İndex

i = product index , i = (1,2)

t = time index ,   t = (1,.......,12)

Parameters

A = monthly labor regular time cost

B = monthly overtime cost for one employee

C = hiring cost for one employee

K = lay off cost for one employee (10 years worked)

E_i = inventory cost (TL / unit) per month

F_i = material cost (TL / unit) per month

G_i = stockout cost (TL/unit) per month

D_i = monthly demand of product i

R_i = required hours to be completed one unit i by one employee (hours/unit)

W_0 = 12 , initial workforce size

IB_0 = 130 , initial inventory of brake disc

IO_0 = 6 , initial inventory of oil cooler

Decision Variables

W_t = workforce size for month t

O_t = number of overtime hours worked in month t

H_t = number of employees hired at the beginning of month

L_t = number of employees laid off at the beginning of month

IB_t = inventory of brake disc at the end of month t

IO_t = inventory of oil cooler at the end of month t

SB_t = number of units of brake disc stocked out at the end of month t

SO_t = number of units of oil cooler stocked out at the end of month t

PB_t = number of units of brake disc produced in month t

PO_t = number of units of oil cooler produced in month t

Constraints

1-) work force hiring and lay-off constraints

$$W_t = W_{t-1} + H_t - L_t \quad \forall t$$

2-) capacity constraints

$$PB_t * R_1 + PO_t * R_2 \leq 22 \text{ workdays} * 8 \text{ (hours/day)} * W_t + O_t \quad \forall t$$

3-) inventory-balance constraints

$$IB_{t-1} + PB_t = D_1 + SB_{t-1} + IB_t \quad \forall t$$

$$IO_{t-1} + PO_t = D_2 + SO_{t-1} + IO_t \quad \forall t$$

4-) overtime limit constraints

$$O_t \leq 22,5 * W_t \quad \forall t$$

Objective function:

Minimize

$$A \sum_{t=1}^{12} W_t + B \sum_{t=1}^{12} O_t + C \sum_{t=1}^{12} H_t + K \sum_{t=1}^{12} L_t + E_1 \sum_{t=1}^{12} IB_t + E_2 \sum_{t=1}^{12} IO_t + G_1 \sum_{t=1}^{12} SB_t + G_2 \sum_{t=1}^{12} SO_t$$

$$+ F_1 \sum_{t=1}^{12} PB_t + F_2 \sum_{t=1}^{12} PO_t$$