THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

MECHANICAL ENGINEERING

FIRST SEMESTER EXAMINATION - 2023

Control Engineering ME 412
June 5th, 2023

MAXIMUM MARKS: 40

TIME ALLOWED: 2 HOURS

INSTRUCTIONS FOR CANDIDATES:

1. You have 10 minutes to read the paper. You must not begin writing during this time.
2. Answer all the **FOUR** questions. Marks or each part of the questions are indicated in the bracket.
3. Use only ink. Do not use pencil or writing except or drawing and sketches.
4. All answers must be written in the answer book provided. No other written material will be accepted.
5. Write your **name** and **ID number** clearly on the front page of the answer booklet provided. **Do it now!**
6. Use of Calculator in the exam room is permitted. Notes, digital phones and textbooks are not allowed. Required property values are provided in the question paper.

Question 1. Write down and discuss the Laplace Transform for the following functions:

1.1. Exponential Function **3 Marks**
1.2. Step Function **2 Marks**
1.3. Ramp Function **2 Marks**
1.3. Impulse Function **3 Marks**

Question 2. Find the inverse Laplace transform of: the following complex functions:

2.1. $F(s)=\dfrac{s^3+3s^2+7s+5}{s^2+2s-3}$. Use the attached Laplace Transform Table. Hint:

The Laplace transform of $\dfrac{d\delta(t)}{dt}$ is s. **5 Marks**

f(t)	F(s)
1	$\frac{1}{s}$
δ	1
$\delta^{(k)}$	s^k
t	$\frac{1}{s^2}$
$\frac{t^k}{k!},\ k \geq 0$	$\frac{1}{s^{k+1}}$
e^{at}	$\frac{1}{s-a}$
$\cos \omega t$	$\frac{s}{s^2+\omega^2} = \frac{1/2}{s-j\omega} + \frac{1/2}{s+j\omega}$
$\sin \omega t$	$\frac{\omega}{s^2+\omega^2} = \frac{1/2j}{s-j\omega} - \frac{1/2j}{s+j\omega}$

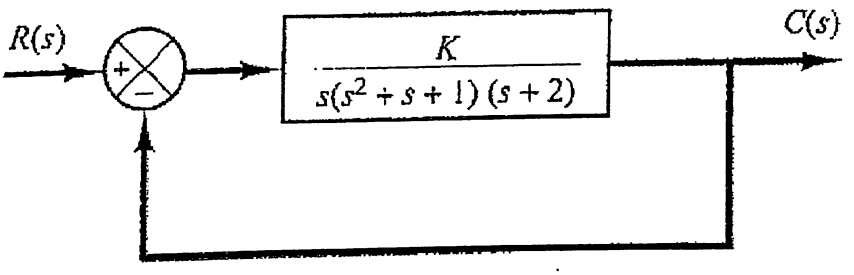
2.2. $F(s)=\dfrac{s^2+2s+3}{(s+1)^3}$ **5 Marks**

Question 3. Discuss the following topics related to First Order Systems based on their specific block diagrams:

3.1. Draw the complete and simplified block diagrams and discuss Unit-Step Response of First Order Systems **5 Marks**

3.2. Draw the complete and simplified block diagrams and discuss Unit Impulse Response of First Order Systems **5 Marks**

Question 4. Consider the system shown below. Determine the range of parameter K for stability using Routh's Criterion. **10 Marks**



Hints:

$$\frac{C(s)}{R(s)} = \frac{b_0 s^m + b_1 s^{m-1} + \ldots + b_{m-1} s + b_m}{a_0 s^n + a_1 s^{n-1} + \ldots + a_{n-1} s + a_n} = \frac{B(s)}{A(s)}$$

$$b_1 = \frac{a_1 a_2 - a_0 a_3}{a_1},\ b_2 = \frac{a_1 a_4 - a_0 a_5}{a_1},\ \frac{b_1 a_3 - a_1 b_2}{b_1},\ c_2 = \frac{b_1 a_5 - a_1 b_3}{b_1},\ d_1 = \frac{c_1 b_2 - b_1 c_2}{c_1}.$$

Marking Criteria:

Criterion Weighting	Exemplary, 85%-100%	Highly Accomplished , 75%-84%	Accomplished 65%-74%,	Satisfactory 50%-64%	Unsatisfac tory, <50%	Marks Awarded
Structure, Effective and Inclusive Language, Grammar, Spelling, Punctuation, Style. 20						
Clear and Complete Definitions, 20						
Correctness of Solutions with Diagrams and Demonstrations, 40						
Discussions and Conclusions, 20						