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Name.....................................

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SEVENTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION JUNE 2012

EE 2K 703/PT EE 2K 701—CONTROL SYSTEMS—II

Time : Three Hours Maximum : 100 Marks

Answer **all** *questions.*

I. 1 Discuss the effects of Lag compensator on the system performace. Draw its magnitude and phase plot.

2 What is the effect of sampling time on the time response of the system ?

3 What are phase portraits ? State its uses.

4 What are singular points ? How the behaviour of the trajectories are studies in the region near a singular point ?

5 Define stability, asymptotic stability and instability in the sense of Lyapunov.

6 Define Negative definite and Positive Semi-definiteness. State its use.

7 Bring out the relationship between transfer function, controllability and Observability.

8 Define the term Performance Index. What are the various types ?

($8 \times 5 = 40$ marks)

II. (A) (i) Compare BODE plot and Root locus methods of designing a compensator.

(4 marks)

(ii) Design a PID controller for a plant with $\frac{C(s)}{R(s)} = \frac{2(s+2)}{s^2+1.6s+16}$ so that overshoot is less than 5 % and settling time less than 2*s*.

(11 marks)'

Or

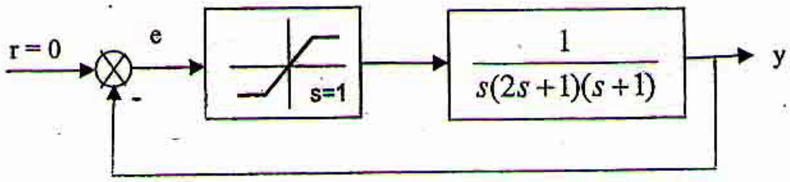
(B) (i) State the steps to design a lag compensator using root locus method. (4 marks)

(ii) Design the lag compensator for the given system so that the $\phi_m = 33°$ and velocity error constant greater than 8. The OLTF of the system is $GH(s) = \frac{K}{s(s+1)(s+5)}u.$

(11 marks)

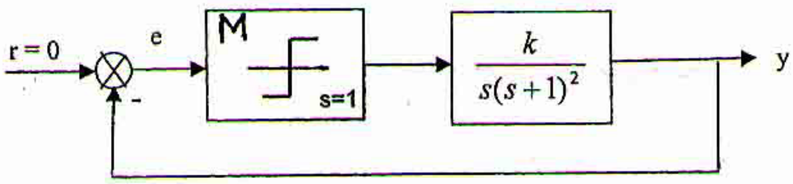
Turn over

III. (A) For the given non-linear system amplifier has a gain of K in the linear region. Determine the frequency, amplitude and nature of limit cycle for a gain K = 3. Also determine the legest value of K for which the system will be stable.



Or

(B) Using the describing function show that a stable limit cycle exists for all values of K > 0. Also find the amplitude of limit cycle when $k = 4$.



IV. (A) For the given state-space representation of LTIV system, check stability at equilibrium point using quadratic function $\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix}$.

Or

(B) $\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ -2x_2^3 \end{bmatrix}$, where $x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$. Take V $(x) = -\left(x_1^2 + x_2^2\right)$. Determine the region of stability for the above Non-linear system.

V. (A) Check the controllability and observability of the given system

$$X = \begin{bmatrix} -2 & 1 \\ 1 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} U; \; y = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}.$$

Or

(B) Consider the system $\dot{x} = \begin{bmatrix} 0 & 1 \\ 0 & 2 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U$. Assume linear control law, $u(t) = -k_1 x_1 - k_1 x_2$.

Find the value of k_1 so that the closed loop system has undamped natural frequency of 2 rad/s, and find k_2 so that $J = \frac{1}{2} \int_0^\infty \left[x_1^2 + x_2^2 \right] dt$ is minimized for X (0) = $\begin{bmatrix} 1 & 0 \end{bmatrix}^T$. Find the minimum value of performance index.

(4 × 15 = 60 marks)