**MC300 Exam 1**Show your work (I give partial credit)

**Problem 1**

Given the single cart system shown below:

x

f(t) is a force  
springs have positive coefficients k1 > 0, k2 > 0  
damper b > 0 and cart mass m > 0  
The cart is initially at x = 0 and is not moving  
The wheels are frictionless.

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Damper, b

k2

k1

m

f(t)

 

1. Find the ordinary differential equation for the cart system above

1. Find the transfer function {X(s)/F(s)}
2. Let f(t) be a unit step function. If the system is stable, what is the final position of the cart?

**Problem 2:**

Given the following system:

y(t)

+

e(t)

r(t)

G(s)

D(s)

-

Where D(s) = 1/s is the controller and the Plant is G(s) = 1/(s+1)(s+2)

1. Find the closed loop transfer function { Y(s)/R(s) }.
2. If the input is a Unit Step, What is e(∞).
3. If the input is a Unit Ramp, What is e(∞).

**Problem 3:**

A system has the block diagram shown below:



1. Find the state variable differential equation.
2. Determine the state transition matrix Φ(s).