University of Mumbai

Examinations Summer 2022

Time: 2 hour 30 minutes Max. Marks: 80

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Note to the students:- All Questions are compulsory and carry equal marks .

Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
1	A system is said to be_____ if it is possible to transfer the system state from any initial state to any desired state in finite interval of time.
Option A:	Cannot be determined
Option B:	Observable
Option C:	Controllable
Option D:	Controllable and observable
2	A control system in which the control action is somehow dependent on the output is known as
Option A:	Closed loop system
Option B:	Semi closed loop system
Option C:	Open system
Option D:	Non feedback control system
3	Consider the systems given by System 1: - $\dot{x} = \begin{bmatrix} 1 & 1 \\ 0 & -1 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$ System 2: -$\dot{x} = \begin{bmatrix} 1 & 1 \\ 2 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$
Option A:	System 1 & system 2 both are controllable
Option B:	System 1 is not completely state controllable but System 2 is completely state controllable
Option C:	System 1 is controllable but System 2 is not completely state controllable
Option D:	System 1 & system 2 both are not controllable
4	The system is represented by $\dot{x} = Ax + Bu$ where $A = \begin{bmatrix} -1 & 2 \\ 1 & -5 \end{bmatrix}; B = \begin{bmatrix} 1 \\ -2 \end{bmatrix};$ and state feedback given as $u = -[3 \quad 2]x = -Kx.$ Find the desired characteristic equation.
Option A:	$s^2 + 5s - 4 = 0$
Option B:	$s^2 - 5s + 4 = 0$
Option C:	$s^2 + 5s + 4 = 0$
Option D:	$s^2 - 5s - 4 = 0$
5	The equation for full state observer is given as:
Option A:	$\dot{\tilde{x}} = (A - KC)\tilde{x} + Bu + K_e y$
Option B:	$\dot{\tilde{x}} = (A - K_e C)\tilde{x} + Bu + Ky$
Option C:	$\dot{\tilde{x}} = (A - KC)\tilde{x} + Bu + Ky$

Option D:	$\dot{\tilde{x}} = (A - K_e C)\tilde{x} + Bu + K_e y$
6	With regard to the filtering capacity the lead compensator and lag compensator are respectively:
Option A:	Low pass and high pass filter
Option B:	High pass and low pass filter
Option C:	Both high pass filter
Option D:	Both low pass filters
7	Lead compensator – i) Speeds up transient response ii) Increases the margin of stability iii) Does not affect the system error constant Of these statements
Option A:	ii and iii are correct
Option B:	i and ii are correct
Option C:	i and iii are correct
Option D:	i, ii, and iii are correct
8	The compensator $G(s) = 5(1+ 0.3s)/ (1 + 0.1s)$ would provide a maximum phase shift of:
Option A:	20^0
Option B:	45^0
Option C:	60^0
Option D:	30^0
9	PID controller:
Option A:	Rise time decreases
Option B:	Decreases steady state error and improves stability
Option C:	Transient response becomes poorer
Option D:	Increases steady state error
10	According to Ziegler-Nichols first method of tuning of PID controller –
Option A:	$K_P = 1.2T/L$, $T_I = 2L$, $T_D = 0.5L$
Option B:	$K_P = 1.4T/L$, $T_I = 2.5L$, $T_D = 0.5L$
Option C:	$K_P = 1.2T/L$, $T_I = 2.2L$, $T_D = 0.05L$
Option D:	$K_P = 1.25T/L$, $T_I = 2.2L$, $T_D = 0.5L$

Q2 (20 Marks)	**Solve any Two Questions out of Three** **10 marks each**
A	Obtain Cascade realization for system having following differential equation $\frac{d^2x}{dt^2} + 3\frac{dx}{dt} + 2x = u$
B	Write down the design steps of Lag Compensator in frequency domain

C	If $G(s) = \frac{k}{s(s+4)(s+6)}$ for which the PD compensator is to be designed such that the compensated system exhibits 12% peak overshoot and has settling time equal to 1 sec.

Q3 (20 Marks)	**Solve any Two Questions out of Three** **10 marks each**
A	Examine and comment on controllability for $$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$
B	Examine and Comment on observability for $$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$ $$y = \begin{bmatrix} 3 & 4 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$
C	Find STM where $$A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$$

Q4 (20 Marks)	**Solve any Two Questions out of Three** **10 marks each**
A	If $G(s) = \frac{k}{s(s+4)(s+6)}$ for which the PD compensator is to be designed such that the compensated system exhibits 12% peak overshoot and has settling time equal to 1 sec.
B	Write down the design steps of Lead Compensator in frequency domain
C	Open loop transfer function of the plant is $$G(s) = \frac{1}{s(s+1)(s+5)}$$ Obtain the values of tuning parameters Kp, Td and Ti using Zigler-Nichols method for PID design.