**ME 332 IEOR**
**HomeWork 1**

**Posted 11th January, 2018 and Due 25th January , 2018**
**Late submissions are penalized**

Instructions:

1. Name your file "YourName_RollNum_HW1" and submit on Google Classroom
2. Please include a cover sheet with your name, RollNum, assignment number and due date
3. Neat graphs,solution procedures along with highlighted solution values where ever applicable are must, otherwise work will not be considered for grading
4. Where ever Excel solution procedure/ available computer codes are used make a copy of your problem definition screen area along with the data, solved values. Also include reports generated by the solvers and highlight/provide the requested values separately.
5. For your own simplex code attach the output of the code and the source code as well.
6. No copying or exchange of e-files allowed, however you can take help of TAs/me if you need more help.
7. **IMP: Any actions that deviate from the IITGN honor code are subjected to strict disciplinary action.**

**PROBLEM 1: (10 points)**

D,I **3.1-6.** Use the graphical method to solve the problem:

Maximize $Z = 10x_1 + 20x_2$,

subject to

$$\begin{aligned} -x_1 + 2x_2 &\leq 15 \\ x_1 + x_2 &\leq 12 \\ 5x_1 + 3x_2 &\leq 45 \end{aligned}$$

and

$$x_1 \geq 0, \ x_2 \geq 0.$$

**PROBLEM 2: (10 points)**

D **3.1-12.** Consider the following problem, where the value of $c_1$ has not yet been ascertained.

$$\text{Maximize} \quad Z = c_1 x_1 + x_2,$$

subject to

$$x_1 + x_2 \le 6$$
$$x_1 + 2x_2 \le 10$$

and

$$x_1 \ge 0, \quad x_2 \ge 0.$$

Use graphical analysis to determine the optimal solution(s) for $(x_1, x_2)$ for the various possible values of $c_1 (-\infty < c_1 < \infty)$.

**PROBLEM 3: (15 points)**

D,I **3.4-8.** Consider the following model:

$$\text{Minimize} \quad Z = 40x_1 + 50x_2,$$

subject to

$$\begin{aligned} 2x_1 + 3x_2 &\geq 30 \\ x_1 + x_2 &\geq 12 \\ 2x_1 + x_2 &\geq 20 \end{aligned}$$

and

$$x_1 \geq 0, \quad x_2 \geq 0.$$

**(a)** Use the graphical method to solve this model.

**(b)** How does the optimal solution change if the objective function is changed to $Z = 40x_1 + 70x_2$? (You may find it helpful to use the Graphical Analysis and Sensitivity Analysis procedure in IOR Tutorial.)

**(c)** How does the optimal solution change if the third functional constraint is changed to $2x_1 + x_2 \geq 15$? (You may find it helpful to use the Graphical Analysis and Sensitivity Analysis procedure in IOR Tutorial.)

Solve (b) and (c) graphically in separate plots

d) For each of a,b,c, use Excel to generate the sensitivity report and interpret the report
   - Tabulate slack variable values and shadow prices of the constraint for all the constraints
   - Tabulate, current optimal, current Ci's and allowable ranges, explain what happens if the changes are beyond the permitted values
   - Check 100% rule change for combined changes in Cj's (choose your own Cjs variation)
   - Tabulate current optimal, current bi's and allowable ranges, explain what happens if the changes are beyond the permitted values

e) Explain what is a shadow price/ dual/ unit worth of resource.

**PROBLEM 4: (40 points)**

**3.1-11.*** The Omega Manufacturing Company has discontinued the production of a certain unprofitable product line. This act created considerable excess production capacity. Management is considering devoting this excess capacity to one or more of three products; call them products 1, 2, and 3. The available capacity on the machines that might limit output is summarized in the following table:

| Machine Type | Available Time (Machine Hours per Week) |
|---|---|
| Milling machine | 500 |
| Lathe | 350 |
| Grinder | 150 |

The number of machine hours required for each unit of the respective products is

**Productivity coefficient (in machine hours per unit)**

| Machine Type | Product 1 | Product 2 | Product 3 |
|---|---|---|---|
| Milling machine | 9 | 3 | 5 |
| Lathe | 5 | 4 | 0 |
| Grinder | 3 | 0 | 2 |

The sales department indicates that the sales potential for products 1 and 2 exceeds the maximum production rate and that the sales potential for product 3 is 20 units per week. The unit profit would be $50, $20, and $25, respectively, on products 1, 2, and 3. The objective is to determine how much of each product Omega should produce to maximize profit.

(a) Formulate a linear programming model for this problem.

C (b) Use a computer to solve this model by the simplex method.

c) Use simplex algorithm in the tabular form to solve the problem. Show the iterations, and identify the solution point in the augmented form.

d) Develop your own simplex procedure to solve the above problem and find the optimal solution

1. Use any programming language you are comfortable with, but develop a generic simplex algorithm by considering you will have only $\leq$ type constraints
2. Program should consider the data as Cj's, bi's and aij's (Program should decide number of constraints, decision variables and slack variables from your input matrices )
3. Program should solve the problem by using simplex procedure through iterations and display at each iteration the following information: Iteration Number, Basic Variables, Non Basic Variables, current BFS point in the augmented form, and the Z function value and simplex table.
4. In the end, program should display the slack variable values and shadow prices of each constraint

**You should include your program copy and the output copy while submitting the assignment.**

**PROBLEM 5: (25 points)**

**3.5-2.*** You are given the following data for a linear programming problem where the objective is to maximize the profit from allocating three resources to two nonnegative activities.

| Resource | Resource Usage per Unit of Each Activity | | Amount of Resource Available |
|---|---|---|---|
| | Activity 1 | Activity 2 | |
| 1 | 2 | 1 | 10 |
| 2 | 3 | 3 | 20 |
| 3 | 2 | 4 | 20 |
| Contribution per unit | \$20 | \$30 | |

Contribution per unit = profit per unit of the activity.

(a) Formulate a linear programming model for this problem.
D,I (b) Use the graphical method to solve this model.
(c) Display the model on an Excel spreadsheet.
(d) Use the spreadsheet to check the following solutions: $(x_1, x_2) = (2, 2), (3, 3), (2, 4), (4, 2), (3, 4), (4, 3)$. Which of these solutions are feasible? Which of these feasible solutions has the best value of the objective function?
C (e) Use the Excel Solver to solve the model by the simplex method.

f) Use simplex algorithm in the tabular form to solve the problem. Show the iterations, and identify the solution point of each iteration graphically.

g) Use the code you developed for the previous problem to find out the optimal solution and display all the information asked in point d of problem 4 (points 3 and 4)

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