is the MOSFET biased in the constant-current, triode, or cutoff region? (15 points)

2) Compute the maximum value of \( R_2 \) for which the MOSFET is biased in the constant-current region. (15 points)
Part 5: MOSFET (II) - 20 min -

Consider the circuit represented in the figure below. Assume that $R_G = 20 \, k\Omega$, $R_S = 1 \, k\Omega$, $I_0 = 0.1 \, mA$, $K = 0.5 \, mA/V^2$, $V_T = 1 \, V$, and $V_{cc} = 5 \, V$.

1) Compute the potential across the current source. (5 points)
2) Compute the drain current. Is the transistor biased in the constant-current or triode region? (10 points)
3) Compute the power dissipated in the transistor. (10 points)