UNIVERSITY OF JOHANNESBURG

PROGRAM	NATIONAL DIPLOMA *CHEMICAL ENGINEERING*
SUBJECT	**PROCESS CONTROL**
CODE	**ICP3111**
DATE	SUMMER EXAMINATION 25 NOVEMBER 2016
DURATION	08:30-11:30
TOTAL MARKS	100
FULL MARKS	100

EXAMINER	: MRS T MASHIFANA AND MS T SITHOLE
MODERATOR	: DR H RUTTO
NUMBER OF PAGES	:6 PAGES INCLUDING COVER PAGE

INSTRUCTIONS:	CALCULATORS ARE ALLOWED (ONE PER STUDENT)
	NO COMPUTER ALLOWED
	ANSWER ALL QUESTIONS

Question 1: [25]

1.1. What are the requirements to be satisfied to meet plant or process objectives? Provide examples to support your answer. [10]

1.2. Ethanol is feed to continuous reactor with presence of Acid Sulphuric catalyzer to produce ethylene. Distillation process then will be applied to separate ethylene-H_2O mixture. Ethylene as a top product is then condensate with condenser to perform liquid ethylene. Hydrogenation of ethylene applies in another reactor with presence of Nickel catalyzer to produce ethane as a final product.

$$CH_3CH_2OH \xrightarrow{H_2SO_4} CH_2{=}CH_2 + H_2O$$

$$CH_2{=}CH_2 + H_2 \xrightarrow[Ni]{} CH_3CH_3$$

(a) What is/are the reactant/s and the final product/s? [3]
(b) List all the major equipment [3]
(c) Develop a block flow diagram (BFD) for these processes. [9]

Question 2 [20]

Figure 2 below shows a distillation column. The objective is to maintain the distillate composition flow rate back to the column at C_D and the flow rate in the tailings at F_T

By following the control system design steps, show how you will implement a control system to achieve the objectives.

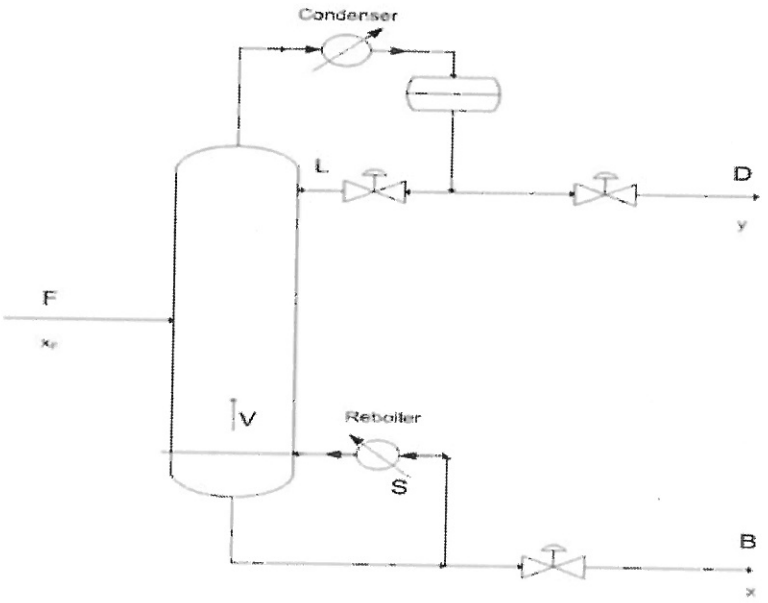


Figure 2: Distillation column

Question 3 [20]

1. Draw a logic circuit for the following

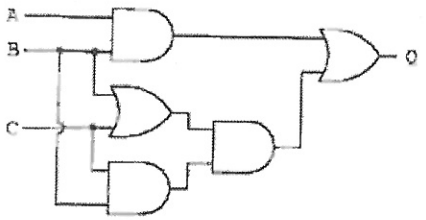
(a) $F = (A+B).C$ [3]

(b) $F = A+B.\overline{C+D}$ [3]

(c) $F = A.B + \overline{A.C}$ [4]

(d) $F = \overline{(A+B)}.(C+D).\overline{C}$ [5]

2. Find the behaviour expression or alarm setting output for the following circuit (Neatly copy the circuit and label each signal stream labelled and show the final expression Q. [5]



Question 4 [15]

A control with an equal percentage inherent characteric has a maximum Cv of 1300 and a rengeability of 40.

(a) Calculate the % changes in the flow for every 10% change in valve. [5]

(b) Calculate the values of Cv corresponding to valve travel from 10% to 40% by step of 10% draw a table containing these values. [10]

Question 5 [20]

(a) What are the types of error signal measurements? Give five [5]

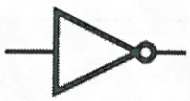
(b) What is the difference between an analogue and a digital signal? [4]

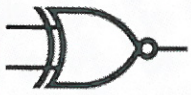
(c) Explain the two main categories of control valve? [4]

(d) What are the uses of op-amps? Give four [4]

(e) Give three types of control valves? [3]

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

<table>
<tr><th>Type</th><th>Distinctive shape</th><th>Boolean algebra between A & B</th><th>Meaning</th><th>Truth table</th></tr>
<tr><td><u>AND</u></td><td>  </td><td>$A \cdot B$</td><td>Output is true if and only if (<u>iff</u>) both A and B are true</td><td>
<table>
<tr><th colspan="2">INPUT</th><th>OUTPUT</th></tr>
<tr><td>A</td><td>B</td><td>A AND B</td></tr>
<tr><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
</table>
</td></tr>
<tr><td><u>OR</u></td><td>  </td><td>$A + B$</td><td>True iff A is true, or B is true, or both.</td><td>
<table>
<tr><th colspan="2">INPUT</th><th>OUTPUT</th></tr>
<tr><td>A</td><td>B</td><td>A OR B</td></tr>
<tr><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
</table>
</td></tr>
<tr><td><u>NOT</u></td><td>  </td><td>$\overline{A}$</td><td>True iff A is false.</td><td>
<table>
<tr><th colspan="2">INPUT</th><th>OUTPUT</th></tr>
<tr><td colspan="2">A</td><td>NOT A</td></tr>
<tr><td colspan="2">0</td><td>1</td></tr>
<tr><td colspan="2">1</td><td>0</td></tr>
</table>
</td></tr>
<tr><td><u>NAND</u></td><td>  </td><td>$\overline{A \cdot B}$</td><td>A and B are not both true.</td><td>
<table>
<tr><th colspan="2">INPUT</th><th>OUTPUT</th></tr>
<tr><td>A</td><td>B</td><td>A NAND B</td></tr>
<tr><td>0</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>0</td></tr>
</table>
</td></tr>
<tr><td><u>NOR</u></td><td>  </td><td>$\overline{A + B}$</td><td>True iff neither A nor B.</td><td>
<table>
<tr><th colspan="2">INPUT</th><th>OUTPUT</th></tr>
<tr><td>A</td><td>B</td><td>A NOR B</td></tr>
<tr><td>0</td><td>0</td><td>1</td></tr>
</table>
</td></tr>
</table>

				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