B.E. (EE) Part-III 5th Semester Final Examination, 2011
Control System – I
(EE - 504)

Time: 3 hrs **Full Marks:70**

i) Use separate answer script for each half.
ii) Answer six questions taking three from each half.
iii) Two marks are reserved for neatness in each half.
iv) Use semi log or ordinary graph paper if required.

FIRST HALF

1.a) When 2 lb of force is applied to a mechanical vibratory system, the mass oscillates. Determine m, b, k of the system from following data:
i) $x(\infty) = 0.1$ ft.
ii) $M_p = 9.5\%$.
iii) $t_p = 2$sec.
b) What is **rise time** of an under damped second order system? Explain with diagram. **[8+3]**

2.a) Draw the equivalent signal flow graph for the system as shown in the following block diagram (Figure 1) and calculate the over all gain by Mason's gain formula.

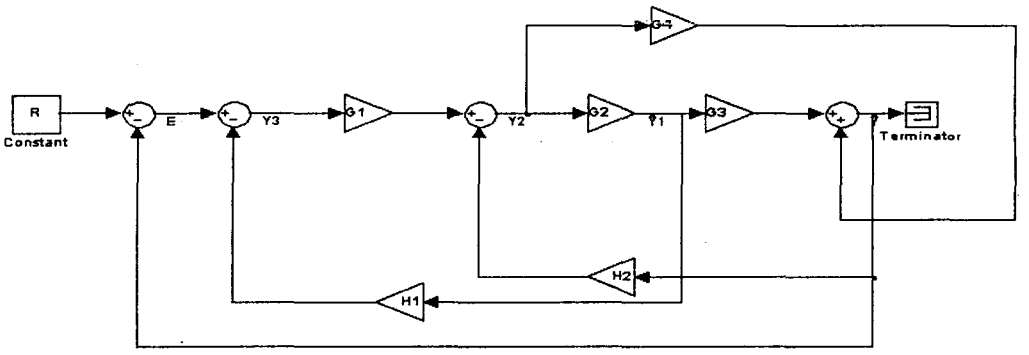

Figure1

b) An OPAMP is connected with an input voltage v_i through an input resistance R_1 and a series combination of R_2 and C in the feedback path. If the output is v_0, find the transfer function of the circuit from fundamental equations. **[6+5]**

3.a) Find out the steady state error of Unit ramp response of a first order system.
b) Deduce the expression for peak time of an under damped second order system.**[4+7]**

4.a) Comment on the steady state error of a **TYPE 1** system with ramp input.
b) What do you understand by the **electrical zero** of a Synchro transmitter and null position of Synchro control transformer?
c) Draw the block diagram of field controlled dc servomotor. **[3+4+4]**

5.a) Find the open loop transfer function of a system with no finite zero and three finite poles at origin, s = -1and s = -5.A **PID** controller is used to control the said system. Deduce one probable transfer function of the controller. **[11]**

SECOND HALF

6. a) What is a linear system? Give an example of a nonlinear one.

b) What do you mean by stability of dynamic systems? Classify stability.

c) In a unity feedback system if $KG(s) = 5\angle 180^0$, symbols having their usual significance, then for what value of K is "s" a point on the Root Locus?

d) What causes an entire row of zeros to show up in the Routh's array?

[2+3+4+2]

7. a) Draw the Bode plots of the open loop transfer function given by:

$$G(s) = \frac{22.5K}{(s+4)(s^2+0.9s+9)}$$

taking K = 1. Find the Gain Margin and Phase Margin from the plot.

b) A system with four poles and two zeros would exibit what value of slope at high frequencies in a Bode magnitude plot?

[8+3]

8. a) What do you mean by "resonance" in a standard second order system? How do resonance frequency, and resonance peak vary with ξ and ω_n (deduction not needed)?

b) A unity feedback system with

$$G(s) = \frac{K}{s(s+7)}$$

Gives a closed loop step response with 10% overshoot.

Design a cascade compensator that decreases the settling time nearly three times without appreciably changing the dominant closed loop pole locations. Check your design.

[3+8]

9. a) Use Nyquist's stability criterion to infer about closed loop stability of a unity feedback system with open loop transfer function, taking K = 1:

$$G(s) = \frac{20K}{s(s+1)(s+4)}$$

b)Also find gain margin, phase cross over frequency and range of K for stability from the plot.

c) Name control system components that can be used as a:

i) Sensor and ii) Transducer

[6+3+2]

10.a) Show the pole-zero locations of a cascade compensator used to improve transient response. State reasons for such placement.

b) The system in 8(b) is now operating with a closed loop step response that has 20% overshoot. What is the settling time? Compute the steady state error to unit ramp input. Design a cascade compensator to decrease the settling time nearly 2 times and additionally decrease the steady state error to unit ramp input by nearly 10 times. (Place lead zero at -3).

Check the accuracy of your design.

[3+8]