Name:

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Section:

IE 400-HOMEWORK 4

Spring 2020

Do not forget to write the Honor code and sign it

Question 1. During the next three months, Toyco must meet (on time) the demands for three types of products shown in Table 1. Two machines are available to produce these products. Machine 1 can only produce products 1 and 2, and machine 2 can only produce products 2 and 3. Each machine can be used for up to 40 hours per month. Table 2 shows the time required to produce one unit of each product (independent of the type of machine); the cost of producing one unit of each product on each type of machine; and the cost of holding one unit of each product in inventory for one month. Formulate a LP that could be used to minimize the total cost of meeting all demands on time.

Month	Product 1	Product 2	Product 3
1	50	70	80
2	60	90	120
3	60	80	100

Product	Production Time (minutes)	Production Cost for Machine 1 ($)	Production Cost for Machine 2 ($)	Holding Cost ($)
1	30	40	-	15
2	20	45	60	10
3	15	-	55	5

Question 2. MEC believes it will need the amounts of generating capacity shown in Table 3 during the next five years. The company has a choice of building (and then operating) power plants with the specifications shown in Table 4.

i) Formulate an IP to minimize the total costs of meeting the generating capacity requirements of the next five years.

Year	Generation Capacity (Million kwh)
1	80
2	100
3	120
4	140
5	160

Plant	Generating Capacity (Million kwh)	Construction Cost ($ Millions)	Annual Operating Cost ($ Millions)
1	70	20	1.5
2	50	16	0.8
3	60	18	1.3
4	40	14	0.6

ii) Suppose that at the beginning of year 1, power plants 1–4 have been constructed and are in operation. At the beginning of each year, MEC may shut down a plant that is operating or reopen a shut-down plant.The costs associated with reopening or shutting down a plant are shown in Table 5. Formulate an IP to minimize the total cost of meeting the demands of the next five years.

Plant	Reopening Cost ($ Millions)	Shutdown Cost ($ Millions)
1	1.9	1.7
2	1.5	1.2
3	1.6	1.3
4	1.1	0.8

Question 3. The owner of a lake must decide how many fish to catch and sell at the beginning of each year. Assume that the market demand for fish is unlimited. If x is the fish sold in year n, a revenue of $r_n(x)$ is earned. The cost to catch x fish in year n is $c_n(x, b)$, where b is the number of fish in the lake at the beginning of the year n. The number of fish in the lake at the beginning of the year is the double of the number in the lake at the end of the previous year. The owner is interested in maximizing the overall profit over the next n years. a) Formulate the problem as a DP model. b) Solve the problem for $n = 3$ years, $r_1(x) = 10x, r_2(x) = 13x, r_3(x) = 12x$. The cost of catching $c_1(x) = 2x; c_2(x) = 4x; c_3(x) = x$ (it does not depend on the number of fish in the lake). Currently there are 10 fish in the lake.

Question 4. i) Consider the list of activities and predecessors that are involved in building a house.

Activity	Description	Immediate Predecessors	Duration (days)	Crashing cost per day	Max possible reduction in duration of activity
A	Foundation	-	5	30	2
B	Walls and ceiling	A	8	15	3
C	Roof	B	10	20	1
D	Electrical wiring	B	5	40	2
E	Windows	B	4	20	2
F	Siding	E	6	30	3
G	Paint	C, F	3	40	1

(a) Draw a project network, determine the critical path and project duration (without considering crashing).
(b) Which activities can be delayed without delaying the entire project?
(c) Suppose that by hiring additional workers, the duration of each activity can be reduced. The costs per day of reducing the duration of activities are given in the table above. Write down the LP that minimizes the total cost of completing the project within 20 days.

ii) The promoter of a Mayfest concert in Bilkent must perform the tasks shown in Table before the concert can be held(all durations are in days)

Activity	Description	Immediate Predecessors	*a*	*b*	*m*
A	Find site	—	2	4	3
B	Find engineers	A	1	3	2
C	Hire opening act	A	2	10	6
D	Set radio and TV ads	C	1	3	2
E	Set up ticket agents	A	1	5	3
F	Prepare electronics	B	2	4	3
G	Print advertising	C	3	7	5
H	Set up transportation	C	0.5	1.5	1
I	Rehearsals	F, H	1	2	1.5
J	Last-minute details	I	1	3	2

Find the probability that concert can be held on 15th day or before. Show all your work clearly.