

On my honor, I submit that I have neither given or received assistance on this exam or consulted any prohibited materials (solutions manuals, internet, etc.). The exam is open book and open notes, so all class material can be used for reference during this exam.

Name: _____

Date: March 01, 2021

MEGR 3122 Dynamics Systems II: Exam 1, Spring 2020

Multiple Choice Problems (Total 10 Points)

Directions: Circle the best answer. Each question is worth 2 points.

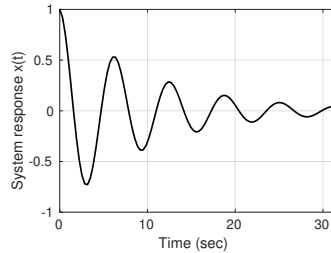


Figure 1: System response from initial condition of $x(t_0) = 1$

- Fig. 1 could be the response of a system described by:
 - $\dot{x} + kx = 0$, where k is a constant
 - $\ddot{x} + a\dot{x} + bx = 0$, where a, b are constants
 - $\ddot{x} = 0$
 - $\dot{x} = \sin(t)$
- If $x(t)$ is a function of time and k is a constant, then $\ddot{x} - kx = 1$ is which of the following?
 - linear, time-invariant, first-order, homogeneous
 - linear, time-invariant, second-order, homogeneous
 - linear, time-invariant, second-order, inhomogeneous
 - nonlinear
- If $z_1 = i$ and $z_2 = e^{i\pi}$, then what is the product $z_1 \cdot z_2$?
 - i
 - 1
 - -1
 - $-i$
- Suppose $z = a + ib$ is a complex number. What is $\arg(z \cdot \bar{z})$?
 - 0
 - $\pi/2$
 - π
 - none of the above, since numbers can't argue
- If the $\int_0^\infty f(t)e^{-st} = 1/s^2$ where t is time and s is a complex variable, then what is $f(t)$ for $t > 0$?
 - t
 - t^2
 - e^{-t}
 - $1/(e^{-st}s)$

Workout Problem Instructions

To receive full credit on the workout problems show all of your work.

Workout Problem 1 (5 pts)

Consider the ODE

$$\ddot{x} + \dot{x} - 2x = 0$$

with initial conditions $x(0) = 4$ and $x'(0) = -5$.

- First, solve for the roots or the characteristic equation
- Then, determine the general solution of the ODE
- Last, compute the particular solution $x(t)$ that satisfies the initial conditions.

Workout Problem 2 (5 pts)

Compute the Laplace transform $F(s) = \mathcal{L}[f(t)]$ of the following function:

$$f(t) = (t + 1)^2 e^{-3t}$$

Workout Problem 3 (5 pts)

Compute the Laplace transform $F(s) = \mathcal{L}[f(t)]$ of the following function:

$$f(t) = u(t) + \cosh(2t)$$

where $u(t)$ is the step function and $\cosh(\cdot)$ is the hyperbolic cosine function.

Workout Problem 4 (5 pts)

Consider the ODE

$$\ddot{x} - 1 = 0$$

with initial values $x(t_0) = a$ and $\dot{x}(t_0) = b$ at the initial time $t_0 = 0$. Rewrite this equation as a system of two first-order ODEs (define any variables you introduce). Then, using Euler's method and a time-step of $h = 3$ sec, determine the values of the simulated state $x(t_1)$ and $\dot{x}(t_1)$ at time $t_1 = 3$ sec (i.e., after one time-step). Note: you may express your answer in terms of any new variables you introduced.