EES/10117/10045

OLABISI ONABANJO UNIVERSITY
COLLEGE OF ENGINEERING AND ENVIRONMENTAL STUDIES, IBOGUN
FACULTY OF ENGINEERING
DEPARTMENT OF COMPUTER
2020/2021 HARMATTAN SEMESTER EXAMINATION

COURSE CODE: CPE 503 **COURSE TITLE:** CONTROL THEORY AND SYSTEMS
TIME ALLOWED: 2hrs 30 mins
COURSE UNIT: 3
INSTRUCTION: Answer FOUR (4) questions in all; at least TWO (2) questions from each section

Section-A

QUESTION ONE

a (i) Explain the operation of ordinary traffic signals which control automobile traffic at roadway intersections. (4 marks)
(ii) Why are they open-loop control systems? (3 marks)
(iii) How can traffic be controlled more efficiently? (4 marks)
(iv) Why is the system of (a) closed loop? (3 marks)

b.. Expand the following equation of Laplace transform in terms of its partial fractions and obtain its time-domain response.
$Y(s) = 2s/(s+1)(s+2)$ (5 marks)

c. Determine the transfer function of the system between the capacitance voltage to the source voltage in the following RLC circuit as shown in fig 1.1 (6 marks)

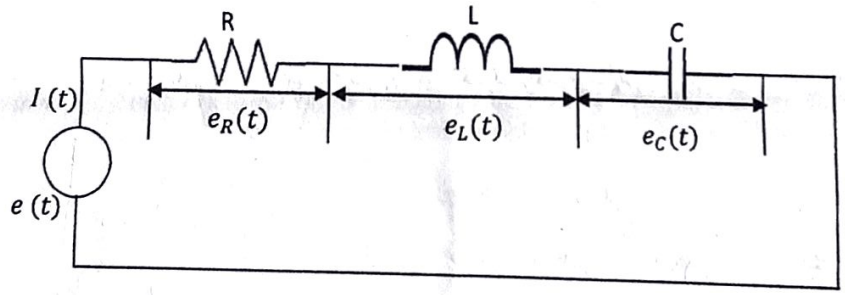

fig Q1c

QUESTION TWO

a. Obtain the pole-zero map of the following transfer function.
$G(s) = (s-2)(s+2+j4)(s+2-j4)/(s-3)(s-4)(s-5)(s+1+j5)(s+1-j5)$ (5 marks)

b. Explain the differences between the following terminologies:
(i) Regulator and Servo System (4 marks)
(ii) Automatic Control System and Combinational Control System (4 marks)
(iii) Deterministic Control System and Stochastic Control System (4 marks)
(iv) Simulation and Optimization (4 marks)

c. Identify the input and output for an automatic washing machine. (4 marks)

QUESTION THREE

(a) Reduce the block diagram given in Fig. 3.1 to unity feedback form and find the system characteristics equation. (5 marks)

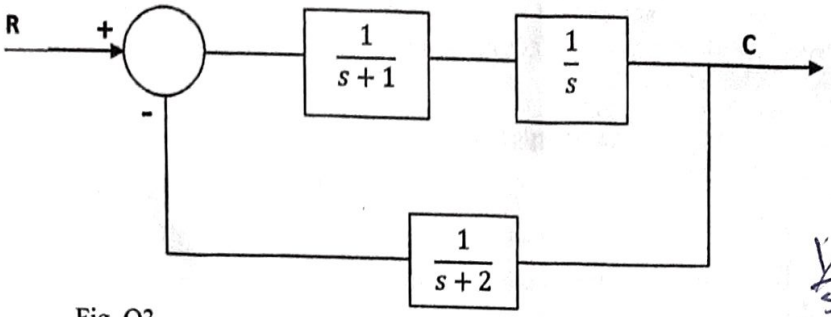

Fig. Q3

b. (i) Describe, in a simplified way, the components and variables (sense organs) of the biological control system involved in walking in a prescribed direction. (4 marks)
(ii) Why is walking a closed-loop operation? (2 marks)
(iii) Under what conditions would the human walking apparatus become an open-loop system? (2 marks)
(iv) A sampled-data system? Assume the person has normal vision. (2 marks)
(v) With the aid of illustrated diagrams, compare the Servomechanisms and Regulators. List two examples of each. (10 marks)

Section-B

QUESTION FOUR

i. State the general equation for a second order system. (4 marks)
ii. What type of response is represented by
$\lim_{t \to \infty} y(t) = 0$ (4 marks)
iii. Describe the transient response of a system and relate it to stability of a system (3 marks)
iv. What is the behavior of a system when its transient response increases exponentially? (3 marks)
v. Briefly describe two properties of linear systems. (3 marks)
vi. Consider the following system equations;
a.) Determine the unit step response of the of the equation
$\frac{dy}{dt} + 5y = f(t)$ (4 marks)

b.)What is the Total response of a system represented by the equation ;
$\frac{dy}{dt} + 4y = 12$. Given a forcing function $x(0) = 7$? (4 marks)

QUESTION FIVE

i. Assuming a singularity input of a unit step , represent the damped oscillations exhibited by the transient response of a system using a diagram. (5 marks)
ii. Consider the system equation $d^2y/dt^2 + 3dy/dt + 2y = 18$
a. The damping ratio. ζ (2 marks) b. The natural frequency wn. (2 marks)
c. The rise time. (2 marks) d. Peak time (2 marks)
e. Maximum overshoot (2 marks) f. Settling time (2 marks)

iii. Describe the transient response of a system and relate it to stability (5 marks)
iv. The transient response of a control system to a singularity input of a unit step function exhibits damped oscillations before reaching a steady-start characteristic. Using a graph show the following characteristics.
a. Overdamped (2 marks) b. Underdamped (2 marks)
c. Undamped (2 marks) d. Critically damped (2 marks)

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QUESTION SIX

i. Determine the roots of the following equations and state whether they are stable or not.
   a. $d^2y/dt^2 + 7dy/dt + 12y = u$ (2marks)
   b. $x^2 + 3x + 2 = u$ (2 marks)

ii. Using the Routh's stability criterion, determine the stability of the following equations
   a. $s^3 + 4s^2 + 8s + 12 = 0$ (4 marks)
   b. $s^3 + 6s^2 + 12s + 8 = 0$ (4 marks)

iii. Given a discrete input of values over a period of 10 days. Derive an expression to represent the average of all inputs and state whether the equation is causal or not. (5marks)

iv. State whether the following systems are static or dynamic
   a. $Y(n) = x(n) + x(n-1) + 4x(n-2) - 2y(n-2) + 3y(n-4)$ (2 marks)
   b. $Y(n) = ax(n) + b^3x(n)$ (2 marks)

v. Draw the equivalence of the following equations;
   a. $Y(n) = x(n) + x(n-1) + 4x(n-2) - 2y(n-2) + 3y(n-4)$ (2 marks)
   b. $Y(n) = 3x(n) + x(n-2) + 2x(n-3) + y(n-2) + 3y(n-5)$ (2 marks)