Bachelor of Electrical Engg. Supplementary Examination, 2017 (OLD)

(3rd year, First Semester)

Control System Engineering (OLD)

Time: Three Hours; Full Marks: 100 (50 Marks for each Part)

Use Separate Answer script for each part

PART I

Answer any *three* questions from this part.

Two marks reserved for neat and well-organized answer

1. For the system shown in Fig. 1, determine the values of gain K and velocity feedback constant K_h so that the maximum overshoot in the unit step response is 0.2 and the peak time is 1 sec. With these values of K and K_h, obtain the rise time and settling time. 16

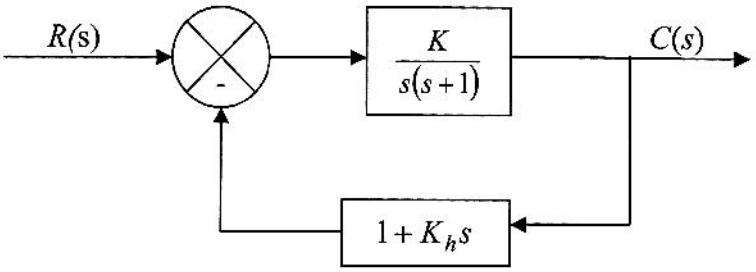

Fig.1

2. a) Briefly discuss the effect of addition of a non-minimum phase zero to a critically damped second order system. 4x4
   b) What do you understand by the terms *dominant poles* and *non-dominant poles* of a system.
   c) Explain why A.C. servomotor should have drooping speed torque characteristics.
   d) What do you understand by the voltage resolution of a potentiometer? What is the voltage resolution of a carbon potentiometer?

3 a) Compare the characteristics of D.C. servomotor when used in armature controlled mode and in field controlled mode. 4+8+4
   b) Find the position, velocity and acceleration error constants and corresponding steady-state errors for the unity feedback control system having the open-loop transfer function

$$G(s) = \frac{10}{(s+1)(s+2)}$$

   c) Find the actuating signal $E_a(s)$ for the system shown in Fig. 2. Find the position, velocity and acceleration constants.

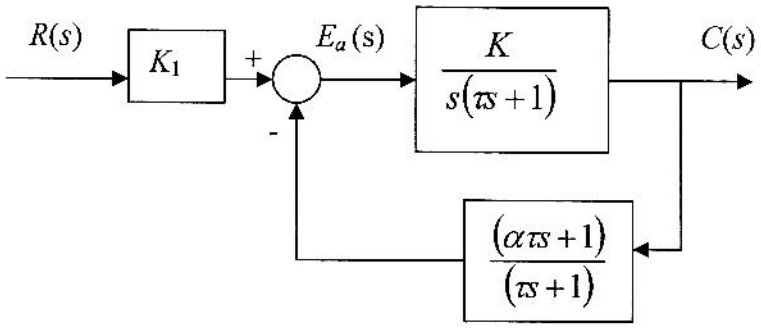

Fig.2

4 a) Explain the principle of operation of A.C. Drag Cup Tachogenerator. 4+12

b) The constants for a voltage regulator are given below:

Gain K_A	=	100 V/V
Field resistance	=	200 ohms
Field inductance	=	100 henry
Field constant	=	1 mwb/amp
Armature resistance	=	0.2 ohm
Armature inductance	=	negligible
Speed	=	1000 rpm
EMF constant	=	200 mV/μwb at 1000 rpm
Load current	=	negligible
Feedback factor	=	0.1

Find the general expression for the forward transfer function and the error transfer function. Determine the steady state error voltage to a step input $V_r=V_i\,u(t)$. Compute this value when V_i=10 volts. What is the steady-state output voltage?

5 The transfer function of a plant is given by 16

$$G(s)=\frac{K}{s(s+1)(s+2)}.$$

Design a suitable compensator to meet the following specifications:

a) Velocity constant $K_v \geq 10\ \text{sec}^{-1}$.

b) Phase margin $\phi_m \geq 35^{\circ}$.

Part-II

Use separate Answer-script for each part

Time: Three Hours **Full Marks: 100/50√**

Answer any three Questions

Two Marks reserved for neat and well organized answers

Q6a. Establish the relation between Routh's stability criterion and Hurwitz's Stability Criterion.

Q6b. Define BIBO Stability and Asymptotic Stability considering the plant to be a linear one. Establish the notions with the help of a suitable example.

6+3+3+4

Q7. Comment on the stability of the system whose open loop transfer function is given by

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

Draw the complete Root-Locus Plot for the system. Also determine i) number and angles of asymptotes, ii) the centroid, iii) the breakaway point/ points, if any, iv) intersection of the root locus and the asymptotes with the imaginary axis, v) the range of gain K for which the closed loop system remains stable, vi) any other value that has relevance to the plot.

Q9. What do you understand by the term "State Variables"? Define. Write down the differential equation describing the dynamics of an n^{th} order linear system. There from obtain a state model of the system in Phase Variable form. What is a Vander Monde Matrix?

Establish the relation between the state model of a linear system and its transfer function.

3+2+4+3+4

Q10. Write short notes on (any two): 8+8

i) Mason's Gain Formula and Signal Flow Graph
ii) Eigen values and Eigen vectors
iii) Root locus Technique: Magnitude and Angle Criteria and their relevancies