EASTERN MEDITERRANEAN UNIVERSITY

DEPARTMENT OF INDUSTRIAL ENGINEERING

INFORMATION SYSTEMS AND TECHNOLOGY

IENG 372 / MANE 372 – Tutorial 1

Fall 2021-2022

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Question 1:

A project has been defined to contain the list of activities shown in Table 1.

Table 1

Task Number	Task	Optimistic time	Most Likely time	Pessimistic time	Predecessors
A	Collect requirements	3	7	11	-
B	Analyze processes	5	9	13	A
C	Analyze data	1	2	9	B
D	Design processes	2	3	16	B
E	Design data	2	4	18	C
F	Design screens	3	4	11	C,D
G	Design reports	1	4	7	D,E
H	Program	3	4	5	F,G
I	Test and Document	2	4	12	G
J	Install	4	9	9	H

Table 2

Activity	Start	END
A	0	7
B	7	16
C	16	19
D	16	21
E	19	25
F	21	26
G	25	29
H	29	33
I	29	34
J	34	42,17

1- Calculate the expected time for each task.
2- Draw a Network Diagram for the activities.
3- Show the critical path.
4- Construct a Gantt chart for the project according to the table 2.
5- What would happen if activity F were revised to take 9 weeks?
6- What would happen if activity F were revised to take 10 weeks?
7- What would happen if activity C were revised to take 4 weeks?
8- What would happen if activity C were revised to take 2 weeks?

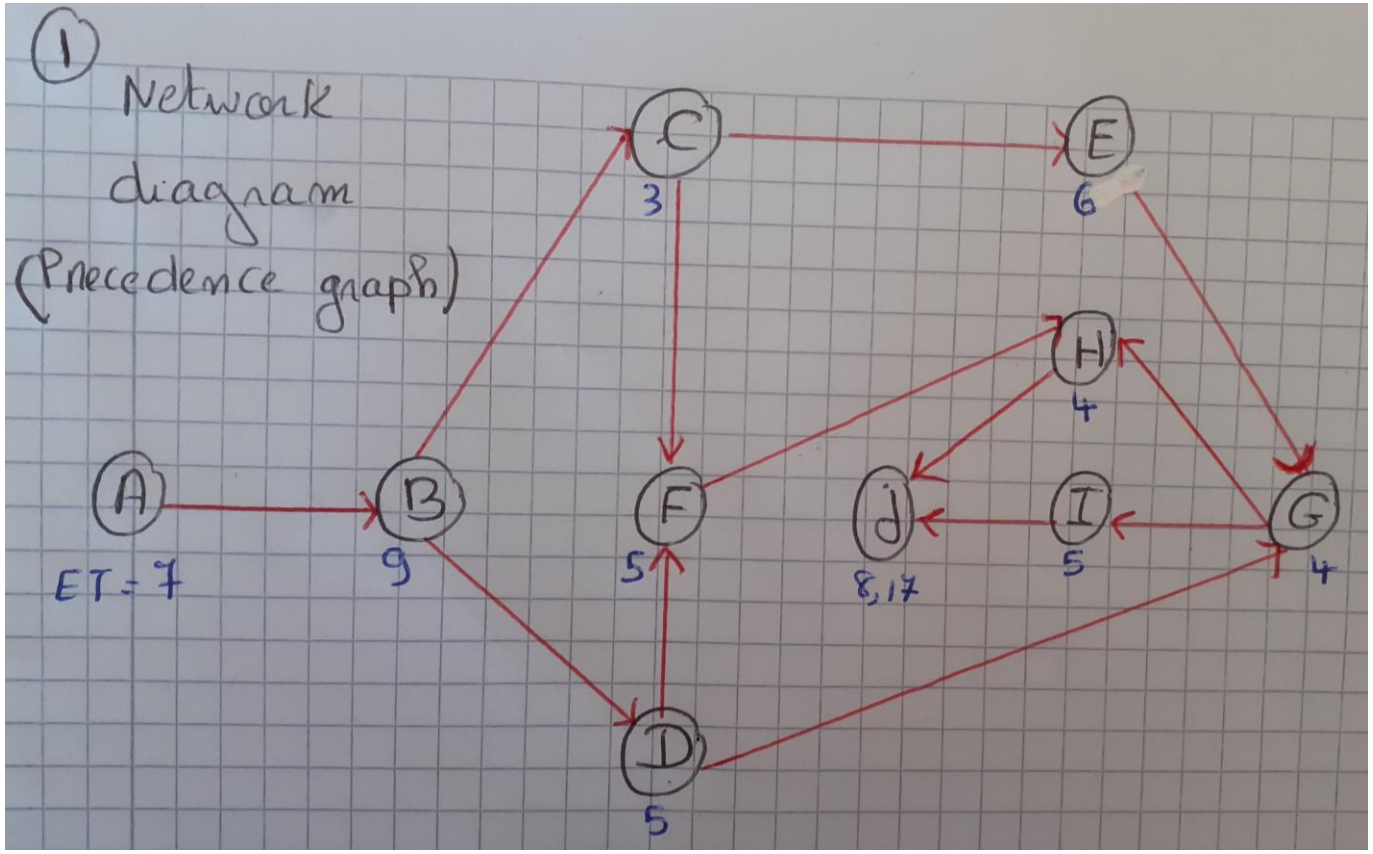
1- Calculate the expected time for each task.

Task Number	Task	Optimistic time o	Most Likely time r	Pessimistic time p	Predecessors	Expected Completion Time **(ET)**
A	Collect requirements	3	7	11	-	**7**
B	Analyze processes	5	9	13	A	**9**
C	Analyze data	1	2	9	B	**3**
D	Design processes	2	3	16	B	**5**
E	Design data	2	4	18	C	**6**
F	Design screens	3	4	11	C,D	**5**
G	Design reports	1	4	7	D,E	**4**
H	Program	3	4	5	F,G	**4**
I	Test and Document	2	4	12	G	**5**
J	Install	4	9	9	H	**8,166667**

$$ET = \frac{o + 4r + p}{6}$$

2- Network Diagram

Activity t	Predecessors t-1	Successors t+1
A	-	B
B	A	C,D
C	B	E,F
D	B	G,F
E	C	G
F	C,D	H
G	D,E	H,I
H	F,G	J
I	G	J
J	H,I	-



3- Critical Path

❑ How to determine the critical path :

1. calculate the earliest expected completion time for each activity (T_E).
2. calculate the latest expected completion time for each activity (T_L).
3. Calculate the slack time for each activity.
4. All activities with a slack time equal to zero are on the critical path

NB: The order of activities is according to the Network Diagram

Notations:

For each activity t, let the preceding activities be t-1 and the succeeding activities t+1

n = number of activities

The earliest expected completion time (T_E)

Start from t =1 to t = n

$$T_E(\mathrm{t}) = \mathrm{ET}(\mathrm{t}) + \max\{T_E\ (\mathrm{t}-1)\}$$

The latest expected completion time (T_L)

Start from t=n to t=1

$$T_L(n) = T_E(n)$$

$$T_L(t) = \min\{T_L(t+1) - ET(t+1)\}$$

Slack (t) $= T_L(t) - T_E(\mathrm{t})$

T_E and T_L

The earliest expected completion time (T_E)

$$T_E(\mathrm{t}) = \mathrm{ET}(\mathrm{t}) + \max\{T_E\ (\mathrm{t}-1)\}$$

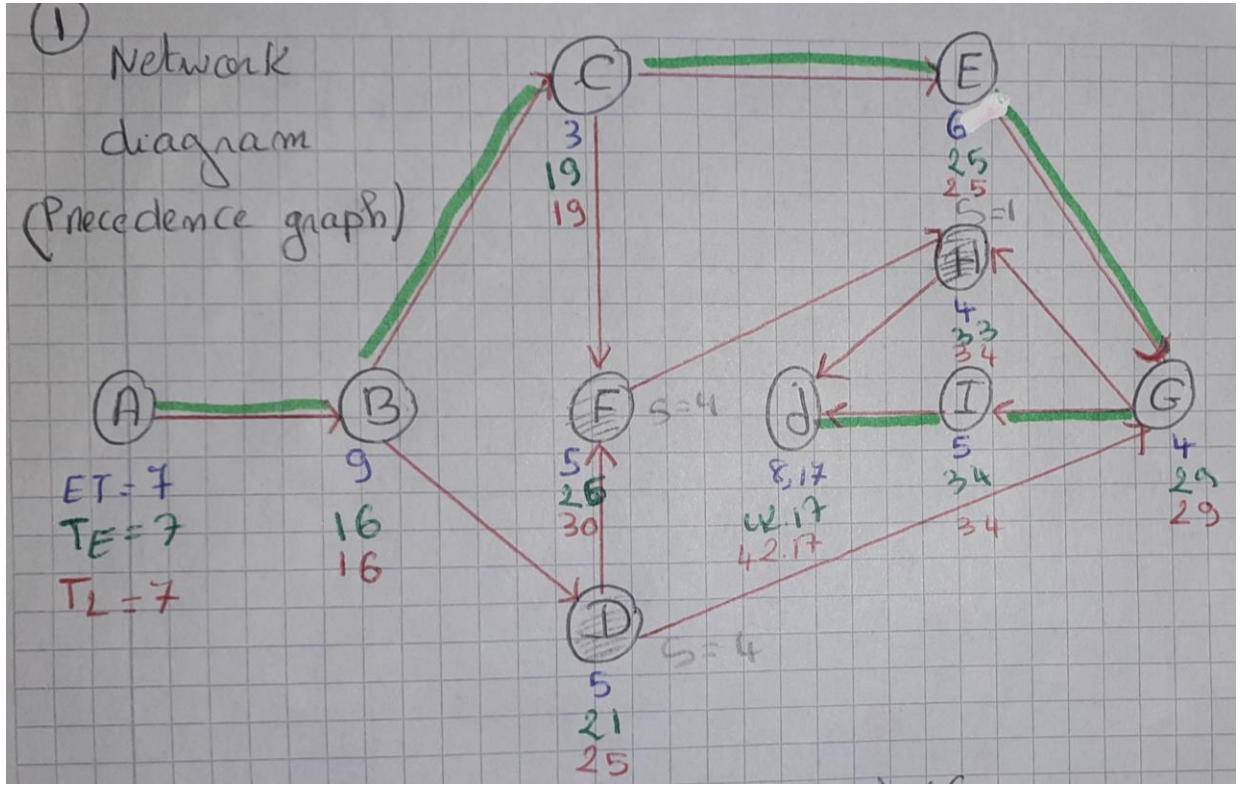
The latest expected completion time (T_L)

$$T_L(t) = \min\{T_L(t+1) - ET(t+1)\}$$

Activity t	Expected Completion Time **(ET)**	Predecessors t-1	max{T_E (t-1)}	T_E	Successors t+1	Min {T_L (t+1)-ET(t+1) }	T_L
A	**7**	-	-	7	B	min{16-9}=7	**7**
B	**9**	A	7	9+7=16	C,D	min{19-3,25-5}=min{16,20}	**16**
C	**3**	B	16	3+16=19	E,F	min{25-6,30-5}=min{19,25}	**19**
D	**5**	B	16	5+16=21	G,F	min{29-4,30-5}=min{25,25}	**25**
E	**6**	C	19	6+19=25	G	min{29-4}=25	**25**
F	**5**	C,D	max{19,21}=21	5+21=26	H	min{34-4}=30	**30**
G	**4**	D,E	max{21,25}=25	4+25=29	H,I	min{34-5,34-4}=min{29,30}	**29**
H	**4**	F,G	max{26,29}=29	4+29=33	J	min{42.17-8.17}=34	**34**
I	**5**	G	29	5+29=34	J	min{42.17-8.17}=34	**34**
J	**8,166667**	H,I	max{33,34}=34	8,17+34=42,17	-	-	**42,17**

Slack Times and Critical Path

Activity	Expected Completion Time **(ET)**	T_E	T_L	**Slack**	**On Critical Path**
A	**7**	**7**	**7**	**0**	**YES**
B	**9**	**16**	**16**	**0**	**YES**
C	**3**	**19**	**19**	**0**	**YES**
D	**5**	**21**	**25**	**4**	**NO**
E	**6**	**25**	**25**	**0**	**YES**
F	**5**	**26**	**30**	**4**	**NO**
G	**4**	**29**	**29**	**0**	**YES**
H	**4**	**33**	**34**	**1**	**NO**
I	**5**	**34**	**34**	**0**	**YES**
J	**8,1667**	**42,17**	**42,17**	**0**	**YES**



4- Gantt Chart

Activity	Start	END
A	0	7
B	7	16
C	16	19
D	16	21
E	19	25
F	21	26
G	25	29
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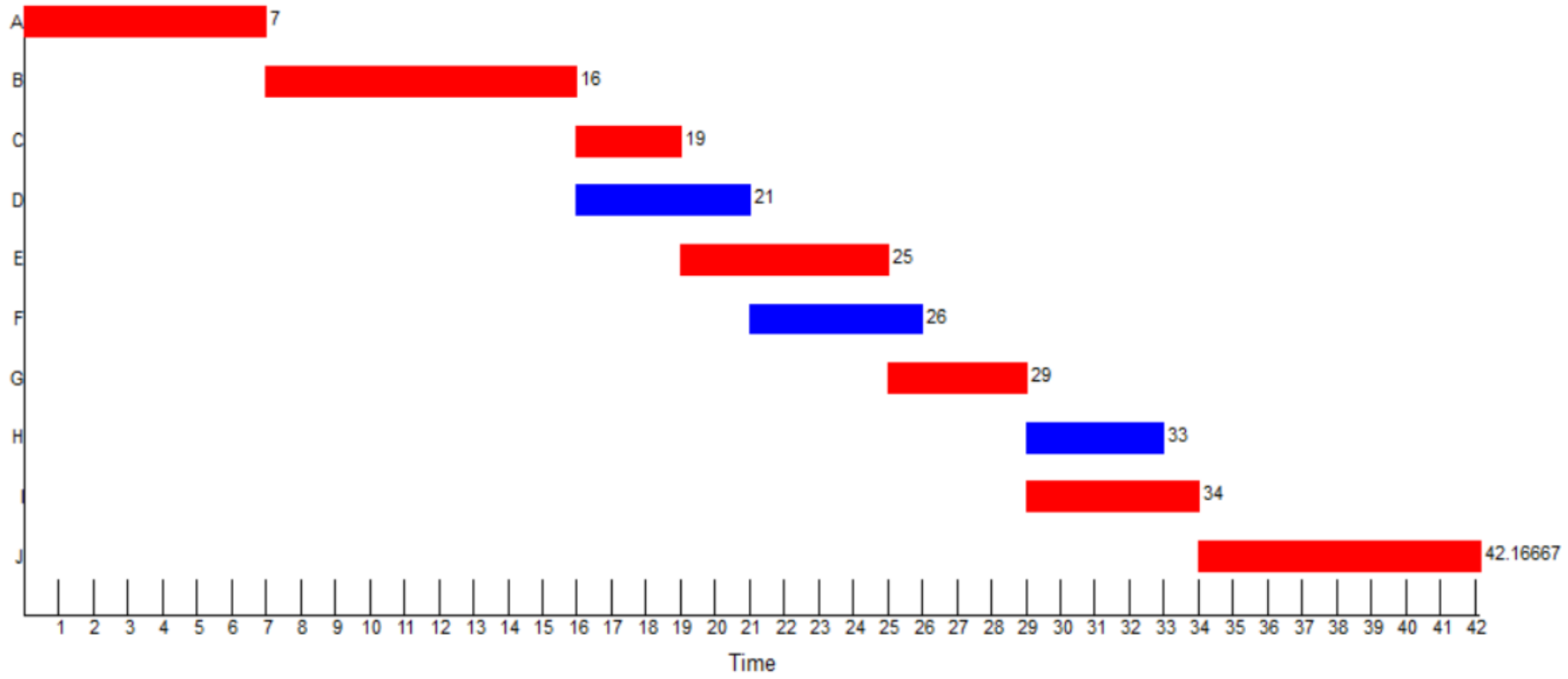
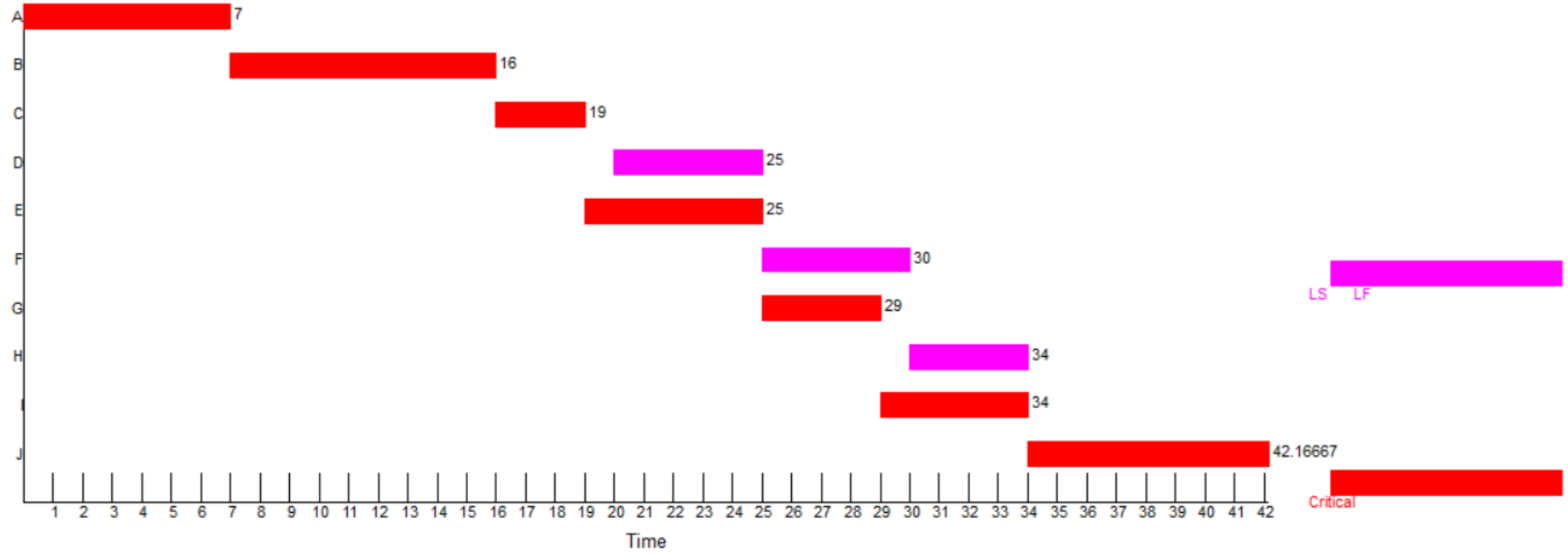
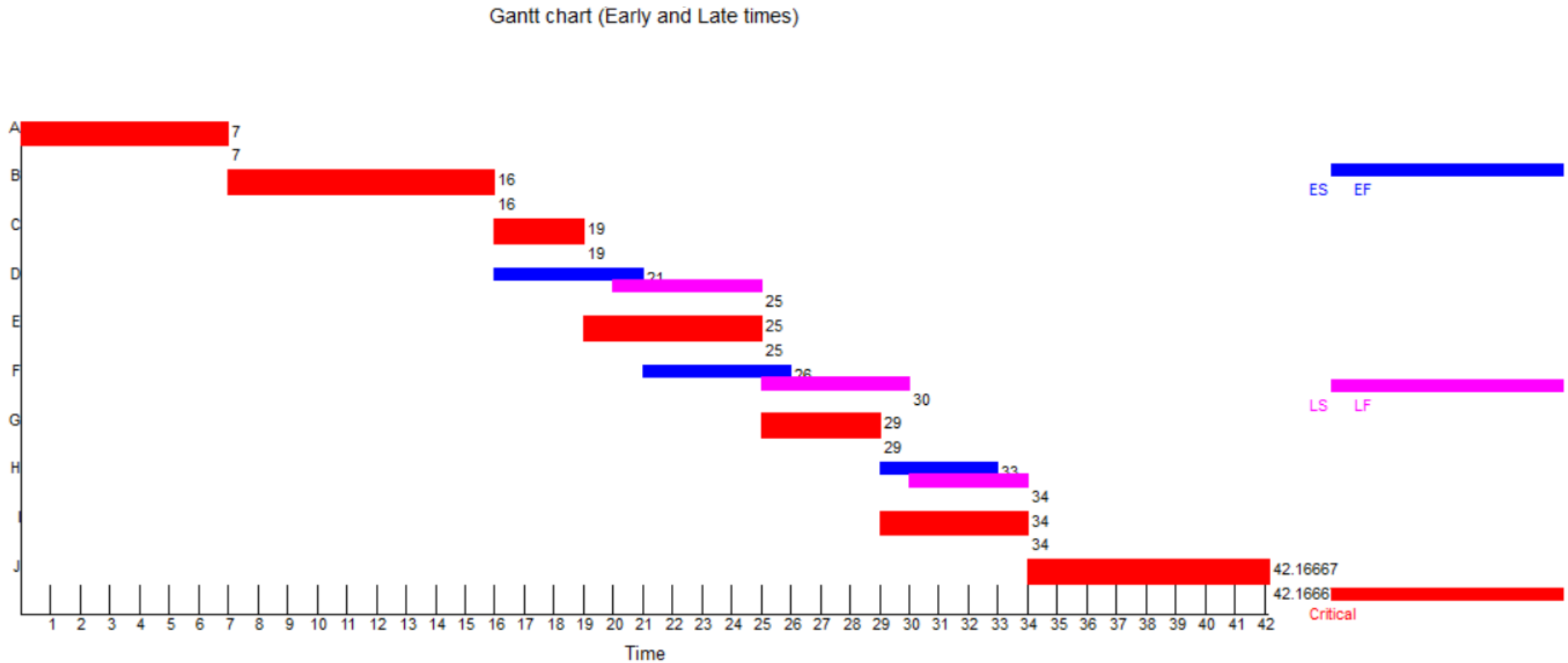


Remarque: If Start and end times are not given, the following Gantt Charts are also correct




Gantt chart (Early and Late times)
A
B
C
D
E
F
G
H
I
J
7
7
16
16
19
19
21
25
25
25
26
30
29
29
33
34
34
34
42.16667
42.1666
ES
EF
LS
LF
Critical
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
Time

5- What would happen if activity F were revised to take 9 weeks?

Activity F is NOT on the Critical Path, with slack time = 4, which means that we can delay it by 4 weeks without delaying the project completion time. If activity F takes 9 weeks instead of 5 weeks, 9-5=4 = slack, then the project completion time will not change.

6- What would happen if activity F were revised to take 10 weeks?

10-5=5 > slack , The project will be delayed by 5-4=1 week.

7- What would happen if activity C were revised to take 4 weeks?

Activity C in ON the critical path, if it is delayed then the project completion time will be delayed as well.

If activity C takes 4 week instead of 3 weeks the project will be delayed by 4-3=1 week.

8- What would happen if activity C were revised to take 2 weeks?

2-3=-1 , the project will finish 1 week earlier.

Question 2

Assume monetary benefits of an information system of $40,000 the first year and increasing benefits of $10,000 a year for the next five years (year 1 = $50,000, year 2 = $60,000, year 3 = $70,000, year 4 = $80,000, year 5 = $90,000). One-time development costs were $80,000 and recurring costs were $45,000 over the duration of the system's life. The discount rate for the company was 11 percent. Using a six-year time horizon, calculate the net present value of these costs and benefits. Also, calculate the overall return on investment and then present a break-even analysis. At what point does break-even occur?

Summary Worksheet

- The yearly NPV cash flows = PV of benefits - PV of costs
- Overall NPV cash flows = NVP of benefits – NVP of costs
- break-even occurs before the first year in which the overall NPV cash flows figure is non-negative
- Identifying the point when Break even occurs can be derived as follows:

$$PV_n = Y \times \frac{1}{(1+i)^n}$$

$$\text{Break-Even Ratio} = \frac{\text{Yearly NPV Cash Flow} - \text{Overall NPV Cash Flow}}{\text{Yearly NPV Cash Flow}}$$

Year		0	1	2	3	4	5	6	Totals		
Net Economic Benefits		$0,00	$40.000,00	$50.000,00	$60.000,00	$70.000,00	$80.000,00	$90.000,00			
Discount Rate	11%	1,0000	1,1100	1,2321	1,3676	1,5181	1,6851	1,8704			
Present Value of Benefits (PV)		$0,00	$36.036,04	$40.581,12	$43.871,48	$46.111,17	$47.476,11	$48.117,68			PVBj
Net Present Value Of benefits (NPV) (Cumul PV)		$0,00	$36.036,04	$76.617,16	$120.488,64	$166.599,81	$214.075,92	$262.193,59	$262.193,59	cumul benefits	CB
One time Costs		$80.000,00	$0,00	$0,00	$0,00	$0,00	$0,00	$0,00			
PV of One time Costs		$80.000,00	$0,00	$0,00	$0,00	$0,00	$0,00	$0,00			
Recurring Cost		$0,00	$45.000,00	$45.000,00	$45.000,00	$45.000,00	$45.000,00	$45.000,00			
PV of Recurring Costs		$0,00	$40.540,54	$36.523,01	$32.903,61	$29.642,89	$26.705,31	$24.058,84			
PV OF ALL Costs		$80.000,00	$40.540,54	$36.523,01	$32.903,61	$29.642,89	$26.705,31	$24.058,84			PVCj
NPV of ALL costs		$80.000,00	$120.540,54	$157.063,55	$189.967,16	$219.610,06	$246.315,37	$270.374,20	$270.374,20	cumul costs	CC
Overall NPV									-$8.180,61		CB-CC
Overall Return In Investment (ORI)									-0,030256633		(CB-CC)/CC
Break Even Analysis											
Yearly NPV cash flow		-$80.000,00	-$4.504,50	$4.058,11	$10.967,87	$16.468,27	$20.770,80	$24.058,84			PVBj-PVCj
Overall NPV cash flow		-$80.000,00	-$84.504,50	-$80.446,39	-$69.478,52	-$53.010,25	-$32.239,45	-$8.180,61			CBj-CCj
		Project break even does not occur before 6 years									
Break Even Ratio											
		NO break even before 6 years >>> INFEASIBLE PROJECT									

In 6 year horizon, The project does not give any benefits, which means it is infeasible in the economic point of view , We conclude that we should edit the project or cancel it

Question 3

Assume monetary benefits of an information system at $70,000 per year . Onetime development costs were $80,000 and recurring costs were $40,000 over the duration of the system's life. The discount rate for the company was 10 percent. Using a five-year time horizon:

1-calculate the net present value of these costs and benefits

2-calculate the overall return on investment

3-present a break-even analysis.

4-At what point does break-even occur?

NB: Provide the used formulas and detailed calculations.

Year		0	1	2	3	4	5	Totals		
Net Economic Benefits		$0,00	$70.000,00	$70.000,00	$70.000,00	$70.000,00	$70.000,00			
Discount Rate	10%	1,0000	1,1000	1,2100	1,3310	1,4641	1,6105			
Present Value of Benefits (PV)		$0,00	$63.636,36	$57.851,24	$52.592,04	$47.810,94	$43.464,49			PVBj
Net Present Value Of benefits (NPV) (Cumul PV)		$0,00	$63.636,36	$121.487,60	$174.079,64	$221.890,58	$265.355,07	$265.355,07	cumul benefits	CB
One time Costs		$80.000,00	$0,00	$0,00	$0,00	$0,00	$0,00			
PV of One time Costs		$80.000,00	$0,00	$0,00	$0,00	$0,00	$0,00			
Recurring Cost		$0,00	$40.000,00	$40.000,00	$40.000,00	$40.000,00	$40.000,00			
PV of Recurring Costs		$0,00	$36.363,64	$33.057,85	$30.052,59	$27.320,54	$24.836,85			
PV OF ALL Costs		$80.000,00	$36.363,64	$33.057,85	$30.052,59	$27.320,54	$24.836,85			PVCj
NPV of ALL costs		$80.000,00	$116.363,64	$149.421,49	$179.474,08	$206.794,62	$231.631,47	$231.631,47	cumul costs	CC
Overall NPV								$33.723,60		CB-CC
Overall Return In Investment (ORI)								0,145591629		(CB-CC)/CC
Break Even Analysis										
Yearly NPV cash flow		-$80.000,00	$27.272,73	$24.793,39	$22.539,44	$20.490,40	$18.627,64			PVBj-PVCj
Overall NPV cash flow		-$80.000,00	-$52.727,27	-$27.933,88	-$5.394,44	$15.095,96	$33.723,60			CBj-CCj
		Project break even Occurs between years 3 and 4.								
Break Even Ratio						0,26				
		The break even occurs at 3,26 years.								

In 5 year horizon, The project Starts giving benefits after 3,26 years, which means it is feasible in the economic point of view , We conclude that we can go to the next step and start the system analysis.