4.6 Decision: Linear Programming and Critical Path Depth: 30-minute Pack

EDEXCEL 9FM0 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A bakery makes x batches of rolls and y batches of loaves each day. The constraints are $4x + y \leq 47$, $x + 3y \leq 31$, $x \geq 0$ and $y \geq 0$. The profit, in hundreds of pounds, is $P = 6x + 6y$, 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 1 is 6 marks)

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2 A bakery makes x batches of rolls and y batches of loaves each day. The constraints are $x + y \leq 15$, $3x + 4y \leq 57$, $x \geq 0$ and $y \geq 0$. The profit, in hundreds of pounds, is $P = 5x + 4y$, 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 A project consists of activities A, B, C, D, E, F, G, H, I. 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 6, after A); C (duration 5, after A); D (duration 5, after A); E (duration 2, after D); F (duration 7, after D); G (duration 7, after B); H (duration 6, after G); I (duration 5, 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 3 is 10 marks)

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4 A farmer plants x hectares of wheat and y hectares of barley. The constraints are $4x + 2y \leq 38$, $x + y \leq 13$, $x \geq 0$ and $y \geq 0$. The profit, in hundreds of pounds, is $P = x + 2y$, 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 4 is 6 marks)

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Mark scheme · 4.6 Decision: Linear Programming and Critical Path Depth: 30-minute Pack

Question 1

(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, 31/3), (10, 7), (47/4, 0) **A1**

(a) Answer: (0, 0), (0, 31/3), (10, 7), (47/4, 0)

(b) evaluates P at each vertex **M1**

(b) values: 0, 62, 102, 141/2 **A1**

(b) maximum P = 102 at (10, 7) **A1**

(b) Answer: P = 102 at (10, 7)

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, 57/4), (3, 12), (15, 0) **A1**

(a) Answer: (0, 0), (0, 57/4), (3, 12), (15, 0)

(b) evaluates P at each vertex **M1**

(b) values: 0, 57, 63, 75 **A1**

(b) maximum P = 75 at (15, 0) **A1**

(b) Answer: P = 75 at (15, 0)

Question 3

(a) earliest start = latest earliest finish of the immediate predecessors **M1**

(a) earliest starts: A 0, B 5, C 5, D 5, E 10, F 10, G 11, H 18, I 11 **A1**

(a) minimum completion time = 24 days **A1**

(a) Answer: 24 days

(b) latest finish = smallest latest start of the successors **M1**

(b) latest finishes: A 5, B 11, C 24, D 17, E 24, F 24, G 18, H 24, I 24 **A1**

(b) critical activities (zero float): A, B, G, H **A1**

(b) Answer: A, B, G, H

(c) total float = latest finish - earliest start - duration **M1**

(c) 24 - 5 - 5 = 14 days **A1**

(c) Answer: 14 days

(d) total duration of all activities = 48 **M1**

(d) 48/24 = 2.00, so at least 2 workers **A1**

(d) Answer: 2

Question 4

(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, 13), (6, 7), (19/2, 0) **A1**

(a) Answer: (0, 0), (0, 13), (6, 7), (19/2, 0)

(b) evaluates P at each vertex **M1**

(b) values: 0, 26, 20, 19/2 **A1**

(b) maximum P = 26 at (0, 13) **A1**

(b) Answer: P = 26 at (0, 13)

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