Ref: PE/T/315/2019

Jadavpur University

B.PowerEngg. 3rd Year First Semester 2019

Control Systems

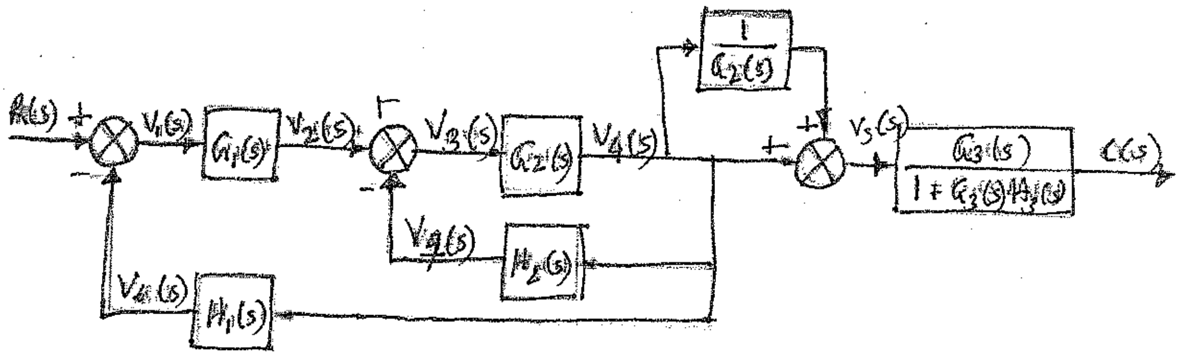
Full Marks :100

Time: 3 hrs

Answer **five** questions with any **two from Group A** and any **three from Group B**

Group A

1. Using Block Diagram Reduction deduce the transfer function $\frac{C(s)}{R(s)}$ for the system shown below



Draw the corresponding Signal Flow Graph and validate the result obtained by Block Diagram Reduction using Mason's Gain Formula.**10+10**

2. Consider a D.C. motor with a constant field flux. If the motor speed ω is controlled by varying the armature input voltage V_a and the load torque is T_L develop the state-variable representation of the motor with relevant assumptions of state variables and motor parameters. Calculate the transfer matrix of the system. **15+5**

3. Derive the Laplace Transform of a unit impulse at $t = 0$. Hence deduce the Laplace Transform of a train of unit impulses with an interval T. **. 6+4**

   Define duty cycle of a pulse train. A pulse train of period 2 secs.and duty cycle 0.25 is applied to a first order system $G(s) = \frac{5}{(0.2s+1)}$. If the pulse amplitude is 2V, deduce the output of the system.

   10

4. Consider a First Order plus Time Delay System $G(s) = \frac{10e^{-0.6s}}{(2s+1)}$. Express the system as its First Order Pade Approximation.

   6

Show that the maximum overshoot due to a step input applied to a standard second order system $G(s)=\dfrac{\omega_n^2}{s^2+2\xi\omega_n s+\omega_n^2}$ depends on its damping ξ only. **14**

Group B

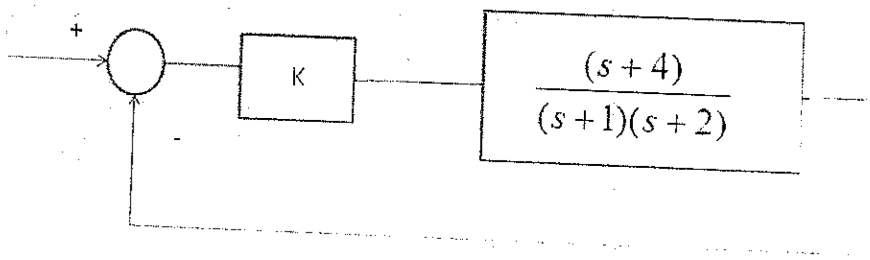
5. Using R-H stability criterion calculate the value of K for which the system with characteristic equation $s^6+s^5-2s^4-3s^3-7s^2-4s-K=0$ has imaginary roots? Find the range of K such that all roots of the system have real parts less than -1. **10+10**

6. Deduce the stability of the unity feedback closed loop system with $G(s)H(s)=\dfrac{5}{s^2(2s+1)}$ using Nyquist stability criterion. **20**

7. Draw the asymptotic Bode Plots for the system defined by $G(s)H(s)=\dfrac{100}{s(0.1s+1)(0.5s+1)}$

   Calculate (i) the Gain Cross Over Frequency (ii) the Phase Cross Over Frequency (iii) the Gain Margin (iv) the Phase Margin and (v) the Delay Margin using the plots.

8. For the system shown below



Draw the root locus diagram for $K \geq 0$.
Compute the following
(i) Angle of the asymptotes
(ii) Breakaway/ Break-in points
(iii) Value of K at breakaway/break in points
(iv) The Maximum value of K for the closed-loop system to be stable **8+12**