

EGT3/EGT2
ENGINEERING TRIPOS PART IIB
ENGINEERING TRIPOS PART IIA

Wednesday 3 May 2023 14.00 to 15.40

Module 4D16

CONSTRUCTION MANAGEMENT

*Answer not more than **three** questions.*

All questions carry the same number of marks.

*The **approximate** percentage of marks allocated to each part of a question is indicated in the right margin.*

*Write your candidate number **not** your name on the cover sheet.*

STATIONERY REQUIREMENTS

Single-sided script paper

SPECIAL REQUIREMENTS TO BE SUPPLIED FOR THIS EXAM

CUED approved calculator allowed

Engineering Data Book

10 minutes reading time is allowed for this paper at the start of the exam.

You may not start to read the questions printed on the subsequent pages of this question paper until instructed to do so.

You may not remove any stationery from the Examination Room.

1 (a) Please answer the following questions:

(i) What is the difference between free float and lag? [10%]

(ii) Is it possible for the total float of an activity A to be less than its lag to a successor activity B with an FS relationship if A is also succeeded by another activity C with a FF/delay relationship? If yes, when? [10%]

(b) Use the project activities information provided in the table below to:

(i) Draw their Activity-on-Arrow (A-on-A) diagram. Perform forward pass calculations to determine for each activity the early start time and early finish time. [20%]

(ii) Perform backward pass calculations to determine for each activity the total float and free float. Indicate which activities belong to the critical path. [30%]

Activity #	Durations (days)	Predecessor Activities: Relationships	Resource Demands (Common Labourers)
A	10	-	4
B	20	A:SF	1
C	7	A:SF/6	3
D	1	-	3
E	6	C:FS	1
F	3	D:SF/4	1
G	5	C:FS, E:FF/2	2
H	2	D:FS, F:SS/-4	2
I	4	F:FS, H:FS	4
J	1	G:FS, B:FS, I:FS/3	5

(c) You have seven available labourers. Perform resource allocation for the above project using the rules presented in class. What is the revised total project duration? How many extra labourers are needed to finish the project in less than 22 days? [30%]

2 (a) (i) Define job overhead and company overhead. [10%]

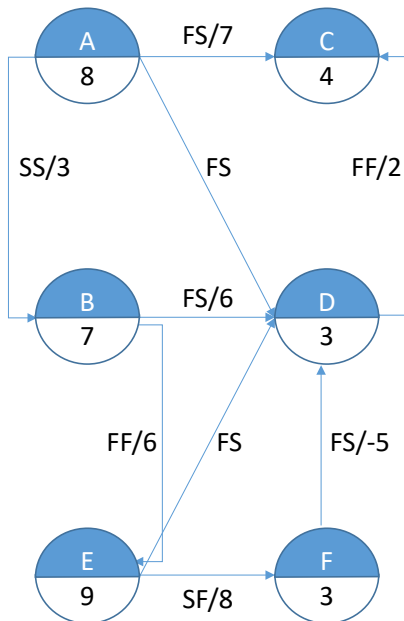
(ii) Will decreasing a project's duration increase or decrease total cost, and why? [5%]

(b) The cost and schedule data for a small project are given below. Perform a time-cost trade-off analysis to determine the following. Assume an indirect cost of £275/day. Stop crashing activities when the cumulative cost starts increasing.

(i) What is the project's total duration, direct and indirect cost without crashing any activities? [25%]

(ii) Determine the minimum overall cost of the project and its associated duration. [60%]

Hint: Calculate for the project the cumulative total cost for every cycle of crashing.



Activities	Cost		Duration (days)	
	Crash	Normal	Crash	Normal
A	£4,000	£1,600	2	8
B	£2,600	£2,100	5	7
C	£5,000	£4,000	1	4
D	£3,800	£3,500	2	3
E	£1,500	£1,000	3	9
F	£900	£800	2	3

- 3 (a) Define risk, issue, and uncertainty in a construction management context. [15%]
- (b) What are the main steps in a risk management process? Provide a short explanation for each step, using a diagram to illustrate where appropriate. [30%]
- (c) Sketch a diagram showing how risk and the impacts of risk vary over the different stages of a project lifecycle. [20%]
- (d) Crossrail significantly exceeded the original project budget. State one lesson learnt for each of the following aspects of the project: design, management and procurement. [15%]
- (e) Due to sub-optimal tunnelling operations during the Crossrail project, ground settlements in parts of London were measured to be significantly higher than original estimates, to the point of possibly exceeding design thresholds.
- (i) Describe a corresponding risk event using the cause-risk-effect format. [10%]
- (ii) Describe a suitable risk assessment process and develop an appropriate risk assessment for part (e)(i) above for three relevant hazards. [10%]

- 4 (a) List three factors that influence a client when choosing a procurement route. For each factor, give one question that the client should consider. [5%]
- (b) (i) Describe the main features of the Traditional procurement route using a diagram to show the relationships between the key parties. [15%]
- (ii) What are the advantages and disadvantages of choosing the cost reimbursable route from a client's and a contractor's point of view? [10%]
- (c) (i) What is the purpose of a pre-tender estimate? Describe the two main pre-tender estimation methods and state the relative advantages and disadvantages of both methods. [10%]
- (ii) How is time considered in pre-tender cost estimates? [10%]
- (d) A contractor has developed a cashflow forecast for two different design options shown in the table below. As part of the budgeted costs, the estimated steel requirements for both design options are also shown in the table.
- (i) Calculate the net present value of both design options and provide a recommendation for the design option that represents the best value for money for the contractor. Assume a discount rate of 10%. [20%]
- (ii) To calculate the steel costs, a price index of 250 was adopted for year 1 with an assumed average inflation rate of 5% per year. However, the new forecasts for inflation are rates of 12.5%, 20%, 25% and 25% in years 2 to 5 respectively. Calculate the new net present values using the same discount factor and hence provide an updated recommendation. [30%]

Year	Cash Flow (£ million)		Steel costs (£ million)	
	Design A	Design B	Design A	Design B
1	0.97	0.30	0.50	0.75
2	0.75	0.50	2.50	3.25
3	0.80	0.75	3.75	3.50
4	0.85	1.00	4.00	2.25
5	0.40	1.50	1.25	0.20

- 5 (a) (i) Explain the cash and accrual methods for accounting. What are the main advantages and disadvantages of each? Which method would you recommend for a start-up construction company? [15%]
- (ii) For long-term contracts, how do the percentage of completion and completed contract methods influence the tax payment process? State possible advantages of both approaches from a contractor's point of view. [15%]
- (b) (i) State three checks a construction company should undertake to assess a prospective client's financial health? What are the implications, if any, if the potential client is a subsidiary of a larger company or a public agency? [15%]
- (ii) What bodies can provide useful additional information during the financial checking process? [5%]
- (c) You have been asked to provide a recommendation on the financial health of a public limited company for an upcoming large-scale construction project. For the year 2021, the company's turnover was £1.13 billion and their profit before tax was £3,619,031. The balance sheet is provided on the next page.
- (i) Using four of the most appropriate financial ratios, comment on the financial health of the company and thus provide a recommendation on whether to proceed with the project. [40%]
- (ii) The company intends to expand by opening a new office location in a new country at an estimated cost of £1 million. The company management are concerned by the implications of expected increases in both tax rates and lending rates. Provide a recommendation, and sufficient justification, on how the company should finance the expansion. [10%]

(cont.

COMPANY BALANCE SHEET		
	2021 (£)	2020 (£)
FIXED ASSETS		
Intangible assets	16,083,987	15,045,842
Property, plant, and equipment	31,622,895	39,523,924
Investments	31,181,029	44,609,014
	<u>78,887,911</u>	<u>99,178,780</u>
CURRENT ASSETS		
Inventories	174,022	512,449
Trade and other receivables	280,469,437	264,523,089
Cash and cash equivalents	60,605,775	69,681,302
	<u>341,249,234</u>	<u>334,716,840</u>
CREDITORS: amounts falling due within one year	<u>-237,927,736</u>	<u>-258,889,784</u>
NET CURRENT ASSETS	<u>103,321,498</u>	<u>75,827,056</u>
TOTAL ASSETS LESS CURRENT LIABILITIES		
Creditors: amounts falling due after more than one year	-69,999,111	-71,831,161
Provisions for liabilities	-6,200,000	-
NET ASSETS	<u>106,010,298</u>	<u>103,174,675</u>
CAPITAL AND RESERVES		
Called up share capital	9,392,858	9,392,858
Share premium account	76,500,000	76,500,000
Hedging reserve	25,396	-6,249
Retained earnings	20,092,044	17,288,066
TOTAL SHAREHOLDERS' FUNDS	<u>106,010,298</u>	<u>103,174,675</u>

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