ELECTRICAL ENGINEERING DEPARTMENT, MNNIT, Allahabad
B.Tech.V-Sem. (Electronics & Communication Engg.): End Sem. Exam.-2015
Subject: Automatic Control System (EE 1505)

Time: 3:00 Hr. Max. Mks.: 60

Note: Attempt all questions. All questions carry equal marks.

Q1. (a) A unity feedback system has

$$G(s) = \frac{20}{s^2 + 5s + 5}$$

Find

(i) Natural frequency ω_n

(ii) Damping Coefficient ξ

(iii) Damped Frequency ω_d

(iv) Rise Time t_r

(v) Peak Time t_p

(vi) Settling Time t_s

(vii) Maximum Peak Overshoot M_p

(b) For the system shown in Figure 1, determine the type of system, error coefficients (K_p, K_v and K_a) and steady state error for the following inputs

i) $r(t) = 6$ ii) $r(t) = 8t$ iii) $r(t) = 10 + 4t + \frac{3}{2}t^2$

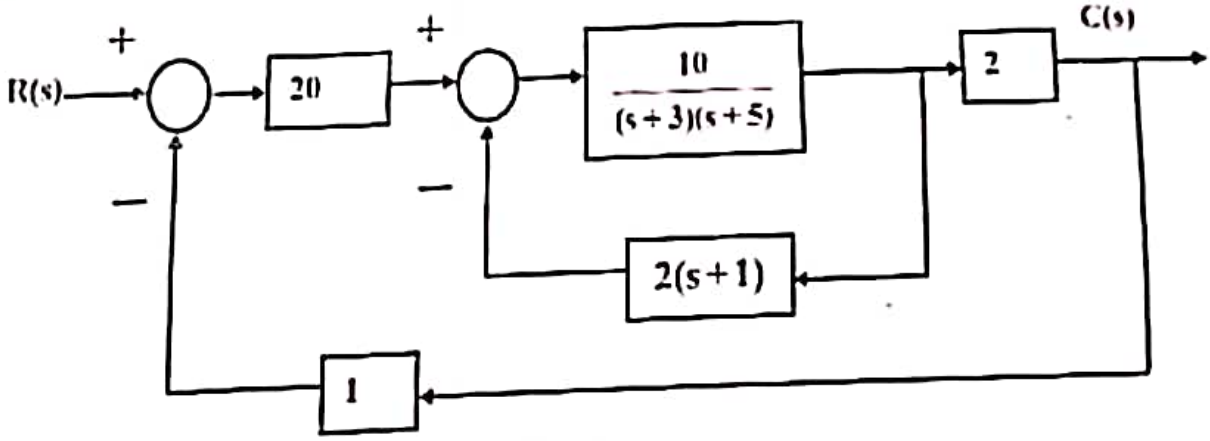

Figure 1

Q2. (a) Define Stability of the system and distinguish between absolute and relative stability.

(b) For unity feedback system having transfer function $G(s) = \frac{K}{s(1+0.6s)(1+0.4s)}$

Determine

(i) range of value of K for which system is stable.

(ii) the value of K for which system becomes oscillatory and find the frequency of sustained oscillation.

Q3. Draw the Nyquist plot for given open loop transfer $G(s)=\frac{5}{s(s+2)(s+4)}$ with unity feedback control. Determine

(i) Gain Crossover frequency and Gain Margin
(ii) Phase Crossover frequency and Phase Margin and
(iii) Comment on stability

Q4. Using Root locus technique design a suitable lead compensator for a system with unity feedback and having open-loop transfer function

$$G(s)=\frac{K}{s(s+1)(s+3)}$$

This has to meet following specifications

(i) Damping ratio $\xi=0.6$
(ii) Undamped natural frequency $\omega_n=2$ radian/sec.

OR

A system has $G(s)=\frac{0.035}{s(1+0.5s)(1+0.04s)}$ using Bode plot design a suitable lag compensator to give velocity error constant 27.3 s^{-1} and phase margin 45^0.

Q5. The dynamic equation of a linear time invariant system is given below

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-2 & 0\\ -1 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u$$

$$y=\begin{bmatrix}1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

Determine the following

(i). The state transition matrix
(ii). x(t) under zero initial condition and a step input
(iii). Controllability and ovserbability of the system and
(iv). Transfer function of the system

Q6. Write short notes on the followings:

(i) Merits and demerits of open loop and closed loop system
(ii) Minimum and non-minimum phase system
(iii) PID controllers
(iv) Discuss the necessary conditions for formulating the root-loci of a system.
(v) With the help of suitable Bode diagram, explain stable and unstable conditions of systems.