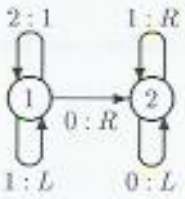
Question 6 (Unit 1) — 10 marks

(i) We wish to design a Turing machine which, if started scanning the rightmost of a string of n 2s (on an otherwise blank tape), would halt scanning the rightmost of a string of n 1s on an otherwise blank tape.

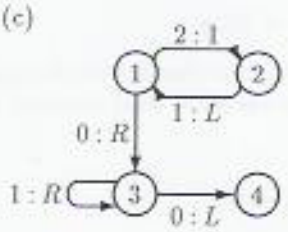
Write down which of the following Turing machines is suitable for this task. For each machine which is unsuitable, explain why it is unsuitable: this explanation can take the form of a sequence of configurations for appropriate test data.

(a)

(b)



(c)

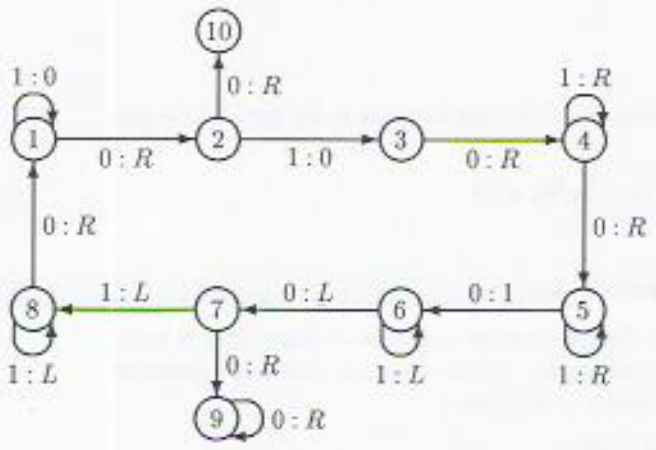


[7]

(ii) Devise and give the flow graph of a Turing machine which, if started scanning the rightmost of a string of n 1s (on an otherwise blank tape), would halt scanning a single 1 on an otherwise blank tape. [3]

Question 7 (Unit 1) — 15 marks

In this question we consider the Turing machine M with the flow graph below.



(i) Write down the machine table for M. [2]

(ii) For each of the following starting configurations of the machine M, write down the sequence of configurations for the subsequent computation.

(a) 0 1 1 0 (1 under the second 1)

(b) 0 1 1 1 0 (1 under the middle 1)

(c) 0 1 1 1 1 0 (1 under the middle 1)

[6]

(iii) The machine M has been designed to take as input a positive integer in monadic notation and to output an integer also in monadic notation. Thus the machine computes the values of a function $f : P \longrightarrow N$.

(a) Write down the values of $f(2)$, $f(4)$, $f(5)$, $f(6)$, $f(9)$. [$2\frac{1}{2}$]

(b) What, in general, is the value of $f(n)$ for $n \in P$? Describe briefly how the machine computes $f(n)$, including an indication of each possible halting state and the circumstances under which it halts there. [$4\frac{1}{2}$]