

GCE

Mathematics (MEI)

Unit **4773**: Decision Mathematics Computation

Advanced GCE

Mark Scheme for June 2017

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All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

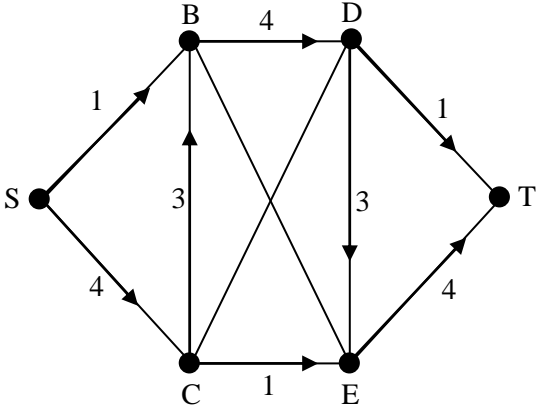
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

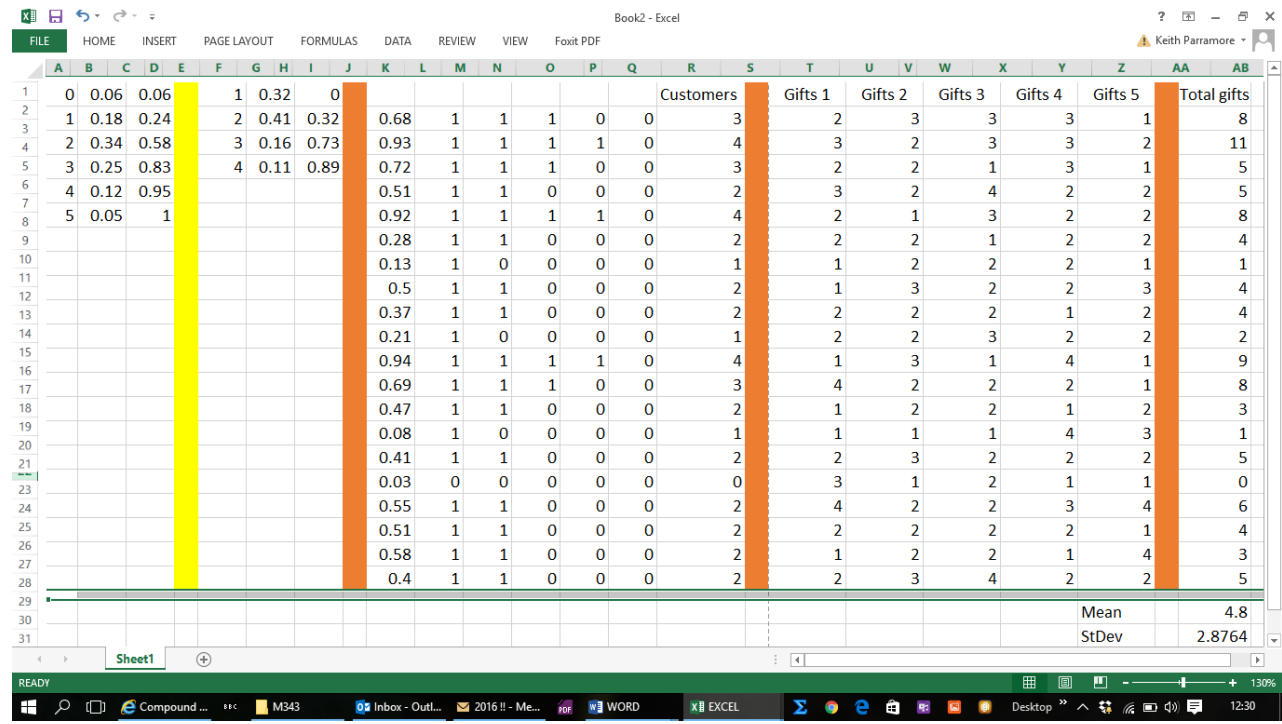
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Question		Answer	Marks	Guidance																																										
1	(i)	<p>There are 2 ways of finishing a path of length $30(n+2)$.</p> <p>Either one “perpendicular” slab added to a path of length $30(n+1)$, or two “parallel” slabs added to a path of length $30n$.</p> <p>So need to add number of ways to make a path of length $30(n+1)$, to the number of ways of making a path of length $30n$.</p>	<p>M1</p> <p>A1</p> <p>A1</p> <p>A1</p>	multiplier of 30 not needed in description																																										
	(ii)	<table style="margin-left: auto; margin-right: auto;"> <tr> <td>n</td> <td>un</td> </tr> <tr> <td>1</td> <td>1</td> </tr> <tr> <td>2</td> <td>2</td> </tr> <tr> <td>3</td> <td>3</td> </tr> <tr> <td>4</td> <td>5</td> </tr> <tr> <td>5</td> <td>8</td> </tr> <tr> <td>6</td> <td>13</td> </tr> <tr> <td>7</td> <td>21</td> </tr> <tr> <td>8</td> <td>34</td> </tr> <tr> <td>9</td> <td>55</td> </tr> <tr> <td>10</td> <td>89</td> </tr> <tr> <td>11</td> <td>144</td> </tr> <tr> <td>12</td> <td>233</td> </tr> <tr> <td>13</td> <td>377</td> </tr> <tr> <td>14</td> <td>610</td> </tr> <tr> <td>15</td> <td>987</td> </tr> <tr> <td>16</td> <td>1597</td> </tr> <tr> <td>17</td> <td>2584</td> </tr> <tr> <td>18</td> <td>4181</td> </tr> <tr> <td>19</td> <td>6765</td> </tr> <tr> <td>20</td> <td>10946</td> </tr> </table>	n	un	1	1	2	2	3	3	4	5	5	8	6	13	7	21	8	34	9	55	10	89	11	144	12	233	13	377	14	610	15	987	16	1597	17	2584	18	4181	19	6765	20	10946	<p>M1</p> <p>A1</p>	<p>relationship correct</p> <p>twenty</p>
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(iii)	<p>Assume that there is a solution of the form $u_n = \lambda^n$</p> <p>Then $\lambda^{n+2} = \lambda^{n+1} + \lambda^n$</p> <p>giving $\lambda^2 - \lambda - 1 = 0$</p>	B1 B1 B1																																																																			
(iv)	<p>$\lambda = \frac{1+\sqrt{5}}{2}$ or $\lambda = \frac{1-\sqrt{5}}{2}$</p> <p>Form a linear combination of the assumed solutions, i.e. $u_n = A\left(\frac{1+\sqrt{5}}{2}\right)^n + B\left(\frac{1-\sqrt{5}}{2}\right)^n$</p> <p>Then use instances of n to determine A and B.</p>	B1 B1 B1																																																																			
(v)	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>n</th> <th>un</th> <th>formula</th> <th>n</th> <th>un</th> <th>formula</th> </tr> </thead> <tbody> <tr><td>1</td><td>1</td><td>1</td><td>11</td><td>144</td><td>144</td></tr> <tr><td>2</td><td>2</td><td>2</td><td>12</td><td>233</td><td>233</td></tr> <tr><td>3</td><td>3</td><td>3</td><td>13</td><td>377</td><td>377</td></tr> <tr><td>4</td><td>5</td><td>5</td><td>14</td><td>610</td><td>610</td></tr> <tr><td>5</td><td>8</td><td>8</td><td>15</td><td>987</td><td>987</td></tr> <tr><td>6</td><td>13</td><td>13</td><td>16</td><td>1597</td><td>1597</td></tr> <tr><td>7</td><td>21</td><td>21</td><td>17</td><td>2584</td><td>2584</td></tr> <tr><td>8</td><td>34</td><td>34</td><td>18</td><td>4181</td><td>4181</td></tr> <tr><td>9</td><td>55</td><td>55</td><td>19</td><td>6765</td><td>6765</td></tr> <tr><td>10</td><td>89</td><td>89</td><td>20</td><td>10946</td><td>10946</td></tr> </tbody> </table>	n	un	formula	n	un	formula	1	1	1	11	144	144	2	2	2	12	233	233	3	3	3	13	377	377	4	5	5	14	610	610	5	8	8	15	987	987	6	13	13	16	1597	1597	7	21	21	17	2584	2584	8	34	34	18	4181	4181	9	55	55	19	6765	6765	10	89	89	20	10946	10946	B1	
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(vii)	1, 1 and 2	B1																																																																			
(viii)	<p>The recurrence relation is $u_{n+3} = u_{n+2} + u_n$</p> <p>This will need programming in Excel and dragging down to $n = 50$.</p> <p>Gives 122 106 097</p>	B1 B1 B1																																																																			

	<p>(ii) Objective value 5</p> <p>Variable SB SC BC CB BD DB BE EB CD DC CE EC DE ED DT ET</p> <p>Value 1 4 0 3 4 0 1 1 1 1 1 0 3 0 1 4</p> <p>Max flow is 5</p> <p>Flows as indicated, but note that there is no net flow in either BE/EB or CD/DC.</p> 	<p>M1</p> <p>A1</p> <p>B1</p> <p>M1</p> <p>A1</p>	<p>running LP</p> <p>graph + interpretation</p>
	<p>(iii) S BCDET or SBCDE T</p>	<p>B1</p>	

Question			Answer	Marks	Guidance
3	(a)	(i)	Max $150x_1+50x_2+250x_3+150x_4+60x_5+60x_6+70x_7+30x_8+15x_9+75x_{10}+15x_{11}+50x_{12}$ st $9x_1+10x_2+153x_3+60x_4+15x_5+30x_6+11x_7+32x_8+64x_9+80x_{10}+6x_{11}+4x_{12}<350$ end int 12	M1A1 M1A1	
		(ii)	Objective value 885 Variable x_1 x_2 x_3 x_4 x_5 x_6 x_7 x_8 x_9 x_{10} x_{11} x_{12} Value 1 1 1 1 1 1 1 1 1 0 0 1 Slack on constraint 200 g All packed except the change of clothing and the waterproof clothing.	M1 A1 B1	running no marks at this point for slack
		(iii)	4.1 kg	B1	
		(iv)	Either delete x_{10} from the model, reduce constraint to 2.7 kg, and add waterproof clothing back in at the end, or increase the value of waterproof clothing. Variable x_1 x_2 x_3 x_4 x_5 x_6 x_7 x_8 x_9 x_{10} x_{11} x_{12} Value 1 1 1 1 1 0 1 0 0 1 1 1 Slack on constraint 20 g All packed except fruit, camera and change of clothing. Total load = 3.48 kg	M1 A1 A1 A1	

Question		Answer	Marks	Guidance
4	(i)	20	B1	
	(ii)	<p>Commentary</p> <p>This compound distribution is difficult to model, so the markscheme might appear to be generous. Most candidates use LOOKUP and nested IF statements, and the maximum number of customers and the maximum number of gifts have been kept low to allow of this. But the approach shown below, using indicator variables for customers, is easier to manage.</p> 	<p>M1</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>A1</p> <p>A1</p> <p>M1</p> <p>A1</p>	<p>Use of “=rand()”</p> <p>Use of CDF for customers</p> <p>Valid methodology for sampling</p> <p>valid methodology for a number of gifts</p> <p>CDF for gifts</p> <p>repeated as needed</p> <p>A1</p> <p>valid methodology for accumulating the correct number of gifts</p>

	(iii)	<p>The above simply needs columns I to AU copying down.</p> <p>At the other extreme, less well designed solutions will require 20 hand-generated repetitions.</p>	<p>M1 A1</p>	<p>No marks for sophistication – it is its own reward.</p>
	(iv)	<p>Mean ... should be between 3 and 6.5 ish.</p> <p>Standard deviation ... between 2 and 3.5 or so.</p> <p>Note: Theoretical answers are ...</p> <p>Mean = $2.34 \times 2.06 = 4.8204$</p> <p>Var = $2.34 \times 0.9164 + 1.4844 \times 2.06^2 = 8.4436$</p> <p>StDev = 2.9058</p>	<p>B1 B1</p>	
	(v)	<p>Standard deviation ≈ 2.9</p> <p>Require n such that $2 \times \frac{2.9}{\sqrt{n}} \leq 0.1$, i.e. about 3400 repetitions.</p>	<p>M1 M1 A1</p>	<p>Use of SD Use of formula</p>

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