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B. E. (Fifth Semester) Examination, Nov.-Dec. 2019

(New Scheme)

(Mechatronics Engg. Branch)

MODERN CONTROL SYSTEMS

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all questions. Part (a) of each question is compulsory and carrying 2 marks and attempt any two parts from (b), (c) and (d) carrying 7 marks each.*

Unit-I

1. (a) Define transfer function. 2

(b) Determine the transfer function relating C and R for the block diagram give below. Use Mason's gain formula. 7

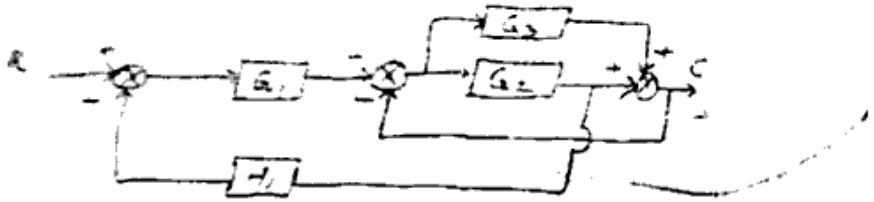
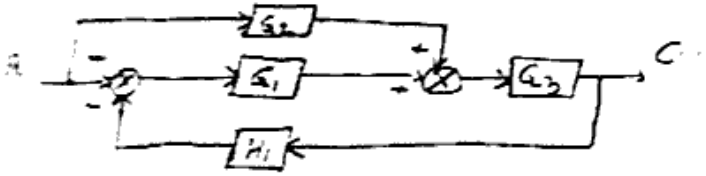


Fig.1

(c) Reduce the block diagram shown in figure into : 7

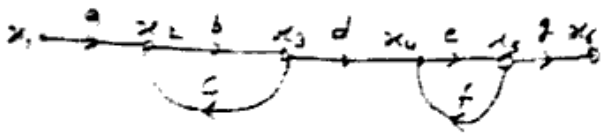
(i) a form having one block in the forwad and one in feedback path

(ii) Single block representation form



(d) (i) Rules for drawing signal flow graphs explain in detail. 7

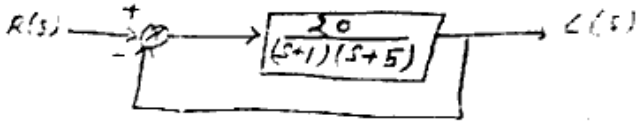
(ii) The signal flow graph shown in figure has two isolated loops and one forward path. Determine the overall transmittance relating x_5 and x_1



Unit-II

2. (a) Define steady state error. How to reduce it? 2

(b) A block diagram of a unity feedback control system is shown below. 7



Determine the characteristics equation of the system, W_n, W_d, t_p, M_p, the time at which the first undershoot occurs, the time period of oscillations and the number of cycles completed before reaching the steady state.

(c) Define Routh-Hurwitz criterion in detail. 7

(d) The open-loop transfer function of a unity feedback control system is given by

$$G(S) = \frac{K}{S(ST_1 + 1)(ST_2 - 1)}$$

Applying Routh-Hurwitz criterion, determine the valve of K in terms of T_1 & T_2 for the system to be stable. 7

Unit-III

3. (a) Define minimum phase and non-minimum phase. 2

(b) Explain root locus in brief. And also solve the given function below for root locus plot 7

$$G(S)H(S) = \frac{KS}{(S+1)}$$

(c) Sketch the Bode plot for the open-loop transfer function for the unity feedback system given below and assess stability. 7

$$G(S) = \frac{50}{(S+1)(S+2)}$$

(d) Draw the root locus plot for a system having open loop transfer function as 7

$$G(S)H(S) = \frac{K}{S(S+1)(S+3)}$$

Unit-IV

4. (a) What is Nquist criterion? 2

(b) Using Nyquist criterion investigate the stability

of a closed loop control system whose open-loop transfer function is given below

$$G(S)H(S) = \frac{K}{S(ST_1 + 1)(ST_2 + 1)}$$

(c) Describe phase-lag compensation in detail. 7

(d) The open loop transfer function of a unity feedback control system is given by

$$G(S) = \frac{K}{S(S+2)}$$

The system is to have 25% maximum overshoot and peak tim is 1·0 second. Determine the value of K and tachometer feedback constant K_t. 7

Unit-V

5. (a) Define state variable and state vector. 2

(b) State and explain what do you understand by controllability and observability of a control system. 7

(c) The transfer function of a system is given by

$$\frac{u(s)}{u(s)} = \frac{s^2 + 3s + 2}{s^3 + 9s^2 + 26s + 24}$$

Determine the state space model. Use direct decomposition method. 7

(d) Verify the controllability. Given that :

$$\dot{x}_1 = x_2 + u_1$$

$$\dot{x}_2 = x_3$$

$$\dot{x}_3 = -2x_2 - 3x_3 + u_1 + u_2$$ 7