6E3090

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B. Tech. VI Semester (Main/Back) Exam. May/June, 2013

ELECTRONICS & COMMUNICATION ENGINEERING # 6EC5

CONTROL SYSTEMS

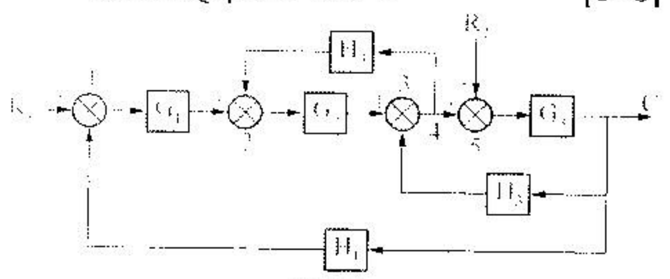
Time : 3 Hours **Min. Passing Marks : 24** **Maximum Marks : 80**

Instruction to Candidates :

*Attempt any **five** questions, selecting **one** question from **each** unit. All questions carry **equal** marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.)*

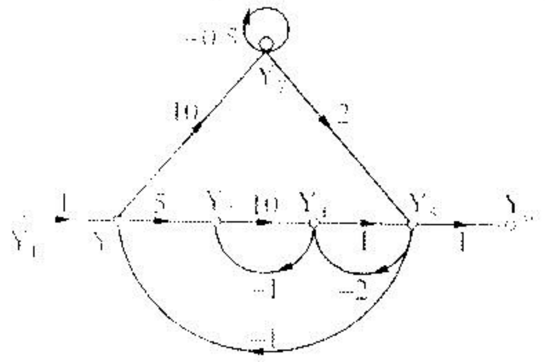
Unit–'I'

1. Evaluate C/R_1 and C/R_2 for a system whose block diagram representation is shown in diagram. R_1 is the input to summing point No. 1. **[8+8]**



OR

1. Find the transfer function for the system shown in diagram. **[16]**



Unit–'II'

2. (a) A servo system for the position control of a rotatable mass is stabilised by viscous friction damping which is three-quarters of that is needed for critical damping. The undamped natural frequency of the system is 12 Hz. Derive an expression for the output of the system, if the input control is suddenly moved to a new position, being initially at rest. Hence, find the maximum overshoot. **[8]**

2. (b) A unity feedback system is characterized by an open loop transfer function

$$G(s) = \frac{k}{s(s+10)}$$

Determine the gain k so that the system will have a damping ratio of 0.5. For this value of k, determine setting time, peak overshoot and time to peak overshoot for a unit step input. **[8]**

OR

2. (a) An angular position of a fly wheel is controlled by an error actuated closed loop automatic control system to follow the motion of input lever. The lever is maintained in sinusoidal oscillations through ± 60° with an angular frequency $\omega = 2$ rad/sec. The inclusive moment of inertia of flywheel is 50 kg.m² and the stiffness of the control is 2400 Nm per radian of misalignment. Calculate the viscous frictional torque required to produce critical damping. Assuming critical damping, calculate the amplitude of swing of flywheel and the time lag between the flywheel and the control lever. **[8]**

2. (b) The forward transfer function of a unity feedback type 1, second order system has a pole at –2. The nature of gain K is so adjusted that damping ratio is 0.4. The above equation is subjected to input $r_{in} = 1 + 4t$. Find the steady state error. **[8]**

Unit–'III'

3. A feedback control system is described by

$$G(s) = \frac{10}{s(1+0.2s)(1+0.01s)}, H(s) = 1$$

Construct an asymptotic log- magnitude plot and an exact phase plot. From this determine

(i) Gain crossover and phase crossover frequency.

(ii) Gain margin and phase margin. **[16]**

OR

3. The open–loop transfer function of a unity feedback system is

$$G(s) = \frac{50k}{s(s+10)(s+5)(s+1)}$$

(i) Gain margin and phase margin

(ii) The value of steady-state error co-efficient for a gain of 10 db and the value which will make the closed-loop system marginally stable. **[16]**

Unit–'IV'

4. (a) A unity feedback system has an open loop transfer function $G(s) = \frac{K(s+13)}{s(s+3)(s+7)}$, using Routh's stability criterion. Find the range of K for the system to be stable. If K = 1, check if all the poles of closed loop transfer function having damping factor greater than 0.5. Assume unity feedback. **[8]**

4. (b) The open-loop transfer function of a feedback system is

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

Comment on stability. **[8]**

OR

4. Sketch the root locus of a control system having open-loop transfer function

$$G(s) = \frac{K}{83.33(s+0.001)(s+2)(s+6)}$$

[16]

Unit–'V'

5. (a) Derive the expression for the transfer function from the state model.

$$\dot{X} = Ax + Bu$$
$$Y = Cx + Du$$

[8]

5. (b) Construct signal flow graph and state model for a system whose transfer function is

$$T(s) = \frac{s^2+3s+3}{s^3+2s^2+3s+1}$$ **[8]**

OR

5. (a) Construct the state model for a system characterized by the differential equation

$$\frac{d^3y}{dt^3} + \frac{6d^2y}{dt^2} + \frac{11dy}{dt} + 6y = u$$

Given the block diagram representation of the state model. **[8]**

5. (b) Find the canonical form of representation and state transition matrix.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 2 & -2 & 3 \\ 1 & 1 & 1 \\ 1 & 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 11 \\ 1 \\ -14 \end{bmatrix} u$$

$$Y = \begin{bmatrix} -3 & 5 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$ **[8]**