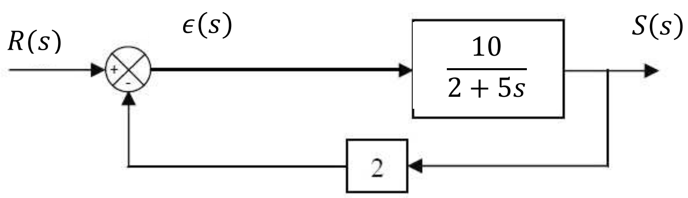
Representation and Analysis of Dynamical Systems

Test – 40min – without documentation

$u(t)$ is an impulse input	1. The Laplace transform $U(s)$ of $u(t)$ is: $\boxed{1}$	/0.5
The Laplace transform of a signal $u(t)$ is: $$U(s) = \frac{10}{1+10s}$$	2. The final value (at $t = \infty$) of $u(t)$ is: $\boxed{0}$ 3. Assuming $u(0) = 0$, $u(t)$ is: ■ $u(t) = \exp(-t/10)$ ☐ $u(t) = \exp(t/10)$ ☐ $u(t) = (1 - \exp(-t/10))$ ☐ I don't know	/0.5 /1
Two signals $u(t)$ and $v(t)$ have respective Laplace transforms $U(s)$ and $V(s)$	4. $w(t) = u(t) + v(t)$ has Laplace transform $W(s) = U(s) + V(s)$ ■ Yes ☐ No 5. $w(t) = u(t) \times v(t)$ has Laplace transform $W(s) = U(s) \times V(s)$ ☐ Yes ■ No	/0.5 /0.5
Consider the transfer function of a system: $$H(s) = \frac{10}{2+5s}$$	6.The static gain of the system is: $\boxed{5}$ 7.The system time constant is: $\boxed{2.5=5/2}$	/0.5 /0.5
A signal $y(t)$ is driven by the differential equation: $$6y''(t) + 3y'(t) + 2y(t) - \partial(t) = 0$$ with $\partial(t)$ unit impulse and initial conditions: $$y(0) = -1 \; and \; y'(0) = 2$$	8. The Laplace transform of $y(t)$ is: $Y(s) = \frac{1}{6s^2+3s+2}$: ☐ Yes ■ No ☐ I do not know	/0.5

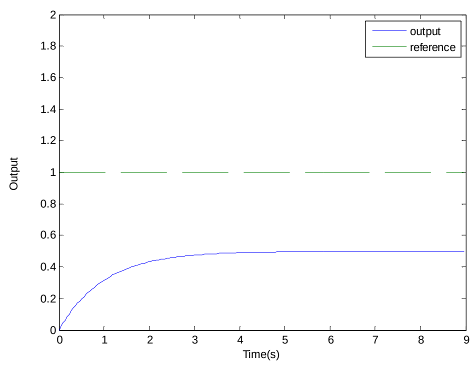
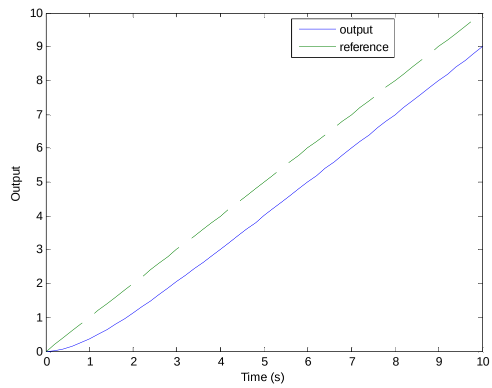
<table>
<tr>
<td>Consider the closed-loop system:

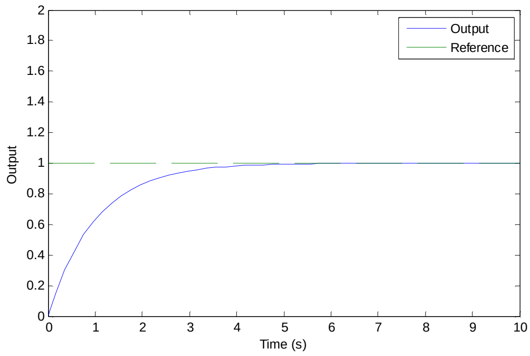

</td>
<td>9. The transfer function of $\frac{S(s)}{R(s)}$ is:

$$\boxed{\frac{10}{22+5s}}$$

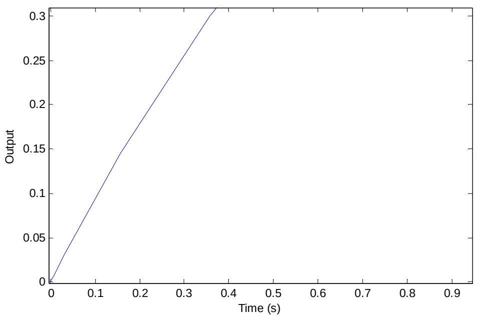
10. The transfer function of $\frac{\varepsilon(s)}{R(s)}$ is:

$$\boxed{\frac{2+5s}{22+5s}}$$</td>
<td>/1

/1</td>
</tr>
<tr>
<td>The following figure plots the step response of a system. (Broken line is the unitary step input, continuous line is the output)

</td>
<td>11.The system has a gain:
☐ equal to 1
■ less than 1
☐ greater than 1
☐ I do not know</td>
<td>/0.5</td>
</tr>
<tr>
<td>The following figure plots the ramp response of a system. (Broken line is the ramp input, continuous line is the output)

</td>
<td>12.The system has a gain:
■ equal to 1
☐ less than 1
☐ greater than 1
☐ I do not know</td>
<td>/0.5</td>
</tr>
</table>



Time response between 0 and 10s



Time response zoomed between 0s and 1s

13. The step response is the response of a first order system:
■ Yes
☐ No
☐ I do not know

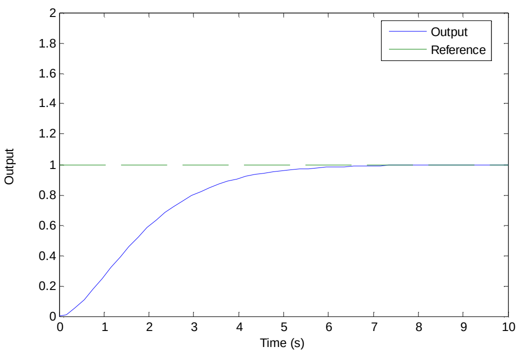
/0.5

14. The step response is the response of a second order system:
☐ Yes
■ No
☐ I do not know

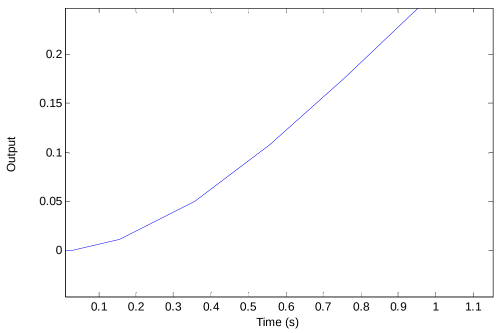
/0.5

15. (if your answer at question 14 is yes) the damping ratio is:
☐ equal or greater than 1
☐ less than 1
☐ I do not know

/0.5



Time response between 0 and 10s



Time response zoomed between 0 and 1s

16. The step response is the response of a first order system:
☐ Yes
■ No
☐ I do not know

/0.5

17. The step response is the response of a second order system:
■ Yes
☐ No
☐ I do not know

/0.5

18. (if your answer at question 17 is yes) the damping ratio is:
■ equal or greater than 1
☐ less than 1
☐ I do not know

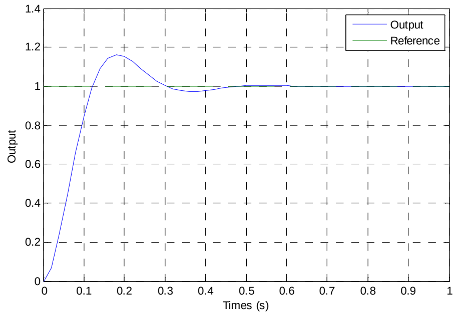
/0.5

Consider the transfer function:

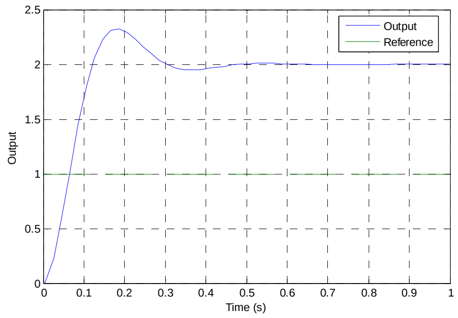
$$H(s) = \frac{800}{s^2 + 20s + 400}$$

and the step responses below:

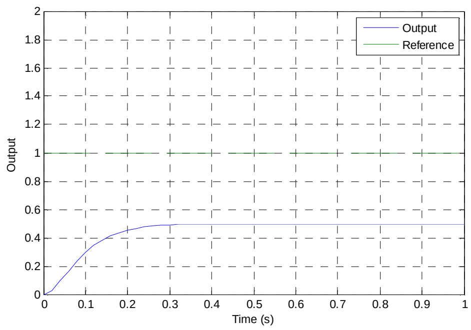
(Broken line is the reference, continuous line is the output)



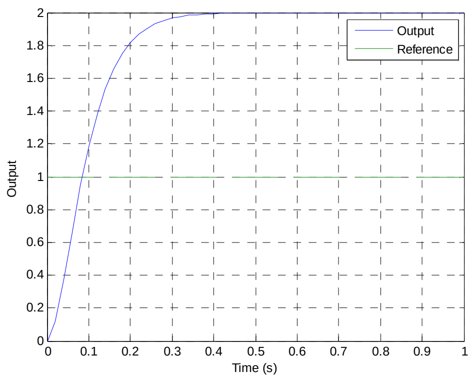
(A)



(B)



(C)



(D)

19. The step response corresponding to the transfer function is: /1

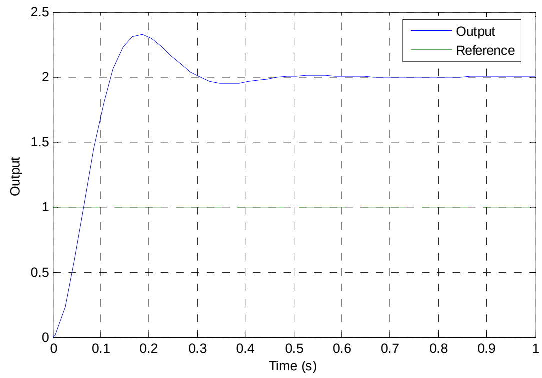
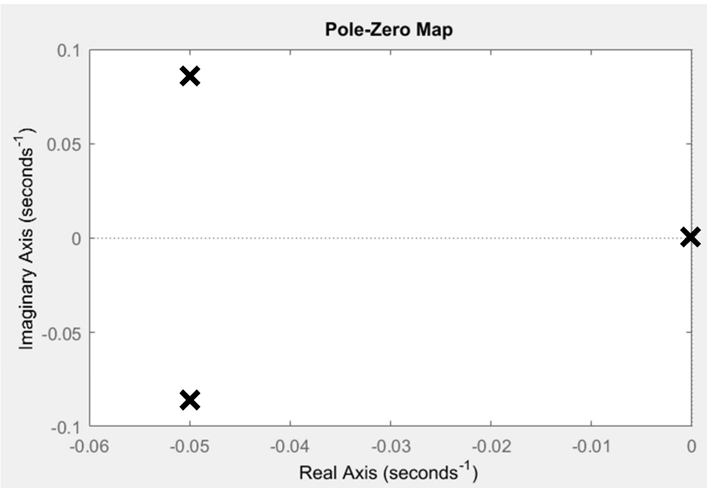
☐ A

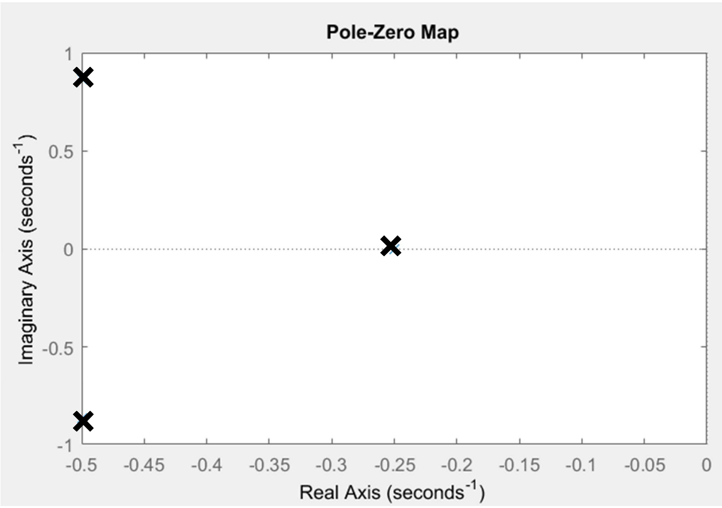
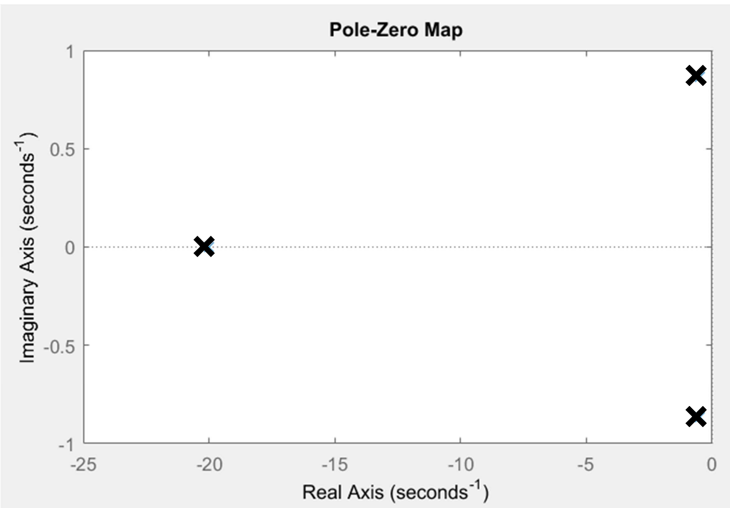
■ B

☐ C

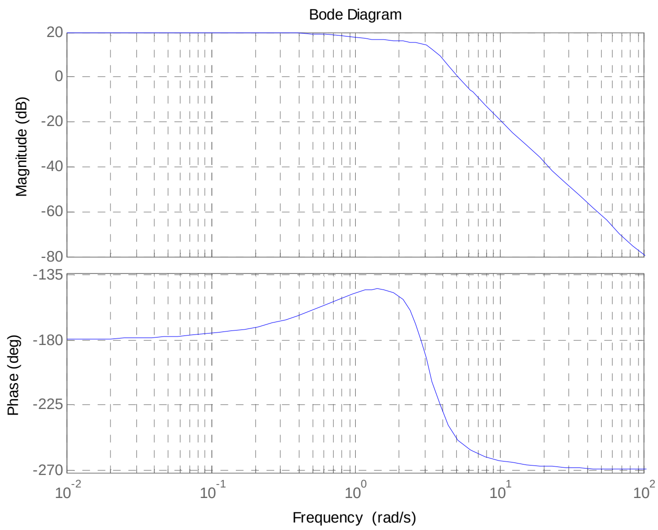
☐ D

☐ I do not know

Consider the step response: (Broken line is the reference, continuous line is the output) 	20. What is the value of the error (in percentage)? 200%	/0.5
Consider the zero-poles map: 	21. This map corresponds to the transfer function of the system described by the transfer function : ☐ $\frac{1}{s^3+0.1^2+0.01s+1}$ ■ $\frac{1}{s^3+0.1s^2+0.01s}$ ☐ I do not know	/1
Consider the transfer function of a system: $$H(s) = \frac{1}{s^4+s^2-s+4}$$	22. The system is stable ☐ Yes ■ No ☐ I do not know	/0.5
Consider the transfer function of a system: $$H(s) = \frac{1}{(s-1)(s^2+s+4)}$$	23. The system is stable ☐ Yes ■ No ☐ I do not know	/0.5

<table>
<tr>
<td>Consider the zero-poles map of a system:
</td>
<td>24. The system is stable
■ Yes
☐ No
☐ I do not know</td>
<td>/0.5</td>
</tr>
<tr>
<td>Consider the zero-poles map of a system whose transfer function is composed of a first order transfer function and of a second order transfer function:
</td>
<td>25. The dynamic of the system is imposed by the second order transfer function (dominant mode):
■ Yes
☐ No
☐ I do not know</td>
<td>/1</td>
</tr>
</table>

Consider the bode diagram of an open-loop system below:



26. This system in closed-loop with unitary feedback is stable:

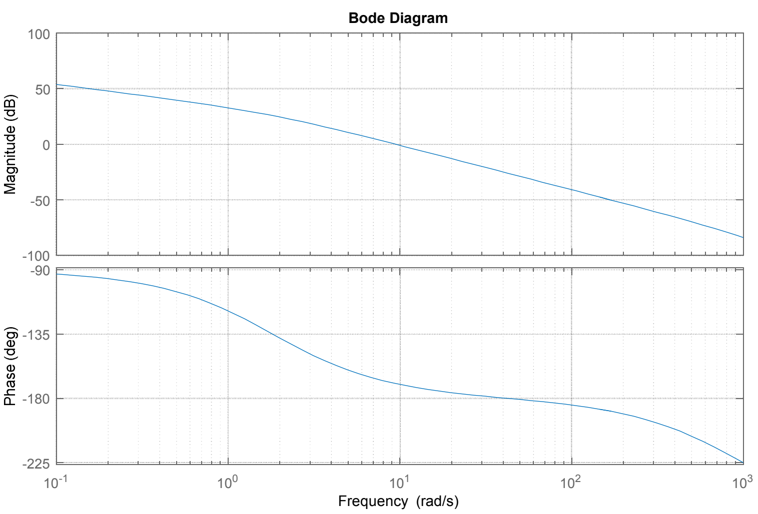
☐ Yes

■ No

☐ I do not know

/0.5

Consider the system whose Bode diagram of the open-loop transfer functions is given below



27. Measure on the Bode diagram

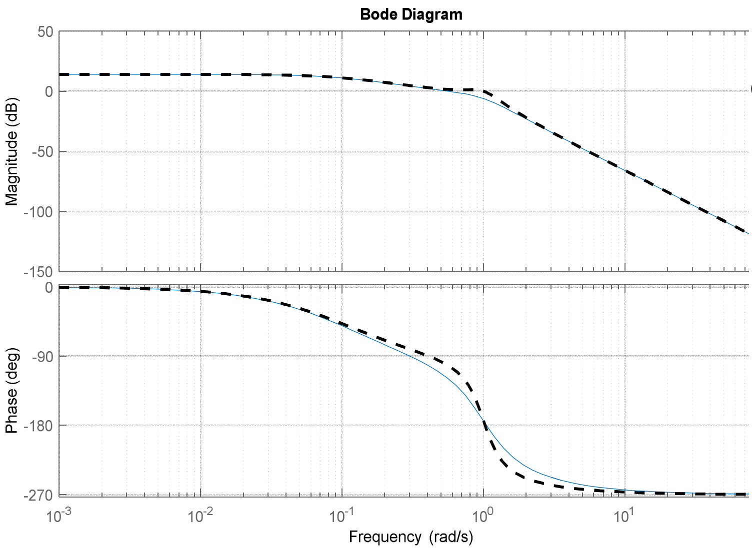
- the gain margin /1

$[10 - 30]\ dB$

- the phase margin /1

$[10 - 30]\ degre$

Consider 2 systems whose Bode diagrams of the open-loop transfer functions are given below



28. Which system will be more stable in closed loop ?

■ The system corresponding to the solid line

☐ The system corresponding to the dashed line

☐ I do not know

/1

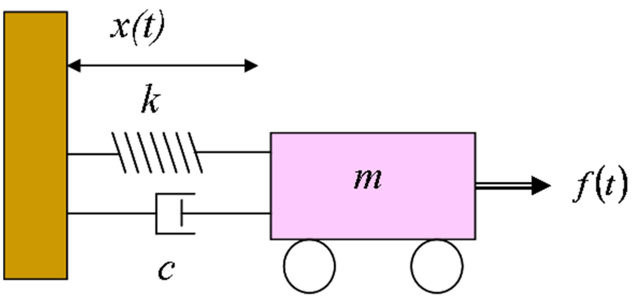
State Space representation

Consider the differential equation that characterizes a mechanical system with a mass *M*, a damper of constant *C* and a stiffness *K*:

$m\ddot{x} + c\dot{x} + kx = F$,

F being the force applied to the system.

The output of the system is the displacement x.



29. A possible representation of the mechanical system is:

☐

$$X = [x \quad \dot{x}]^t$$
$$\dot{X} = \begin{bmatrix} 0 & 1 \\ \frac{k}{m} & \frac{c}{m} \end{bmatrix} X + \begin{bmatrix} 0 \\ \frac{1}{m} \end{bmatrix} F$$
$$Y = [1 \quad 0]X$$

■

$$X = [x \quad \dot{x}]^t$$
$$\dot{X} = \begin{bmatrix} 0 & 1 \\ -\frac{k}{m} & -\frac{c}{m} \end{bmatrix} X + \begin{bmatrix} 0 \\ \frac{1}{m} \end{bmatrix} F$$
$$Y = [1 \quad 0]X$$

☐

$$X = [x \quad \dot{x}]^t$$
$$\dot{X} = \begin{bmatrix} 0 & 1 \\ -\frac{c}{m} & -\frac{k}{m} \end{bmatrix} X + \begin{bmatrix} 0 \\ \frac{1}{m} \end{bmatrix} F$$
$$Y = [1 \quad 0]X$$

☐ I do not know

/1