

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM 695 547

B.Tech (Electronics and Communication Engg)-Quiz 1, February 2023

AV224 – Control Systems
(Answer all questions)

Time: 1 Hour

Date: 14/02/2023

Max. Marks: 50

1. Draw the block schematic of typical closed loop control system and briefly explain the functions of each block. **(6 marks)**
2. Find the overall transfer function $C(s)/R(s)$ of the following block diagram. Use only the standard block diagram reduction rules for simplification.

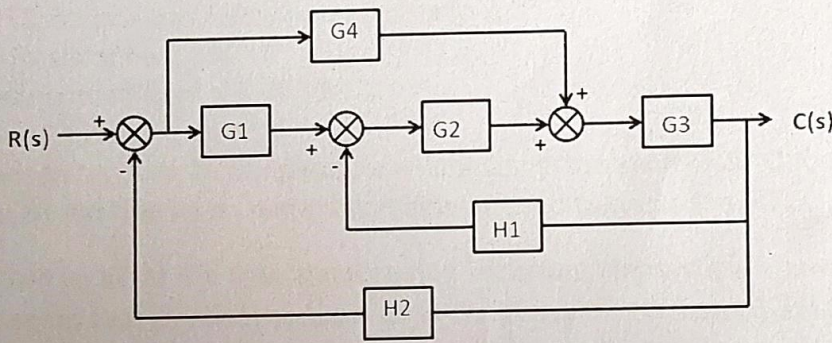


Figure 1: Block diagram for simplification

(6 marks)

3. (a) Derive the expression for the unit step response of a standard second order transfer function given below:

$$G(s) = \frac{\omega_n^2}{(s^2 + 2\zeta\omega_n s + \omega_n^2)} \quad \text{for} \quad 0 < \zeta < 1$$

Draw the step response for under damped case and mark the upper and lower bounds with their respective expressions.

- (b) Derive the expressions for the peak time (t_p) and peak overshoot (M_{peak}) in the above response.

(12+7 marks)

4. (a) Derive the transfer function, $G(s) = \frac{\theta_L}{E_a}(s)$ for an actuator driven by an armature controlled DC torque motor with standard parameters K_T, K_b, R_a and a gear ratio $N = \frac{N_L}{N_m}$ where N_L and N_m represent the number of gear teeth on load side and motor side respectively and θ_L is the load shaft deflection and E_a is the voltage applied across the armature windings. The mechanical dynamics to be considered are J_m and B_m on motor side and J_L on load side. Neglect the inductive effect of armature winding.
- (b) Design a suitable closed loop control system to achieve a closed loop transfer function with parameters (ω_n, ζ).

(12 + 7 marks)