SESA3030 AERO CONTROL SYSTEMS

ASSESSED ASSIGNMENT 1

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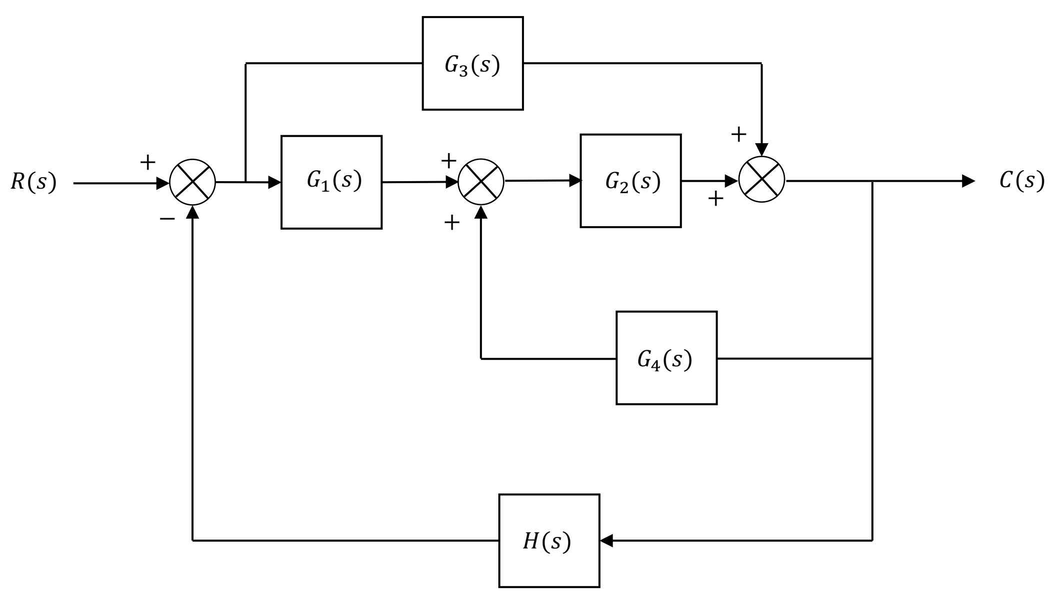
The assignment should be completed and submitted as a single pdf file through the link `Assignments -> Assessed Assignment 1` on Blackboard by **23:00 November 9th 2023**. To produce a pdf file for submission, you can for example take photos of your solutions and combine them into a single pdf file using Adobe tools on Windows, or Preview on Mac OS.

Please show a sufficient number of steps to your solutions for each problem. No credit will be given to correct answers by themselves.

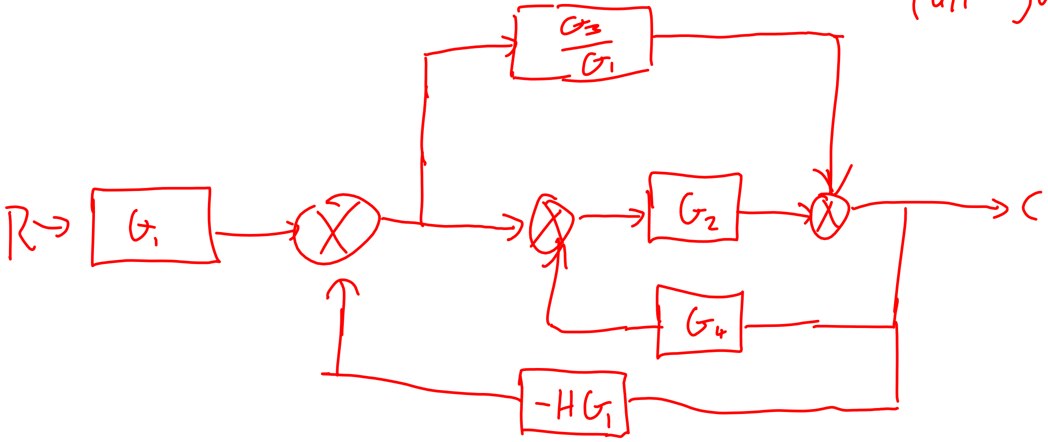
Late submission policy. The total mark for this assignment is 20 (6.67% of the overall module mark). The late submission penalty is **2 marks per day late** (0 total mark after 10 days).

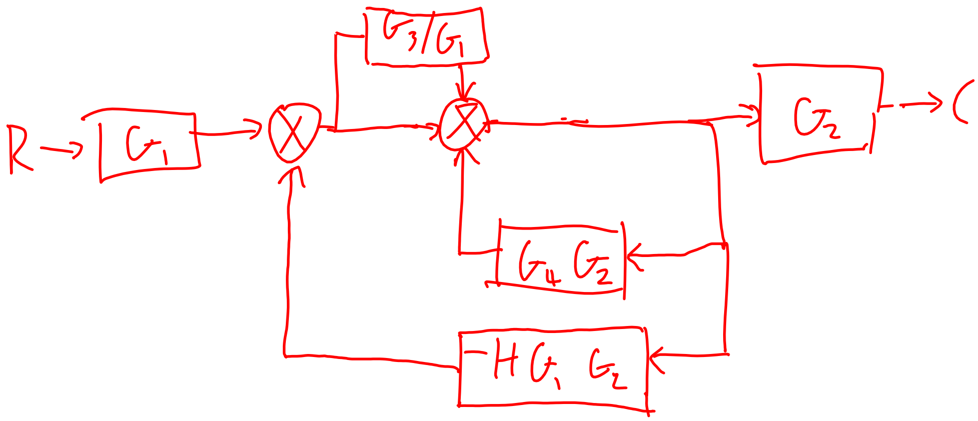
Work should be attempted on an individual basis.

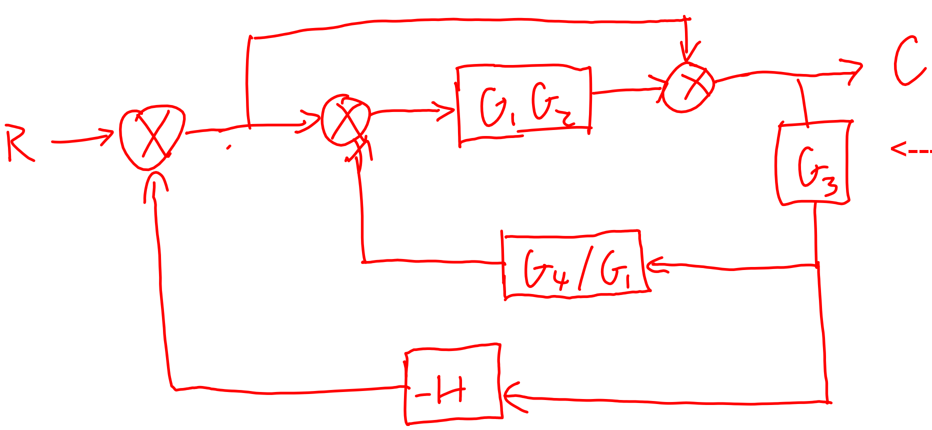
1. Use the block diagram reduction techniques to simplify the following block diagram to a single transfer function. Note: block manipulation must be used to solve this question, the alternative purely algebraic approach will not be accepted as a solution. [**6 Marks**]:



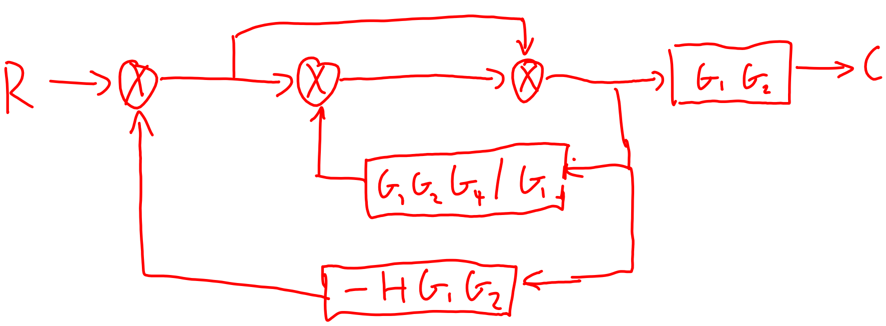
(all junctions positive)

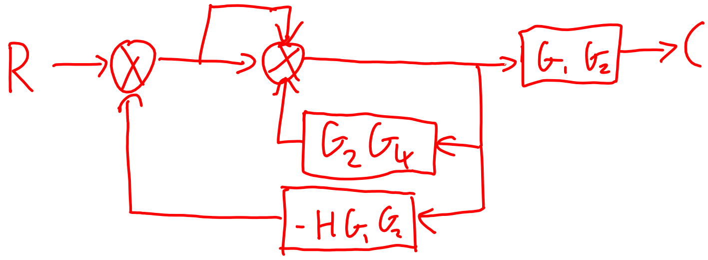


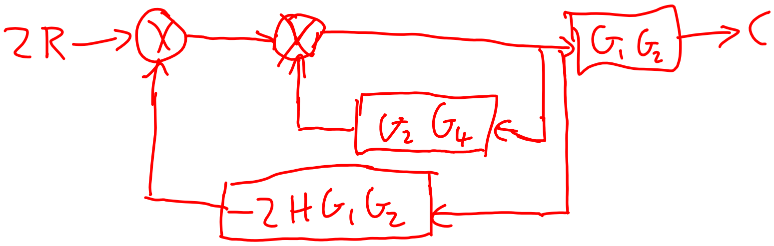


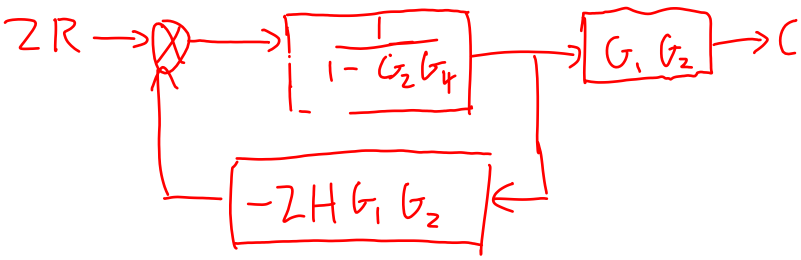


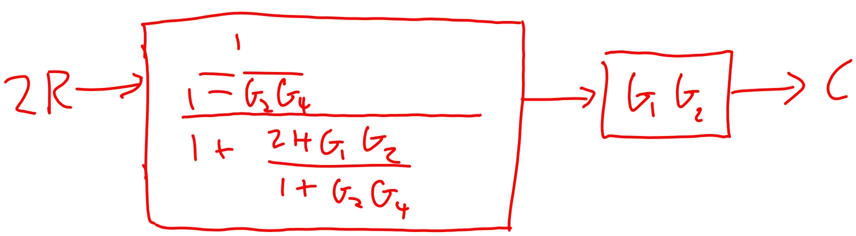
<-- G_3 bad do again!

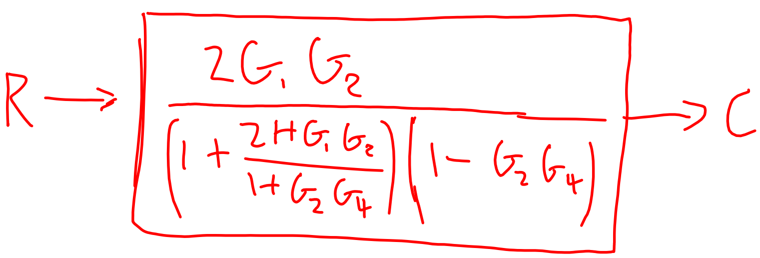



R
$G_1 G_2$
C
$G_2 G_4$
$-HG_1G_2$

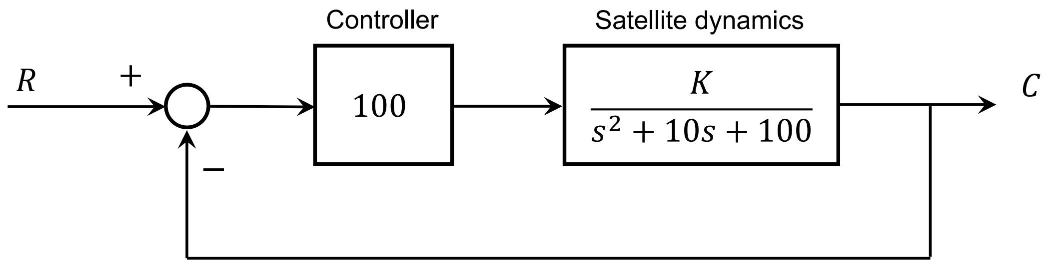

2R
$G_1 G_2$
C
$G_2 G_4$
$-2HG_1G_2$


2R
$\frac{1}{1-G_2G_4}$
$G_1 G_2$
C
$-2HG_1G_2$


2R
$\dfrac{\frac{1}{1-G_2G_4}}{1+\frac{2HG_1G_2}{1+G_2G_4}}$
$G_1 G_2$
C


R
$\dfrac{2G_1G_2}{\left(1+\frac{2HG_1G_2}{1+G_2G_4}\right)\left(1-G_2G_4\right)}$
C

2. The figure below shows a block diagram of a satellite's orientation system.



When a step input is applied to the system input and the gain is $K = 3$, based on the closed-loop transfer function find:

(a) damping factor and natural frequency of the overall system,

(b) loop gain,

(c) settling time,

(d) overshoot,

(e) peak time,

(f) draw or plot the time response as accurately as possible,

(g) sketch the location of the poles in the s-plane (include numerical values of the poles including the phase angle ϕ in the plot).

[**8 Marks**]

3. Linearise the ordinary differential equation:

$$\frac{d^3x}{dt^3} + \frac{dx}{dt} + 4x^2 = \exp(-2t^3)$$

around the steady state equilibrium operating point $t = t_e$, $x = x_e$, where t_e and x_e are constants, such that the resulting equation is linear in both t and x variables.

[**6 Marks**]

2)

$$R \rightarrow \boxed{\dfrac{\dfrac{100k}{s^2+10s+100}}{1+\dfrac{100k}{s^2+10s+100}}} \rightarrow C$$

$$R \rightarrow \boxed{\dfrac{1}{\dfrac{s^2+10s+100}{100k}+1}} \rightarrow C$$

$$R \rightarrow \boxed{\dfrac{100k}{s^2+10s+100(1+k)}} \rightarrow C$$

let $k=3$

$$R \rightarrow \boxed{\dfrac{300}{s^2+10s+400}} \rightarrow C$$