UNIVERSITY OF
LINCOLN
UNITED KINGDOM

College of Science

School of Engineering

Time Constrained Assessment

Module Title	**Control Systems**
Module Code	**EGR2006M**
Module Coordinator	**Dr. Mithun Poozhiyil and Manu H. Nair**
Duration of Assessment	**4.5 hours**
Date	**16/06/2022**
Release Time	**13:30**
Submission Time	**18:00**

General Instructions to Candidates.

1. You **must** submit your answers to TurnItIn on Blackboard **before** the submission time: failure to do so will be classified as misconduct in examinations. We strongly recommend you submit 15 minutes prior to the deadline.
2. You **must** also send a copy of your work to: soesubmissions@lincoln.ac.uk at the same time. You must place the Module Code and your Student Id in the Subject Field of the Mail.
3. For students who choose to word process their answers, hand-written notes or diagrams, **must** be photographed (preferably using Microsoft Lens which is available as part of your Office 365 package) and inserted into the Word Document as an image.
4. This assessment is an open resource format: you may use online resources, lecture and seminar notes, textbooks and journals.
5. All work will be subject to plagiarism and academic integrity checks. In submitting your assessment, you are claiming that it is your own original work; if standard checks suggest otherwise, Academic Misconduct Regulations will be applied.
6. The duration of the Time Constrained Assessment will vary for those students with Learning Support Plans (LSPs). Extensions do not apply, but Extenuating Circumstances can be applied for in the normal way.

Module Specific Instructions to Candidates

1. Answer All Questions
2. All questions carry EQUAL marks (25)

Question One:

1. **1.** Derive the transfer function of the whole system shown in Figure 1. **(10 points)**
2. **2.** What is the order of **(5 points)**
   2.1. Each sub-system in the dotted boxes?
   2.2. The whole system?
3. **3.** Calculate the steady-state error of the whole system for a unit step input. **(10 points)**

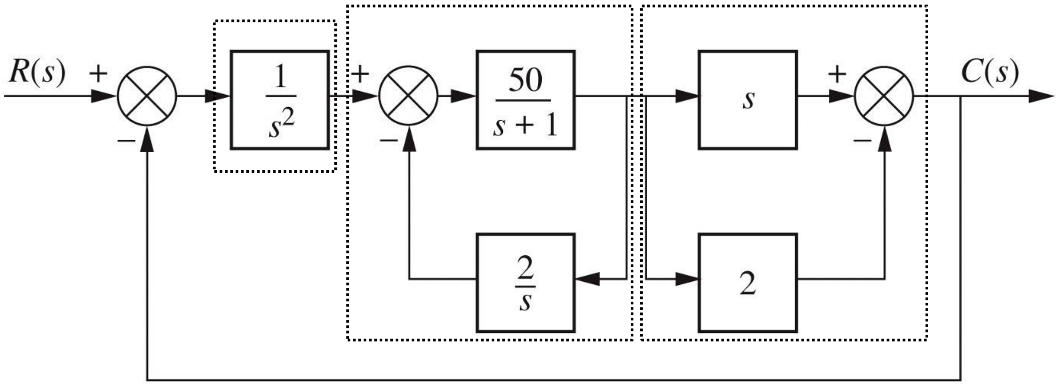

Fig. 1

Question Two:

For the following system shown in Figure 2,

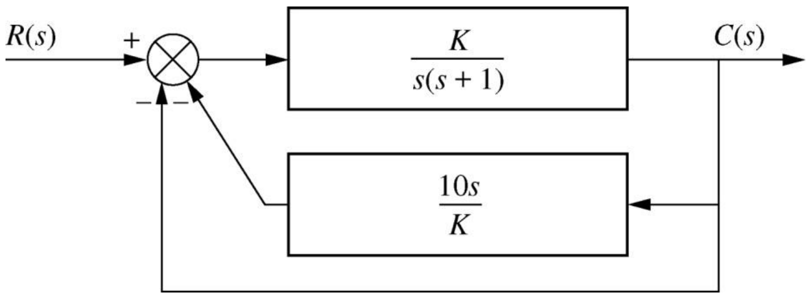

Fig. 2

- **a.** Find the system transfer function. **(5 points)**
- **b.** Design the value of K so that for an input 100tu(t), there will be a 1% steady-state error. **(7 points)**
- **c.** Does the calculated value for K meets the criteria for stability? **(6 points)**
- **d.** Find the steady-state error in terms of K for the following inputs: $100r(t)$, $100t^2r(t)$ where r(t) is a step input and comment on the results. **(7 points)**

Question Three: (25 points)

It is desired to develop a policy for drug delivery to maintain the virus count at prescribed levels. For the purpose of obtaining an appropriate $u_{1,}$ the feedback shown in Figure 3 will be used. As a first approach, consider $G(s) = K,$ a constant to be selected. Use the Routh – Hurwitz criterion to find the range of the gain K to keep the closed loop system stable. The HIV (AIDS) linearized model can be shown to have the following transfer function:

$$P(s) = \frac{-520s - 10.3844}{s^3 + 2.6817s^2 + 0.11s + 0.0126}$$

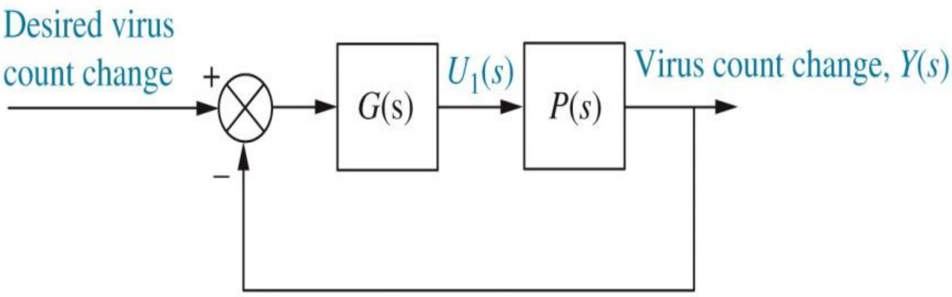

Fig. 3

<u>Question Four</u>:

For the system shown in Figure 4,

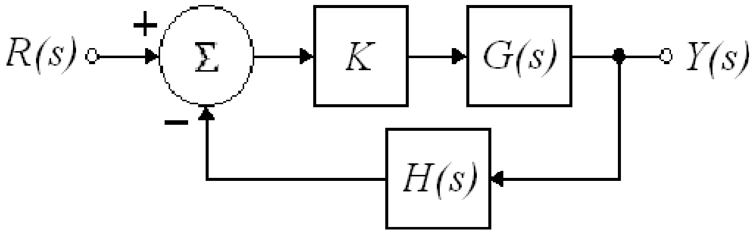

Fig. 4

The function $G(s)H(s)$ is given as:

$$G(s)H(s) = \frac{(S+4)(S+3)}{(S+1)(S+2)}$$

a. Sketch the root locus of the closed-loop system **(10 points)**
b. State all root locus rules you used in solving this problem. **(5 points)**
c. What is the value for the control gain K that keeps the system stable? **(10 points)**