1

Motilal Nehru National Institute of Technology, Allahabad

B. Tech. V Semester, Electronics & Communication Engineering

Subject: Automatic Control System (EC 1505)

End Semester Theory Examination (Odd Semester, 2016-17)

Time: 3:00 Hrs. **Maximum Marks: 60**

Note: Attempt all Questions. If any data is missing, assume as per requirement and mention the same.

1. (a) Discuss the advantages and disadvantages of open and closed loop control systems. [3]

(b) Obtain the transfer function C(s)/R(s) and C(s)/D(s) of given system as shown in Figure 1.

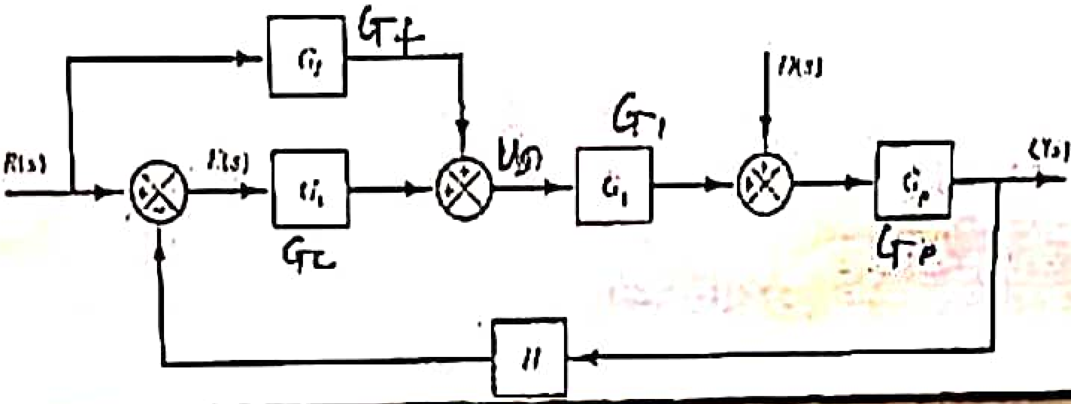

Figure 1 [3]

(c) The open loop transfer function of a unity feedback control system is given by

$$G(s)=\frac{K(s+2)}{s^3+\beta s^2+4s+1}$$

Determine the value of K and β such that the closed loop unit step response has $\omega_n=3$ rad/sec and $\zeta=0.2$. [4]

2. Sketch the root locus for given open loop transfer function $G(s)H(s)=\dfrac{K(s+0.1)}{s(s-0.2)(s^2+s+0.6)}$ and determine the range of values K for which the closed loop system is stable. [10]

3. Construct the Bode plots for the system having

$$G(s)=\frac{80}{s(s+2)(s+20)}$$

From the plots determine:

(i) Gain and phase crossover frequencies

(ii) Gain and Phase margin

(iii) Comment on stability of the system [10]

4. Consider a unity feedback system given by open loop transfer function $G(s) = \frac{20}{(s+1)(s+2)(s+6)}$

Draw the Nyquist plot and determine

(i) Gain margin and phase margin

(ii) Comment on stability of the system

OR

What do you understand by the principle of Argument? Discuss in detail the Nyquist stability criterion. [10]

5. (a) What is the lag compensator? Obtain the transfer function of lag compensator and draw the pole-zero plots. Also, discuss its effects and limitations. [3]

(b) The forward path transfer function of a unity feedback control system is given by

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

Design a suitable lag network using root locus to meet following specifications

(i) Overshoot $\leq 16\%$ for unit step input

(ii) Steady state error for unit ramp input $\leq \frac{2}{15}$ radian [7]

6. (a) Derive a state space model for given electrical network as shown in Figure 2

Figure 2

[4]

(b) Consider the system given by following state space model and initial conditions as:

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t), \qquad \begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$y(t) = \begin{bmatrix} 1 & 0 \end{bmatrix} x(t)$$

Calculate the following:

(i) State transition matrix $\phi(t)$

(ii) $x(t)$ and $y(t)$

(iii) Comment on controllability and observability of the system

(iv) Comment on stability

(v) Obtain the transfer function of the system [6]