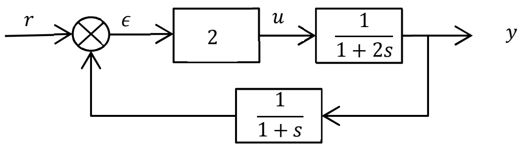
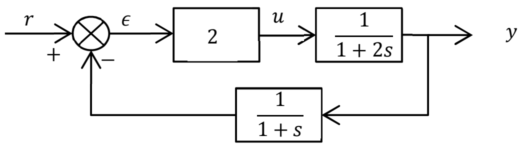
Representation and Analysis of Dynamical Systems

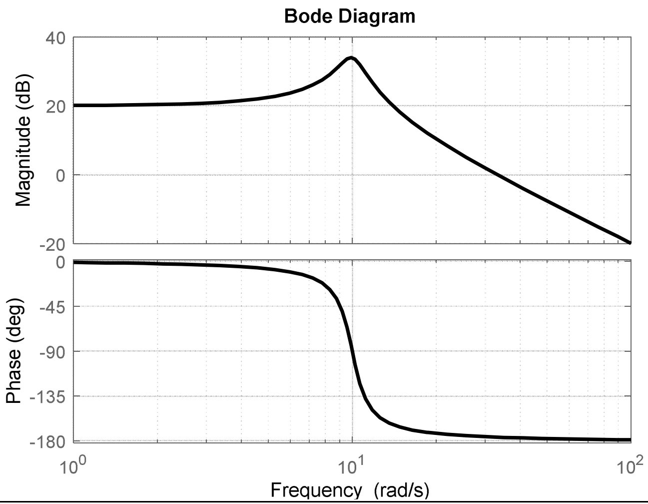
Test – 40min – without documentation

$u(t)$ is unitary step signal	1. The Laplace transform $U(s)$ of $u(t)$ is: $\boxed{1/s}$	
The Laplace transform of a signal $u(t)$ is: $U(s) = \frac{10}{10+s}$	2. The final value (at $t = \infty$) of $u(t)$ is: ☐ 10 ☐ 1 ■ 0 ☐ I don't know	
The transfer function of a system is: $U(s) = \frac{10}{10+s}$	3. The static gain is: ☐ 10 ■ 1 ☐ 0 ☐ I don't know	
A linear system (input $u(t)$, output $y(t)$) is driven by the differential equation: $y''(t) + 3\,y'(t) + 2y(t) = u(t)$	4. The transfer function is: ■ $F(s) = \frac{1}{s^2+3s+2}$ ☐ $F(s) = \frac{1}{2s^2+3s+1}$ ☐ I don't know	
A linear system (input $u(t)$, output $y(t)$) is driven by the differential equation: $y''(t) + 3\,y'(t) + 2y(t) = u(t) + u'(t)$	5. The transfer function is: $F(s) = \frac{1}{s+2}$ ■ $True$ ☐ $False$ ☐ I don't know	
Consider the system: 	6. The transfer function between r and y is: $\boxed{\frac{2s+2}{2s^2+3s+3}}$	
Consider the system: 	7.The transfer function between r and u is: $\boxed{\frac{4s^2+6s+2}{2s^2+3s+3}}$	

The transfer function of a system is:

$$F(s) = \frac{A}{1 + \frac{2\sigma}{\omega_0}s + \frac{s^2}{\omega_0}}$$

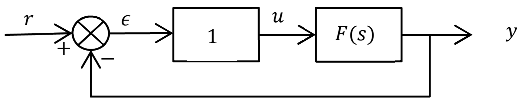
The Bode plot is given below:



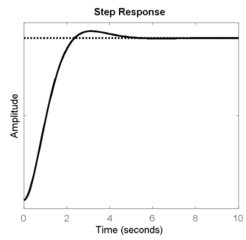
8. The correct set of coefficients is:

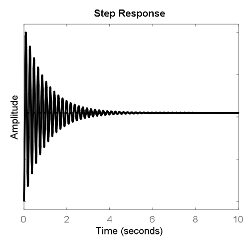
■ $A = 10\,; \sigma = 0.1\,;\ \omega_0 = 10$
☐ $A = 1\,; \sigma = 0.1\,;\ \omega_0 = 1$
☐ $A = 10\,; \sigma = 10\,;\ \omega_0 = 1$
☐ $A = 100\,; \sigma = 0.1\,;\ \omega_0 = 10$
☐ I don't know

The system given by the last question is included in a closed loop such as:



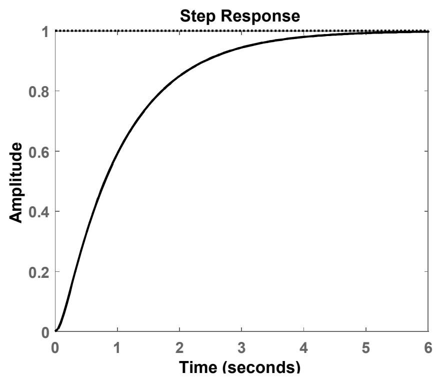
9. The correct step response is:

☐ 

■ 

☐ I don't know

The step response of a system is given below:



10. This step response correspond to the transfer function:

☐ $F_1 = \frac{1}{1+0.1s}$

☐ $F_1 = \frac{10}{1+s}$

■ $F_1 = \frac{1}{1+1.1s+0.1s^2}$

☐ $F_1 = \frac{1}{1+0.1s+0.1s^2}$

☐ I don't know

Consider the transfer function of a system:

$$F(s) = \frac{1}{s^2 + s + 1}$$

11. The system is stable

■ Yes
☐ No
☐ I do not know

Consider the transfer function of a system:

$$F(s) = \frac{1}{s^5 - 3s^2 + s + 1}$$

12. The system is stable

☐ Yes
■ No
☐ I do not know

Consider the transfer function of a system:

$$F(s) = \frac{1}{s}$$

13. The system can be stabilized with a pure proportional controller:

■ Yes
☐ No
☐ I do not know

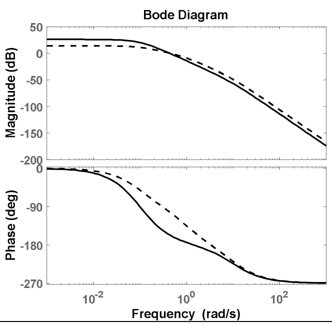
Consider the transfer function of a system:

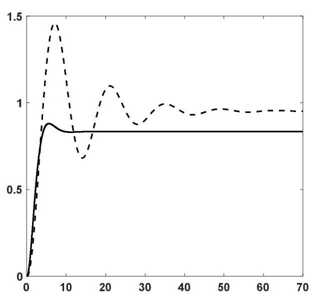
$$F(s) = \frac{1}{s^2}$$

14. The system can be stabilized with a pure proportional controller:

☐ Yes
■ No
☐ I do not know

We give the Bode diagram (open loop) and step response (in closed loop) of two systems (solid line and dashed line):

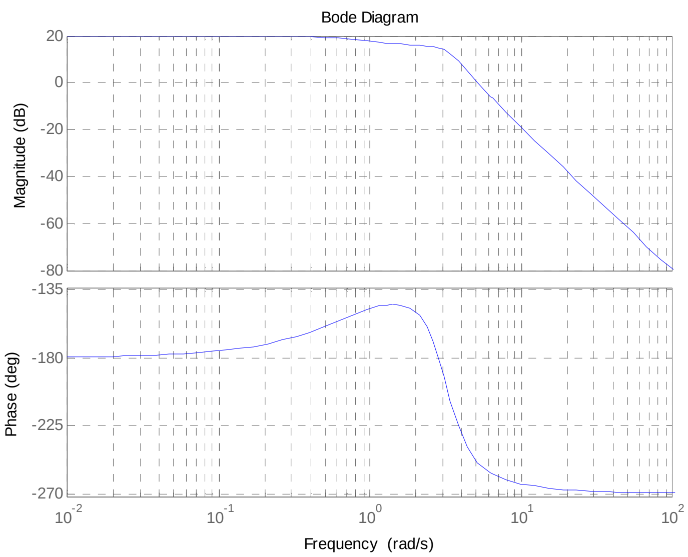




15. The system with dashed line (resp. solid) of the Bode diagram corresponds to the system with dashed line (resp. solid) of the step response:

☐ Yes
■ No
☐ I do not know

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



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

☐ Yes
■ No
☐ I do not know

Question cancelled

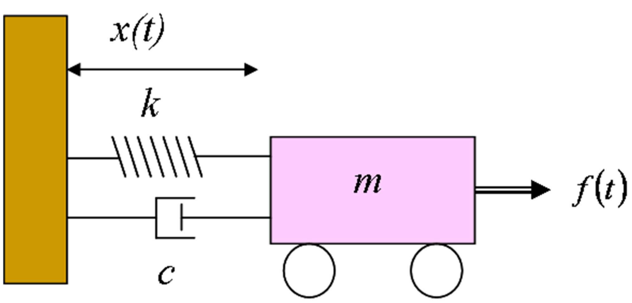
The system H is given by its transfer function:

$$H(s) = \frac{100}{s^2 + 4s}$$

17. This system in closed loop has a zero static error:

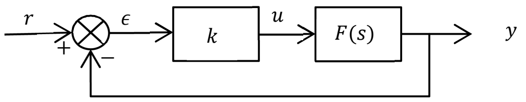
■ Yes
☐ No
☐ I do not know

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.



18. A possible representation of the mechanical system is:

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

The Laplace transform of a signal $u(t)$ is: $$U(s) = \frac{2}{1+2s}$$	19. The final value (at $t = \infty$) of $u(t)$ is: ☐ $u(\infty) = 2$ ■ $u(\infty) = 0$ Question neutralized 20. Assuming $u(0) = 0$, $u(t)$ is: ■ $u(t) = \exp(-t/2)$ ☐ $u(t) = \exp(t/2)$ ☐ $u(t) = (1 - \exp(-t/2))$ ☐ I don't know	
The 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: $$y(0) = -1 \; and \; y'(0) = 2$$	21. The Laplace transform of $y(t)$ is: ☐ $Y(s) = \frac{1}{6s^2+3s-2}$ ☐ $Y(s) = \frac{6s-8}{6s^2+3s+2}$ ■ $Y(s) = \frac{10-6s}{6s^2+3s+2}$ ☐ I don't know	
A system is given by its transfer function: $$F(s) = \frac{1-s}{1+s+s^2}$$ 	22. This system (open loop: input $u(t)$ output $y(t)$ is stable: ☐ Yes ■ No question neutralized AMBIGUOUS: $k = 1$ was not mentioned in the text!! ☐ I do not know 23. This system in closed loop with $k = 2$ (see fig: input $r(t)$ output$y(t)$) is stable: ☐ Yes ■ No ☐ I do not know	