Philadelphia University
Faculty of Engineering and Technology

Student Name: **Student Number:**

Final Exam, First Semester: 2019/2020
Mechatronics Engineering Department

Course Title: Digital Control	**Date:** 26/01/2020
Course No: 0640441	**Time:** 2 hours
Lecturer: Dr. Jasim Ghaeb	No. of pages: 5

Question 1: ***(7 marks)***

The transfer function of an open-loop control system is given below:

$$G(s)= \frac{2(1- e^{-5s})}{s(s + 2)}$$

Derive the z-transfer function of the system G(z). Assume T=1 sec.

Question 2: ***(9 marks)***

A-) The full- scale reference voltage of a 4-bit A/D is 15 V. The analog number comes between two digital levels is truncated to a digital level. Determine:
a-) the maximum quantization error. (e_{qmax}).
b-) the maximum analog input signal to A/D without exceeding the quantization error.

B-) Find the f(k) sequence at k= 0, 1, 2 and 3 for:

$$F(z) = \frac{z}{z^2 - 0.5z - 0.5}$$

Question 3: ***(7 marks)***

The characteristic equation of the unity f.b system is given below. Use Routh-Hurwitz Criterion to determine the range of (k) for system stability.

$(8.4 + 0.525k)W^2 + (111.846 – 0.3684k)W + 199 - 0.09013k=0$

Question 4: ***(7 marks)***

Use Jury stability test to determine the stability of the digital control system of characteristic equation given below:

$$Q(z) = z^2 - 0.14 = 0$$

Question 5: ***(10 marks)***

A closed-loop system of loop-transfer function of: $GH(z) = \dfrac{0.632k\ z}{(z-1)(z-0.368)}$

The Nyquist plot of GH(z) is shown in Fig.1, which intersects the negative real axis at $z = -0.231k$.

1-) Use Nyquist stability criterion to:

a-) determine the maximum value of (k) to keep the system stable.

b-) determine the z_{-1} for unstable system.

c-) determine the range of (k) for system stability.

2-) If the critical point is taken at (1, j0), what is the value of the angle-traversed for system stability?

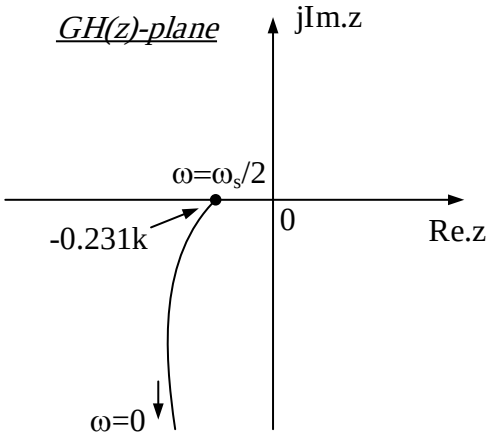

Figure 1