

IE375 Fall 2020 Homework II - Due: October 23, Friday, 17:00

Information on Homework II

- **Homework II is 2%. Make sure that you review course material before you start. Cite sources used if any.**
- **Grading Policy:** The homework grades will not be only based on the correctness of the answers provided, but on the perceived degree of effort on the returned assignment. This means that even without obtaining the correct answers one can obtain full credit. The grade scale will be “2” (full effort, all questions); “1” (some effort or full effort, some questions); “0” (no effort or no submission). The submissions that exceed expectations may get a bonus – grade will be “3” (extra effort). Note that “2” corresponds to a grade out of 100% - 2% of the overall grade in this case. Late submissions will not be accepted.
- The grading scale for each question is 2 points (full effort), 1 point (some effort), and 0 (no effort or no submission). Total points that would lead to your overall HW grade are given below:

Total Points	HW Grade
4+	3
3-4	2
1-2	1
0	0

- **Academic Dishonesty (taken from IE375 Course Information):** Academic misconduct is not tolerated, and violations will be treated in accordance with the University policy. For assignments: Discussion of the course material and working in groups are effective ways of learning. However, this does not mean that you can copy the assignment from one of your friends. You can discuss with your friends, but you should be alone, without any written solution in front of you, when you prepare your assignment. It is extremely important to understand the value of this exercise in the process of learning. Any violation of the above understanding will result measures outlined in the student rules and regulations.
- **Submission Information:** Please send your solution as a pdf file to IE375 Course TA Egemen Elver. Make sure that pdf contains your name, and you mail it from your mail account available in STARS. Also note that if your mail is different than the one provided by Bilkent University, there is a chance that it will be received after the due time.
- **Information on Questions: What is expected? How to study?**

Homework II is on APP. In both questions you are asked to model and analyze the solution. All the related material modeling and solution are among the topics covered in your previous courses. Hence, your responses regarding the questions are expected to use the jargon of IE375. Hence, it will be useful for you to over the course material presented in Chapter 3. The questions are not of equal weight, however for the purpose homework are serving; I made them equal. Specifically, in Question 1) you are asked several questions which includes formulation and solution of an LP. The second question does not ask you to formulate the problem but implement strategies which are explained in the textbook. I would try to formulate the solution using structural inequalities like what I mentioned in class.

One final remark: In the exams, please get used to receiving question types that you have not seen before. One useful purpose of homework and exercises is to cover the “routine” so that you can go beyond that during the exams, and elsewhere. Note that these are questions (except the solution of LP) asked in the previous exams of IE375.

PLEASE READ QUESTIONS CAREFULLY. FOR THE QUESTIONS FROM THE TEXT-BOOK THERE MIGHT BE CHANGES IN THE GIVEN VALUES PRESENTED BEFORE THE PROBLEM STATEMENT.

Problem 1 (50 points)

An engine block manufacturer plans to produce cast engine blocks for the next three periods. The forecasts for each model are given in Table 1.

Table 1: Demand and Weight Data for Engine Blocks (in units)

Model	Period 1	Period 2	Period 3	Weight (kg/unit)
HS	100	200	100	150
SS	250	150	200	200
GS	150	100	300	250
MS	200	250	150	300
OS	100	100	200	200

The aggregate production plan to be prepared should take the current inventory of 20 units of model SS and 2 units of GS. The regular time, overtime and subcontracting capacities of the plant are given in Table 2.

Table 2: Plant Capacities for Engine Blocks (in kg)

Period	Regular	Overtime	Subcontracting
1	190,000	25,000	32,000
2	200,000	20,000	36,000
3	100,000	40,000	25,000

Backorders are not planned, and hence not allowed. The variable production cost per kg of any model is \$2, 3 and 4, for regular time, overtime, and subcontracting, respectively. Inventory carrying cost is \$2/kg/period.

- (10 points)** Aggregate end products with respect to their weights, so that you have one aggregate product to deal with. Compute aggregate demands for each period.
- (10 points)** Formulate the above aggregate production plan as a linear programming problem (in other words assume continuous variables). Define your decision variables, constraints, etc.
- (15 points)** Solve the LP problem you have formulated. Report the solution in a table devised by you which shows the production quantities in regular time, overtime, and subcontracting. Also report the dual variable values and explain what they mean.
- (10 points)** Compute the cost of a solution that manufactures equal number of aggregate units in each period (using regular time and overtime) and subcontracts remaining units (if needed in any period and carries inventory of subcontracted units, as well). Note that there will be many solutions adhering the above description – shortly discuss the quality of the solution you have proposed with respect to the optimal solution.
- (2 points)** Would the optimal objective function value decrease or increase (or stay the same) if the forecast values in Table 1 were increased?
- (3 points)** Under what condition the optimal objective function value would change if we increase one of the regular time capacities in Table 2? State the nature of change (increase or decrease).

Question 2 (50 points)

A local firm manufactures children's bicycles. An increase in sales for a new model is expected, most probably requiring new workforce. The forecasted demand and number of workdays for the next three months are presented below:

Month	Workdays	Forecasted Demand (in aggregate units)
1	25	1400
2	20	1800
3	24	2400

Assume that a normal working day is eight hours and there is no possibility of overtime. It requires 2 hours for one worker to assemble one (aggregate) bicycle. Hiring costs are 500 TL. Laying-off workers is not allowed. A given new hired worker will only be 50% efficient during his first month of work; in other words, he requires 4 hours to assemble one (aggregate) bicycle in his first month of work. Holding cost is 5 TL per aggregate unit held per month. Assume that the beginning (period 1) inventory is 200 and desired ending (period 3) inventory is at least 400 aggregate units, possibly to cover future uncertainties. Assume that the current workforce level is 8 workers. Salary per worker per month is 2500 TL. No backorders are allowed. Assume that we do not let any worker receive a salary and not to produce; in other words, we assume that a worker will produce all the quantity he can, regardless it is desirable or not.

- a) **(20 points)** Determine the plan that changes the workforce level each month to match the demand and the cost of that plan. Note that as laying-off is not allowed, the salary you pay for 8 workers (current workforce level) will be a constant and hence you do not need to compute.
- b) **(30 points)** Find the minimum constant workforce plan for the three months. Note that this means you will hire all needed workforce in period 1 and do not hire again. Compute the total labor, hiring, and holding costs of that plan. Note that as laying-off is not allowed, the salary you pay for 8 workers (current workforce level) will be a constant and hence you do not need to compute those.