B.E. (EE) Part-III 6th Semester Examination, 2012
Control System –II (EE – 603)

Time : 3-hours | Full Marks : 70

Answer **SIX** questions taking **THREE** from each half.
Two marks are reserved for neatness in each half.
Use graph paper (supplied), if required.
Justified data(s), if required, can be chosen.

FIRST HALF

1 (a) Determine the Z-transform of the following [3x2]
(i) $f(t) = t^2$
(ii) $f(t) = te^{-at}$

(b) Obtain the pulse transfer function for the sampled data control system shown in Fig.-1 below: [5]

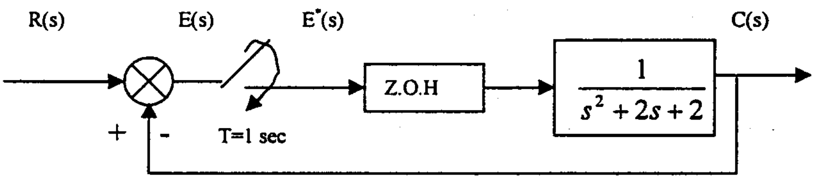

Fig.-1

2 (a) Obtain the frequency response of Zero-Order-Hold system and plot the characteristics of amplitude and phase angle against the frequency. [6]

(b) For step, ramp and parabolic inputs, find the steady-state errors for the feedback control system shown in Fig.-2, where sampling time (T) is 0.4 sec. and $G_1(s) = 20(s+1)/\{(s+4)(s+5)\}$ [5]

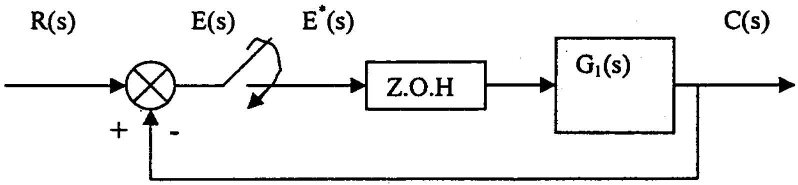

Fig.-2

3 (a) Find out the response of the system described by the difference equation $f(k+2) - 5f(k+1) + 6f(k) = u(k)$; given that $f(0) = 0$ and $f(1) = 1$. [6]

(b) Use Jury's stability criterion to investigate the stability of a discrete-time system described by the characteristic polynomials $F(z) = 3z^4 + 6z^3 + 10z^2 + 4z + 1 = 0$ [5]

4 (a) A system described by its dynamic equation as $\ddot{y} + 0.6y + 1 = 0$. Draw the phase-trajectory for this system by using the method of isoclines. Choose the initial point as required. [6]

(b) Describe the Popov's criterion for stability of non-linear systems. [5]

5 (a) Fig.-3 shows a nonlinear control system with saturation type of non-linearity. Derive the expression for describing function. [6]

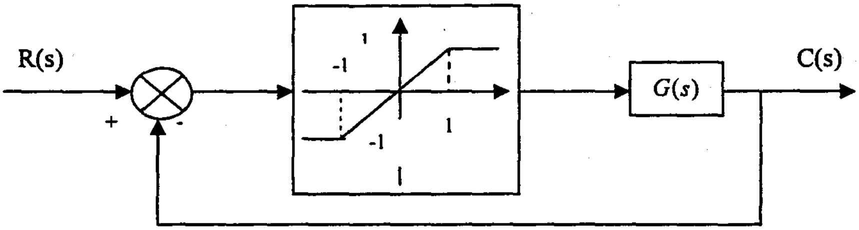

Fig.-3

(b) Determine whether the system is stable or not, given that

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} x.$$ Choose the initial value as applicable. [5]

SECOND HALF

6. (a) What are "states" in a dynamic system? What is meant by linear independence?

(b) For the system given below (Fig. 4) obtain a state space model considering f(t) as the input and the displacement of the mass M as the output. Take M = 0.5 kg and K = 1 N/m.

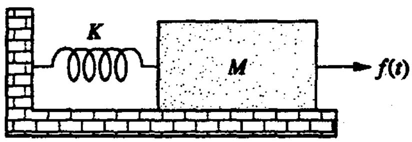

Fig. 4

c) Comment on the stability of the above system. **[3+6+2]**

7. (a) Define Zero Input Stability.

(b) Examine whether the system below is BIBO stable and/or Zero Input Stable:

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

$$y(t) = \begin{bmatrix} 1 & 0 \end{bmatrix} X(t)$$

(c) State the Linear Quadratic Regulator Problem. Briefly (in two sentences) mention the physical significance of each term in the performance index.

[2+6+3]

8. (a) Define the state-transition matrix of a state-space model. How can it be evaluated?

(b) State the advantages of LSVF control over classical PI/PD or lead/lag controllers.

(c) Obtain the zero input response of the system in 7. (b). Also find the value of the state at 't = 1 sec.'. **[3+2+6]**

9. (a) Write the dynamic equations of an Observer. When is an Observer needed for a plant? What are the pre-requisites that the plant should satisfy for the design of an Observer?

(b) Design an LSVF controller for the system G(s) given below to attain $\xi = 0.7$ and $\omega_n = 1 rad/\sec$ for the closed loop plant. $G(s) = \dfrac{10}{s(s+1)}$

(c) What do you mean by 'uncertainty' in a state space model? What is a Robust Controller?

[3+6+2]

10.(a) Derive a discrete time state space model from U_k to Y_k of a continuous-time one which is preceded by a sampler and a zero order hold as shown below in Fig. 5

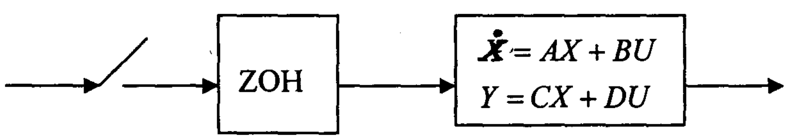

Fig. 5

(b) What should be the number of states chosen in a given system? Can this number vary?

(c) Check whether the system in 7 (b) is controllable and/or observable.

[6+3+2]

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