**Spring 2022-23**

**IM29204: Operations Research Laboratory**

**L-T-P : 0-0-3, Credits - 2**

**Lab Assignment – 3**

**Maximum Marks: 10**

**Instructions :**

1. Attempt **all Questions**.
2. All questions carry **equal** marks.
3. Assume any missing data suitably and state all your assumptions clearly.
4. You need to make this submission via **MS teams**.
5. The usage of **mobile phones** and **internet** during the lab hours is **strictly prohibited** unless specially instructed.
6. Write your name and roll number inside the file. Name your file as: Your Roll No\_Name. For example, if your Roll No. is 10IM9999 and your name is Ravi, then you should name your file as: **10IM9999\_Ravi**
7. Submission Deadline – The file must be submitted during the lab hours. **Assignments submitted after due date and time will NOT be evaluated.**
8. Do not submit multiple files for same assignment. In case of multiple files compress them in one “.zip” file and then submit.

To meet the demands of its customers, an apparel company manufactures its products in its own factories (inside production) or buys them from other companies (outside production). Inside production is subject to some resource constraints: each product consumes a certain amount of each resource. In contrast, outside production is theoretically unlimited. The problem is to determine how much of each product should be produced inside and outside the company while minimizing the overall production cost, meeting the demand, and satisfying the resource constraints. Please refer to attached model and data files for above problem (Appendix B, C, D) to understand how this problem is coded on CPLEX-OPL.

Extend the above problem to several production periods. Consider several production periods and include inventories in the model. Consider the demand for the products over several periods and to allow the company to produce more than the demand in a given period. Of course, there is an inventory cost associated with storing the additional production. With this information answer the following: -

1. Create model file (.mod) to solve the above problem on CPLEX-OPL.
2. Create data file (.dat) to solve the above problem on CPLEX-OPL.
3. Make the use of ‘Tuple’ for appropriate coding in your model file
4. Find the optimal solution and the corresponding best objective function value.
5. Display the appropriate elements of the solution your results into Scripting log in the following format:

Optimal solution found with objective: X

plan=

[[<X X X> < X X X > < X X X >]

[<X X X > < X X X > < X X X >]

[<X X X > < X X X > < X X X >]]

**Appendix A:**

**Please find below the necessary data to solve above problem:**

Products – Pant, Shirt, Jacket

Resources – Cotton, Wool

Number of period – 3

Consumption –

|  |  |  |  |
| --- | --- | --- | --- |
|  | Pant | Shirt | Jacket |
| Cotton | 0.5 | 0.4 | 0.3 |
| Wool | 0.2 | 0.4 | 0.6 |

Capacity – Cotton: 20, Wool: 40

Demand –

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Period 1** | **Period 2** | **Period 3** |
| **Pant** | 10 | 100 | 50 |
| **Shirt** | 20 | 200 | 100 |
| **Jacket** | 50 | 100 | 100 |

Inventory and costs -

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Pant** | **Shirt** | **Jacket** |
| **Inventory** | 0 | 0 | 0 |
| **Inventory cost** | 0.1 | 0.2 | 0.1 |
| **Inside cost** | 0.4 | 0.6 | 0.1 |
| **Outside cost** | 0.8 | 0.9 | 0.4 |

**Appendix B:**

**Model file for your reference:**

{string} Products = ...;

{string} Resources = ...;

float Consumption[Products][Resources] = ...;

float Capacity[Resources] = ...;

float Demand[Products] = ...;

float InsideCost[Products] = ...;

float OutsideCost[Products] = ...;

dvar float+ Inside[Products];

dvar float+ Outside[Products];

minimize

sum( p in Products )

( InsideCost[p] \* Inside[p] + OutsideCost[p] \* Outside[p] );

subject to {

forall( r in Resources )

ctCapacity:

sum( p in Products )

Consumption[p][r] \* Inside[p] <= Capacity[r];

forall(p in Products)

ctDemand:

Inside[p] + Outside[p] >= Demand[p];

}

**Appendix C:**

**Data file for your reference:**

Products = { "Pant", "Shirt", "Jacket" };

Resources = { "Cotton", "Wool" };

Consumption = [ [0.5, 0.2], [0.4, 0.4], [0.3, 0.6] ];

Capacity = [ 20, 40 ];

Demand = [ 100, 200, 300 ];

InsideCost = [ 0.6, 0.8, 0.3 ];

OutsideCost = [ 0.8, 0.9, 0.4 ];

**Appendix D:**

**Data file**

Model file using Tuple

{string} Products = ...;

{string} Resources = ...;

tuple productData {

float demand;

float insideCost;

float outsideCost;

float consumption[Resources];

}

productData Product[Products] = ...;

float Capacity[Resources] = ...;

dvar float+ Inside[Products];

dvar float+ Outside[Products];

execute CPX\_PARAM {

cplex.preind = 0;

cplex.simdisplay = 2;

}

minimize

sum( p in Products )

(Product[p].insideCost \* Inside[p] +

Product[p].outsideCost \* Outside[p] );

subject to {

forall( r in Resources )

ctInside:

sum( p in Products )

Product[p].consumption[r] \* Inside[p] <= Capacity[r];

forall( p in Products )

ctDemand:

Inside[p] + Outside[p] >= Product[p].demand;

}

tuple R { float x; float y; };

{R} Result = { <Inside[p],Outside[p]> | p in Products };

execute { writeln("Result=",Result); }

Data file for Tuple

Products = { "Pant", "Shirt", "Jacket" };

Resources = { "Cotton", "Wool" };

Product = #[

kluski : < 100, 0.6, 0.8, [ 0.5, 0.2 ] >,

capellini : < 200, 0.8, 0.9, [ 0.4, 0.4 ] >,

fettuccine : < 300, 0.3, 0.4, [ 0.3, 0.6 ] >

]#;

Capacity = [ 20, 40 ];