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: 2012-13
Duration: 3 Hours | Max. Mark: 50

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 State whether following statements are true or false and justify **(10)**

(a) Lag compensators improves signal to noise ratio

(b) In lead compensator design selection of zero/pole has limitations

(c) Gain adjustment of system is not sufficient to meet transient or steady state requirement

(d) Derivative controller is not preferred for a system with noisy input signal.

Q. 2 A 2-tank liquid level control system, the liquid inflow to the lower tank with capacity C_1 system can be controlled using valve R_1 and is represented by F_1. The inflow to the upper tank is F_0. The output flow of the lower tank with capacity C_2 is F_2 is controlled with valve R_2, where $R_1 = R_2 = C_1 = C_2 = 1$. Find its mathematical model for the output as liquid level in the tank 2 for the input flow F_0. Design PID controller for this system to improve settling time to 2 sec. and peak time of 0.5 sec. with zero steady state error. **(10)**

Q. 3 (a) A unity feedback system is characterized by OLTF **(5)**

$$G(s) = \frac{K}{s(s+3)(s+9)}$$

Determine

i. Determine the value K if 20% peak overshoot to step input is desired.

ii. For the above value of K determine settling time and velocity error constant.

iii. Design cascade compensator that will give approximately 15% overshoot to a step input while settling time is decreased by a factor of 2.5 and $K_v \geq 20$

(b) Design an observer for **(5)**

$$G(s) = \frac{50}{(s+6)(s+3)(s+9)}$$

represented in phase variable form with a desired performance of 10% overshoot and settling time of 0.5 sec. The observer will 10 times as fast as plant, and the observer's nondominant pole will be 10 times as far as from the imaginary axis as dominant poles. Design the observer by converting to observer canonical form.

Q. 4 (a) Obtain output response $y(t)$ for the system **(5)**

$$\dot{x}(t) = \begin{bmatrix} -1 & -0.5 \\ 1 & 0 \end{bmatrix} x(t) + \begin{bmatrix} 0.5 \\ 0 \end{bmatrix} u(t); \quad \begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \quad \text{and} \quad y(t) = [1 \quad 0]x(t)$$

where $u(t)$ is the unit step input.

(b) Realize the following TF with the hardware in Companion-II form and derive mathematical model from the realization **(5)**

$$G(s) = \frac{8(s+2)(s+4)}{(s+1)(s+3)(s+9)}$$

Q. 5 Design a lead compensator for the unity feedback system whose OLTF is given as **(10)**

$$G(s) = \frac{K}{s(s+1)}$$

i. PM $\geq$ 45.

ii. Steady state error for a unit step input should be less than 1/5 deg per deg/sec of final output velocity.

iii. The gain cross over frequency of the system must be less than 7.5 rad/sec