

**ORDRE DES INGÉNIEURS DU QUÉBEC**

**MAY 2019 SESSION**

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

**14-IN-A3 – FACILITIES PLANNING**

**QUESTION I (20 points)**

A machine shop located on the outskirts of Los Angeles accepts custom orders from a number of hi-tech firms in southern California. The machine shop consists of four departments: A (lathes), B (drills), C (grinders), and D (sanders). The from-to chart showing distances in feet between department centers is given below.

	To	A	B	C	D
From					
A			45	63	32
B		29		27	46
C		63	75		68
D		40	30	68	

The shop has accepted orders for production of four products: P1, P2, P3, and P4. The routing for production of these products and the weekly production rates are

Production	Routing	Weekly production
P1	A-B-C-D	200
P2	A-C-D	600
P3	B-D	400
P4	B-C-D	500

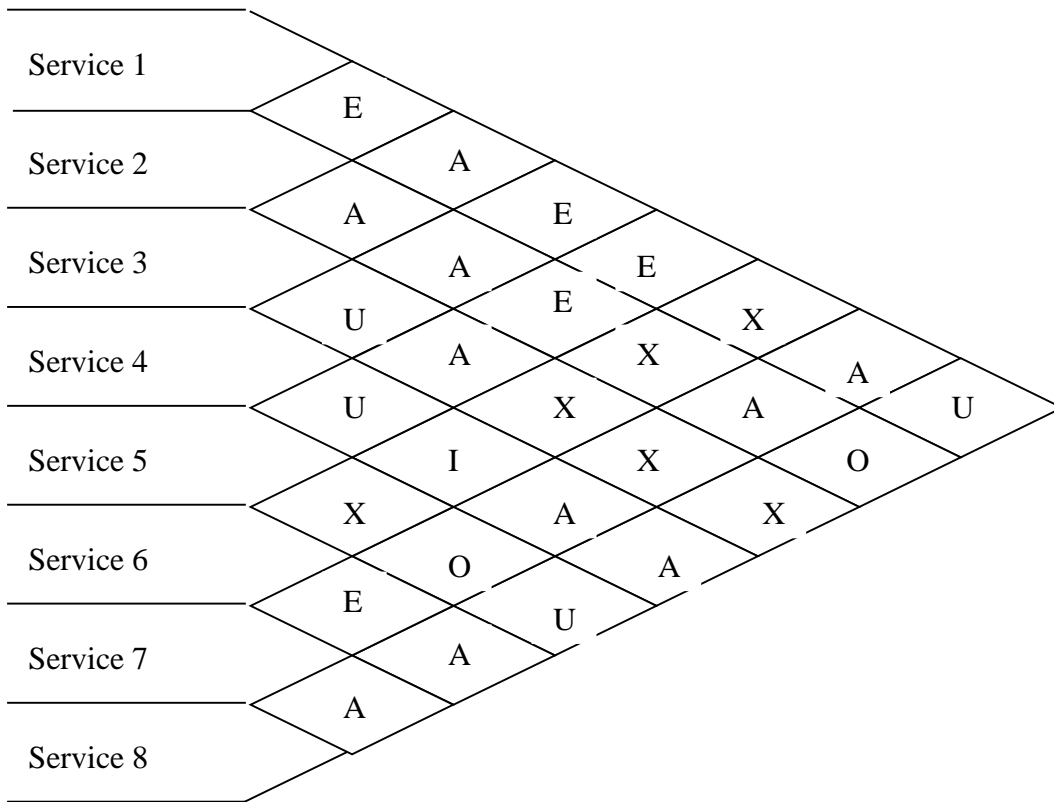
Assume that products are produced in batches of 25 units.

- Convert this information into a “from-to” chart giving numbers of materials handling trips per week between departments. **(10 points)**
- If the cost to transport one batch one foot is estimated to be \$1.50, convert the “from-To” chart you find in part (a) to one giving the materials handling cost per week between departments. **(10 points)**

## QUESTION II (20 points)

Arrange the eight departments shown in the accompanying the relational grid in 2x4 format. Department 1 must be in the location shown (cell 1, 2).

	1		



**QUESTION III (20 points)**

After sales for PEROVEN, a popular soft drink imported from France, soared in recent years, the company's headquarters in Paris decided to build a new bottling plant in the United States to cover nationwide distribution. Following a feasibility study three locations were identified because of purity of their water, and the relevant data were summarized:

Location	Market section (*)					
	Region 1		Region 2		Region 3	
	$r_1$	$c_1$	$r_2$	$c_2$	$r_3$	$c_3$
A	2.500	0.012	800	0.016	1.500	0.010
B	1.200	0.018	1.100	0.012	300	0.011
C	1.600	0.015	1.400	0.017	700	0.008
Projected monthly deliveries, crates	10,000		12,000		15,000	

(\*)  $r_i$ =distance to region  $i$  in miles,  $c_i$  = shipping cost per crate per mile

1. Assuming that production costs and other subjective factors are the same for all three alternatives, determine the location that minimizes the expected monthly distribution cost. **(10 points)**
2. Suppose that the annual operating costs for each location that meets water-quality criteria are:

Location	Annual fixed costs	Variable unit costs
A	\$760,000	\$0.83
B	\$580,000	\$0.96
C	\$690,000	\$0.87

Assuming the proposed plant capacity is 900,000 crates/year:

- a) Which location results in the smallest annual production cost per year for the projected demand level? **(5 points)**
- b) Which location will have the smallest annual production cost if demand has doubled by the time plant construction is completed? **(5 points)**

#### QUESTION IV (20 POINTS)

An assembly line with 17 tasks must be balanced. The duration of the longest task is 2.4 minutes and the total duration of all tasks is 18 minutes. The channel will run 450 minutes a day.

- a - What are the minimum and maximum production cycles? **(4 points)**
- b - What production capacity is theoretically possible for the chain? **(4 points)**
- c - What is the minimum number of workstations needed if one wants to reach the maximum production rate? **(4 points)**
- d - Which cycle will produce a production rate of 125 units per day? **(4 points)**
- e - What production potential would you get if the cycle is 9 minutes? 15 minutes? **(4 points)**

#### QUESTION V (20 POINTS)

Eight workstations must be placed in an 'L' shaped building. The locations of stations 1 and 3 are assigned as shown in the following diagram. If transportation costs are \$ 1 per load per meter, develop a suitable layout that minimizes transportation costs by using the information below. Calculate the total cost. (Consider that the inverse distances are the same.)

A 1	B	
C	D	E 3
F	G	H

		DISTANCE (METERS)							
		A	B	C	D	E	F	G	H
A		-	40	40	60	120	80	100	110
B			-	60	40	60	140	120	130
C				-	45	85	40	70	90
D					-	40	50	40	45
E						-	90	50	40
F							-	40	60
G								-	40
H									-

