

Question 7 (Unit 4) - 5 marks

- (i) Draw the flow graph of the Turing machine M given by the following tables of values of $a(x, y)$ and $q(x, y)$.

[2]

$a(x, y)$	y		$q(x, y)$	y	
	0	1		0	1
1	3	0	1	3	4
2	0	1	2	0	0
x 3	0	2	x 3	0	4
4	2	0	4	3	5
5	3	1	5	1	0
$a(x, y) = y$ otherwise			$q(x, y) = 0$ otherwise		

- (ii) At a certain stage in M 's computation on a certain input, the left number and right number describing M 's tape configuration are 29 and 16 respectively, and M is in state 4.

(a) Produce a diagram of M 's tape at this stage.

(b) Calculate the left and right numbers after the next step in M 's computation.

[3]

Question 8 (Unit 5) - 10 marks

- (i) For each of the following strings of symbols, state whether or not the string is a formula. (Simply answer YES or NO.)

(a) $\forall z \exists x (x' + (x \cdot z))$

(b) $(\forall x (x + x) = x \rightarrow \forall y (x \cdot y \cdot z) = x)$

(c) $\exists y ((y + z) = x' \vee \forall x y = (z \cdot z))$

[3]

- (ii) For each string in part(i) which is not a formula, explain briefly why it is not a formula.

[2]

- (iii) By choosing suitable subformulas, show that the formula

$$((0 = y \rightarrow \neg(\forall y (0 = y \ \& \ \forall y \ 0 = y) \vee \neg \forall y \ 0 = y)) \rightarrow (0 = y \rightarrow \forall y \ 0 = y))$$

has truth value 1 under all interpretations of the symbols used in the formula.

[5]