SRI CHANDRASEKHARENDRA SARASWATHI VISWA MAHAVIDHYALAYA

(University Established Under Section 3 of UGC Act 1956)

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Software Lab V

Operations Research

LABORATORY RECORD

Name : _____

Reg. No. : _____

Class : **II M.Sc (Maths)**

Subject : **Software Lab V (Operations Research)**

SRI CHANDRASEKHARENDRA SARASWATHI VISWA MAHAVIDHYALAYA

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BONAFIDE CERTIFICATE

Certified that this is a bonafide record of work done by the candidate Mr/Ms_____ with Register No. _____ of II M.Sc (Mathematics) in Software Lab V (Operations Research) during the academic year 2019-2020.

Staff In-charge Head of the Department

Submitted for the practical examination held on _____.

Internal Examiner External Examiner

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Ex.No.1	Introduction in MS Excel

Before formulating a Linear Programming Problem on a spreadsheet, we need to compile all data given in the problem, to ascertain the decisions to be taken, to determine the constraints on these decisions and, to recognize the overall measure of performance for the problem. Once these basic questions are answered, the following procedure (which will be explained while solving Problems) can be adopted to formulate a spreadsheet model and to solve using Solver.

1. Transfer all data into “data cells”
2. Display the decisions using “Changing Cells”
3. Engage the constraints using “Output Cells”
4. Specify the overall measure of performance in the “Target Cell”
5. Run the model with test values to verify that the model works in the desired way
6. Run Excel® solver after specifying the Target cell, Changing Cells and Constraints
7. Gain insights for interpretation using Answer, Sensitivity and Limits reports.

Ex.No.2	Linear Programming Problem

Problem 001 - ARRANGE WELL Cabinet Makers Problem

ARRANGE WELL Cabinet maker has 12 units of wood and intends to build two different kinds of bookcases within 36 hours. Model 1 requires 3 units of wood and 9 hours of labor, while model 2 requires 2 units of wood and 8 hours of labor. The selling prices of the models are $150 and $90 respectively. How many bookcases of each model should the cabinet maker assemble in order to maximize his revenue? Formulate the problem as a linear programming problem in Excel® and find an optimal solution using Solver.

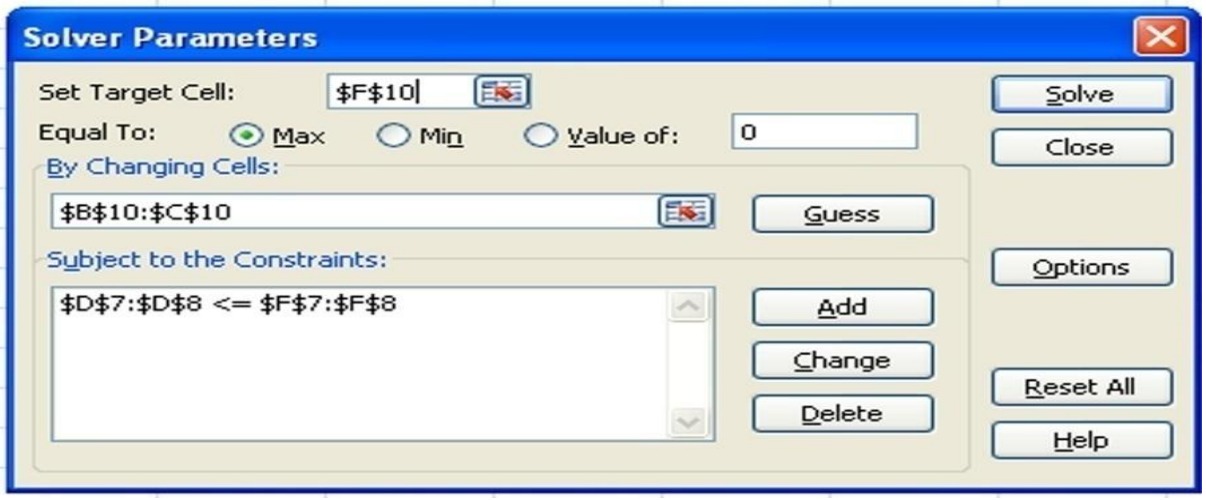
All the data given in the problem can be summarized comprehensively as in the following table

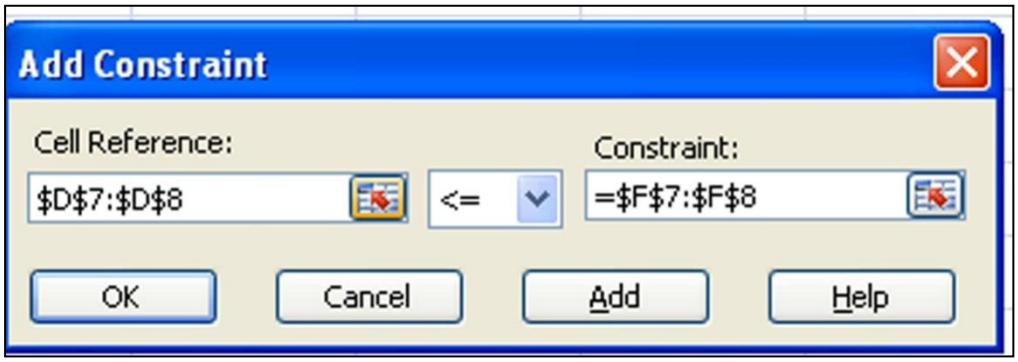
	Model 1	Model 2	Available
Selling Price	$150	$90	
Wood (Units)	3	2	12
Labour (Hours)	9	8	36

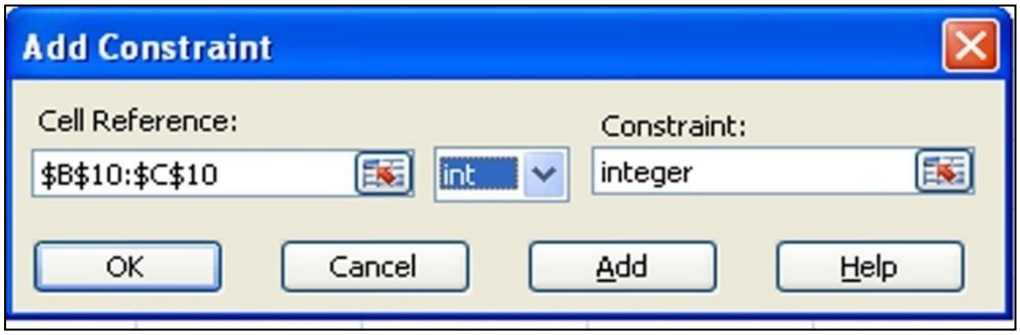
	Model 1	Model 2	Used		Available
Selling Price	$150	$90			
Wood (Units)	3	2		≤	12
Labour (Hours)	9	8		≤	36
No of bookcases				Revenue	

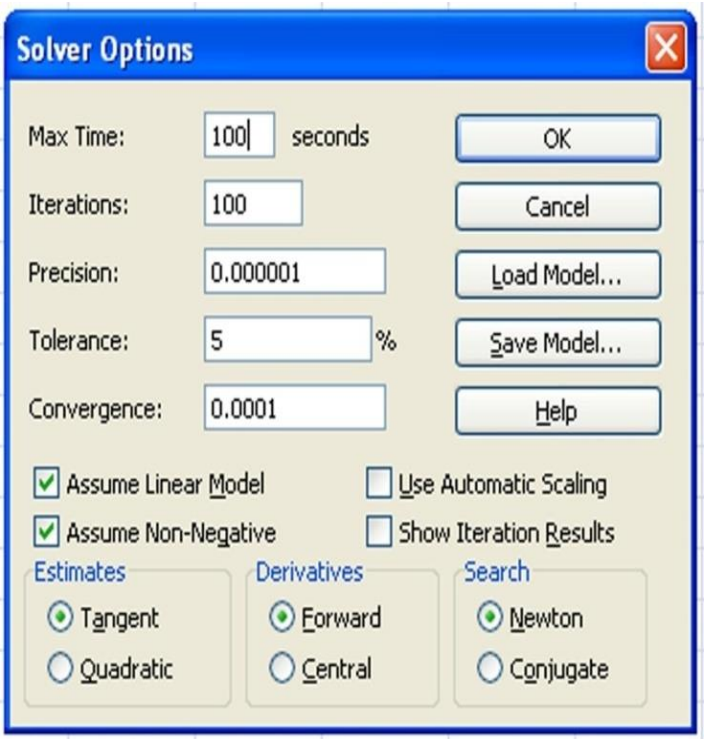
	A	B	C	D	E	F
1	ARRANGE WELL Cabinet maker's problem					
2						
3		Model 1	Model 2	Used		Available
4	Selling Price	150	90			
5						
6	Requirement					
7	Wood (Units)	3	2	=SUMPRODUCT(B10:C10,B7:C7)	≤	12
8	Labor (Hours)	9	8	=SUMPRODUCT(B10:C10,B8:C8)	≤	36
9						
10	No of bookcases				Revenue	=SUMPRODUCT(B10:C10,B4:C4)

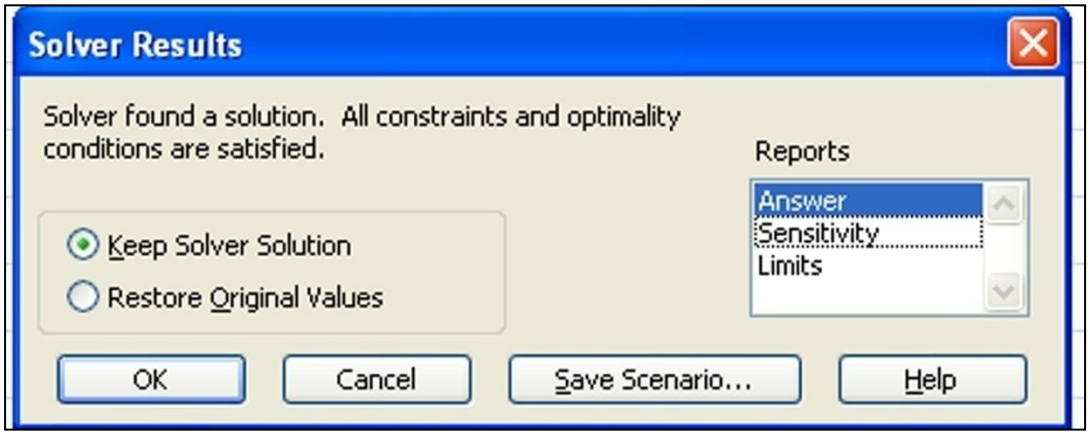
	A	B	C	D	E	F
1	ARRANGE WELL Cabinet maker's problem					
2						
3		Model 1	Model 2	Used		Available
4	Selling Price	$150	$90			
5						
6	Requirement					
7	Wood (Units)	3	2	8	≤	12
8	Labor (Hours)	9	8	26	≤	36
9						
10	No of bookcases	2	1		Revenue	$390






Add Constraint
Cell Reference:
$B$10:$C$10
int
Constraint:
integer
OK
Cancel
Add
Help


Solver Options
Max Time:
100
seconds
Iterations:
100
Precision:
0.000001
Tolerance:
5
%
Convergence:
0.0001
OK
Cancel
Load Model...
Save Model...
Help
Assume Linear Model
Use Automatic Scaling
Assume Non-Negative
Show Iteration Results
Estimates
Tangent
Quadratic
Derivatives
Forward
Central
Search
Newton
Conjugate


Solver Results
Solver found a solution. All constraints and optimality conditions are satisfied.
Reports
Answer
Sensitivity
Limits
Keep Solver Solution
Restore Original Values
OK
Cancel
Save Scenario...
Help

	A	B	C	D	E	F
1	ARRANGE WELL Cabinet maker's problem					
2						
3		Model 1	Model 2	Used		Available
4	Selling Price	$150	$90			
5						
6	Requirement					
7	Wood (Units)	3	2	12	≤	12
8	Labor (Hours)	9	8	36	≤	36
9						
10	No of bookcases	4	0		Revenue	$600

	A	B	C	D	E	F
1	**ARRANGE WELL Cabinet maker's problem**					
2						
3		**Model 1**	**Model 2**			
4	**Selling Price**	$150	$90			
5						
6	**Requirement**			**Used**		**Available**
7	**Wood (Units)**	3	2	12	≤	12
8	**Labor (Hours)**	9	8	36	≤	36
9						
10	**No of bookcases**	4	0		**Revenue**	**$600**
11						
12	**Legend**			**Range Name**	**Range**	
13	Data Cells			Available	F7:F8	
14	Output Cells			LaborRequirement	B8:C8	
15	Changing Cells			NoOfBookCases	B10:C10	
16	Target Cell			Revenue	F10	
17				SellingPrice	B4:C4	
18				Used	D7:D8	
19				WoodRequirement	B7:C7	

Problem 002 PUSHKARProblem

PUSHKAR operates a pushcart. He sells hotdogs and sodas. His cart can support 210 lbs. A hotdog weighs 2 ounces; a soda weighs 8 ounces. He knows from experience that he must have at least 60 sodas and at least 80 hotdogs. He also knows that for every two hotdogs he sells, he needs at least one soda. He makes $8 profit on a hotdog and $4 profit on a soda. Formulate the problem as linear programming to find how many sodas and hotdogs he must have in order to maximize profits.

Solution:

PUSHKAR Problem

	Hotdog	Soda			
Profit	$8	$4			
Ounces	2	8	3360	<=	3360
Production	560	280	280	>=	280
	>=	>=			
Minimum	80	60		**Net Profit**	**$5,600**

Legend	
Data Cells	
Output Cells	
Changing Cells	
Target Cell	

Problem 003 FASTAUTO Problem

FASTAUTO automobile manufacturer makes automobiles and trucks in a factory that is divided into two shops. Shop 1, which performs the basic assembly operation, must work 5 man-days on each truck but only 2 man-days on each automobile. Shop 2, which performs finishing operations, must work 3 man-days on each automobile or truck that it produces. Because of men and machine limitations Shop 1 has 180 man-days per week available while Shop 2 has 135 man-days per week. The manufacturer makes a profit of $300 on each truck and $200 on each automobile. Formulate the problem as a linear programming problem to find how many of each should he produce to maximize his profit?

Solution:

FASTAUTO Problem

	Auto	Truck			
Profit	200	300			
Shop 1	2	5	180	<=	180
Shop 2	3	3	135	<=	135
Production	15	30			

Net Profit	**12000**

Legend	
Data Cells	
Output Cells	
Changing Cells	
Target Cell	

Problem 004 COMFORT SIT

COMFORT SIT Company makes desk organizers. The standard model requires 2 hours of the cutter's and one hour of the finisher's time. The deluxe model requires 1 hour of the cutter's time and 2 hours of the finisher's time. The cutter has 104 hours of time available for this work per month, while the finisher has 76 hours of time available for work. The standard model brings a profit of $6 per unit, while the deluxe one brings a profit of $11 per unit. The company, of course, wishes to make the most profit. Assuming that they can sell whatever is made; formulate the problem as a linear problem to find how much of each model should be made in each month?

Solution:

COMFORT SIT Problem

	Standard	Deluxe	Used Hrs.		Available Hrs.
Profit	$6	$11			
Cutter	2	1	104	<=	104
Finisher	1	2	76	<=	76
No. Produced	44	16			

Net Profit	**$440**

Legend	
Data Cells	
Output Cells	
Changing Cells	
Target Cell	

Problem 005 DRINKCOLD Problem

DRINKCOLD Company wishes to bottle 2 different drinks. It takes 2 hours to can one gross of drink A, and it takes 1 hour to label the cans. It takes 3 hours to bottle one gross of drink B, and it takes 4 hours to label the cans. The company makes a $10 profit on one gross of drink A and a $20 profit on one gross of drink B. Given that the bottling department has 20 hours available, and the labeling department has 15 hours available. Formulate the problem as a linear programming problem in Excel to find out how many gross of drink A and drink B must be packaged in order to maximize the profit.

Solution:

DRINKCOLD Problem

	Drink A	Drink B	Used		Capacity
Profit	$10	$20			
Canning	2	3	20	<=	20
Labelling	1	4	15	<=	15
Total Produced	7	2			

Total Profit	**$110**

Legend	
Data Cells	
Output Cells	
Changing Cells	
Target Cell	

Ex.No.3	Transportation Problem

Problem 001 Solve the following Transportation problem

Solution

	D1	D2	D3	D4	SUPPLY
S1	11	13	17	14	250
S2	16	18	14	10	300
S3	21	24	13	10	400
DEMAND	200	225	275	250	

100	150	0	0	250	<=	250
100	75	0	125	300	<=	300
0	0	275	125	400	<=	400
200	225	275	250			
=	=	=	=			
200	225	275	250			

TRANSPORTCOST 12075

	LEGEND
DATACELL	
TARGETCELL	
CHANGINGCEL	

Problem 002 Solve the following Transportation problem

Solution

	1	2	3	4	supply
s1	21	16	25	13	11
s2	17	18	14	23	13
s3	32	27	18	41	19
demand	6	10	12	15	

0	0	0	11	11	<=	11
6	3	0	4	13	<=	13
0	7	12	0	19	<=	19
6	10	12	15			
=	=	=	=			
6	10	12	15			

	TRANSPORTCOST		796

	LEGEND
DATACELL	
TARGETCELL	
CHANGINGCEL	

Problem 003 Solve the following Transportation problem

Four gasoline dealers A, B, C and D require 50, 40, 60 and 40 KL of gasoline respectively. It is possible to supply these from locations 1, 2 and 3 which have 80, 100 and 50 KL respectively. The cost (in Rs.) for shipping very KL is shown in the table below. Determine the most economical supply.

		Dealers			
		A	B	C	D
Locations	1	7	6	6	6
	2	5	7	6	7
	3	8	5	8	6

Solution:

		Dealers					
		A	B	C	D		
Locations	1	7	6	6	6	0	80
	2	5	7	6	7	0	100
	3	8	5	8	6	0	50
		50	40	60	40	40	

0	0	50	30	80	<=	80
50	0	10	0	60	<=	100
0	40	0	10	50	<=	50
50	40	60	40			
=	=	=	=			
50	40	60	40			

Cost	1050

	LEGEND
DATACELL	
TARGETCELL	
CHANGINGCEL	

Problem 004 Solve the following Transportation problem

National Oil Company has three refineries and four depots. Transportation cost per ton, capacities and requirements are given below. Determine the optimum allocation of output.

		Depot				
		D1	D2	D3	D4	Capacity
Refinary	R1	5	7	13	10	700
	R2	8	6	14	13	400
	R3	12	10	9	11	800
	Requirement	300	600	700	400	

Solution:

		Depot				
		D1	D2	D3	D4	Capacity
Refinery	R1	5	7	13	10	700
	R2	8	6	14	13	400
	R3	12	10	9	11	800
	Requirement	300	600	700	400	

0	500	200	0	700	<=	700
300	100	0	0	400	<=	400
0	0	400	400	800	<=	800
300	600	600	400			
=	=	=	=			
300	600	700	400			

cost	17100

	LEGEND
DATACELL	
TARGETCELL	
CHANGINGCEL	

Problem 005 Solve the following Transportation problem

Consider the following transportation table. The costs are given in rupees; the supply and demand are in units. Determine an optimum solution.

		Destination					
		1	2	3	4	5	Supply
Source	I	40	36	26	38	30	160
	II	38	28	34	34	198	280
	III	36	38	24	28	30	240
	Demand	160	160	200	120	240	

Solution:

		Destination					
		1	2	3	4	5	Supply
Source	I	40	36	26	38	30	160
	II	38	28	34	34	198	280
	III	36	38	24	28	30	240
	Demand	160	160	200	120	240	

0	40	120	0	0	160	<=	160
160	120	0	0	0	280	<=	280
0	0	0	0	240	240	<=	240
160	160	120	0	240			
=	=	=	=	=			
160	160	200	120	240			

cost	21200

	LEGEND
DATACELL	
TARGETCELL	
CHANGINGCEL	

Ex.No.4	Assignment Problem

Problem 001 Solve the following Assignment Problem

Solution:

	A	B	C	D
I	1	4	6	3
II	9	7	10	9
III	4	5	11	7
IV	8	7	8	5

	A	B	C	D			
I	1	0	0	0	1	=	1
II	0	0	1	0	1	=	1
III	0	1	0	0	1	=	1
IV	0	0	0	1	1	=	1
	1	1	1	1			
	=	=	=	=			
	1	1	1	1			

cost	21

	LEGEND
DATACELL	
TARGETCELL	
CHANGINGCEL	
OUTPUTCEL	

Problem 002 Solve the following Assignment Problem

	1	2	3	4	5
A	8	5	2	6	1
B	0	9	5	5	4
C	3	8	9	2	6
D	4	3	1	0	3
E	9	5	8	9	5

Solution:

	1	2	3	4	5
A	8	5	2	6	1
B	0	9	5	5	4
C	3	8	9	2	6
D	4	3	1	0	3
E	9	5	8	9	5

	1	2	3	4	5			
A	0	0	0	0	1	1	=	1
B	1	0	0	0	0	1	=	1
C	0	0	0	1	0	1	=	1
D	0	0	1	0	0	1	=	1
E	0	1	0	0	0	1	=	1
	1	1	1	1	1			
	=	=	=	=	=			
	1	1	1	1	1			

COST	9

	LEGEND
DATACELL	
TARGETCELL	
CHANGINGCEL	
OUTPUTCEL	

Problem 003 Solve the following Assignment problem

	I	II	III	IV
1	8	26	17	11
2	13	28	4	26
3	38	19	18	15
4	19	26	24	10

Solution:

	I	II	III	IV
1	8	26	17	11
2	13	28	4	26
3	38	19	18	15
4	19	26	24	10

	I	II	III	IV			
1	1	0	0	0	1	=	1
2	0	0	1	0	1	=	1
3	0	1	0	0	1	=	1
4	0	0	0	1	1	=	1
	1	1	1	1			
	=	=	=	=			
	1	1	1	1			

COST	41

	LEGEND
DATACELL	
TARGETCELL	
CHANGINGCEL	
OUTPUTCEL	

Problem 004 Solve the following assignment problem so as to maximize the assignment cost.

	P	Q	R	S
A	18	26	17	11
B	13	28	14	26
C	38	19	18	15
D	19	26	24	10

Solution:

	P	Q	R	S
A	18	26	17	11
B	13	28	14	26
C	38	19	18	15
D	19	26	24	10

	P	Q	R	s			
A	0	0	1	0	1	=	1
B	1	0	0	0	1	=	1
C	0	1	0	0	1	=	1
D	0	0	0	1	1	=	1
	1	1	1	1			
	=	=	=	=			
	1	1	1	1			

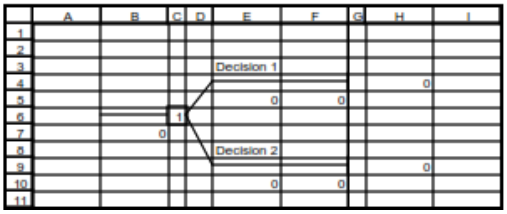
COST	59

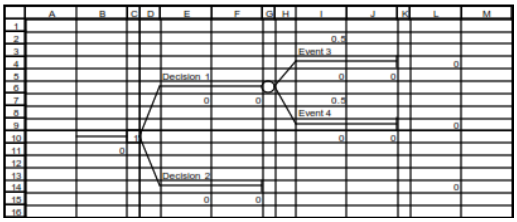
Ex.No.5	Decision Tree Problem

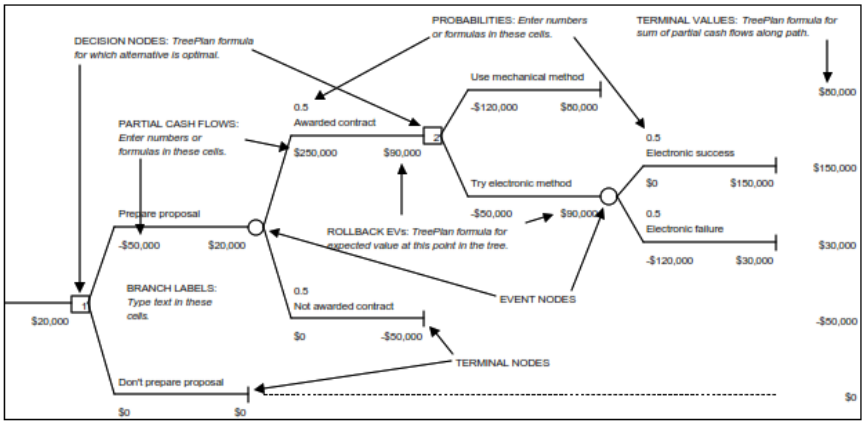
Quick Start:

Tree Plan is an Excel add-in that allows you to build decision trees in Excel. It was developed by Professor Michael R. Middleton at the University of San Francisco and modified for use at Fuqua (Duke) by Professor James E. Smith. Building a Decision Tree in Tree Plan

You can start Tree Plan either by choosing Tools | Decision Tree from the menu bar or by pressing Ctrl+t (hold down the Ctrl key and press t). If the worksheet doesn't have a decision tree, Tree Plan prompts you with a dialog box with three options; choose New Tree to begin a new tree. Tree Plan draws a default initial decision tree with its upper left corner at the selected cell. For example, the figure below shows the initial tree when $B$2 is selected. (Note that Tree Plan writes over existing values in the spreadsheet: begin your tree to the right of the area where your data is stored, and do not subsequently add or delete rows or columns in the tree-diagram area.) In Excel 5 and 95 a terminal node is represented by a triangle instead of a vertical bar.



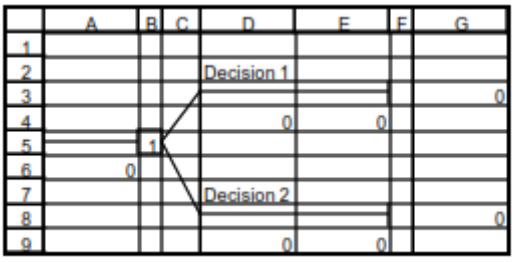




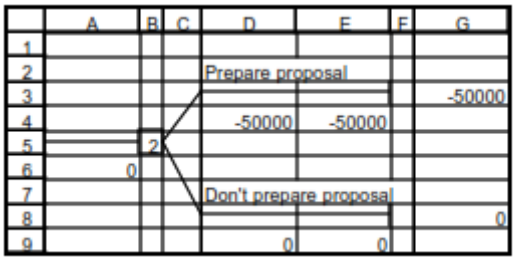
Building the Tree Diagram

1. Start with a new worksheet. (If no workbook is open, choose File | New. If a workbook is open, choose Insert | Worksheet.)

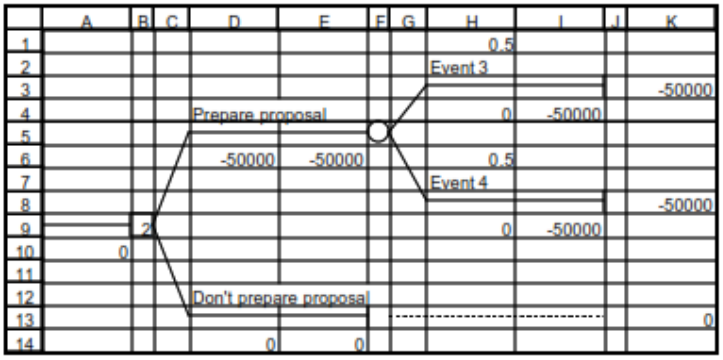
2. Select cell A1. From the Tools menu, choose Decision Tree. In the TreePlan New dialog box, click the New Tree button. A decision node with two branches appears.



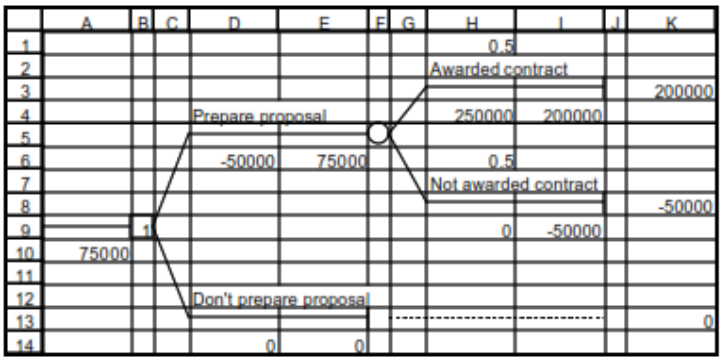
3. Do not type the quotation marks in the following instructions. Select cell D2, and enter Prepare proposal. Select cell D4, and enter –50000. Select cell D7, and enter Don't prepare proposal.



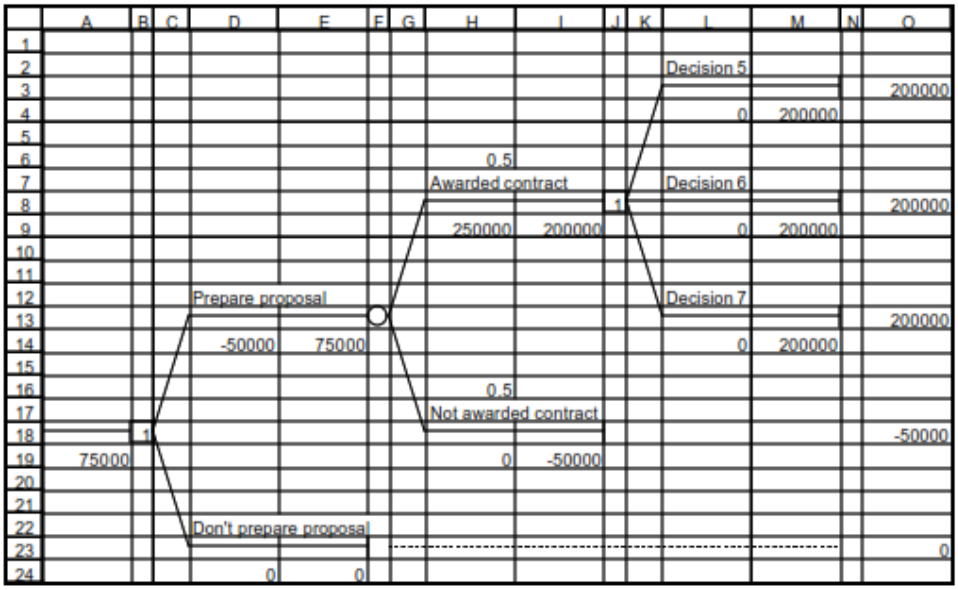
4. Do not type the quotation marks in the following instructions. Select cell D2, and enter Prepare proposal. Select cell D4, and enter –50000. Select cell D7, and enter Don't prepare proposal.



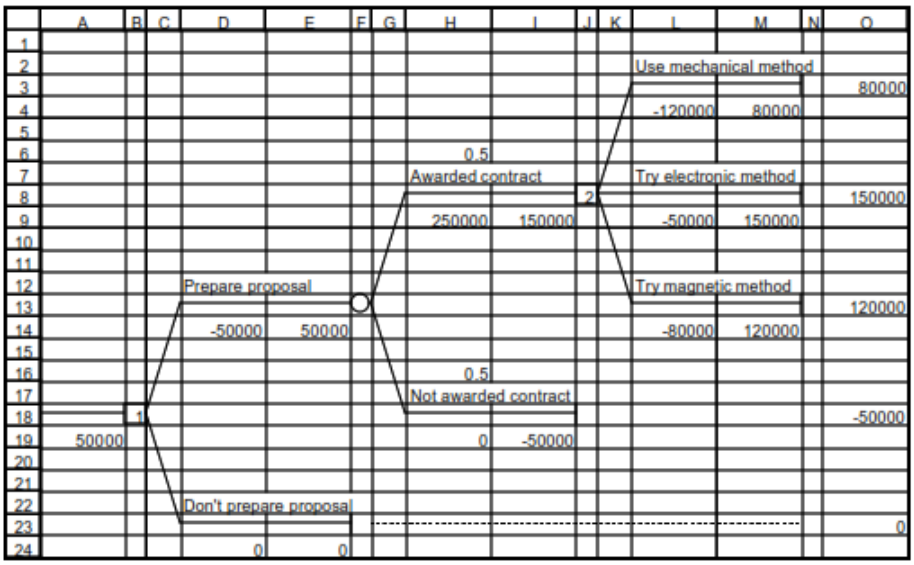
5. Select cell H2, and enter **Awarded contract**. Select cell H4, and enter **250000**. Select cell H7, and enter **Not awarded contract**.



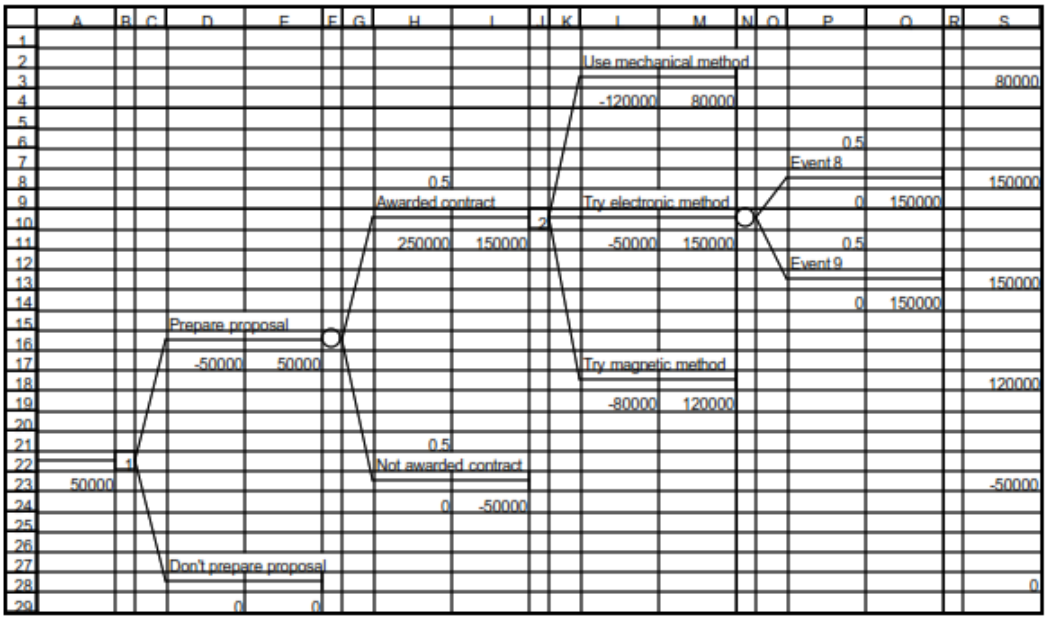
6. Select cell J3. From the Tools menu, choose Decision Tree. In the TreePlan Terminal dialog box, select Change To Decision Node, select Three Branches, and click OK. The tree is redrawn.



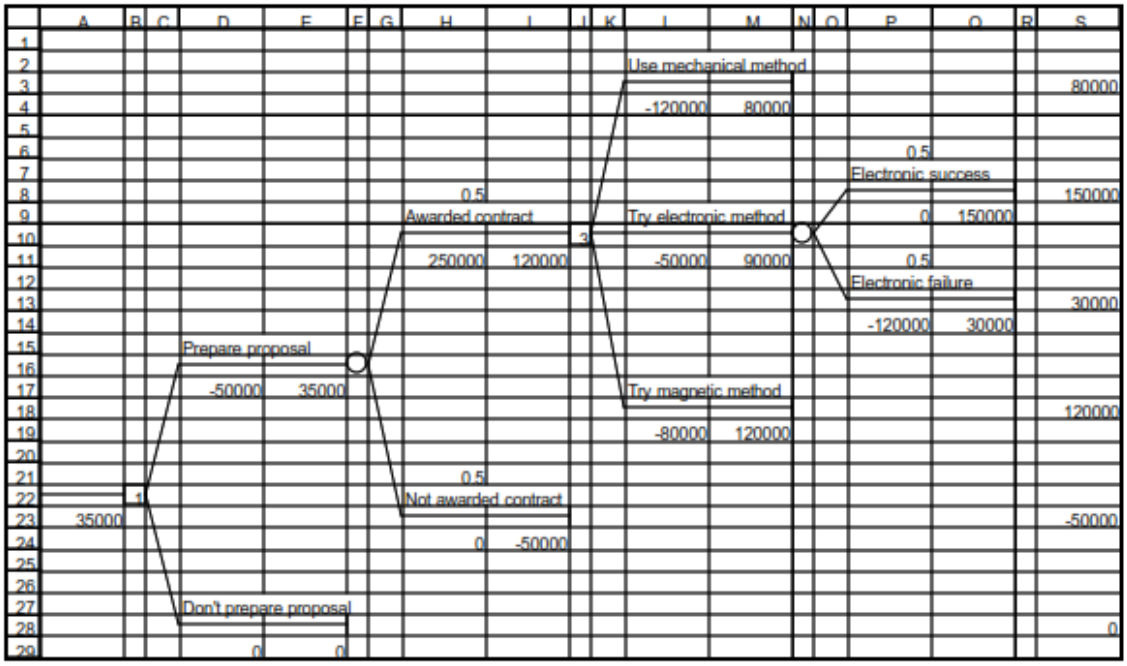
7. Select cell L2, and enter **Use mechanical method**. Select cell L4, and enter **–120000**. Select cell L7, and enter **Try electronic method**. Select cell L9, and enter **–50000**. Select cell L12, and enter **Try magnetic method**. Select cell L14, and enter **–80000**.



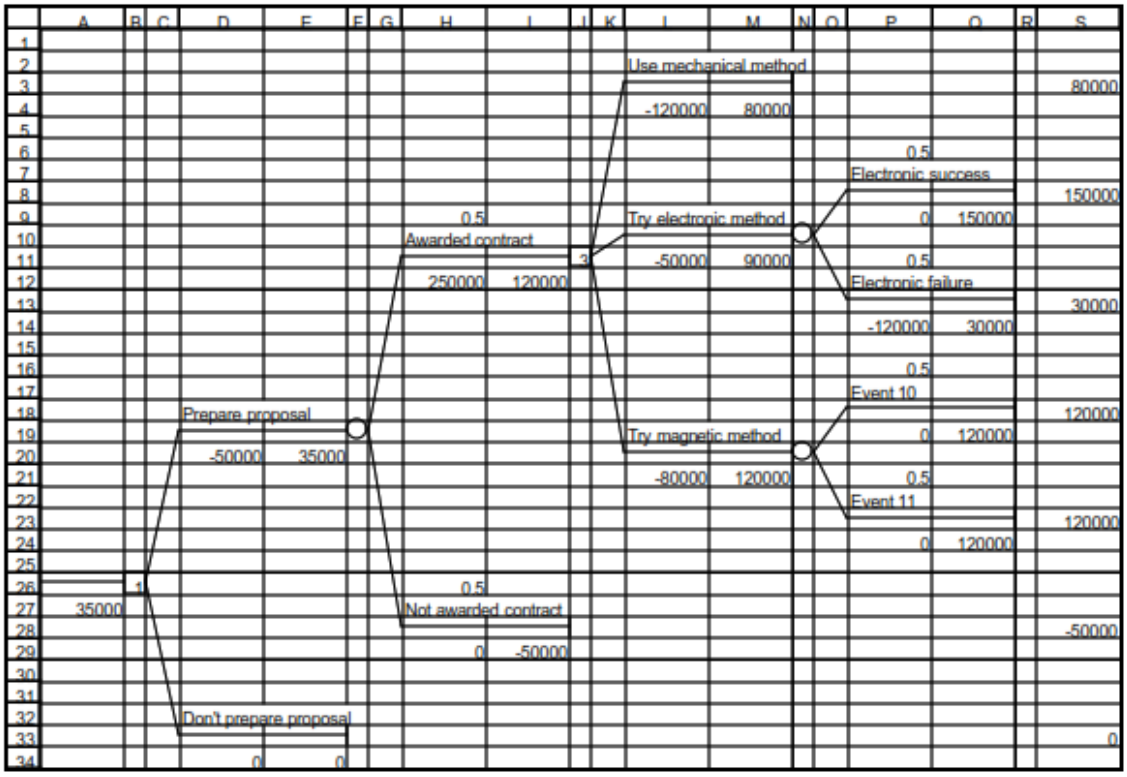
8. Select cell N8. From the Tools menu, choose Decision Tree. In the TreePlan Terminal dialog box, select Change To Event Node, select Two Branches, and click OK. The tree is redrawn.



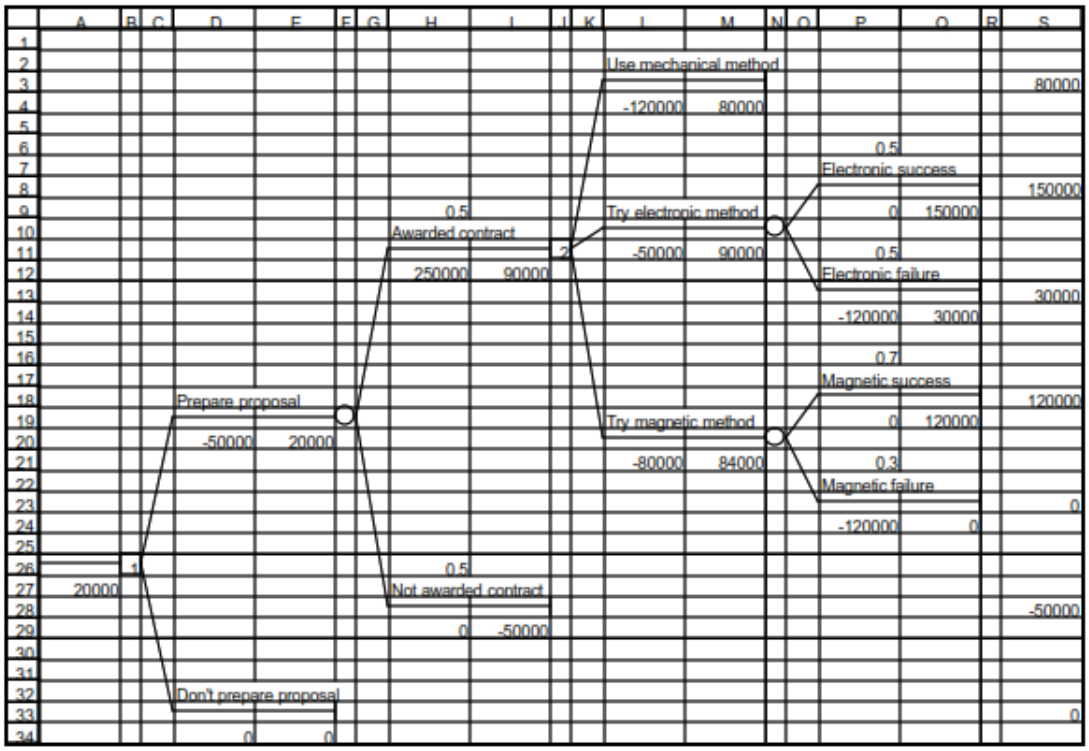
9. Select cell P7, and enter **Electronic success**. Select cell P12, and enter **Electronic failure**. Select cell P14, and enter **–120000**.



10. Select cell N18. From the Tools menu, choose Decision Tree. In the TreePlan Terminal dialog box, select Change To Event Node, select Two Branches, and click OK. The tree is redrawn.

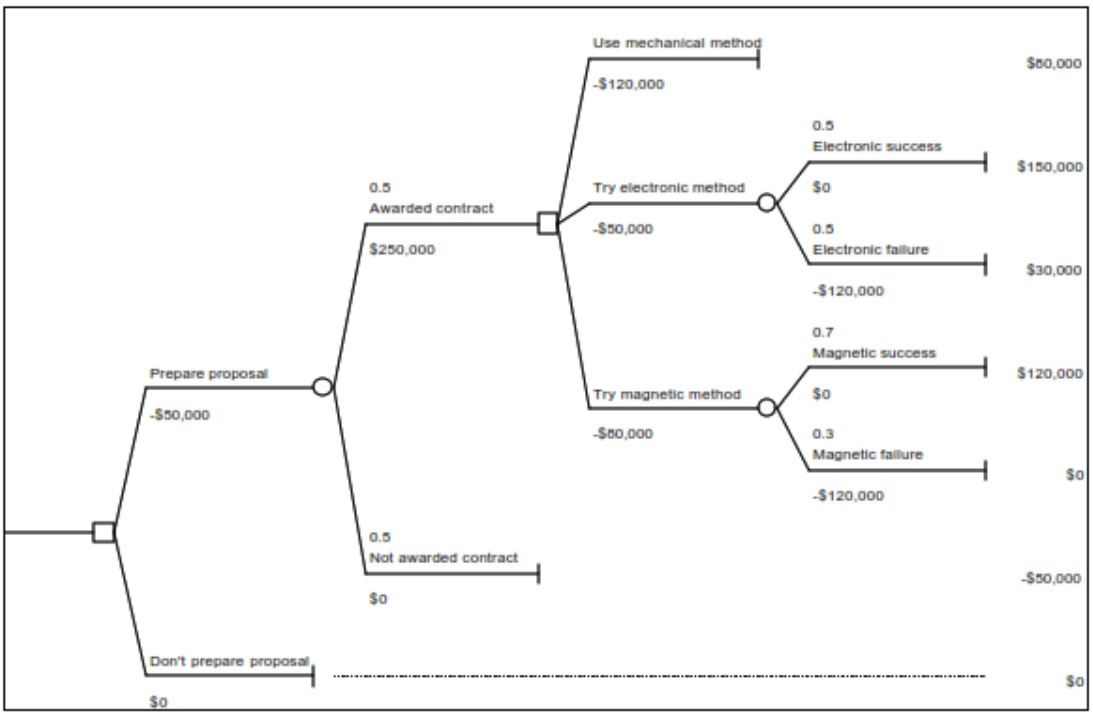


11. Select cell P16, and enter **.7**. Select cell P17, and enter **Magnetic success**. Select cell P21, and enter **.3**. Select cell P22, and enter **Magnetic failure**. Select cell P24, and enter **–120000**.



12. Double-click the sheet tab (or right-click the sheet tab and choose Rename from the shortcut menu), and enter **Original**. Save the workbook.

25. To print the tree diagram from Word, clear the check boxes for Gridlines and for Row And Column Headings on Excel's Page Setup dialog box Sheet tab. Select the tree diagram range. Hold down the Shift key and from the Edit menu choose Copy Picture. In the Copy Picture dialog box, click the option button As Shown When Printed, and click OK. In Word select the location where you want to paste the tree diagram and choose Edit | Paste.



Ex.No.6	Decision Tree Practice Problems

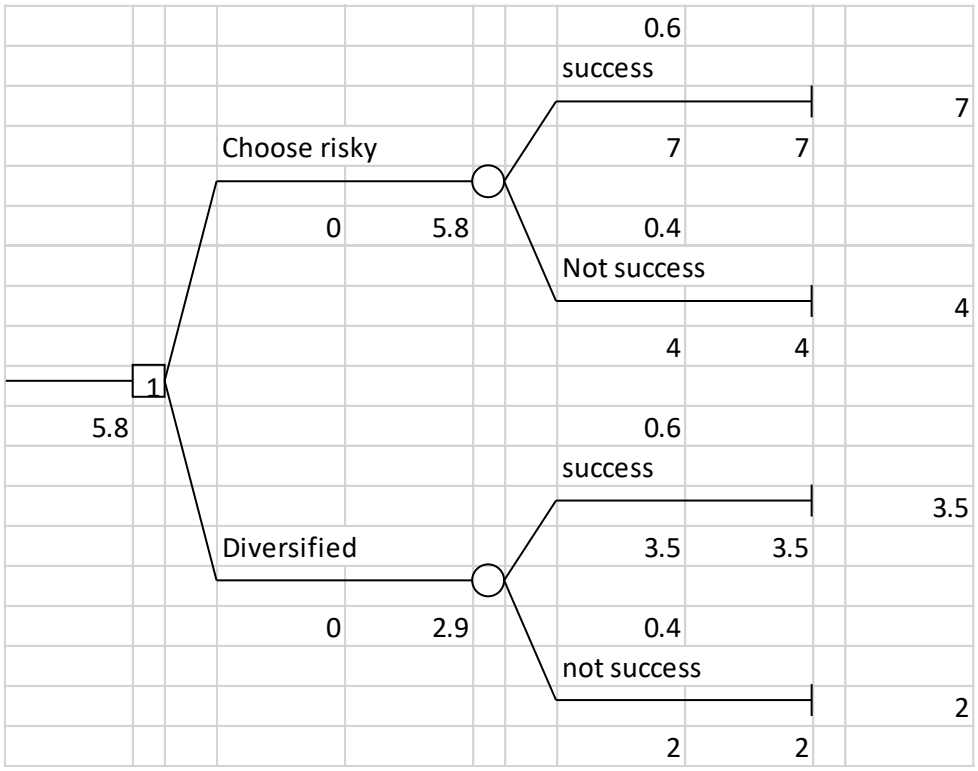
Problems:

1. A clever investor is given the following investment alternatives and percentage rates of return

	Market Conditions		
Options	Low	Medium	High
Regular Shares	7%	10%	15%
Risky Shares	-10%	12%	25%
Property	-12%	18%	30%

Over the past 300 days, 150 days have been medium markets conditions and 60 days have had high market increases. On the basis of these data, state the optimum investment strategy for the investment.

Solution:



2. BRIGHT FACE Company management is faced with the problem of choosing one of three products: Oil face wash; Dry face wash & Silky Face wash for manufacturing. The potential demand for each product may turn out to be good, moderate or poor. The probabilities for each of the states of nature were estimated as follows:

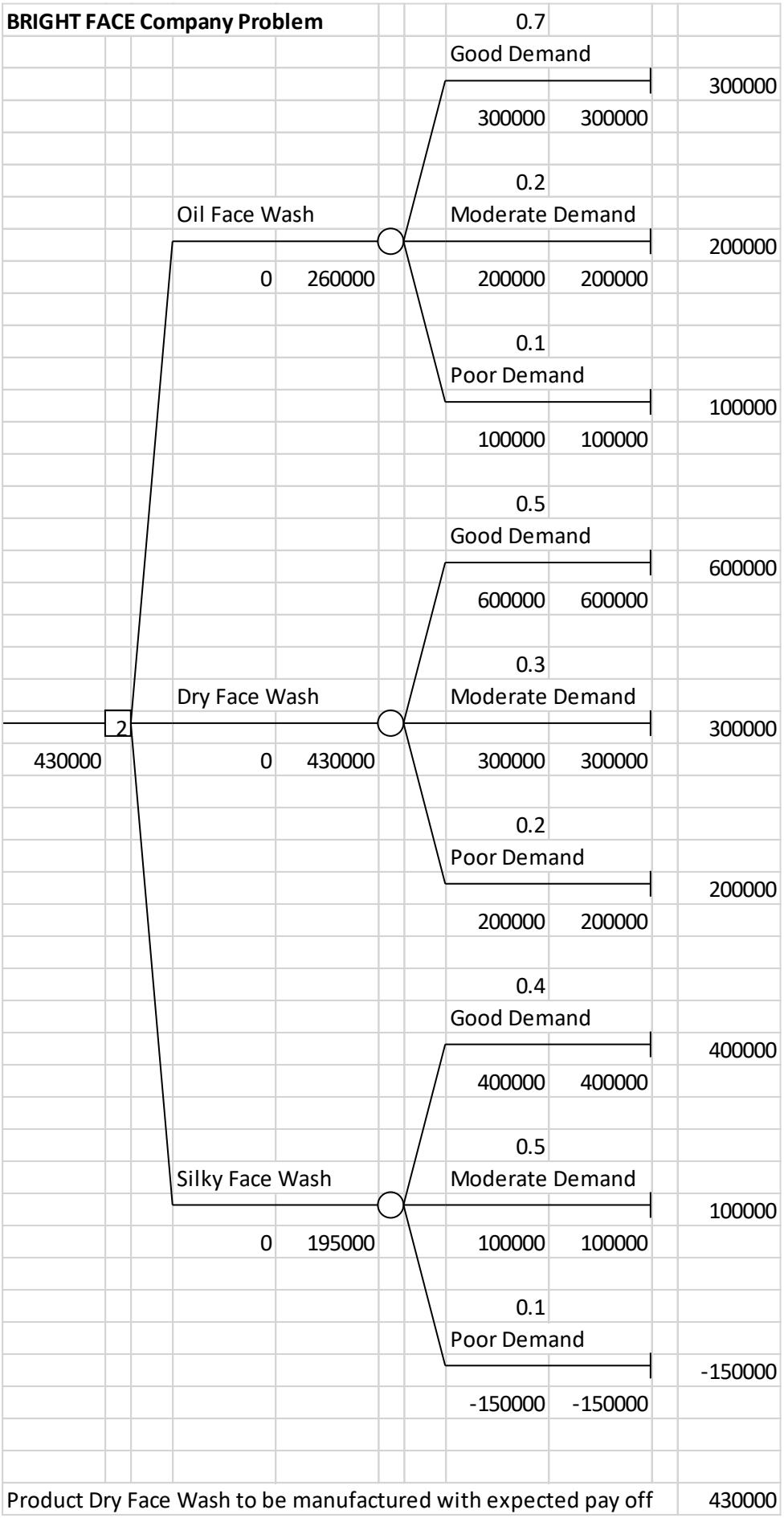
	States of Nature		
Product	Good	Moderate	Poor
Oil Face Wash	0.7	0.2	0.1
Dry Face Wash	0.5	.03	0.2
Silky Face Wash	0.4	0.5	0.1

The estimated profit or loss under the three states may be taken as

	States of Nature		
Product	Good	Moderate	Poor
Oil Face Wash	300000	200000	100000
Dry Face Wash	600000	300000	200000
Silky Face Wash	400000	100000	-150000

Advice the management about the choice of the product

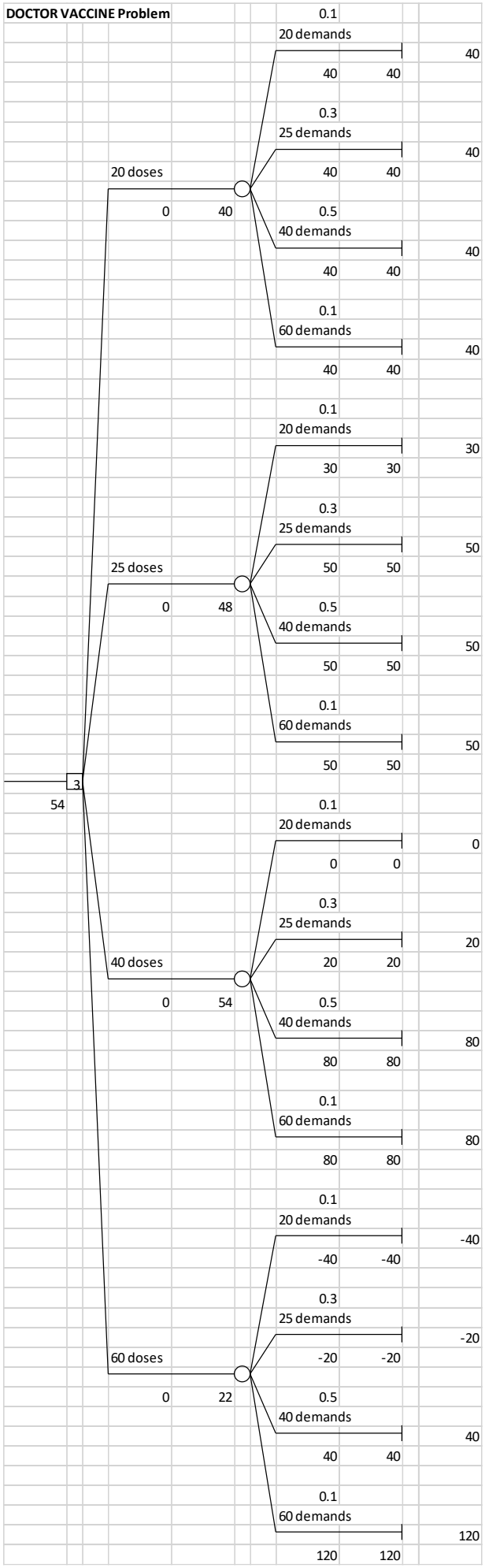
Solution:


BRIGHT FACE Company Problem
0.7
Good Demand
300000
300000 300000
0.2
Oil Face Wash
Moderate Demand
200000
0 260000
200000 200000
0.1
Poor Demand
100000
100000 100000
0.5
Good Demand
600000
600000 600000
0.3
Dry Face Wash
Moderate Demand
2
300000
430000
0 430000
300000 300000
0.2
Poor Demand
200000
200000 200000
0.4
Good Demand
400000
400000 400000
0.5
Silky Face Wash
Moderate Demand
100000
0 195000
100000 100000
0.1
Poor Demand
-150000
-150000 -150000
Product Dry Face Wash to be manufactured with expected pay off
430000

3. Doctor Vaccine purchases Polio Vaccine on Monday of each week. The vaccine must be used within the week following, otherwise it becomes worthless. The vaccine costs Rs.2 per dose and the doctor charges Rs4 per dose. In the past 50 weeks, the doctor has administered the vaccine in the following quantities:

Doses per week	20	25	40	60
Number of weeks	5	15	25	5

Determine how many doses the doctor should buy every week.


DOCTOR VACCINE Problem
0.1
20 demands
40
40 40
0.3
25 demands
40
40 40
20 doses
0 40
0.5
40 demands
40
40 40
0.1
60 demands
40
40 40
0.1
20 demands
30
30 30
0.3
25 demands
50
50 50
25 doses
0 48
0.5
40 demands
50
50 50
0.1
60 demands
50
50 50
3
54
0.1
20 demands
0
0 0
0.3
25 demands
20
20 20
40 doses
0 54
0.5
40 demands
80
80 80
0.1
60 demands
80
80 80
0.1
20 demands
-40
-40 -40
0.3
25 demands
-20
-20 -20
60 doses
0 22
0.5
40 demands
40
40 40
0.1
60 demands
120
120 120

Ex.No.7	Network Using Excel - CPM

PROCEDURE:

1. Determine Early start (ES0 and Early finish (EF) for each activity
    - Activities with no Predecessor Activities (PA), Early start = 0
    - For all activities, Early finish = Early start + Duration
    - Activities with one predecessor activity,

    Early start = Early finish of predecessor activity
    - Activities with more than one predecessor activity,

    Early start = Max(Early finish of all predecessor activity)
2. Invert Predecessor Activities to obtain Successor Activities
3. Determine Late finish (LF) and Latest start (LS) for each activity
    - Activities with no successor activities,

    Latest finish = Time of completion
    - For all activities,

    Latest start = Latest finish – Duration
    - Activities with one successor,

    Latest finish – Latest start of successor
    - Activities with more than one successor activity,

    Latest finish = Min(Latest start of all successor)
4. Calculate slack for each activity
    - For all activities, Latest finish – Early finish
5. Define Critical activities & Critical path
    - Critical if slack is zero,

    =IF(slack=0,"YES", "NO")

PROBLEMS:

1. A publisher has a contract with an author to publish a textbook. The (simplified) activities associated with the production of the textbook are given subsequently. Develop the associated network for the project:

Activity	Description	Predecessor	Successor	Time
A	Manuscript reading by the editor	-	E	5
B	Sample pages prepared by the typesetter	-	E	3
C	Book cover design	-	J	5
D	Preparation of deagrams used in the book	-	H	4
E	Author's approval of sample pages	A,B	F	3
F	Book typesetting	E	G	5
G	Author's proof reading of typeset pages	F	I	3
H	Author checks art-work	D	I	2
I	Production of printing plates	G,H	J	3
J	Book production and binding	C,I	-	7

D20

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1														
2														
3	Activity	Description	Predecessor	Successor	Time	ES	EF	LS	LF	Slack	Critical?		Range Name	Cells
4	A	Manuscript reading by the editor	-	E	5	0	5	0	5	0	YES		Activity	A4:A13
5	B	Sample pages prepared by the typesetter	-	E	3	0	3	5	5	2	NO		Critical?	K4:K13
6	C	Book cover design	-	J	5	0	5	14	19	14	NO		Description	B4:B13
7	D	Preparation of deagrams used in the book	-	H	4	0	4	10	14	10	NO		EF	G4:G13
8	E	Author's approval of sample pages	A,B	F	3	5	8	5	8	0	YES		ES	F4:F13
9	F	Book typesetting	E	G	5	8	13	8	13	0	YES		LF	I4:I13
10	G	Author's proof reading of typeset pages	F	I	3	13	16	13	16	0	YES		LS	H4:H13
11	H	Author checks art-work	D	I	2	4	6	14	16	10	NO		ProjectDuration	C16
12	I	Production of printing plates	G,H	J	3	16	19	16	19	0	YES		Slack	J4:J13
13	J	Book production and binding	C,I	-	7	19	26	19	26	0	YES		Time	E4:E13
14														
15														
16		Project Duration	26											

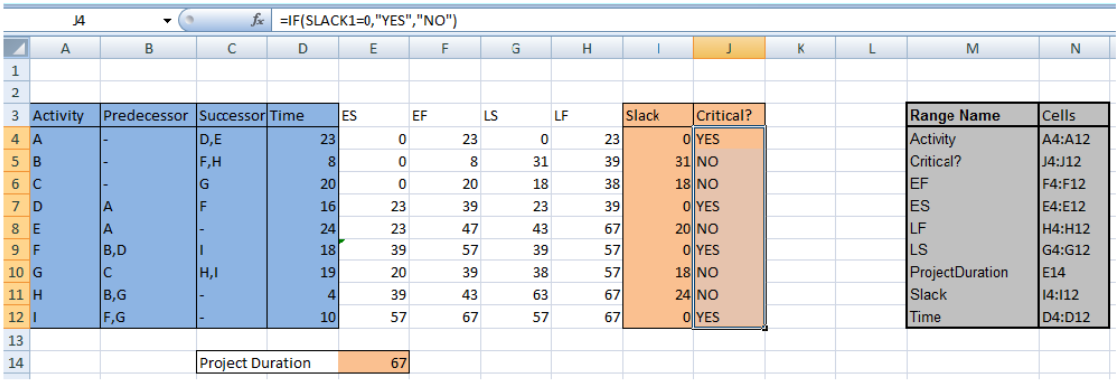
2. A project consists of a series of tasks labeled A, B, …, H, I with the following relationships,

A < D,E; B, D < F; C < G; B, G < H; F, G < I.

With this notation construct the network diagram and also find the minimum time of completion of the project, when the time (in days) of completion of each task is as follows:

Task	A	B	C	D	E	F	G	H	I
Time	23	8	20	16	24	18	19	4	10

SOLUTION:



J4 =IF(SLACK1=0,"YES","NO")

	Activity	Predecessor	Successor	Time	ES	EF	LS	LF	Slack	Critical?
4	A	-	D,E	23	0	23	0	23	0	YES
5	B	-	F,H	8	0	8	31	39	31	NO
6	C	-	G	20	0	20	18	38	18	NO
7	D	A	F	16	23	39	23	39	0	YES
8	E	A	-	24	23	47	43	67	20	NO
9	F	B,D	I	18	39	57	39	57	0	YES
10	G	C	H,I	19	20	39	38	57	18	NO
11	H	B,G	-	4	39	43	63	67	24	NO
12	I	F,G	-	10	57	67	57	67	0	YES
14			Project Duration		67					

Range Name	Cells
Activity	A4:A12
Critical?	J4:J12
EF	F4:F12
ES	E4:E12
LF	H4:H12
LS	G4:G12
ProjectDuration	E14
Slack	I4:I12
Time	D4:D12

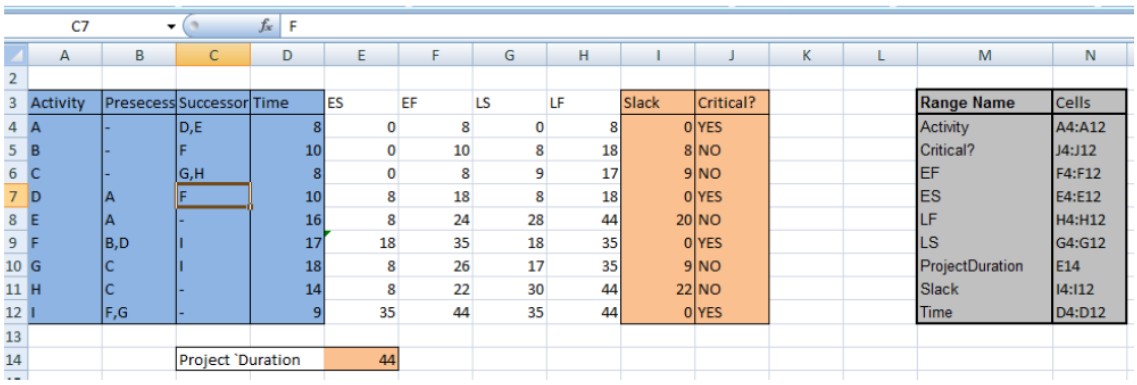
3. Tasks A, B, C, …,H, I constitute a project. The notation X < Y means that the task X must be finished before Y can begin. With this notation:

A < D; A < E; B < F; D < F; C < G; C < H; F < I; G < I

Draw a graph to represent the sequences of tasks and find the minimum time of completion of the project, when the time (in days) of completion of each task is as follows:

Task	A	B	C	D	E	F	G	H	I
Time	8	10	8	10	16	17	18	14	9

SOLUTION:



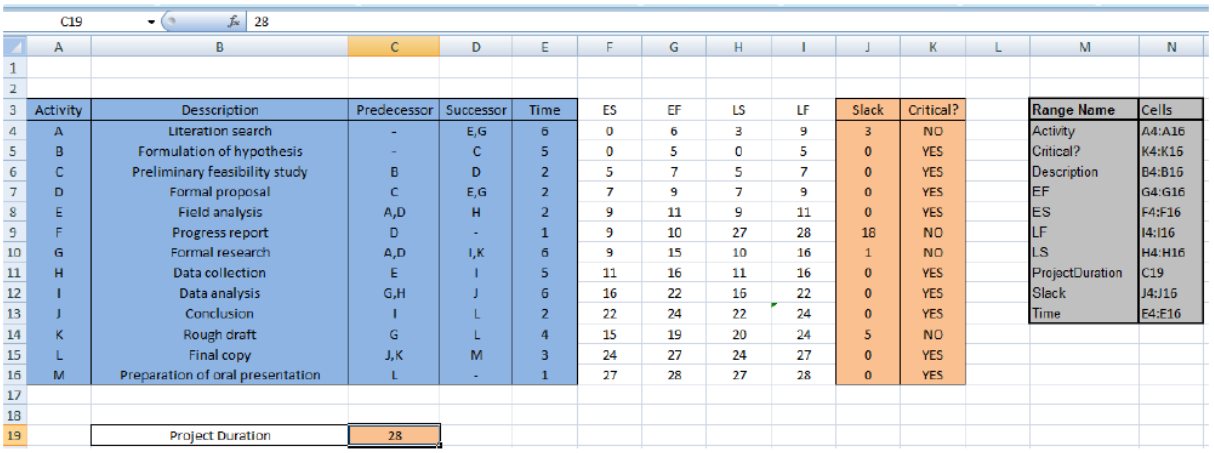
C7 fx F

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
2														
3	Activity	Presecess	Successor	Time	ES	EF	LS	LF	Slack	Critical?			Range Name	Cells
4	A	-	D,E	8	0	8	0	8	0	YES			Activity	A4:A12
5	B	-	F	10	0	10	8	18	8	NO			Critical?	J4:J12
6	C	-	G,H	8	0	8	9	17	9	NO			EF	F4:F12
7	D	A	F	10	8	18	8	18	0	YES			ES	E4:E12
8	E	A	-	16	8	24	28	44	20	NO			LF	H4:H12
9	F	B,D	I	17	18	35	18	35	0	YES			LS	G4:G12
10	G	C	I	18	8	26	17	35	9	NO			ProjectDuration	E14
11	H	C	-	14	8	22	30	44	22	NO			Slack	I4:I12
12	I	F,G	-	9	35	44	35	44	0	YES			Time	D4:D12
13														
14			Project `Duration		44									

4. Listed in the table are the activities and sequencing requirements necessary for the completion of a research report.

Activity	Desscription	Predecessor	Successor	Time
A	Literation search	-	E,G	6
B	Formulation of hypothesis	-	C	5
C	Preliminary feasibility study	B	D	2
D	Formal proposal	C	E,G	2
E	Field analysis	A,D	H	2
F	Progress report	D	-	1
G	Formal research	A,D	I,K	6
H	Data collection	E	I	5
I	Data analysis	G,H	J	6
J	Conclusion	I	L	2
K	Rough draft	G	L	4
L	Final copy	J,K	M	3
M	Preparation of oral presentation	L	-	1

SOLUTION:



C19 fx 28

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1														
2														
3	Activity	Desscription	Predecessor	Successor	Time	ES	EF	LS	LF	Slack	Critical?		Range Name	Cells
4	A	Literation search	-	E,G	6	0	6	3	9	3	NO		Activity	A4:A16
5	B	Formulation of hypothesis	-	C	5	0	5	0	5	0	YES		Critical?	K4:K16
6	C	Preliminary feasibility study	B	D	2	5	7	5	7	0	YES		Description	B4:B16
7	D	Formal proposal	C	E,G	2	7	9	7	9	0	YES		EF	G4:G16
8	E	Field analysis	A,D	H	2	9	11	9	11	0	YES		ES	F4:F16
9	F	Progress report	D	-	1	9	10	27	28	18	NO		LF	I4:I16
10	G	Formal research	A,D	I,K	6	9	15	10	16	1	NO		LS	H4:H16
11	H	Data collection	E	I	5	11	16	11	16	0	YES		ProjectDuration	C19
12	I	Data analysis	G,H	J	6	16	22	16	22	0	YES		Slack	J4:J16
13	J	Conclusion	I	L	2	22	24	22	24	0	YES		Time	E4:E16
14	K	Rough draft	G	L	4	15	19	20	24	5	NO			
15	L	Final copy	J,K	M	3	24	27	24	27	0	YES			
16	M	Preparation of oral presentation	L	-	1	27	28	27	28	0	YES			
17														
18														
19		Project Duration	28											

Ex.No.8	Network Using Excel -PERT

To perform Program Evaluation and Review Technique in MS Excel

PROCEDURE

1. Calculate mean (expected time duration) μ= IF(= " ", " ", (o+4*m+p)/6) where o=optimistic time,
   m= most likely time and
   p=pessimistic time estimates
2. Determine critical activities & critical path by considering expected time duration μ as mean time.
3. Calculate variance, σ^2= IF (o = " ", " ", $\left(\frac{p-o}{6}\right)^2$)
4. Determine mean critical path, μ = SUMIF(On mean critical path,"*", Activity mean)
5. Determine path variance, = SUMIF(On mean critical path,"*", Activity variance)