UNIVERSITY
OF
JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *CHEMICAL ENGINEERING*
SUBJECT	:	**PROCESS CONTROL**
CODE	:	**ICP 3111**
DATE	:	SUMMER SSA EXAMINATION 2014 4 DECEMBER 2014
DURATION	:	(SESSION 2) 11:30 - 15:30
WEIGHT	:	40: 60
TOTAL MARKS	:	100

EXAMINER	:	MRS TP MASHIFANA
MODERATOR	:	DR H RUTTO
NUMBER OF PAGES	:	6 PAGES INCLUDING ANNEXURES

INSTRUCTIONS	: QUESTION PAPERS MUST BE HANDED IN. : CALCULATORS ARE ALLOWED : NO COMPUTERS ALLOWED : NUMBER AND ANSWER ALL QUESTIONS IN AN ORDER : UNIVERSITY EXAM RULES APPLY

Question 1

a) Give the operating principle, advantages and disadvantages for Radar transmitters

b) Give the difference between a feedback control and a feed-forward control and provide the advantages and disadvantages for each.

c) Define the following terms:
   • Programmable logic controller (PLC)
   • Ladder logic

d) Figure 1 shows a stirred batch reactor, a simple feedback control and cascade control can be applied to control the temperature in and around the reactor. Use diagrams to show the difference between simple feedback control and cascade control

Feed (F_i, T_i)

Tc

Product
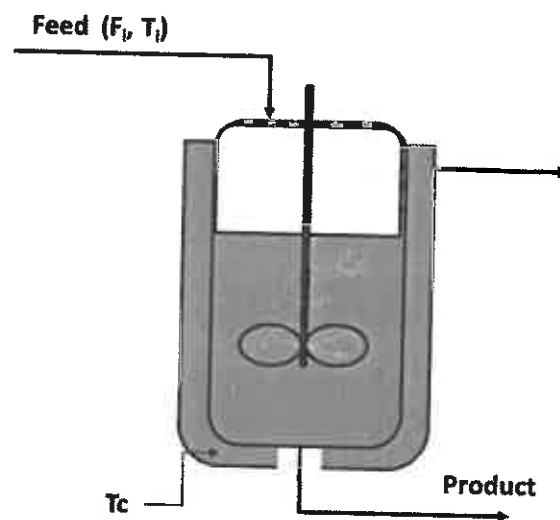
Figure 1: stirred batch reactor

Question 2

[15]

A pressure transmitter (TT) has a range from 0.5 bar to 1.5 bar which corresponds to a linear analog signal range of 4 mA to 20 mA. Determine the value of pressure that corresponds to a current signal of 15 mA.

N.B: Use SI Units

(a) Derive the linear formula expressing pressure in terms of current signal.

(b) Determine the value of the pressure that corresponds to a current signal of 15 mA.

Question 3

Figure 1: Logic circuit

a) Develop a Boolean expression for the logic circuit in figure 2
b) Simplify the Boolean expression and prove that the final Boolean expression is B(A+C)
c) Design a logic circuit for the final expression

Question 4

Diagram below shows a schematic of a shower flow diagram.

Figure 1: Schematic of a shower flow diagram

The design intent of the automated shower is to maintain the temperature of the mixed warm water Ts at some shower temperature set point Ts,sp.

The disturbances that can bring instability to the shower system are

• The flow of hot water F_H, which decreases or increases as how water taps are opened or closed by other users in other parts of the house.

- The temperature of the hot water T_H, which changes as the operation of the geyser is influenced by the use of water around the house.

The temperature of cold water T_C, is constant and cannot be manipulated.
The flow of cold water F_C, can be changed by a control valve to increase or decrease the flow as may be required.

1.   Design a feedback control loop for the shower system using and draw a clear picture of the final answer showing process flow diagram with control loop.

Appendix A : Traditional digital logic gate symbols, Boolean functions and truth table

Type	Distinctive shape	Boolean algebra between A & B	Meaning	Truth table		
AND		$A \cdot B$	Output is true if and only if (iff) both A and B are true	**INPUT**		**OUTPUT**
				A	B	A AND B
				0	0	0
				0	1	0
				1	0	0
				1	1	1
OR		$A + B$	True iff A is true, or B is true, or both.	**INPUT**		**OUTPUT**
				A	B	A OR B
				0	0	0
				0	1	1
				1	0	1
				1	1	1
NOT		$\overline{A}$	True iff A is false.	**INPUT**		**OUTPUT**
				A		NOT A
				0		1
				1		0
NAND		$\overline{A \cdot B}$	A and B are not both true.	**INPUT**		**OUTPUT**
				A	B	A NAND B
				0	0	1
				0	1	1
				1	0	1
				1	1	0

NOR		$\overline{A+B}$	True iff neither A nor B.	INPUT		OUTPUT
				A	B	A NOR B
				0	0	1
				0	1	0
				1	0	0
				1	1	0

XOR		$A \oplus B$	True iff A is not equal to B.	INPUT		OUTPUT
				A	B	A XOR B
				0	0	0
				0	1	1
				1	0	1
				1	1	0

XNOR		$\overline{A \oplus B}$	True iff A is equal to B.	INPUT		OUTPUT
				A	B	A XNOR B
				0	0	1
				0	1	0
				1	0	0
				1	1	1