25UMET412	PLANT LAYOUT AND MATERIAL HANDLING	Category	L	T	P	R	Credit	Year of Introduction
		PEC	3	0	0	0	3	2025

Preamble:
This course provides a comprehensive deep dive into the strategic and operational aspects of Industrial Engineering. It bridges the gap between theoretical factory design and practical operational efficiency. By exploring the synergy between plant layout and material handling systems, students will learn to design environments that minimize waste, maximize throughput, and ensure worker safety

Prerequisite: Nil

Course Outcomes: After the completion of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Describe the factors influencing plant site selection and the basic characteristics of process, product, and fixed-position layouts.	K2 Understand
CO2	Apply heuristic methods and optimization models to develop efficient plant layout designs.	K3 Apply
CO3	Explain the principles of material handling and the criteria for selecting equipment based on path, function, and layout requirements.	K2 Understand
CO4	Apply motion and flow analysis methods to minimize handling costs and improve ergonomic safety.	K3 Apply

Mapping of course outcomes with program outcomes and program specific outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	-	-	1	-	-	-	-	1	2	1
CO2	3	3	2	2	2	-	-	-	-	-	-	2	3
CO3	3	2	2	-	1	-	-	-	-	-	1	3	2
CO4	2	2	2	1	-	2	-	-	-	-	2	3	2
Avg	2.5	2.25	2.25	1.5	1.5	1.5	-	-	-	-	1.3	2.5	2.00

Mapping of Course Outcomes with Knowledge and Attitude Profile (WK)

	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	*	*	*	*	*	_	_	*	_
CO2	*	*	*	*	*	*	*	*	_
CO3	*	*	*	*	*	*	_	*	_
CO4	*	*	*	*	*	*	*	*	_

WKs Mapped with the Course

WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
*	*	*	*	*	*	*	*	-

Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	**40**	**60**	**2.5 hrs**

Continuous Internal Evaluation Pattern:

Attendance : 5 marks
Continuous Assessment Test : 20 marks
Continuous Assessment Assignment : 15 marks

SYLLABUS

Module 1 (10 hrs)

Introduction – Factors to be considered – influence of location on plant layout, selection of plant site, Consideration in facilities planning and layout. Classification of layout, advantages and limitations of different layouts, layout design procedures, over view of the plant layout. Process lay out and product lay out selection, specification, implementations and follow up comparison of product and process lay out.

Module 2 (10 hrs)

Heuristics for plant layout-ALDEP, CORELAP, CRAFT, Group Layout, Fixed position layout-Quadratic assignment model. Branch and bound method

Module 3 (10 hrs)

Introduction, material handling systems: selection, material handling principles, classification of material handling equipment, relationship of material handling to plant layout. Basic material handling systems: Selection, Material handling method – path, Equipment,
Function orientated systems

Module 4 (12 hrs)

Methods to minimize cost of material handling- Maintenance of material handling equipment's, safety in handling ergonomics of material handling equipment. Analysis of Material Handling: Motion analysis, flow analysis, graphic analysis, safety analysis, equipment cost analysis, palletization analysis

Text Books:

1. Sharma, S. C., *Plant layout and material handling*. Khanna Publishers, 2007.
2. Agarwal, R., *Plant layout and material handling*. Jain Brothers Publications, 2008.
3. Mahajan, M., *Industrial engineering and production management*. Dhanpat Rai & Co., 2008.

Reference Books:

1. Shubin, J. A., *Plant layout*. PHI Publications, 1965.
2. Oberman, Y. A., *Material handling*. Mir Publishers, 1980.
3. Sharma, S. C., *Material management and material handling*. Khanna Publishers, 1995.

END SEMESTER EXAMINATION – MODEL QUESTION PAPER

Course Code	**25UMET412**			
Course Name	**PLANT LAYOUT AND MATERIAL HANDLING**			
Max. Marks: 60	**Duration: 2.5 Hours**			
Part A (Answer all questions. Each question carries 3 marks)				
Qn No.	**Question**	**Marks**	**CO**	**BL**
1	Explain the factors influencing the selection of a plant site.	3	1	L2
2	Distinguish between process layout and product layout, citing one advantage of each.	3	1	L2
3	A pairwise interchange between two departments reduces the total material handling cost from Rs. 6,200 to Rs. 5,750. Compute the percentage reduction in cost achieved by this interchange.	3	2	L3
4	In a Quadratic Assignment Problem, department X has a flow of 40 units/day to department Y, and the distance between their assigned locations is 15 m. Compute the flow–distance cost contributed by this department pair to the objective function.	3	2	L3
5	Explain the basic principles of material handling.	3	3	L2
6	Describe the criteria used for selecting material handling equipment based on path and function.	3	3	L2
7	A handling cycle currently takes 45 seconds. After eliminating unnecessary motions identified through motion analysis, the cycle time reduces to 32 seconds. Compute the percentage reduction in cycle time.	3	4	L3

<table>
<tr><td>8</td><td>In a flow analysis study, material travels a total distance of 180 m through 6 handling stations. Compute the average distance travelled per station.</td><td>3</td><td>4</td><td>L3</td></tr>
<tr><td colspan="5">Part B (Answer any one full question from each Module. Each carries 9 marks)</td></tr>
<tr><td colspan="5">Module I</td></tr>
<tr><td>Qn No.</td><td>Question</td><td>Marks</td><td>CO</td><td>BL</td></tr>
<tr><td>9</td><td>Explain the various factors influencing plant site selection and discuss the considerations involved in facilities planning and layout.</td><td>9</td><td>1</td><td>L2</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>10</td><td>Describe the classification of plant layouts (process, product, fixed-position, and group layout) along with their advantages and limitations. Compare process layout and product layout in terms of selection, specification, and implementation.</td><td>9</td><td>1</td><td>L2</td></tr>
<tr><td colspan="5">Module II</td></tr>
<tr><td>Qn No.</td><td>Question</td><td>Marks</td><td>CO</td><td>BL</td></tr>
<tr><td>11</td><td>Departments A, B, C, and D are currently assigned to locations 1, 2, 3, and 4 respectively, arranged in a row. The material flow (units/day) between departments and the distance (m) between locations are given below.
Material flow (units/day):
<table>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th></tr>
<tr><td>A</td><td>–</td><td>10</td><td>5</td><td>8</td></tr>
<tr><td>B</td><td>10</td><td>–</td><td>6</td><td>4</td></tr>
<tr><td>C</td><td>5</td><td>6</td><td>–</td><td>12</td></tr>
<tr><td>D</td><td>8</td><td>4</td><td>12</td><td>–</td></tr>
</table>
Distance between locations (m):
<table>
<tr><th></th><th>Loc 1</th><th>Loc 2</th><th>Loc 3</th><th>Loc 4</th></tr>
<tr><td>Loc 1</td><td>–</td><td>10</td><td>20</td><td>30</td></tr>
<tr><td>Loc 2</td><td>10</td><td>–</td><td>10</td><td>20</td></tr>
<tr><td>Loc 3</td><td>20</td><td>10</td><td>–</td><td>10</td></tr>
<tr><td>Loc 4</td><td>30</td><td>20</td><td>10</td><td>–</td></tr>
</table></td><td>9</td><td>2</td><td>L3</td></tr>
</table>

	(a) Compute the total material handling cost of this initial layout. (b) Apply the CRAFT algorithm concept to evaluate whether interchanging the locations of B and C reduces the total cost. Show your calculations and state your conclusion.			
OR				
12	Three departments P, Q, and R are to be assigned to three locations 1, 2, and 3. The flow (units/day) between department pairs and the distance (m) between location pairs are given below. *Material flow (units/day):* **P** – 8 5 Q 8 – 10 R 5 10 – *Distance between locations (m):* **Loc 1** – 15 25 Loc 2 15 – 10 Loc 3 25 10 – Using the Quadratic Assignment Model, compute the total material handling cost for the assignment P→1, Q→2, R→3. Then compute the cost for the alternative assignment P→3, Q→2, R→1, and recommend the better assignment.	9	2	L3
Module III				
Qn No.	**Question**	**Marks**	**CO**	**BL**
13. a	Explain the basic principles of material handling and discuss their importance in facility design.	5	3	L2
13. b	Describe the relationship between material handling and plant layout.	4	3	L2
OR				
14. a	Explain the classification of material handling equipment based on	5	3	L2

	path, function, and the systems they serve.			
14. b	Discuss the criteria considered while selecting material handling equipment.	4	3	L2
Module IV				
Qn No.	**Question**	**Marks**	**CO**	**BL**
15. a	A worker's current handling cycle involves 8 motions taking a total of 60 seconds, including 3 unnecessary motions accounting for 18 seconds. Apply motion analysis principles to determine the reduced cycle time after eliminating the unnecessary motions, and compute the percentage time saved.	6	4	L3
15. b	Explain the role of ergonomics in improving the safety of material handling operations.	3	4	L2
OR				
16. a	In a flow analysis study, material moves through 5 stations with travel distances of 12 m, 8 m, 15 m, 10 m, and 20 m respectively, at a handling cost of Rs. 2 per metre. Apply flow analysis to compute the total material handling cost and identify the inter-station movement contributing the highest cost.	6	4	L3
16. b	Discuss the equipment cost analysis approach used in evaluating material handling systems.	3	4	L2