

MAU11602 first quiz, week 2, Wed 2/2/22

Answers

Rules and procedures.

1. Attempt 3 questions. Only *your first three answers* will be marked. **2.** Each question carries 20 marks, so the maximum quiz mark is 60. **3.** If a particular method of solution is stipulated, you get no marks if you don't use it. **4. *Show all work.*** No marks will be given for answers which do not show the calculations. **5.** Your answers should be scanned and submitted to Blackboard.

All turing machines must conform to the pattern required for the turinginC program. Also, if and when a machine terminates, the square being scanned should contain the leftmost nonblank tape symbol (blank if the tape is blank).

Question 1. Give a Turing machine which increments ternary strings: the input alphabet is $\{0, 1, 2\}$. It should loop on empty input.

Answer.

1. loop on empty
2. move to right
3. move left past 2
4. increment
5. left to blank, then right

q0 B B R q0 loop

q0 0 0 R q1

q0 1 1 R q1

q0 2 2 R q1

q1 0 0 R q1

q1 1 1 R q1

q1 2 2 R q1 Move to right

q1 B B L q2 move left past 2s

q2 2 0 L q2 changing 2 to 0

q2 1 2 L q3

q2 0 1 L q3

q2 B 1 L q3 increment and move left

q3 0 0 L q3
q3 1 1 L q3
q3 2 2 L q3

q3 B B R q4 to left of string and halt

Question 2. Give a Turing machine which multiplies binary strings by 4. It should loop on empty input.

Answer.

q0 B B R q0
q0 0 0 R q1
q0 1 1 R q1
q1 0 0 R q1
q1 1 1 R q1
q1 B 0 R q2
q2 B 0 L q3
q3 0 0 L q3
q3 1 1 L q3
q3 B B R q4

Question 3. Give a Turing machine which reverses binary strings.

Answer.

q0 0 0 L q1
q0 1 1 L q1
q1 B x R q2

q2 y y R q2
q2 0 y L q4
q2 1 y L q5

q4 0 0 L q4
q4 1 1 L q4
q4 y y L q4
q4 x x L q4
q4 B 0 R q6

q5 0 0 L q5
q5 1 1 L q5
q5 y y L q5
q5 x x L q5
q5 B 1 R q6

q6 0 0 R q6
q6 1 1 R q6

q6 x x R q2

q2 B B L q7

q7 y B L q7

q7 x B L q7

q7 0 0 L q7

q7 1 1 L q7

q7 B B R q8

Question 4. Add comments to the Turing machine below. What is the domain of the partial function?

Answer.

q0 0 B R q1

q0 1 B R q2

q1 0 B R q1

q1 1 B R q2 scan past zeroes until the first 1

q1 B B L q3

q2 B B L q3 If it occurs at end, halt

q2 0 B R q4 Otherwise, state q4

q2 1 B R q4

q4 0 B R q4

q4 1 B R q4

q4 B B L q4 State q4 always loops

It halts with empty tape if the input string has only zeroes, or has just one occurrence of 1, at the right-hand end.

Question 5. Below is an encoding of a Turing machine. Translate it into recognisable quintuples. What does the machine do?

111

11011011000110011011

11011001100110110011

11001100011000110011011

111

Answer.

q0 0 B R q0

q0 1 1 L q1

q1 B B R q0

Halts empty output if the input contains no 1s, else it loops.