EEE 51 Assignment 8

2nd Semester SY 2017-2018
Due: 5pm Tuesday, Apr. 24, 2018 (Rm. 220)

Instructions: Write legibly. Show all solutions and state all assumptions. Write your full name, student number, and section at the upper-right corner of each page. Start each problem on a new sheet of paper. Box or encircle your final answer.

Answer sheets should be color coded according to your lecture section. The color scheme is as follows:

THQ – yellow
THR – blue
THU – white
THX – green
WFX – pink

1. **CS amplifier with source degeneration frequency response.** For the given circuit below, assume that there is no body effect and channel length modulation is ignored.

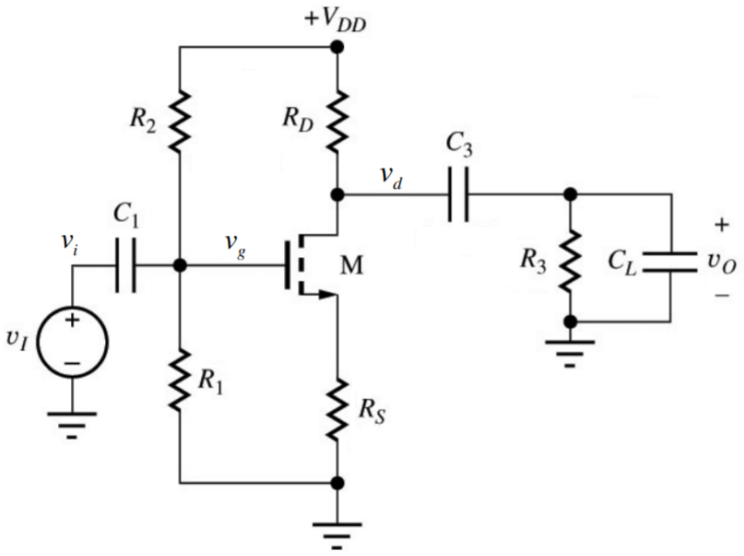

Figure 1: CS Amplifier with Source Degeneration

   (a) Draw the small-signal equivalent circuit including C_{GD} and C_{GS}. [2 pts]

   (b) Find the expression for the small-signal transfer function of the circuit. State *all* assumptions and show your *complete* solution. [5 pts]

   (c) Determine the expression(s) for the pole(s) and/or zero(s) of the circuit. [3 pts]

2. **Emitter-degenerated BJT Amplifier**. A BJT Q_1 with $\beta = 100$, $I_S = 10\,\text{fA}$, $V_{CE,sat} = 0.2\,\text{V}$ and $V_A = 200\,\text{V}$ is biased with resistors. Assume that the BJT has no parasitic capacitances. The resistors used are $R_C = 500\,\Omega$, $R_B = 50\,\text{k}\Omega$, $R_E = 300\,\Omega$. The supply voltage V_{CC} is 5 V. A DC-blocked input is connected to the base, as shown in Figure 2. The DC block is not ideal, with a finite capacitance $C_{in} = 1\,\mu\text{F}$. A capacitor is placed in parallel to the emitter resistor, with $C_E = 1\,\text{fF}$. The amplifier drives a load capacitor, $C_L = 1\,\text{nF}$.

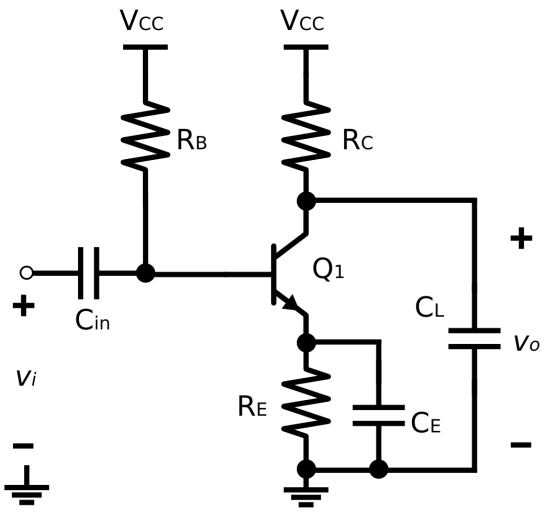

Figure 2: Emitter-degenerated amplifier with load capacitance

(a) Solve for the overall transfer function $H(s) = \frac{v_o(s)}{v_i(s)}$. Write this in terms of the small-signal parameters and component values. [7 pts]

(b) Compute for and list all the pole and zero frequencies in H(s). If multiple poles or zeroes are on the same frequency, list them separately. [3 pts]

3. **Two-stage differential amplifier frequency response.** Given the circuit with the parameters below, solve for the following:

$V_{DD} = 5V$, I_{M8}=$50uA$, $k_{1,2,8} = 100\frac{uA}{V^2}$, $k_{3,4} = 75\frac{uA}{V^2}$, $k_{5,6,7,9} = 50\frac{uA}{V^2}$, $\lambda = 0.02V^{-1}$, and $|V_{TH_{n|p}}| = 1V$

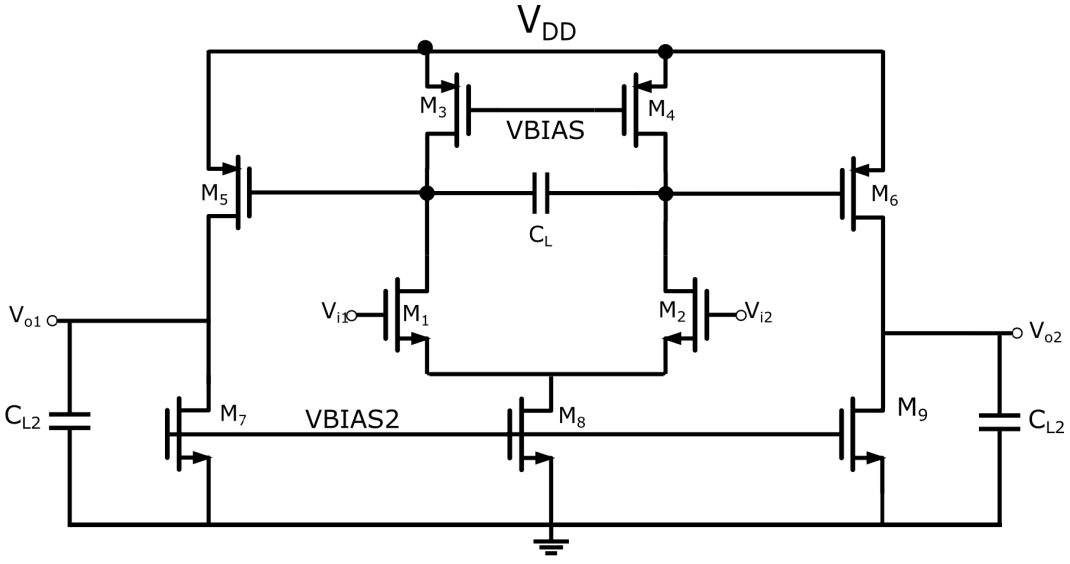

Figure 3

(a) Plot the magnitude and phase response of the amplifier. [2 pts]

(b) Determine ω_{p1} [2 pts], ω_{p2} [2 pts], $-3dB$ point [2 pts], and unity gain bandwidth [2 pts].

TOTAL: 30 points.