END SEMESTER EXAMINATION

B.Tech. – IV Semester, Electrical Engineering

Session: 2015-16

Subject: Basic Control System (EE 1402)

Max. Time: 3.00 hr **Max. Marks: 60**

NOTE: Attempt any FOUR questions from Part-A and any THREE questions from Part-B. Questions in part-A carry 9-marks and in part-B carry 8-marks.
USE OF SEMILOG PAPER AND GRAPH PAPER IS ALLOWED

PART-A

Prob. 1: Consider a unity feedback control system with the controller transfer function D(s) and the plant transfer function given by (9)

$$G(s) = \frac{1}{(s-1)(0.5s+1)}$$

With the choice of proportional controller D(s) = k_p, determine the value of the proportional gain k_p such that the peak overshoot is 16.3%. Obtain the steady state error at this value of the gain. What value of k_p is needed for steady state error of 10%. Choose a PD controller as $k_p + k_d s$. Determine the value of proportional and derivative gains, k_p and k_d such that the steady state error is 10% and the peak overshoot is the same 16.3%. Suggest the advantage of using PD controller from this example.

Prob. 2: Consider a feedback system with open loop transfer function (9)

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

Using Nyquist stability criterion, determine the range of values of K for which the system is stable.

Prob. 3: Consider the following open loop transfer function of a closed loop system.

$G(s)H(s) = \dfrac{10}{s(0.5s+1)(0.1s+1)}$. Determine the gain crossover frequency, GM and PM. If a lead with the following transfer function is inserted (9)

$G_c(s) = \dfrac{1+0.23s}{(1+0.023s)}$ in the forward path, determine the new gain crossover frequency, GM and PM. Comment upon the effect of the lead compensator using above results.

PTO

Prob. 4: Two unity feedback closed loop systems with open loop transfer functions are given below.

$$G_1(s) = \frac{(s+5)}{(s+2)(s+1)}; \quad G_2(s) = \frac{(s-5)}{(s+2)(s+1)} \qquad \textbf{(9)}$$

Draw the polar plot for both the above systems and categorize them as minimum phase and non-minimum phase. Which system has higher stability margin.

Prob. 5: Model a closed loop armature controlled servo position control system. Obtain a closed loop block diagram and transfer function. Reduce the order of the system using suitable approximation. **(9)**

PART-B

Prob. 6: Approximately sketch the root-locus for a control system with open loop transfer function $G(s)H(s) = \dfrac{K(s^2+2s+10)}{(s^2+6s+10)}$. Determine the range of values of K for which the system is overdamped, critically damped and underdamped. Is it possible to achieve damping ratio of 0.1? **(8)**

Prob. 7: The open loop transfer function of a unity feedback system is $G(s)H(s) = \dfrac{K}{s(s+4)(s+5)}$. It is desired that the velocity error constant should be at least 5 $\sec^{-1}$ and the damping ratio should be 0.707. Design a suitable lag compensator to meet these requirements using root-locus technique. **(8)**

Prob. 8: Consider the transfer function

$$\frac{Y(s)}{R(s)} = \frac{10}{(s+1)} \qquad \textbf{(8)}$$

Find the expression of the transient response $y(t)$ to the sinusoidal input $r(t) = R_o \sin \omega t$; where R_o is constant and ω is the sinusoidal frequency. Determine the expression of steady state response. Draw approximately linear plot between magnitude ratio and phase, verses frequency using this expression by varying the ω from 0 to infinity, calculating both magnitude and phase at some selected frequencies.

Prob. 9: Using the expression of constant M and N circles approximately draw the magnitude and phase characteristics of closed loop transfer function with open loop transfer function $G(s) = \dfrac{1}{s}$. **(8)**