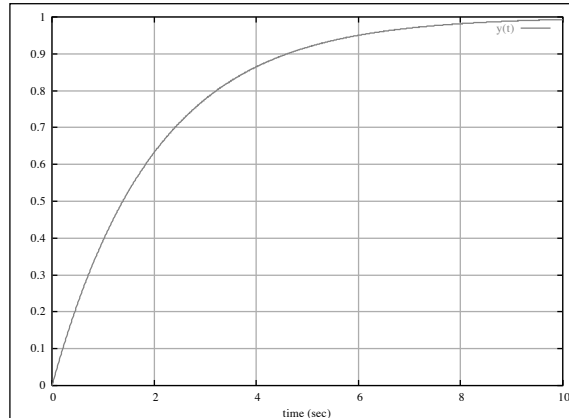


You may use 1 formula sheet (to be turned in), computer with matlab and simulink, calculator, fundamentals of engineering handbook and email (but only as directed in the exam). No other use of email or the web is allowed.

1. Estimate a model for the system for which the step response is given as follows:



2. Obtain by means of your choice the solutions to the following:

- (a) $10\dot{y} + 2y = 5t$, $y(0) = 1$
- (b) $10\dot{y} + 2y = 5u(t)$ where $u(t)$ is the step input, $y(0) = 1$.
- (c) $2\ddot{y} + 2\dot{y} + y = 2u(t)$, $y(0) = \dot{y}(0) = 0$.

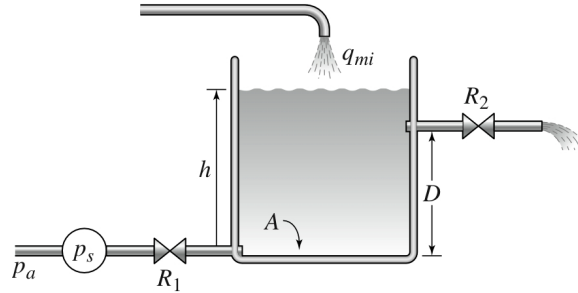
3. A system $10\ddot{x} + 0.1\dot{x} + 1400x = f(t) + \dot{f}(t)$ is excited by $f(t) = 10\sin(11t + \frac{\pi}{4})$.

- (a) What is the magnitude and phase of the frequency response (transfer) function at the frequency of interest?
- (b) What is the magnitude of the frequency response function at the frequency of interest in dB?
- (c) Using this information directly, what is $x(t)$.
- (d) Generate the bode plot of the system.
 - i. *Write* the necessary commands in your exam book
 - ii. Print the bode plot to a .eps file and email it to me. I will verify that I have received it during the exam.
Select your figure
Go directly to the matlab prompt
From the matlab prompt type:

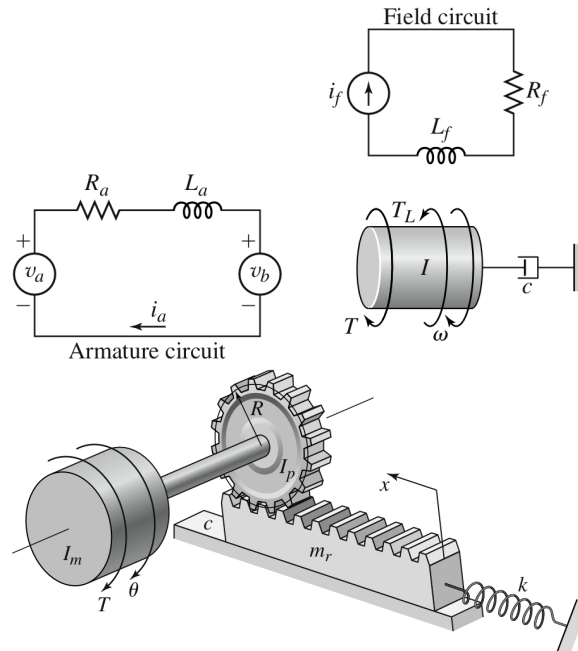
```
>> print -depsc problem3.eps
>> pwd
```

The last command will tell you where Matlab put the file so you can email it to me.

4. In the liquid level system shown in the following figure the resistances R_1 and R_2 are linear, and the input is the pressure source p_s . Obtain the differential equation model for the height h , assuming the $h < D$. Put the model in state space form.



5. An electric motor is typically used to drive a dynamic system. Note that the I in the first figure is the same as I_m of the second figure. Note that c in the top right figure is simply a dummy load! The real load is the resistance to motion of everything in the second figure. T_L is the load torque represented by the mechanics of the bottom figure. Develop the governing equations of motion with v_a as the input and position of the rack as the output in state space form.



6. Presuming a model given by

$$10\ddot{x} + \dot{x}(1 - y^2) + 3x - 2y = f(t) \quad (1)$$

$$\ddot{y} + 3\dot{y} + 3y - 2x = 0 \quad (2)$$

with a nominal force of $f(t) = 1u(t)$, generate the simulink simulation for the system with results for the first 10 seconds. Print both the simulink block diagram and the output response to a .eps file and email to me during the exam. You will receive confirmation that they have been received.