NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF TECHNICAL AND ENGINEERING EDUCATION AND TRAINING

INSTRUMENTATION AND CONTROL II

PTE 4252

Second Semester Main Examination Paper

May 2019

This examination paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Semi-log paper, graph paper & Laplace Transforms tables

Examiner's Name: Eng G Kanyemba

INSTRUCTIONS AND INFORMATION TO CANDIDATE

1. This question paper contains six (6) questions
2. Answer any four (4) questions.
3. Each question carries 25 marks.
4. Use of calculators is permissible.

Question 1

(a) What is a transfer function of a system? [1]

(b) To what sort of systems do transfer functions apply? [2]

(c) With the use of clearly labelled diagrams and examples of appropriate application areas, distinguish between open loop control and closed loop control system. [10]

(d) Using standard block diagram reduction techniques derive the overall transfer function for the system represented by the block diagram in Figure Q1. [6]

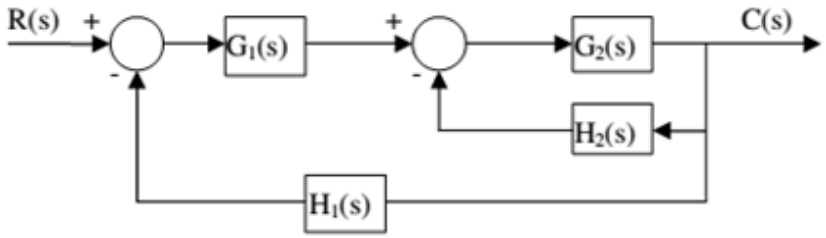

Figure Q1: Block diagram

(e) For the system shown in Figure Q1, given that $G_1(s) = \frac{1}{s+2}$, $G_2(s) = \frac{3}{s+1}$ and $H_1(s) = H_2(s) = 1$. Find $\frac{C(s)}{R(s)}$. [6]

Question 2

(a) State the following theorems

(i) Initial Value Theorem, [2]

(ii) Final Value Theorem. [2]

(b) Use Final Value Theorem to determine the steady state value of the following casual time signal : $F(s) = \frac{s^2+2s+4}{s^3+3s^2+2s}$ [5]

(c) State and explain the two methods of developing a system model. [8]

(d) For the electrical circuit shown in Figure Q2, find the differential equation relating $V_1(t)$ and $V_2(t)$. [8]

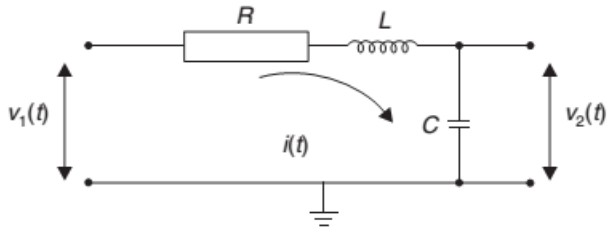

Figure Q2: RLC circuit.

Question 3

A PLC has five basic components.

(a) Show using a block diagram how these functional elements are interconnected. [5]

(b) Describe in detail the function of each component. [20]

Question 4

(a) Explain the root locus controller design method. [5]

(b) A system has an open-loop transfer function of

$$G(s)H(s) = \frac{K}{s(s+2)(s+6)}$$

(i) Determine the poles and zeros. [2]

(ii) Determine the asymptote directions. [4]

(iii) Determine the centroid. [4]

(iv) Plot the root locus diagram. [8]

(v) Comment on the stability of the system. [2]

Question 5

(a) State and explain the Routh Hurwitz stability criterion. [6]

(b) The block diagram of a closed loop control system is given in Figure Q5

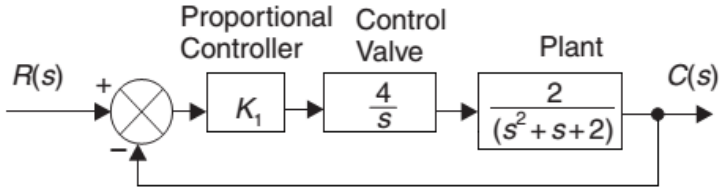

Figure Q5: Close loop control system

(i) Determine the closed loop transfer function of the system. [5]

(ii) Derive the characteristic equation of the transfer function. [2]

(iii) Use the Routh Hurwitz stability criterion to find the value of the proportional gain controller to make the system just unstable. [12]

Question 6

(a) Construct the bode diagram the system whose transfer function G(*s*) is given as

$$G(s) = \frac{15000}{(s+5)(s+10)(s+200)}$$

[12]

(b) On the plot show clearly

(i) The gain crossover frequency [2]

(ii) The gain margin [2]

(iii) The phase crossover frequency [2]

(iv) The phase margin [2]

(v) Determine from the plot if the system is stable [1]

(c) Write the Matlab commands required to produce the bode plot of the system. [4]

End of examination paper.