University of Mumbai

Program: **Electrical**
Curriculum Scheme: Rev2019
Examination: TE Semester VI
Course Code: EEC603 and Course Name: Control System Design

Time: 2 and half hour Max. Marks: 80

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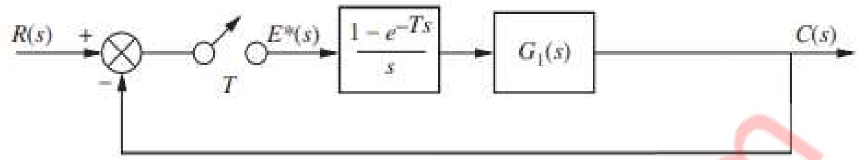
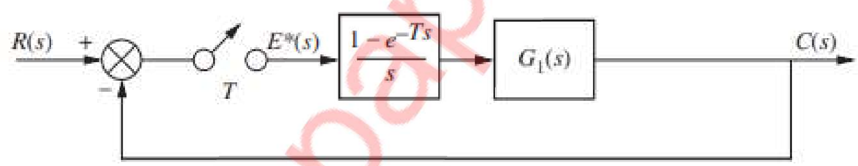
Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks (20Marks)**
1.	Which of the following system provides excellent steady state response
Option A:	Lead compensator
Option B:	Lag compensator
Option C:	Proportional + Differential controller
Option D:	Proportional + Integral controller
2.	The state feedback controller
Option A:	Increases the steady state error
Option B:	Decreases the steady state error
Option C:	Improves the transient behavior
Option D:	Improves both steady state and transient behaviour
3.	Where on the s-plane should a pole be placed to drive the steady-state error of a system to zero?
Option A:	At origin
Option B:	s=1
Option C:	s<1
Option D:	s>1
4.	Pole of a first order compensator is on the right side of the compensator zero on s-plane. Identify the compensator
Option A:	Lead compensator
Option B:	Lag compensator
Option C:	Lag-Lead compensator
Option D:	Lag or Lead compensator
5.	The objective of the continuous compensator design is to reduce the settling time by a factor of 2 with the same damping ratio. One of the dominant closed loop poles of the system with the required damping ratio is at -5-j4. Then the new peak time is
Option A:	8sec
Option B:	10sec
Option C:	0.31sec
Option D:	0.39sec
6.	What is the steady state error for the digital system with forward transfer function G(z)= $\frac{0.13\,(z+2)}{(z-1)(z-0.6)}$ with ramp input, if the sampling time T=0.5sec ?
Option A:	0

Option B:	2.12
Option C:	1.95
Option D:	2.05
7.	During the lag compensator design with Bode-plot it is observed that the frequency corresponds to $PM_{required}$ -180 +10 is 29rad/sec. At this frequency, magnitude of the uncompensated system is 22dB. Then the lag compensator is,
Option A:	$\frac{0.079(s+2.9)}{(s+0.23)}$
Option B:	$\frac{0.018(s+2.9)}{(s+0.052)}$
Option C:	$\frac{0.079(s+0.018)}{(s+2.9)}$
Option D:	$\frac{0.018(s+0.079)}{(s+2.9)}$
8.	Which of the following system is controllable but not observable?
Option A:	A= $\begin{bmatrix}-5 & 0\\ 0 & -2\end{bmatrix}$ B= $\begin{bmatrix}2\\ 0\end{bmatrix}$ and C=$[1 \quad 5]$
Option B:	A= $\begin{bmatrix}-5 & 0\\ 0 & -2\end{bmatrix}$ B= $\begin{bmatrix}2\\ -3\end{bmatrix}$ and C=$[0 \quad 5]$
Option C:	A= $\begin{bmatrix}-5 & 0\\ 0 & -2\end{bmatrix}$ B= $\begin{bmatrix}0\\ -3\end{bmatrix}$ and C=$[0 \quad 5]$
Option D:	A= $\begin{bmatrix}-5 & 0\\ 0 & -2\end{bmatrix}$ B= $\begin{bmatrix}2\\ -3\end{bmatrix}$ and C=$[2 \quad 5]$
9.	A pulsed transfer function in the forward path of the unity feedback system is G(z)= $\frac{K(z+3)}{(z-0.2)(z-0.5)}$ .What is the range of K for which the system is stable?
Option A:	0<K<0.25
Option B:	0<K<0.5
Option C:	0<K<0.3
Option D:	0<K<0.125
10.	One of the dominant closed loop poles of a digital system in z-domain is at 0.4+j0.5. What is the settling time with the sampling time T=0.25?
Option A:	4.42 sec
Option B:	2.24 sec
Option C:	1.26sec
Option D:	2.83sec

PART-B

Q2	Solve any Two Questions out of Three 10 marks each
A	Given the negative unity feedback system G(s) =$\frac{K}{s(s+8)(s+15)}$ use frequency response methods to determine the value of gain, K, to yield a step response with a 20% overshoot.
B	Consider the following transfer function: G(s) =$\frac{(s+6)}{(s+3)(s+8)(s+10)}$. If the system is represented in cascade form, design a controller to yield a closed loop response of 10% overshoot with a settling time of 1 sec. Design the controller

	by first transforming the plant to phase variables. Draw the plant representation in cascade form with the controller gains.
C	For step, ramp, and parabolic inputs, find the steady-state error for the feedback control system shown in Figure with $G_1(s) = \frac{10}{s(s+1)}$. Consider T=0.1 sec. 

Q3	**Solve any Two Questions out of Three** **10 marks each**
A	Consider a unity feedback system with feed forward transfer function $G(s) = \frac{K(s+6)}{(s+2)(s+3)(s+5)}$. It is operating with a dominant-pole damping ratio of 0.707. Using Root-locus, design a PD controller so that the settling time is reduced by a factor of 2. Draw the compensated Root-locus and verify the performance.
B	Find the range of sampling interval, T, that will keep the following system with $G_1(s) = \frac{10}{(s+1)}$ stable. 
C	Given the plant $x' = \begin{bmatrix} -1 & 1 \\ 0 & 2 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \quad y = [1 \quad 1]x$ Design an integral controller to yield a 15% overshoot, 0.6 second settling time, and zero steady-state error for a step input.

Q4	**Solve any Two Questions out of Three** **10 marks each**
A	Given $T(z) = \frac{N(z)}{D(z)}$ where $D(z) = z^4 + z^3 - 2z + 0.5$, use the Routh- Hurwitz criterion to find the number of z-plane poles of T(z) inside, outside and on the unit circle. Is the system stable?
B	For a unity feedback system with $G(s) = \frac{K}{s(s+10)(s+200)}$ design a lag compensator using Bode-plot so that the system operates with a 20% overshoot and a static error constant of 100. Draw the compensated Bode-plot to verify the performance after the design.
C	Consider the plant $G(s) = \frac{(s+2)}{(s+5)(s+6)(s+9)}$ which is represented in parallel form. Design an observer with a transient response described by ζ=0.6 and w_n=120. Place the observer third pole 10 times as far from the imaginary axis as the observer dominant poles. Transform the plant to observer canonical form for the design.