

ECE 137B Final Exam

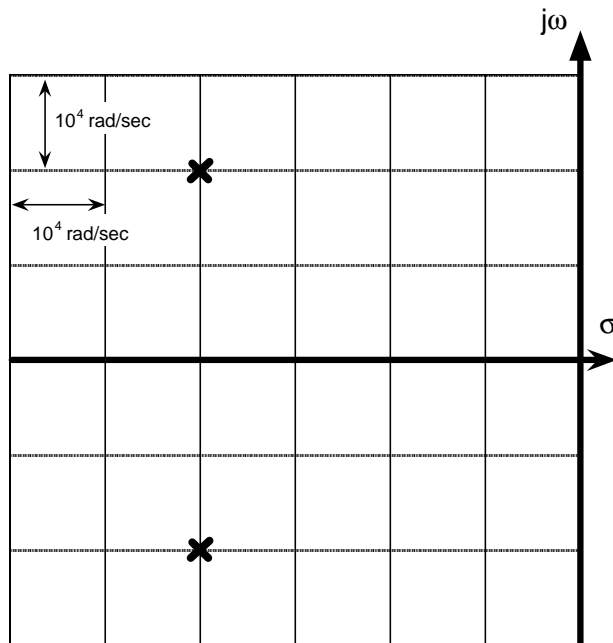
June 11, 1996

There are 8 problems on this exam and you have 3 hours

Do not open this exam until told to do so

Name: _____

Problem 1, 10 points
LaPlace Transforms



Above is the root locus for a system with $V_{out}(s)/V_{in}(s) = H(s)$. $H(s)=3$ at DC (at $s=0$ rad/sec).

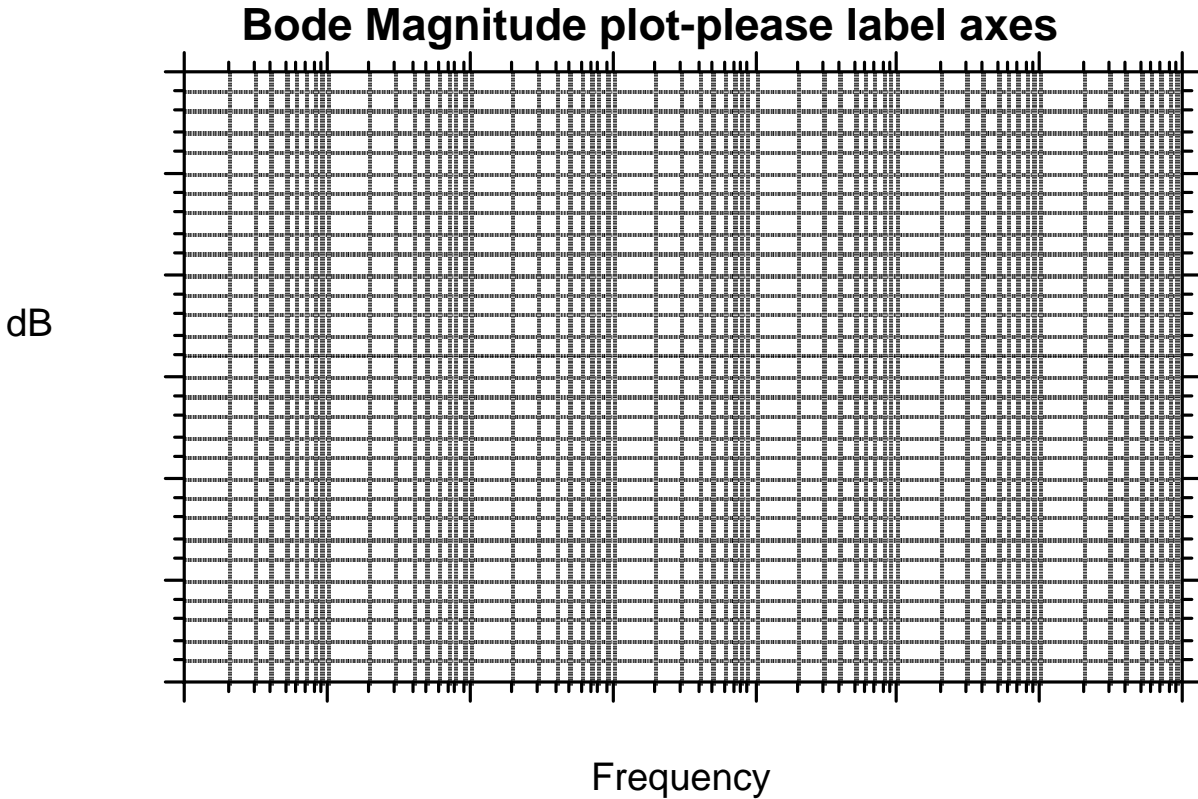
Part a), 5 points

Give an algebraic expression for $H(s)$ in standard ratio-of-polynomials form

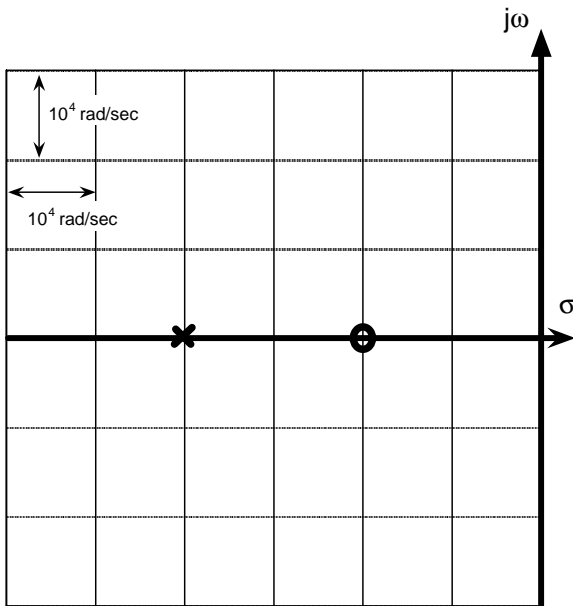
$$V_{out}(s)/V_{in}(s) = H(s) =$$

Part b), 5 points

Draw an ACCURATE Bode plot of the magnitude of the transfer function. Label all slopes, critical frequencies, and initial values.



Problem 2, 10 points
LaPlace Transforms



Above is the root locus for a system with $V_{out}(s)/V_{in}(s) = H(s)$. $H(s)=2$ at DC (at $s=0$ rad/sec).

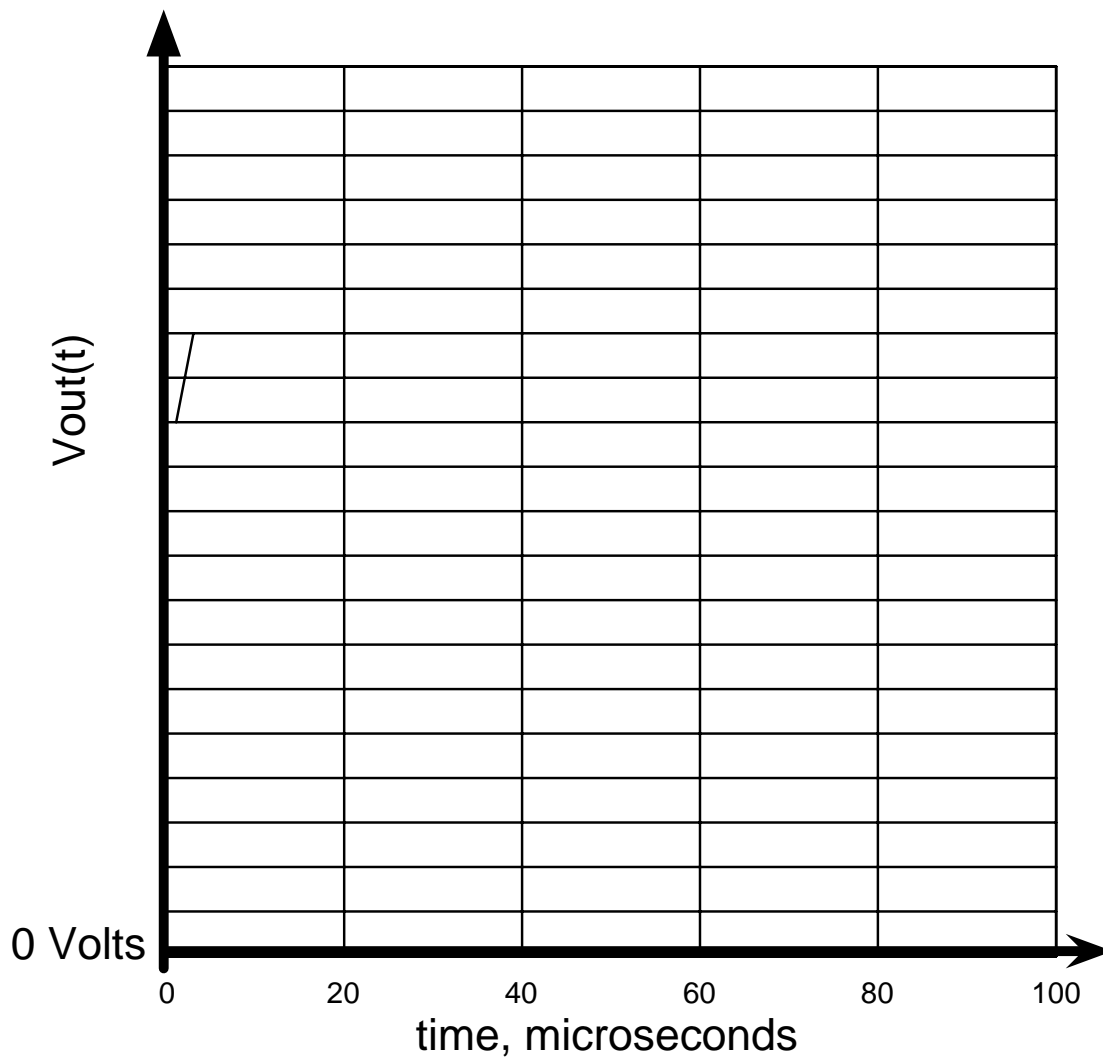
Part a), 5 points

Give an algebraic expression for $H(s)$ in standard ratio-of-polynomials form

$V_{out}(s)/V_{in}(s) = H(s) =$

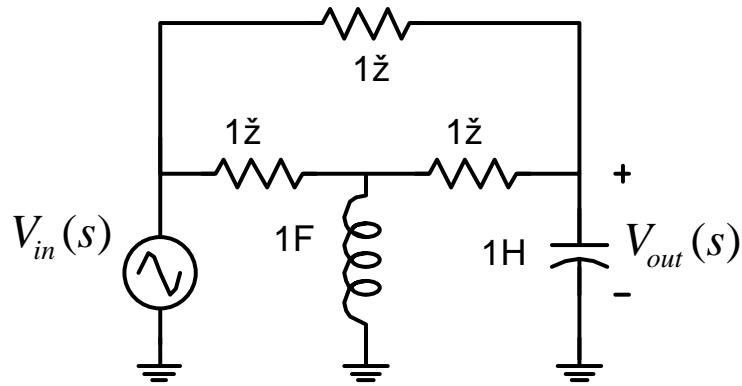
Part b) 5 points

With $V_{in}(t)=2 \text{ Volts} \cdot U(t)$, given an algebraic expression for $V_{out}(t)$ and plot $V_{out}(t)$ accurately below



Problem 3, 10 points

Fundamental circuit analysis

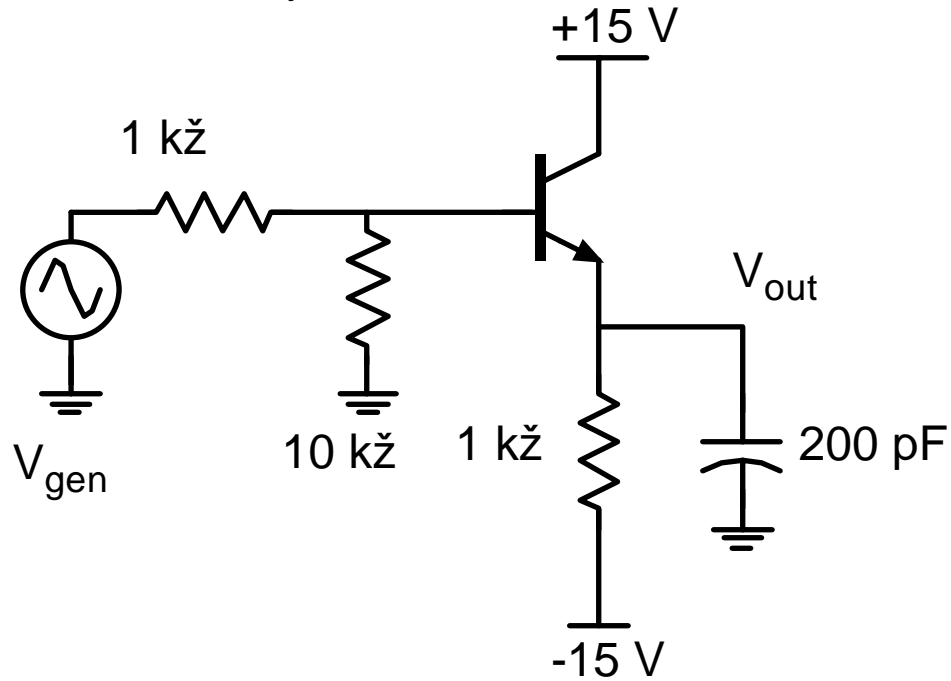


Give an algebraic expression for $V_{out}(s)/V_{in}(s) = H(s)$ in standard ratio-of-polynomials form.

$V_{out}(s)/V_{in}(s) = H(s) =$

Problem 4, 10 points

Transistor circuit analysis

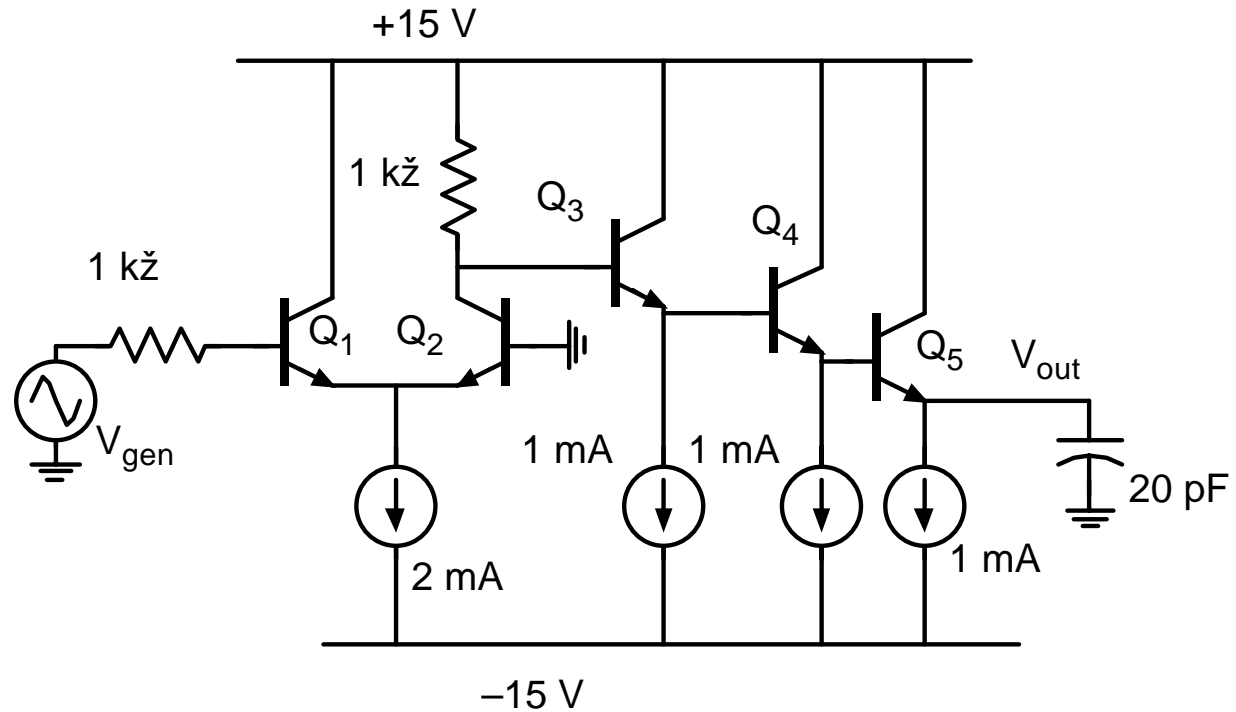


The transistor has $\beta=1000$, $V_A=1000$ Volts, $f_t=150$ MHz, $C_\mu=50$ pF. Find $V_{out}(s)/V_{gen}(s)$

$V_{out}(s)/V_{gen}(s) =$

Problem 5, 20 points

Method of first-order time constants



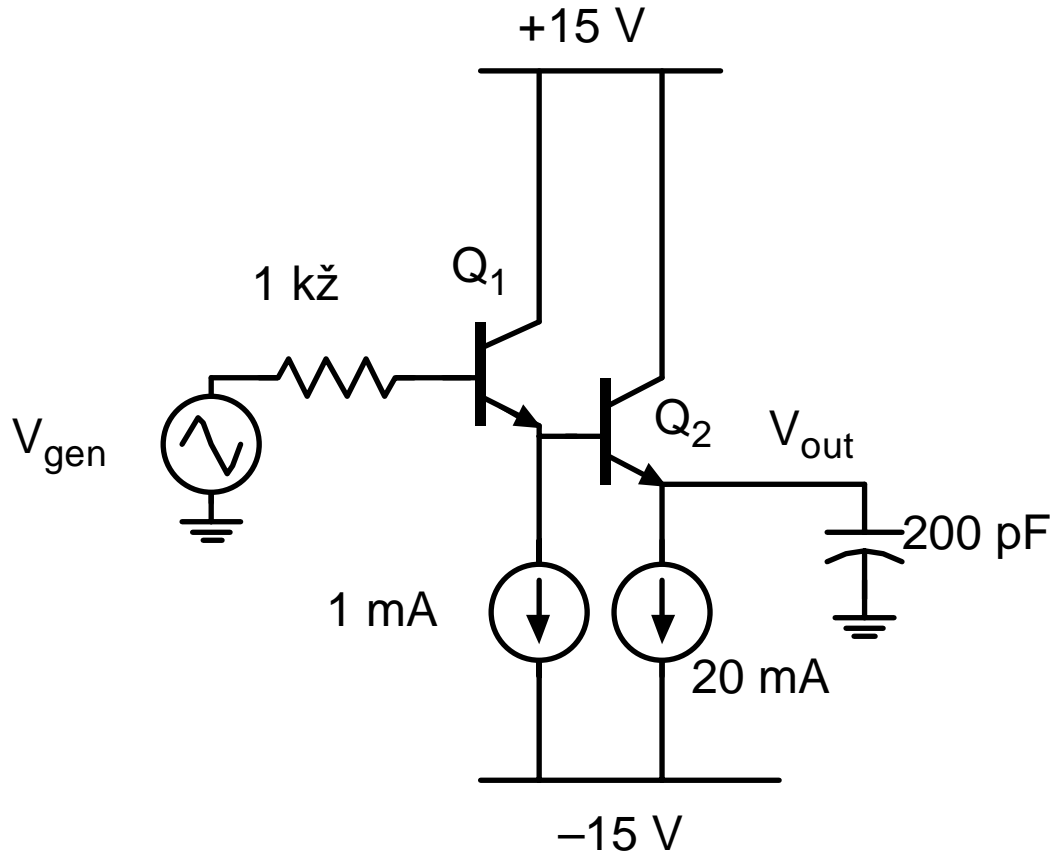
All transistors have $\beta = \infty$, $V_A = \infty$, $\tau_f = 1$ ns and $C_\mu = 10$ pF.

Use the method of time constants to find the dominant time constant a_1 of the transfer function $V_{out}(s)/V_{gen}(s)$.

$a_1 =$

Problem 6, 20 points.

Method of first **and** second-order time constants



All transistors have $\beta = \infty$, $V_A = \infty$, $f_T = 350\text{ MHz}$ and $C_\mu = 0\text{ pF}$.

Use the method of time constants to find the (possibly complex) frequencies of the first TWO POLES of the transfer function $V_{out}(s)/V_{gen}(s)$. Comment on whether the system is stable or unstable.

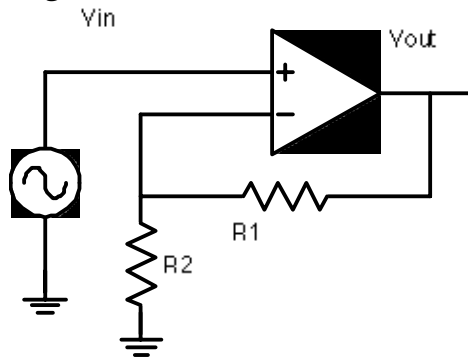
first pole=

second pole=

Stable or Unstable?

Problem 7, 10 points

Negative Feedback



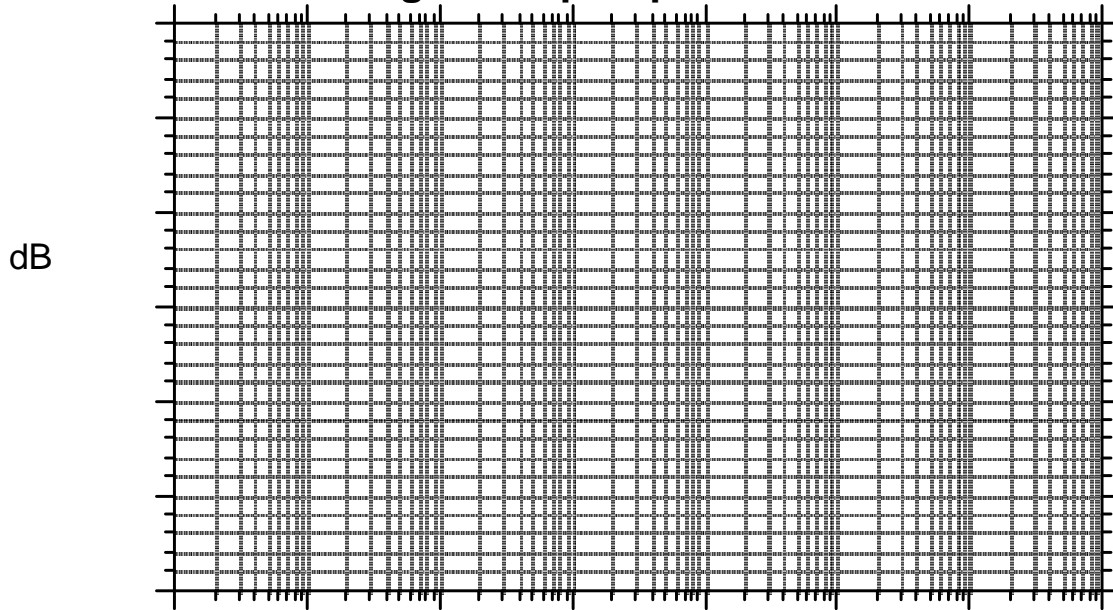
The amplifier has a differential gain of 1,000,000.

Its input impedance is infinite, its output impedance is zero.

$R_1=9\text{k}\Omega$, $R_2=1\text{k}\Omega$. The differential amplifier has 3 poles in its transfer function: one at 10 Hz, one at 2 MHz, and one at 4 MHz.

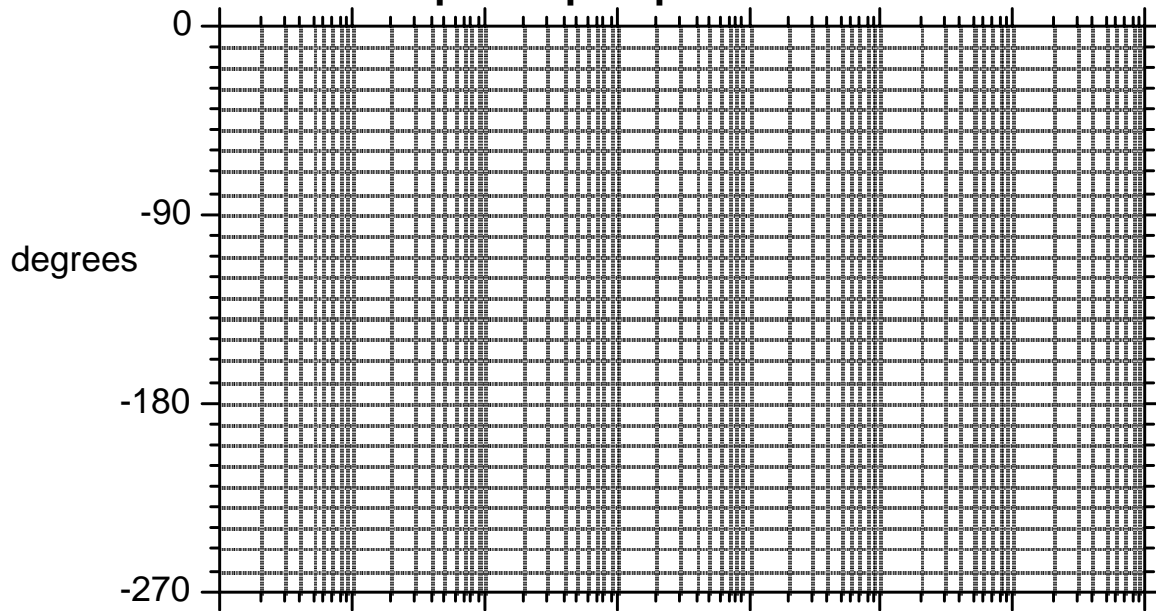
Determine the loop gain margin and phase margin using the plots below.

Bode Magnitude plot-please label axes



Frequency

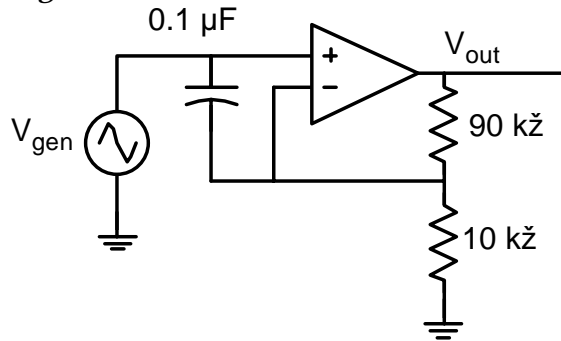
Bode phase plot-please label axes



Frequency

Problem 8, 10 points

Negative Feedback



The amplifier has a differential gain of 1,000,000.

Its input impedance is infinite, its output impedance is zero.

The differential amplifier has no poles in its transfer function.

Part a, 5 points

Find the loop transmission $T(s)$ and the loop bandwidth in Hz.

$T(s) =$

Loop bandwidth =

Part b, 5 points

Find $V_{out}(s)/V_{gen}(s)$

$$V_{out}(s)/V_{gen}(s) =$$