<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Points</th>
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<td>5</td>
<td>2b</td>
<td>4</td>
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<td>10</td>
<td>4b</td>
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<td>10</td>
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<tr>
<td>10</td>
<td>4b</td>
<td>14</td>
<td>5</td>
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Name:

\[
\frac{\frac{\omega}{x} + \frac{\omega + s}{x + s}}{\frac{\omega}{x}} \quad (i) \omega \cdot \left(\frac{\omega}{x} \sin x \right) \quad (i) \omega \cdot \left(\frac{\omega}{x} \cos x \right) \quad (i) \omega \cdot \left(\frac{\omega}{x} \right)
\]

<table>
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<tr>
<th>Time Function</th>
<th>1</th>
<th>2</th>
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<td>Tρiece Τransformation</td>
<td>1</td>
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Don't panic!

Classroom sheets and 3 pages (front and back—6 surfaces) of your own notes permitted.

Credit will not be given for correct answers if supporting work is not shown.

Show all work.

Do not open this exam until told to do so.

There are 4 problems 1-2 in the exam; please make sure all are there.

There are 4 problems on this exam and you have 3 hours.

6/11/2013, 8-11 AM

ECE137B Final Exam
In the relationship $\frac{V_{\text{IN}} + 1}{I} = V_{\text{OUT}}$, what is $V_{\text{OUT}}$ for this circuit?

**Part A.5 Points**

Note: Simplify the problem by using the approximation shown above right.

- $C = C_{\text{in}}, C = 127 \text{ pF}, C = 0 \text{ nF}, C = 0.45 \text{ pF}$
- $C = 159 \text{ pF}$
- $R_{\text{in}} = \infty$ for all FETs

In the circuit above $R_{\text{in}} = 20 \text{ ms}, R_{\text{11}} = 100 \text{ ms}, R_{\text{11}} = 1\text{ k}\Omega, R_{\text{10}} = 2\text{ k}\Omega$.

**Problem 1.40 Points**

[Diagram of a circuit with labeled components]
\[
0.9996 = (6.9999 - 0.001) \cdot 10^4 = 0.9999 
\]

Find the value of the loop transmission at DC and the closed-loop gain at DC.
Find the first two pole frequencies of the loop transmission function.

Transmission circuit frequency response.

Part C: 15 points
Draw the loop transmission 1 on this plot.

Plot the loop transmission (labels slopes, label critical frequencies)

Determine the loop bandwidth and phase margin

\[
\text{Phase margin} = \frac{\text{loop gain}}{\text{loop delay}} \times 10^6
\]

Part d. 10 points
Part e, 5 points

closed-loop bandwidth

Plot the closed-loop gain vs. frequency, estimating the gain peaking at $f_{loop}$.

closed-loop bandwidth =

Draw the closed loop gain on this plot

Frequency, Hz

Gain, dB
Problem 2, 20 points

Circuit frequency response by MOC.

Find the gain Vo/Vin at low frequencies. Vo/Vin = 50

midband analysis

5 points

R = 1 kΩ.
R0 = 1.5 kΩ.
R0 = infinity for both FETs.
R = 1000 kΩ, C = 15 pF, C = 79.3 kF. C = 0 kΩ.

In the circuit above 8 = 10 ms, 8 = 50 ms.
Find $\omega_1$, $\omega_2$, and $\omega_3$ if the poles are real, find $\omega_1$, $\omega_2$, and $\omega_3$ if they are complex, and find $\omega_1$, $\omega_2$, and $\omega_3$ if they are complex and $\omega_1 < \omega_2 < \omega_3$. 

**Frequency response analysis**

part b: 10 points
\[ z = \frac{\sqrt{2}}{2} = \frac{\sqrt{2}}{2} \]
Hi, I'm learning to design circuits. Here's what I've done so far:

1. I've set up the basic circuit diagram.
   - A generator connected to a load.
   - Resistors and capacitors in series and parallel.

2. I've calculated the impedance:
   - $Z = 6$ (ohms)
   - $Z' = 18$ (ohms)
   - $Z'' = 1.5$ (ohms)

3. I've determined the current at the generator:
   - $I = \frac{V_{in}}{Z} = \frac{5}{6}$ (amps)
   - $I' = \frac{V_{in}'}{Z'} = \frac{5}{18}$ (amps)
   - $I'' = \frac{V_{in}''}{Z''} = \frac{5}{1.5}$ (amps)

4. I've used nodal analysis to find the voltage at the generator:
   - $V_{out} = 1 + 18 * \frac{5}{18} = 5$ (volts)
   - $V_{out}' = 1 + 1.5 * \frac{5}{1.5} = 5$ (volts)

5. I've calculated the power in the circuit:
   - $P = I * V_{out} = 5$ (watts)
   - $P' = I' * V_{out}' = 5$ (watts)
   - $P'' = I'' * V_{out}'' = 5$ (watts)

6. I've confirmed the results with a computer simulation.

Hi! Nodal analysis will be slow and painful.

The answer must be in standard form.

I'm using the frequency response analysis method.

Another frequency response analysis method involves a transfer function. You'll need the transfer function to find the output voltage.

Part C: 5 points
\[
\begin{align*}
\mathcal{L}(s) &= \frac{(s^2 + 3s + 2)}{(s^2 + s + 1)} \\
&= \frac{1}{s^2 + s + 1}
\end{align*}
\]

or if there are \( N \) poles at DC, \( \mathcal{L}(s) = \frac{1}{s^N + \ldots + 1} \).

The answer must be in standard form: \( \mathcal{L}(s) = \mathcal{L}(s) \).

Find the loop transmission \( \mathcal{L}(s) \).

**Simple model analysis**

**Part a:** 10 points

For the circuit above, \( V_1 \) is a differential amplifier with a voltage gain of 1.

In the circuit above, \( V_2 \) and \( V_3 \) are ideal, infinite-gain op-amps.

\[ R_1 = 1 \text{k}\Omega, \quad R_2 = 4 \text{k}\Omega, \quad C_1 = 1.5 \text{mF}, \quad C_2 = 15.9 \text{PF}. \]

**Problem 3:** 20 points

Negative feedback and stability
First, adapt the problem given at the end of the chapter. Solve the year.

\[ 1111 = \left( \frac{\pi}{2} \right)^2 \]

\[ \Rightarrow 1111 \text{ arcsec}^2 = 0.159129 \text{ radians}^2 \]

\[ (\frac{\pi}{2})^2 = 0^2 \cos^2 \theta \]

\[ \theta = \arccos \left( \frac{0}{1} \right) = 0 \]

If we round this value up to \( \theta = 0.5 ^\circ \),

\[ \text{Part B: Problem} \]

\[ \text{First, adapt the problem given at the end of the chapter. Solve the year.} \]

\[ 1111 = \left( \frac{\pi}{2} \right)^2 \]

\[ \Rightarrow 1111 \text{ arcsec}^2 = 0.159129 \text{ radians}^2 \]

\[ (\frac{\pi}{2})^2 = 0^2 \cos^2 \theta \]

\[ \theta = \arccos \left( \frac{0}{1} \right) = 0 \]

If we round this value up to \( \theta = 0.5 ^\circ \),

\[ \text{Part B: Problem} \]
\[ \text{Phase margin} = \frac{\text{loop gain at 1 rad/}\text{s}}{10 \text{db}} \]

Determine the loop bandwidth and phase margin.

Plot the loop transmission (labels slopes, labels critical frequencies).
Determine the frequency and damping factor of the dominant poles of the transfer function.

A circuit has the response to a unit step-function input:

Transmission response

Part a. 10 points

Frequency response

Problem 4. 20 points
\[ \frac{1}{y} = \ \text{csc}(\theta) + 2 \]

Point A & B, corresponding to successive minima:

\[ H(\theta) = 1 - (\text{csc}(\theta) + 2) \]

Where \( \theta = 1/\text{sec} \).
You have four unknown circuits (1-4) whose response is a step-function as above. You must identify which possible circuits (a-e) might give this observed response. Consider the possibility that some elements in the circuits a-e might have negligible values.

For each, you must identify, giving your reasons clearly, which possible circuits (a-e) might give the observed response. You must justify your conclusions.

(a) 

(b) 

(c) 

(d) 

(e) 

There are 10 points for the transient response.
response #1: circuits

why:
Circuit 1 has a single real pole, and is high-pass.

a) yes; if \( \frac{1}{s} \) is negligible, not lost.
b) no; too close to pole.
c) yes; if \( s \ll \frac{1}{C} \), large \( C \).
d) yes; \( f \) is \( 0 \).
e) no; pole @ \( \infty \).

response #2: circuits

why:
This has complex poles.

a) No continuous complex poles;  
   b) Can't tell.
   c) Yes, with large \( s \) and \( C \).
   d) Yes RLC with \( L < 1 \).

response #3: circuits

why:
High pass, yes @ DC, one real pole.

a) no @ DC.
b) yes; \( R \to \infty \).
c) yes

d) no; real pole & real zero.

response #4: circuits

why:
This has a real pole & a real zero.
The zero has a lower frequency than the pole.

a) no – no zeros.
b) yes.
c) no – because DC gain of \( a \) is \( 1 \) & DC gain of \( b \) is \( 0 \).

D) no – no poles.

e) no. zero is at DC.
   DC gain is zero.