Rutgers University, Business School/Undergraduate New Brunswick
Operations Management (33:623:386:03)
Spring 2008; Instructor: Adi Ben-Israel

Hourly Exam 2 — March 31, 2008

You have 80 minutes to complete this examination. The exam has 8 pages.

Please do not read past this page until instructed to.

Allowed materials:

- A single "cram sheet" in your own handwriting (both sides allowed)
- A dictionary (if English is not your first language)
- A calculator

You may detach any page from the exam form, but you must turn in all pages at the end of the exam.

Name:

ID:

Section No: 03

DO NOT WRITE BELOW

Q1	
Q2	
TOTAL	

Name:

Q1: Project scheduling (60 points). A project consists of 7 activities, A – G. The table lists the activities, their prerequisites, the normal duration of each activity, the fixed and variable costs of reducing that duration, and the minimum and maximum days that can be crashed.

Activity	Requires	Duration [days]	Fixed cost of crashing [$]	Variable cost of crashing [$/day]	Minimum Crash [days]	Maximum Crash [days]
A	----	8	600	200	2	5
B	----	12	400	500	3	3
C	A, B	7	500	300	1	4
D	A, B	9	600	400	2	7
E	C	10	500	200	4	6
F	C, D	8	700	400	3	5
G	D, E	13	800	200	5	9

For example, Activity F requires the completion of C and D before it can start, and normally lasts 8 days. If one chooses to crash activity F, then it must be crashed at least 3 days, and at most 5 days. If one crashes F by 5 days, the cost is $2700.

We are given in addition:

1. At most one of the two actvities A and B can be crashed.
2. If Activity C is crashed, then Activity F must be crashed by at least the same number of days.
3. If Activity D is crashed 4 days, then its variable cost of crashing drops to $200. Thus, if Acivity D is reduced 6 days, the cost is 600 + 4*400 + 2*200 = 2600.

Part (a). Formulate a model to minimize the cost of finishing the project in 18 days. Give clear definitions of your variables, and write your constraints clearly. You will need most of these constraints in part (b), and to save work give them numbers, and refer to the numbers later.

Part (b). Formulate a model to find the shortest duration of the project if a budget of $8,000 can be used for crashing.

Name:

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Q2: Power (40 points, Spreadsheet)**.** Garden State Electricity (**GSE**) plans its operations for the next 5 years. The demand for power in each year is given below

Year	**Demand** [million of KWh]
1	80
2	100
3	120
4	140
5	160

To meet the demand in each year, GSE can use 4 power plants, with capacities (in million of KWh) and costs (in millions of dollars) shown below

Plant	**Capacity** [millions of KWh]	**Fixed Cost** [millions of dollars]	**Annual Operating Cost** [millions of dollars]
1	70	20	1.5
2	50	16	0.8
3	60	18	1.3
4	40	14	0.6

Each plant can be started in any year, and is then used without interruption. There is no need to use all plants (demand can be satisfied without using Plant 3.) The **fixed cost** is charged in the year a plant is started, and the **annual operating cost** is charged in every year afterwards. For example, if plant 3 is started in year 2, its cost in that year is 19.3 millions (18 + 1.3 millions) and its annual cost in following years is 1.3 millions.

GSE would like to minimize the total cost of meeting the demand. For this purpose the following spreadsheet is used.

(a) What is the target cell? What are the changing cells? (5 points)

(b) The formula in cell B17 (available capacity of plant 1 in year 1) is =SUM($B11:B11)*$D4 and is copied to cells B17:F20. What formula appears in cell D19? (5 points)

(c) Write the formula in cell B26 (operating cost of plant 1 in year 1), that when copied to cells B26:F29 gives the correct results. (5 points)

Name:

	A	B	C	D	E	F	G	H	I
1	**Problem 2**								
2		**Fixed Cost**	**Operating Cost**	**Capacity**					
3		[million $]	[million $]	[million KWh]					
4	**Plant 1**	$20	$1.5	70					
5	**Plant 2**	$16	$0.8	50					
6	**Plant 3**	$18	$1.3	60					
7	**Plant 4**	$14	$0.6	40					
8									
9	**Start plants (1 if plant is used first in that year, 0 if not)**								
10		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Sum**		**Max**
11	**Plant 1**	1	0	0	0	0	**1**	<=	**1**
12	**Plant 2**	1	0	0	0	0	**1**	<=	**1**
13	**Plant 3**	0	0	0	0	0	**0**	<=	**1**
14	**Plant 4**	0	0	1	0	0	**1**	<=	**1**
15									
16	**Available capacity**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**			
17	**Plant 1**	70	70	70	70	70			
18	**Plant 2**	50	50	50	50	50			
19	**Plant 3**	0	0	0	0	0			
20	**Plant 4**	0	0	40	40	40			
21	**Total**	**120**	**120**	**160**	**160**	**160**			
22		>=	>=	>=	>=	>=			
23	**Demand**	**80**	**100**	**120**	**140**	**160**			
24									
25	**Operating costs**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**			
26	**Plant 1**	$1.5	$1.5	$1.5	$1.5	$1.5			
27	**Plant 2**	$0.8	$0.8	$0.8	$0.8	$0.8			
28	**Plant 3**	$0.0	$0.0	$0.0	$0.0	$0.0			
29	**Plant 4**	$0.0	$0.0	$0.6	$0.6	$0.6			
30									
31	**Summary of costs (in $millions)**								
32	**Total fixed cost**	$50							
33	**Total operating co**	$13.3							
34	**Total cost**	**$63.3**							
35									

Name:

(d) Write the formula in cell B21 (total capacity in year 1) that gives the correct result when copied to cells C21:F21 (5 points)

(e) What do the 1's in cells I11:I14 represent? (5 points)

(f) Write the formula in cell B32 (total fixed cost). (5 points)

(g) Write the constraints in the Solver dialog box. (10 points)