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SOLUTION

ADM 2302
Business Decision Models
FINAL EXAM

December 7, 2005

Last Name: _____ First Name: _____

Student #: _____ Section: _____

Professor (circle): Lane (A) Michalowski (B) Jaber(C and D)

Instructions:

1. Please answer all the questions in the space provided. Please use scrapbook for notes, etc. Only answers in this questionnaire will be marked.

2. This is a closed-book exam: One review sheet (double sided) and calculator are allowed.

3. Verify that your exam has 11 pages (including this front page and the last page containing the Normal Distribution table).

DO NOT WRITE ON THE TABLE BELOW

Question	1	2	3	4	5	Total
Notes						
Points	25	12	13	25	25	100

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Statement to be signed by the student:
I have read the text on academic integrity and I pledge not to have committed or attempted to commit academic fraud in this examination.

Signed:_____

Note: an examination copy or booklet without that signed statement will not be graded and will receive a final exam grade of zero.

QUESTION 1: (25 points)

Electronics Play Group (EPG) of Packenham, Ontario is considering how to distribute a new portable MP3 player they manufacture of which a first production run of 5,000 units is now in progress in time for the Christmas season. EPG expects to sell all 5,000 units. A strategy for distributing the new MP3 player involves deciding how many units to distribute among different markets. These markets include: (1) retail technology distributors (e.g., Future Shop, Best Buy, The Source); (2) retail business equipment distributors (e.g., Business Depot/Staples); (3) retail commercial big box outlets (e.g., Wal-Mart); and (4) direct on-line Internet purchases (e.g., eBay).

Profits from the product will vary according to the distribution market because of differing costs of distribution. As well, advertising costs and personnel sales requirements by market also differ as per the table below. The advertising budget is limited to $50,000 and a maximum sales force time of 4,600 hours is available.

Distribution Channel	Profit per Unit	Advertising Cost per Unit	Sales Effort per Unit
1. Technology (T)	$75	$14	2.5 hours
2. Business (B)	$63	$9	3.75 hours
3. Commercial (C)	$50	$10	3.80 hours
4. Internet (I)	$44	$7	0.50 hour

A contract with Wal-Mart requires that at least 40 dozen (480 units) new MP3 players be distributed there. The company wants to establish a distribution strategy to maximize total expected profits from the distribution of the new MP3 player. The correct linear programing formulation for EPG's market distribution problem is given below:

Let T, B, C, and I denote the number of units of the new MP3 player to distribute to Technology, Business, Commercial, and Internet markets respectively.

MAX 75T + 63B + 50C + 44I Profits ($)

Subject to

1. Advertising Budget:	14T + 9B + 10C + 7I	≤ $50,000
2. Sales Effort Limit:	2.5T + 3.75B + 3.8C + 0.5I	≤ 4,600 hrs
3. Production Limit:	T + B + C + I	= 5,000 units
4. Commercial Contract:	C	≥ 480 units
5. Non-negativity:	T, B, C, I all ≥ 0	

Consider the following problems (a) and (b) below. Modify the formulation above to include the changes implied by the problems. The problems (a) and (b) are to be considered independently. Note: you need only write the changes to the original formulation – not the entire formulation – in the spaces below.

(a) Consider the opportunity to purchase more hours for the sales effort. There are up to 900 additional hours available at a cost of $14.50 per hour. Write down the revised formulation to account for this change. (5 points)

Solution
1) add a new decision variable: SHE to denote additional sales effort hours
2) change constraint 2: 2.5T + 3.75B + 3.8C + 0.5I ≤ 4,600 hrs +SHE
3) modify the Objective function: add: -14.50*SHE
4) add upper bound constraint on new variable: SHE<=900 hours

(b) EPG wants to ensure that their distribution of the MP3 product in the technology retail stores (T) is at least 75% of total distribution in all the retail stores (T+B+C). Write down the revised formulation to account for this change. (4 points)

Solution:
1) Add a new constraint: T/(T+B+C) >=0.75 (or equivalent form)

QUESTION 1: (continued)

The following correct output for this problem above in its original form is provided below as Excel Solver output. You will need this output to answer the following questions (c) through (f) below each part of which is to be considered independently of all others.

Microsoft Excel 11.0 Answer Report

Target Cell (Max)

Name	Original Value	Final Value
Total Profit	$230,878	$230,878

Adjustable Cells

Name	Original Value	Final Value
Decision Variable Values T	258	258
Decision Variable Values B	0	0
Decision Variable Values C	480	480
Decision Variable Values I	4262	4262

Constraints

Name	Cell Value	Formula	Status	Slack
Advertising Cost LHS	38246	$H$14<=$J$14	Not Binding	11754
Sales Effort LHS	4600	$H$15<=$J$15	Binding	0
Production Limit LHS	5000	$H$16=$J$16	Not Binding	0
Commercial Contract LHS	480	$H$17>=$J$17	Binding	0

Microsoft Excel 11.0 Sensitivity Report

Adjustable Cells

Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
Decision Variable Values T	258	0	75	1E+30	19.30769231
Decision Variable Values B	0	-31.375	63	31.375	1E+30
Decision Variable Values C	480	0	50	45.15	1E+30
Decision Variable Values I	4262	0	44	31	1E+30

Constraints

Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
Advertising Cost LHS	38246	0	50000	1E+30	11754
Sales Effort LHS	4600	15.5	4600	3358.285714	516
Production Limit LHS	5000	36.25	5000	1032	3409.6
Commercial Contract LHS	480	-45.15	480	156.3636364	480

QUESTION 1: (continued)

(c) From the optimal solution, what are the sales effort allocations to each of the distribution channels? (4 points)

Solution:
Sales effort allocation to each distribution channel is:
1) T: 258 units * 2.5 hrs per unit = 645 hours
2) B: 0 units * 3.75 hrs per unit = 0 hours
3) C: 480 units * 3.8 hrs per unit = 1824 hours
4) I: 4262 units * 0.5 per unit = 2131 hours

d) What would need to happen to the Business distribution option unit profits before it would be optimal to acquire an advertising and sales force allocation of its own? (4 points)

Solution:
Unit Profits from the Business distribution option would need to increase by the "Reduced Cost" amount of $31.375 to $94.375 (=63+31.375) before it would be optimal to distribute there and acquire an advertising and sales force allocation.

(e) Given the highly competitive markets for MP3 players in 2005, EPG was considering committing more financial resources to support the advertising costs for this project. After some discussion, the Board of Directors approved another $12,000 for this project. What will be the impact on the new optimal profit of these new operating funds for advertising? (4 points)

Solution:
Since the Shadow Price for Advertising dollars is zero, then all the available funds are not being used up now. Therefore, it would not be worthwhile for EPG to add more advertising dollars, and the new optimal profit will not change from these new operating funds.

(f) Given a high volume of sales in early December, Wal-Mart has sent a memo to EPG requesting that the current contract be renegotiated so that the 480 units be increased by 144 more units. Determine the impact on EPG's total optimal profit if the new terms of the contract go into effect. (4 points)

Solution:
Given the Shadow Price for Commercial Contract sales of -45.15, then it costs EPG to increase distribution to Wal-Mart. Thus, only if forced to do so, the optimal objective function value would decrease from $230,878 to $230,878 + (144 units * -45.15) = $230,878-$6501.60 = $224,376.40. Note also that the decrease of 144 units does not exceed the "Allowable Increase" of 156 units and therefore the Shadow Price is applicable.

QUESTION 2: (12 points)

The Research and Development Department of DWR Ltd has developed new game consoles: zbox and ybox. Production of these consoles requires setting up computerized and fully automated production lines that would cost $25,000 for zbox and $32,000 for ybox. Once the initial costs are covered, each console generates hefty profits: $150/unit for zbox and $210/unit for ybox.

In its current production facilities in Kanata, DWR Ltd has space for creating three production lines capable of manufacturing the consoles and each line can be used to manufacture both consoles (if necessary) at the same time. However, management has decided that in order to mitigate the risks, only one production line would be open.

Console zbox can be produced at the rate of 15 units/hr on line 1, 18 units/hr on line 2, and 22 units/hr on line 3. The ybox can be produced at the rate of 20 units/hr, 17 units/hr, and 10 units/hr respectively. Line 1 has 340 hours production capacity, line 2 has 400 hours capacity, and line 3 has 380 hours capacity.

Write in the space below the algebraic formulation for the above mixed binary integer programming problem. DO NOT SOLVE.

Solution

Decision Variables
Let Xij = the number of game console i produced at on production line j,

Where i = 1(zbox), 2 (ybox) and j = 1, 2,3

Yi = 1 if game console i is produced, where i = 1 (zbox), 2 (ybox)

Yi = 0 if game console i is NOT produced

Pj = 1 if game console zbox and ybox are produced on production line j

Pj = 0 if game console zbox and ybox are NOT produced on production line j

where j = 1, 2, 3

Max $150 (X11 + X12 + X13) + 210 (X21 + X22 + X23) – 25,000Y1 – 32,000 Y2

Subject to

$$\frac{1}{15}X11 + \frac{1}{20}X21 \leq 340P1$$

$$\frac{1}{18}X12 + \frac{1}{17}X22 \leq 400P2$$

$$\frac{1}{22}X13 + \frac{1}{10}X23 \leq 380P3$$

P1 + P2 + P3 = 1

(X11 + X12+ X13) <= 99999Y1 (or (X11 + X12+ X13) <= 8360Y1)
(X21 + X22 + X13) <= 99999Y2 (or (X21 + X22 + X13) <= 6800Y2)

Xij >= 0 and INTEGER ; Yi and Pj = 0 or 1 for all i= 1, 2 and j = 1, 2

QUESTION 3: (13 points)

Slight differences in the broad back measurement of tires for large body passenger jets result in different safe lifetime periods for the tires. The broad back test is not entirely accurate. However, Bo Ng Aircraft manufacturers would like to determine as best it can the relationship between broad back measurement and safe lifetime period, in order to advise clientele as to tire usage. Bo Ng has decided that goal programming would provide the best predictive approach.

For data, Bo Ng has collected observations on 135 tires. For each tire, the broad back measurement (BM) and actual safe lifetime period (ASLP) were recorded. For simplicity, assume that it is sufficient to base the study on only three tires. Data are given below:

BM: Broad back Measurement (mm)	ASLP:Actual safe lifetime period (hours)
2.22	813.6
2.10	975.2
1.96	791.0

The model that will be used to predict ASLP is:

predicted same lifetime period (PSLP) = a(BM) + b

For example, if "a" were 365 and "b" were 27, the PSLP for the first tire would be equal to 365(2.22) + 27 = 837.3 hrs. Thus, the PSLP would exceed the ASLP by 837.3-813.6 = 23.7 hrs.

We would like to determine values for "a" and "b" using goal programming by applying the equation

$$PSLP_i + u_i = ASLP_i.$$

where the residual for the i^{th} tire (observation) is:

$$u_i = ASLP_i - PSLP_i$$

For "n" observations (n=3 in our example), the goal programming objective function would be

$$\text{Min } \Sigma_{1\le i\le n} (d_i^- + d_i^+)$$

where $u_i = (d_i^-) - (d_i^+.)$

Formulate the goal programming model that will predict the ASLP given the broad back measurements (BM's) based on the sample. DO NOT SOLVE.

Solution:

Note: while it is virtually impossible (empirically) for "a" to be negative, that is not so for "b". I would suggest we accept either b≥0 or b unconstrained in the answer. Some students may use u_i as well as d_i^+ and d_i^-. In other words, I would expect different formulations, for which we will have to adapt the marking key.

Let a and b be parameters in the prediction equation PSLP = a(BM) + b
Let d_i^+ and d_i^- denote positive and deviations of the actual ASLP from the predicted PSLP.

Min $d_1^+ + d_1^- + d_2^+ + d_2^- + d_3^+ + d_3^-$

subject to (note – the students can transpose the variables if desired):

$2.22a + b - d_1^+ + d_1^- = 813.6$
$2.10a + b - d_2^+ + d_2^- = 975.2$
$1.96a + b - d_3^+ + d_3^- = 791.0$

All variables ≥ 0 (or all variables except b ≥ 0)

QUESTION 4: (25 points)

T. Bone Puckett, a corporate raider, has acquired a textile company and is contemplating the future of one of its major plants located in Ontario. Three alternative decisions are being considered: (1) expand the plant and produce lightweight, durable materials for possible sales to the military, a market with little foreign competition; (2) maintain the status quo at the plant, continuing production of textile goods that are subject to heavy foreign competition; or (3) sell the plant now for a net profit of $500,000.

If one of the first two alternatives is chosen, the plant will still be sold at the end of a year. The amount of net profit that could be earned by selling the plant in a year depends on foreign market conditions, including the status of a trade embargo bill in Parliament. If the future political and foreign competitive situations are good, the net profit of the first and second alternatives will be $800,000 and $1,300,000 respectively. In case of poor foreign competitive conditions, the net profit will be $500,000 for the first alternative, and a net loss of $150,000 (or negative profits, ($150,000)) for the second alternative.

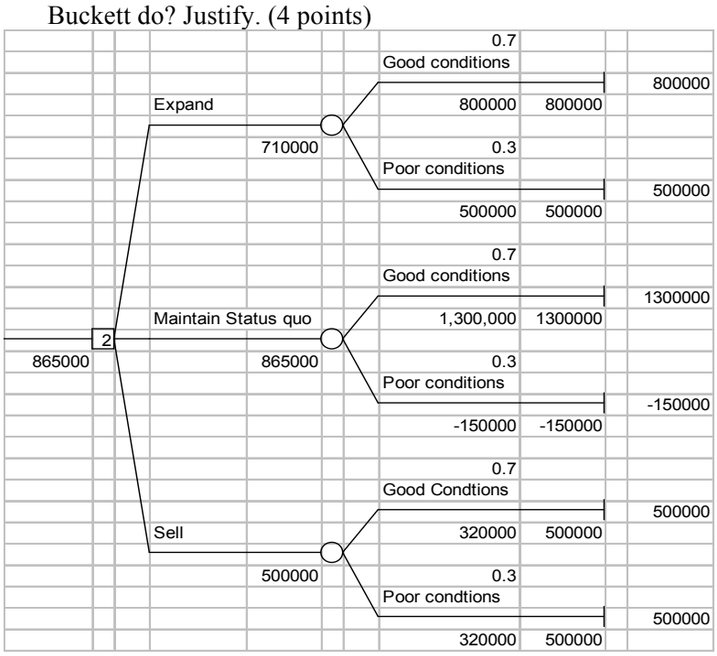
a) Develop the decision (payoff) table for this problem. If T. Bone Puckett wants to be conservative in his decision, what should he do? Justify. (4 points)

Alternatives	State of nature: Good Foreign Competitive Conditions	State of nature: Poor Foreign Competitive conditions	Minimum Payoff	
Expand	$800,000	$500,000	$500,000	<-- Max
Maintain Status Quo	$1,300,000	-$150,000	-$150,000	
Sell Now	$500,000	$500,000	$500,000	<-- Max

Conservative in his decision, Mr. Puckett will apply the Maximin criterion

Decision will be either to Expand of Sell Now.

b) Assume it is now possible to estimate a probability of 0.3 that poor foreign competitive conditions will exist. Construct the decision tree for this problem. What should T. Bone Buckett do? Justify. (4 points)



Decision: He should Maintain Status Quo (such decision has the maximum expected payoff of $865,000)

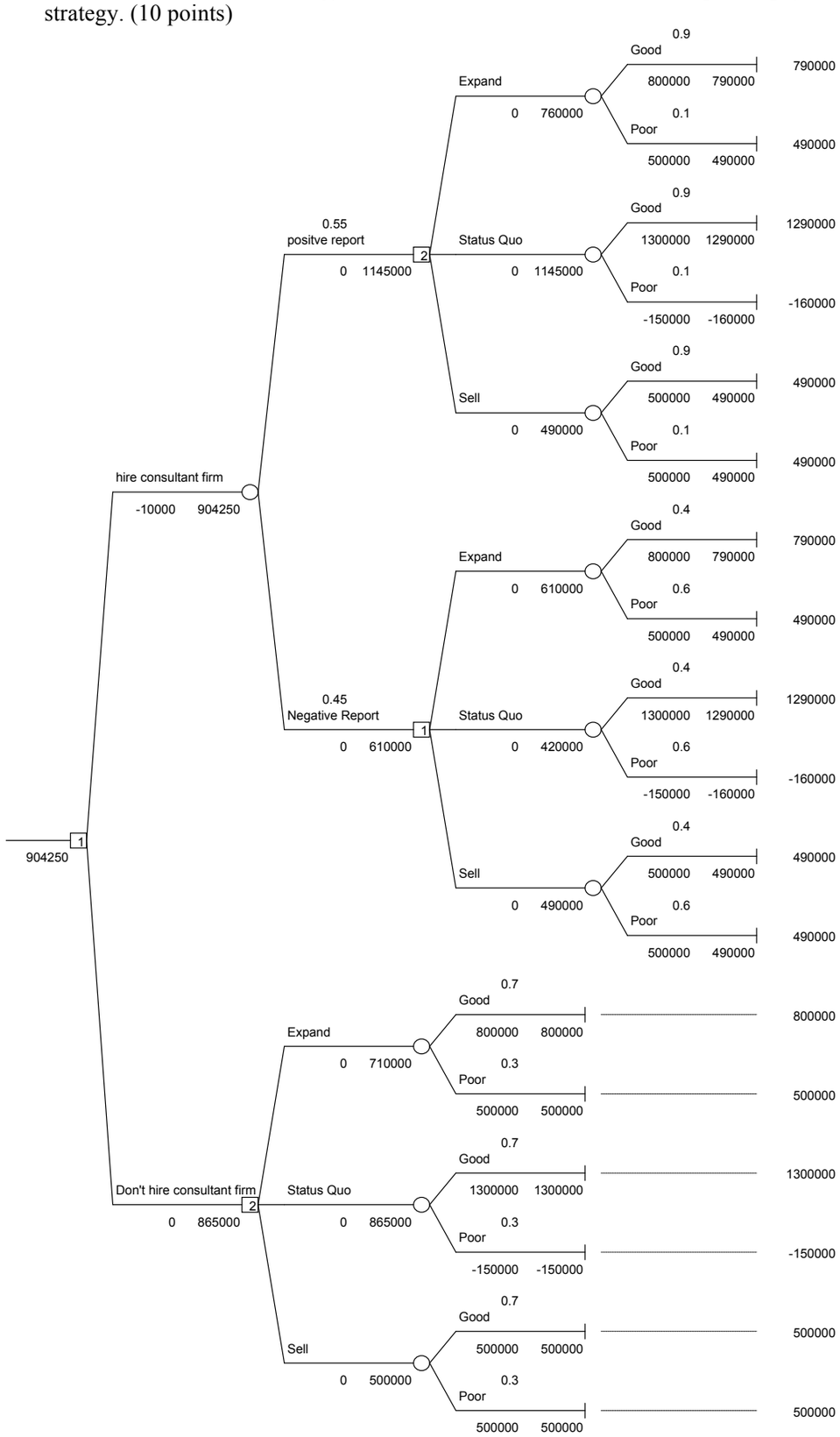
c) What is the expected value of perfect information (EVPI)? (4 points)

Solution

Expected value given perfect information = 1,300,000 (0.7) + 500,000 (0.3) = $ 1,060,000
Expected Value without perfect Information = $865,000
EVPI = $1,060,000 – 865,000 = $195,000

QUESTION 4: (continued)

d) T. Bone Puckett is considering hiring a consulting firm at a cost of $10,000 to predict future political and market situations. There is 0.55 probability that the consulting firm will predict good conditions, but even if it predicts good conditions, there is a 10% chance that its prediction is wrong. If the consulting firm predicts poor conditions, there is still a 40% chance that good conditions can occur.
Determine the decision strategy that T. Bone should follow and the expected payoff of this strategy. (10 points)



Decision Strategy: Hire the consultant firm, if the firm provides a positive report then maintain status quo, if the firm provides a negative report then Expand. The Expected payoff of this strategy is $904,250

e) What is the maximum amount T. Bone Puckett should pay the consulting firm for the report results on future political and market situations? (3 points)

EVSI = ($904,250 + $10,000) – 865,000 = $49,250

QUESTION 5: (25 points)

Klone Computers is a small manufacturer of personal computers which is about to design and manufacture the Klonepalm 2005 palmbook computer. The company faces two major tasks in introducing the new computer: (1) manufacturing the new computer; (2) training staff and vendor representatives to operate the new computer.

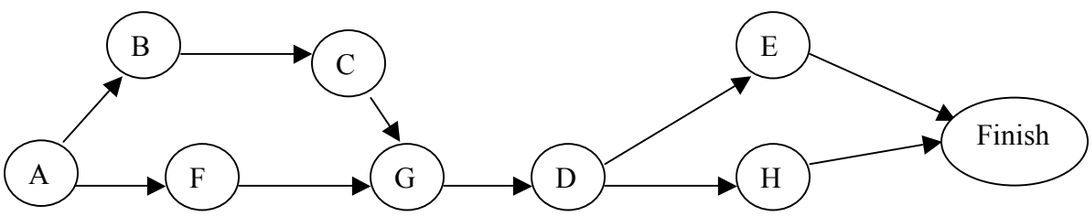
The entire project can be represented by 8 activities – five manufacturing (A, B, C, D, E), and three training (F, G, H). These activities are provided in the table below with the corresponding precedence relations.

Activity	Description	Immediate Predecessors
A	Prototype model design	---
B	Purchase of materials	A
C	Manufacture of prototype models	B
D	Revision of design	G
E	Initial productions run	D
F	Staff training	A
G	Staff input on prototype models	C, F
H	Sales training	D

The Table below details the three time estimates for the completion of the activities (in days)

Activity	Optimistic Time (a)	Most Likely Time (m)	Pessimistic Time (b)	Expected Time	Variance
A	76	86	120	90	53.78
B	12	15	18	15	1.00
C	4	5	6	5	0.11
D	15	18	33	20	9.00
E	18	21	24	21	1.00
F	16	26	30	25	5.44
G	10	13	22	14	4.00
H	24	28	32	28	1.78

a) Complete the table above, draw the project diagram of the Klonepalm 2005 Model, and compute ES, EF, LS, LF and Slack for each activity in the space below. (9 points).



Activity	Immediate Predecessors	Completion Time	ES	EF	LS	LF	SLACK
A		90	0	90	0	90	0
B	A	15	90	105	95	110	5
C	B	5	105	110	110	115	5
D	G	20	129	149	129	149	0
E	D	21	149	170	156	177	7
F	A	25	90	115	90	115	0
G	C,F	14	115	129	115	129	0
H	D	28	149	177	149	177	0

QUESTION 5: (continued)

b) What are the critical path, the expected project length and its standard deviation? (6 points)

Solution:

Critical path: _A-F-G-D-H _____

Expected Project duration: __177 days._____

Project Standard deviation: _____8.60_____
The project variance = 53.78 + 5.44+ 4 + 9 + 1.78 = 74

c) What is the probability of completing the project in 170 days? (4 points)

Solution:

Z = [170 – 177]/ 8.60 = - 0.81

P[X ≤ 170] = 1 - P[z≤ 0.81]= 1 – 0.791 = 0.209 (approximately 21 % chance that project will be completed in 170 days)

d) What time should Klone Computers report such that they are 99% sure that the project will be complete by that time? (4 points)

Solution :

P[X≤T] = P[z≤(T-177)/8.60] = .99

(T-177)/8.60 = 2.33

T= 197.04 days

e) The company is considering reducing the length of the project by one day. To do so, they have the option of either expediting the purchase of materials (B) at an additional cost of $500 or hiring another designer to assist in the Revision of Design activity (D) at an additional cost of $1,000. Recommend to the company which option they might use to crash this project by one period. (2 points)

Solution:

Activity D is critical thus it is the one that should be crashed for one period.