1. This is a closed book and notes exam.
2. Budget your time.

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Problem 1:
For the following current source determine:

A) \( I_{\text{REF}} \) = 

B) \( R_E \) = 

C) \( V_E \) = 

D) \( R_{\text{out}} \) = 

\[ \beta = 100, V_T = 25 \text{ mV}, V_A = 50V \]
Problem 2:

Determine the following for the common source amplifier shown:

a) Drain Current \( ID \)  
\[ ID = \ldots \]

b) Transconductance \( g_m \)  
\[ g_m = \ldots \]

b) Input resistance \( R_{id} \)  
\[ R_{id} = \ldots \]

\[ V_T = 2V, \ k_n(W/L) = 2 \text{ mA/V}^2 \]
Problem 3:
For the following differential mode amplifier with matched Q1 and Q2, determine the input resistance $R_{id}$, differential gain $A_d$, and output resistance $R_o$ following:

\[
R_{id} = \text{_________} \quad (8)
\]
\[
A_d = \frac{v_o}{v_d} = \text{_________} \quad (8)
\]
\[
R_o = \text{_________} \quad (4)
\]

\[\beta = 99, \ \text{and} \ \ V_T = 25 \text{ mV}\]
Problem 4:
The nMOSFET has $V_t = 2V$, $k_n = 20 \mu A/V^2$, $W=400 \mu m$, $L=10 \mu m$,

Operation mode is  
Explain why?

$R_D = \text{__________}$

$V_S = \text{__________}$

$R_S = \text{__________}$
Problem 5:

Figure 1:

1) Examine the above I-V characteristics in Figure 1 and circle the correct answer:

1) The n-MOSFET type is    
   (a) enhancement   (b) depletition

2) The threshold voltage is  
   (a) positive      (b) negative

3) When VGS = 2 V, the corresponding I-V curve will be:  
   (a) curve A       (b) Curve B

4) When VGS = -1V, the corresponding I-V curve will be:  
   (a) curve A       (b) Curve B

5) This type of MOSFET is normally  
   (a) ON           (b) OFF
Problem 5 (continued)

II) Sketch the shape of the MOSFET channel at points 1, 2, 3, and 4 on the above I-V characteristics in Figure 2:

III) On Figure 2 sketch the I-V curve corresponding to a device with:
   1) $W = 5 \mu m$ and $L = 2 \mu m$
   2) $W = 10 \mu m$ and $L = 1 \mu m$

IV) If $V_t = 1V$, $k_nW/L = 10 \mu A/V^2$, determine the transconductance at $V_{GS} = 3V$