Total number of printed pages–7

53 (IE 506) CNTH

2018

CONTROL THEORY

Paper : IE 506

Full Marks : 100

Time : Three hours

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

Answer ***any five*** *questions out of* ***seven.***

1. *(a)* Compare the performance of open loop and closed loop control systems using the following parameters : 10

   (i) Stability

   (ii) Sensitivity

   (iii) Noise

   (iv) Accuracy.

(b) For the mechanical system shown in *Fig. (1)*, write the differential equations describing its behaviour, draw the equivalent electrical circuits according to force-current and force-voltage analogies, and also obtain the transfer function, $\frac{Y_1(s)}{F(s)}$. 10

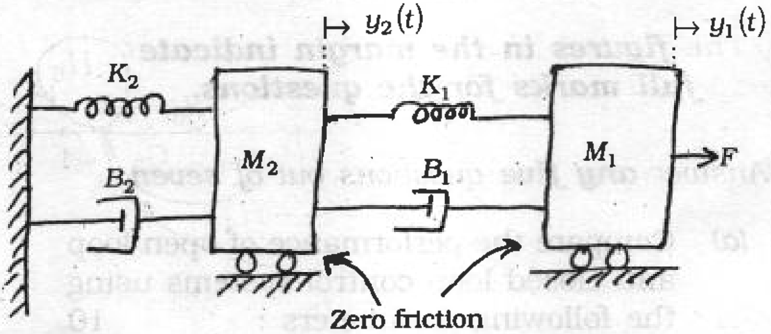

Fig. (1)

2. (a) Design an angular position tracking control system based on an AC servo-motor. Model the system using differential equations draw the block

diagram and determine its transfer function. Explain the behaviour of all integral parts of the system such as error detector, stator, rotor, ... etc. 10

(b) Find the transfer function $\frac{x_7}{x_1}$ of the signal flow graph shown in *Fig. (2).* 10

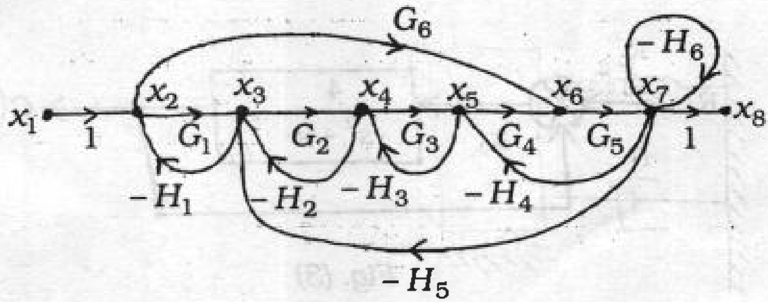

Fig. (2)

3. (a) Determine the impulse response of a second order LTI system for different ranges of the value of damping co-efficients. Explain how the locations of roots in the *s*-plane affect the nature of response. 10

(b) A closed-loop control system with unity feedback is shown in *Fig. (3)*. By using derivative controller (PD), the damping ratio (ς) is to be made 0·75. Determine the value of K_D, the co-efficient of derivative control. Also determine the rise time, peak time and peak overshoot with and without derivative controller. 10

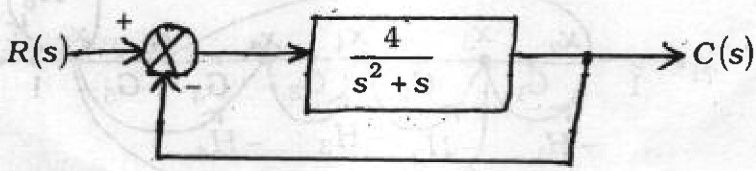

Fig. (3)

4. (a) Derive the condition for stability of an LTI system given its impulse response. Explain the relationship between the location of poles of the transfer function and different cases of stability. 10

(b) Determine the values of 'K' and 'a' so that the system shown in *Fig. (4)* is marginally stable with a frequency of oscillation, $2 rad/s$. 10

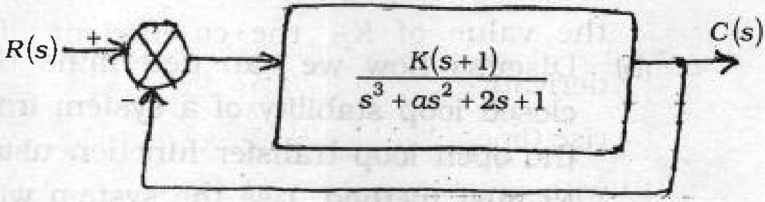

Fig. (4)

5. (a) For the unity feedback system with open loop transfer function $G(s) = \dfrac{K(s+a)}{s(s+b)}$, show that the root locus plot lie either on the real axis or on a semi-circle. 8

(b) Discuss the concept behind each step in drawing root locus of a system using the example,

$$G(s)H(s) = \frac{K(s^2+2s+10)}{s^2(s+2)}.$$

Also demonstrate the use of this plot in determining the stability of the system. 12

6. *(a)* Draw the polar plot of a second order system. Explain what happens to its behaviour when the damping ratio (ς) is changed from 0 to ∞. 8

(b) Discuss how we can determine the closed loop stability of a system from the open loop transfer function using Nyquist method. Use the system with

$$G(s)H(s) = \frac{K(s-4)}{(s+1)^2}$$ as the practical example. 12

7. *(a)* What are the advantages of Bode plot compared to other methods for plotting frequency response? Discuss how stability could be analysed using Bode plot. 6

(b) Draw the circuit diagram for a lead compensator and plot its frequency response using Bode plot. 6

(c) Determine the expressions for *M* and *N* circles and discuss its behaviour as you change magnitude and phase of the open loop transfer function. 8