**EASTERN MEDITERRANEAN UNIVERSITY**



**Department of Industrial Engineering**

**IENG/MANE212 Modelling and Optimization**

**HOMEWORK 1 Spring 2021-22**

1. Consider the following problem



* 1. Sketch the feasible region
  2. Find the optimal solution.

1. Solve the following problem graphically



Find the regions for vector **c***= (c1,c2)* in a manner that if the **c** place in this regions the problem has unbounded solution

1. A television set manufacturing firm has to decide on the mix of colour and black-and-white TVs to be produced. A market research indicates that, at most, 3000 units and 5000 units of colour and black-and-white TVs can be sold per month. The maximum number of man-hours available is 60,000 per month. A colour TV requires 15 man-hours and a black-and-white TV requires 10 man-hours to manufacture. The unit profits of the colour and black-and-white TVs are $60 and $35, respectively. It is desired to find the number of units of each TV type that the firm must produce in order to maximize its profit. Formulate the problem as a linear program.
2. A manufacturer produces three models, I, II, and III, of a certain product using raw materials A and B. the following table gives the data for the problem.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Requirements per unit | | |  |
| Raw material | I | II | III | Availability |
| A | 2 | 3 | 5 | 4000 |
| B | 4 | 2 | 7 | 1700 |
| Minimum demand | 200 | 200 | 150 |  |
| Profit per unit ($) | 38 | 27 | 53 |

The labour time per unit of model I is twice that of II and three times that of III. The entire labour force of the factory can produce the equivalent of 3000 units of model I. the market requirements specify the ratios 3:2:5 for the production of three respective models. Formulate the problem as a linear program.

1. A steel manufacturer produces for size of I beams: small, medium, large and extra large. These beams can be produced on any one of three machine types: A, B, and C. The lengths in feet of the I beams that can be produces on the machines per hour are summarized.

|  |  |  |  |
| --- | --- | --- | --- |
| MACHINE | | | |
| BEAM | A | B | C |
| Small | 340 | 620 | 550 |
| Medium | 200 | 300 | 600 |
| Large | 230 | 320 | 530 |
| Extra large | 140 | 210 | 200 |

Assume that each machine can be used up to 60 hours per week and that the hourly operating costs of these machines are respectively $45.00, $58.00 and $92.00. Further suppose that 12,000, 8,500, 9,000 and 7,000 feet of the different size I beams are required weekly. Formulate the machine scheduling problem as a linear program.

1. A manufacturer of metal sheets produces rolls of standard fixed width *w=1.5m* and of standard length *L=12m*. A large order is placed by a customer who needs sheets of width *w* and varying lengths. In particular, *bi* sheets with length *li* and width *w* for i= 1,2,3,4,5 are ordered as follow. The manufacturer would like to cut the standard rolls in such a way as to satisfy the order and to minimize the waste.

|  |  |  |
| --- | --- | --- |
| *No of order* | *li* | *bi* |
| *1* | *2* | *100* |
| *2* | *3* | *250* |
| *3* | *4* | *70* |
| *4* | *5* | *320* |
| *5* | *7* | *95* |

1. An oil refinery can buy two types of oils: light crude oil and heavy crude oil. The cost per barrel of these types is respectively $20 and $16. The following quantities of gasoline, kerosene and jet fuel are produced per barrel of each type of oil.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Gasoline | Kerosene | Jet Fuel |
| Light crude oil | 0.43 | 0.2 | 0.35 |
| Heavy crude oil | 0.32 | 0.4 | 0.2 |

Note that 5 percent and 8 percent of the crude are lost respectively during the refining process. The refinery has contracted to deliver 1 million barrels of gasoline, 450,000 barrels of kerosene and 150,000 barrels of jet fuel. Formulate the problem of finding the number of barrels of each of the crude oil that satisfies the demand and minimizes the total cost as a linear program.

1. The security and traffic force must satisfy the staffing requirements as shown below on the eve of Republic Day celebration. Officers work 8-hour shifts starting at each of the 4-hour interval as shown below. How many officers should report for duty at the beginning of each time period in order to minimize the total number of officers needed to satisfy the requirements? (10 points)

|  |  |
| --- | --- |
| *Time* | *Number of Officers* |
| *0:01-4:00* | *8* |
| *4:01-8:00* | *10* |
| *8:01-12:00* | *19* |
| *12:01-16:00* | *7* |
| *16:01-20:00* | *13* |
| *20:01-24:00* | *10* |

1. Toolco has contracted with Automate to supply their automotive discount stores with wrenches and chisels. Automate weekly demand consists of 1600 wrenches and 1400 chisels. Toolco’s present one-shift capacity is not large enough to produce the requested units and must use overtime and possibly subcontracting with other tool shops. The result is an increase in the production cost per unit, as shown in the following table. The market restricts wrenches to chisels to a ratio of at least 2:1.

|  |  |  |  |
| --- | --- | --- | --- |
| Tool | Production type | Weekly production range (units) | Unit cost ($) |
| Wrenches | regular | 0-540 | 2.20 |
| overtime | 541-800 | 2.75 |
| subcontracting | 801-∞ | 3.00 |
| Chisel | regular | 0-620 | 2.20 |
| overtime | 621-900 | 3.25 |
| subcontracting | 901-∞ | 4.20 |

Formulize the problem as a linear program.

1. Sketch the feasible region of the set *X={x: Ax<=****b****}* where *A* and ***b*** are given below. In each case state whether the feasible region is empty or not, and whether it is bounded or not.
2. A= **b**=
3. A= **b**=
4. Consider the following linear programming problem.



* 1. Reformulate the problem so that it is in standard format.
  2. Reformulate the problem so that it is in canonical format.
  3. Convert the problem into a maximization problem.