OCR
Oxford Cambridge and RSA

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.

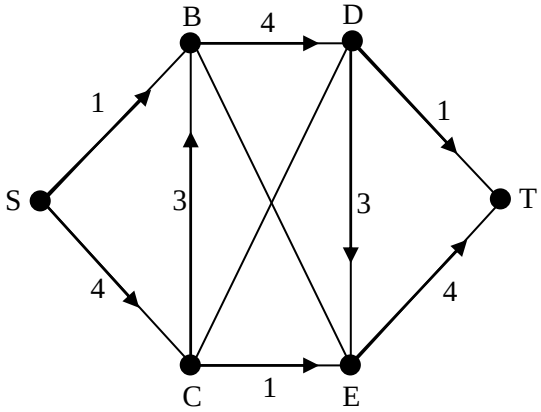
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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

Question			Answer	Marks	Guidance
1	(i)		There are 2 ways of finishing a path of length 30(n+2). Either one "perpendicular" slab added to a path of length 30(n+1), or two "parallel" slabs added to a path of length 30n. 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.	M1 A1 A1 A1	multiplier of 30 not needed in description
	(ii)		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	M1 A1	relationship correct twenty

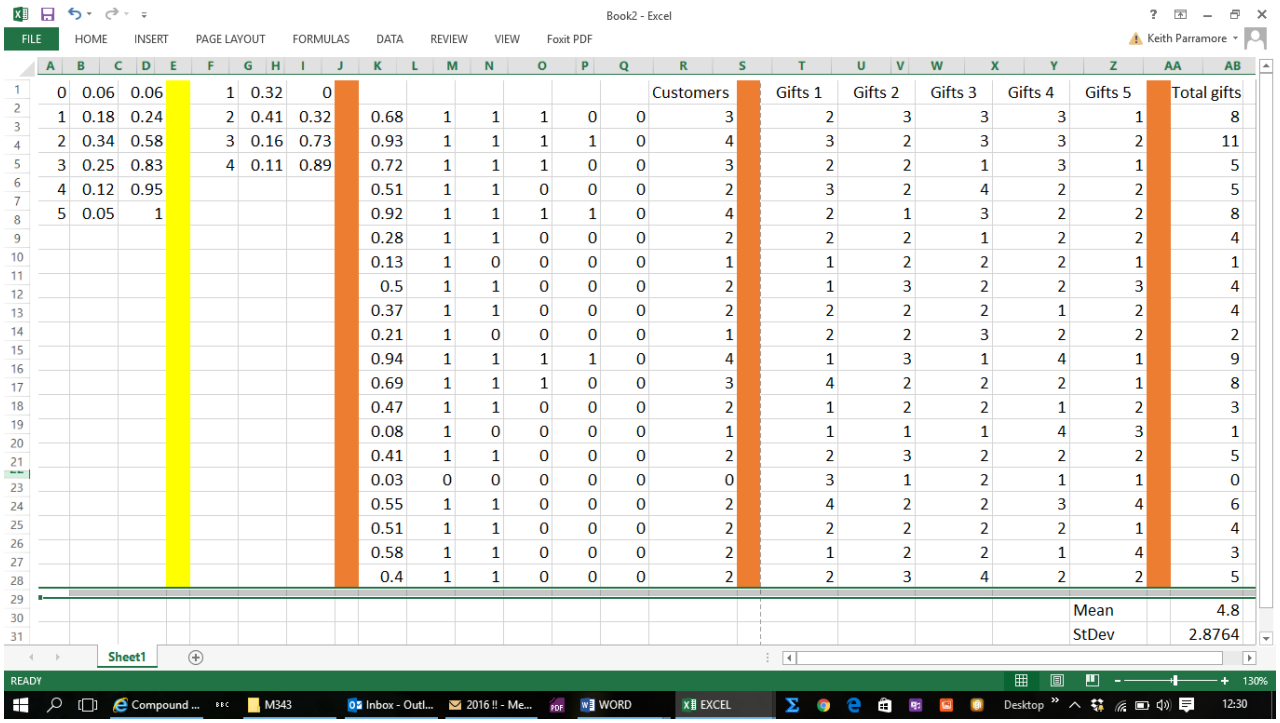
	(iii)		Assume that there is a solution of the form $u_n = \lambda^n$ Then $\lambda^{n+2} = \lambda^{n+1} + \lambda^n$ giving $\lambda^2 - \lambda - 1 = 0$	B1 B1 B1	
	(iv)		$\lambda = \frac{1+\sqrt{5}}{2}$ or $\lambda = \frac{1-\sqrt{5}}{2}$ Form a linear combination of the assumed solutions, i.e. $u_n = \mathrm{A}\left(\frac{1+\sqrt{5}}{2}\right)^n + \mathrm{B}\left(\frac{1-\sqrt{5}}{2}\right)^n$ Then use instances of n to determine A and B.	B1 B1 B1	
	(v)		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	
	(vi)		20 365 011 074	B1	
	(vii)		1, 1 and 2	B1	
	(viii)		The recurrence relation is $u_{n+3} = u_{n+2} + u_n$ This will need programming in Excel and dragging down to $n = 50$. Gives 122 106 097	B1 B1 B1	

Question			Answer	Marks	Guidance
2	(a)	(i)	Shortest path … … from A to F.	B1 B1	
		(ii)	… that the path leaves A.	B1	
		(iii)	… that if the path arrives at B, then it leaves B.	B1	
		(iv)	Shortest path has length 5. Shortest path is A B E C D F	B1 B1	
	(b)	(i)	Max SB+SC st SB<1 SC<4 BC<3 CB<3 BD<4 DB<4 BE<1 EB<1 CD<1 DC<1 CE<1 EC<1 DE<3 ED<3 DT<1 ET<4 SB+CB+DB+EB-BC-BD-BE=0 SC+BC+DC+EC-CB-CD-CE=0 BD+CD+ED-DB-DC-DE-DT=0 BE+CE+DE-EB-EC-ED-ET=0 end	B1 M1 A1 M1 A1 A1	Could be max DT+ET capacities one correct balance at B and C at D and E

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

Question			Answer	Marks	Guidance
3	(a)	(i)	Max 150x1+50x2+250x3+150x4+60x5+60x6+70x7+30x8+15x9+75x10+15x11+50x12 st 9x1+10x2+153x3+60x4+15x5+30x6+11x7+32x8+64x9+80x10+6x11+4x12<350 end int 12	M1A1 M1A1	
		(ii)	Objective value 885 Variable x1 x2 x3 x4 x5 x6 x7 x8 x9 x10 x11 x12 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 x10 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 x1 x2 x3 x4 x5 x6 x7 x8 x9 x10 x11 x12 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	

	(b)	**(i)**	Max 150x1+50x2+250x3+150x4+60x5+60x6+70x7+30x8+15x9+75x10+15x11+50x12 st 9x1+10x2+153x3+60x4+15x5+30x6+11x7+32x8+64x9+80x10+6x11+4x12<1500 x1<5 x2<5 x3<5 x4<5 x5<5 x6<5 x7<5 x8<5 x9<5 x10<5 x11<5 x12<5 end gin 12	B1 B1	RHS changed
		(ii)	Objective value 4275 Variable x1 x2 x3 x4 x5 x6 x7 x8 x9 x10 x11 x12 Value 5 5 5 5 5 5 5 0 0 0 5 5 Slack on constraint 100 g The porter carries all except cameras, changes of clothing and waterproofs. The load is 14.9 kg.	M1 A1 A1 A1	running

Question			Answer	Marks	Guidance
4	(i)		20	B1	
	(ii)		Commentary 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. 	M1 M1 M1 A1 M1 A1 A1 A1 M1 A1	Use of "=rand()" Use of CDF for customers Valid methodology for sampling valid methodology for a number of gifts CDF for gifts repeated as needed A1 valid methodology for accumulating the correct number of gifts

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

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