

School of Engineering Science

Applied Operations Research

Sub-course

Course code PR505G

Credits for written examination: 2 ECTS

Date 2023-12-18

Examination time 8:15 – 12:30

Available teacher: Masood Fathi

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Visiting the examination ☐ Yes

☒ No

Aids and other information for invigilators: n/a.

Calculator ☐ Provided by the University

Writing paper ☒ Lined

☒ Student's own calculator

☐ Squared

☐ Not allowed

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School of Engineering Science

WRITTEN EXAMINATION

Course: Applied Operations Research

Sub-course

Course code: PR505G

Credits for written examination: 2 ECTS

Date 202312-18

Examination time 08:15 – 12:30

Examination responsible: Amos Ng

Teachers concerned: Masood Fathi

Aid at the exam/appendices: Calculator

Other

Instructions

- ☐ Take a new sheet of paper for each teacher.
- ☒ Take a new sheet of paper when starting a new question.
- ☒ Write only on one side of the paper.
- ☒ Write your name and personal ID No. on all pages you hand in.
- ☒ Use page numbering.
- ☒ Don't use a red pen.
- ☒ Mark answered questions with a cross on the cover sheet.

Grade points (ECTS)

A 22 - 24 B 19 - 21 C 16 - 18 D 13 - 15 E 10 - 12 F 0 - 9

Examination results should be made public within 18 working days

Good luck!

Total number of pages: 3

Question 1 (6p)

A manufacturing company produces two products: stand fan and ceiling fan. Both products require a two-step process, namely wiring and assembly. It takes 3 hours to wire each stand fan and 4 hours to wire a ceiling fan. The final assembly of both stand and ceiling fans requires 1 hour. The production capability is such that only 48 hours of wiring time and 12 hours of assembly time are available. Moreover, a stand fan needs 2 meters of cable and a ceiling of 4 meters. There is a restriction for ordering cable from the supplier. Due to the shipping cost, no less than 24 meters of cable can be ordered.

The company's profit for each stand fan and ceiling fan is \$24 and \$20, respectively. The company needs to decide on the optimal number of products from each type to increase the total profit. The LP formulation of the problem is as follows.

Solve the problem using the **graphical solution method** and report the optimal production mix. *Present all the calculations and solution steps.*

$$\text{Max } Z = 24x_1 + 20x_2$$

$$x_1 + x_2 \leq 12$$

$$2x_1 + 4x_2 \geq 24$$

$$3x_1 + 4x_2 \leq 48$$

$$x_1, x_2 \geq 0$$

Question 2 (6p)

A company has four agents and four tasks that should be performed. Each agent can perform each task at a particular cost. The cost to perform each task by each agent is presented in the table below. Help the company find the best agent for each task to minimize the total cost. Solve the problem using the **Branch & Bound** method. *Present all the calculations and solution steps.*

Agent	Task			
	1	2	3	4
A	3	5	9	2
B	9	3	3	4
C	1	4	2	6
D	5	3	7	2

Question 3 (6p)

A company has three types of machines A, B, and C. The company can manufacture two products, namely products 1 and 2. Both of the products have to visit all the three machines. The order of visiting the machines is: first to machine A, then to B, and then to C. The hours needed at each machine per product unit and the total available hours for each machine per week are given in the table below. The profit of each product per unit sold for product 1 is \$1, and for product 2 is \$1.5.

	Machine		
	A	B	C
Hours/week	16	12	28
Hours at each machine for product 1	2	1	4
Hours at each machine for product 2	2	2	2

The LP model of the problem is as follows.

$$\text{Maximize } Z = x_1 + 1.5x_2$$

Subject to:

$$2x_1 + 2x_2 \leq 16$$

$$x_1 + 2x_2 \leq 12$$

$$4x_1 + 2x_2 \leq 28$$

$$x_1, x_2 \geq 0$$

Solve the given LP problem using the *Simplex* algorithm. *Present all the calculations and solution steps.*

Question 4 (6P)

A company manufactures four different products. The company has four machines, and all machines can produce all products—however, the cost of production is not the same for each machine. Help the company assign products to machines with the lowest possible production cost. The production cost of each product by each machine is presented in the table below. Find the optimal assignment, which minimizes the total cost using the **Hungarian method**. What is the minimum cost for this assignment problem? *Present all the calculations and solution steps.*

Machine	Product			
	1	2	3	4
A	24	30	34	28
B	40	36	42	40
C	30	32	44	36
D	38	36	38	32