

**UNIVERSITY OF TORONTO**  
**FACULTY OF MECHANICAL AND INDUSTRIAL ENGINEERING**  
**FINAL EXAMINATION, APRIL 2001**

**MIE468S- Facility Planning**  
**Exam Type: A (Non Programmable calculators permitted)**  
**Thursday, April 26, 2001, 09:30 - 12:00**

**Examiner- Eli Lewin**

**100 marks representing 35% of the course mark**

- 1** A regional telephone company is attempting to determine the optimal location for a training facility for its operators. The operators are located in four "operations centres". The coordinates (KM) of the four centres and the number of operators are the following:

<u>Centre</u>	<u>X</u>	<u>Y</u>	<u>No of employees (000)</u>
Centre 1	32	58	6.8
Centre 2	49	42	4.3
Centre 3	11	69	6.0
Centre 4	42	31	3.4

Assume the rectilinear distance is the most appropriate measure.  
The cost of employee moving one KM is \$2.

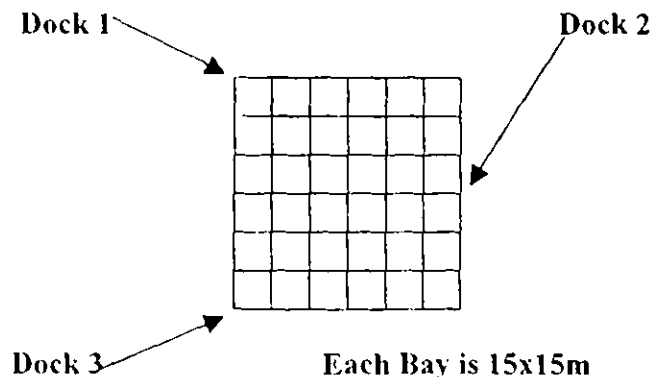
- 3 **a** Define the Objective function in general terms (X, Y, a, b, w, ,).
- 2 **b** What is the name of the method that you would use to get an optimal solution?
- 5 **c** Determine the optimal coordinates of the training facility.
- 2 **d** What is the actual cost of your solution, for one training session, for all the employees in the company?
- 2** The table below gives the map coordinates and the shipping loads for some local cities. We wish to build a new warehouse in a central location, in order to minimize transportation costs to the cities.  
Using the Centre of Gravity method do the following:
- 2 **a** Write the objective function of the model.
- 4 **b** Develop and write the formulas for the coordinates of the warehouse.
- 3 **c** At what coordinates should this warehouse be located?
- 2 **d** Name and describe a Qualitative Method for single facility location.

City	Map Co-ordinates (x, y)	Number of truckloads
A	(6, 3)	9
B	(9, 10)	10
C	(6, 3)	15
D	(3, 2)	6
E	(2, 1)	18
F	(2, 4)	12
G	(4, 2)	8

- 3 A drugstore chain plans to open four stores in a medium-size city. However, funds are limited, so only two can be open this year. Given the following matrix, showing the weighted population distance costs for each area and each store site,
- 3 a Select, according to Ardalan's Method, the first and second locations to be opened.
- 3 b If additional funds become available, which store should be the third to open?

		Store			
		1	2	3	4
<u>Geographic</u> <u>Area</u>	1	0	20	160	60
	2	80	0	40	80
	3	120	80	0	100
	4	80	100	60	0

- 4 Three classes of products (A, B and C) are to be stored in the warehouse depicted in the figure below. Product storage requirements are 15 bays for A, 5 bays for B and 16 bays for C. Forty percent of I/O goes through Dock 1 and the other 60% is split between Dock 2 and Dock 3.
- The rate of activity (Load rate) for A, B and C products is 100, 120, 80, respectively.
- 3 a Present the model for your decision that minimizes cost.
- 5 b Calculate the expected distance to each storage bay.
- 4 c Determine the location for each product, that minimizes expected travel distance.



- 5 2 a What is, on average the most expensive and time-consuming activity in a warehouse, and what methods are used to reduce its cost/time?
- 3 b Name the main two policies to store components. Which policy requires less space, and why?  
What is the disadvantage of the policy that requires less space?
- 5 c The table below shows the stock quantities in pallets, of 6 different products, over 12 periods.  
Determine the storage requirement, in terms of pallets, according to two different policies that you want to discuss.

Inventory levels (No. of pallets) for 6 products:

Period	A	B	C	D	E	F
1	24	12	2	12	11	12
2	22	9	8	8	10	9
3	20	6	6	4	9	6
4	18	3	4	24	8	3
5	16	36	2	20	7	24
6	14	33	8	16	6	21
7	12	30	6	12	5	18
8	10	27	4	8	4	15
9	8	24	2	4	3	12
10	6	21	8	24	2	9
11	4	18	6	20	1	6
12	2	15	4	16	24	3

- 6 8 You require a rectangular warehouse of area  $S$ , and two service windows on the long side of the warehouse. Each window, manned by a storeman, is located at  $1/4$  of the distance from the end of the store and serves  $1/2$  of the store. The components in the warehouse have the same I/O rate.  
Calculate the geometric shape of this warehouse- length, width, type of rectangular, which minimizes the average walking distance (Rectilinear) of each storeman.
- 7 8 Describe 4 measures for distance- The mathematical formula for each, and when it is suitable to be used.
- 8 9 Mention 3 Computer Aided Layout software packages. For each of them comment on the following: Description (1-2 sentences), Objective Function, Type of Input Data, Main disadvantage.
- 9 A conveyor line is being planned to run into a warehouse. It will begin at the Point (0.5) and run parallel to the X axis, in an increasing direction of x. IE. The conveyor line runs to the right of Point (0, 5). Items entering the

warehouse on the conveyor are picked up at the end of it, and manually transported to one of the truck docks at the points  $P1(7, 10)$ ,  $P2(15, 7)$ ,  $P3(15, 3)$  and  $P4(12, 0)$ . Assume that the quantities shipped from each dock are equal. The distance that items travel between the end of the line and any one of the docks, is calculated by the rectilinear distance.

The following costs are given:

Transport costs (\$/Metre) between the end of the conveyor to points  $P1$ ,  $P2$ ,  $P3$ ,  $P4$  are 80, 20, 30, 70 respectively. The conveyor transport cost is \$90/Metre.

- 4 a Construct a model representing the total cost for transporting items, using the conveyor and the manual transport.
- 4 b Using the model developed in Part a, find the conveyor line length to minimize the total material handling cost.
- 4 c At what cost per metre of the conveyor line, it becomes uneconomic to use one at all. IE. To use only manual transport.

**10** Consider a Three-Station conveyor system, with 16 carriers. The load and unload sequence for the three stations is as follows:

$F1 = \{0, -1, -1\}$      $F2 = \{-1, -1, 0\}$      $F3 = \{1, 1, 2\}$

- 2 a Are we going to have a steady state operation, and why?
- 10 b Determine the required capacity of a carrier.