

# CBCS SCHEME



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15EC43

**Fourth Semester B.E. Degree Examination, June/July 2019**

## Control Systems

Time: 3 hrs.

Max. Marks: 80

*Note: Answer any FIVE full questions, choosing ONE full question from each module.*

### Module-1

1. a. Define a control system. Explain the difference between open loop and closed loop control system with example for each. (06 Marks)
- b. Determine the transfer function  $X_2(s)/F(s)$  for the mechanical system shown in Fig.Q.1(b) (08 Marks)

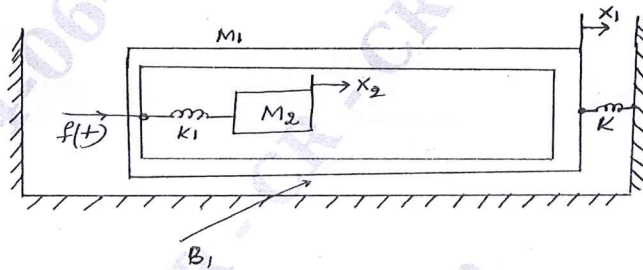


Fig.Q.1(b)

- c. State advantages of the block diagram reduction technique. (02 Marks)

OR

2. a. Explain the block diagram reduction rules. (04 Marks)
- b. Obtain  $C(s)/R(s)$  using block diagram reduction rules for the Fig.Q.2(b). (06 Marks)

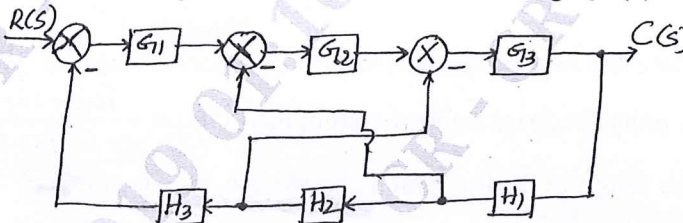


Fig.Q.2(b)

- c. Using Mason's gain formula, find the gain of the system in Fig.Q.2(c). (06 Marks)

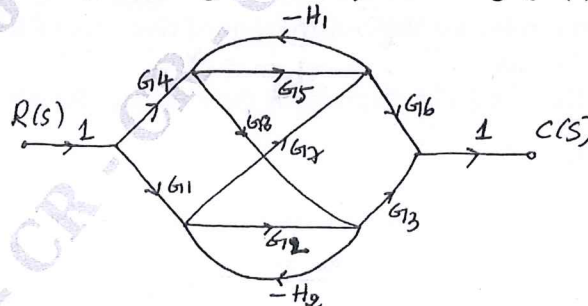


Fig.Q.2(c)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg. 42+8 = 50, will be treated as malpractice.

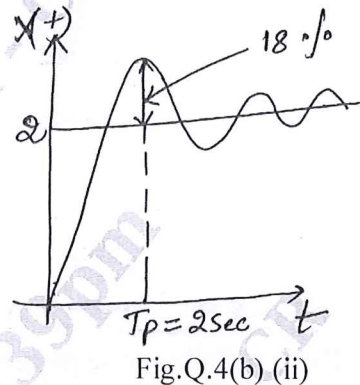
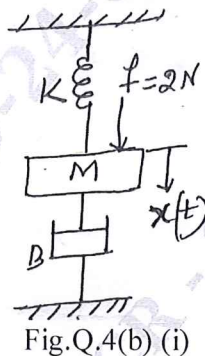
**Module-2**

- 3 a. What are disadvantages of static error coefficient method? (03 Marks)  
 b. Find  $k_p$ ,  $k_v$ ,  $k_a$  and static error for a system with open loop transfer function as:  

$$G(s)H(s) = \frac{10(s+2)(s+3)}{s(s+1)(s+5)(s+4)}$$
 where the input is  $r(t) = 3 + t + t^2$ . (05 Marks)  
 c. Derive the expression of unit step response of a second order system (under damped case). (08 Marks)

**OR**

- 4 a. Derive the expressions for Peak Time ( $T_p$ ), Peak over shoot ( $M_p$ ), Rise Time ( $T_R$ ) and Settling Time ( $T_S$ ). (08 Marks)  
 b. For a spring mass damper shown in Fig.Q.4(b) (i), an experiment was conducted by applying a force of 2 Newton's to the mass. The response  $X(t)$  was recorded using an xy plotter and the experimental result are shown in Fig.Q.4(b) (ii). Find the value of M, K and B. (08 Marks)

**Module-3**

- 5 a. State and explain Routh-Hurwitz criterion of stability. What are limitations? (05 Marks)  
 b. A unity feedback control system has  $G(s) = \frac{K(s+13)}{s(s+3)(s+7)}$ , using Routh's criterion calculate the range of K for which the system is i) stable ii) has its closed loop, poles more negative than -1. (08 Marks)  
 c. Define absolute stability and marginal stability. (03 Marks)

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**OR**

- 6 a. State the rules for the construction of root loci of the characteristic equation of a feedback control system. (04 Marks)  
 b. Draw the root locus diagram for the loop transfer function:  

$$G(s)H(s) = \frac{K}{s(s^2 + 8s + 17)}$$
  
 From the diagram, evaluate the value of K for a system damping ratio of 0.5. (12 Marks)

**Module-4**

- 7 a. Explain the correlation between time and frequency time for second order system. (06 Marks)  
 b. A unity feedback control system has  $G(s) = \frac{80}{s(s+2)(s+20)}$ . Draw the bode plot. (10 Marks)

OR

- 8 a. Distinguish between gain margin and phase margin. (04 Marks)  
 b. Draw the complete Nyquist plot of the system whose loop transfer function is given by  

$$G(s) = \frac{10}{s^2(s + 0.25s)(1 + 0.5s)}$$
 And hence determine system is stable or not. (12 Marks)

**Module-5**

- 9 a. Define state variables and state transition matrix. List the properties of the state transition matrix. (06 Marks)  
 b. For a certain system, when  

$$X(0) = \begin{bmatrix} 1 \\ -3 \end{bmatrix}$$
 then 
$$X(t) = \begin{bmatrix} e^{-3t} \\ -3e^{-3t} \end{bmatrix}$$
 while 
$$X(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$
 then 
$$X(t) = \begin{bmatrix} e^t \\ e^t \end{bmatrix}$$
. Determine the system matrix A. Also find state transition matrix. (10 Marks)

OR

- 10 a. Obtain the state model for the electrical system as shown in the Fig.Q.10(a), choosing the state variables as  $i_1(t)$ ,  $i_2(t)$  and  $v_c(t)$ . (06 Marks)

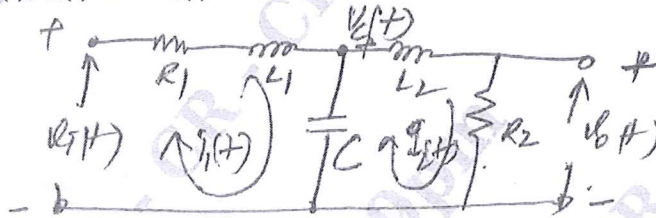


Fig.Q.10(a)

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- b. State and prove sampling theorem for low pass signals. (10 Marks)

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