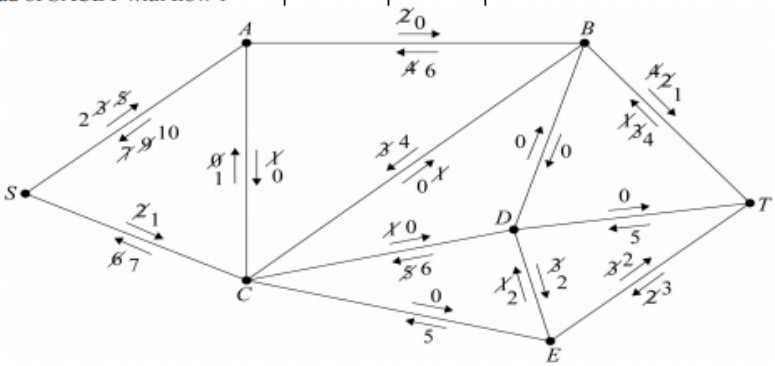
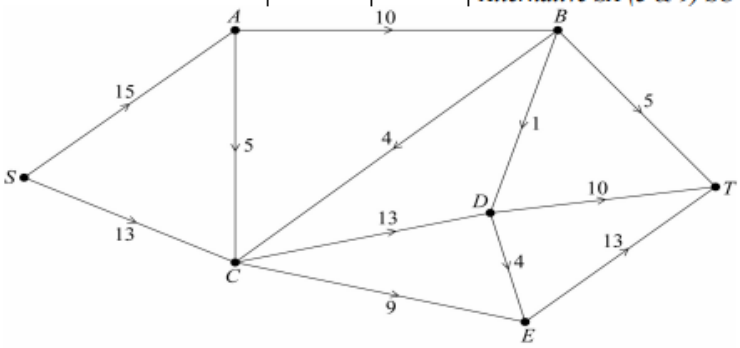
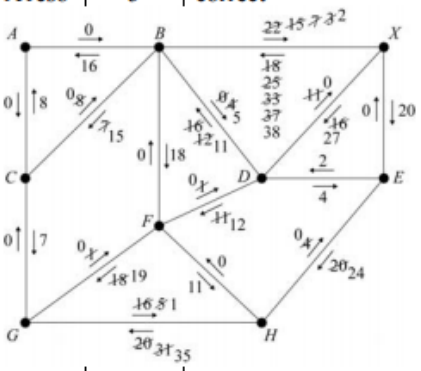
JUNE 2010

Q	Solution	Marks	Total	Comments
6(a)	Value of cut = 10 + 10 + 15 – 4 – 1 = 30	M1 A1	2	condone one slip if working shown
(b)	*BT* 2 , *DE* 3 , *ET* 12	B1 B1	2	any 2 correct all correct
(c)(i)	Initial flows forward and back or double Arc with arrows(at **least 6 pairs correct**)	M1 A1	2	Condone pairs of values, (coordinates) with single arrow all correct (condone pairs with single arrow provided key indicated)
(ii)	**Path** / **Flow** *SABT* / 2 *SCDET* / 1 *SACBT* / 1 (or SCBT instead of SACBT with flow 1	M1 A1 A1		first correct path and flow another correct path and flow all correct (*other possibilities also*)
				
	Must have forward and backward flows	M1 A1	5	augmenting flows (6 pairs correct) correct
(iii)				*Alternative SA (3 & 9) SC (0&8)*
	May have *SA*(14), *SC*(14) and *AC*(4) using alternative			
	Maximum flow values	M1 A1	2	at least 8 correctly interpreted from their Figure 4 but 24 < *their maxflow* < 29
(d)	Cut through *AB, CB, CD* and *CE* May use {*S,A,C*} / {*B,D,E,T*}	B1 B1	1	**But** must have total flow of 28 in their network (condone one slip)

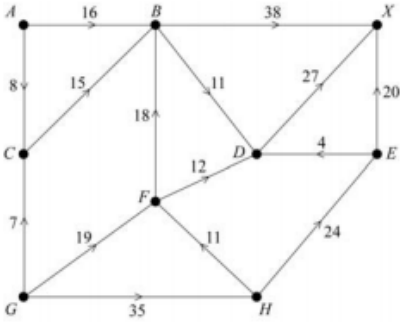
JAN 2011

Q	Solution	Marks	Total	Comments
6(a)	$SP \geq 12$ $SQ \geq 10$ $SR \geq 17$	B1		S in correct place, (arrows) and capacities
	$YT \geq 18$ $ZT \geq 17$	B1	2	T in correct place, (arrows) and capacities
(b)	$S\,P\,U\,Y\,T$ 10 $S\,R\,V\,W\,Z\,T$ 8	B1 B1	2	
(c)(i)	Initial flow forward and backward PU 2 and 10 ; UY 0 and 10 RV 0 and 8 ; VW 1 and 8 ; WZ 2 and 8	B1 B1	2	withhold one B1 if paths to S and T not updated
(ii)	Two correct routes and flows on Figure 6 Correct additional flows Max flow = 33 Adjustment of at least 4 edges corresponding to flows (forward and backward) Correct final flows forward and backward (must score A1 for table)	M1 A1 M1 A1cso	4	$S\,P\,U\,Y\,T$ 10 $S\,R\,Y\,W\,Z\,T$ 8 $S\,P\,U\,X\,Y\,T$ 2 $S\,Q\,V\,U\,X\,Y\,T$ 6 $S\,R\,W\,X\,Z\,T$ 5 $S\,R\,W\,Z\,T$ 2 (other possibilities) edges UY, UX, WX and WZ will be saturated $XY + XZ = 13$ in back flow
(d)	Cut with value 33 is through UY, UX, WX and WZ	B1	1	
	Total		**11**	
	TOTAL		**75**	

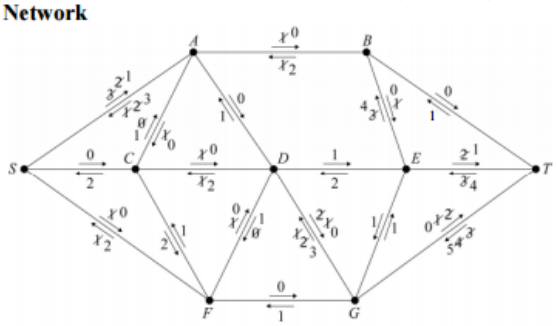
JUNE 2011

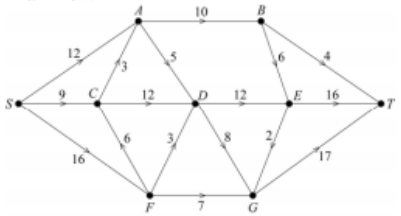
5(a)	Cut value $= 40 + 27 + 0 + 24$ $= 91$	 B1	 1	
(b)	*ABDX* 16 *GFBX* 18 *GHEX* 20	B1 B1 B1	 3	
(c)(i)	One correct route with additional flow	M1		any feasible route and flow
	Another 2 routes and flows correct	A1		total flow at least 80
	All routes correct with total flow = 85	A1cso		
	Forward and backward flows on diagram (directions must be clear)	M1		at least 8 edges with pairs of values 'correct'
	Augmenting flows	A1cso	5	correct
	Consider other possible correct flows *Condone diagram as shown but really should have initial flows in DE, etc*			

Route	Flow
ABDX	16
GFBX	18
GHEX	20
GCBX	7
ACBX	8
GHFDX	11
GHEDBX	4
GFDBX	1

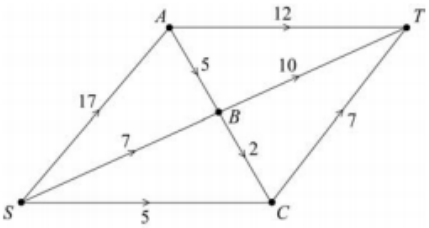
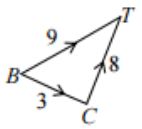
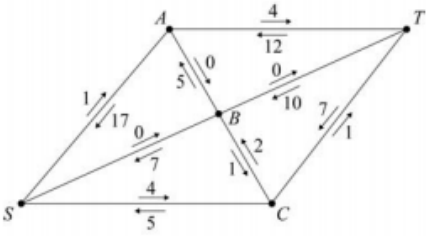
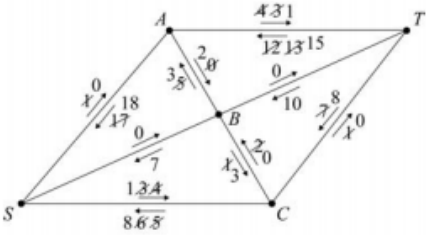
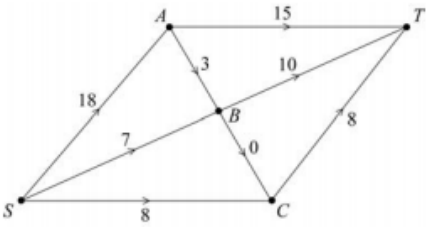
(ii)	Max flow = 85	B1		
	Correct max flow	B1	2	
	Consider other possible correct flows			
(d)	Considering 'their' $AB+CB+FB-45$ $= 4$ fewer $\Rightarrow$ max number = 81	M1 A1cao	 2	
	Total		**13**	

JAN 2012

Q	Solution	Marks	Total	Comments
6(a)	$10 + 13 - 1 + 17$ $= 39$	M1 A1	2	3 values added and –1 (condone one slip)
(b)(i)	*DE* 12 *FG* 7	B1 B1	2	on Figure 2
(ii)	**arc** **forward** **backward** *SA* 3 1 *AB* 1 1 *BT* 0 1 *SC* 0 2 *CA* 0 1 *AD* 0 1 *CD* 1 1 *DE* 1 2 *BE* 1 3 *ET* 2 3 *SF* 1 1 *FC* 1 2 *FD* 1 0 *FG* 0 1 *DG* 2 1 *EG* 1 1 *GT* 2 3	M1 A1	2	at least 6 pairs correct on Figure 3 (must have arrows) all correct
(iii)	**Table** **Path** **Extra Flow** *SABET* 1 *SFDGT* 1 *SACDGT* 1	M1 A1		1 correct path and extra flow all correct *DEG triangle may have different flows with implications to triangle GET.*
	Network  	M1 A1	4	1 path correctly augmented forward and backward **but** must have earned M1 in part (b)(ii) network correct
(c)(i)	Max flow = 37	B1	1	

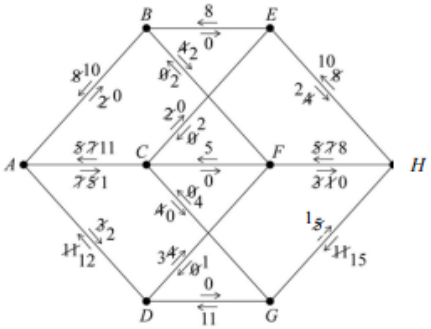
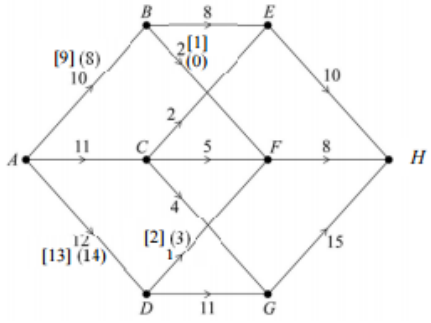
Q	Solution	Marks	Total	Comments
6(c) cont. **(ii)**	Max flow  	B2 2		correct flow of 37 condone 2 slips or omissions in flow of 37 **or** "correct" feasible flow of 36 for SC1
(d)	Cut through *AB*, *AD*, *CD*, *FD* and *FG*	B1	1	$\{S, A, C, F\}$ $\{B, D, E, G, T\}$
	Total		**14**	
	TOTAL		**75**	

JUNE 2012

Q	Solution	Marks	Total	Comments
6(a)(i)	18 +(0+) 10 + 3 + 5 (= 36)	B1	1	
(ii)	30 , 32 , 36 (missing cut values)	B3	3	B1 each value correct
(iii)	Max flow = 29 because value of minimum cut is 29	B1 E1	2	Award B0 E1 if their min^{m} cut is < 29 and min^{m} value explained as max flow
(iv)		B1 cao	1	may have  see alternative solution on next page
(b)(i)		M1		potential flow (forward and back) 4 pairs 'correct' including *SC* and *AT* ft their (a)(iv) provided 0 < flow < 30
		A1√		all pairs correct (condone missing 0s) ft their (a)(iv) if correct flow < 29
		m1		one correct flow in table
		A1		table correct *SAT* 1 *SCT* 1 *SCBAT* 2 If (a)(iv) flow < 29 then may score A1 for correct table giving max flow of 33
				(see also the alternative solution)
		m1		modifying flows (forward and back) 1 flow correct ft their initial flow
		A1	6	modified flows all correct, including all 0s (may score A1 from a correct flow < 29 seen in (a)(iv) if final flow correct)
(ii)	new max flow = 33	B1		
		M1		6 flows correctly interpreted from their labelling procedure provided M2 or M3 scored in (b)(i) *(may have AB 2, AT 16, BT 9 – see over)*
		A1	3	flow correct **SC** B1 if flow of 33 shown correctly but not from correct labelling procedure
	Total		**16**	

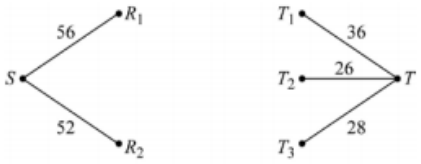
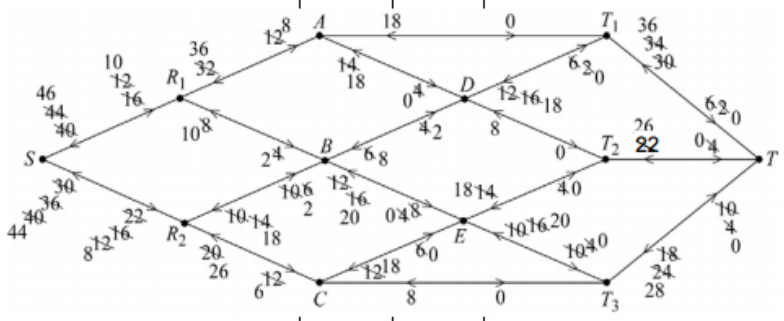
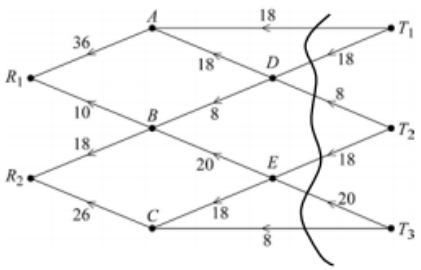
JAN 2013

Q	Solution	Marks	Total	Comments
(4)(a)(i)	Max Flow = 50 (Min cut = 50)	E1		Either statement
(ii)	35 ≤ max flow ≤ 50 (or min cut)	E1, E1		E1 for strict inequalities
(iii)	Error or contradiction	E1	4	oe
(b)	At F, flow in ≥ 8 flow out ≤ 7	M1 A1	2	Stating F and one of the 'flows'
	Total		**6**	

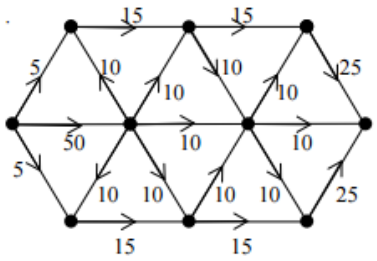
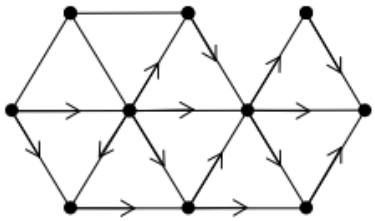
Q	Solution	Marks	Total	Comments
(8)(a)	$A\,B\,E\,H$ 8 $A\,C\,F\,H$ 5 $A\,D\,G\,H$ 11	B1	1	
(b)(i)	$ACEH$ 2 $ACGH$ 4 Either $ADFH$ 1 and $ABFH$ 2 Or $ADFH$ 3	M1 A1 A1		One correct route and flow At least one other correct All correct
	 	M1		Forward and back flows on diagram
		A1	5	All correct
(ii)	Max flow 33	B1		
	 	B1	2	OE
(c)	Cut through BE, CE, FH, CG, DG	B1	1	
	Total		**9**	

JUNE 2013

2(a)	19	B1	1	
(b)	E	B1	1	
(c)	C	B1	1	
(d)	$x = 8$ $y = 13$ $z = 39$	B1 × 3	3	
(e)	76	B1	1	
(f)	83	B1	1	
	Total		**8**	

7(a)		B1 B1	 2	Edges with values ≥ 56, 52 Edges with values ≥ 36, 26, 28
b(i)		M1 A1	 	initial diagram with forward/back flows Fully correct diagram
	SR_1ADT_1T 4 SR_1BDT_1T 2 SR_2CET_3T 6 SR_2BET_2T 4 SR_2BET_3T 4	M1 A1 A1	 5	One correct path and flow At least one other correct path and flow all correct (ignore connections to S and T)
(ii)	Max flow 90	B1		
		B1	2	
(c)	Cut through (shown)	B1		PI by correct list
	AT_1, DT_1, DT_2, ET_2, ET_3, CT_3	B1	2	OE
	Total		**11**	

JUNE 2014

Q	Solution	Mark	Total	Comment
3(a)	$C_1 = 60$	**B1**		
	$C_2 = 80$	**B1**	**2**	
(b)	e.g. . 	**M1** **A1**	**2**	Correct at *D*
(c)(i)		**M1**		Correct to *D, E, F* either by inspection or flow augmentation
		A1		All correct
	oe			
	MAX = 45	**B1**	**3**	
(ii)	CUT THRU' *EG,DG, DF, DC, AC*	**B1**		Or {*A,B,D,E*} {*C,FG,,H,IJ*}
	Max flow = Min cut	**E1**	**2**	Must have scored B1,B1 in point (C)
	Total		**9**	