4.4 Decision Maths: Critical Path Analysis and Linear Programming: 30-minute Pack

EDEXCEL 9FM0 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A project consists of activities A, B, C, D, E, F, G, H. Each activity is listed with its duration in days and the activities that must be completed before it can start: A (duration 5, after none); B (duration 7, after A); C (duration 2, after B); D (duration 5, after A); E (duration 5, after B); F (duration 6, after E); G (duration 8, after B); H (duration 9, after B).

(a) Carry out a forward pass to find the earliest start time of each activity, and state the minimum completion time of the project. **(3)**

(b) Carry out a backward pass and hence find the critical activities. **(3)**

(c) Find the total float of activity C. **(2)**

(d) Find a lower bound for the number of workers needed to complete the project in the minimum time, if each activity needs one worker. **(2)**

(Total for Question 1 is 10 marks)

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2 A farmer plants x hectares of wheat and y hectares of barley. The constraints are $4x + 3y \leq 81$, $2x + 2y \leq 46$, $x \geq 0$ and $y \geq 0$. The profit, in hundreds of pounds, is $P = 3x + 4y$, and the profit is to be maximised.

(a) Draw the feasible region and find the coordinates of each of its vertices. **(3)**

(b) Evaluate P at each vertex and hence find the maximum profit and the values of x and y which give it. **(3)**

(Total for Question 2 is 6 marks)

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3 Newbridge Ltd is planning a small refurbishment project. The table below shows the activities involved. Time is measured in days from the start of the project (Day 0).

Activity	Task	Duration (days)	Immediate predecessors
P	Remove the old flooring	5	-
Q	Deliver the new floor tiles	3	-
R	Install the underfloor heating	6	P
S	Lay the new floor tiles	4	P, Q
T	Fit the skirting boards	2	R, S

(a) Carry out a forward pass and a backward pass on the network. Present your results as a table showing the EST, EFT, LST and LFT of each activity. **(6)**

(b) A project manager claims that the critical path is P - S - T, with a completion time of 11 days. By referring to your results in part (a), verify whether this claim is correct, explaining your reasoning. **(3)**

(Total for Question 3 is 9 marks)

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Mark scheme · 4.4 Decision Maths: Critical Path Analysis and Linear Programming: 30-minute Pack

Question 1

(a) earliest start = latest earliest finish of the immediate predecessors	**M1**
(a) earliest starts: A 0, B 5, C 12, D 5, E 12, F 17, G 12, H 12	**A1**
(a) minimum completion time = 23 days	**A1**
(a) Answer: 23 days	
(b) latest finish = smallest latest start of the successors	**M1**
(b) latest finishes: A 5, B 12, C 23, D 23, E 17, F 23, G 23, H 23	**A1**
(b) critical activities (zero float): A, B, E, F	**A1**
(b) Answer: A, B, E, F	
(c) total float = latest finish - earliest start - duration	**M1**
(c) 23 - 12 - 2 = 9 days	**A1**
(c) Answer: 9 days	
(d) total duration of all activities = 47	**M1**
(d) 47/23 = 2.04, so at least 3 workers	**A1**
(d) Answer: 3	

Question 2

(a) plots both constraint lines and shades the unwanted region	**M1**
(a) finds the intercepts with the axes and the intersection of the two lines	**M1**
(a) vertices: (0, 0), (0, 23), (12, 11), (81/4, 0)	**A1**
(a) Answer: (0, 0), (0, 23), (12, 11), (81/4, 0)	
(b) evaluates P at each vertex	**M1**
(b) values: 0, 92, 80, 243/4	**A1**
(b) maximum P = 92 at (0, 23)	**A1**
(b) Answer: P = 92 at (0, 23)	

Question 3

(a) correct forward-pass method at each merge activity (S takes max of EFT(P), EFT(Q); T takes max of EFT(R), EFT(S))	**M1**
(a) EST/EFT all correct: P(0,5), Q(0,3), R(5,11), S(5,9), T(11,13)	**A1**
(a) correct backward-pass method at the branch activity (P takes min of LST(R), LST(S))	**M1**
(a) LST/LFT all correct: T(11,13), R(5,11), S(7,11), Q(4,7), P(0,5)	**A1**
(a) project duration = 13 days stated or implied	**B1**
(a) fully correct, internally consistent table for all five activities (allow follow-through from one earlier slip)	**B1**
(a) Answer: P: EST0 EFT5 LST0 LFT5 (float 0). Q: EST0 EFT3 LST4 LFT7 (float 4). R: EST5 EFT11 LST5 LFT11 (float 0). S: EST5 EFT9 LST7 LFT11 (float 2). T: EST11 EFT13 LST11 LFT13 (float 0). Project duration = 13 days.	
(b) length of path P-S-T = 5 + 4 + 2 = 11 days (or note that S has a total float of 2, so S is not a critical activity)	**M1**
(b) state that the true project duration is 13 days (from part (a)), not 11, so the manager's claim is incorrect	**A1**
(b) correctly identify the true critical path as P - R - T, explaining that S has positive float (2 days) and so is not critical, whereas the manager's path omits the genuinely critical activity R (oe)	**B1**
(b) Answer: The claim is incorrect. The true critical path is P - R - T, length 13 days; S has total float 2 days, so P-S-T (length 11 days) is not the critical path.	

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