BLENDING or MIXING PROBLEM:

- Blending (Mixing) several components (or commodities or materials) to create one or more products corresponding to a demand, for example
    - A metal blending (mixing some metals to form an Alloy)
    - A set of oil blending (combining different types of crude oil to form a gasoline)
    - A food blending (mixing different kinds of oil to make final product)
- The Problem is to determine how much of each commodity should be purchased and blended with the rest so that the characteristics of the mixture lie within specified bounds and the total cost (total profit) is minimized (maximized).

- Blending problems are frequently solved using Linear Programming (LP).

Example # 1: A food is manufactured by refining raw oils and blending them together. The raw oils are of two categories:

Vegetable oils	VEG 1
	VEG 2
Non-vegetable oils	OIL 1
	OIL 2
	OIL 3

Vegetable oils and non-vegetable oils require different production lines for refining. In any month, it is not possible to refine more than 200 tons of vegetable oil and more than 250 tons of non-vegetable oils. There is no loss of weight in the refining process and the cost of refining may be ignored. There is a technological restriction of hardness in the final product. In the units in which hardness is measured, this must lie between 3 and 6. It is assumed that hardness blends linearly. The costs (per ton) and hardness of the raw oils are

	VEG 1	**VEG 2**	**OIL 1**	**OIL 2**	**OIL 3**
Cost	£110	£120	£130	£110	£115
Hardness	8.8	6.1	2.0	4.2	5.0

The final product sells at £150 per ton. How should the food manufacturer make their product in order to maximize their net profit?

Model Formulation:

Decision Variables:

- x_j = Quantities (tons) of VEG1, VEG2, OIL1, OIL2, OIL3(i.e. Raw material) that should be bought, refined and blended in a month
- y = Quantity of the product that should be made

The Model:

Maximize: $Z = 150y - 110x_1 - 120x_2 - 130x_3 - 110x_4 - 115x_5$

Subject to:

$x_1 + x_2 \leq 200$ (Refining Capacity Constraint–1)

$x_3 + x_4 + x_5 \leq 250$ (Refining Capacity Constraint–2)

$8.8x_1 + 6.1x_2 + 2.0x_3 + 4.2x_4 + 5.0x_5 - 3y \geq 0$ (Final product hardness limitation Constraint–1)

$8.8x_1 + 6.1x_2 + 2.0x_3 + 4.2x_4 + 5.0x_5 - 6y \leq 0$ (Final product hardness limitation Constraint–2)

$x_1 + x_2 + x_3 + x_4 + x_5 - y = 0$ (Weight of final product must be equal to weight of the ingredients)

$x_i \geq 0 \quad \forall\, i, y \geq 0$

Compact Model Formulation

Index:

- i = Raw material (i.e. Raw oil types)
- j = Production lines

Model Parameters:

- Cap_j = Refining Capacity for the j^{th} Production line
- c_i = Unit cost of i^{th} raw material
- p = Unit price the final product
- a_i = Amount of hardness of i^{th} raw material
- $\underline{a}$ = Minimum hardness required in the final product
- $\bar{a}$ = Maximum hardness required in the final product

Decision Variables:

x_i = Quantity of the i^{th} raw material
y = Quantity of the final product

The Model:

$\boldsymbol{Maximize}$: $py - \sum_i c_i x_i$

Subject to:

$\sum_i x_i \leq Cap_j \quad \forall j$ (Capacity constraint)

$\sum_i a_i x_i - \underline{a}\, y \geq 0$ (Hardness constraint–1)

$\sum_i a_i x_i - \bar{a}\, y \leq 0$ (Hardness constraint–2)

$\sum_i x_i = y$ (Wright Equality constraint)

$x_i \geq 0 \quad \forall i, y \geq 0$