NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF FIBRE AND POLYMER MATERIALS ENGINEERING

PRODUCTION AND OPERATIONS MANAGEMENT SYSTEMS

TFE 5105

First Semester Examination Paper

December 2024

This examination paper consists of 4 pages

Time Allowed:	3 hours
Total Marks:	100
Special Requirements:	N/A
Examiner's Name:	Dr. M. MOYO

INSTRUCTIONS

1. Answer **QUESTION 1** and **ANY OTHER THREE** Questions.
2. The first fifteen minutes should be spent reading the question paper and making notes.
3. **Do not** open your answer sheet until told to do so.
4. Marks will be awarded for skill in appreciating the scope of questions, clarity of argument and conciseness of presentation as well as for the knowledge displayed by a candidate.

MARK ALLOCATION

QUESTION	MARKS
1.	25
2.	25
3.	25
4.	25
5.	25

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QUESTION 1

Table Q1 shows a 6-months demand forecast (in units) and working days for a company that manufactures polymer products. It takes 5 hours to produce a single polymer unit and an employee works for 8 hours a day.

Table Q1 Demand and working days for manufacturing polymer products

Month	January	February	March	April	May	June
Demand Forecast	400	500	600	700	500	600
Working days	20	22	21	19	20	22

The cost data for the plant is given as follows:

Hiring cost per employee ($)	500
Inventory carrying (holding) cost per unit per month ($)	10
Regular wage per employee per month ($)	2400
Layoff cost per employee ($)	700
Overtime wage per hour ($)	15

Formulate a production plan for the company using the following plans and compare their total costs:

a) Level Production Plan.   **[7 Marks]**

b) Chase Demand Production Plan.   **[14 Marks]**

c) With reference to the calculations performed in a) and b), explain **one** advantage and **one** disadvantage of:

    i.   Level production plan.   **[2 Marks]**

    ii. Chase demand production plan.   **[2 Marks]**

QUESTION 2

a) Discuss the role of the Critical Path Method (CPM) in managing project production flows and how it improves efficiency.   **[10 Marks]**

b) Propose a project production flow for developing a high-temperature-resistant polymer material, highlighting the key steps, challenges and how the simulation software can be used in the project production flow.   **[15 Marks]**

QUESTION 3

a) Table Q3a) shows a weaving company's quarterly fabric demand (in kg) for the last 4 years.

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Table Q3a) Quarterly fabric demand for the last 4 years

Quarter	Year 1	Year 2	Year 3	Year 4
Fall	2530	2690	2790	2860
Winter	2300	2420	2410	2600
Spring	1900	2000	2105	2175
Summer	1510	1775	1875	1945

Based on the data given in Table Q3a) and assuming that the annual demand is expected to be 2800 in year 5, forecast the fabric demand for the four quarters of year 5 using the seasonal forecasting method. Show all your workings. **[10 Marks]**

b) You are tasked to select relevant important manufacturing processes for producing lightweight polymer components for an electric vehicle. Discuss the type of component you would make and the relevant important manufacturing processes involved in manufacturing that component. Justify your choice of processes and materials.

[15 Marks]

QUESTION 4

a) Describe the nature of a facility layout you would recommend for a small-scale polymer recycling plant, highlighting key areas and justifying their placement. **[4 Marks]**

b) Elucidate the **five** key components of a queuing system in the context of polymer processing and provide specific examples under each component. **[5 Marks]**

c) A polymer manufacturing company produces high-performance resin sheets. The annual demand for resin sheets is 20,000 units. The cost per order is $50, the holding cost per unit per year is $2, and the lead time for delivery is 5 working days. The factory operates 250 working days a year. Determine and explain the meaning of the obtained figures for:

    i.   Economic Order Quantity (EOQ) of the resin sheets. **[3 Marks]**

    ii.   Total inventory cost (total annual cost). **[3 Marks]**

   iii. Reorder Point (ROP). **[3 Marks]**

d) Assume you have been given the responsibility to manage the maintenance and repairs of polymer manufacturing extruders at the company you were attached. Currently, four extruder machines, namely, A, B, C and D need to be repaired and you have received their job cards in the order A first, then B, then C and D last. The estimated repair times (in days) and promise dates are shown in Table Q4d).

Table Q4d) Estimated labour time and promise date

Extruder	Estimated Repair Time (days)	Promise Date
A	5	5
B	10	18
C	1	12
D	3	15

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Based on the First Come First Served (FCFS) sequence and showing all your calculations, determine the following five performance measures: makespan, mean job flow time, average number of jobs in the system, number of tardy jobs and average job tardiness. Today is day 0.   **[7 Marks]**

QUESTION 5

a) With reference to the company where you did your attachment, discuss any **four** types of Muda (waste) observed and provide examples specific to polymer engineering.

[12 Marks]

b) Frank's Fine Floats is in the business of building elaborate parade floats. Frank's crew has a new float to build and would like to use PERT/CPM to help manage the project. Table Q5b) shows the activities that comprise the project as well as each activity's estimated completion time (in days) and predecessors.

Table Q5b) Frank's Fine Floats

Activity	Description	Immediate Predecessors	Completion Time (days)
A	Initial paperwork	-	3
B	Build body	A	3
C	Build frame	A	2
D	Finish body	B	3
E	Finish frame	C	7
F	Final paperwork	B,C	3
G	Mount body to frame	D,E	6
H	Install skirt on frame	C	2

Using the information given in Table Q5b);

i.   draw the network diagram for building a new float showing earliest start and finish times.   **[7 Marks]**

ii. determine all the possible paths and their associated duration for completing the float building project.   **[5 Marks]**

iii. Identify the critical path.   **[1 Mark]**

END OF EXAMINATION QUESTION PAPER

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