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B. Tech EE (Semester –8th)
CONTROL SYSTEMS DESIGN
Subject Code: BELED1-813
Paper ID: 18111550

Time: 03 Hours **Maximum Marks: 60**

Instruction for candidates:

1. Section A is compulsory. It consists of 10 parts of two marks each.
2. Section B consist of 5 questions of 5 marks each. The student has to attempt any 4 questions out of it.
3. Section C consist of 3 questions of 10 marks each. The student has to attempt any 2 questions.

Section – A **(2 marks each)**

Q1. Attempt the following:

a) Name the different time domain and frequency domain specifications used in designing a control system.
b) Define the terms maximum overshoot and steady state error.
c) Draw the time response of a first order system subjected to a unit step input.
d) What is the effect of addition of pole on system performance?
e) What is the difference between a compensator and a controller?
f) Discuss the effect of a right half plane zero on the time response of a system.
g) What are eigen values? How the stability of a system is decided using eigen values?
h) Discuss the effect of pole zero cancellation on controllability of the system.
i) What are singular points? Explain.
j) What are the different types of non-linearities existing in a control system?

Section – B **(5 marks each)**

Q2. A second order system defined by G(s)= $\frac{25}{s^2+5s+25}$ is given a unit step input. Calculate the time taken for the output to settle within ±2 % of input. Also find out the value of maximum overshoot and damping ratio. Draw the estimated time response of the system.

Q3. How a PID controller is different from an ON-OFF controller? Discuss the various steps in designing a PID controller using Ziegler and Nicholas method.

Q4. The open loop transfer function of an uncompensated system is given by:

$$G(s) = \frac{K}{s(s+3)(s+5)}$$

Design a compensator to meet the following specifications:
Damping ratio=0.7
Undamped natural frequency=2 rad/sec

Error constant K_v is greater than or equal to 6

Q5. Check for the controllability of the following system:

$$\dot{x}(t)=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0 & -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}+\begin{bmatrix}0 & 1\\ 0 & 0\\ 1 & 0\end{bmatrix}u(t)$$

Q6. Explain with the help of suitable example the designing of a control system using pole placement design approach.

Section – C **(10 marks each)**

Q7. Consider the control system G(s)=10/s(s+2)(s+5). Design a compensator such that the dominant closed-loop poles are located at $s=-2\pm j2\sqrt{3}$ and the static velocity error constant K_v is 50.

Q8. Define the terms controllability and observability. Consider a system given by:

$$\dot{X}=AX+BU$$

Where

$$\mathbf{A}=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -1 & -5 & -6\end{bmatrix}, \quad \mathbf{B}=\begin{bmatrix}0\\ 1\\ 1\end{bmatrix}$$

By using the state feedback control $U=-KX$ it is desired to have closed loop poles at $s=-2\pm j4$, $s=-10$. Determine the state feedback matrix K.

Q9. Discuss the advantages of phase plane method. Draw the phase portrait of the following system:

$$\ddot{\theta}+\dot{\theta}+0.5\theta=0$$