Total No. of printed pages = 5

CAI-501/CS/5th Sem/2016/N

CONTROL SYSTEMS

Full Marks – 70

Pass Marks – 28

Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer any *five* questions.

1. (a) Describe the operation of an automatic control system with necessary block diagram. 5

   (b) What do you mean by linear system ? Why a series RC circuit powered by d.c supply is said to be a linear system ? 1+4=5

   (c) Obtain the force equation of a mechanical accelerometer. 4

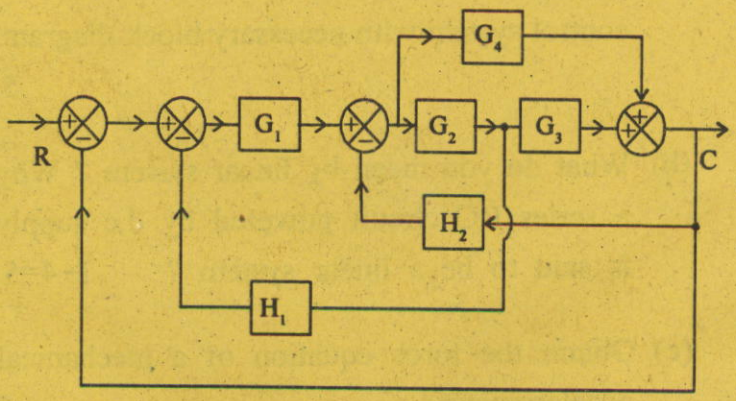
[Turn over

2. (a) What is the transfer function of a system ? Determine the transfer function of a field contolled D.C servomotor. What is the relationship between torque and angular speed of motor ? 1+5+1=7

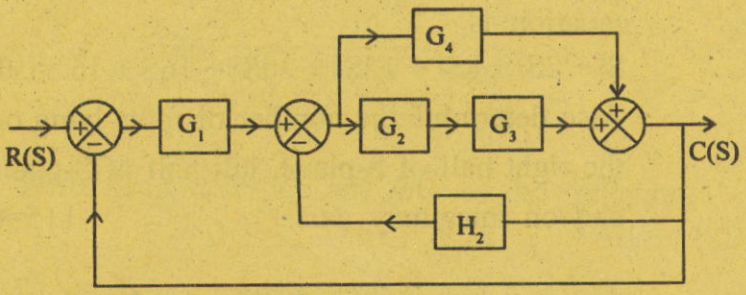
(b) Explain the working principle of synhchro transmitter. Derive the output voltage of stator coils of a synchro transmitter. 4+3=7

3. (a) Explain the working principle of an amplidyne. 3

(b) Using block diagram reduction technique, find the closed loop transfer function of the following system. 6



(c) Convert the following block diagram to signal flow graph and determine the transfer function using Mason's gain formula. 5



4. (a) Define the following : 3

(i) Unit step signal

(ii) Unit impulse signal and

(iii) Peak overshoot of an underdamped system.

(b) Determine the time response of a first order system for a unit step input. What do you mean by steady state error ? 5+1=6

(c) The response of a servomechanism is $c(t) = 1 + 0.2\, e^{-6t} - 1.2\, e^{-10t}$ when subject to a unit step input. Obtain an expression for closed loop transfer function. Determine the undamped natural frequency and damping ratio. 5

5. (a) What is the meaning of stability of a system ? Construct Routh array and determine the stability of the system whose characteristic equation is

$S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0.$

Also determine the number of roots lying on the right half of S-plane, left half of S-plane and on imaginary axis. 1+5=6

(b) Determine the range of k for stability of unity feedback system whose open loop transfer function is 5

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

(c) If the open loop transfer function of a system is $G(s) = \frac{k}{S(S+a)}$,

find the ranges of k for which the roots of system is 3

(i) real and distinct

(ii) real and equal and

(iii) are complex conjugate using the concept of root locus.

6. Plot the Bode diagram for the following transfer function and obtain the gain and phase cross over frequencies 14

$$G(s)\ \frac{10}{S(1+0.4s)(1+0.1s)}$$

7. Write short notes on any *four* of the following : $4\times3\frac{1}{2}=14$

   (i) Servomechanism

   (ii) Magnetic amplifier

   (iii) AC servomotor

   (iv) Stepper motor

   (v) Synchro control transformer.