ELC 3314 – Electronic Design
Fall 2015
Final Exam – December 12, 2015
Closed Book/Closed Notes
2 hours

1. The exam is closed-book/closed-notes.

2. A calculator may be used to assist with the test. No laptops or PDAs are allowed. No cellular phones may be used in any way during the test. Unauthorized electronic device use will result in disqualification.

3. You must circle or box your answers to get full credit.

4. All work and steps toward a solution must be clearly shown to obtain credit.

5. Partial credit may be given provided that the grader can clearly follow your work to the extent that an understanding of the problem is demonstrated.

6. No collaboration is allowed on this examination. Only Dr. Baylis or an exam proctor may be consulted for clarification.

7. You may attach extra sheets to the exam if necessary. Each page should contain your name, the problem number, and the page number for that problem.

Please sign the statement below. YOU MUST SIGN THE STATEMENT OR YOU WILL GET A ZERO FOR THIS EXAMINATION!!!

I hereby testify that I have neither provided or received information from unauthorized sources during the test and that this test is the sole product of my effort.

Signed ______________________________________                          Date_____________________
PROBLEM 1 (20 points): Sketch both the magnitude and phase Bode plots for the following function:

\[ A(s) = \frac{2000\pi(s + 2000\pi)}{(s + 200\pi)(s + 20000\pi)} \]

Label all amplitudes, angles, and frequencies clearly on your plots.
PROBLEM 2 (15 points): Consider the following feedback system, with open–loop gain $A = 10^2$ and feedback network gain $\beta = 0.3$:

(a) (7 points) What is the value of the closed-loop gain $A_f$?

(b) (8 points) If $A$ is found to vary by $\pm 7\%$ based on ambient temperature changes, what is the closed-loop percent variation in $A_f$?
**PROBLEM 3 (15 points):** Find the value of output voltage $v_o$ for the following circuit. Assume that both of the op amps are ideal and that negative feedback is occurring in the circuit.
PROBLEM 4 (15 points): Find $V$ for the following circuit, assuming that the diodes are ideal.
(more workspace for Problem 4):
**PROBLEM 5 (20 points):** Consider the common-emitter amplifier shown below. Assume $\beta = 100$, $V_{BEQ} = 0.7$ V, and $V_T = 26 \times 10^{-3}$ V. Also assume that the capacitance values are very large for all capacitors.

![Amplifier Circuit Diagram]

(a) (8 points) What is the value of $r_n$ in the small-signal transistor model? Verify that your assumed DC region of operation is correct.
(b) (6 points) Find the value of the voltage gain

\[ A_V = \frac{v_o}{v_{in}} \]

for this amplifier.

(c) (6 points) Find the input resistance \( Z_{in} \) for this amplifier.
PROBLEM 6 (15 points): For the differential amplifier pictured below, find the small-signal differential voltage gain (for balanced load) \( A_{vdb} = v_{od}/v_{id} \), where \( v_{id} = v_{i1} - v_{i2} \). Assume \( \beta = 100 \) and \( V_T = 26 \times 10^{-3} \) V for the identical transistors \( Q_1 \) and \( Q_2 \), assume that both transistors are biased in the active region, and assume that the output resistance of the DC current source is infinite. Do not neglect the quiescent bias base currents.

Equations:

\[
A_{vds} \text{(single-ended)} = \frac{v_{o1}}{v_{id}} = \frac{-R_c \beta}{2[r_\pi + (\beta + 1)R_{EF}]} ,
A_{vdb} \text{(balanced)} = \frac{-R_c \beta}{r_\pi + (\beta + 1)R_{EF}} ,
\]

\[
r_\pi = \frac{BV_T}{I_{CQ}}
\]

(more workspace on next page)
(more workspace for Problem 5):