INC 364 - 2021

Linear Programming (LP)

Linear Programming

- Mathematical modelling technique in which a linear function is **maximised** or **minimised** when subjected to various constraints.

- Provide the **best solution** in allocating finite resources such as money, energy, manpower, machines, time, space, and many other variables.

- Useful for guiding quantitative decisions for business planning and in industrial engineering.

Common Terminologies

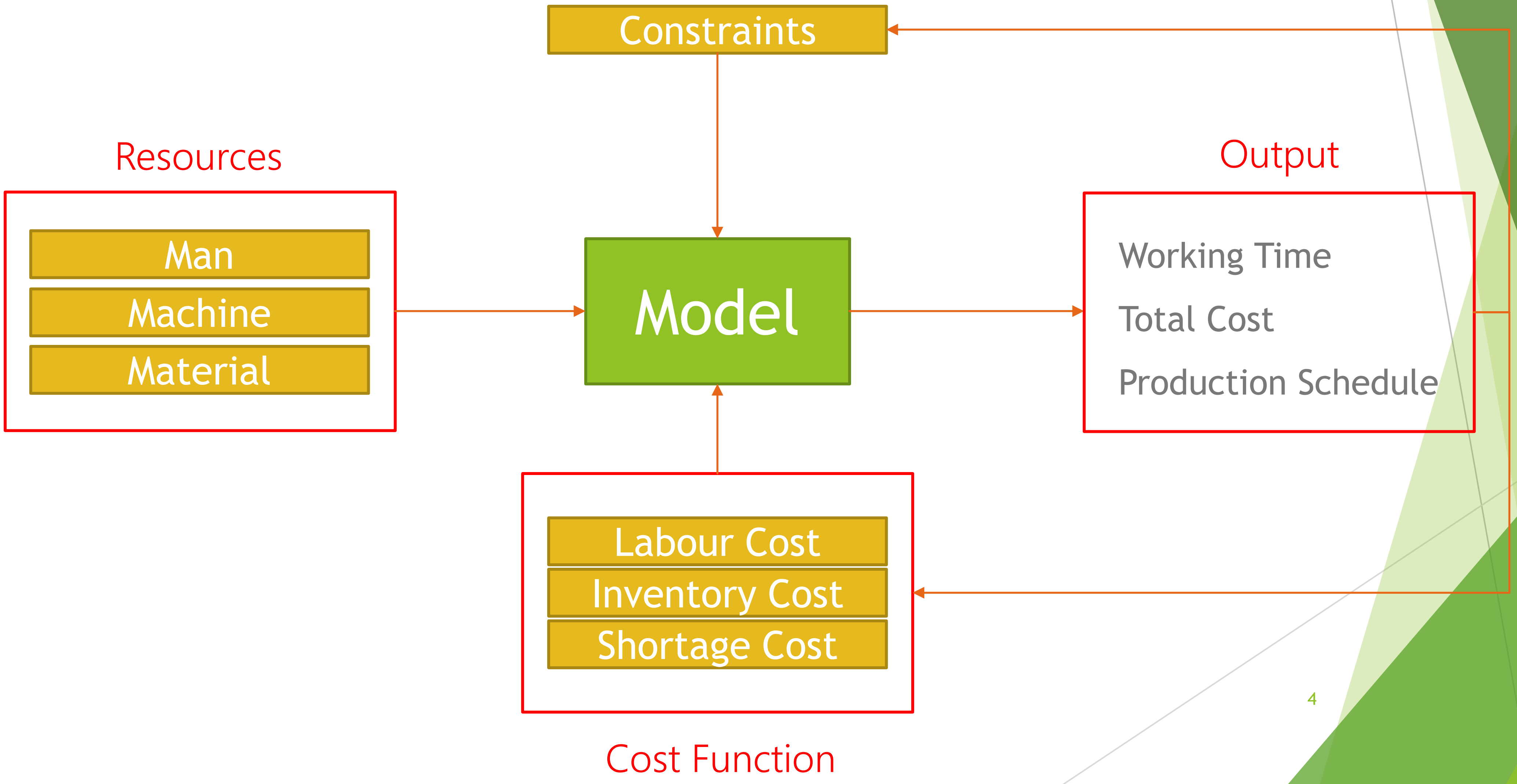
Decision Variables: the variables that will decide the output. To solve any problem, we first need to identify the decision variables.

Objective Function: the objective of making decisions. Sometimes it will be called as “Cost Function”.

Constraints: restrictions or limitations on the decision variables. They usually limit the value of the decision variables.

Non-negativity restriction: For all linear programming, the decision variables should always take non-negative values. This means the values for decision variables should be greater than or equal to 0.

What we are focusing today



Process to Formulate LP

1. Identify the decision variables
2. Write down the objective function
3. Mention the constraints
4. Explicitly state the non-negativity restriction
5. Solve for LP solution

*** Note that all the decision variables, objective function, and constraints all have to be **linear functions**.

Solving LP Techniques

Examples of solving methods

1. Graphical method
2. Simplex method
3. Least Cost method
4. Solver (OpenSolver, Gurobi, etc.)
5. Programming (python, R, etc.)

This workshop will focus on **Graphical method** and **Python.**

*** **Gurobi** for the next sessions.

Recall the Knowledge

1. Solving LP by Graphical Method

Very Simple Example

Maximise $J(x, y) = 30x + 70y$

Subjected to

$$x + y <= 10$$

$$10x + 30y <= 180$$

$$x >= 0$$

$$y >= 0$$

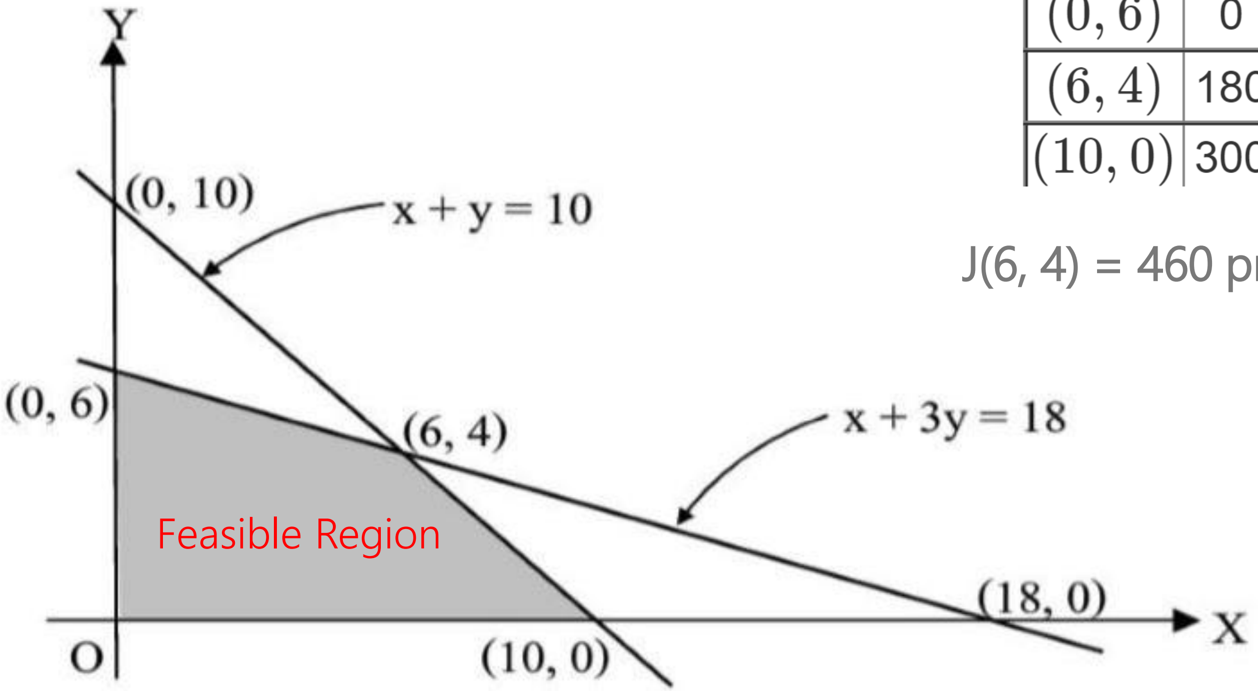
Maximise $J(x, y) = 30x + 70y$

Subjected to $x + y <= 10$

$10x + 30y <= 180$

$x >= 0$

$y >= 0$



Intersection Points

(x, y)	$30x$	$70y$	$P = 30x + 70y$
$(0, 0)$	0	0	0
$(0, 6)$	0	420	420
$(6, 4)$	180	280	460
$(10, 0)$	300	0	300

J(6, 4) = 460 provide the maximum value

Source: https://www.mathpaper.net/index.php/en/mathmatics-m6/1203-2019-12-05-04-02-10

Identifying the problem

Company want to produce 5 cabinets, 12 tables, and 18 bookshelves. There are 2 workers. First worker can produce 1 cabinet, 3 tables, and 3 bookshelves within 1 hour. Second worker can produce 1 cabinet, 2 tables, and 6 bookshelves within 1 hour. The company need to pay first and second worker for 25 Baht and 22 Baht each hour, respectively. How many working hour for each worker that lowest the manpower cost.

1. Identify the decision variables
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1. Identify the decision variables: **first worker hour (x) and second worker hour (y)**
2. Write down the objective function: **minimise manpower cost**

$$J(x,y) = 25x + 22y$$

3. Mention the constraints

$$x + y >= 5$$

$$3x + 2y >= 12$$

$$3x + 6y >= 18$$

4. Explicitly state the non-negativity restriction

$$x >= 0$$

$$y >= 0$$

Let's use python to solve this problem!

Assignment II

A factory makes two products (cupboard and door) using two machines (A and B). Each unit of produced cupboard requires 50 minutes processing time on machine A and 30 minutes processing time on machine B. Each unit of produced door requires 24 minutes processing time on machine A and 33 minutes processing time on machine B.

At the start of the current week there are 30 units of cupboard and 90 units of door in stock. Available processing time on machine A is forecast to be 40 hours and on machine B is forecast to be 35 hours.

The demand for cupboard in the current week is forecast to be 75 units and for door is forecast to be 95 units. Company policy is to maximise the combined sum of the units of cupboard and the units of door in stock at the end of the week.

How much of each product to make in the current week?

Assignment II

* Follow the steps below

1. Identify the decision variables

2. Write down the objective function

3. Mention the constraints

4. Explicitly state the non-negativity restriction

5. Solve for LP solution using "**Python programming**".

** Submit as a PDF (code, result, graph, etc).

*** Don't forget to give a final answer.