

Code No: 125DU

**R15**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**B. Tech III Year I Semester Examinations, November/December - 2017**

**CONTROL SYSTEMS ENGINEERING**

**(Common to ECE, ETM)**

**Time: 3 hours**

**Max. Marks: 75**

**Note:** This question paper contains two parts A and B.

Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

**PART - A**

**(25 Marks)**

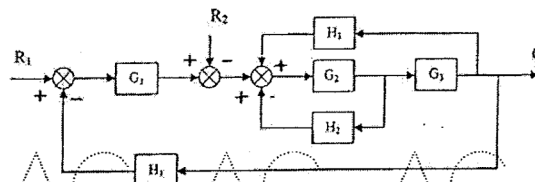
- 1.a) Explain about various types of control systems with examples briefly. [2]
- b) Briefly explain about the characteristics of feed-back signal. [3]
- c) Why test signals are needed? Explain various test signals used in feed-back control systems. [2]
- d) Define time constant and explain its importance. [3]
- e) Explain the concept of stability of a control system with an example. [2]
- f) Distinguish between qualitative stability and conditional stability of a control system. [3]
- g) What is compensation? Explain different types of compensators. [2]
- h) Define gain margin and phase margin in frequency domain stability analysis. [3]
- i) Discuss the significance of state Space Analysis. [2]
- j) Define state variables. [3]

**PART - B**

**(50 Marks)**

- 2.a) Explain the operation of ordinary traffic signal, which control automobile traffic at roadway intersections. Why are they open loop control systems? How can traffic be controlled more effectively?

- b) For the system represented in below figure 1, obtain transfer function  $\frac{C}{R_1}$ ,  $\frac{C}{R_2}$  [5+5]



**Figure-1**  
**OR**

- 3.a) Derive the transfer function of the following electrical network  $\frac{V_o(s)}{V_i(s)}$  figure 2.



Figure 2

- b) For a signal flow graph in below figure 3, determine the overall gain by masons gain formula. [5+5]

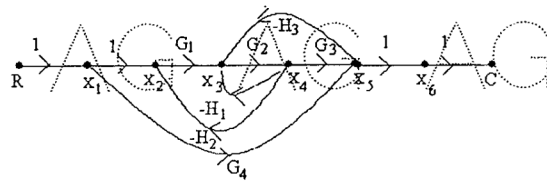


Figure 3

- 4.a) A unity feedback system is characterized by an open-loop transfer function  $G(s) = K/s(s+5)$ . Determine the gain  $K$  so that the system will have a damping ratio of 0.5. For this value of  $K$  determine settling time, peak overshoot and time to peak overshoot for a unit-step input.

- b) The open-loop transfer function of a servo system with unity feedback is  $G(s) = 10/s(0.1s+1)$ . Evaluate the static error constants ( $K_p$ ,  $K_v$ ,  $K_a$ ) for the system. Obtain the steady-state error of the system when subjected to an input given by the polynomial  $r(t) = a_0 + a_1t + a_2t^2/2$ . [5+5]

OR

- 5.a) A unity feedback system has forward transfer function  $G(s) = 20/(s+1)$ . Determine and compare the response of the open and closed loop systems for unit step input. Suppose now that parameter variation occurring during operating conditions causes  $G(s)$  to modify to  $G'(s) = 20/(s+0.4)$ . What will be the effect on unit-step response of open and closed loop systems? Comment upon the sensitivity of the two systems to parameter variations.

- b) The response of a system subjected to a unit step input is  $c(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$ . Obtain the expression for the closed loop transfer function of the system. Also determine the undamped natural frequency and damping ratio of the system. [5+5]

- 6.a) Apply R-H criterion to determine stability of the system with the following characteristic equation  $2s^4 + 10s^3 + 5s^2 + 5s + 10 = 0$ . Find the number roots with positive real parts, if any.

- b) Explain the limitations of Routh's stability criteria. [5+5]

OR

7. Plot the root locus for the system with  $G(s)H(s) = \frac{K(s+1)(s+3)}{s^3}$ . Sketch the root locus and determine the range of  $K$  for which the system is stable. [10]

8. Sketch the Bode plots for a system  $G(s) = \frac{15(s+5)}{s(s^2+16s+100)}$ . Hence determine the stability of the system. [10]

OR

- 9.a) Explain the effect of addition of a pole at the origin on the polar plot of a given system.  
b) Sketch the polar plot and hence find the frequency at which the plot intersects the positive imaginary axis for the system  $G(s) = \frac{0.1}{s(1+s)(1+0.1s)}$ . Also find the corresponding magnitude. [5+5]

- 10.a) Obtain the state variable representation of an armature controlled D.C Servomotor.  
b) Derive the state models for the system described by the differential equation in phase variable form. [5+5]

$$\ddot{y} + 4\dot{y} + 5y + 2\dot{u} = 2\ddot{u} + 6\dot{u} + 5u$$

OR

- 11.a) Obtain the solution of a system whose state model is given by  $\dot{X} = AX(t) + BU(t)$ ;  $X(0) = X_0$  and hence define state Transition matrix.  
b) Obtain the state model of the system shown in below figure 4. [5+5]  
Consider the state variables as  $i_1$ ,  $i_2$  and  $v$ .

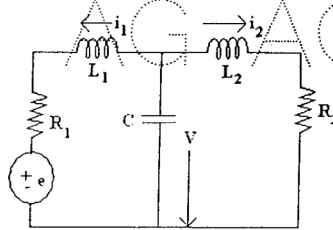


Figure 4

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