# UNIVERSITI KUALA LUMPUR
## MALAYSIAN INSTITUTE OF INDUSTRIAL TECHNOLOGY

# FINAL EXAMINATION

# JANUARY 2016 SEMESTER

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|---|---|---|
| COURSE CODE | : | JCB 10103 |
| COURSE TITLE | : | INTRODUCTION TO INSTRUMENTATION AND PROCESS CONTROL |
| PROGRAMME LEVEL | : | BACHELOR |
| DATE | : | 31 MAY 2016 |
| TIME | : | 9.00 AM – 12.00 PM |
| DURATION | : | 3 HOURS |

## INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.

2. This question paper is printed on both sides of the paper.

3. This question paper consists of ONE (1) section.

4. Answer FOUR (4) questions ONLY in Section A.

5. Please write your answers on the answer booklet provided.

6. Please answer all questions in English only.

THERE ARE 9 PAGES OF QUESTIONS EXCLUDING THIS PAGE.

SECTION A (Total: 100 marks)

INSTRUCTION: Answer FOUR (4) questions ONLY.
Please use the answer booklet provided.

Question 1

(a)    Based on our lab session in the Chemical Lab, in order to keep the chemical sample that we want to test out maintains its original form, i.e. does not change its concentration, we need to have the basic requirement for the facility. Find TWO (2) basic requirements for the Chemical Lab's facility that is needed to serve the purpose.

(2 marks)

(b)    The current situation of economic pressures have greatly affected the performance and growth in industries that are applying process automation.

i.     With your own words, explain on the reason that industries need a process automation.

(3 marks)

ii.    Identify THREE (3) general criterion for evaluating the quality of the performance of a process control system.

(3 marks)

(c)    As shown in Figure 1, a manometer is used to measure the pressure in a tank. The fluid used has a specific gravity of 0.85, and the manometer column height, H is 55 cm. If the local atmospheric pressure is 96 kPa, determine the absolute pressure within the tank.
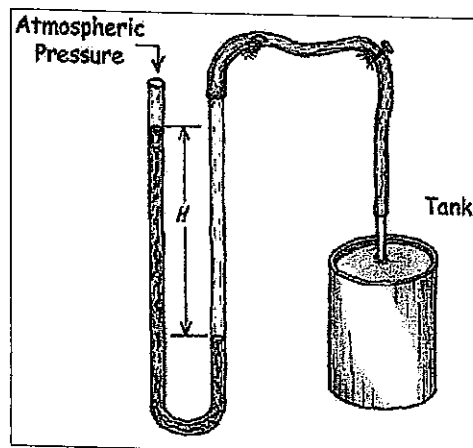
(5 marks)



Figure 1: Manometer Used to Measure the Pressure in a Tank

(d)     Figure 2 shows the manual process of controlling the flow of a water in a pipeline in an oil and gas industry. The desired output flow (Qout) is done by the operator by controlling the valve manually based on monitoring the water tank level. As a Process Control Engineer in the company, recommend an automatic control system by redrawing the diagram of the new automatic process control. Include the important elements of automatic process control in your diagram.
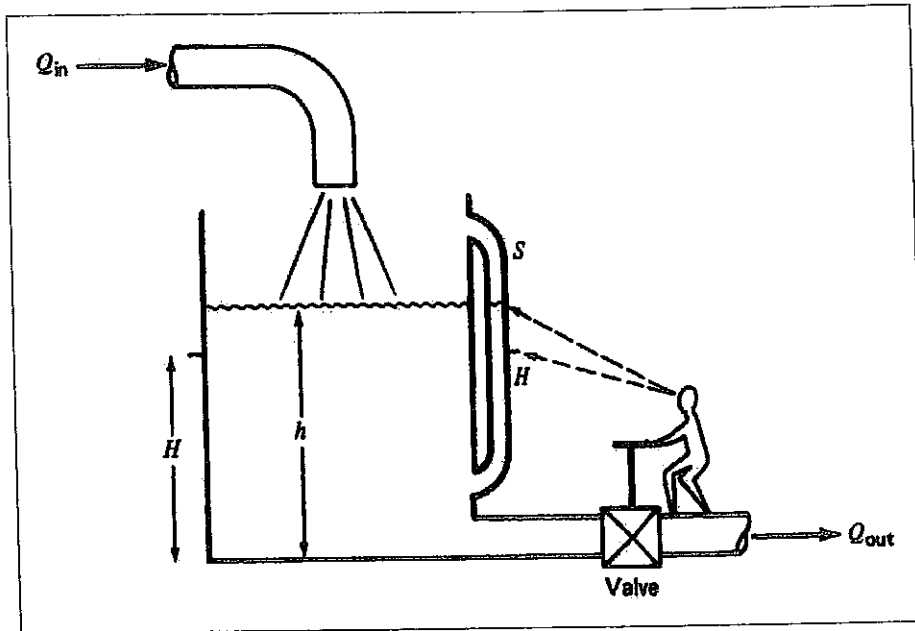
(6 marks)



Figure 2: Operator Adjusting the Valve to Control Water Flow

(e)     Express the basic elements of a **Close-loop System** by showing it in a block diagram in accordance with its correct flow.

(6 marks)

**Question 2**

(a)     The unit kg/m³ describes a material's characteristic or property. Define the name of the property.

(1 mark)

(b)     Classify each of the system below to be either the Open Loop or Closed Loop system.

   i.    Kettle

   ii.   Refrigerator

(2 marks)

(c)     Process control is the controlling of an output variable by sensing the amplitude of the output parameter from the process, and comparing it to the desired set point. The signal will be fed back to control an input variable. Explain **FOUR (4)** objectives of process control.

(4 marks)

(d)     All electrical instruments need to be protected from electrical shock. Devices that are used to protect the instrument from excessive charges flow are the **Fuse** and the **Circuit Breaker**. Investigate how does each of them functions to protect the electrical instruments in industry.

(4 marks)

(e)     The Wheatstone Bridge was developed by Charles Wheatstone in 1850 and it has been served for a long time as the most accurate way of measuring resistance. With the aid of a diagram, show your analysis on the balanced Wheatstone Bridge equation.

(4 marks)

(f)     Measurement systems are important tools for the quantification of the physical variable. Identify the **FOUR (4)** general characteristics of Measurement Systems.

(4 marks)

(g)     In general, there are **TWO (2)** types of temperature measuring devices or instruments. Explain both of the types and provide **ONE (1)** example for each of them.

(6 marks)

**Question 3**

(a)　*"It comprises of at least two metals joined together to form two junctions. One of this junction is connected to the body whose temperature is to be measured and it is called the Measuring End. The other junction of this device is called the Tail or Reference End."*

Recognize the correct measuring instrument that is best described by the above statement.

(1 mark)

(b)　A voltmeter is used to read a voltage that is known to be 5.00 V. These 10 readings were obtained after a certain measurement period; [5.03, 4.97, 5.00, 4.99, 5.02, 4.98, 5.03, 5.02, 5.01, 4.97]. Based on the readings:

　　i.　Calculate the average reading of the voltmeter.

(2 marks)

　　ii.　Conclude on the **Accuracy** and **Precision** of this devise.

(2 marks)

　　iii.　Other than Accuracy and Precision, indicate another **THREE (3)** parameters under the Static Characteristics of measurement that are to be considered in the choice of instrument for a particular application.

(3 marks)

(c)   Figure 3 shows the working principle of a Bourdon Tube gage. It is a type of a measurement system. Based on Figure 3:

i.    State the name of the property that is measured by the Bourdon tube.

(1 mark)

ii.   Translate each alphabet; **A**, **B**, **C** and **D** based on General Measuring System's elements.

(4 marks)

iii.  There are few points to consider in choosing the appropriate measuring systems. Outline **FOUR (4)** of them.
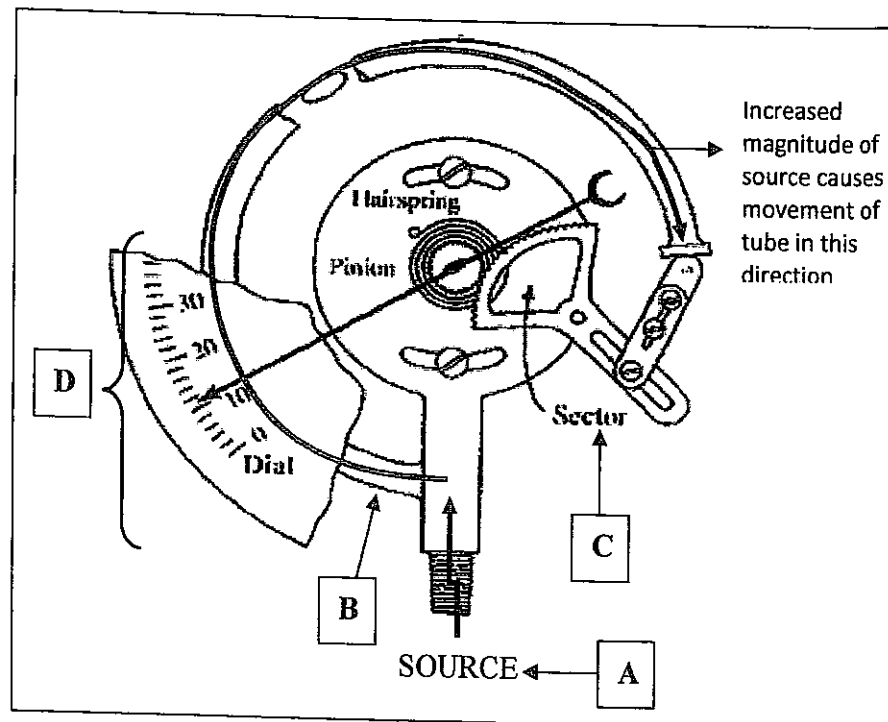
(4 marks)



Figure 3: Bourdon-Tube Gage

(d)   Every employee has the tendency to be exposed to hazards at work place. Explain the **FOUR (4)** types of hazards. Your answer must include **ONE (1)** example for each type of hazard.

(8 marks)

## Question 4

(a)     Closed-Loop Systems are the only type of systems that allow correct control of a process or system. It is now being used widely in many industries. Clarify **TWO (2)** advantages and **TWO (2)** disadvantages of a Closed-Loop system.

(4 marks)

(b)     EMC is the interaction of electrical and electronic equipment with its electromagnetic environment, and with other equipment. All electronic devices have the potential to emit electromagnetic fields. With the proliferation of electronic devices into everyday life - TVs, Washing machines, Electronic ignitions, Traffic lights, Mobile phones, ATMs, Anti-theft tags, to name but a few - there is therefore a huge potential for devices to interfere with each other. Figure 4 shows how coupling can occur inside a radio receiver. Clarify **TWO (2)** coupling mechanisms as illustrated in the figure.
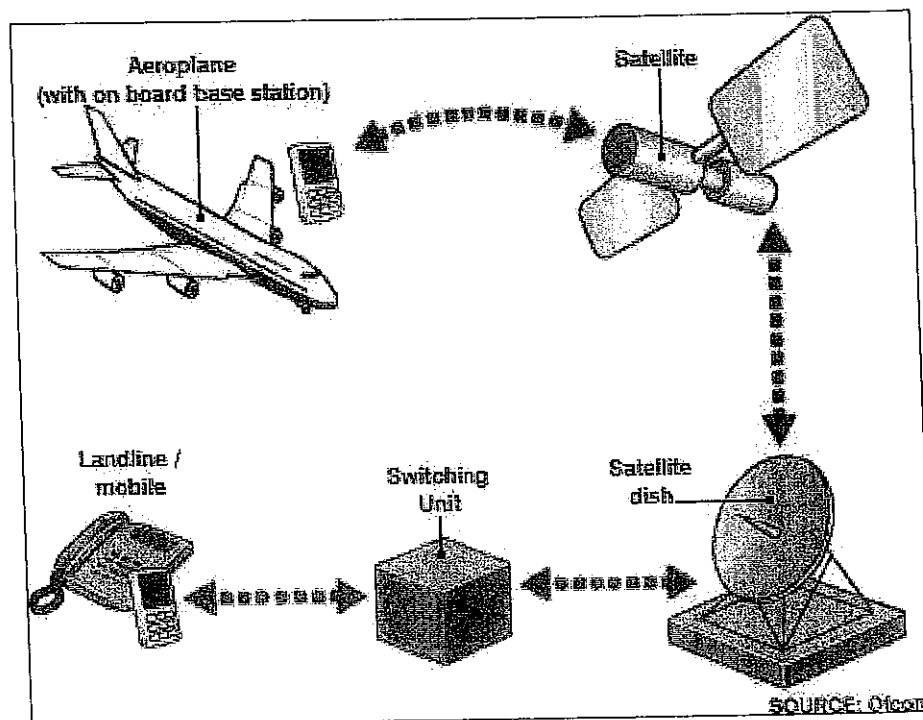
(4 marks)



Figure 4: Interference in the Radio Receiver

(c)    Imagine you own a swimming pool at the backyard of your house as in Figure 5. In order to maintain the pH level of the swimming pool, the amount of the acidic solution that is added to the swimming pool has to be controlled. Based on Figure 5, identify the **Process**, **Actuator**, **Controlled Variable**, **Manipulated Variable** and **Disturbance/s** of the system.
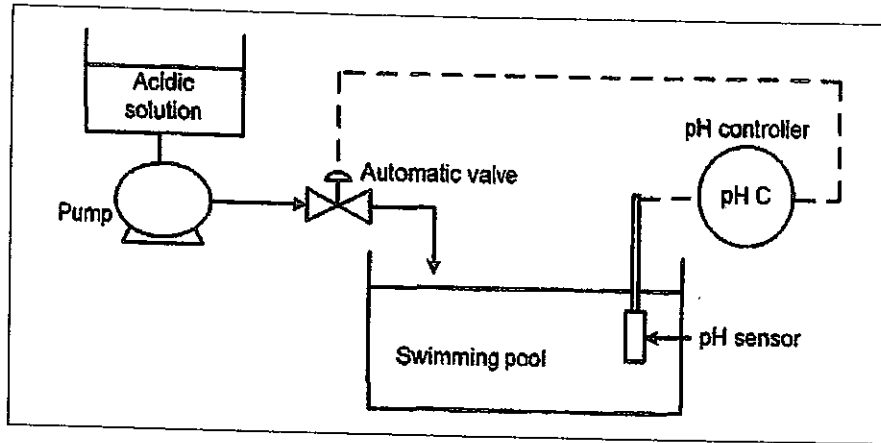
(5 marks)



Figure 5: Backyard Swimming Pool's pH Control System

(d)    With your own words, explain the word Transmitter. Provide **THREE (3)** types of transmitter used in Process Industries.

(6 marks)

(e)    A measurement of the current across resistor is recorded as 40A. The expected value of the voltage across a resistor is 45A. Calculate:

i.     Absolute error

ii.    Percentage error

iii.   Relative accuracy

(6 marks)

**Question 5**

(a)   Monitoring systems served as the need for the accountability of process control. Compare **TWO (2)** advantages of Conventional Monitoring and Automatic/Computer-Based Monitoring.

(4 marks)

(b)   A transmitter is a device that produces an output signal, often in the form of a 4–20 mA electrical current signal, using voltage, frequency, pressure, or ethernet are possible and transmits that signal to a monitor or controller.

A pH transmitter has a calibrated range of 4 pH to 10 pH, with a 4-20 mA output signal. Calculate the pH sensed by the transmitter if its output signal is 11.3 mA.

(4 marks)

(c)   A pool of oil has a mass of 852 kg. The pool has a volume of 0.917 m³. Calculate the **Density** and **Specific Weight** of the oil.

(4 marks)

(d)   A consequence of the pressure in a fluid has been the source of many inventions that are a part of our daily lives such as hydraulic brakes and lifts. This is what enables us to lift a car easily, as shown in Figure 6. Based on Figure 6:

   i.      Express the relationship between Force and Pressure in a Hydraulic System.

(2 marks)

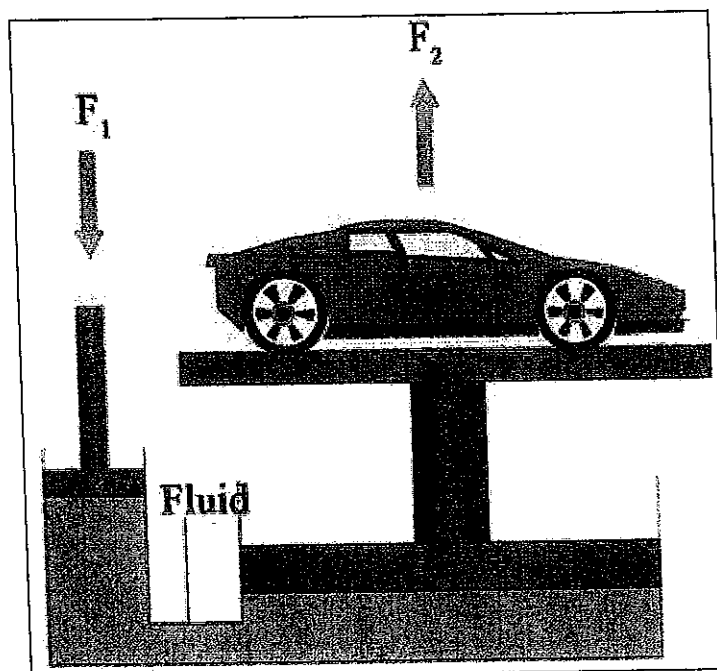   ii.     Elaborate the working principles of the Hydraulic System/Actuator.

(3 marks)



Figure 6: Lifting of a Car Using a Hydraulic Car Jack

(e)  The following table gives a summary of reading after a measurement is carried out:

Table 1: Readings of a Measurement

| No. | Results | No. of trial |
|-----|---------|--------------|
| 1 | 2.10 | 2 |
| 2 | 2.11 | 4 |
| 3 | 2.12 | 8 |
| 4 | 2.13 | 3 |
| 5 | 2.14 | 1 |

Interpret these reading by determining:

i.    Arithmetic mean

ii.   Deviation from mean

iii.  Standard deviation

(8 marks)

## END OF EXAMINATION PAPER