NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

'ARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

MENG MANUFACTURING SYSTEMS/ENGINEERING & OPERATIONS MANAGEMENT

DESIGN, ANALYSIS AND CONTROL OF MANUFACTURING SYSTEMS

TIE6111

STAGE 1 EXAMINATION

SEPTEMBER 2024

This examination paper consists of **6** printed pages

Time Allowed: **3 HOURS**

Total Marks: **100**

Examiner's Name: **TAKUDZWA M MUHLA**

INSTRUCTIONS AND INFORMATION TO CANDIDATE

1. Answer any FIVE **(5)** Questions.
2. Each Question carries a total of 20 Marks.
3. Start the answer to each full question on a fresh page.
4. Use of calculators is permissible.
5. Ensure neatness and legibility of work.

QUESTION 1

a) What are the advantages of using the Rank Order Clustering Algorithm over other clustering algorithms? **[5]**

b) Consider the part-machine incidence matrix presented in Table Q1 below, identify the logical part families and machine groups using the Rank Order Clustering Algorithm. **[15]**

Table Q1: Part Machine Matrix

Machines	Parts									
	1	2	3	4	5	6	7	8	9	10
M1	1	1	1	1	1		1	1	1	1
M2		1	1	1					1	1
M3	1				1	1	1			
M4		1	1	1				1	1	1
M5	1	1	1	1	1	1	1	1		

QUESTION 2

A computer Assembly requires the following tasks in the given sequence in Table Q2 below. The Desired Output rate is 140 computers/week and the assembly line operates for 1 shift/day (7 hours, 5 days a week).

Table Q2: Precedence Table

Task	Immediate Predecessor	Task time(minutes)
A	-	12
B	A	6
C	B	6
D	B	2
E	B	2
F	B	12
G	C, D	7
H	G	5
I	E	1
J	F,I	4
k	H, J	6
L	K	7

a) Draw the Precedence diagram **[8]**

b) Calculate the cycle time **[3]**

c) Calculate the theoretical number of workstations **[3]**

d) Calculate the Lead time **[3]**

e) Calculate the Efficiency **[3]**

QUESTION 3

a) Explain what is meant by line balancing and outline its importance **[4]**

b) An assembly line consists of twelve work elements as shown in Table Q3. Assuming a cycle time of 1 minute, you are required to design a well-balanced assembly line.

Table Q3: Assembly Line

M1	1	2	3	4	5	6	7	8	9	10	11	12
M2	0.2	0.4	0.7	0.1	0.3	0.1 1	0.3 2	0.6	0.27	0.38	0.5	0.12
M3	-	-	1	1,2	2	3	3	3,4	6.7. 8	5,8	9,10	11

i. Determine the minimum possible number of workstations for the line. **[2]**

ii. Use the Largest Candidate Rule Method to balance the Assembly line. **14]**

QUESTION 4

a) Using an appropriate diagram, compare the five generic types of manufacturing processes in terms of production volumes and variety of products produced. **[10]**

b) Liquid Manufacturing Group seeks to establish the best location for a new production facility that will supply five warehouses around Zimbabwe. They have hired you as a consultant for this task. The Location as well as demand for each warehouse are as shown in Table Q4 below. The unit transportation cost per unit distance is assumed to be the same for all the warehouses. Using the Centre of Gravity Method, determine the best location for the new production facility.

[10]

Table Q4: Warehouse Location and Demand

Warehouse	Location (x,y)	Demand (units)
A	(200,300)	5000
B	(100,50)	1500
C	(50,200)	3000

D	(50,50)	200
E	(75,150)	400

QUESTION 5

a) Briefly explain any four methods that can be used to improve the line balance. **[8]**

b) Consider a problem of Five (5) machines and ten parts as shown in Table Q5 below. Find the possible manufacturing cells using the Similarity Coefficient Algorithm. **[10]**

Table Q5: Part-Machine Matrix

Machines	Components									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
M1	1	1	1	1	1		1	1	1	1
M2		1	1	1					1	1
M3	1				1	1	1			
M4		1	1	1				1	1	1
M5	1	1	1	1	1	1	1	1		

c) Develop a dendogram from solution in **(b)**. **[2]**

QUESTION 6

A Group Technology Cell has four machines: 1, 2, 3 and 4. An analysis of 50 parts processed on these machines has been summarised in the From-To Chart as outlined in Table Q6 below.

Table Q6: From-To Chart

From	To			
	1	**2**	**3**	**4**
1	0	5	0	25

2	30	0	0	15
3	10	40	0	0
4	10	0	0	0

Additional Information

- 50 parts enter the machine grouping at machine 3.
- 20 parts leave after processing at machine 1.
- 30 parts leave machine 4 after processing.

Using the Holier Method, determine the most logical machine sequence. **[20]**

QUESTION 7

a) Expricos Taxis is considering changing their target market from commuting to providing airport shuttle services. At the present moment the organisation has seven taxi cabs which will be stationed at the airport. The organisation has determined that during the late-evening hours on weeknights, customers request cabs at a rate that follows the Poisson distribution with a mean of 6.6 per hour. Service time is exponential with a mean of 50 minutes per customer. Assuming there is one customer per cab, Find:

   i) Average number of customers in queue. **[2]**

   ii) Probability of having zero customers in the queue. **[3]**

   iii) Average waiting time for an arrival not immediately served. **[3]**

b) Mr MaPlanks owns a hotdog, burger and soft drink stand just outside the NUST campus gates. Although Mr MaPlanks can service 30 customers in an hour on the average, he only gets 20 customers per hour. Because he can wait on 50% more customers than those who actually visit his stand, it doesn't make sense to Mr MaPlanks that he should have any waiting lines. He has thus hired you as a consultant to examine the situation and to determine some characteristics of his queue. Given that you have observed this to be an M/M/1 system, determine:

   i) Average number of customers in the queue. **[2]**

ii) Average time customer spends in the queue. **[2]**

iii) Average number of customers waiting for service. **[2]**

iv) Percentage of time Mr MaPlanks is waiting on customers. **[3]**

v) Probability that there are no customers in the system at any given time. **[3]**