

ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2021 SESSION

Open-book examination
Calculators: only authorized models
Duration : 3 hours

14-IN-A3: FACILITIES PLANNING

Question 1 (20 points)

The following table gives the map coordinates and the shipping loads for four cities that we wish to connect through a central hub.

City	Map Coordinate (X(East), Y(North))	Shipping Load
City 1	(50, 10)	5
City 2	(15, 60)	10
City 3	(40, 60)	15
City 4	(30, 20)	5

- Near which map coordinates should the hub be located? (10 points)
- If the shipments from city 1 triple, how does this change the coordinates? (5 points)
- If a single truck were sent from the central hub to each city and back (four round trips), how many miles would be traveled? (5 points)

Question 2 (25 points)

The physical examination center “A” performs the following seven activities:

Activity	Average Time (Min)
Medical history	10
Blood tests	8
Eye examination	5
Measurements (e.g., weight, height, blood pressure)	7
Medical examination	16
Psychological interview	12
Exit medical evaluation	10

These activities can be performed in any order, with two exceptions: Medical history must be taken first, and Exit medical evaluation is last. At present, there are three paramedics and two physicians on duty during each shift. Only physicians can perform exit evaluations and conduct psychological interviews. Other activities can be carried out by either physicians or paramedics.

- Develop a layout and balance the line. (5 points)
- How many people can be processed per hour? (5 points)
- What is the total idle time per cycle? (5 points)
- If one more physician and one more paramedic can be placed on duty, how would you redraw the layout? (10 points)

Question 3 (20 points)

ABC Inc. decides to improve material flow in its facility. The current layout of eight departments is shown in Figure 1. The only physical restriction is the need to keep "Department A" in its current location. All other departments can be moved to a different work area (each 12 square meters) if layout analysis indicates a move would be beneficial. The material movements among departments in an average month are shown in Figure 2. The objective is to design the layout to minimize the total movement (distance traveled) of material in the facility. Diagonal departments are also assigned a distance of 12 meters. One meter is considered as 1 unit of cost.

- Analyze the current layout and calculate the material movement. (5 point)
- Propose a new layout to reduce the total cost? Justify your response. (10 point)
- Do you see any room for further improvement? Justify your response. (5 point)

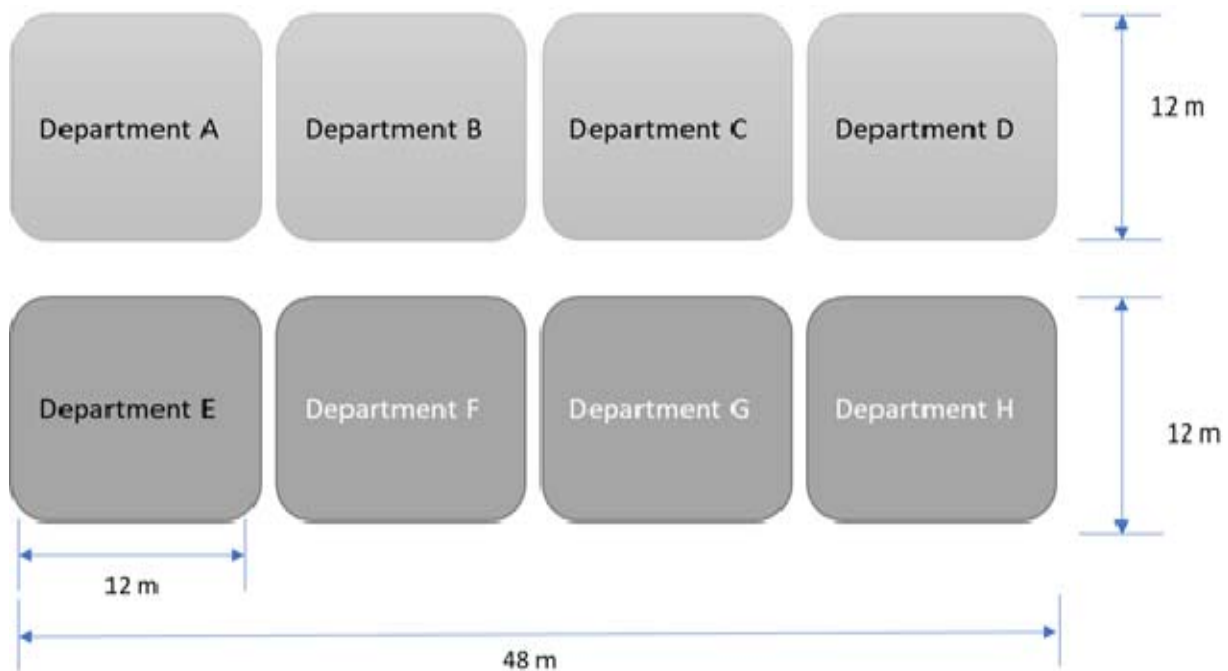


Figure 1.

Dep. A	Dep. B	Dep. C	Dep. D	Dep. E	Dep. F	Dep. G	Dep. H	
	200	200	0	0	0	0	0	Dep. A
		0	100	40	0	0	0	Dep. B
			60	60	0	0	0	Dep. C
				40	0	0	40	Dep. D
					40	0	20	Dep. E
						60	0	Dep. F
							0	Dep. G
								Dep. H

Figure 2.

Question 4 (15 points)

A firm is about to undertake the manufacture of a product, and it is weighing three capacity alternatives: small job shop, large job shop, and repetitive manufacturing. The small job shop has fixed costs of \$3,000 per month, and variable costs of \$10 per unit. The larger job shop has fixed costs of \$12,000 per month and variable costs of \$3 per unit. The repetitive manufacturing plant has fixed costs of \$30,000 and variable costs of \$1 per unit. Demand for the product is expected to be 1,000 units per month with "moderate" market acceptance, but 2,000 under "strong" market acceptance. The probability of moderate acceptance is estimated to be 60 percent; strong acceptance has a probability of 40 percent. The product will sell for \$25 per unit regardless of the capacity decision. Which capacity choice should the firm make?

Question 5 (20 points)

A production process is presented in Figure 3. The operation in station 3 occurs separately from, and simultaneously with, operations in station 1 and 2, which are independent and sequential operations. The product needs to go through only one of the three stations 5, 6 or 7 (the operations are in parallel).

- Which operation is the bottleneck? Justify your response (10 points)
- If the manufacturing plant operates 7 hours per day, 22 days per month, what is the monthly capacity of this process? (10 points)

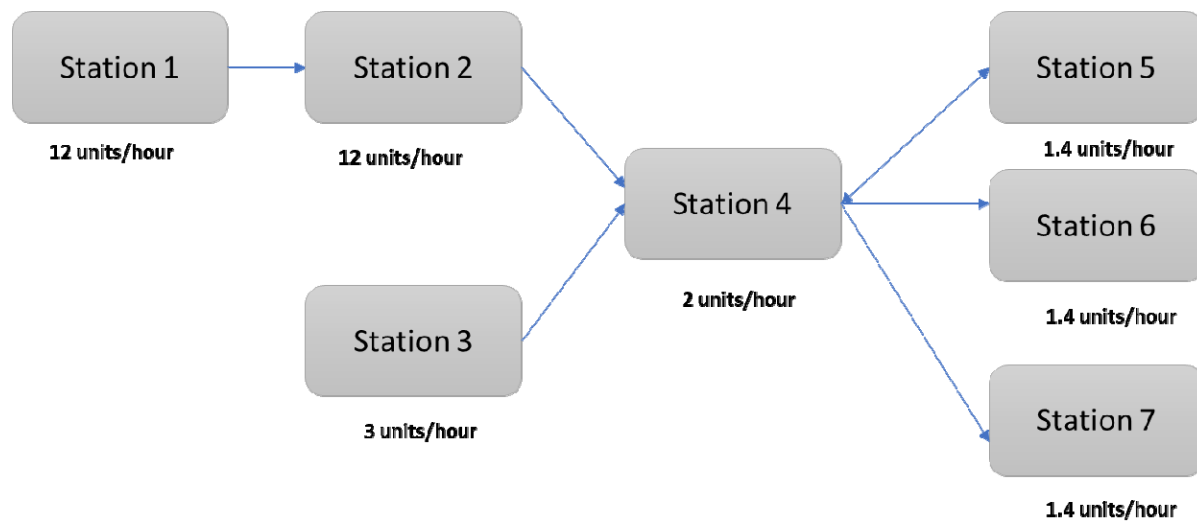


Figure 3.