# Microelectronic Circuits II
ECE16366- Spring 2007
Professor Mufeed MahD

## Midterm Exam 1

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| Problem 1 |  |
| Problem 2 |  |
| Total Score |  |

**Notes:**

This is an hour (50 minutes) midterm exam.
Two problems for 20 points (10 points each)
It is open book.
Show steps of solution not only final results
Write your name in all sheets including the extras
Need extra sheets! Just ask.
Good luck
Problem (1): Assuming that |VBE| = 0.7, β >> in the shown circuit:

1. Design $R_A$ such that $I_{ref} = 2\, \text{mA}$.
2. Calculate all branch currents and node voltages for $V_{CC} = -V_{EE} = 10\, \text{V}$ and $R_{C1} = R_{C2} = \frac{1}{2} R_{C3} = \frac{1}{2} R_{C4} = 2\, \text{kΩ}$.

\[ KVL \quad RA \cdot I_{REF} + V_{BEA} = 10 = 0 \]
\[ RA = \frac{10 - V_{BE}}{I_{REF}} = \frac{9.3}{2\, \text{mA}} = 4.65\, \text{kΩ} \]

$(RA = 4650 \, \text{kΩ})$
Problem (2): Assuming that $|R_c| = 5K, \beta >>$ in the shown circuit:

- Design a simple current source that will give a differential output gain of $A_d = 100V/V$.
- Design $R$ (input resistance of the current source) to get common mode gain of $2 V/V$. 
(a) 

\[ A_d = \frac{\alpha V_R C}{r_C} = \frac{\alpha V_R C}{\frac{V_T}{I_E}} = \frac{160}{V_T} \]

\[ \Rightarrow A_d = \frac{160}{\frac{V_T}{I_E}} \]

Since \( A_V = 100 \Rightarrow \frac{200 V_T}{I_E} = 1 \)

or \( I = \frac{200 \times 25 \times 10^{-3}}{5 \times 10^3} = \frac{50 \times 10^{-1}}{5 \times 10^3} = \frac{5}{5 \times 10^3} = 1 mA \)

VCC = 10V

\[ I = 1 mA \]

KVL:

\[ -10 + R \cdot I_{REF} + V_{BE1} = 0 \]

\[ \alpha \cdot R = \frac{9.3}{1 mA} = 9.3 \]
(b) \[ A_{cm} = \frac{\alpha R_C}{re + 2R} \Rightarrow \alpha = 1 \]

\[ R_C = 5k\Omega \]

\[ re = \frac{VT}{(I/2)} \]

\[ = \frac{25mV}{1/2mA} \]

\[ = 50\Omega \]

\[ 2 = \frac{5k}{50 + 2R} \Rightarrow 100 + 4R = 5000 \]

\[ 4R = 4900 \]

\[ R = 1225\Omega \]

\[ R = 1.225\ k\Omega \]