भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

Indian Institute of Technology Hyderabad

Department of Electrical Engineering

EE1220 – Basic Control Theory

Assignment 02

Submission Deadline: None

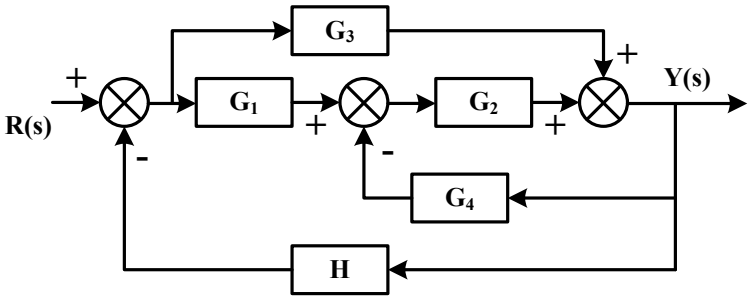
Key Learning from the Assignment:

- Block Diagram Reduction
- Time Response Analysis

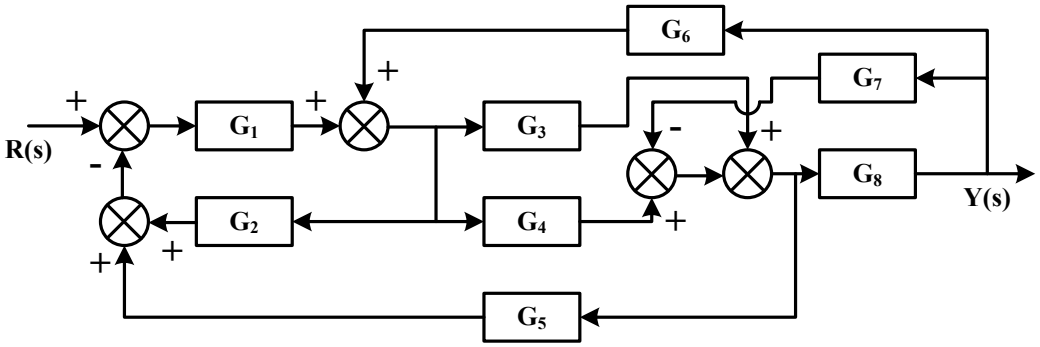
Instructions: RN = last two digits of your roll number.

You need to show all steps for block diagram reduction.

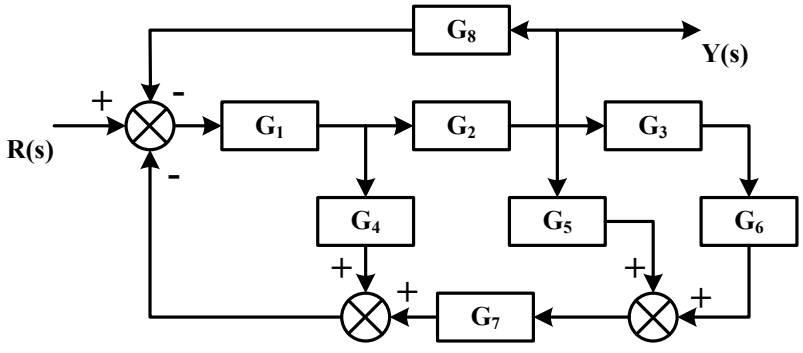
1. For the system shown below find transfer function using block diagram reduction technique.



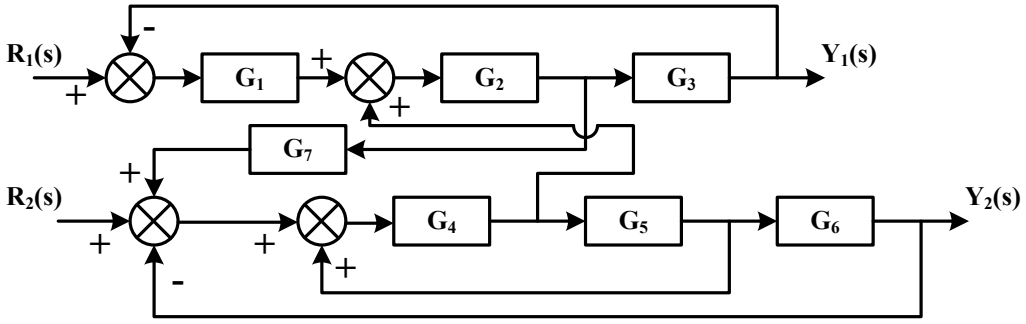
2. For the system shown below find transfer function using block diagram reduction technique.



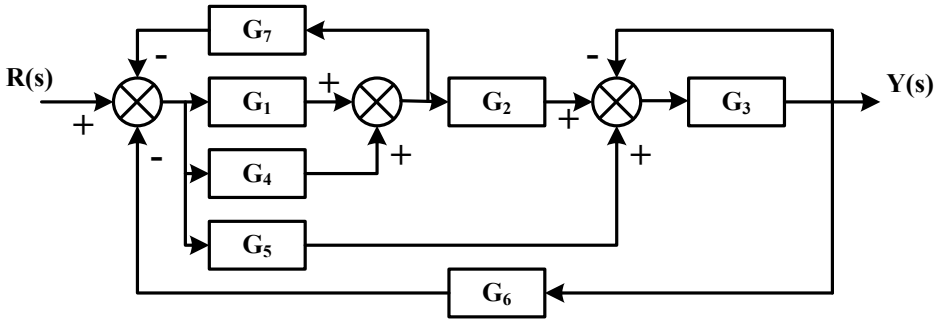
3. For the system shown below find transfer function using block diagram reduction technique.



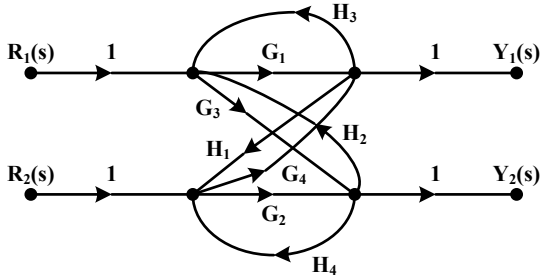
4. For the system shown below find transfer function using block diagram reduction technique.



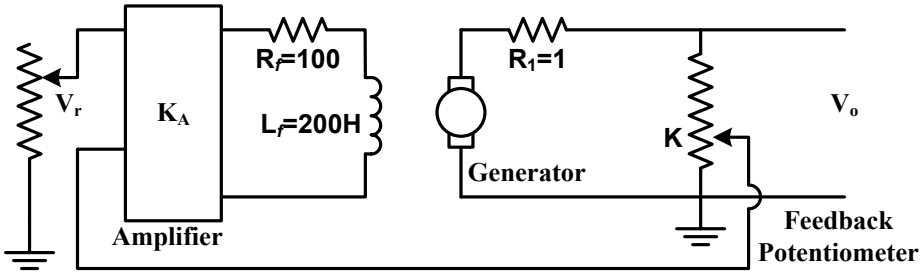
5. For the system shown below find transfer function using block diagram reduction technique.



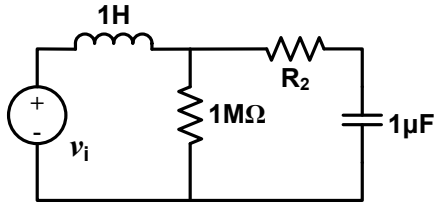
6. Convert the block diagrams given in Q. 1 through Q. 5 into equivalent signal flow graph. Find transfer functions using Mason's gain formula.
7. For the system shown below find all possible transfer functions.



8. A simple voltage regulator is shown in figure below. A potentiometer is used as the output terminals of the generator to give a feedback voltage KV_o where K is constant. The potentiometer resistance is high enough that it may be assumed to draw negligible current. The amplifier has a gain of 20 Volts/volt. The generator gain is 50 volts/amps (field current). Reference voltage V_r is 50 V.
   a. Draw block diagram of the system when generator is supplying current.
   b. Determine the value of K in order to give a steady no-load generator terminal voltage of 250 V. What is the change in terminal voltage caused by a steady load current of 30 A? What reference voltage would be required to restore the generator terminal voltage of 250 V?
   c. Determine the reference voltage needed to obtain a steady no-load voltage of 250 V for open-loop system. What would be the change in terminal voltage for a load of 30 A?
   d. Discuss effect of feedback in terms of sensitivity with respect to K_A and K, changes in terminal voltage due to load current for open loop and closed loop system.



9. For a standard second order system whose dynamics are underdamped, derive expressions for rise time, peak time, maximum peak overshoot and settling time.
10. Determine transfer function of the system G(s), if unity feedback system's settling time is 1 s and peak overshoot is 40%. Use exact equation for settling time.
    a. Determine where the poles of the system G(s) must lie (show neatly on a graph paper) if following constraints are given: 40% < MP < 15% and 0.75 s < t_s < 1 s (you can use approximations for settling time equation for this part).
11. For a closed loop system with negative feedback, G(s) = K/(s(τs+1)) and H(s) = 1. The constants K and τ are positive real numbers. By what factor should the gain K be changed so that the peak overshoot of unit step response is reduced from 75% to 25%.
12. For a series RLC circuit, when a step change is made to supply voltage $v_i(t)$, find values of R and C to yield 20% peak overshoot and 1 ms settling time for $v_c(t)$, if L = 1 H.
13. For the circuit shown below, find the values of R_2 and C to yield 15% maximum overshoot with a settling time of 1 ms for $v_c(t)$, with $v_i(t)$ being a step input.



14. A spring (spring constant k = 2 N/m) and a damper (damping coefficient f_v) are connected in parallel. Find an equation that relates 2% settling time to the value of f_v for the translational system. (Hint: Consider external force F acting on the system.)