Examenes 9 March 2009, questions

Projectmanagement (Universiteit Gent)

Project Management

Final Exam

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Name: .....

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Final exam Project Management course

Duration : 3 hours
You may use a calculator. PCs are not allowed.
Please hand in this exam sheet at the end of the exam.

Good luck!
Mario Vanhoucke

Question 1. Project Scheduling (PERT)

Find the project data in the table below.

Activity	Predecessor	Optimistic time (days)	Normal time (days)	Pessimistic time (days)
A	-	2	4	6
B	-	3	5	9
C	A	4	5	7
D	A	4	6	10
E	B, C	4	5	7
F	D	3	4	8
G	E	3	5	8

A normal table is given in the appendix.

(Qa) Network analysis
- Find the expected time and standard deviation for each activity.
- Draw the activity-on-the-node network and find the critical path and time.

[20 marks]

(Qb) Critical path analysis 1
- Find the probability that the entire network will be completed in 23 days (motivate your calculations).
- Explain the use and importance of the central theorem in your calculations.

[20 marks]

(Qc) Critical path analysis 2
- How many days are required for the critical path to have a 90% probability of completion?

[25 marks]

(Qd) Scheduling approach
- PERT is known to slightly underestimate the real project duration. Explain the weaknesses of PERT and suggest improvements.

[35 marks]

Question 2. Project Scheduling (CPM)

Find the project data in the table below.

Activity	Predecessor	Normal time (days)	Normal cost (£)	Crash time (days)	Crash cost (£)
A	-	5	50.00 £	3	150.00 £
B	-	4	40.00 £	2	200.00 £
C	B	7	70.00 £	6	160.00 £
D	A, C	2	20.00 £	1	50.00 £
E	A, C	3	30.00 £	-	-
F	B	8	80.00 £	5	290.00 £
G	D	5	50.00 £	4	100.00 £
H	E, F	6	60.00 £	3	180.00 £

(Qa) Network analysis

- Draw the activity-on-the-node network and find the critical path, time, and cost for an all-normal level of project activity.
- Calculate the crash cost-per-day for each activity.

[20 marks]

(Qb) Activity crashing 1

- Find the optimal way of getting an 18-day delivery time. What is the project cost?
- Find the optimal way of getting a 16-day delivery time. What is the project cost?

[20 marks]

(Qc) Activity crashing 2

- Calculate the shortest delivery time for the project. What is your cost?

[25 marks]

(Qd) Scheduling approach

- Explain how an automatic computerized scheduling software tool should find the optimal project cost given a predefined project deadline.
- Explain how an automatic computerized scheduling software tool should find the optimal project duration given a predefined project budget and compare with the first scheduling approach.

[35 marks]

Question 3. Project Scheduling (Resources)

Find the project data in the table below.

Activity	Predecessor	Duration (days)	Resource use	Cash
A	-	2	X, Y	+50 £
B	A	2	X	+20 £
C	A	3	X	-10.00 £
D	B, C	4	X, Y	+100 £
E	D	3	W, X	-50.00 £
F	D	1	W, X, Y	+40 £
G	E, F	2	X, Y	+300 £

Three renewable resource types are used in this project (W, X, Y). All resources have a constant availability of one unit per day.

(Qa) Scheduling (ignore resource use)
- Draw the activity-on-the-node network and an earliest start Gantt chart.
- Assuming a seven-day week, find the critical path and project duration in days.

[20 marks]

(Qb) Scheduling 1 (with limited resource use and ignoring cash flows)
- Given that each resource is assigned 100 percent to each activity, identify the resource conflicts.
- Level the resources and determine the new project durations and critical chain.

[20 marks]

(Qc) Scheduling 2 (with limited resource use and cash flows)
- Identify the critical chain taking the cash flows into account (+ = cash inflow and - = cash outflow) and determine the new project duration (motivate your answer).

[25 marks]

(Qd) Priority based scheduling
- Calculate the priority sequence for all activities using the Greatest Rank Positional Weight (GRPW) priority rule.
- Use this rule to schedule the project with a serial or parallel generation scheme. Explain your calculations and compare the schedule with the schedules from questions b and c.

[35 marks]

Question 4. Project Scheduling (Critical Chain)

Find the project data in the table below.

Activity	Predecessor	Duration (days)	Resource use
A	-	10	V
B	-	16	W
C	-	2	V, W
D	B	10	X, Z
E	A, B	8	X
F	C	8	V
G	F	2	V
H	D, E, F	2	Y
I	G, H	12	Z

Five renewable resource types are used in this project (V, W, X, Y, Z). All resources have a constant availability of one unit per day.

Note that the activity duration estimates are considered to be the 90% estimates, and therefore, the durations should be cut in two to obtain the aggressive time estimates.

(Qa) Scheduling (ignore resource use)
- Draw the network (AoA or AoN).
- Assuming a seven-day week, find the critical path and project duration in days using normal durations (no aggressive estimates).

[25 marks]

(Qb) Scheduling (with limited resource use)
- Construct a Gantt chart using Eli Goldratt's "Theory Of Constraints" approach, known as the "Critical Chain/Buffer Management (CC/BM)" and show the critical chain.

[35 marks]

(Qc) Buffer management
- Insert all buffers (project buffer, feeding buffers and resource buffers) using the 50% rule.
- Discuss the impact on the total duration of the project.

[40 marks]

Question 5. Project Control (EVM)

Find the project data in the table below.

Activity	Predecessor	Duration (weeks)	Budget	Actual cost	% Completed
A	-	2	300.00 £	400.00 £	100%
B	-	3	200.00 £	180.00 £	100%
C	A	2	250.00 £	300.00 £	100%
D	A	5	600.00 £	400.00 £	20%
E	B, C	4	400.00 £	200.00 £	20%

The project is at the end of its sixth week.

(Qa) Earned Value Management

- Find the cost and schedule variances CV and SV. Also find the CPI and SPI.
- Calculate the EAC for the project (using one or different formulas and motivate your choice (1 sentence)).

[20 marks]

(Qb) Earned Schedule

- Calculate the earned schedule metric (ES). Also find the SPI(t).
- Calculate the EAC(t) using earned schedule (using one or different formulas and motivate your choice (1 sentence)).

[20 marks]

(Qc) Progress reporting.

- Draw general conclusions on the current project performance (linking the metric values with general conclusions in words).
- Define proposals for improvements to your management.

[25 marks]

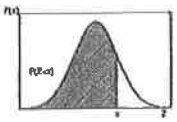
(Qd) Earned schedule.

- Explain why SPI(t) is a better performance indicator than the SPI.
- Illustrate the weaknesses of SPI and the strengths of SPI(t) on the project data.

[35 marks]

Appendix

Tabel 9.1: Standaard normale verdeling



	Tweede decimaal van z									
z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990

Exam Project Management

2011 - 2012

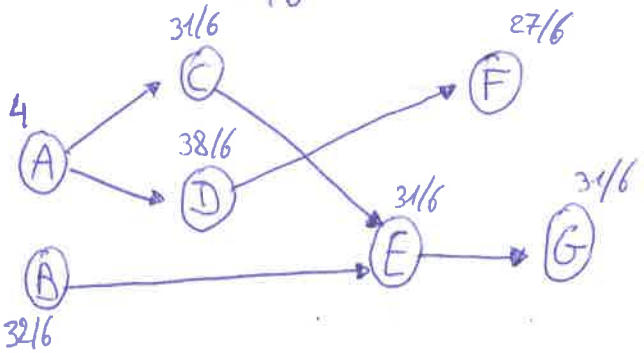
Question 1

a)

Activity	μ	σ
A	4	2/3
B	32/6	1
C	31/6	1/2
D	38/6	1
E	31/6	1/2
F	27/6	5/6
G	31/6	5/6

$\begin{cases} a = \text{optimistic time} \\ b = \text{pessimistic time} \\ m = \text{normal time} \end{cases}$

$\begin{cases} \mu = \dfrac{a+4m+b}{6} \\ \sigma = \dfrac{b-a}{6} \end{cases}$



→ CP = A - C - E - G

↳ time = ~~18,5~~ 19,5 days

b) $\mu = 19{,}5$ days

$\sigma^2 = \sigma_A^2 + \sigma_C^2 + \sigma_E^2 + \sigma_G^2$

$= \frac{4}{9} + \frac{1}{4} + \frac{1}{4} + \frac{25}{36}$

$= 1{,}64$

$\Rightarrow \sigma = 1{,}28$

↳ $\Phi\left(\frac{23-\mu}{\sigma}\right) = \Phi\left(\frac{23-19{,}5}{1{,}28}\right) = \Phi(2{,}734) \approx 99{,}7\%$

↳ more precise: use linear interpolation

c) $\Phi\left(\frac{x - 19{,}5}{1{,}28}\right) = 0{,}90$

↳ linear interpolation in table

z	Pb
1,28	0,8997
?	0,90
1,29	0,9015

$\Rightarrow z = 1{,}28 + \frac{1{,}29 - 1{,}28}{0{,}9015 - 0{,}8997}(0{,}90 - 0{,}8997)$

$= 1{,}2817$

$\Rightarrow \frac{x - 19{,}5}{1{,}28} = 1{,}2817 \Rightarrow x = 21{,}14$

d] PERT

Weaknesses

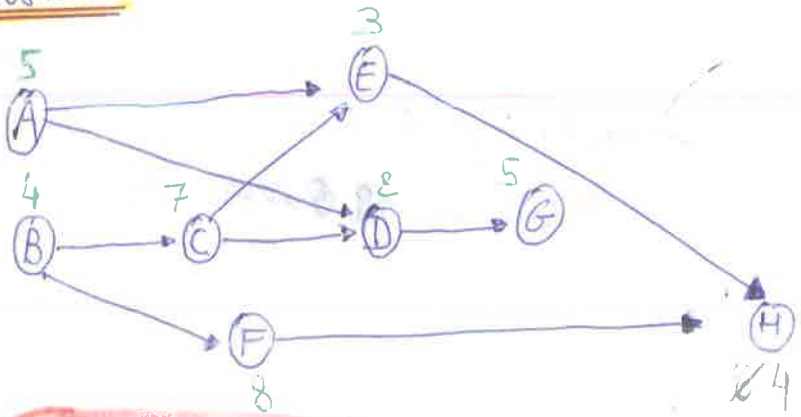
- everything starts with input: wrong input (e.g. bad estimation a, b, m) => wrong output
- statistical simplifications
- focus on CP ; every path can become critical

↳ improvements?

- good communication with team
- promise always a sufficient high service level to your client (e.g. 90 or 95%) => risk ↓

Question 2

a)



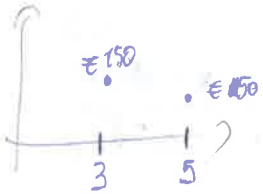
CP = B - C - E - H
time = 20 days

cost = Σ all activities
cost = 400.00 £

↳ crash cost per day?

crash cost per day = $\frac{\text{crash cost} - \text{normal cost}}{\text{normal time} - \text{crash time}}$

Activity	crash cost / day (£)	
A	~~50.00~~	50,00
B	~~100.00~~	80,00
C	~~26.67~~	90,00
D	~~50.00~~	30,00
E	-	
F	~~58.00~~	70,00
G	~~25.00~~	50,00
H	~~60.00~~	40



b) · focus on critical path (B-C-E-H)
· focus on critical activities (with smallest cost slope)

18 days ↳ crash activity H
↳ 2 days → crash cost = 2 × 40,00 £
= 80,00 £

=> total project cost = 400.00 + 40 (- 20?)
= 440,00 £

16 days
↳ crash activity H: 2 days => crash cost = 40,00 £ x 2 => 80,00 £

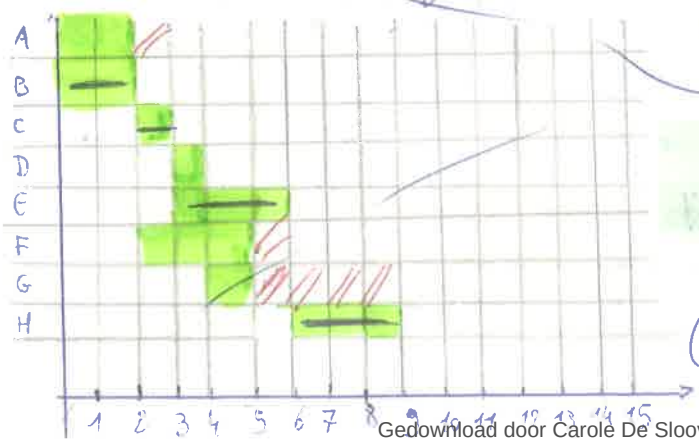
=> B-C-E-H = 18 days → crash C 1 day ; crash H 1 day ; crash D 1 day
B-C-D-G = 18 days

=> possibilities: (cheapest)

=> project cost = 400,00 + 120,00 £ 400 + 80 + 90 + 40 + 30 = 640
= £

c)

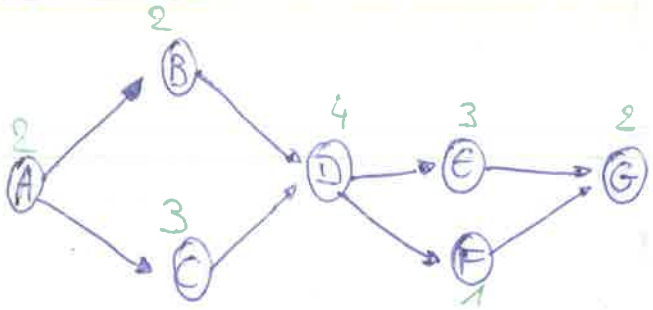
=> strategy = crash everything first and see then which activities can last longer (i.e. activities not on critical path)



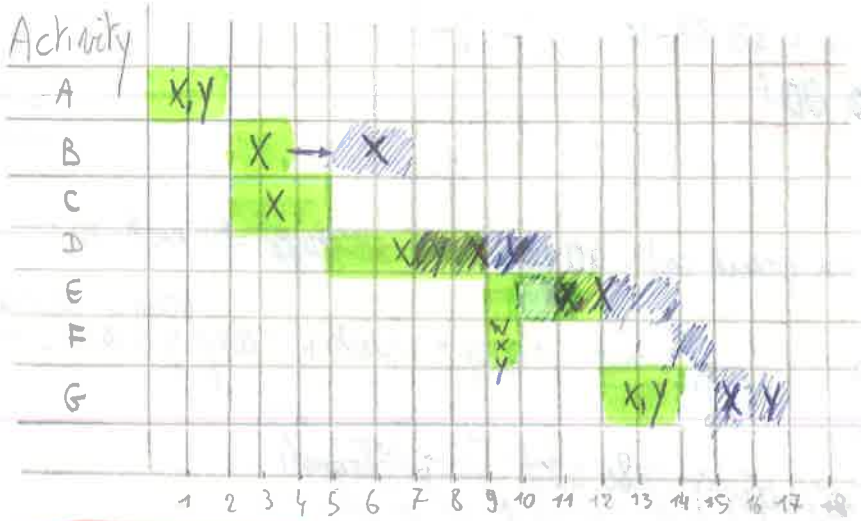
→ CP = BCEH
= 9 days

=> G can last 4 days longer (- 100.00 £)
=> F can last 1 day longer (- 58,00 £)
=> A can last 1 day longer (- 50,00 £)
↳ cost = 400.00 £ + crash everything - longer duration
= 400,00 £ + 1130,00 £ - 208,00 £
= 1322 £

Question 3



a)



CP = A-C-D-E-G
PD = 14 days

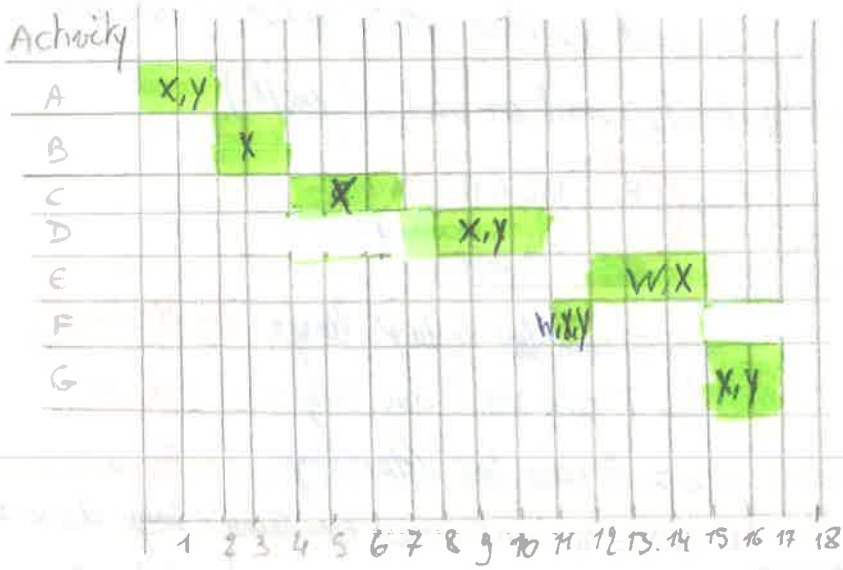
b) • resource conflicts : ★ B-C (X)
★ E-F (W, X)

• level resources (on Gantt chart)

↳ new PD = ~~17~~ days

CC = A-B-D-F-G

c) time value of money : ★ cash in : the sooner, the better
★ cash out : the later, the better



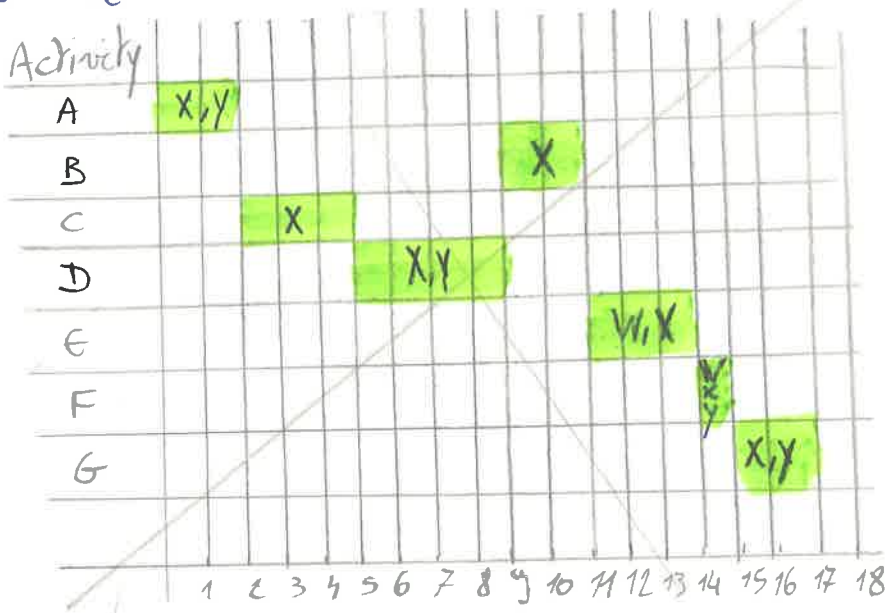
→ PD = 17 days
→ CC = A - B - D - E - G

(d) GRPW: p159 in book

	GRPW
A	7
B	6
C	7
D	8
E	5
F	3
G	2

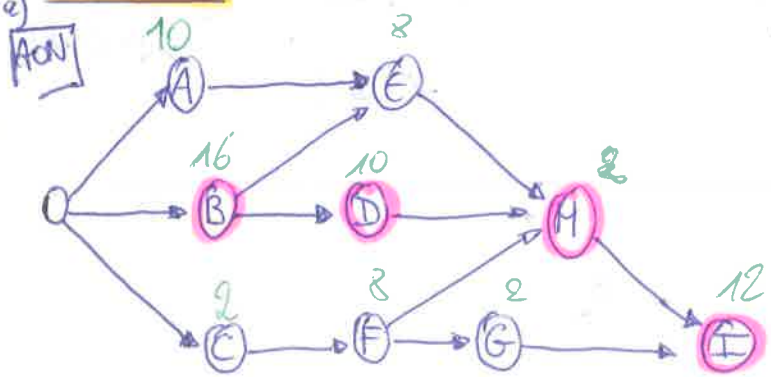
{D, A, C, B, E, F, G}

Serial



Question 4

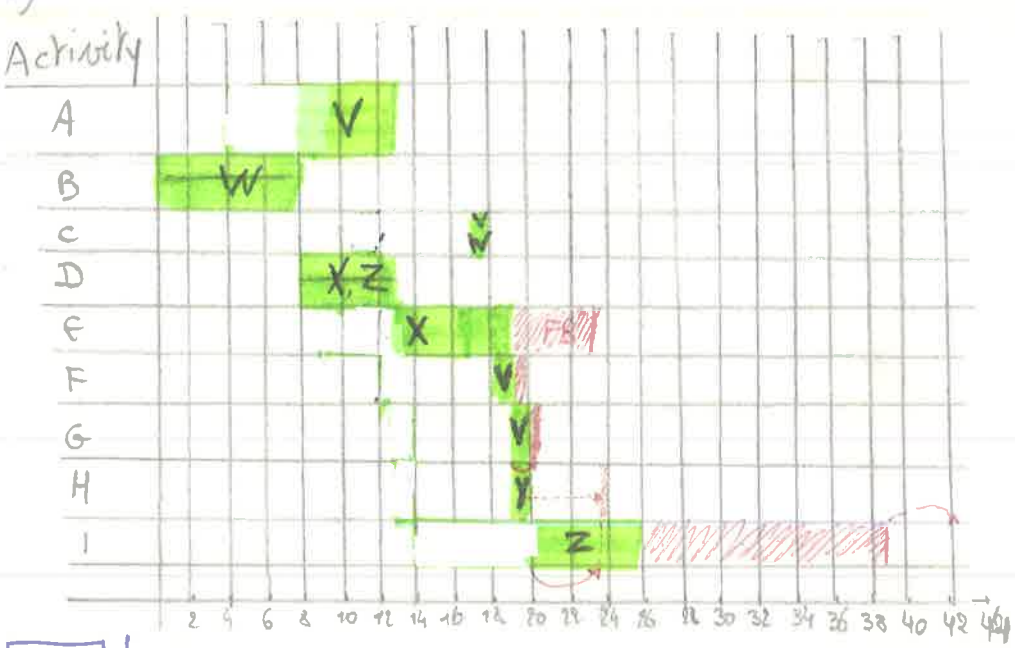
e)



CP = B-D-H-I

PD = 40 days

4)



aggressive estimates	
A	5
B	8
C	1
D	5
E	4
F	4
G	1
H	1
I	6

ALAP !

CC = B - D - H - I

e)

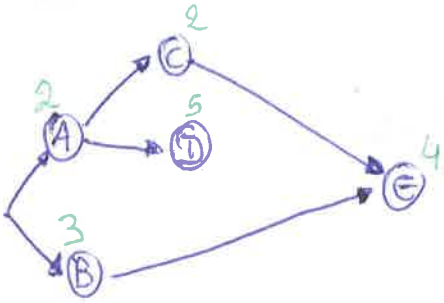
* project buffer = 50% PD
  = 13 days

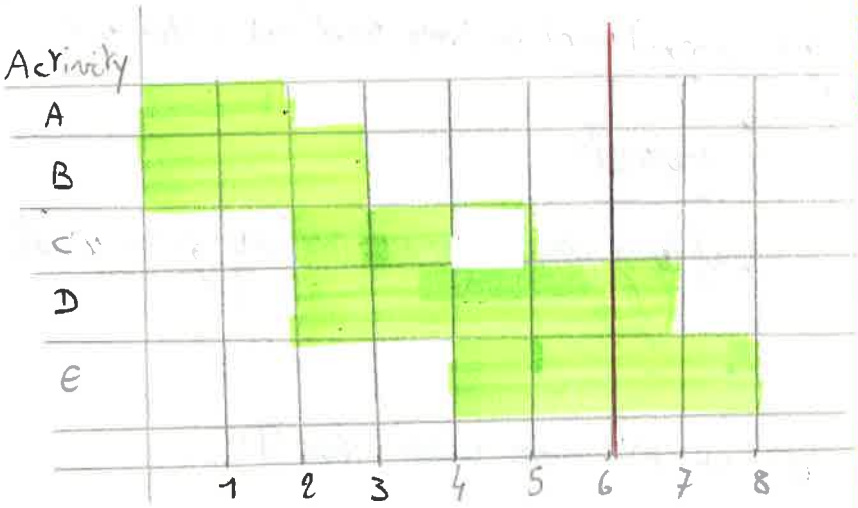
* feeding buffer
  A - E = 4,5 days FB
  G = 0,5 days
  C - F = 1 day

↳ inserting buffers ⇒ new resource conflicts ⇒ PD ↑ , i.e. = 39 days + 3 days (↳ shift of H)
= 42 days

↳ resource buffers

Question 5





End 6th week

a) $\begin{cases} CV = EV - AC \\ SV = EV - PV \end{cases}$ $\begin{cases} CPI = EV/AC \\ SPI = EV/PV \end{cases}$

$EV = \%\ completed \times BAC$

→ $BAC = 1750.00\ £$

→ $EV = 100\% \cdot 300 + 100\% \cdot 200 + 100\% \cdot 250 + 20\% \cdot 600 + 80\% \cdot 400$

$= 950.00\ £$

→ $AC = 400 + 180 + 300 + 400 + 200$

$= 1480.00\ £$

⇒ $CV = -530.00\ £$; $CPI = 0,64$

* $PV = 300 + 200 + 250 + \frac{4}{5} \times 600 + \frac{1}{2} \times 400$

$= 1430\ £$

⇒ $SV = -480\ £$; $SPI = 0,66$

* $EAC_3 = AC + \frac{(BAC - EV)}{CPI \times SPI} = 3373,94\ £$

b) ES : time at which you should have reached your current EV according to PV

PV at week 4 : $300 + 200 + 250 + 240 = 990$

PV at week 3 : $300 + 200 + \left(\frac{1}{2}\right) \cdot 250 + \left(\frac{1}{5}\right) \cdot 600 = 745$

⇒ $ES = 3 + \frac{950 - 745}{990 - 745} = 3,84$

⇒ $SPI(t) = \frac{ES}{AD} = \frac{3,84}{6} = 0,64$

⇒ $EAC(t)_3 = AT + \frac{(PD - ES)}{CPI \cdot SPI(t)}$

$= 16.16$ days

(c) project not on time and not within cost

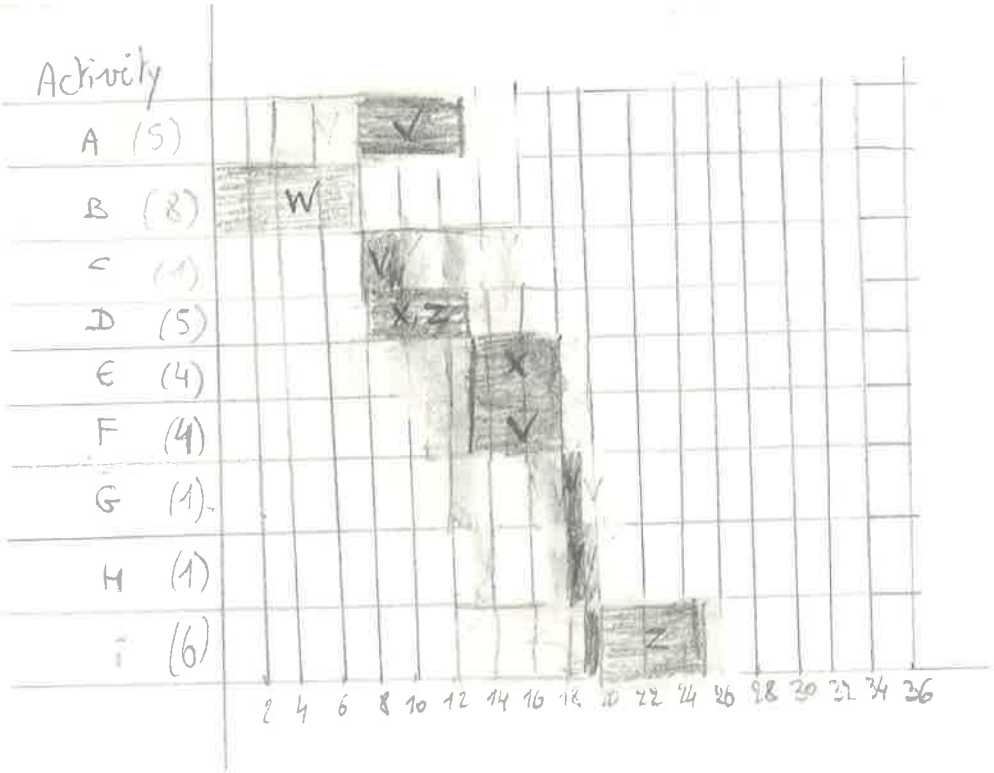
↳ proposals

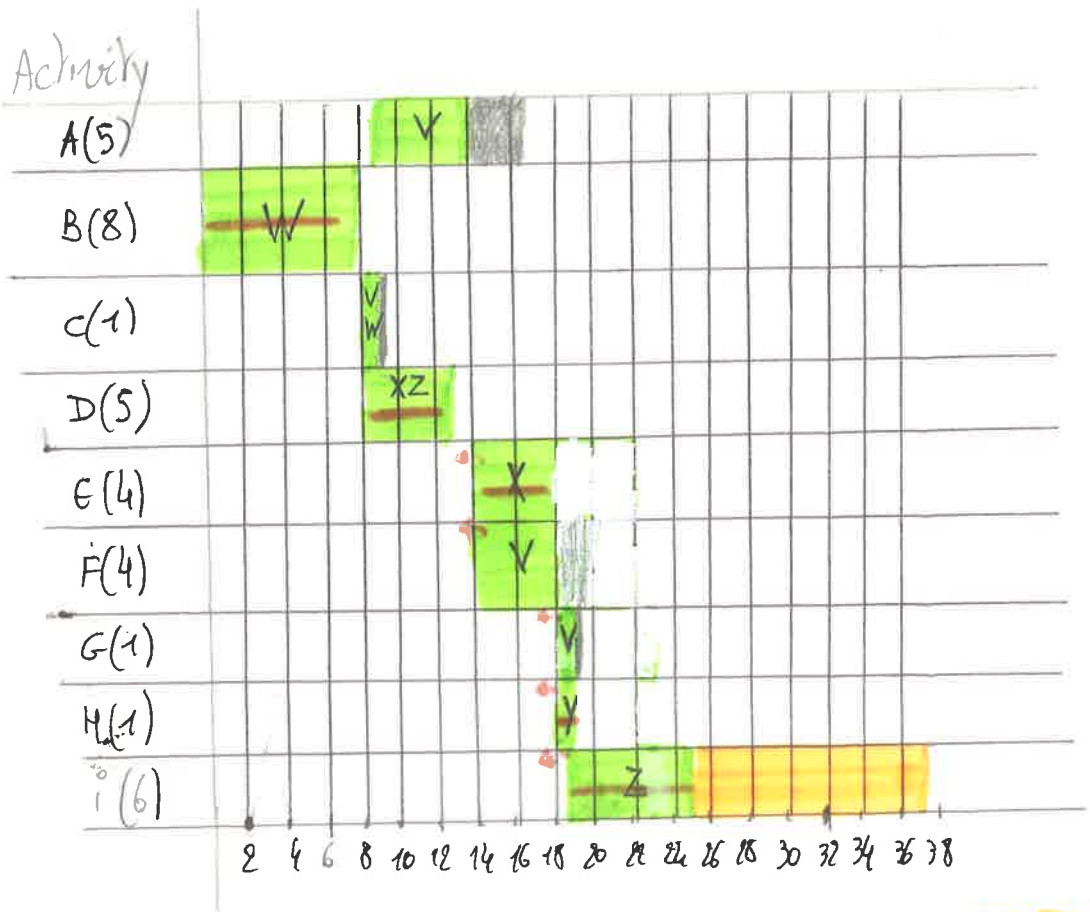
- if large penalty for not meeting given deadline => crash activities
- ??

(d) SPI(t) : more reliable than SPI

↳ at end of project : always SPI = 1
=> spi doesn't tell you if your project is in time

↳ spi(t) gives time performance because you work with ES





= PB

= CC

PD = 24 days

PB = $\frac{1}{2}$ · PD = 12,5 days

FB = $\frac{1}{2}$ · feeding chain

FC_A = 2,5 days

FC_C = 0,5 days

FC_F = 2 days

FC_G = 0,5 days