COLLEGE OF ENGINEERING, PUNE

(An autonomous Institute of Government of Maharashtra)

END SEMESTER EXAMINATION

(IE 305) Control System Design

Programme: T.Y.B.Tech. (Instrumentation & Control) Year: 2013-14
Duration: 3 Hours Max. Mark: 60

Instructions to candidates:

1. All questions are compulsory.
2. Neat diagrams must be drawn wherever necessary.
3. Figure to the right indicate full marks.

Q. 1 A unity feedback system with OLTF

$$G(s) = \frac{K}{s^2(s+10)}$$

Design compensator with steady state error to unit ramp input is less than 0.5 and $PM \geq 35^o$. (Use Bode plot) **(12)**

Q. 2 Suppose it is desired to control the elevation of an antenna designed to track a sattelite. The antenna and a drive part have a moment of inertia and J and damping B, arising to some extent from bearing and aerodynamic friction, but mostly from the back emf of the DC drive motor. The equation of the motion is

$$J\ddot{\theta} + B\dot{\theta} = T_c$$

where T_c is net torque from drive motor, simplifies above equation to

$$\frac{1}{a}\ddot{\theta} + \dot{\theta} = u$$

where $a = \frac{B}{J}$ and $u = \frac{T_c}{B}$, if $a = 0.1$ design controller to improve $T_s = 5$ sec. (Use root locus) **(12)**

Q. 3 Suppose a pendulum with frequency ω_o and state space description is given by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -\omega_o^2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u; y = [1 \quad 0]x$$

Using Ackerman's formula find the control law that places the CL poles of the system so that they are both at $-2\omega_o$. Also design an observer to place the two estimator poles at $-10\omega_o$. Also write Matlab program for both. **(16)**

Q. 4 (a) For a given system

$$\dot{x}(t) = \begin{bmatrix} -4 & 3 \\ -6 & 5 \end{bmatrix} x(t)$$

Determine eigen values and eigen vectors of a matrix A, and use these results to find state transition matrix. (4)

(b) Derive the relation between phase margin and ζ (4)

Q. 5 State weather the following statement are true or false with justification (12)

(a) Derivative controller amplifies system noise.

(b) Pure state feedback controller does not work when system have uncertainty and disturbances.

(c) PID controller is commonly found in chemical process applications.

(d) Luenberg observer is purely for LTI system having no uncertainty and disturbances.