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## RULES

This is a closed book, closed notes test. You are, however, allowed one piece of paper (front side only) for notes and definitions, but no sample problems. The top half is the same as from the first test, and the bottom half contains the information added for the second test. You are also permitted to use a calculator. Additionally, a table of common Laplace Transforms has been provided at the end of this test.

You have 50 minutes to complete the test. Please read through the entire test before starting, and read through the directions carefully. To receive partial credit, you must show your work.

There is to be absolutely no cheating. Cheating will not be tolerated.
I you have any questions, please raise your hand, and I will come to you to answer them. Do not hesitate to ask questions.

| Problem | Value | Score |
| :---: | :---: | :---: |
| 1 | 10 |  |
| 2 | 10 |  |
| 3 | 20 |  |
| 4 | 20 |  |
| 5 | 10 |  |
| 6 | 30 |  |
| Total | 100 |  |

$\qquad$

Find the Laplace Transform of each of the following signals.
A. Determine the Laplace Transform of $\mathrm{x}(\mathrm{t})$.

$$
x(t)=3 t \sin (2 t) u(t)
$$

B. Using the expression for $x(t)$ from Part A above, determine the Laplace Transform of $v(t)$.
where $v(t)=x(t-5) u(t-5)$
$\qquad$

## PROBLEM 2

A signal is given by the following.

$$
X(s)=\frac{4}{(s+2)(s+10)}
$$

A. Determine the initial value of this signal (i.e, the value at time $t=0$ ).
B. If possible, determine the final value of this signal (as time approaches infinity), and state how you know that a final value exits. If it is not possible to determine the final value of the signal, state why this is the case, and also state how you would go about finding the final value if it were possible to do so. Justify your answer.
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## PROBLEM 3

A system is defined by the following transfer function.

$$
H(s)=\frac{\left(s+\frac{1}{2}\right)}{(s+2)^{2}}
$$

This system receives the following input.

$$
X(s)=\frac{-1}{s+1}
$$

A. Determine the Laplace-domain output, $Y(s)$, of the system in response to the input.

EE 327 Signals and Systems 1
Name
(Problem 3 Work Page)
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PROBLEM 4
(20 Points)
Determine the transfer function for the following systems. You must express the transfer functions as rational functions of " $s$ " and simplify where appropriate.
A. $\dddot{y}+\ddot{y}+6 y=\ddot{x}+2 \dot{x}$
(10 Points)
B. The following plot is the step response of a first-order system. Find the transfer function. (10 Points)

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## PROBLEM 5

October 22, 2013

For each of the following systems, determine if the system is stable, marginally stable, or unstable. For all systems, determine how many poles are unstable. You must write your answers on the lines provided. You must justify your response to receive credit.
A. $H(s)=\frac{(s-1)(s-3)}{(s-2)(s-4)(s-6)}$

Stable, Marginally Stable, or Unstable?
Number of Unstable Poles?
B. $H(s)=\frac{1}{s^{5}+3 s^{4}+4 s^{3}+4 s^{2}+3 s+1}$

Stable, Marginally Stable, or Unstable?
Number of Unstable Poles?
$\qquad$

## PROBLEM 6

A second-order, continuous-time system is defined by the following transfer function.

$$
H(s)=\frac{200}{s^{2}+101 s+100}
$$

This system receives a step input.
A. What is the steady-state output, $y_{s s}(t)$, resulting from a step input?
(5 Points)
B. What is the natural frequency, $\omega_{n}$, for this system?
(3 Points)
C. What is the damping ratio, $\zeta$, for this system?
(3 Points)
D. Is this system under damped, critically damped, or over damped? Why?
(2 Points)
$\qquad$
F. Does this system overshoot the steady-state value if there is a step input? Explain why or why not. If so, what is the percent overshoot?
G. With a step input, does this system oscillate? Explain why or why not. If so, at what frequency?
H. What is the $5 \%$ settling time?
(3 Points)
I. Sketch the step response of this system using the previous parts as a guide. Label all important points. Be as detailed as possible.

