D 51616 (Pages 3) Name..... Reg. No.....

FIFTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION, DECEMBER 2008

AI/IC 04 502—CONTROL ENGINEERING

(2004 Admissions)

Time : Three Hours **Maximum : 100 Marks**

Part A

Answer **all** *questions.*

I. (a) Write Force-Torque-voltage analogy table.

(b) State principle of superposition.

(c) Draw time response of a second order undamped and underdamped system when excited with unit step input.

(d) Distinguish between absolute stability and relative stability.

(e) Draw the asymptotic plot for $G(s)\,H(s) = \dfrac{4}{s\,(1 + 0.5s)}$.

(f) Define and terms gain margin and phase Margin.

(g) State and prove Cayley Hanilton theorem.

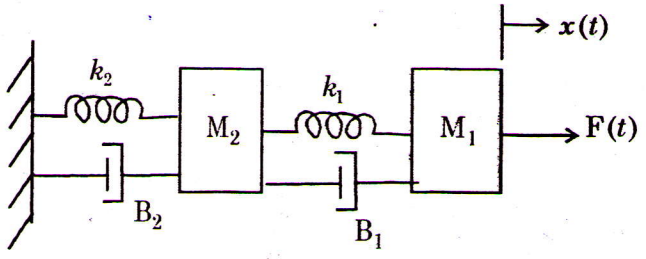
(h) Given $\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$ and $y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ check for state controllability.

($8 \times 5 = 40$ marks)

Part B

UNIT I

II. (a) Draw force-voltage and force current analogus circuit for the mechanical translation system given below in Figure.



Or

Turn over

(b) Derive the transfer function of a field controlled DC servomotor.

UNIT II

III. (a) Sketch root locus for the open loop transfer function $G(s)\,H(s) = \frac{k}{s(s+1)(s+3)}$. Determine :

(i) value of k for marginal stability.

(ii) Range of k for system to be underdamped.

Or

(b) A second order system is represented by transfer function $\frac{Q(s)}{T(s)} = \frac{1}{Js^2 + fs + k}$ where Q is regular displacement, T is applied torque, J is moment of inertia, f is viscous friction coefficient and k is rotational spring constant. A step input of 10 Nm is applied to the system and the test results are :

(i) Peak overshoot = 6%

(ii) Peak time = 1 second

(iii) Steady study output = 0.5 radian.

Determine the values of J, f and k.

UNIT III

IV. (a) Sketch polar plot for $G(s)\,H(s) = \frac{6}{s(2s+1)(s+1)}$. Find gain margin and phase margin.

Or

(b) A system has open loop transfer function $G(s)\,H(s) = \frac{k(s+1)}{(s+0.5)(s-2)}$. Use Nyquist criterion to determine range of k for which closed loop system is stable.

UNIT IV

V. (a) Use Cayley Hamilton theorem to find state transition matrix for $A = \begin{bmatrix} 0 & -1 \\ 2 & 3 \end{bmatrix}$. Determine $x(t)$ for unit step input with $x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$.

Or