GUJARAT TECHNOLOGICAL UNIVERSITY
BE- SEMESTER–V (NEW) EXAMINATION – WINTER 2020

Subject Code: 2150909   **Date: 22/01/2021**
Subject Name: Control System Engineering
Time: 10:30 AM TO 12:30 PM   **Total Marks: 56**

Instructions:
1. Attempt any FOUR questions out of EIGHT questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

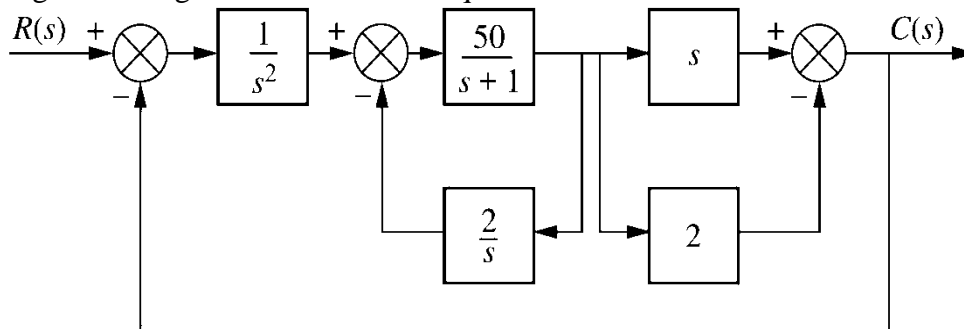|			MARKS
Q.1	**(a)**	Describe the components and variables of biological control system involved in walking in a prescribed direction.	**03**
	(b)	Write the difference between open loop and closed loop control system.	**04**
	(c)	Explain transfer function and write its advantages and disadvantages.	**07**
Q.2	**(a)**	Name the analogous electrical elements in force-voltage analogy for the elements of mechanical translational system.	**03**
	(b)	Can a signal flow graph be drawn for nonlinear system? State Mason's gain formula.	**04**
	(c)	Reduce the block diagram shown in Figure 1 to a single transfer function $\frac{C(s)}{R(s)}$ using block diagram reduction technique.	**07**

Figure 1

Q.3	**(a)**	Define the following terms 1) Delay time 2) Rise time 3) Peak time	**03**
	(b)	Distinguish between type and order of a control system.	**04**
	(c)	Find the steady-state errors for inputs of 5u(t), 5tu(t), and $5t^2$u(t) to the system shown in Figure 3. The function u(t) is the unit step.	**07**

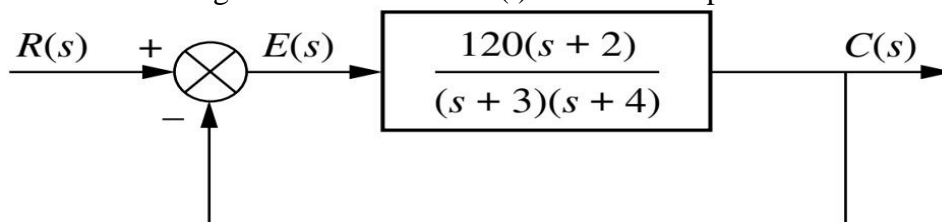Figure 3

Q.4	**(a)**	Define the following terms.	**03**

1) State 2) State variable   3) State vector.

(b) Explain standard test signals used in control system. **04**

(c) The closed loop transfer function of unity feedback control system is given by **07**

$$\frac{C(s)}{R(s)} = \frac{100}{s^2 + 8s + 100}$$

Determine

1) Damping ratio
2) Natural undamped resonance frequency
3) Percentage peak overshoot

Q.5 **(a)** What are the conditions to be satisfied for the Root locus to exist at any point in the s-plane? **03**

(b) Write a short note on the correlation between time and frequency responses. **04**

(c) For the closed loop transfer function **07**

$$T(s) = \frac{10}{s^8 + s^7 + 12s^6 + 22s^5 + 39s^4 + 59s^3 + 48s^2 + 38s + 20}$$

Check stability of the system. Find how many poles are in the right-half plane? Using Routh-Hurwitz stability criterion

Q.6 **(a)** What is a Root locus? How can you tell from the Root locus if a system is unstable? **03**

(b) Explain how do you determine the gain crossover frequency and phase crossover frequency from the Bode plot? **04**

(c) The unity feedback system has **07**

$$G(s)H(s) = \frac{k}{s(s+2)(s+4)}$$

Draw the rough sketch of the Root locus.

Q.7 **(a)** Define the Bode plot. What do you mean by an approximate Bode plot? **03**

(b) Briefly explain about Polar plots. **04**

(c) Sketch the Bode plots for the transfer function given below: **07**

$$G(s)H(s) = \frac{200}{s(s+2)(s+10)}$$

Q.8 **(a)** By applying the final-value theorem, find the final value of f(t) whose Laplace transform is given by **03**

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

(b) State Nyquist stability criterion. Why the Nyquist criterion is called a frequency response method? **04**

(c) Derive Overall transfer function of Field controlled DC motor. **07**

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