## 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	25	
4	30	
5	25	
Total	100	

Name \_\_\_\_\_

**PROBLEM 1** 

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(30 Points)

Find the Laplace Transform of each of the following signals. You <u>must</u> write your answer as a rational function of "s" where applicable. (5 D is  $f_{1}$  (i)

A. Determine the Laplace Transform of x(t).

(5 Points)

 $x(t) = e^{-2t} \cos(3t)u(t)$ 

B. Determine the Laplace Transform of x(t) given v(t).

(5 Points)

If 
$$v(t) = (e^{-t} - e^{-2t})u(t)$$
  
Find  $X(s)$  for  $x(t) = tv(t)$ 

## **PROBLEM 2**

A signal is given by the following.

$$X(s) = \frac{s+3}{(s)(s+2)(s+4)}$$

A. Determine the initial value of this signal (the value at time t=0). (5 Points)

B. If possible, determine the final value of this signal (as time approaches infinity). 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. (5 Points)

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<b>PROBLEM 3</b> A. What is required for a system to be stab	le in terms of poles and zeros?	(25 Points) (5 Points)

Parts B-E

For each of the following systems in Parts B-E, 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. <u>You must justify your response to receive credit</u>.

B. 
$$H(s) = \frac{s-1}{(s+10)(s+200)}$$

Stable, Marginally Stable, or Unstable?

Number of Unstable Poles?

C. 
$$H(s) = \frac{s+1}{(s+10)(s+200)}$$

(5 Points)

Stable, Marginally Stable, or Unstable?

Number of Unstable Poles?

(5 Points)

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\_\_\_\_\_

\_\_\_\_\_

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D. 
$$H(s) = \frac{1}{s^3 + 3s^2 + 3s + 1}$$

(5 Points)

Stable, Marginally Stable, or Unstable?

Number of Unstable Poles?

E. 
$$H(s) = \frac{3s^2 + 4s + 2}{s^5 + 3s^4 + 2s^3 + s + 2}$$

(5 Points)

Stable, Marginally Stable, or Unstable?

Number of Unstable Poles?

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## **PROBLEM 4**

(30 Points)

A. Find a transfer function that represents the entire system shown below. Use block-diagram reduction to reduce this system to a single block. Write as a rational function of s.

(10 Points)



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B. A system is given by the following transfer function. Determine the expression for a differential equation that represents this system. (10 Points)

$$H(s) = \frac{s+3}{s^2+2s+8}$$

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C. A first-order system receives a step input and produces the following step response. Determine the transfer function of this system. (10 Points)



## **PROBLEM 5**

A system is defined by the following differential equation.

 $\dot{y} + 2y = 4x$ 

Given the following input and initial conditions, determine a solution to the differential equation. Express you solution in both the Laplace domain as Y(s) and in the time domain as y(t), and place your answers on the lines that have been provided.

 $x(t) = e^{-10t}u(t)$  y(0) = 1

Answers

Y(s) = \_\_\_\_\_

y(t) = \_\_\_\_\_

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(25 Points)

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Name \_\_\_\_\_

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(Extra Page for Problem 5)