FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI
SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
2017/18 HARMATTAN SEMESTER:
EEE 405: PROCESS CONTROL TECHNOLOGY

Instruction: Attempt Any Five Questions at least two from each section: Time Allowed: 2½ hours. Unit: 2

SECTION A

1. (a) Draw a clearer diagram representing four elements of process control with a comparator. Explain the functions and physical implementation of each element mentioned above. (16 marks)
   (b)(i) A digital meter has 10-bit accuracy, what is the resolution on the 20v range (2 marks)
   (ii) A pressure sensor has an accuracy of $\pm 2.2\%$ of reading, and a transfer function of $27mV/kPa$. If the output of the sensor is 230mV, then what is the range of pressures that could give this ready (2 marks)
2. (a) Describe the following pressure sensing elements stating suitable materials, mode of operation and basic characteristics of such element. (i) Diaphragm (ii) Capsules (iii) Bellows (iv) Bourdon Tubes. (16 marks) (b) What is the average thermal speed of an oxygen atom at 320^0R? The molecular mass of oxygen is 26.7×10^{-27}kg (4 marks)
3. (a) Describe the following process control transducers detailing mode of operation and characteristics of each device. (i) Thermal couples (ii) Oritice plates (iii) Displacers (12 marks). (b) If the height of a column of water in fig 3b is 4.3m, what is the pressure at P? Assume the areas at points 2 and 3 are $29cm^2$ and $17cm^2$ respectively?(8 marks)

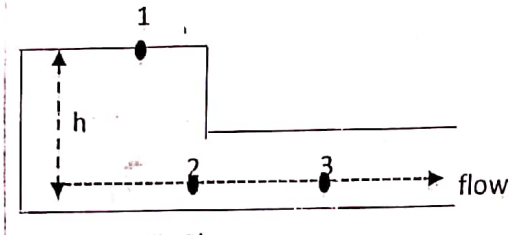

Fig 3b

SECTION B

4. (a) (i) What are the effects of setting the derivative of a controller large? *6mks*
   (ii) State the difference between PI and PD in relation to offset error of the control system. 4mks
   (b) For the control system shown in Fig.4 find the closed loop transfer function Y(s)/R(s) of the system using Mason's gain rule. 10mks

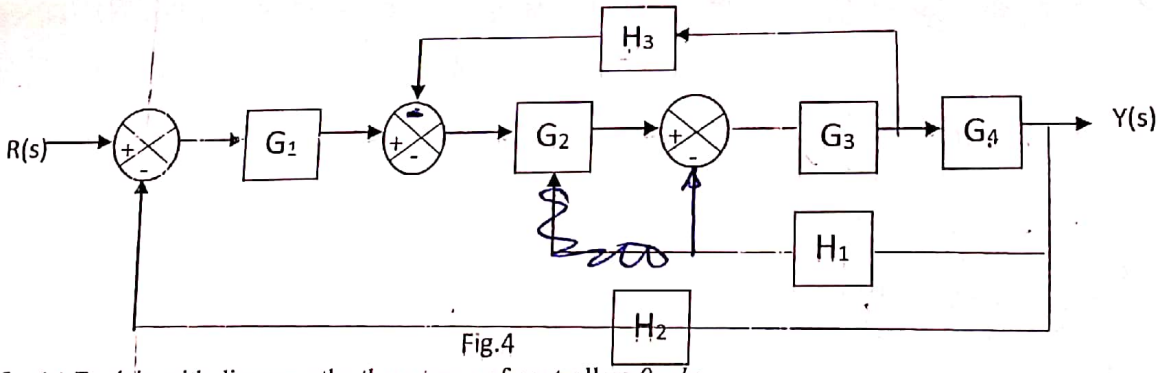

Fig.4

5. (a) Explain with diagrams the three types of controllers. *9 mks*
   (b) (i) What do you understand by the gain of a controller? *2 mks*
   (ii) For a controller whose input changes by 20 % when the output to the controller increases from 25 units to 50 units. Calculate the gain of the controller. *5 mks*
   (c) Explain the following as applied to signal flow graph; transmittance, branch, loop and forward path gain. *4 mks*
6. (a) (i)Why do Controllers Need Tuning? *2 mks*
   (ii) State two ways of expressing the settings for the proportional mode. *2 mks*
   (b) (i) State Mason's gain rule for evaluating the transfer function of a physical system. *3 mks*
   (iii) What is the advantage of the signal flow graph technique over the successive block diagram reduction in evaluating the transfer function of a system? *3 mks*
   (c) Using the Mason's gain rule, find the closed loop transfer function Y(s)/X(s) of the system shown in Fig.6. *10 mks*

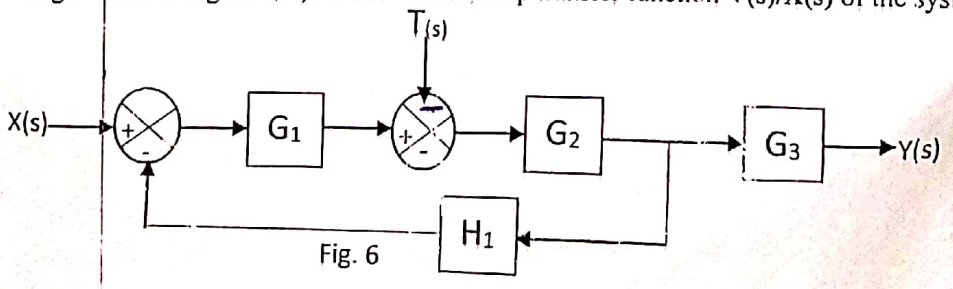

Fig. 6

Nwosu Izuchukwu
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DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
2016/2017 HARMATTAN SEMESTER EXAMINATION
Course: EEE 405- Process Control Technology

INSTRUCTIONS: Answer any four questions. TIME ALLOWED: $2\frac{1}{2}$ Hours

QUESTION 1

(a) i. Briefly explain four reasons for process control. **4mks**

ii. With appropriate diagrams and example, explain the difference between an open loop and close loop control systems. **4mks**

(b) i. State seven terms used to identify signal flow graphs and define each of them. **7mks**

ii. An integral controller has a reset action of 2.2 minutes. Express the integral controller constant in s^{-1}. Find the output of this controller to a constant error of 2.2%. **5mks**

QUESTION 2

i. (a) What is a controller mode? **2mks**, Give the analytical expression for the following modes: (b) Proportional control (c) Integral control and (d) Derivative control. **6mks**

ii. (a) Explain why proportional control mode equation represent reverse action. **2mks** (b) Give two practical applications where two position controllers can be adopted. **2mks**

iii. (a) State the difference between PI and PD in relation to offset error of the control system. **4mks**
(b) Explain multiposition controller mode. **4mks**

QUESTION 3

i. (a) What is process control? **2mks** (b) Differentiate between set-point and process variable? **2mks** (c) Identify six process industries you know. **3mks**

ii The temperature sensor of an industrial process desired to be kept 5 °C of 100 °C measures 120 °C. State its set point error and the measured variable and briefly discuss them. **6mks**

iii Briefly explain three major signal types mainly used in the process control industry, stating the common adopted standards in each case **6mks**

QUESTION 4

i (a) What is signal conditioning? **1mk** (b) Discuss 5 general methods of signal conditioning. **5mks**

ii (a) Differentiate between transducer and sensor. **2mks** (b) List 5 factors that must be considered when selecting transducers in the process industry. **3mks**

iii. Write short notes on the following, give examples and support your discussion with schematic diagrams where necessary (a) Mechanical transducers. **3mks** (b) Thermal transducers. **3mks** (c) Optical transducers. **3mks**

QUESTION 5

i. With a detailed diagram, design a system of two variables for a feedback control system that will control the flow rate of input, temperature of fluid in the tank, and satisfy other conditions in the process industry? **7mks**

ii. State Mason's gain rule and explain each terms. **5mks**

iii. For the control system shown in Fig Q_1, find the closed loop transfer function $\frac{Y(s)}{R(s)}$ of the system using Mason's gain rule. **8mks**

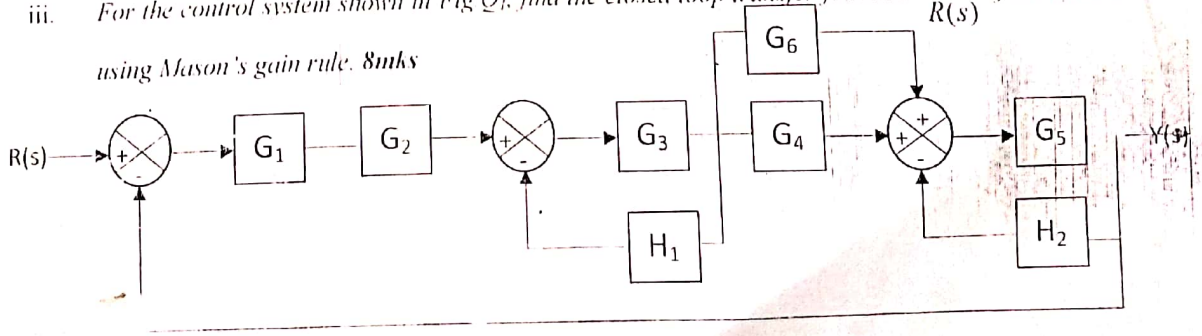

Fig. Q_1

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ELECTRICAL/ELECTRONIC ENGINEERING DEPARTMENT

HARMATTAN SEMESTER EXAMINATION 2014/2015 SESSION.

COURSE TITLE: PROCESS CONTROL TECHNOLOGY COURSE CODE: EEE405

TIME ALLOWED: 3 HOURS

INSTRUCTIONS: ANSWER ANY FIVE QUESTIONS.

1. Define error? Write short notes on the three major components of error? What type of control is used in an application where noise is present, but where no offset can be tolerated?

2. What is a process? Differentiate between set point and process variable? With a detailed diagram, design a system of two variables that will control the flow rate, process variable and other conditions in the process industry? Identify six process industries you know?

3. a. What is a Current-to-Pressure Converter? List and discuss 5 factors to consider when selecting a transducer in the process control industry?

   b. Write short notes on the following:
      i. Mechanical transducer.
      ii. Thermal transducer.
      iii. Optical transducer.

4. What is a PLC? What are the major components of a PLC system? With a well labelled diagram, explain the concept of PLC ladder logic?

5. State the Sampling theorem? How is Aliasing corrected? What are the functional components of an A/D board? Discuss in detail, the three kinds of signals used in Process Control industry?

6. What are the major disadvantages of proportional action control? Explain in details, the three tasks associated with any control loop? Explain in details, the reasons why manufacturers control the production process?