
UNIVERSITI SAINS MALAYSIA

Semester I Examination
Academic Session 2010/2011

November 2010

EEE 510 – ADVANCED ANALOGUE CURCUIT DESIGN

Time: 3 Hours

INSTRUCTION TO CANDIDATE:

Please ensure that this examination paper contains **SIX** printed pages and **SIX** questions before answering.

Answer **FIVE** questions.

Distribution of marks for each question is stated accordingly.

All questions must be answered in English.

1. Calculate the output resistance and the minimum output voltage, while maintaining all transistors in saturation, for the circuit shown in Figure 1. Assume that I_{OUT} is also $10\mu A$.

(100 marks)

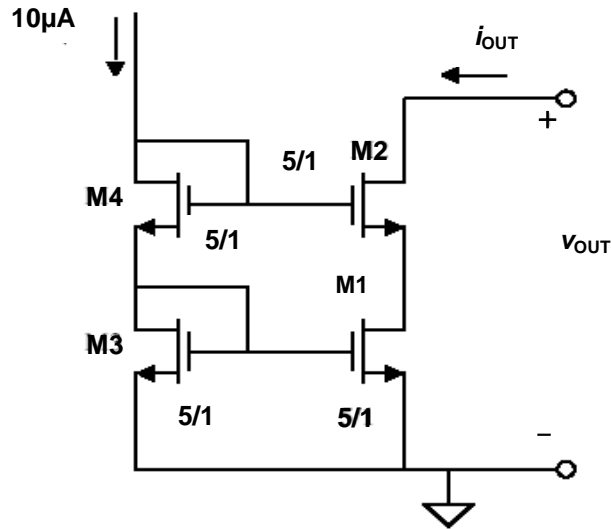


Figure 1: Cascode Current Source

2. A CMOS amplifier is shown in Figure 2. Assume M1 and M2 operate in the saturation region.

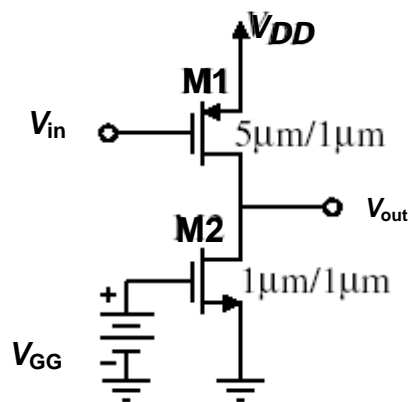


Figure 2: Common Source Amplifier

- (a) What value of V_{GG} gives $100\mu\text{A}$ through M1 and M2? (30 marks)
- (b) What is the DC value of input voltage V_{in} ? (30 marks)
- (c) What is the small signal voltage gain, V_{out}/V_{in} ? (40 marks)

3.

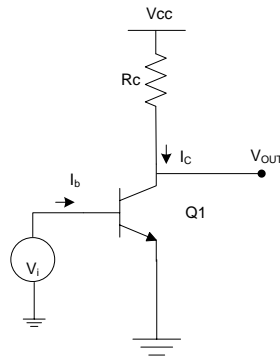


Figure 3: Common Emitter Amplifier

- (a) Draw small signal equivalent circuit of the circuit in Figure 3. (30 marks)
- (b) If $R_C = 2.5\text{ k}\Omega$, $I_C = 100\text{ }\mu\text{A}$ and current gain, $\beta = 100$, determine the gain, A_V of the circuit in Figure 3. (20 marks)

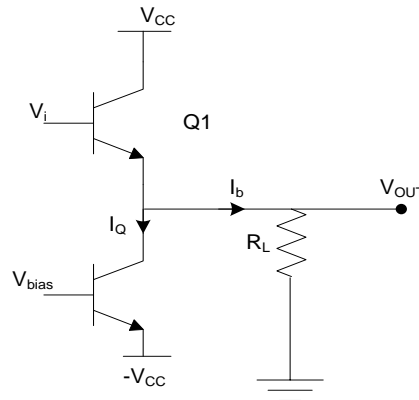


Figure 4. Class A Amplifier

(c) Figure 4 shows a typical Class A Bipolar amplifier. Based on the circuit, prove that the ideal efficiency of the amplifier is 25 %.

(50 marks)

4. Circuit in Figure 5 shows basic design of voltage regulator.

(a) Find expression of V_o .

(20 marks)

(b) If you were to increase the output current by β . What are the modification need to the circuit? Show the modified diagram after modification.

(80 marks)

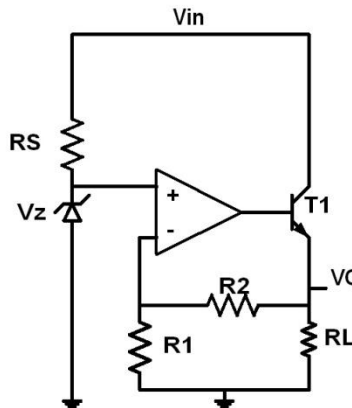


Figure 5: Voltage Regulator

5. Find the output resistance of the double-cascode current mirror shown in Figure 6. Assume all the transistors operate in active region with $I_D = 10\mu A$, $V_A = 50V$ and $g_{mro} = 50$. Neglect body effect.

(a) Derive output resistance.

(60 marks)

(b) Calculate the output resistance.

(40 marks)

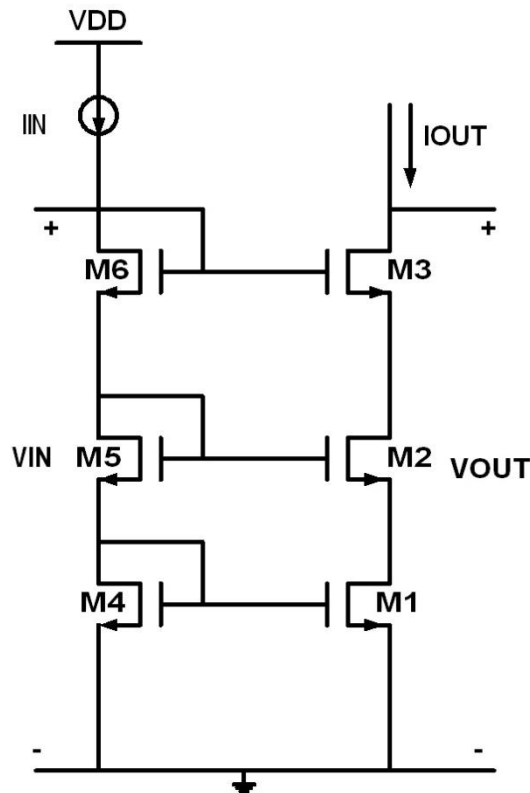


Figure 6 : Cacode Current Mirror

6. Circuit in Figure 7 shows cascade common source having both load of 10K. This circuit is aimed to build a good control current source (CCCS). Therefore 10K is inserted as feedback resistor. R_{ds} and g_m for both transistor is 40k and 2mS.

(a) Calculate $\frac{I_{in}}{V_{in}}$ when I_{out} equal 0. (20 marks)

(b) Calculate $\frac{V_{out}}{V_{in}}$ when I_{out} equal 0. (40 marks)

40 Calculate $\frac{V_{out}}{I_{out}}$ when input v_i is short circuit. (40 marks)

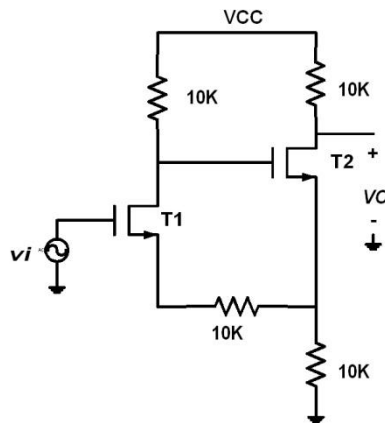


Figure 7: Cascade Common Source