

# BITS, PILANI – DUBAI CAMPUS

Course No: ES-UC-312-IIC (EIE)

Class: BE (Hons.) III-Year

Course Title: Industrial Instrumentation and Control

## COMPREHENSIVE EXAMINATION (Closed book)

Date: June 7, 2004

Time: 3 Hours

M.M. = 120

**NOTE:**

- (i) Answer all the questions.
- (ii) All questions to be answered in the answer sheet only.
- (iii) Question paper contains *Four Pages*.
- (iv) Answer all the parts of a question in continuation.
- (v) Do not leave any blank page(s) in between the answers.
- (vi) Do not write any thing on the question paper except your hall ticket number.
- (vii) Cross the blank page (s), if any.

Q.1 (a) Compare simple feedback to simple feed-forward control configuration. Which one you would trust to perform better in achieving your control objective? Why? [5]

(b) Consider the heater system shown in figure-1 below. A liquid enters the tank with a flow rate  $F_i$  ( $\text{ft}^3/\text{min}$ ) and a temperature  $T_i$  ( $^{\circ}\text{F}$ ), where it is heated with steam. Let  $F$  and  $T$  be the flow rate and temperature of the stream leaving the tank. The tank is considered to be well stirred, which implies that the temperature of the effluent is equal to the temperature of the liquid in the tank. [10]

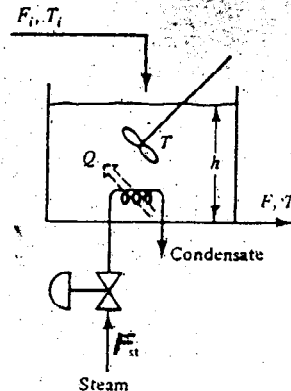


Figure 1. Stirred tank heater.

Construct the feedback and feed-forward temperature control configurations for a tank heater (fig.-1) that will satisfy the control objective in the presence of disturbance and draw the control loop diagram.

- (c) Draw the liquid level control scheme for the stirred tank as show in figure-1. [5]
- Q.2 (a) Compare the characteristics, merits and demerits of the following: [15]
- (i) PLC Vs PID
  - (ii) Neural Network Vs Traditional Computing
  - (iii) Air to open valve Vs Air to close valve.
- (b) Describe the function of a current to pressure converter with the help of figure. [5]
- Q.3 (a) Assume you are driving a car in a traffic where speed limit is posted at 80mph. Convert the speed of 80mph in to fuzzy variable. Define all the membership function used. [5]
- (b) Determine the membership function and linguistic rules to control the motor at target speed 2000rpm by DC output of the generator. Assume DC output voltage is proportional to speed. The speed error may be positive or negative. Take three linguistic terms for speed and voltage. [10]
- (c) Draw and discuss the block diagram of cascaded control system. [5]
- Q.4 (a) Why Distributed Control System (DCS) is preferred over Centralized Computer Control? Justify your answer. [8]
- (b) If you are working in a petrochemical industry as a maintenance engineer, where thousands of process parameter are measured or controlled. The management want to replace the existing control systems with DCS. What factor factors you would like to have in DCS for taking care of full plant maintenance efficiently. Give your brief comments on each point. [7]
- (c) Define Trapezodial rule and interpolation technique? Explain how it helps to modify the PID equation? [5]

- Q.5 (a) Draw the block diagram of direct digital control interfacing to the process for data acquisition and control. Write brief description of each block. [5]
- (b) A temperature sensor T1 produces a logic zero voltage, when the temperature at its location is greater than  $25^{\circ}\text{C}$ . Another temperature sensor T2, produces a logic one voltage, when the temperature at its location is above  $10^{\circ}\text{C}$ . A heater H is to be turned ON, when the temperature is between 10 and  $25^{\circ}\text{C}$ . If the temperature falls below  $10^{\circ}\text{C}$  an alarm is to be sounded. Obtain the Boolean equation for the above conditions and design the digital signal conditioning circuit. [5]
- (c) Differentiate between electrical and pneumatic actuator. [5]
- (d) Given a drawing as shown in figure-2 below. Identify and name the figure-2. Write the names of the parts indicated in the drawing. [5]

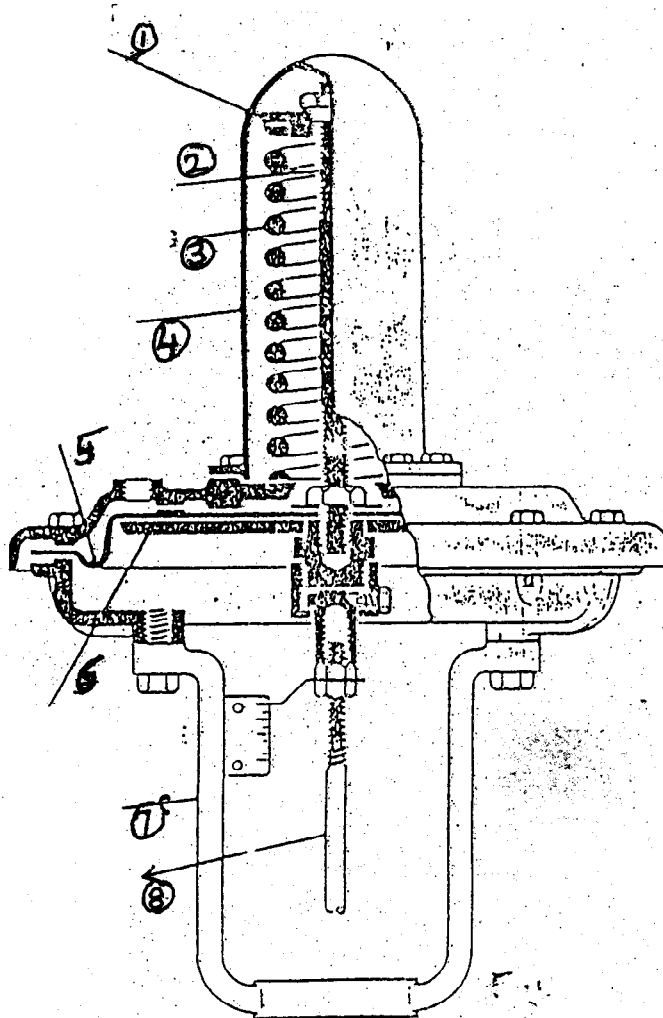
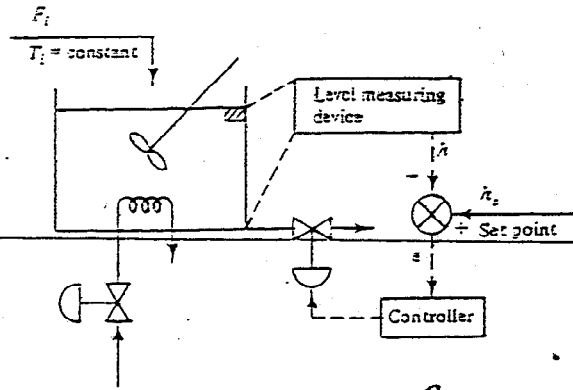


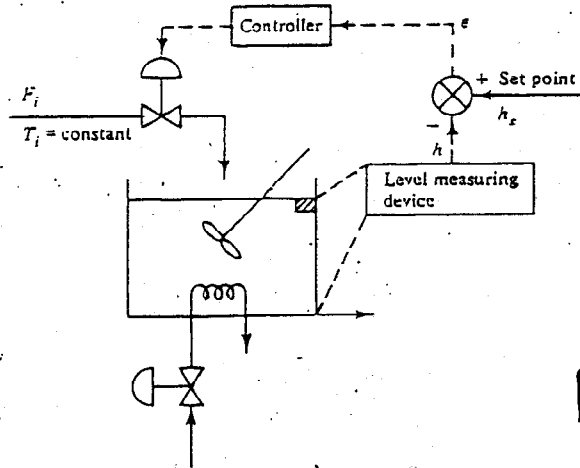
Figure-2

- Q.6
- (a) Enlist the basic function of SCADA. Draw and discuss the block diagram of real time structure of PLC with SCADA system. [12]
- (b) Write control valve symbols for: [3]
- (i) Hydrolically operated Control Valve
  - (ii) Electrically operated Control Valve
  - (iii) Mechanically operated Control Valve
- (c) A conveyer motor has to started 10 minutes after the start push button is pressed. Before starting the motor sound the horn as a warning signal. A stop push button is provided to stop the above process at any time. Draw the logic ladder, input and output diagram. [5]

(c)



OR



[5]

Alternative liquid-level control schemes.

Q.2 (a) (iii) Air to open

(i) Air pushes down

(ii) Diaphragm & Diaphragm Plate are free to move

(iii) Air is applied through an opening in the upper part of the case

(iv) with increase Air Pressure Diaphragm plate lowers

(v) stem, attached to plate through stem strap lowers

(vi) valve open

Air to close

(i) up

(ii) held stationary

(iii) through stem

(iv) Rises

(v) Rises

(vi) valve close

(1/2 marks for each)

Ans:

(i)

PLC	PID Controllers
<ol style="list-style-type: none"> <li>1. ideal for low loop count</li> <li>2. performance drops with increasing loop count</li> <li>3. purely free running mode</li> <li>4. not responsible for updating HMI database.</li> <li>5. individual database for every node</li> <li>6. low updation rate 2s to 8s or 16s!</li> <li>7. analog processing simulated through digital computing</li> <li>8. communication on low speed serial bus-9,600 bauds maximum</li> <li>9. Manual network addressing configuration</li> <li>10. limited scalability and expandibility</li> <li>11. limited interfacing capabilities</li> <li>12. multiple project files</li> <li>13. no interplant connectivity</li> </ol>	<ul style="list-style-type: none"> <li>• Relatively easy to design PID Controllers</li> <li>• Most widely applied in the industry</li> <li>• Can be implemented in computer or single controller</li> <li>• Applicable to many processes</li> <li>• Gives reasonable performances</li> <li>• Low overshoot, fast rise time, NO SSE</li> <li>• Increased Complexity</li> </ul>

$2\frac{1}{2} + 2\frac{1}{2} = 5$

CHARACTERISTICS	TRADITIONAL COMPUTING (including Expert Systems)	ARTIFICIAL NEURAL NETWORKS
Q.2a (ii) Processing style functions	Sequential Logically (left brained) via Rules Concepts Calculations	Parallel Gestalt (right brained) via Images Pictures Controls
Learning Method Applications	by rules (didactically) Accounting word processing math inventory digital communications	by example (Socratic) Sensor processing speech recognition pattern recognition text recognition

$2\frac{1}{2} + 2\frac{1}{2} = 5$

Max. Marks:30

Sixth Semester

Marks Obtained:

# BITS, PILANI – DUBAI CAMPUS

Course No: ES-UC-312-IIIC (EIE)

Class: BE (Hons.)-III Year (EIE)

Course Title: Industrial Instrumentation and Control

QUIZ TEST-1 (Closed Book)

ID No: \_\_\_\_\_ Name: \_\_\_\_\_ Date: 31/03/04

Answer all the questions:

Time: 20Mins.

- Q.1 Fill the blank with appropriate word (s). (2 marks each) [20]
- (i) Minimum value that an instrument can record with [ ]  
uncertainty is known as.....
  - (ii) Give two examples of acoustic Transducer. [ ]
    - (i)
    - (ii)
  - (iii) Which control mode is preferred, when sensor is susceptible [ ]  
to Noise .....(PI/PD).
  - (iv) 12psig process signal equal to-----electronic signal. [ ]
  - (v) What does HART stands in Control system. [ ]
  - (vi) Stability of system reduces with .....(PI/PD).control [ ]  
Mode.
  - (vii) 25% process signal equal to-----psig (Pneumatic) [ ]
  - (viii) The value of inaccuracy in manufacturer and is accepted [ ]  
within stated values known as.....
  - (ix) Measurement is.....quantity [ ]  
to be encountered in a process.
  - (x) The equivalent SI range of Pneumatic signal is ..... [ ]

- Q.2**      **Indicate the following statements are True/False.(one each)**      **[6]**
- (i) If an open loop system is unstable by applying feedback will always improve its stability. [      ]
  - (ii) Feedback is sometimes used to improve the sensitivity of control system. [      ]
  - (iii) A closed loop system is usually more accurate than an open loop system. [      ]
  - (iv) Discrete data control system are more susceptible to noise, due to the nature of the signal. [      ]
  - (v) Inferential control is basically a extension of feed-forward control. [      ]
  - (vi) Dead time is known as delay in Process. [      ]

- Q.3**      **Write the correct answer (s) in the bracket. (one each)**      **[4]**
- (i) Feed control to a chemical reactor where particular proportion of component is to be maintained is an example of [      ]
    - a) Cascade Control
    - b) PID Control
    - c) Proportional Control
    - d) Ratio Control
  - (ii) In PI control, Proportional is used to [      ]
    - a) Overcome the residual error
    - b) Get faster response
    - c) Both a and b
    - d) None of the above
  - (iii) In Integral control, the FCE responds to [      ]
    - a) Amplitude of the error
    - b) Rate of change of the error
    - c) Time duration error
    - d) Both a and c
    - e) Both a and b
  - (iv) In water heating system the temperature of the water is consider to be [      ]
    - a) Manipulated variable
    - b) Control variable
    - c) Load variable
    - d) Disturbance variable
    - e) None of the above



Max. Marks:30

Sixth Semester

Marks Obtained:

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Course Title: Industrial Instrumentation and Control

Answer Sheet of QUIZ TEST-1 (Closed Book)

ID No: \_\_\_\_\_ Name: \_\_\_\_\_ Date: 31/03/04

Answer all the questions:

Time: 20Mins.

- Q.1 Fill the blank with appropriate word (s). (2 marks each) [20]
- (i) Minimum value that an instrument can record with [ ]  
uncertainty is known as... **Resolution**.....
  - (ii) Give two examples of acoustic Transducer. [ ]  
(i) **Piezo electric**  
(ii) **acoustic filter and IDT**
  - (iii) Which control mode is preferred, when sensor is susceptible [ ]  
to Noise ...**PI**.....(**PI/PD**).
  - (iv) 12psig process signal equal to—**16mA**-----electronic [ ]  
signal.
  - (v) What does HART stands in Control system. [ ]  
**Highway Addressable Remote Transducer**
  - (vi) Stability of system reduces with ...**PI**...(**PI/PD**) control [ ]  
Mode.
  - (vii) 25% process signal equal to **6 psig** (Pneumatic) [ ]
  - (viii) The value of inaccuracy in manufacturer and is accepted [ ]  
within stated values known as **Tolerance**.
  - (ix) Measurement is...**an Unkwon**.....quantity to be [ ]  
encountered in a process.
  - (x) The equivalent SI range of Pneumatic signal is **20 to 100KPa** [ ]

- Q.2** Indicate the following statements are True/False.(one each) [6]
- (i) If an open loop system is unstable by applying feedback will always improve its stability. [ F ]
  - (ii) Feedback is sometimes used to improve the sensitivity of control system. [ T ]
  - (iii) A closed loop system is usually more accurate than an open loop system. [ T ]
  - (iv) Discrete data control system are more susceptible to noise, due to the nature of the signal. [ F ]
  - (v) Inferential control is basically a extension of feed-forward control. [ F ]
  - (vi) Dead time is known as delay in Process. [ F ]

- Q.3** Write the correct answer (s) in the bracket. (one each) [4]
- (i) Feed control to a chemical reactor where particular proportion of component is to be maintained is an example of [ d ]
    - a) Cascade Control
    - b) PID Control
    - c) Proportional Control
    - d) Ratio Control
  - (ii) In PI control, Proportional is used to [ b ]
    - a) Overcome the residual error
    - b) Get faster response
    - c) Both a and b
    - d) None of the above
  - (iii) In Integral control, the FCE responds to [ d ]
    - a) Amplitude of the error
    - b) Rate of change of the error
    - c) Time duration error
    - d) Both a and c
    - e) Both a and b
  - (iv) In water heating system the temperature of the water is consider to be [ b ]
    - f) Manipulated variable
    - g) Control variable
    - h) Load variable
    - i) Disturbance variable
    - j) None of the above

Max. Marks: 50

Sixth Semester

Marks Obtained:

# BITS, PILANI – DUBAI CAMPUS

Course No: ES-UC-312-IIC (EIE)

Class: BE (Hons.)III-Year

Course Title: Industrial Instrumentation and Control

Test-I (Closed Book)

ID No: \_\_\_\_\_ Name: \_\_\_\_\_ Date: 28/03 /04

Answer all the questions:

- Q.1 (a) Discuss in brief the purpose of transducer in control application. (3)
- (b) Classified the transducer, based on the technology with suitable examples. (10)
- Q.2 Differentiate between: (12)
- (a) On-off and Proportional Control
- (b) PI and PD control
- (c) PID and Fuzzy Control
- Q.3 (a) Discuss in brief the development in direct digital and micro-computer period in control system. (5)
- (b) Draw the neat block diagram of analog control system for water heating. Discuss the function of each component in brief. (7)
- Q.4 (a) Discuss the advantages and disadvantages of feed-forward control system. (5)
- (b) Three pressure sensor each produces a logic zero output, when the pressure at their location falls below a pre-set pressure P1, P2 or P3. A pump is to be turned on , whenever the pressure at all three locations falls below the pre-set value. Obtain the Boolean equation describing the above conditions and design the digital circuit. (5)
- (c) Differentiate between electrical and pneumatic actuator. (3)