

**ITY512E OPERATIONS RESEARCH
MIDTERM EXAM**

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- Please submit your answers at the course hours on March 1, 2019.
- Only hard copy (printout) or handwritten output submission is allowed (except Open Solver files).
- Please solve the problems in Questions 2 and 3 using OpenSolver in different sheets of a single excel file. Send the excel file via e-mail to ozgurkabak@gmail.com.
- Model formulations and interpretations related to Questions 2 and 3 should be included in the class submission.
- You may ask your questions regarding the exam via ozgurkabak@gmail.com.
- This is an individual exam! Do not plagiarize your peers' answers or others' thoughts. The work you hand in is to be your own.

QUESTIONS

1. (40 points) AEK-White produces handmade wooden chairs and tables. They earn 70 TL profit for each chair, and 110 TL profit for each table. Three employees work in AEK's Macka workshop. Ayşe, who is experienced in producing chairs, can make 6 chairs per day. Arda is experienced in producing tables and can make 4 tables per day. After the products are made, they are polished by Ali. It takes 1 hour to polish a chair and 1.5 hours to polish a table. All employees work 9 hours per day and 5 days per week. AEK-White wishes to determine how many chairs and tables to produce per week to maximize total profit.
 - (a) Formulate a linear programming model for this problem.
 - (b) Use the graphical approach to solve this model.
 - (c) A new competitor in town has started making tables as well. This may force the company to lower the price they charge and so lower the profit made for each table. How would the optimal solution change (if at all) if the profit per table decreases to 105 TL? What about 80TL?
 - (d) Ali is considering lowering his working hours. How would the optimal solution change if he works only 6 hours per day?
 - (e) Suppose that if Arda or Ayşe are not working with full capacity they can help Ali for polishing. For instance, if Ayşe makes only 15 chairs per week that is under her capacity of 30 chairs per week, she will work 2,5 days ($=5 \cdot 15 / 30$). For the other 2,5 days, which is 22,5 hours ($=2,5 \cdot 9$), she can work for polishing. How will you modify your model for this new situation? Formulate a new linear program and solve it using graphical approach. Compare the result with the previous one.

2. (30 points) ATK-Textile produces five types of trousers: Classical, Wide leg, High waist, Jumpsuit, and Bermuda. Pants are processed in three workshops: cutting, sewing and packaging (processing times are given in table below). The number of workers working in these workshops is also given in the table. There is a total of 22 working days next month and company employees work 8 hours a day. To meet customer needs, the total production of classical and wide leg trousers should be at least 1500 pieces.

Products	Cutting	Sewing	Packaging	Sales Price
Classical	15 min.	13 min.	4 min.	199 TL
Wide leg	11 min.	12 min.	6 min.	169TL
High waist	8 min.	7 min.	4 min.	149 TL
Jumpsuit	13 min.	15 min.	6 min.	249 TL
Bermuda	6 min.	8 min.	4 min.	129 TL
Number of workers	4	5	2	

- Assuming all trousers produced can be sold for the sales price given in the table, formulate a LP to maximize the revenue of ATK-Textile in the next month. Hint: Define decision variables as $x_1, x_2, x_3, x_4,$ and x_5 are numbers of classical, wide leg, high waist, jumpsuit, and Bermuda trousers produced in the next month, respectively.
 - Solve the problem using OpenSolver.
 - Interpret the solution (submit an executive summary).
3. (30 points) You own a wheat warehouse with a capacity of 20,000 bushels. At the beginning of month 1, you have 5,000 bushels of wheat. Each month, wheat can be bought and sold at the price per 1000 bushels given in the table. The sequence of events during each month is as follows:
- You observe your initial stock of wheat.
 - You can sell any amount of wheat up to your initial stock at the current month's selling price.
 - You can buy (at the current month's buying price) as much wheat as you want, subject to the warehouse size limitation.
- Formulate an LP that can be used to determine how to maximize the profit earned over the next 10 months.
 - Solve the LP formulated in part a) using OpenSolver.
 - Interpret the solution (submit an executive summary).
 - Suppose that cash flow will be considered. Such that you can buy wheat subject to the cash at the beginning of a month that is earned from sales of previous months. Assume you have \$10,000 at the beginning of month 1. How will you modify your model? Formulate a new linear program and solve it using OpenSolver. Compare the result with the previous one.

Month	Sales Price \$	Purchase Price \$
1	3	4
2	7	6
3	2	4
4	5	6
5	7	8
6	9	10
7	8	9
8	4	6
9	5	6
10	7	8