UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	PROCESS INSTRUMENTATION
COURSE CODE	:	BNQ 40303
PROGRAMME	:	3 BNN
DATE	:	DECEMBER 2014/ JANUARY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS PAPER CONSISTS OF **FIVE (5)** PAGES

Q1   (a)   Differentiate between static and dynamic instrumentation characteristics

(4 marks)

(b)   Two pressure gauges (pressure gauge A and B) have a full scale accuracy of ± 5%. Sensor A has a range of 0 - 10 bar and sensor B has a range of 0 – 50 bar. Determine which gauge is more suitable to be used if the reading is 7 bar? Explain your answer.

(6 marks)

(c)   Identify **FIVE (5)** static instrumentation characteristics and briefly elaborate the identified characteristics.

(10 marks)

(d)   The output of a platinum resistance thermometer (RTD) is shown in **Table Q1**:

Table Q1

Input (°C)	Output (Ohm)
0	0
150	300
300	600
450	900
600	1200

Based on data from **Table Q1** with the aid of a graph paper:

(i)   Draw an input versus output graph.

(3 marks)

(ii)   Calculate the sensitivity of the equipment.

(2 marks)

Q2   (a)   Numerical representation is divided into two types that are analog and digital.

(i)   Compare analog representation to digital representation.

(6 marks)

(ii)   Give an example with related figure of each.

(4 marks)

(b)   **Table Q2** shows types of material for a thermocouple complete with its temperature span and sensitivity.

Table Q2

Type	Materials	Span (°C)	Sensitivity, S (μV/°C)
A	Platinum 30% rhodium/ platinum 6% rhodium	0 to 1800	3
B	Chromel / constantan	-200 to 1000	63
C	Iron / constantan	-200 to 900	53
D	Chromel / alumel	-200 to 1300	41
E	Nirosil / nisil	-200 to 1300	28
F	Platinum / Platinum 13% rhodium	0 to 1400	6
G	Platinum/ Platinum 10% rhodium	0 to 1400	6
H	Copper / Constantan	-200 to 400	43

Based on **Table Q2**, determine the type of thermocouple with:

(i)   Largest Range of Span

(1 mark)

(ii)   Highest measurement capacity

(1 mark)

(iii)   Lowest range of span

(1 mark)

(iv)   Largest output span (Output span = Range of Span X S)

(2 marks)

Note: You may present your answer in the table form, if necessary.

(c)   (i)   Describe the characteristics of control valve openings :

(a) Linear

(2 marks)

(b) Equal percentage

(2 marks)

(c) Quick opening type.

(2 marks)

(ii)   Illustrate your description of all control valve opening in **Q2(c)(i)** by plotting corresponding graph relating flow rates and its relative stem position.

(4 marks)

Q3 (a) List **SEVEN (7)** important criteria that need to be considered when selecting a transducer.

(7 marks)

(b) Select **THREE (3)** of the following transducers/sensors listed in **Table Q3**. For each of the transducer/ sensor selected, identify:

(i) Basic principle (with related equation if necessary)

(6 marks)

(ii) Advantages and disadvantages of each selected transducer/ sensor

(12 marks)

Prepare your answer in **TWO (2)** table forms:
1. **Table 1 - Transducer/ sensor VS basic operating principle**
2. **Table 2 - Transducer/ sensor VS advantage and disadvantage.**

Table Q3

Transducers/ sensors in the process industry
1. Differential Pressure Flow Meter   2. Bimetallic Sensor   3. Radiation Pyrometer   4. Piezoelectric Pressure Sensor   5. Static Pressure Type Level Sensor   6. Magnetic Flow Meter

Q4 (a) Instruments normally operate on digital signals. Therefore analog signals need to be converted into digital signals using Analog to Digital Converter (ADC) device. Two operations which normally involved in this process are sampling process and quantization process.

(i) Describe the process of sampling from analog signal to ADC converter. Include related diagram to assist your description.

(5 marks)

(ii) Analog to digital 4 bytes converter has a ± 0.5 byte of quantization error and 8 volt of input full scale voltage. Calculate:
(i) resolution,
(ii) quantization error in volt and;
(iii) accuracy percentage (Full scale) of the instrument.

(6 marks)

(b) (i) Differentiate between Filter and Filtering Process based on definition

(4 marks)

(ii) List **THREE (3)** functions and **THREE (3)** applications of a filter

(6 marks)

(iii)   Interpret the meaning of Transmission and Attenuation in filtering process.

(4 marks)

Q5   (a)   Name **FOUR (4)** types of valve's design.

(4 marks)

(b)   Based on your answer in **Q5 (a)**, build a table summarizing the applications, advantages and disadvantages of all four types of the valve's design.

(6 marks)

(c)   Valve sizing is very important in determining the required valve characteristic and also the flow capacity of the valve. **Table Q5** shows the valve size (inches) also its flow co-efficiency (Cv).

Table Q5

Valve size (Inches)	Cv
0.25	0.3
0.50	3.0
1.00	14.0
1.50	35.0
2.00	55.0
3.00	108.0
4.00	174.0
6.00	400.0
8.00	725.0

*Note: Show every steps of calculation.

(i)   Determine the suitable Cv for a valve that allows the flow of 120-gallon ethyl alcohol in 1 min with a specific gravity of 0.78 at a maximum pressure of 60 psi.

(3 marks)

(ii)   Based on **Table Q5**, predict the size of the valve needed for **Q5 C (i)**.

(1 marks)

(d)   An equal percentage valve has a maximum flow of 60 cm^3/s and has a minimum flow 3 cm^3/s. If the maximum flow diameter is 5 cm, determine the flow rate when the opening is 2 cm.

(4 marks)

(e)   There are many factors to be considered before making an important valve purchase. Determine **SEVEN (7)** of the criteria used to design and to select the best valve for any particular application.

(7 marks)

END OF QUESTIONS