ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

FIRST SEMESTER EXAMINATION, 2017/2018 ACADEMIC SESSION

COURSE CODE: EEE 515

COURSE TITLE: CONTROL ENGINEERING

DURATION: 3Hours

INSTRUCTIONS:

1. ANSWER ANY FIVE (5) QUESTIONS
2. SEVERE PENALTIES APPLY FOR MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM.

Question 1

a.) What are the advantages of using a PID controller over the on and off controllers? (4 marks)

b.) Consider a unity feedback control system with the feedforward transfer function

$$G(s) = \frac{K}{s(s^2 + 4s + 8)}$$

Plot the root loci doe the system (8 marks)

Question 2

a.) With the aid of a suitable diagram, describe briefly on the operation of:

i.) Proportional control

ii.) Derivative control

iii.) Integral control (3 marks)

b.) Given the basic form of a PD controller as shown in figure 1, show by proving that the controller action is given by: $(K_p + K_d s)E(s)$

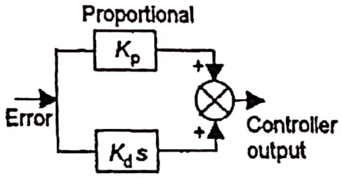

Figure 1: Basic form of a PD controller

(4 marks)

c.) Given the basic form of a PID controller as shown in figure 1, show by proving that the controller action is given by: $k_p\ (1+\frac{k_i}{k_p s} + \frac{k_d}{k_p} s)E_s$

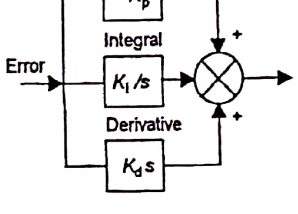

Figure 2: Basic form of a PID controller

(5 marks)

Question 3

a.) What are the differences between classical control and the state space control? (4 marks)

b.) How would you tune a PID controller using the first method of Zeigler Nicholas? (4 marks)

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

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

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

Question 4

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: $G(s) = \dfrac{2}{(s+5)}$. 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 5

Consider the transfer function

$$\frac{Y(s)}{U(s)} = \frac{s^2 + 3s + 1}{s(s^2 + 6s + 8)}$$

a.) Represent it in state space general form and build the state space simulation diagram

$$\frac{Y(s)}{U(s)} = \frac{s^2 + 3s + 1}{s^3 + 6s^2 + 8s}$$

(6 marks)

b.) *Represent it in state space parallel form and build the state space simulation diagram*

$$\frac{Y(s)}{U(s)} = \frac{s^2 + 3s + 1}{s(s^2 + 6s + 8)}$$

(6 marks)

Question 6

a.) Discus briefly on the following as it relates to control system:

i.) Stability ii.) Controllability iii.) Observability (3 marks) b.) For the state space model

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t), \quad y(t) = \begin{bmatrix} 3 & 1 \end{bmatrix} x(t)]$$

and an input $r(t) = 1(t)$ Find:

The full state feedback matrix H which place the poles of the closed loop system at positions $s_1 = (-2,+j2),\ s_2 = (-2,-j2)$ (9 marks)

Question 7

a.) The plant is described in state space by the model

$$\dot{x}(t) = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(t) \qquad x(0) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \quad y(t) = [2 \quad 1] x(t)$$

i.) Find the analytical expression for the matrix transfer function in Laplace domain (3 marks)

ii.) Calculate the matrix transfer function. (3 marks)

b.) Consider the following transfer function

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

i.) Given the series state space formulations (3 marks)

ii.) Draw out the resulting system diagrams (3 marks)