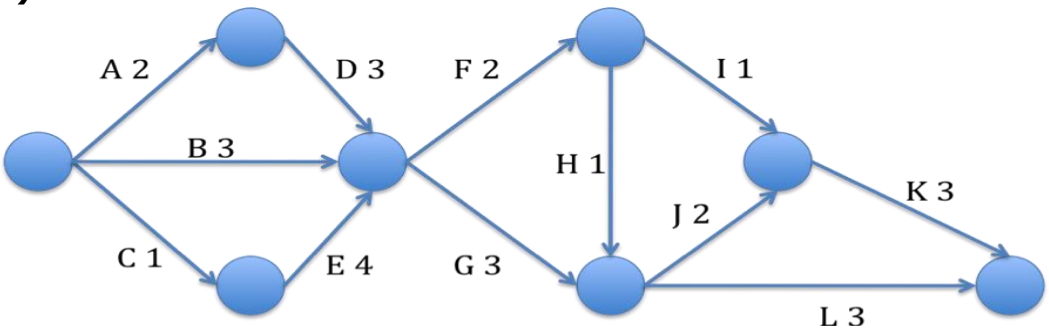
Project Management Exercises Solutions

PM_1:

a)



b)

Activ.		t	ES	EF	LF	LS	Slack
A		2	0	2	2	0	0
B		3	0	3	5	2	2
C		1	0	1	1	0	0
D		3	2	5	5	2	0
E		4	1	5	5	1	0
F		2	5	7	7	5	0
G		3	5	8	8	5	0
H		1	7	8	8	7	0
I		1	7	8	10	9	2
J		2	8	10	10	8	0
K		3	10	13	13	10	0
L		3	8	11	13	10	2

c) Project duration - 13 days.

d)

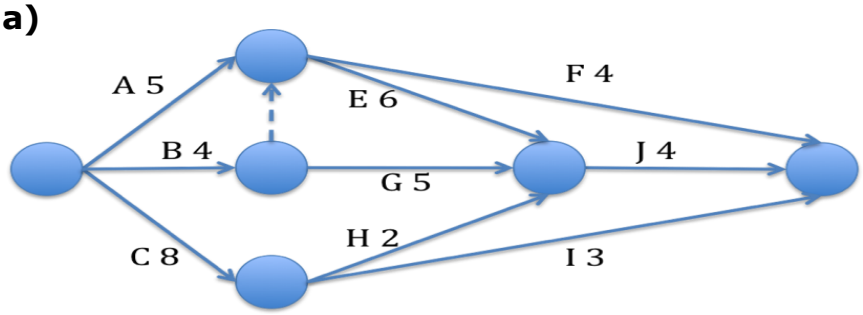
ADFIK - 11 days
ADFHJK - 13 days
ADFHL - 11 days
ADGJK - 13 days
ADGL - 11 days

BFIK - 9 days
BFHJK - 11 days
BFHL - 9 days
BGJK - 11 days
BGL - 9 days

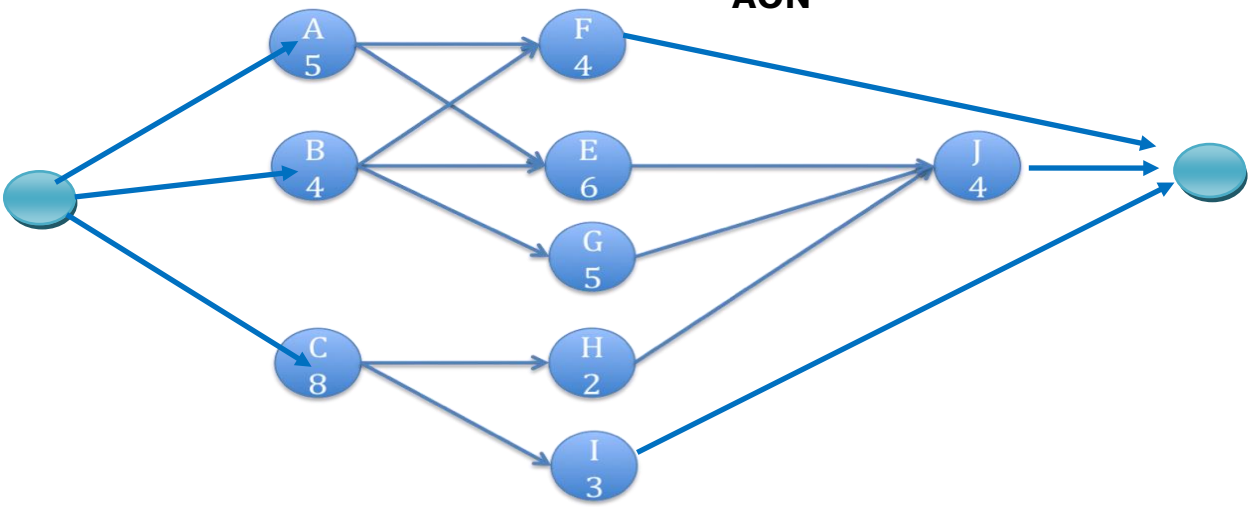
CEFIK - 11 days
CEFHJK - 13 days
CEFHL - 11 days
CEGJK - 13 days
CEGL - 11 days

PM_2:

a)



AON



b)

Activ.	t	ES	EF	LF	LS	Slack
A	5	0	5	5	0	0
B	4	0	4	5	1	1
C	8	0	8	9	1	1
E	6	5	11	11	5	0
F	4	5	9	15	11	6
G	5	4	9	11	6	2
H	2	8	10	11	9	1
I	3	8	11	15	12	4
J	4	11	15	15	11	0

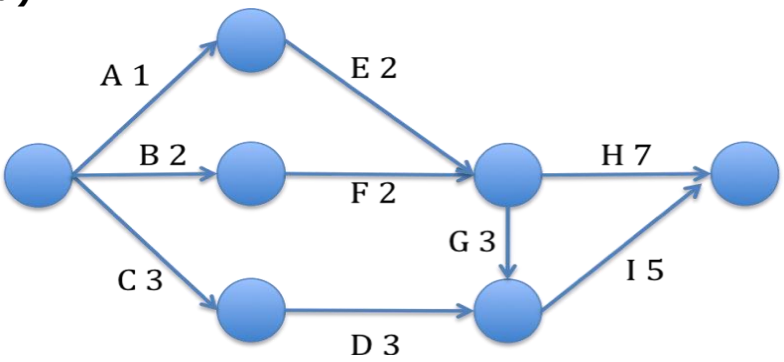
c) Project duration - 15 days. Critical path: AEJ.

d)

AF - 9 days
AEJ - 15 days
BF - 8 days
BEJ - 14 days
BGJ - 13 days CHJ - 14 days
CI - 11 days

PM_3:

a)



b)

Act.	a	m	b	t	Var
A	1	1	1	1	0.00
B	1	2	3	2	0.11
C	1	3	5	3	0.44
D	2	3	4	3	0.11
E	1	2	3	2	0.11
F	2	2	2	2	0.00
G	1	3	5	3	0.44
H	3	7	11	7	1.78
I	2	5	8	5	1.00

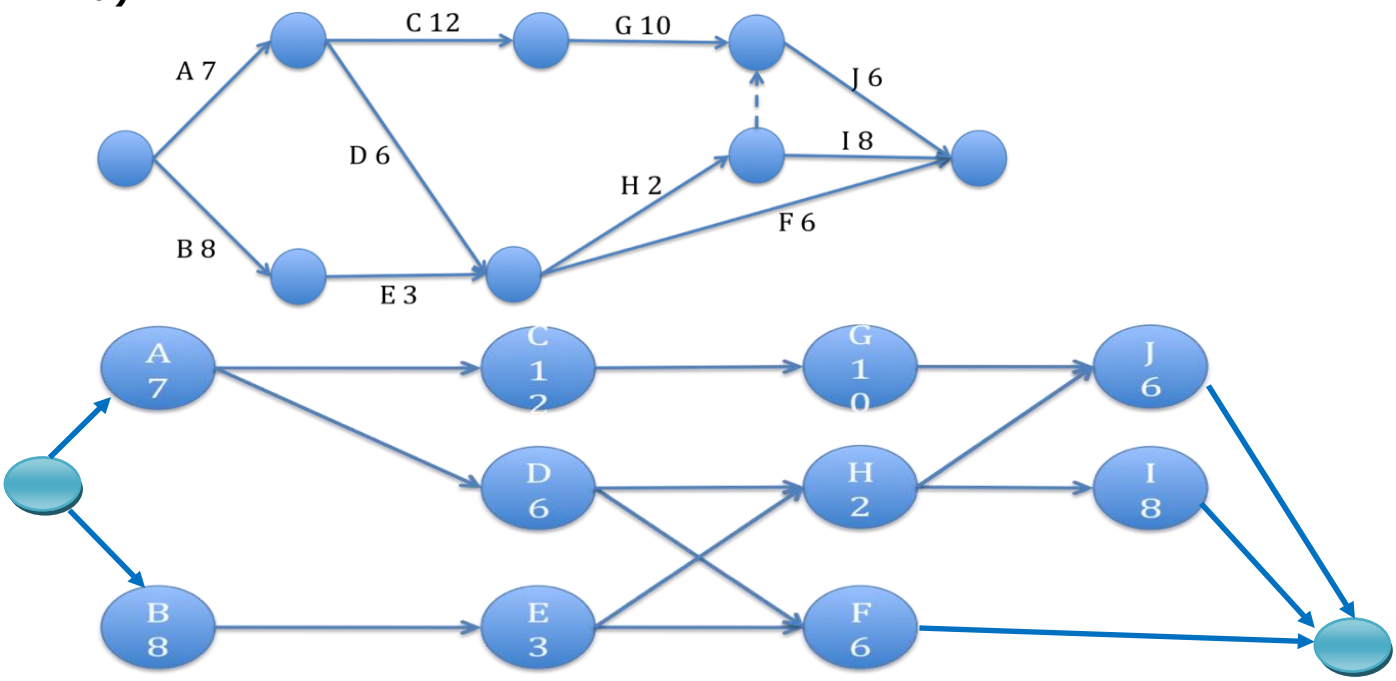
c)

Activ.	t	ES	EF	LF	LS	Slack
A	1	0	1	2	1	1
B	2	0	2	2	0	0
C	3	0	3	4	1	1
D	3	3	6	7	4	1
E	2	1	3	4	2	1
F	2	2	4	4	2	0
G	3	4	7	7	4	0
H	7	4	11	12	5	1
I	5	7	12	12	7	0

R.: The minimum duration for the project is 12 days, the critical activities are B, F, G and I.

PM_4:

a)



b)

Act.	t	σ	ES	EF	LF	LS	Slack
A	7	3	0	7	7	0	0
B	8	1	0	8	22	14	14
C	12	2	7	19	19	7	0
D	6	3	7	13	25	19	12
E	3	2	8	11	25	22	14
F	6	1	13	19	35	29	16
G	10	4	19	29	29	19	0
H	2	2	13	15	27	25	12
I	8	1	15	23	35	27	12
J	6	2	29	35	35	29	0

R.: Critical path ACGJ (35 days).

c)

Act. t	a b
B 8	4 16
t =	$\frac{a+4m+b}{6}$
8 =	$\frac{4+4m+16}{6}$
48 =	4m+20
4m =	28
m =	7 days

d)

X - variable that describes project duration

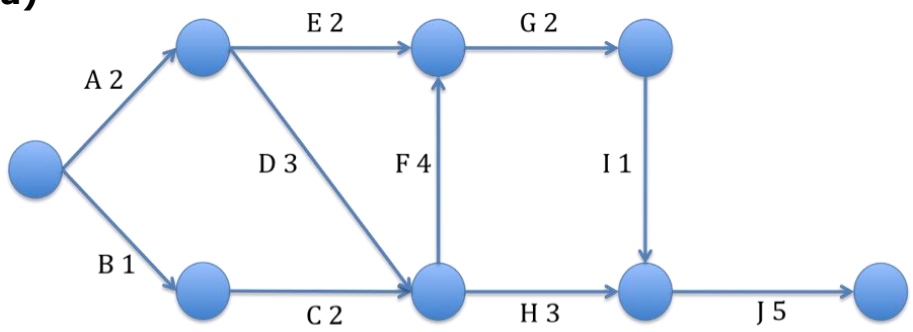
$X \sim N(35;33)$

Average - 35 days
Variance = $3^2+ 2^2+ 4^2 + 2^2=33$
Standard deviation = 5,7446

$P(X< 34) = P(Z< ((34-35)/5,7446)) = P(Z < -0,1741) = 1-P(Z<0,1741)$
=
= 1-0,5675 = 0,4325 ➔ 43,25%.

PM_5:

a)



b)

Act.	a	m	b	t	Var	ES	EF	LF	LS	Slack
A	2	2	2	2	0.00	0	2	2	0	0
B	1	1	1	1	0.00	0	1	3	2	2
C	1	2	3	2	0.11	1	3	5	3	2
D	2	3	4	3	0.11	2	5	5	2	0
E	1	2	3	2	0.11	2	4	9	7	5
F	3	4	5	4	0.11	5	9	9	5	0
G	1	2	3	2	0.11	9	11	11	9	0
H	2	3	4	3	0.11	5	8	12	9	4
I	1	1	1	1	0.00	11	12	12	11	0
J	4	5	6	5	0.11	12	17	17	12	0

AEGIJ - 12 days
ADFGIJ - 17 days
ADHJ - 13 days
BCFGIJ - 15 days
BCHJ - 11 days

R.: Project minimum execution is 17 days.
The critical activities are: A, D, F, G, I and J.

c)

X - variable that describes project duration

X ~ N(17;0,66)

Average - 17 days
Variance – 0,44
Standard deviation – 0,67
P(X<16) = P(Z<((16-17)/0,67)) = P(Z<-1,5) = 1-P(Z □ 1,5) = = 1-0,9332 = 0,0668 ➔ 6,68%.

d)

Act.		t	Critical Act.	Daily cost	Act. Cost
A		2	Yes	200	400
B		1	No	100	100
C		2	No	100	200
D		3	Yes	200	600
E		2	No	100	200
F		4	Yes	200	800
G		2	Yes	200	400
H		3	No	100	300
I		1	Yes	200	200
J		5	Sim	200	1000
TOTAL					4200

R.: The total cost of the project is 4200 euros.

e)

IF X <= 15 days - Bonus 10% (1,5×(1+0,1)=1,65 million euros
IF X => 18 days - Penalty 12,5% (1,5×(1-0,125)= 1,325 million euros)
IF 15<X<18 days - Value (1,5 million euros)

P(X <= 15) = P(Z <= ((15-17)/0,66)) = P(Z<= -3,03) = 1-P(Z<3,03) =
= 1-0,9988 = 0,0012

P(X => 18) = P(Z => ((18 -17)/0,66)) = P(Z => 1,52) = 1-P(<1,52) =
= 1-0,9357 = 0,0643

P(15<X<18) = 1-(0,0012+0,0643) = 0,9345

Expected Value. = (1,65×0,0012+1,5×0,9345+1,3125×0,0643)
×1000000 = 1 488 123,75 euros

PM_6:

a) Critical Path: A – C – F – H Activities with slack = 0
$\mu_{DT} = \mu_A + \mu_C + \mu_F + \mu_H = 2 + 7 + 2 + 4 = 15$ weeks

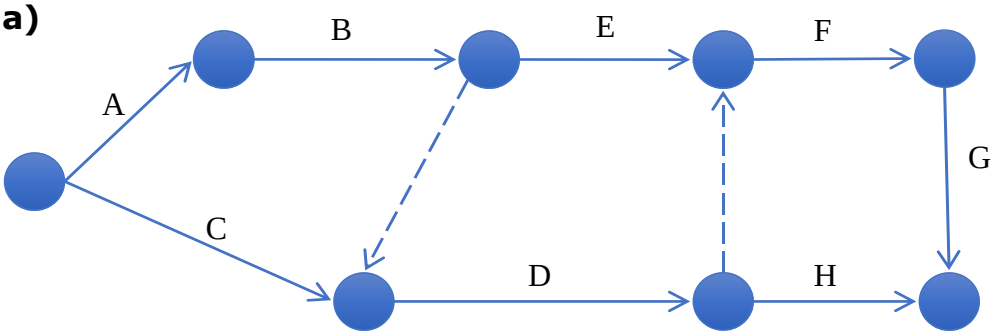
b) A ➔ slack = 0
G ➔ slack = 3
The project completion time will be 15 + 3 = 18 weeks

c) 30% of the expected receipt value Project contract value = 500.000

Expected receipt value = (500.000 x 1,2) x 0,3264 + (500.000 – 0,25 x500.000) x 0,4129 + 500.000 x (1 – 0,419 – 0,3264) = 481.027,5€

PM_7:

a)



b)

ABEFG = 23
ABDFG = 26
ABDH = 15
CDFG = 28
CDH = 17
Project Duration = 28 weeks
Project cost = Σ normal cost = 8075€

c)

	A	B	C	D	E	F	G	H
nt – ct	1	2	3	3	2	4	-	-
Crash cost/week	70	65	50	150	15	125	-	-

Duration	Affected activity	Crash cost	Total cost	Min Activ.
28	-	-	8075	G,H
27	C	50	8125	G,H
26	C	50	8175	G,H
*25	B,C	115	8290	C,G,H
**24	F	125	8415	G,H,C

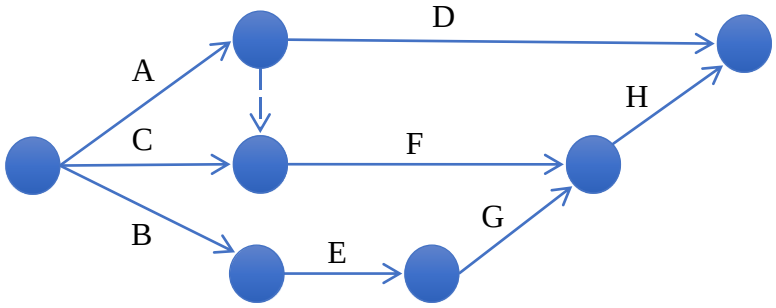
* Options:
B (65) + C (50) = 115
D (150) = 150
F (125) = 125

** Options:
F(125) = 125
D(150) = 150

Paths	It1	It2	It3	It4	It5
ABEFG	23	23	23	22	21
ABDFG	26	26	**26**	**25**	**24**
ABDH	15	15	15	14	14
CDFG	**28**	**27**	**26**	**25**	**24**
CDH	17	16	15	14	14

d) Optimum duration is 25 weeks. The crash cost to reduce project completion time from 25 weeks to 24 weeks is 125 euros. This cost is higher than the weekly cost of renting a car (120).

PM_8:



b) Paths AD = 11
AFH = 19
CFH = 18
BEGH = 17
Critical path = AFH= 19 days

c) Total cost of the project = Σ normal cost = 1.200€

d)

	A	B	C	D	E	F	G	H
nt-ct	2	1	2	2	-	2	2	1
Crash cost/day	15	20	5	25	-	40	75	30

Duration	Activity crashed	Crash cost	Total cost	
18	A	15	1.215	E
17	A,C	20*	1.235	E,A
16	H	30**	1.265	E,A,H
15	F,G	47.5	1.312,5	E,A,H

* A (15) + C (5) = 20 or F = 40 or H = 30
** H (30)

Paths	It1	It2	It3	It4
AD	11	10	9	8
AFH	**19**	**18**	**17**	**16**
CFH	18	**18**	**17**	**16**
BEGH	17	17	**17**	**16**

PM_9:

a) Critical path = A-C-F-G
Total cost of the project = Σ normal cost = 1.760.000,0 euros

b) Budget = 1.900.000

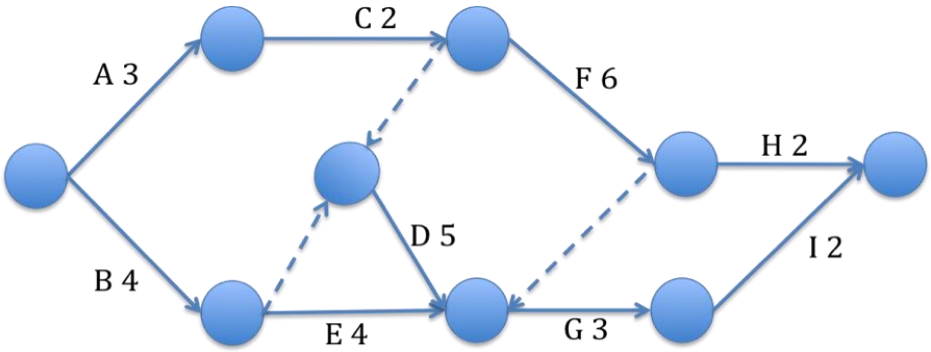
Duration	Crashed activities	Crash cost	Total cost (1000)	
14	-	-	1760	C, H
13	F	30	1790	C, H
12	F, D*	45	1835	C, H, D
11	G**	50	1885	C, H, D

*A = 60 or G = 50 or F (30)+ D(15) = 45
** A = 60 or G = 50

Paths	It1	It2	It3	It4
ACFH	13	12	11	11
ACFG	**14**	**13**	**12**	**11**
ACDG	13	**13**	**12**	**11**
BEG	11	11	11	10
BDG	12	12	11	10

PM_10:

a)



b)

Act.	tn	ES	EF	LF	LS	Slack
A	3	0	3	3	0	0
B	4	0	4	6	2	2
C	2	3	5	5	3	0
D	5	5	10	11	6	1
E	4	4	8	11	7	3
F	6	5	11	11	5	0
G	3	11	14	14	11	0
H	2	11	13	16	14	3
I	2	14	16	16	14	0

Paths	Duration
ACFH	13
ACFGI	16
ACDGI	15
BDGI	14
BEGI	13

R.: The time needed to finish the project is 16 weeks.

c)

Act.	tn	tc	tn-tc	cn	cc	cc/ut
A	3	2	1	1500	2100	600
B	4	2	2	2000	2500	250
C	2	2	0	2000	2000	----
D	5	4	1	1000	1800	800
E	4	3	1	800	900	100
F	6	3	3	1200	2100	300
G	3	1	2	1000	2000	500
H	2	2	0	1500	1500	----
I	2	1	1	700	1100	400

Paths	Duration	It1	It2	It3
ACFH	13	12	12	12
ACFGI	**16**	**15**	**14**	**13**
ACDGI	15	**15**	**14**	**13**
BDGI	14	14	13	12
BEGI	13	13	12	11

It	Critical Path	Affected Act. (new dur.)	Additional Cost	Total Cost	Dur.	Min Activ.
0	ACFGI			11700	16	C, H
1	ACFGI ACDGI	F (5)	300	12000	15	C, H
2	ACFGI ACDGI	I (1) [1]	400	12400	14	C, H, I
3	ACFGI ACDGI	G (2) [2]	500	12900	13	C, H, I

[1]
H1) I - 400
H2) F+D - 300+800=1100

[2]
H1) G - 500
H2) F+D - 300+800=1100

R.: The following activities will be crashed F, I e G (1 day each).

d)

Paths	Duration	It1	It2	It3	It4	It5
ACFH	13	12	12	12	11	10
ACFGI	16	15	14	12	11	10
ACDGI	15	15	14	12	11	10
BDGI	14	14	13	11	11	10
BEGI	13	13	12	10	10	10

Iter	Critical Path	Affected Act (new dur.)	Additional Cost	Total Cost	Duration	Min. Activ.
0	ACFGI			37300	16	C, H
1	ACFGI ACDGI	F (5)	300	12000	15	C, H
2	ACFGI ACDGI	I (1) (1)	400	12400	14	C, H, I
3	ACFGI ACDGI ACFH	G (1) (2)	2*500=1000	13400	12	C, G, H, I
4	ACFGI ACDGI ACFH BDGI	A (2) (3)	600	14000	11	A, C, G, H, I
5	ACFGI ACDGI ACFH BDGI BEGI	F (4) D (4)	300 800	15100	10	A, C, D, G, H, I

(1) H1) I – 400

H2) F+D - 300+800=1100

(2) H1) G - 500

H2) F+D - 300+800=1100

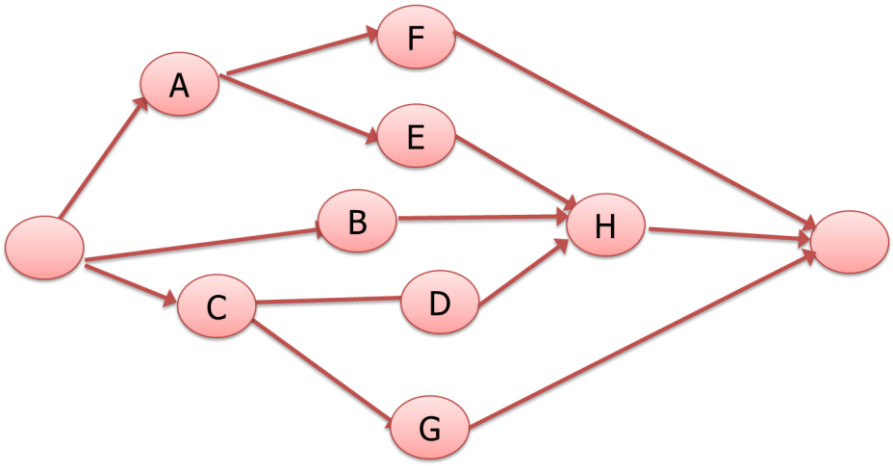
(3) H1) A - 600

H2) F+D - 300+800=1100

Minimum time: 10 weeks. Optimal cost: 15 100 euros.

PM_11:

Activities	A	B	C	D	E	F	G	H
Precedencies	-	-	-	C	A	A	C	B,D,E
Normal Time (days)	4	1	5	2	2	1	2	3
Crash time (days)	3	1	3	1	1	1	2	1
Normal Cost (1000 €)	50	60	70	50	25	10	80	30
Crash cost (1000 €)	55	60	90	62	28	10	80	38
nt-ct	1	----	2	1	1	----	----	2
Crash cost/day (cc/ut)	5	----	10	12	3	-----	-----	4



Possible paths:

AF	5	5	5	5
AEH	9	8	7	**7**
BH	4	3	2	2
CDH	**10**	**9**	**8**	**7**
CG	7	7	7	6

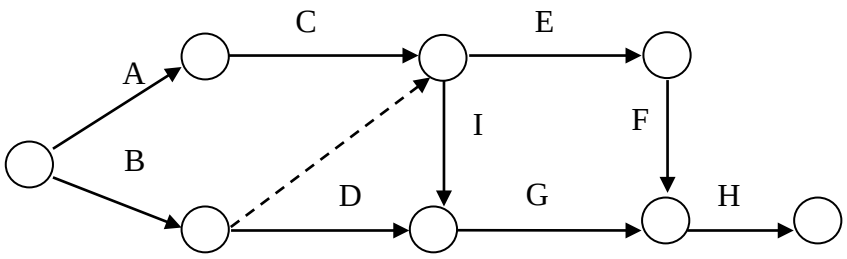
Iter.	Critical Affected Act (new dur.)		Additional C.	Total C.	Dur.	Min. Act. path
0	CDH			375	10	B,F,G
1	CDH	H(2)	4	379	9	B,F,G
2	CDH	H (1)	4	383	8	B,F,G,H
3	CDH	C (4)	10	393	7	B,F,G,H
4	CDH AEH	C(3), E(1)	13[1]	406	6	B,F,G,H,C,E

[1]
C =10
E =3

The duration of the project can be crashed in 3 days.

MULTIPLE CHOICE QUESTIONS

1. Consider the project CENTRO with network diagram, expected activity durations, and standard deviations represented below:



Activities	A	B	C	D	E	F	G	H	I
Expected Time(days)	3	8	3	3	2	4	6	3	5
Standard deviation (days)	4	4	2	2	1	2	2	1	1

What is the minimum duration of the project CENTRO?		
1		18 days
2	X	22 days
3		20 days
4		15 days

The early finish (EF) of activity E is:		
1		8 days
2		11 days
3	X	10 days
4		12 days

Knowing that the most likely and pessimistic durations for activity G are 5 and 14 days, respectively, what is the optimistic duration?		
1		3 days
2		5 days
3	X	2 days
4		6 days

Consider a new project with identical expected durations and standard deviations as before, but with a different set of preceding activities. Assuming the critical path of such new project is ABDF, what is the probability that the project duration exceeds 20 days?		
1	X	0.3745
2		0.6255
3		0.5675
4		0.4325

2. The contract agreed upon for project LISHOME defines that if the contractor finishes the project before the 6th month, a bonus of 15% over the project value (5 million euros) is paid. However, if the contractor only concludes the project after the 10th month a 30% penalty over the value of the project is to be enacted. It is known that the probability of concluding the project in more than 10 months is 12% and that the likelihood of finishing the project in less than 6 months is of 4%.

What is the expected value the contractor will receive for the LISHOME project?		
1		5.030 million de euros
2		7.510 million de euros
3	X	4.850 million de euros
4		0.650 million de euros

3. Consider the following data taken from the DMP project:

Activities	A	B	C	D	E	F	G	H
Normal time (weeks)	5	2	2	2	3	4	4	5
Crash time (weeks)	4	1	2	1	1	4	3	2
Normal cost (euros)	1000	1000	800	700	800	800	900	500
Crash cost (euros)	1200	1070	800	1200	1600	800	1400	800

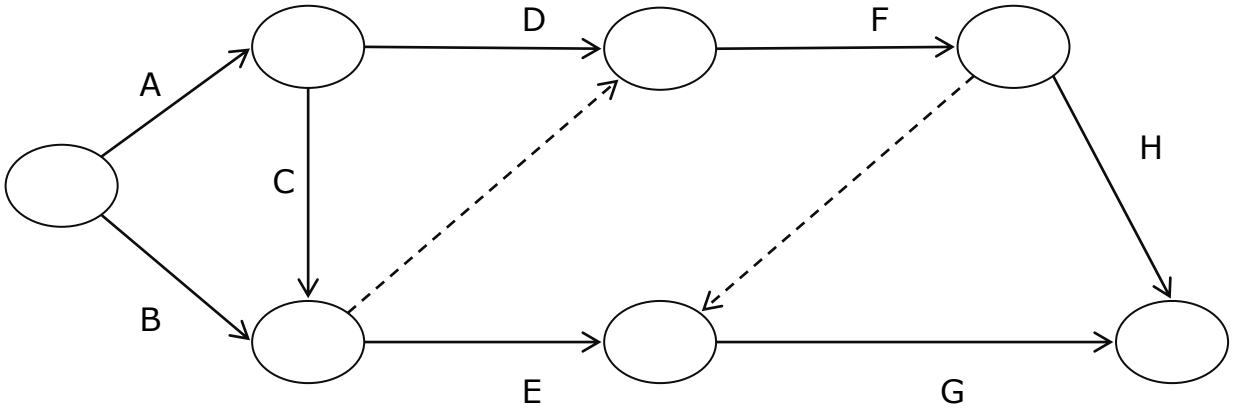
After the graphical representation of the network diagram of project DMP the following paths were identified:

BDF
ACEH
BCH
ABEG

Compute the total cost of project DMP.		
1		5700 euros
2		3100 euros
3		8870 euros
4	X	6500 euros

By what amount will total cost vary if the duration of project DMP is crashed by two weeks?		
1		200 euros
2	X	270 euros
3		300 euros
4		470 euros

4. The following network diagram describes the activities of project SODA. The table below refers to the expected durations and standard-deviations of the project activities:



Activity	A	B	C	D	E	F	G	H
Expected duration (days)	2	3	4	5	4	3	6	4
Standard deviation (days)	1	2	2	3	2	1	2	2

Identify the critical activities for project SODA		
1		A, C, E, and G
2	x	A, D, F, and G
3		A, C, D, E, F, and G
4		A, C, F, and G

Which of the following is the late start (LS) of activity H?		
1	x	12 days
2		10 days
3		13 days
4		11 days

If the optimistic duration of activity G is 2 days and its pessimistic duration is 14 days, then the most likely duration of activity G is:		
1	x	5 days
2		4 days
3		6 days
4		3 days

5. Please consider the following data for the ITECH project

Activities	A	B	C	D	E	F	G	H
Normal Time (weeks)	2	3	4	5	4	3	5	6
Crash time (weeks)	1	2	1	1	2	1	1	2
Normal Cost (euros)	1,000	1,200	800	600	1,000	800	900	800
Crash cost (euros)	1,130	1,350	995	1,080	1,400	920	1500	1200

A graphical representation of the network activities produced the paths identified below:

ACEG
ADFG
ADFH
BEG

If the value of the project is of 8,500 euros, then the contractor will:		
1		earn a 4,070 euro profit
2		face a 1,075 euro loss
3	x	earn a 1,400 euro profit
4		face a 3,745 euro loss

By how would the total cost increase if the duration of the ITECH was reduced by two weeks?		
1	x	185 euros
2		190 euros
3		120 euros
4		125 euros

How would a reduction of the duration of activity H to 2 weeks (via crashing) impact on the total project duration?		
1		13 weeks
2		14 weeks
3	x	15 weeks
4		16 weeks

6. Consider the following data from project NOW:

Activities	A	B	C	D	E	F	G	H
Normal time (weeks)	6	5	4	3	5	4	3	3
Crash time (weeks)	5	4	2	2	2	4	3	2
Normal cost (euros)	1200	600	1000	500	600	800	500	800
Crash cost (euros)	1600	700	2100	950	1200	800	500	1100

After a network diagram was drawn the following paths were identified:

ACH
BCDE
BFGH
ACDH

Estimate the impact of crashing activity E by three weeks on the total duration of the project.		
1	x	Project duration is shortened by one week
2		Project duration is shortened by two weeks
3		Project duration is shortened by three weeks
4		Project duration remains unaltered

If the duration of the NOW project is crashed by two weeks what is the minimum total project cost?		
1	x	6550
2		6450
3		6300
4		6000