ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

SECOND SEMESTER EXAMINATION, 2017/2018 ACADEMIC SESSION

COURSE TITLE: CONTROL THEORY

COURSE CODE: EEE 318

EXAMINATION DATE: AUGUST, 2018

COURSE LECTURER: DR O. K. OGIDAN

TIME ALLOWED: 3 HOURS

HOD's SIGNATURE

INSTRUCTIONS:

1. ANSWER ANY **FIVE QUESTIONS**
2. ANY INCIDENT OF MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM SHALL BE SEVERELY PUNISHED.
3. YOU ARE **NOT** ALLOWED TO BORROW CALCULATORS AND ANY OTHER WRITING MATERIALS DURING THE EXAMINATION.
4. ELECTRONIC DEVICES CAPABLE OF STORING AND RETRIEVING INFORMATION ARE PROHIBITED.
5. DO **NOT** TURN OVER YOUR EXAMINATION QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO.

Question 1

a.) Define the following control engineering terms:

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 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

(4 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. $4\frac{d^2v}{dt^2} + 2\frac{dv}{dt} - y$, initial value of variable $v = 3$ at $t = 0$

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

(8 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?

(3 Marks)

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

(3 Marks)

c.) Give two examples of a second order system

(1 Mark)

d.) Give two examples of a first order system

(1 Mark)

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?

Question 5

(4 Marks)

a.) Describe the concept of stability and its importance in control systems

(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 shown in figure 1

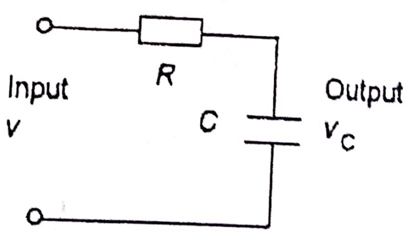


Figure 1: circuit with a resistor and capacitor

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)

Question 6

a.) Describe briefly the following control action:

i.) Proportional control

ii.) Derivative control

iii.) Integral control

(3 Marks)

b.) Given the basic form of a PD controller as shown in figure 2, show by proving that the controller action is given by: $\left(K_p + K_d s\right)E(s)$

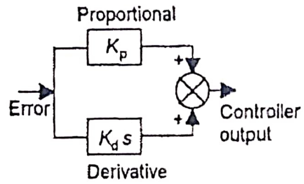


Figure 2: Basic form of a PD controller

(4 Marks)

c.) Given the basic form of a PID controller as shown in figure 3, show that the controller action is given by:

$$K_p\left(1 + \frac{1}{T_i s} + T_d s\right)E(s)$$

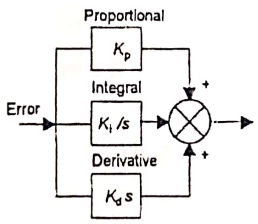


Figure 3: Basic form of a PID controller

(5 Marks)

Question 7

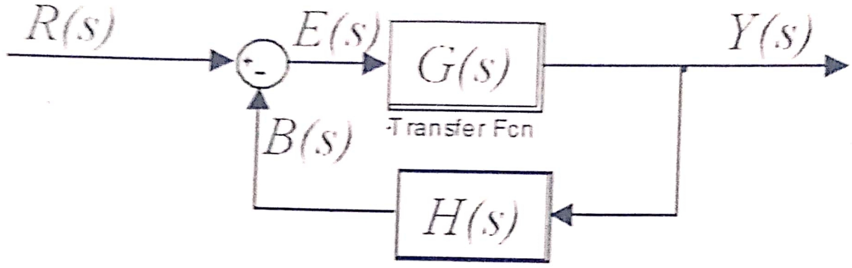
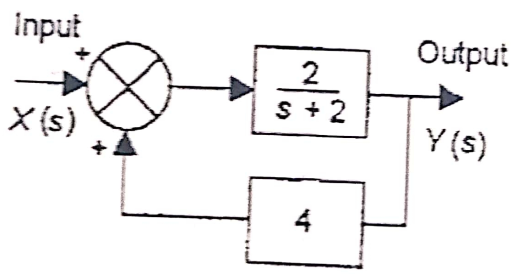


Figure 4: Closed loop system

a) Given the block diagram in figure 4, 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.) Given a second order system: $G(s)=\dfrac{1}{s^2+3s+2}$ 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 (6 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	$\frac{e^{-at}}{(b-a)(c-a)}+\frac{e^{-bt}}{(c-a)(a-b)}+\frac{e^{-ct}}{(a-c)(b-c)}$	$\frac{1}{(s-a)(s+b)(s+c)}$
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	$1-\frac{1}{\sqrt{1-\zeta^2}}e^{-\zeta\omega t}\sin\left(\omega\sqrt{1-\zeta^2}\,t+\phi\right)$, $\cos\phi=\zeta$	$\frac{\omega^2}{s(s^2+2\zeta\omega s+\omega^2)}$