ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

SEMESTER II EXAMINATION, 2016/2017 ACADEMIC SESSION

COURSE TITLE: CONTROL THEORY

COURSE CODE: EEE 318

EXAMINATION DATE: 2nd AUGUST 2017

COURSE LECTURER: DR. OGIDAN O.K.

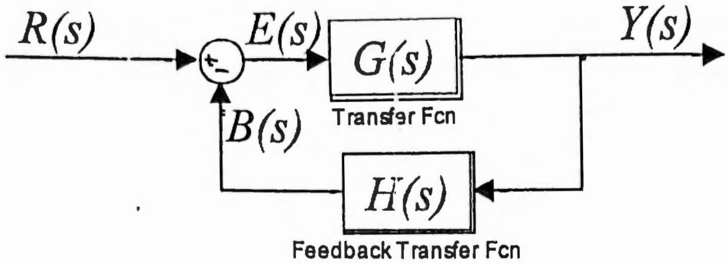
HOD's SIGNATURE

TIME ALLOWED: 3HRS.

INSTRUCTIONS:

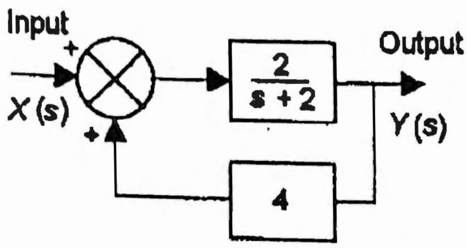
1. ANSWER ANY 5 OUT OF THE 7 QUESTIONS
2. SEVERE PENALTIES APPLY FOR MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM.
3. YOU WILL BE PROVIDED WITH A TIME/LAPLACE TRANSFORM SHEET FOR THIS EXAM.
4. YOU ARE **NOT** ALLOWED TO BORROW CALCULATORS AND ANY OTHER WRITING MATERIALS DURING THE EXAMINATION.

Question 1

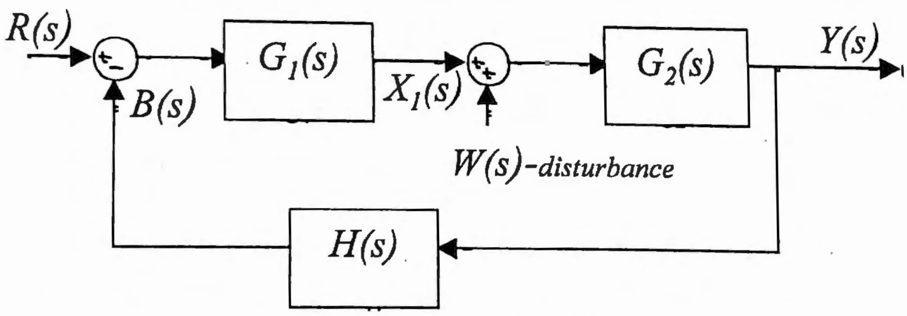


a) Given the block diagram in the diagram above, find the closed loop transfer function. (3 marks)

b) Determine the overall transfer function of a system with a forward path transfer function of 2/(s+2) and a feedback transfer function of 4. (3 marks)



c.) Consider a system under disturbance as shown below. Determine the overall closed loop transfer function of such a system:



i.) Without disturbance, ii.) with disturbance iii.) with and without disturbance. (6 marks)

Question 2

a.) What are the differences between open loop and closed loop system?

b.) Outline the differences between on-off control and the Proportional Integral Derivative (PID) control (6 marks)

c.) Write the following differential equations in the Laplace (s) domain

i. $F = m\frac{d^2y}{dt^2} + c\frac{dy}{dt} + ky$, initial value of variable $y = 0$ at $t = 0$

ii. $v = RC\frac{dvc}{dt} + vc$, initial value of variable $v = 0$ at $t = 0$

iii. $\frac{d^2y}{dt^2} + 2\zeta w_n \frac{dy}{dt} + w_n^2 y = kw_n^2 x$, initial value of variable $y = 0$ at $t = 0$

(6 marks)

Question 3

a.) A control system has two elements in series with transfer functions of $\frac{1}{(S+2)}$ and $\frac{1}{(S+4)}$

i.) Determine the overall transfer function

ii.) Write a programme (to be run in the MATLAB workspace) that inputs a unit step function into the system and to output a steady state response. (5 marks)

b.) A system has an output y related to the input x by the differential equation: $\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 6y = x$

What will be the output from the system when it is subjected to a unit step input? Initially both the input and output are zero.

Hint: Use the Time/Laplace domain transformation table. (7 marks)

Question 4

a.) What are the differences between differential equation and transfer function? (2 marks)

b.) Outline the differences between first order and second order systems. (2 marks)

c.) Give two examples of a second order system. (2 marks)

d.) Give two examples of a first order system. (2 marks)

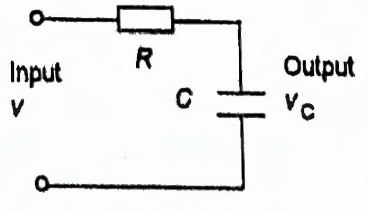
e.) A system has a transfer function $\frac{1}{(s+5)}$. What will be its output as a function of time when it is subjected to a unit step input of 1V? (4 marks)

Question 5

a.) Describe the concept of stability and its importance in control system. (2 marks)

b.) Compare and contrast between classical and modern control systems. (4 marks)

c.) Consider a circuit with a resistor R and capacitor C in series:



i.) Determine the transfer function for the circuit in c.

ii.) What will be its output as a function of time if it is subjected to a 5V ramp input? (6 marks)

Tim

Question 6

a.) Define briefly the following

I. Transfer function
II. Modeling
III. System identification
IV. Bode plot
V. Nyquist stability criterion

(5 marks)

b.) A system has a transfer function: $G(s) = \frac{2}{(s+5)}$. Determine the magnitude and phase of the output from the system when it of subjected to a sinusoidal input of $2\sin 3t$. (7 marks)

Question 7

a.) When is a system be said to be stable? (2 marks)

b.) Given the following transfer functions, state which of them are stable or unstable and plot their positions in the s-plane.

i.) $G(s) = \frac{1}{s^2+3s+2}$

ii.) $G(s) = \frac{1}{s^2-3s+2}$

iii.) $G(s) = \frac{1}{s^2+2s+4}$

iv.) $G(s) = \frac{1}{s^2-2s+4}$

v.) $G(s) = \frac{1}{(s+1)^2}$

(5 marks)

c.) Give n a second order system: $G(s) = \frac{1}{s^2+3s+2}$ which is subjected to a unit step input.

i.) Express as a function of time and
ii.) State if it is a stable system or not in relation to its transient (exponential) terms and give reasons for your answer

(5 marks)

Time function/Laplace transform table

	Time function $f(t)$	Laplace transform $F(s)$
1	A unit impulse	1
2	A unit step	$\frac{1}{s}$
3	t, a unit ramp	$\frac{1}{s^2}$
4	e^{-at}, exponential decay	$\frac{1}{s+a}$
5	$1-e^{-at}$, exponential growth	$\frac{a}{s(s+a)}$
6	te^{-at}	$\frac{1}{(s+a)^2}$
7	$t-\frac{1-e^{-at}}{a}$	$\frac{a}{s^2(s+a)}$
8	$e^{-at}-e^{-bt}$	$\frac{b-a}{(s+a)(s+b)}$
9	$(1-at)e^{-at}$	$\frac{s}{(s+a)^2}$
10	$1-\frac{b}{b-a}e^{-at}+\frac{a}{b-a}e^{-bt}$	$\frac{ab}{s(s+a)(s+b)}$
11	$\frac{e^{-at}}{(b-a)(c-a)}+\frac{e^{-bt}}{(c-b)(a-b)}+\frac{e^{-ct}}{(a-c)(b-c)}$	$\frac{1}{(s+a)(s+b)(s+c)}$
12	$\sin\omega t$, a sine wave	$\frac{\omega}{s^2+\omega^2}$
13	$\cos\omega t$, a cosine wave	$\frac{s}{s^2+\omega^2}$
14	$e^{-at}\sin\omega t$, a damped sine wave	$\frac{\omega}{(s+a)^2+\omega^2}$
15	$e^{-at}\cos\omega t$, a damped cosine wave	$\frac{s+a}{(s+a)^2+\omega^2}$
16	$\frac{\omega}{\sqrt{1-\zeta^2}}e^{-\zeta\omega t}\sin\omega\sqrt{1-\zeta^2}\,t$	$\frac{\omega^2}{s^2+2\zeta\omega s+\omega^2}$
17	$1-\frac{1}{\sqrt{1-\zeta^2}}e^{-\zeta\omega t}\sin\left(\omega\sqrt{1-\zeta^2}\,t+\phi\right)$, $\cos\phi=\zeta$	$\frac{\omega^2}{s(s^2+2\zeta\omega s+\omega^2)}$