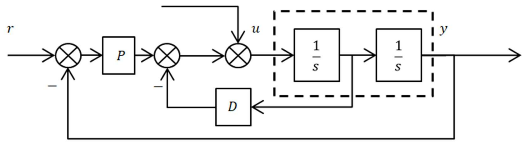
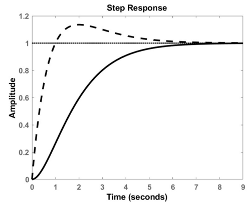
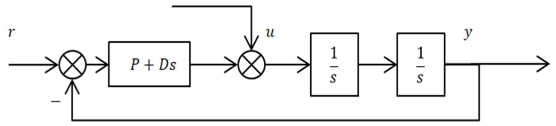
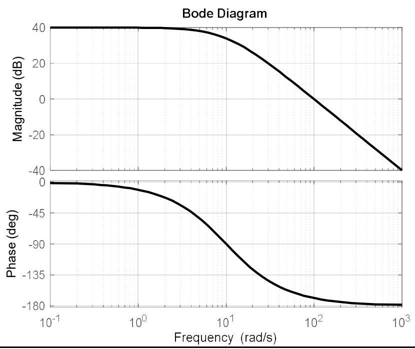
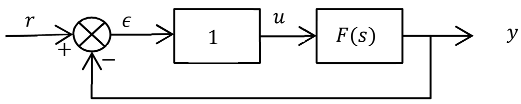
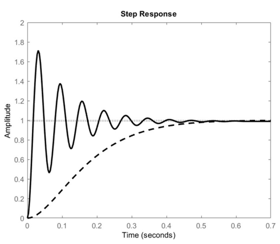
Representation and Analysis of Dynamical Systems

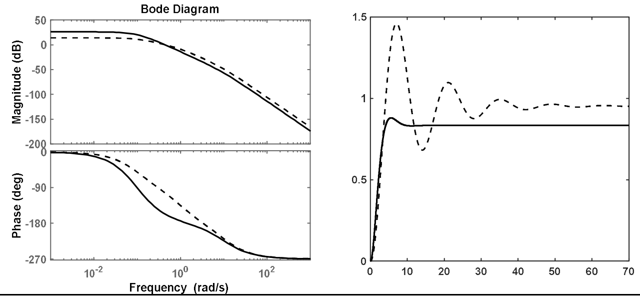
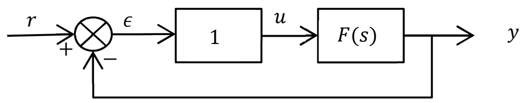
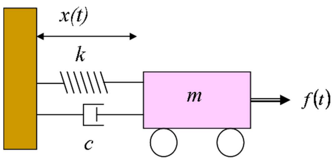
Test – 40min – without documentation

Questions may have more than one positive answer

true: 1 points (correct answer is A and you checked A)
partially true: 0,5 points (correct answer is AB and you checked A or B)
false: -0.1 points (correct answer is A and you checked B, or correct answer is AB and you checked AC)

1	We consider a ramp signal: $u(t) = t$	The Laplace transform $U(s)$ of $u(t)$ is: a : $U(s) = 1$ b : $U(s) = 1/s$ **c : $\boldsymbol{U(s) = 1/s^2}$**
2	The Laplace transform of a signal $u(t)$ is: $U(s) = \frac{1}{10+s}$	The final value (at $t = \infty$) of $u(t)$ is: a : 10 b : 1 c : 0.1 **d: none (checking nothing or d:+1)**
3	The transfer function of a system is: $U(s) = \frac{1}{10+s}$	The static gain is: a : 10 b : 1 **c : 0.1**
4	The transfer function of a system is: $U(s) = \frac{1}{10+s}$	The time constant is: a : 10 s b : 1 s **c : 0.1 s**
5	The transfer function of a system is: $U(s) = \frac{1}{10+s}$	The bandwidth is: **a : 10 rad/s** b : 1 rad/s c : 0.1 rad/s
6	A linear system (input $u(t)$, output $y(t)$) is driven by the differential equation : $y''(t) - 2\,y'(t) - 3y(t) = u'(t) + u(t)$ (Initial condition $y(0) = u(0) = 0$)	The transfer function is: **a : $\boldsymbol{F(s) = \frac{s+1}{s^2-2s-3}}$** **b : $\boldsymbol{F(s) = \frac{1}{s-3}}$** b : $F(s) = \frac{1}{s^2-2s-3}$
7	A linear system (input $u(t)$, output $y(t)$) is driven by the differential equation : $y''(t) - 2\,y'(t) - 3y(t) = u'(t) - 3u(t)$ (Initial condition $y(0) = u(0) = 0$)	The transfer function is $F(s) = \frac{1}{s+1}$ **a : True** b : False
8	A linear system (input $u(t)$, output $y(t)$) is driven by the differential equation : $y''(t) - 2\,y'(t) - 3y(t) = u'(t) - 3u(t)$	The system is stable: a: True **b : False. The system has an unstable pole at s=3. This pole is cancelled in the transfer function (loss of observability or controllability) but the system remains unstable.**

9	Consider the system (controller $P = 1$; $D = 2$, system $F = 1/s^2$): 	The input $r(t)$ is a unitary step. The output $y(t)$ is:  **a : solid** b: dashed
10	Consider the system (controller $P = 1$; $D = 2$, system $F = 1/s^2$): 	The damping of the closed loop system is: a: $\sigma = 0.5$ **b : $\boldsymbol{\sigma = 1}$** The natural frequency of the closed loop system is : **c : $\boldsymbol{\omega_0 = 1}$** d : $\omega_0 = 0.1$
11	The Bode plot of a transfer function $F(s)$ is given: 	The corresponding transfer function is: a: $F(s) = \frac{100}{1+0.1s}$ b : $F(s) = \frac{1}{1+0.1s}$ c : $F(s) = \frac{100}{s^2+20s+100}$ **d : $\boldsymbol{F(s) = \frac{10000}{s^2+20s+100}}$**
12	The system given by the last question is included in a closed loop such as:  And the step response is: 	The correct step response (input r(t) is a step) is: **a : solid** b : dash
13	Consider the transfer function of a system: $$F(s) = \frac{1}{1 - s + s^2}$$	The system is stable a : Yes **b : No**
14	Consider the transfer function of a system: $$F(s) = \frac{1}{1 - s + s^2}$$	The system can be stabilized with a pure proportional controller: a : Yes **b : No**

15	We give the Bode diagram (open loop) and step response (in closed loop) of two systems (solid line and dashed line):  	The system with dashed line (resp. solid) of the Bode diagram corresponds to the system with dashed line (resp. solid) of the step response: a : Yes **b : No**
16	A system is given by its transfer function: $F(s) = \dfrac{1-2s}{1+s+s^2}$  	This system is stable **in open loop** (input u(t) output y(t)): **a: Yes** b: No This system is stable **in closed loop** (input r(t) output y(t)): c: Yes **d: No**
17	A system (input $u(t)$ output $y(t)$ internal state $x(t)$ is driven by the state space equation: $\begin{cases} \dot{x}(t) = -3x(t) - x(t)^2 + u^2(t) \\ y(t) = x(t)^2 \end{cases}$ The state and output variation near the equilibrium point (U_0, X_0, Y_0) are $(\delta u(t), \delta x(t), \delta y(t))$ such as: $u(t) = U_0 + \delta u(t)$ $x(t) = X_0 + \delta x(t)$ $y(t) = Y_0 + \delta y(t)$ The system is trimmed at the equilibrium point corresponding to $u(t) = U_0 = 2$.	The equilibrium point corresponds to $\begin{cases} U_0 = 2 \\ X_0 = 2 \end{cases}$ a : true **b : false** The linearized dynamic state space equation near the equilibrium point is $\begin{cases} \dot{\delta x}(t) = -5\delta x(t) + 2\delta u(t) \\ \delta y(t) = -2\delta x(t) \end{cases}$ c : true d : false **this question could not be answered without knowing the equilibrium point. Suppose we take $U_0 = 2, X_0 = 1$ as an equilibrium point then the linearized state space equation is:** $\begin{cases} \dot{\boldsymbol{\delta x}}(\boldsymbol{t}) = -\mathbf{5}\boldsymbol{\delta x}(\boldsymbol{t}) + \mathbf{4}\boldsymbol{\delta u}(\boldsymbol{t}) \\ \boldsymbol{\delta y}(\boldsymbol{t}) = -\mathbf{2}\boldsymbol{\delta x}(\boldsymbol{t}) \end{cases}$ **(question not rated)**
18	 	The kinetic energy is a : $E_k = \frac{1}{2}kx^2$ **b :** $\boldsymbol{E_k = \frac{1}{2}m\dot{x}^2}$ c : $E_k = 0$

19	We consider an electrical system with input $u(t)$ and output $y(t)$. The corresponding differential equations are: $\begin{cases} u(t) = Ri(t) + L\frac{di(t)}{dt} + v_c(t) \\ y(t) = v_c(t) + R\,i(t) \\ C\frac{dv_c(t)}{dt} = i(t) \end{cases}$	A possible representation of the mechanical system is (with $X = [x_1(t) \quad x_2(t)]^t$): a : $\begin{cases} \dot{X} = \begin{bmatrix} -\frac{R}{L} & \frac{1}{L} \\ \frac{1}{C} & 0 \end{bmatrix} X + \begin{bmatrix} \frac{1}{L} \\ 0 \end{bmatrix} u(t) \\ y(t) = [R \quad 1]X \end{cases}$ b : $\begin{cases} \dot{X} = \begin{bmatrix} -\frac{R}{L} & -1 \\ \frac{1}{L} & 0 \end{bmatrix} X + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(t) \\ y(t) = \begin{bmatrix} \frac{R}{L} & \frac{1}{C} \end{bmatrix} X \end{cases}$ c : $\begin{cases} \dot{X} = \begin{bmatrix} R & L \\ 1 & R \end{bmatrix} X + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(t) \\ y(t) = [C \quad 0]X \end{cases}$ **d: none**
20	We consider linear system represented by a state space equation: $\begin{cases} \dot{X} = [-1]X + [1]u(t) \\ y(t) = [1]X \end{cases}$	This system is stable: **a : yes** b : no