TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

Department of Electrical and Electronic Engineering

UNIVERSITY EXAMINATION FOR:

Diploma of Technology in Electrical Engineering (Instrumentation and Control)

Diploma of Technology in Electrical Engineering (Power)

ECI 2205: CONTROL SYSTEMS I

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: SEPTEMBER 2018

TIME: 2 HOURS

DATE: Sep 2018

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** Questions; Question ONE is compulsory. In addition attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory 20 marks)

(a) Identify a possible input and a possible output for a rotational generator of electricity. (2 marks)

(b) Explain how a n open loop automatic washing machine operates. (4 marks)

(c) Devise a simple control system which automatically turns on a room lamp at dusk and turns off in day light. (4 marks)

(d) Figure Q 1(d) is a block diagram representing a complex control system. Obtain the transfer function $\frac{Y(s)}{R(s)}$ using rules for transformation of block diagrams.

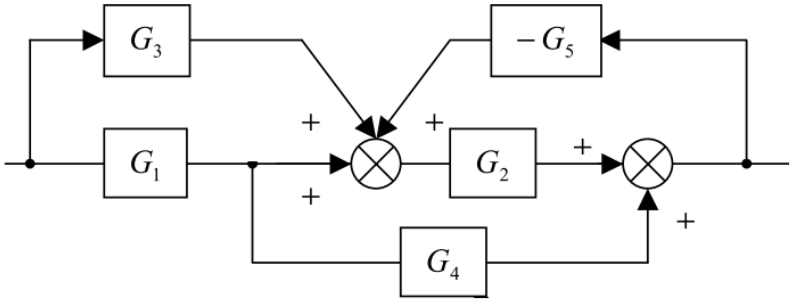

Figure Q 1(d)

(10 marks)

Question TWO

(a) With the aid of a canonical block diagram of a closed-loop system, derive:-

i) The closed-loop transfer function

ii) The error ratio

iii) The primary feedback ratio

(9 marks)

(b) For the block diagram of figure Q2 (b) determine the closed loop transfer function using Mason's gain formula.

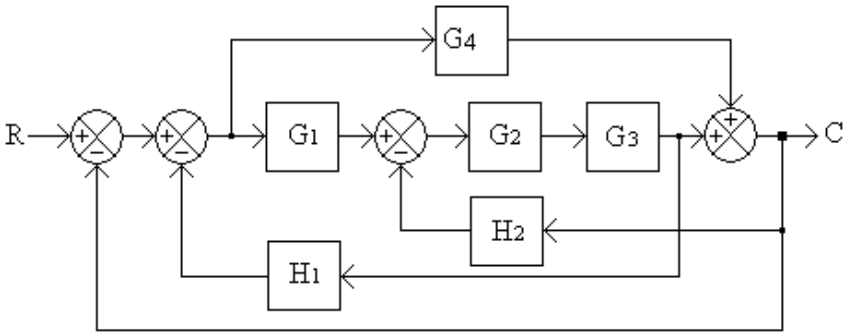

Figure Q2 (b) (11 marks)

Question THREE

(a) State the electrical equivalents of the following mechanical quantities in the Force-voltage analogy

i) Displacement

ii) Spring stiffness

(2 marks)

(b) Figure Q3 (b) shows a mechanical vibratory system when a force of 8.9N is applied to the system, the mass oscillates as shown in its time response. Determine the values of the constants M, F and K of the system from this response. (10marks)

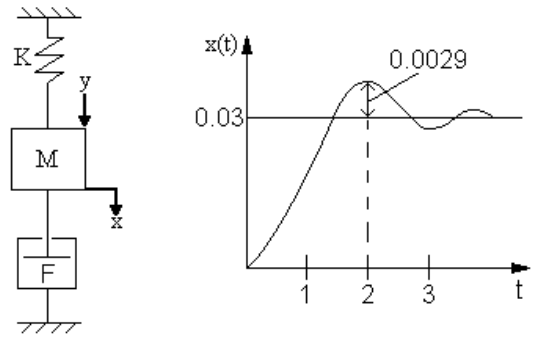

Figure Q3 (b)

(c) A low-pass R-C passive filter has the following constants: $R = 1M\Omega$; $C = 1\mu F$. Derive the filter's

i) Transfer function

ii) Time response expression to a unit step input.

(8 marks)

Question FOUR

(a) For the system shown in Figure Q4 (a), If the damping factor is 0.5, calculate:.

i) The value of k
ii) The steady state transfer function
iii) The final steady state value of $C(s)$ if the input is a step function of 2 volts
iv) The size of the 1st overshoot
v) The time taken to reach the 1st overshoot
vi) The derivative derived feedback to be applied if critical damping is required
vii) The final steady state value of the output with this derivative derived feedback

(15 marks)

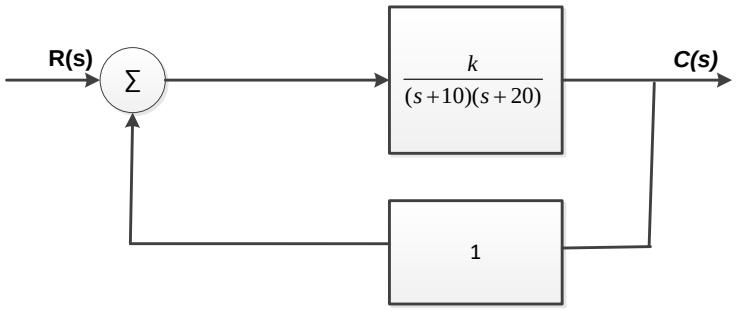

Figure Q4 (a)

(b) Calculate the steady state error for a system with loop gain $G(s)H(s) = \dfrac{2000}{(s+2)(s+10)}$ for a nit step input of $3.18\,\pi$ radians. (5 marks)

Question FIVE

(a) The system illustrated in Figure Q 5 (a) is a series electrical circuit consisting of an inductance (henry), a resistance (ohm) and a capacitance (farad). Show that the transfer function for this system is: $\dfrac{E_O(s)}{E_I(s)} = \dfrac{1}{LCs^2 + RCs + 1}$ (10 marks)

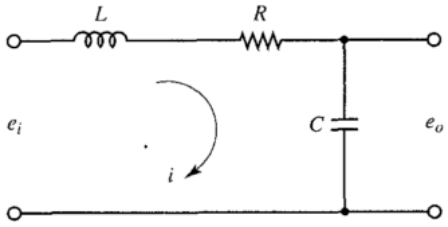

Figure Q 5 (a)

(b) Obtain mathematical models of the mechanical shown in Figure Q 5 (b)

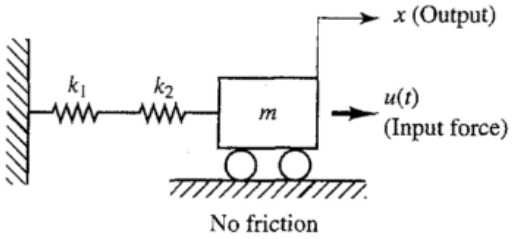

Figure Q 5 (b)

(10 marks)