UNIVERSITY OF UTAH

ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

ECE 3110

Electronics II

Midterm 2

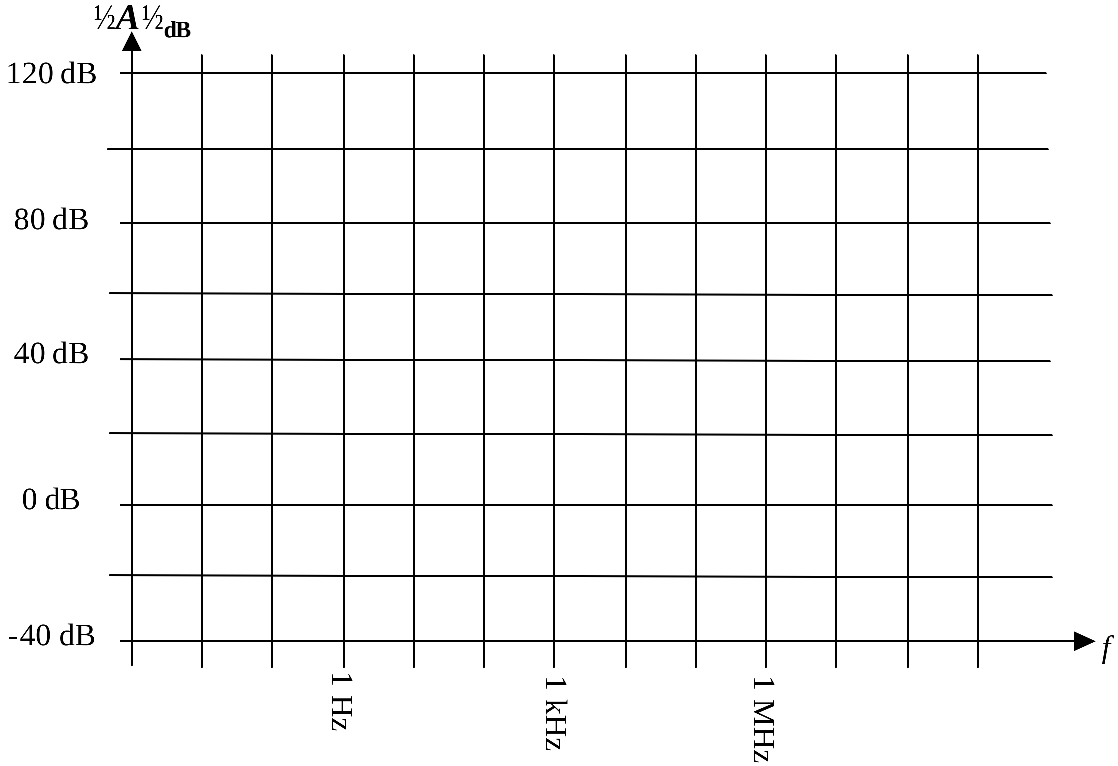
November 22, 2004

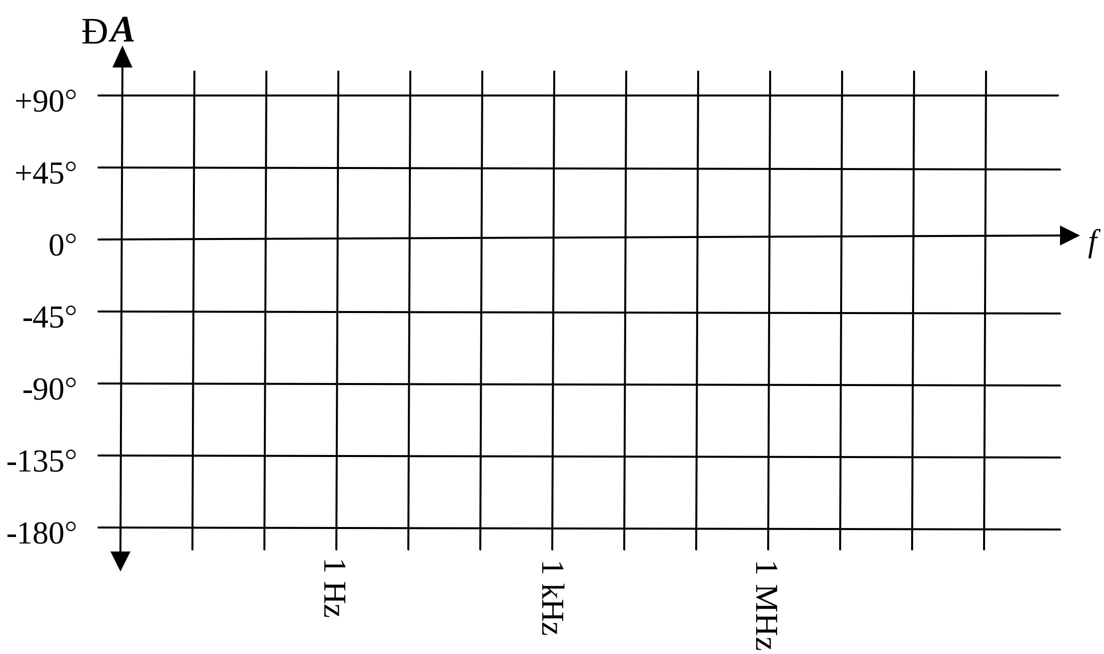
NAME: ____

(Please print)

- Do not open the exam until instructed.
- Draw a circle or box around your final answers.
- All answers should include units (e.g., V, mA, kΩ) where appropriate. **For frequencies, use Hz (or kHz, or MHz), *not* radians/second.**
- If you want partial credit on incorrect answers, *show your work on the pages you turn in!* If you choose to turn in any sheets of scratch paper, *write your name on those sheets!*
- Don't spend all of your time on one difficult problem. Don't be afraid to skip ahead if you get stuck. You don't have to work the problems in order.
- The use of wireless devices is prohibited during the exam.

1. (20 points) (a) We have an amplifier with a dc gain of 100 dB and (normal) poles at 100 Hz and 1 MHz. Draw the Bode magnitude and phase plots of this amplifier below.





(b) What is the phase margin for $b = 0.001$? ________________

(c) What is the *lowest* closed-loop gain A_f for which this amplifier has acceptable stability (having a phase margin of at least 45°)? A_f = __________

2. (22 points) What type of feedback topology is shown below (e.g., series-series, shunt-series,…)?

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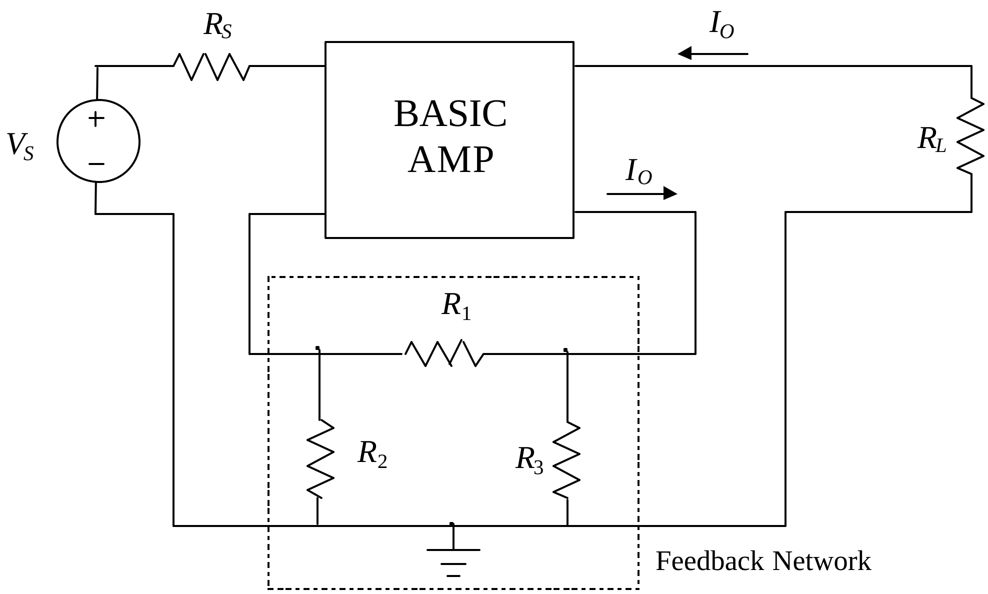
Draw three pictures showing the circuit configurations used for measuring b, R_{11}, and R_{22} for the feedback network shown, and derive expressions for b, R_{11}, and R_{22} as a function of circuit parameters.



3. (22 points) A voltage amplifier (voltage input, voltage output) having an open-circuit gain of 200, an input resistance of 10 kΩ, and an output resistance of 100 Ω is connected in a negative-feedback loop.

(a) Which feedback topology (e.g., series-shunt, series-series, etc.) would be used in this situation?

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The feedback network has an R_{11} and R_{22} of 5 kΩ and provides a feedback factor b = 0.15. The amplifier is fed by a voltage source having R_S = 1 kΩ, and a load resistance R_L = 1 kΩ is connected at the output.

(b) What is A? (Hint: It is *not* 200!)

(c) What is the closed-loop gain A_f of the feedback amplifier?

(d) What is the feedback amplifier's input resistance R_{in}?

4. (20 points) The datasheet of the PN2222A bipolar transistor contains the following information:

Maximum allowable junction temperature T_{Jmax} = 150°C
Maximum power dissipation P_{Dmax} = 625 mW at ambient temperature T_A = 25°C
Junction-to-case thermal resistance q_{JC} = 80°C/W

(a) Draw an equivalent electrical circuit for this thermal system. Label all components as well as the junction temperature T_J, the case temperature T_C, and the ambient temperature T_A. (Note that we are not using a heat sink in this problem.)

(b) Find the case-to-ambient thermal resistance q_{CA}.

(c) Assuming an ambient temperature of 25°C, what is the case temperature T_C when the transistor dissipates 500 mW?

5. (16 points) Circuit concepts.

(a) We discussed three types of power amplifiers or output stages in class: **Class A, Class B,** and **Class AB.**

Which type has the worst distortion? ________________

Which type has the highest power efficiency? ___________________

Which type has the lowest power efficiency? ____________________

(b) If we put a square wave into a feedback amplifier, and the output shows too much ringing for our application, is the phase margin too high or too low? _________________

(c) Name a clever circuit structure used to generate binary-weighted currents that does not require binary-weighted resistors: ________________________

(d) All else being equal, which ADC consumes more power: a flash ADC or a successive-approximation ADC? ___________________

(e) All else being equal, which ADC is *fastest*: a flash ADC, a successive-approximation ADC, or a dual-slope ADC? _________________

(f) All else being equal, which ADC is *slowest*: a flash ADC, a successive-approximation ADC, or a dual-slope ADC? _________________