Seat No.: ________ Enrolment No.____________

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER 2012

Subject code: 714702 **Date: 09-01-2013**

Subject Name: Advance Control Systems

Time: 02.30 pm – 05.00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Do as directed. **07**

(1) State the limitations of analyzing nonlinear systems by describing function and phase-plane methods.

(2) Discuss the advantages of state-space analysis.

(3) Write the advantages and disadvantages of sampled data control systems.

(b) (1) Explain and show how the *s*-plane is mapped into *z*-plane? Discuss the stability criterion for each of them. **07**

(2) Discuss in brief the various types intelligent control systems.

Q.2 **(a)** Compare the frequency domain characteristic of phase-lag and phase-lead networks used for control system compensations. Discuss the importance of each other. **07**

(b) Design suitable lead compensator for a system with unity feedback and having open-loop transfer function **07**

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

to meet the following specifications:

(i) Damping ratio (ζ) = 0.5

(ii) Undamped natural frequency (w_n) = 4 rad/sec

OR

(b) The open-loop transfer function of a unity feedback control system is given by **07**

$$G(s) = \frac{\mathrm{K}}{s(1+0.5s)(1+0.2s)}$$

It is desired that

(i) for a unity ramp input the steady state error of the output position be less than 0.125 degrees/(degree/second)

(ii) the PM ≥ 30°

(iii) the GM ≥ 10 db

Design a suitable compensation network.

Q.3 **(a)** Derive the describing function of the element whose input – output characteristic is shown in Figure 1. **07**

(b) For the system shown in Figure 2, using the describing function analysis find the amplitude and frequency of the limit cycle. **07**

OR

Q.3 **(a)** Derive the describing function of the element whose input – output characteristic is shown in Figure 3. **07**

(b) Using phase – plane method, plot phase trajectory for **07**

$\ddot{x} + \dot{x} + x = 0$ with initial condition $\begin{matrix} x(0) = 1 \\ \dot{x}(0) = 0 \end{matrix}$

Q.4 **(a)** Determine z-transform of the function $F(s) = \dfrac{s(2s+3)}{(s+1)^2(s+2)}$. **07**

(b) Determine the unit step time response for the pulse transfer function **07**

$$\frac{C(z)}{R(z)} = \frac{z}{z^2 - z + 0.5}$$

OR

Q.4 **(a)** Obtain the pulse transfer function for the sampled data system shown in Figure 4. **07**

(b) Find out inverse z – transform, using partial expansion method **07**

$$F(z) = \frac{z}{3z^2 - 4z + 1}$$

Q.5 **(a)** For the given differential equation **07**

$$\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 2y = u(t)$$

(a) Represent in state variable form.

(b) Find out state transition matrix.

(b) A system is described by the following equations **07**

$$\dot{x}(t) = \begin{bmatrix} -1 & 1 \\ 0 & -2 \end{bmatrix} x(t) + \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \end{bmatrix} u(t) \ ; \qquad y(t) = \begin{bmatrix} 1 & 2 \\ 1 & 0 \\ 1 & 1 \end{bmatrix} x(t)$$

Find the transfer function of the system.

OR

Q.5 **(a)** Obtain the state model for a system whose transfer function is given as, **07**

$$\frac{C(s)}{R(s)} = \frac{1}{s^3 + 9s^2 + 26s + 24}$$

(b) A linear-time-invariant system is characterized by the homogeneous state equation **07**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}; \text{ Assume the initial state vector } \begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

Compute the solution of homogeneous state equation.

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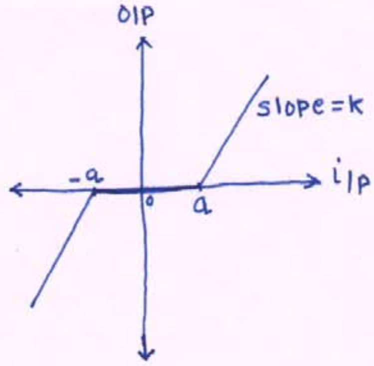

Figure. 1

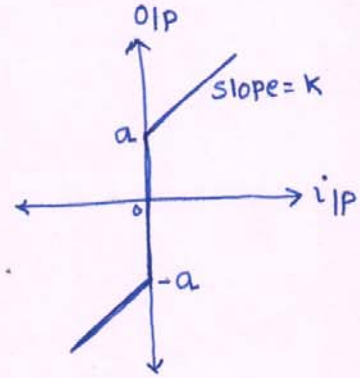

Figure. 3

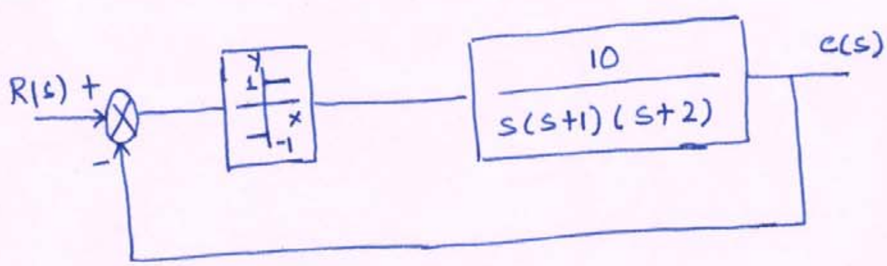

Figure. 2

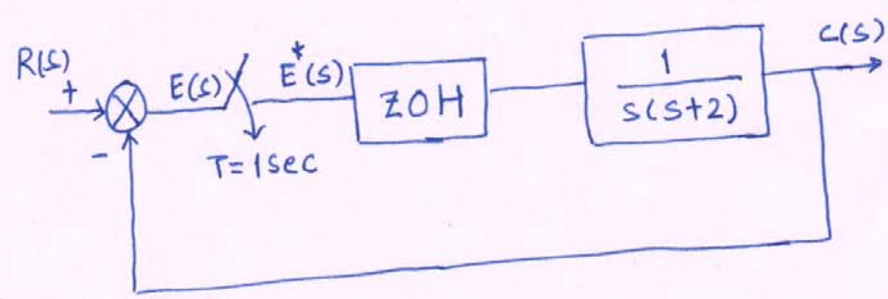

Figure. 4