HOMEWORK 1:

Problem 1: Base coupled cascode differential pair

All BJT’s are identical and have the following parameters:
Icq = 0.5 mA ; B = 200 ; Rc = 500 ; Rbb = 5 K

a) Draw the differential mode half circuit ( not eqnt ckt )
b) Determine AVDM
c) Draw the common mode half circuit
d) Determine AVCM
e) Determine CMRR

Problem 2: (Cascade Amp)

Rs = 50 Ω; Rs = 50 Ω; RG2 = 10 K; gm1 = gm2 = 0.04; rd1 = rd2 = 10 K

a) Determine the voltage gain $A_v = V_o / V_s$
b) Determine the input resistance $R_i$ of the circuit
Problem 3: (Cascade amp)

\[
\text{Rs} = 50 \, \Omega; \quad \text{Rs} = 50 \, \Omega; \quad B = 100; \quad I_{CQ1} = I_{CQ2} = 500 \mu A
\]

a) Determine the voltage gain \( A_v = V_o / V_s \)
b) Determine the input resistance \( R_i \) of the circuit

Problem 4: (BIMOS Cascode)

\[
\text{FET} : \quad \text{gm} = 0.1; \quad \text{rd} = 1 \, \text{K}; \quad I_{DQ} = 0.1 \, \text{mA}; \quad \text{Rs} = 1500
\]
\[
\text{BJT} : \quad \text{VT} = 25 \, \text{mV}; \quad B = 100; \quad R_{c2} = 10 \, \text{K}; \quad R_L = 10 \, \text{K}
\]

a) Find \( R_i \) \quad (b) Find \( A_v1 \) \quad (c) Find \( A_v2 \) \quad (d) Find \( A_{VT} = V_o / V_s \)

Problem 5: (AMPLIFIERS)

\[
(1.)
\]

\[
\text{Rs} \quad \text{Rs} \quad \text{Rs} \quad \text{Rs} \quad \text{Rs} \quad \text{Rs}
\]
For each of the above given circuits, find
a) \( R_i \) and (b) \( A_{VT} = \frac{V_o}{V_s} \)

FET: \( gm = 0.01 \); \( rd = 1 \text{ K} \); \( RS1 = 400 \); \( Rs = 1000 \); \( R_D = R_L = 20 \text{ K} \); \( R_G = 10 \text{ K} \)

BJT: \( VT = 25 \text{ mV} \); \( B = 100 \); \( R_{E1} = 75 \frac{\text{V}}{\text{mV}} \); \( R_{E2} = 100 \frac{\text{V}}{\text{mV}} \); \( Rs = 30 \text{ K} \)

Problem 6: (JFET – Source Coupled Pair)

The JFETs in a source coupled pair have a \( gm = 0.001 \); \( rd = 50 \text{ K} \); They are biased by a current source having an output resistance of 40 K. Drain resistor \( R_D = 30 \text{ K} \). Determine

a) \( A_{VDM} \)  ; (b) \( A_{VCM} \)  ; (c) CMRR
Problem 7: (BJT Differential Pair)

Vcc

RC1

RC2

Q1

Q2

IBIAS

500 K

V1

Vo

V2

B = 100

a) Find AVDM for a differential input and a single ended output
b) Find AVCM for a common mode input and a single ended output
c) Find CMRR
d) Find input resistance from the base of Q1 to the base of Q2
e) For an applied V1 = 3.001 V and V2 = 2.999 V. Find Vo

Problem 8: (BJT Differential Amp)

Vcc

RC1

RC2

Vi1

Vi2

Q1

Q2

REE

IEEQ

Ri

Ri

Vo

IREE

REE
\( R_{E1} = R_{E2} = 1 \, K \); \( R_{EE} = 10 \, K \); \( R_{c1} = R_{c2} = 20 \, K \); \( I_{EEQ} = 0.1 \, mA \); \( B = 100 \)

a) Find \( R_i \) (diff mode)

b) Draw the diff mode half ckt

c) Determine \( A_{VDM} = \frac{V_o}{V_d} \) when \( V_d = V_{i1} - V_{i2} \)

d) Draw the common mode half circuit

e) Determine the common mode gain

f) Determine CMRR

**Problem 9:**

The BJTs in a base coupled pair have a \( B = 100 \) and a \( R_c = 25 \, K \). They are biased by a 200 \( \mu \)A current source having an output resistance of 1.25 M

a) Draw the transistor half ckt for \( A_{VDM} \) and find \( A_{VDM} \)

b) Draw the transistor half ckt for \( A_{VCM} \) and find \( A_{VCM} \)

c) Find CMRR

**Problem 10:**

\( R_2 = 5 \, K \); \( R_1 = R_3 = R_4 = 1 \, K \)

a) Find \( V_o \) for \( V_1 = +1 \, V \); \( V_2 = -1 \, V \)

b) Find \( V_o \) for \( V_1 = +1 \, V \); \( V_2 = +1 \, V \)

c) Find the CMRR of this circuit