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17EC43

Fourth Semester B.E. Degree Examination, Jan./Feb. 2021
Control Systems

Time: 3 hrs. Max. Marks: 100

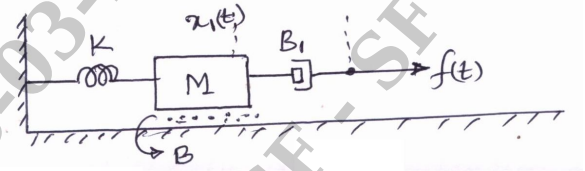
Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Differentiate between Open loop control system and Closed loop control system. **(06 Marks)**

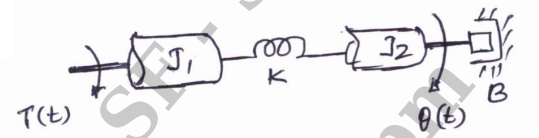
b. For the mechanical system, shown in fig. Q1(b), write the i) Mechanical network ;
ii) Differential equations of performance. **(06 Marks)**

Fig.Q1(b)



c. Obtain the transfer function of the system shown in fig. Q1(c).

Fig.Q1(c)



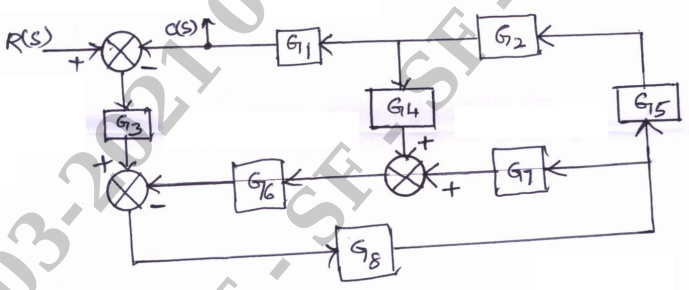
(08 Marks)

OR

2 a. Explain the block diagram rule regarding : i) Combining blocks in cascade
ii) Moving a take off point beyond a block. **(04 Marks)**

b. Determine the transfer function C(s)/R(s) for the block diagram shown in fig. Q2(b), using block diagram reduction techniques.

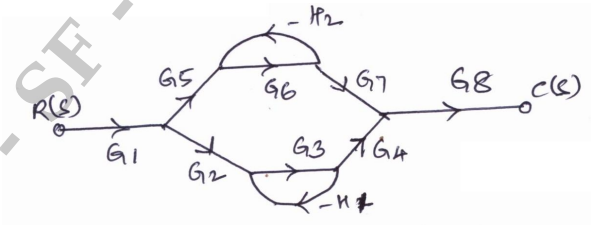
Fig.Q2(b)



(08 Marks)

c. Find $\frac{C(s)}{R(s)}$ for the following signal flow graph of fig. Q2(c).

Fig.Q2(c)



(08 Marks)

Module-2

3 a. With usual notation, derive an expression for the Peak time (t_p) and Rise time (t_r) of a response of second order system to a unit step input. **(06 Marks)**

b. Explain PI and PID controllers of a control system. **(06 Marks)**

c. A second order control system is represented by a transfer function given below :

$\frac{Q(s)}{T(s)} = \frac{1}{Js^2 + Bs + K}$, where Q(s) is the proportional output and T(s) is the input torque.

A step unit of 10N-mt is applied to the system and test results are given below :

i) Maximum overshoot is 6% ii) Peak time is 1 sec iii) Steady static value of the output is 0.5 radian. Determine the values of J , F and K. **(08 Marks)**

OR

4 a. Define Steady state error and Static error coefficients with respect to step input, velocity input and acceleration inputs. **(06 Marks)**

b. For a unity feedback system $G(s) = \frac{s(s+1)}{s^2(s+3)(s+10)}$. Determine the type of system, error coefficients and steady state error for input γ(t) = 1 + 3t. **(06 Marks)**

c. A signal is represented by the equation $\frac{d^2\theta}{dt^2} + 10.\frac{d\theta}{dt} = 150.e$. Where e = (r-θ) is the actuating signal. Calculate the value of damping ratio, undamped and damped frequency of oscillation. Also determine Open loop transfer function. **(08 Marks)**

Module-3

5 a. State R – H criterion and discuss its limitation. **(06 Marks)**

b. State the different rules for the construction Root locus. **(06 Marks)**

c. The open loop transfer function of a unity feedback system is given by

$G(s) = \frac{K}{s(s+3)(s^2+s+1)}$. Determine the value of K that will cause sustained oscillations in the closed loop system. Also find the frequency of sustained oscillations. **(08 Marks)**

OR

6 a. A unity feedback control system has $G(s) = \frac{K}{s(s+2)(s+5)}$. Sketch the root locus and show clearly i) Break away points ii) The frequency at which root locus crosses imaginary axis and corresponding value of K. **(12 Marks)**

b. The open loop transfer function of a unity feedback system is given by

$G(s) = \frac{K(s+1)}{s^3 + as^2 + 2s + 1}$. Determine the value of K and a, so that the system oscillates at a frequency of 2 rad/sec^2. **(08 Marks)**

Module-4

7 a. With figure, define the frequency domain specifications. **(06 Marks)**

b. Construct the Bode plot for a unity feedback control system with

$G(s) = \frac{10(s+10)}{s(s+2)(s+5)}$. Find the Gain margin and Phase margin. Comment on the stability. **(14 Marks)**

OR

8 a. Explain Lag – lead compensating networks. **(06 Marks)**

b. Given $G(s)H(s) = \dfrac{12}{s[s+1][s+2]}$. Draw the Polar plot and hence determine if system is stable? **(06 Marks)**

c. The open loop transfer function of a control system is $G(s)H(s) = \dfrac{1}{s^2(s+2)}$. Sketch the Nyquist plot, Path and asertain the stability. **(08 Marks)**

Module-5

9 a. What is Signal Reconstruction? Explain it with SAMPLE and HOLD circuit. **(06 Marks)**

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

c. Consider the system given by $\ddot{y} + 9\ddot{y} + 26\dot{y} + 24y = 6U$. Obtain its state model. **(08 Marks)**

OR

10 a. List the properties of State transition matrix. **(06 Marks)**

b. Explain Spectrum analysis of Sampling process. **(06 Marks)**

c. Obtain the transition matrix Q(t) of the following system

$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$. Also obtain the inverse of the transition matrix $\phi^i(t)$. **(08 Marks)**

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