



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 7 Examination in Engineering: October 2019

Module Number: CE7301

Module Name: Construction Management

[Three Hours]

[Answer all questions, each question carries twelve marks]

- Q1. a) Explain the three variances related to earn value analysis. [3.0 Marks]
- b) List two ways of how can earn value analysis be used as an early warning indicator for a project. [2.0 Marks]
- c) Explain how the earn value analysis works best when the project is broken down into an organized work breakdown structure. [2.0 Marks]
- d) Assume that you are the contractor of a small project to install lighting fixtures in a 200 room hotel. You have to install 5 lighting fixtures in each room. Your project's approved budget is \$500,000 and the approved schedule is 14 weeks. After 8 weeks, you have 110 of the rooms completed and you have spent \$250,000. Determine the following.
- i. Budget at Completion
 - ii. Planned Value
 - iii. Earned Value
 - iv. Actual Cost
 - v. Cost Variance
 - vi. Cost Performance Index
 - vii. Schedule Variance
 - viii. Estimate at Completion
- [5.0 Marks]
- Q2. a) Clients often ask for projects to be speeded up. List three reasonable ways of reducing the duration of a project. [1.5 Marks]
- b) Graphically illustrate the variation of total project cost with the project duration showing the impacts of crashing and, extending the project duration. Indicate when the project duration is optimum. [2.0 Marks]
- c) Figure Q2-1 shows the activity network diagram for a small project. Determine the normal project duration and the critical path of this network diagram using Activity on Arrow method by using information in Table Q2-1. [1.5 Marks]
- d) Table Q2-1 shows the planned time (days) and cost (\$) for different activities in the network given in Figure Q2-1, with possible crashing information. Find the

lowest cost to complete the project in 10 days. Show all the steps necessary to justify your answer.

[4.0 Marks]

- e) What is meant by "fast tracking" of a project? List one advantage and one disadvantage associated with fast tracking?

[3.0 Marks]

- Q3. a) Briefly explain why a "growing surplus" is not always best for a young company.

[2.0 Marks]

- b) What is the difference between two terms "cash flow" and "profit" for a construction project?

[2.0 Marks]

- c) Consider following cash information for a construction project with the project duration of 12 months. Draw the corresponding cash flow diagram. You may name only the transaction and, values are not required.

Contractor has taken a bank loan at the beginning of June 2018 and he started the construction at the beginning of July 2018. Contractor received an advance payment from the client at the beginning of July 2018. At the end of every month after starting the construction, contractor is receiving payments from the client and at the same time contractor should pay for wages, interest on bank loan, pay for subcontractors and material supplies.

[2.0 Marks]

- d) Table Q3-1 comprises the expected payments and receipts for a contractor of a small project. Prepare a cash flow forecast considering the following factors. You may use the Data Sheet provided in Page 07 when answering and attach it with your answer booklet.

- Contractor is responsible for paying wages weekly.
- Material suppliers will be paid at the end of each month. But contractor has to keep Rs. 50,000.00 deposit to the material supplier at the beginning of the construction and the deposit will be re-funded at the end of the last month of the construction.
- Client will pay to the contractor at the end of the month keeping 5% retention.
- Sub-contractors will be paid with one-month delay keeping 5% retention.
- Half retention will be released to both contractor and sub-contractors after two months of the last payment and second half of the retention will be released at the end of the year.
- Contractor is expecting to receive a payment of Rs. 100,000.00 at the end of April from another project and he wishes to use it in this project.

[6.0 Marks]

- Q4. a) Explain two strategies used in the "Line of Balance method" to balance the rate of progress of operations and schedule them to eliminate interference.

[3.0 Marks]

- b) Briefly explain how the "Line of Balance" method differs from the traditional bar chart method of scheduling.

[2.0 Marks]

- c) A construction company has been awarded a contract to erect 20 basic factory units on a large industrial estate. Each factory unit is identical in size and design. The sequential operation involved in the construction of each factory together with the estimated man-hours and optimum number of men necessary for each operation are given in table Q4. You may use information provided in Table Q4-2.

The client requires that the target rate of building should be 2 units per week and that the overall contract period must not exceed 25 weeks.

- i. Prepare a LOB schedule for the contract assuming an 8-hour day, 5-day week and the minimum buffer time of 5 days.
- ii. What could be the overall delay incurred by the contract if, without notice, a national building trade strike takes place during the five weeks following 15th week of the contract program?
- iii. Find the new rate of building required by the contractor to ensure that even with a five-week delay, the contract is completed without exceeding the given time frame.

[7.0 Marks]

- Q5. a) "Awarding a civil engineering contract to a contractor is a legal binding between the client and the contractor". Explain this statement in relation to the fundamental elements of contract.

[3.0 Marks]

- b) Briefly explain the followings in relation with the ICTAD/CIDA SBD conditions of contracts.

- i. Bid Security
- ii. The role of "the Engineer"

[3.0 Marks]

- c) State whether each statement is "True" or "False" in relation with ICTAD/CIDA standard bidding document.

- i. Each bidder can submit more than one bid if he/she wishes to do so.
- ii. It is the employer's responsibility to show the bidder the site and surrounding during bid preparation.
- iii. Before the deadline for submission of bids, the employer may modify the bidding documents by issuing an addenda.
- iv. Once submitted, bidders cannot modify or withdraw their bids even before the deadline for submission of bids.
- v. The bidder shall submit only the "ORIGINAL" document set when submitting the bid.
- vi. No bid shall be rejected at bid opening except late bids.

[3.0 Marks]

- d) Why is it important for the employer to examine whether a bid is substantially responsive to the requirements of the bidding documents?

[1.5Marks]

- e) Explain the statement "Officials shall refrain from any personal gain from any procurement action" mentioned under the instructions to bidders.

[1.5Marks]

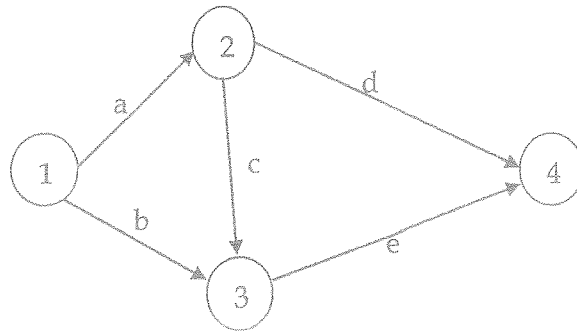


Figure Q2-1 Network Diagram of a Project

Table Q2-1 Details of Time and Cost for Normal and Crash Situations

Activity	Time in (Days)		Cost in (\$.)		Partial Crashing?
	Normal	Crash	Normal	Crash	
a	3	3	60	60	No
b	7	6	30	80	Yes
c	5	2	50	90	No
d	6	5	30	50	No
e	4	2	40	100	Yes

Note: Table Q3-1 can be found in Page 6 of 7.

Table Q4-1 Project Operation Details

Operation	Man hours per operation	Optimum gang size
Foundation for ground floor slab	320	4
Structural steel frame	96	4
Cladding	160	5
Internal finishes	72	3
External works	96	4

Table Q4-2 Supporting Details to Develop a LOB Diagram

C1	Activity Description
C2	The estimated man-hours for each activity (M)
C3	Theoretical number of men required to maintain the output (G) $= \frac{\text{rate of production} \times \text{man hours per activity}}{\text{No of working hours per week}}$
C4	The optimum gang size decided by experience and historical data (Q)
C5	Actual number of men (g) This is chosen as a number which is a multiple of the optimum gang size nearest to the theoretical number of men (G) If $g > G$ rate of output is more than the target rate If $g < G$ rate of output is less than the target rate
C6	The actual rate of output (u) $= \frac{\text{Actual no of men} \times \text{target rate}}{\text{Theoretical no of men}}$
C7	Time taken for one activity in days $= \frac{\text{Man hours per activity}}{(\text{number of men in one team} \times \text{No of hours in a working day})}$
C8	The time in days from start of the first item to the start of the last item $= \frac{(\text{No of items} - 1) \times \text{No of working days/week}}{(\text{Actual rate of build})}$

Table Q3-1: Contractor's Payments and Receipts

Month	Week No	Wages, plant hire and Overheads	Materials delivered	Sub Contractors accounts received	Total prime cost and overheads	QS valuation
January	1	3,000	5,500			
	2	3,500	5,000			
	3	3,000	4,000			
	4	2,500	4,000			
	5	2,500	4,000		37,000	35,000
February	6	3,000	3,000			
	7	3,000	5,000			
	8	2,000	6,000			
	9	3,000	6,000	15,000	83,000	85,000
March	10	5,000	8,000			
	11	5,000	2,500			
	12	7,500	18,000			
	13	4,000	10,000	25,000	168,000	165,000
April	14	3,500	8,000			
	15	3,500	10,000			
	16	4,000	10,000			
	17	5,000	7,000	10,000	229,000	230,000
May	18	4,000	10,000			
	19	3,500	15,000			
	20	3,500	8,000			
	21	2,500	10,000			
		3,000	5,000	12,500	306,000	310,000

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Data Sheet to Prepare Contractor's Cash Flow

Month	Week No	Wages, plant hire and Overheads	Materials	Sub-Contractors	Total	Accounts received	Cumulative cash flow
January	1						
	2						
	3						
	4						
	5						
February	6						
	7						
	8						
	9						
March	10						
	11						
	12						
	13						
April	14						
	15						
	16						
	17						
May	18						
	19						
	20						
	21						
	22						
June							
July							
August							
December							

Note: Detach this page and attach it to your answer script.