

ORDRE DES INGÉNIEURS DU QUÉBEC
NOVEMBER 2018 SESSION

All documentation is permitted
Calculators: allowed models only
Exam duration: 3 hours

14-CI-A7 BUILDING CONSTRUCTION MANAGEMENT

Question 1 (6 points)

Which type of organization is best for a company whose management system is oriented towards a project-driven collaborative function? Explain this organizational form.

Question 2 (20 points)

Using the data in Table 1, draw the Precedence Diagram Method (PDM) also called AON diagram (Activity-On-Node) and indicate the critical path.

Indicate, for each activity, the Early Start (ES), the Early Finish (EF), the Late Start (LS), the Late Finish (LF), the total Float (TF), and the Free Float (FF).

Table 1

Activity	Duration	Relations	
		Start	End
E	6		
F	8		
G	5		After the end of H
H	12	After the End of E and F	
I	8	2 days after the Start of H	
K	4	10 days after the End of G	
L	10	After the End of I	

Question 3 (20 points)

The following figure shows a CPM network with the AOA (Activity On Arrow) diagram.

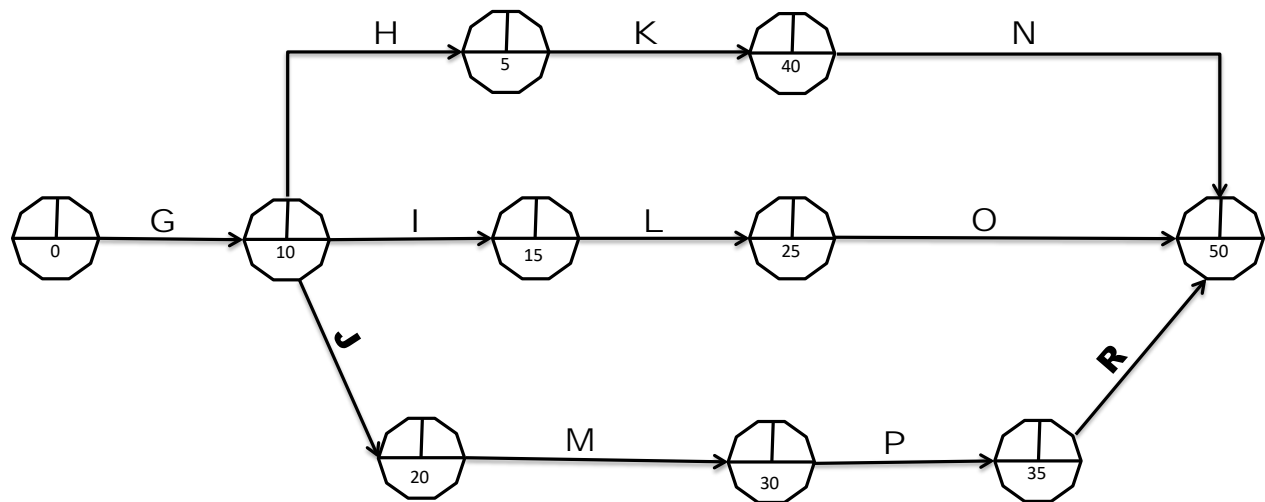


Figure 1 – CPM network

Table 2 shows the optimistic, pessimistic and most likely durations for each activity.

Table 2

Activity	Optimistic Duration	Most Likely Duration	Pessimistic Duration	Te	σ^2	σ
A	10	10	10			
B	16	20	30			
C	22	25	28			
D	16	20	30			
E	13	15	23			
F	18	20	28			
G	8	15	16			
H	8	10	12			

- Calculate and indicate in Table 2, the expected duration TE, the variance σ^2 and the standard deviation σ for each activity. (6 points)
- Calculate the project duration. (2 points)
- Calculate the project variance. (2 points)
- Calculate the probability to complete the project within 45 days. (5 points)
- Calculate the probability to complete the project within 30 days. (5 points)

Question 4 (20 points)

You have to draw a **LINEAR SCHEDULE** for the construction of a 10 km tunnel. See Figure 2.

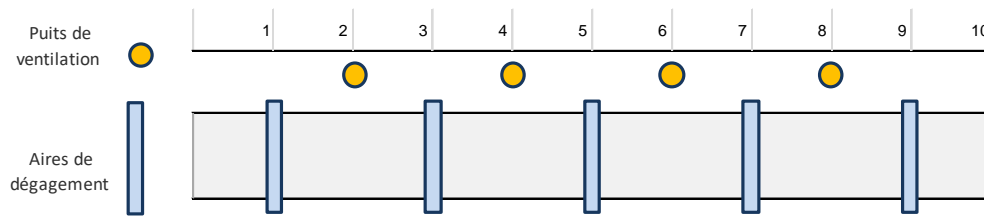


Figure 2 – Construction of a 10 km tunnel

For this project, you have the following teams:

1. Two teams of tunnelers « Tun »: With a production of 1 km per day per team. These two teams can work at the same time, but not at the same place.
2. Two teams for walls concreting "Bet": With a production of 1 km per day per team. These two teams can work at the same time, but not at the same place.
3. Two teams for the installation of the clearance wells (*aires de dégagement*) "Air": Five (5) wells must be built per kilometer 1; 3; 5; 7; and 9. The duration of intervention is 3 days per well.
4. A team for the construction of the ventilation shafts (*puits de ventilation*) "Pui". Four (4) shafts are to be built per kilometer 2; 4; 6; and 8. The duration of intervention is 2 days per shaft.
5. A team of installation of networks of pipes, cabling, lighting and telecommunication "Res": With a production of 2.5 Km per day.

The execution is done in order, one team after the other, except for the two teams "Pui" and "Air" which can run in parallel. That means that the order is the following:

- « Tun » teams
- « Bet » teams
- « Pui » and « Air » teams
- « Res » team

Constraints

- Two teams of the same type cannot work at the same place at the same time.
- There must be a shift of at least 1 day at any time between the different successive teams.
- **YOU CANNOT USE THE GANTT DIAGRAM METHOD OR THE CPM NETWORKS**

Question 5 (20 points)

For the earthworks (volume of cut and fill) of the road illustrated in Figure 3, you should perform the following tasks:

- 1 - Draw the longitudinal section (2,5 pts)
- 2 - Draw the cross sections for all the demonstrated chaining: 15+000 ; 15+300 ; 16+000 ; 18+500 ; 20+000 ; 23+000 ; et 24+000 (7,5 pts)
- 3 - Calculate the areas of the cross sections for these same chaining (5 pts)
- 4 - Using the cross sections method (sections en travers), calculate the volumes of excavation and backfilling required for the road earthworks (5 pts)

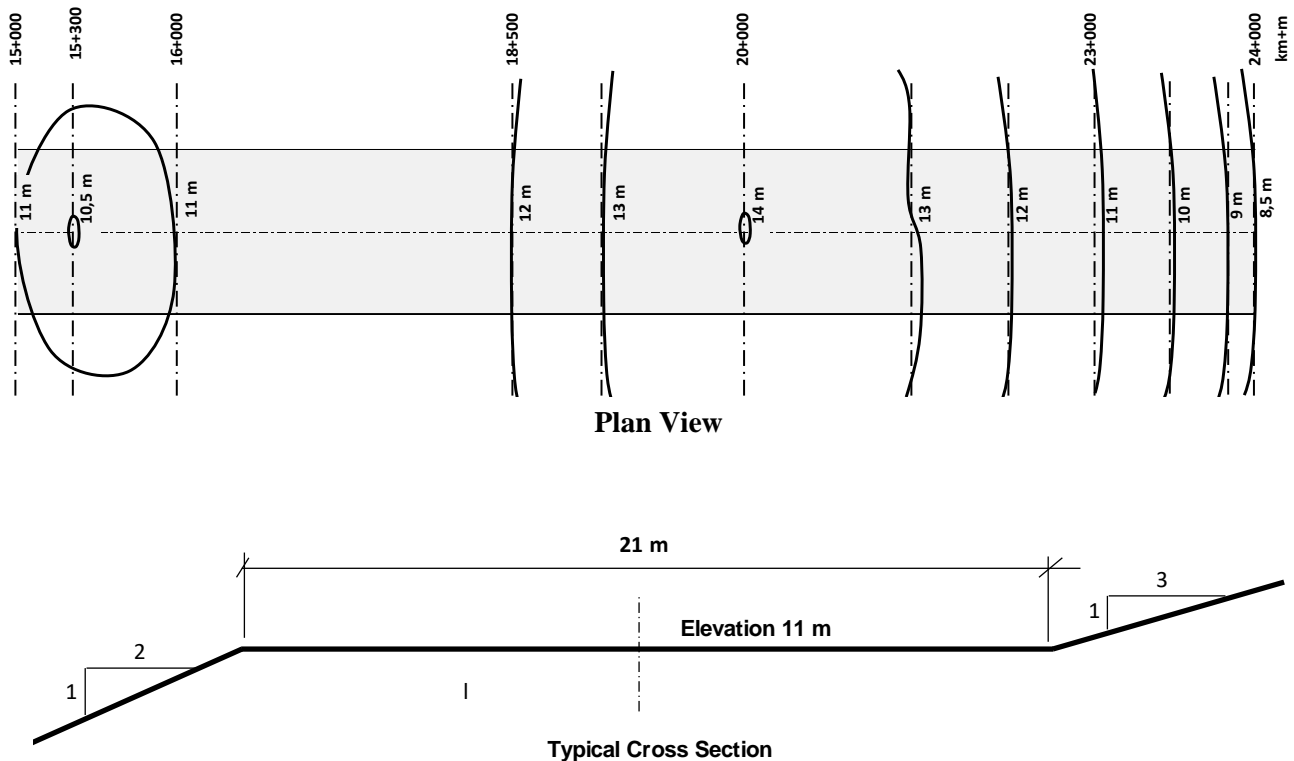


Figure 3. Plan and cross section of the road

Question 6 (9 points)

You are an industrial construction contractor. Your bond limit is \$ 15,000,000. Currently, you have \$ 4,000,000 in contracts and you have three estimators at your job. One of your estimators is preparing and submitting a bid to be submitted in three weeks worth an estimated \$ 3,250,000; the second is preparing a quote for next week valued at \$ 1,250,000. The third is free. Say if you can or want to prepare bids for the following projects, and why?

Submissions	Would you?	Why ?
1. A project to build a 5 km road valued at \$ 5,000,000. Submissions must be submitted in 6 weeks.		
2. A project for the construction of a \$ 5,000,000 plant, for which only 4 bidders are invited. Submissions must be submitted in 2 weeks.		
3. A project to build a \$ 6,000,000 school. Submissions must be submitted in 5 weeks.		
4. A project for the construction of a \$ 4,200,000 plant. Submissions must be submitted within 3 weeks.		
5. A \$ 2,000,000 building project, which must be submitted in 3 weeks.		
6. A project for the construction of a \$ 8,000,000 plant, for which only 5 bidders are invited. Submissions must be submitted within a week.		

Question 7 (5 points)

Explain when must a bid be submitted to the BSDQ?