CBCS Scheme

USN | | | | | | | | | | | **15EC43**

Fourth Semester B.E. Degree Examination, June/July 2018
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. Write the differential equations for the mechanical system shown in Fig.Q1(a) and obtain F-V analogy. **(06 Marks)**

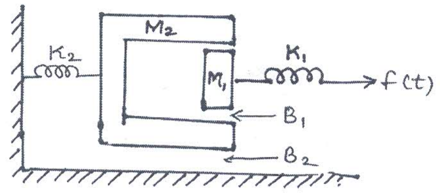

Fig.Q1(a)

b. Differentiate between open loop control system and closed-loop control system. **(06 Marks)**

c. For the rotational system shown in Fig.Q1(c). Draw torque-voltage analogous circuit. **(04 Marks)**

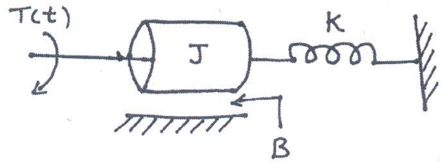

Fig.Q1(c)

OR

2 a. Reduce the following block diagram of the system shown on Fig.Q2(a) into a single equivalent block diagram by block diagram reduction rules. **(06 Marks)**

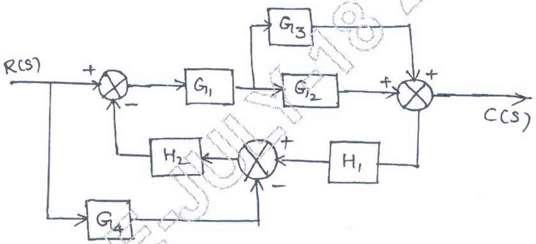

Fig.Q2(a)

b. Find $\frac{C(s)}{R(s)}$ for the following signal flow graph. [Refer Fig.Q2(b)] **(06 Marks)**

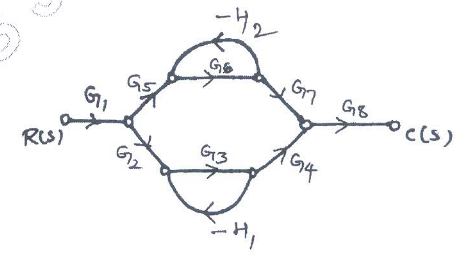

Fig.Q2(b)

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.

c. For the following circuit write the signal flow graph. [Refer Fig.Q2(c)] **(04 Marks)**

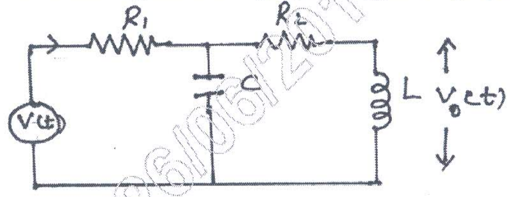

Fig.Q2(c)

Module-2

3 a. For the system shown in Fig.Q3(a). Find the : i) system type ii) static error constants k_p, k_v and k_a and iii) the steady state error for an input r(t) = 3 + 2t. **(06 Marks)**

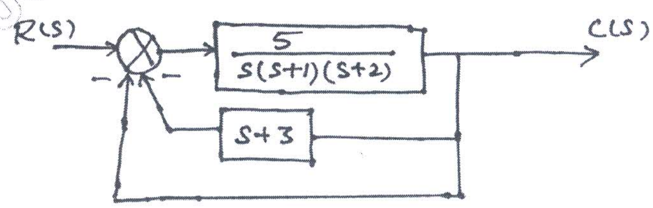

Fig.Q3(a)

b. Find the step-response, C(t) for the system described by $\frac{C(s)}{R(s)} = \frac{4}{S+4}$. Also find the time constant, rise time and settling time. **(05 Marks)**

c. Derive the equation for steady state error of simple closed loop system. **(05 Marks)**

OR

4 a. A second order system is represented by the transfer function.

$$\frac{Q(s)}{I(s)} = \frac{1}{JS^2 + fS + K}$$

A step input of 10 Nm is applied to the system and the test results are :

i) maximum overshoot = 6%
ii) time at peak overshoot = 1sec
iii) the steady state value of the output is 0.5 radian.

Determine the values of J, f and K. **(06 Marks)**

b. A system has 30% overshoot and settling time of 5 seconds for on unit step input. Determine: i) The transfer function ii) peak time 't_p' iii) output response (assume e_{ss} as 2%). **(06 Marks)**

c. Write the general block diagrams of the following :

i) PD type of controller
ii) PI type of controller. **(04 Marks)**

Module-3

5 a. Determine the ranges of 'K' such that the characteristic equation :

$S^3 + 3(K+1)S^2 + (7K+5)S + (4K+7) = 0$ has roots more negative than S = –1. **(06 Marks)**

b. Check the stability of the given characteristic equation using Routh's method.

$S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0$. **(06 Marks)**

c. Mention few limitations of Routh's criterion. **(04 Marks)**

OR

6 a. Sketch the complete root locus of system having, $G(s)H(s) = \dfrac{K}{S(S+1)(S+2)(S+3)}$. **(12 Marks)**

b. Consider the system with $G(S)H(s) = \dfrac{K}{S(S+1)(S+4)}$. Find whether S = –2 point is on root locus or not using angle condition. **(04 Marks)**

Module-4

7 a. The open loop transfer function of a system is $G(s) = \dfrac{K}{s(1+s)(1+0.1s)}$. Determine the values of K such that i) gain margin = 10 dB ii) phase margin = 24°. Use Bode plot. **(10 Marks)**

b. Derive the expression for resonant peak 'M_r' and corresponding resonant frequency 'W_r' for a second–order underdamped system in frequency response analysis. **(06 Marks)**

OR

8 a. Sketch the Nyquist plot for a system with the open-loop transfer function :

$$G(s)H(s) = \frac{k(1+0.5s)(1+s)}{(1+10s)(s-1)}$$

Determine the range of values of 'k' for which the system is stable. **(08 Marks)**

b. Write the polar plot for the following open-loop transfer function :

$$G(S)H(s) = \frac{1}{1+0.1s}.$$ **(04 Marks)**

c. Explain Nyquist stability criteria. **(04 Marks)**

Module-5

9 a. Explain spectrum analysis of sampling process. **(06 Marks)**

b. Explain how zero–order hold is used for signal reconstruction. **(04 Marks)**

c. Find the state–transition matrix for $A = \begin{bmatrix} 0 & -1 \\ +2 & -3 \end{bmatrix}$. **(06 Marks)**

OR

10 a. Obtain an appropriate state model for a system represented by an electric circuit as shown in Fig.Q10(a).

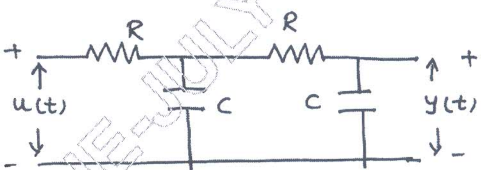

Fig.Q10(a) **(06 Marks)**

b. A linear time invariant system is characterized by the homogeneous state equation :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Compute the solution of homogeneous equation, assume the initial state vector.

$$X_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}.$$ **(06 Marks)**

c. State the properties of state transition matrix. **(04 Marks)**

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