EGT3/EGT2
ENGINEERING TRIPOS PART IIB
ENGINEERING TRIPOS PART IIA

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Friday 26 April 2019   14.00 to 15.40

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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.

1   Figure 1 depicts the main components of a steel gantry which is to be erected on a hillside, and Fig. 2 shows a precedence network diagram for the project.

(a)   Undertake a time analysis of the network to determine earliest and latest dates for each activity, the overall project duration, and the critical path.   [25%]

(b)   The first attempt at a diagram rarely achieves the most effective programme, and it is often necessary to re-define and re-arrange activities to achieve an optimal network. Modify the network in Fig. 2 to reduce the overall project duration, and amend the time analysis.   [25%]

Hint: Consider whether some activities contain elements of work which are not logically linked.

(c)   (i)   Based on the revised network, and using earliest dates, calculate the daily requirements for each of the three resources employed on the project (Engineers, Machine Operators, and Labourers).   [25%]

(ii)   Your firm is currently very busy, and the availability of labour is restricted. Undertake a resource allocation analysis based on using no more than 2 labourers on any day. What is the effect on the overall project duration? Explain the contribution of float to this result.   [25%]
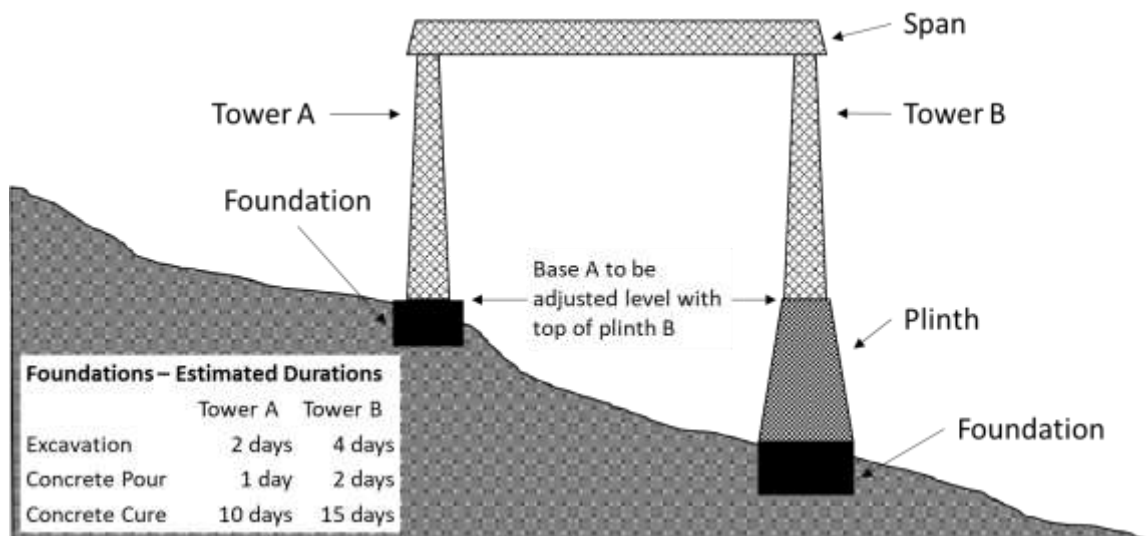

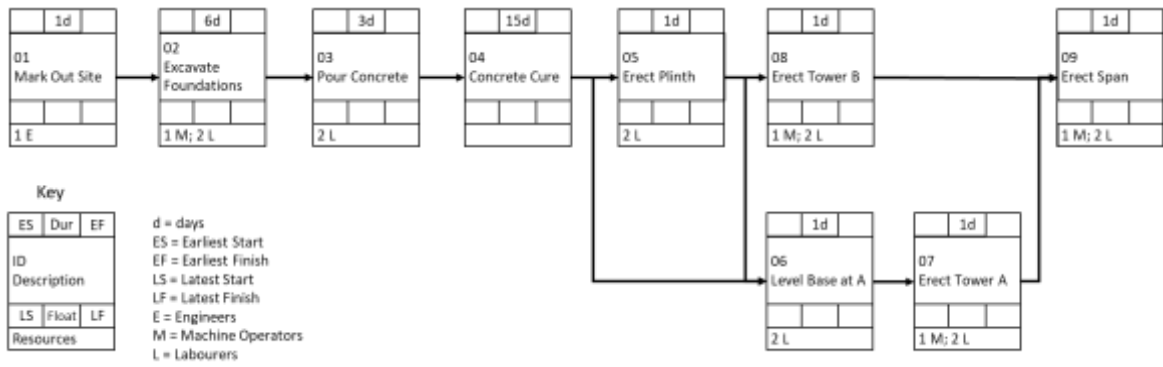Foundations – Estimated Durations

	Tower A	Tower B
Excavation	2 days	4 days
Concrete Pour	1 day	2 days
Concrete Cure	10 days	15 days

Fig. 1

(cont.

Fig. 2

(TURN OVER

2   (a)   The Construction Design and Management (CDM) Regulations 2015 are the most significant Statutory Instrument relating specifically to health and safety in the construction industry in the UK.

    (i)   Under what enabling legislation are the regulations enacted?   [5%]

    (ii)   What is the main aim of the CDM regulations 2015, and what types of work are defined as "construction"?   [25%]

(b)   Your firm has been appointed to advise an inexperienced commercial client planning to construct a new headquarters building. You have been asked for your advice on the duties of the client under the CDM regulations.

    (i)   What would you describe as the principal duties of the Client?   [25%]

    (ii)   The client representative is confused about the nature and content of the Health and Safety File, the Pre-Construction Information, and the Construction Phase Plan. Explain the purpose of each of these documents, with a brief description of their contents and the identity of the duty holder with primary responsibility for producing them.   [35%]

    (iii)   In what circumstances would the Client be responsible for all three documents?   [10%]

3   (a)   What are the main types of business found in the construction industry, and what are their principal distinguishing features? Give examples of the industry participants most likely to be operating under each business type.   [40%]

(b)   A Public Limited Company (PLC) is seeking investment funding. Describe the main sources of finance available to the business and compare their relative benefits and drawbacks.   [40%]

(c)   Your firm has been invited to tender for a large contract for the subsidiary of a large multi-national organisation. What financial checks would you recommend, and what safeguards might be necessary if you decide to proceed?   [20%]

4   You have recently taken over a project the precedence network diagram for which is depicted in Fig. 3. The project has been underway for 12 weeks (assume 5 days per week). The previous construction manager departed at short notice, and it was not possible to arrange a handover. Your Project Director has asked for your evaluation of the current cost and programme status of the project, and your plans to ensure that the project is delivered on time.

(a)   Table 1 summarises the project plan, and the status at the end of week 12. Undertake an earned value analysis of the project, calculating the following:

(i)   Budgeted Cost of Work Scheduled (BCWS) and Budgeted Cost of Work Performed (BCWP) for each activity.   [20%]

(ii)   Cost Variance (CV) and Schedule Variance (SV) for each activity (CV = BCWP - ACWP; SV = BCWP - BCWS).   [15%]

(iii)   Cost Variance, Schedule Variance, Cost Performance Index (CPI) and Schedule Performance Index (SPI) for the whole project (CPI = BCWP / ACWP; SPI = BCWP / BCWS).   .   [15%]

(b)   Based on the analyses above, what do you estimate to be the earliest completion date (in weeks from the start) and the total cost of the project?   [10%]

(c)   How would you propose to recover the programme at the minimum additional cost?   [20%]

(d)   The client has received a copy of your report and has used the CPI and SPI to extrapolate the current status to arrive at a projected total cost of more than £4.7 million, and overall project duration of 192 days. Explain why this is not an appropriate use of the CPI and SPI.   [20%]
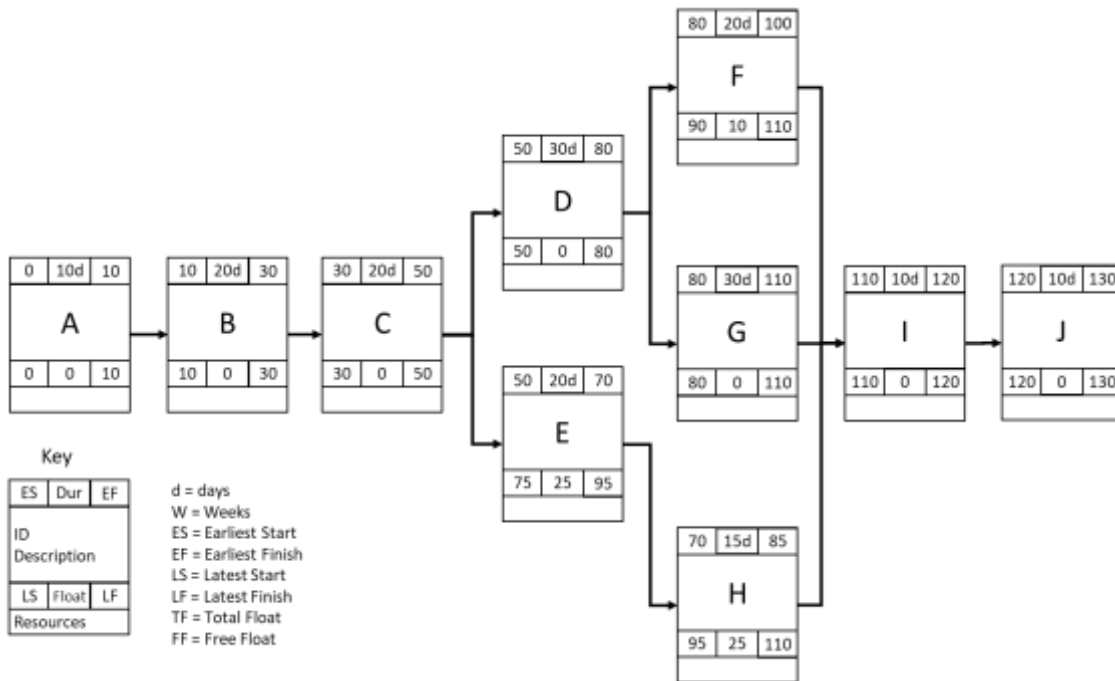
Fig. 3

Table 1

Activities	ES	EF	LS	LF	TF (d)	FF (d)	Normal Duration (days)	Min Duration (days)	Budget Cost	Crash Cost	Planned Progress (end W12)	ACWP (end W12)	Actual Progress (end W12)
A	0	10	0	10	0	0	10	10	£200,000		100%	£250,000	100%
B	10	30	10	30	0	0	20	15	£400,000	£500,000	100%	£500,000	100%
C	30	50	30	50	0	0	20	20	£400,000		100%	£400,000	75%
D	50	80	50	80	0	0	30	20	£600,000	£750,000	33%		0%
E	50	70	75	95	25	0	20	20	£400,000		50%		0%
F	80	100	90	110	10	10	20	15	£400,000	£550,000	0%		0%
G	80	110	80	110	0	0	30	20	£600,000	£750,000	0%		0%
H	70	85	95	110	25	25	15	10	£300,000	£350,000	0%		0%
I	110	120	110	120	0	0	10	10	£200,000		0%		0%
J	120	130	120	130	0	0	10	10	£200,000		0%		0%
Total									£3,700,000			£1,150,000	

Note: Budget cost refers to the cost to complete the activity if it is completed with the normal duration. Crash cost refers to the cost required to complete with the minimum duration. ACWP is Actual Cost of Work Performed.

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5 (a) It has been reported (e.g. CIOB, 2016) that productivity improvement in the construction industry consistently lags that of manufacturing and other parts of the economy. What features of the industry might constrain productivity improvement? [25%]

(b) You have been asked to investigate productivity on one of your firm's construction sites. What methods would you consider, and what are the main benefits and drawbacks of each? What approach would you recommend to obtain a measure of productivity and the underlying issues affecting it? [35%]

(c) Table 2 below summarises the results of a sampling exercise on a single task being undertaken by 3 operatives.

(i) Calculate the overall Labour Utilisation Factor and discuss the significance and validity of the result. [25%]

(ii) What would be the minimum number of observations required to achieve a 95% confidence level and +/- 5% limit of error? [5%]

(iii) What is the meaning of a 95% confidence level and +/- 5% limit of error? [10%]

Table 2

Observation	Operative 1	Operative 2	Operative 3
1	E	E	C
2	C	C	E
3	I	I	E
4	E	E	C
5	E	C	C
6	C	E	I
7	I	E	I
8	C	I	E
9	E	E	E
10	I	I	E

Key
E = Effective
C = Contributory
I = Ineffective

END OF PAPER

Numerical Answers

Question 1

(a) Project duration 29 days; critical path 01,02,03,04,05,06,07,09

(b) Revised duration 26 days

Question 4

(a) (iii) CV -£250,000; SV -£500,000; CPI 0.783; SPI 0.643

Acceptable alternative answers: SV -£498,000; SPI 0.644

(b) Earliest completion 29 weeks; Total cost £3,983,000

Question 5

(c) (i) 53.3%

(c) (ii) 384