IE 375 – Production Planning
Homework Assignment 2 – March 19

Apple has designed iPhone 14 in such a way that consumer returns can be easily disassembled, remanufactured, and remarketed. Currently, Apple's lenient return policy allows its consumers to return their devices for a full refund within one month of purchase. Apple is now at the stage of deciding whether the returned devices should be remanufactured to meet the demand of its price-sensitive customers. Apple's sales division forecasts the demand for new and refurbished versions of iPhone 14 in the first six months of the year 2023 as follows:

	New	Refurbished
January	50000	1000
February	40000	2000
March	20000	2000
April	30000	3000
May	20000	3000
June	15000	4000

Taking the above forecasts as an input, Apple's operations division has been asked to plan the production of iPhone 14 for the first six months of the year 2023. Apple's refurbishment decision will be based on the aggregate production plan of the operations division.

(a) (60 points) Consider the production planning of new devices only. The smartphones are assembled with a special equipment that can be leased for one or more months. One such equipment can assemble 1000 items per month. The leasing cost is equal to \$60000 per equipment per month. Once the equipment is leased, it should be configured for the assembly process. The configuration cost is \$30000 per equipment. The leasing duration can start at the beginning of any month but its termination before the end of June results in an additional fee of \$20000 per equipment. The equipment may be underutilized within the leasing duration but overtime production is not permitted. Apple has no such equipment at the end of 2022. Any demand that is not satisfied on time is backlogged, incurring a unit cost of \$40 per month. Apple wants to have no backlog at the end of June. Apple has no inventory at the end of 2022 and wants to have no inventory at the end of June. The inventory holding cost for one unit of new device is \$20 per month. Assume that a fractional number of the equipment can be leased.

(i) (30 points) Formulate a linear program to calculate the optimal number of devices that should be assembled and the optimal number of equipment that should be leased in each month. Solve this linear program using the Excel Solver.

(ii) (15 points) Modify the linear program in part (i) to calculate the chase strategy (i.e., the zero-inventory/zero-backlog plan) and solve the modified linear program. What is the additional cost of the chase strategy?

(iii) (15 points) Modify the linear program in part (i) to calculate the level strategy (i.e., the constant equipment plan) and solve the modified linear program. What is the additional cost of the level strategy?

(b) (40 points) Now consider the production planning of new and refurbished devices together. The equipment leased is capable of assembling new devices as well as disassembling and remanufacturing consumer returns. Each equipment can be used in either the assembly line or the remanufacturing line in any month. It can assemble 1000 new devices per month or remanufacture 800 returns per month. The equipment used for one of the two lines in any month can be configured for the other line in the next month at no cost.

Remanufacturing operations are constrained by consumer returns. Apple estimates that 25% of the new devices sold in any month will be returned by consumers at the beginning of the next month (within the time period allowed by the lenient return policy). All these returns will become available for remanufacturing (starting in February). Any unmet demand for refurbished devices is backlogged, incurring a unit cost of $10 per month. Apple aims to clear all backlogs for both devices at the end of June. Apple has no inventory for either device at the end of 2022 and wants to have no inventory for either device at the end of June. The inventory holding cost for one unit of refurbished device is $5 per month.

Formulate a linear program to calculate the optimal number of new devices that should be assembled, the optimal number of returns that should be remanufactured, and the optimal number of equipment that should be leased and their optimal allocation between the two product lines in each month. Solve this linear program using the Excel Solver. Assume that a fractional number of the equipment can be leased.