VIII. (a) The open loop transfer function of a unity feedback control system is $G(s) = \frac{k}{S(1+0.5s)}$. It is required that the velocity error constant should be at least 15 and that the phase margin is atleast 40°. Design a compensator for the same. (12)

(b) Explain lead and lag-lead compensation networks. (8)

IX. (a) What are the advantages and disadvantages of state variable approach compared to conventional approach? (8)

(b) The driving function $r(t)$ and the response function $c(t)$ of a single input single output system are related by

$$a_3 \frac{d^3c}{dt^3} + a_2 \frac{d^2c}{dt^2} + a_1 \frac{dc}{dt} + a_0\, c(t) = b_0\, r(t)$$

Form a state variable model of the system. (12)

OR

X. Write short notes on:

(i) AC Servo motor

(ii) Hydraulic Controllers

(iii) Stepper Motors

(iv) Magnetic Amplifier (20)

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BTS (C) 055 (A)

B.Tech. Degree VI Semester Examination, July 2002

EB/CS/EI/EC 605 CONTROL SYSTEMS ENGINEERING

(1999 Admissions)

Time: 3 Hours Maximum Marks: 100

I. (a) Obtain the Laplace transform of the function defined by

$f(t) = 0$ for $t < 0$

$f(t) = t^2 e^{-at}$ for $t > 0$ (6)

(b) Determine the Inverse Laplace transform for the function

$F(s) = 1/s(s^2 + w^2)$ (6)

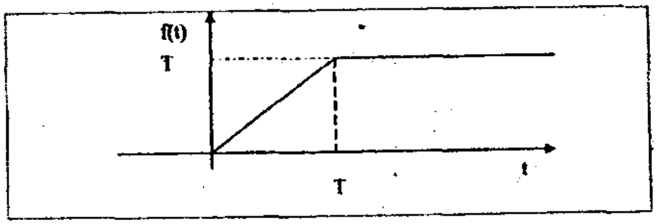
(c) Solve the following differential equation

$\ddot{x} + 2\xi w_n \dot{x} + w_n^2 x = 0$ where $x(0) = a$; $\dot{x}(0) = b$

where a and b are constants. (8)

OR

II. (a) Obtain the Laplace transform of the function $f(t)$ shown in the figure below: (6)



(b) Find the Inverse Laplace transform for the function

$$F(s) = \frac{(s+1)}{s(s^2+s+1)}$$ (6)

(c) Solve the following differential equation $2\ddot{x} + 7\dot{x} + 3x = 0$; $x(0) = 3$; $\dot{x}(0) = 0$. (8)

(Turn over)

III. (a) Derive expressions for peak overshoot M_p and peak time t_p of the time response of a second order system subjected to a unit step input. (10)

(b) A unity feedback control system has open loop transfer function $G(s) = K/s(s+1)$. Find the value of K for damping coefficient of 0.5. For this value of K determine peak time, maximum overshoot and settling time for unit step input. (10)

OR

IV. (a) The characteristic equation of a servo system is given by $a_0 s^4 + a_1 s^3 + a_2 s^2 + a_3 s + a_4 = 0$. Determine the condition which must be satisfied by the coefficients of the characteristic equation for the system to be stable. (10)

(b) Measurements conducted on a servomechanism show the system response to be $c(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$ when subjected to a unit step input.

(i) Obtain the expression for the closed-loop transfer function.

(ii) Determine the undamped natural frequency and damping ratio of the system. (10)

V. (a) Sketch the root locus plot for a unity feedback system with $G(s) = \dfrac{K}{s(s+1)\,(s^2+4s+13)}$. Obtain the range of K for stability. (10)

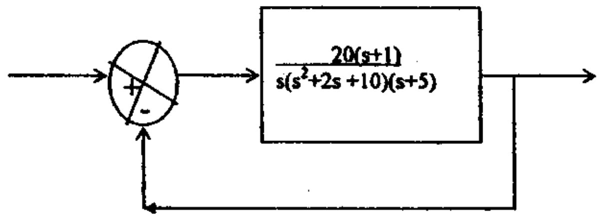
(b) The forward path transfer function $G(s)$ of a unity feedback system is $G(s) = \dfrac{K}{s(1+0.01s)\,(1+0.05s)}$. Draw the Bode plot and determine the gain margin and phase margin for $K = 50$. (10)

OR

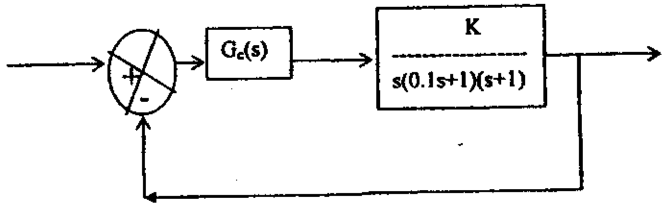
Contd................3.

VI. (a) Draw a Nyquist locus for the unity feedback control system with the open loop transfer function $G(s) = \dfrac{K(1-s)}{(s+1)}$. Using the Nyquist stability criterion, determine the stability of the closed loop system. (10)

(b) Consider the system shown in figure below. Draw a Bode diagram of the open-loop transfer function $G(s)$. Determine the gain and phase margins. (10)



VII. (a) For a closed loop system shown in figure, design a lead compensator $G_c(s)$ such that the phase margin is 45°, gain margin is not less than 8dB and the velocity error constant K_v is $4.0\,\text{sec}^{-1}$. (12)



(b) How are the compensation networks used to modify the system characteristics? Explain using an example. (8)

OR

Contd...............4.