Experiment #	<TO BE FILLED BY STUDENT>	Student ID	<TO BE FILLED BY STUDENT>
Date	<TO BE FILLED BY STUDENT>	Student Name	<TO BE FILLED BY STUDENT>

Pre-Tutorial (To be completed by student before attending tutorial session)

1. Define computability.

Solution:

Computability refers to the study of what problems can be solved by a computational process and the limits of what can be computed. More formally its a branch of theoritical computer science and mathematical logic that explores the capabilities & limitations

2. In what real-world scenarios do you think Turing machines or their principles are applied today? Can you identify any algorithms or technologies that are based on Turing machine concepts?

Solution:

Programming languages - universal computation guide how compilers and interpreters work.

AI and ML Algorithms process data and make decisions, inspired by logical steps of turing machines.

3. Design a Turing machine that accepts strings if and only if they are palindrome the alphabet {0, 1}.

Solution:

$L = \{010, 101, 001100, 1001, \ldots\}$

i/p :- BB010BB

δ	0	1	X	Y	B
$\rightarrow q_0$	(q_1, X, R)	(q_2, Y, R)	(q_0, X, R)		
q_1	(q_3, X, L)	$(q_1, 1, R)$			
q_2			(q_4, X, L)		
q_3		$(q_3, 1, L)$	(q_0, X, R)		
q_4					$(q_5, 4, L)$
$* q_5$					

initial state $\rightarrow q_0$ final state q_5

$M = (\{q_0, q_1, q_2, q_3, q_4, q_5\}, \{0, 1\}, \{0, 1, x, y, B\}, \delta, q_0, B, \{q_5\})$

TUTORIAL (To be carried out in presence of faculty in classroom)

1. Construct a Turing Machine for the language L = {$a^n b^n c^n$ | n ≥ 0}.

tion: {ε, abc, aabbcc, aaabbbccc ....}

Sol:

tape Symbols

δ	a	b	c	X	Y	Z	B
q_0	(q_1, X, R)				(q_4, Y, R)		(q_5, B, R)
q_1	(q_1, a, R)	(q_2, Y, R)			(q_1, Y, R)		
q_2		(q_2, b, R)	(q_3, Z, Y)			(q_2, Z, R)	
q_3	(q_3, a, L)	(q_3, b, L)			(q_3, Y, L)	(q_3, Z, L)	
q_4					(q_4, Y, R)	(q_4, Z, R)	(q_5, t, R)
q_5	—	—	—		—	—	—

$M = (\{q_0, q_1, q_2, q_3, q_4, q_5\}, \{a, b, c\}, \{a, b, c, X, Y, Z, B\}, \delta, q_0, B, \{q_5\})$

2. **Design a Turing machine that takes a binary number as input (e.g., 101) increments it by 1 (e.g., outputs 110). Assume the input is given with the significant bit on the left.**

Solution:

δ	0	1	B
$\rightarrow q_0$	$(q_1, 1, R)$	$(q_0, 0, R)$	$(q_1, 1, R)$
$* q_1$	—	—	—

Initial state – q_0, final state – q_1

$$M = (\{q_0, q_1\}, \{0, 1\}, \{0, 1, 5\}, \delta, q_0, B, \{q_2\})$$

Create a ... accepts binary numbers divisible by 3.

δ	0	1	x	y	B
$\rightarrow q_0$	(q_0, x, R)	(q_1, y, R)	(q_0, x, R)	(q_1, y, R)	(q_3, B, R)
q_1	(q_2, x, R)	(q_0, y, R)	(q_2, x, R)	(q_B, y, R)	(q_3, B, R)
q_2	(q_1, x, R)	(q_2, y, R)	(q_3, B, R)	(q_2, y, R)	(q_3, B, R)
$* q_3$	—	—	—	—	—

$M = (\{q_0, q_1, q_2, q_3\}, \{0,1\}, \{0,1,x,y,B\}, \delta, q_0, B, \{q_3\})$.

4. **Construct a Turing Machine that cop… input is 011, the output should be 011011.**

Solution:

δ	0	1	X	Y	B
$\rightarrow q_0$	(q_1, X, R)	(q_2, Y, R)	(Error)	(Error)	(q_1, B, R)
q_1	$(q_1, 0, R)$	$(q_1, 1, R)$	E	E	$(q_4, 0, L)$
q_2	$(q_2, 0, R)$	$(q_2, 1, R)$			
q_3	E	E	$(q_3, 0, R)$	$(q_3, 1, R)$	(q_6, B, L)
q_4	$(q_4, 0, L)$	$(q_4, 1, L)$	(q_0, X, R)	E	E
q_5	$(q_5, 0, L)$	$(q_5, 1, L)$	E	(q_0, Y, R)	E
q_6	E	E	$(q_6, 0, L)$	$(q_6, 1, L)$	(q_7, B, R)
$* q_7$	—	—	—	—	—

$$M = (\{q_0, q_1, q_2, q_3, q_4, q_5, q_6, q_7\}, \{0, 1\}, \{0, 1, X, Y, B\}, q_0, \delta, B, \{q_7\})$$

4. Construct a Turing Machine that copies a binary string. For example, if the input 011, the output should be 011011.

Solution:

δ	0	1	X	Y	B
$\rightarrow q_0$	(q_1, X, R)	(q_2, Y, R)	(Error)	(Error)	(q_1, B, R)
q_1	$(q_1, 0, R)$	$(q_1, 1, R)$	E	E	$(q_4, 0, L)$
q_2	$(q_2, 0, R)$	$(q_2, 1, R)$			
q_3	E	E	$(q_3, 0, R)$	$(q_3, 1, R)$	(q_6, B, L)
q_4	$(q_4, 0, L)$	$(q_4, 1, L)$	(q_0, X, R)	E	E
q_5	$(q_5, 0, L)$	$(q_5, 1, L)$	E	(q_0, Y, R)	E
q_6	E	E	$(q_6, 0, L)$	$(q_6, 1, L)$	(q_7, B, R)
$* q_7$	—	—	—	—	—

$$M = (\{q_0, q_1, q_2, q_3, q_4, q_5, q_6, q_7\}, \{0, 1\}, \{0, 1, X, Y, B\}, q_0, \delta, B, \{q_7\})$$

Create a Turing Machine to decide the language L = {0^m 1^n | m ≠ n}

:

δ	0	1	X	Y	B
$\to q_0$	(q_1, X, R)	(q_2, Y, R)	E	E	(q_5, B, R)
q_1	$(q_1, 0, R)$	(q_3, Y, R)	E	(q_1, Y, R)	(q_4, B, L)
q_2	(q_3, X, R)	$(q_2, 1, R)$	E	E	(q_4, B, L)
q_3	$(q_4, 0, L)$	$(q_4, 1, L)$	(q_4, X, L)	(q_4, Y, L)	(q_0, B, R)
q_4					
$*q_5$	—	—	—	—	—

$$M = (\{q_0, q_1, q_2, q_3, q_4, q_5\}, \{0, 1\}, \{0, 1, X, Y, B\}, \delta, q_0, B, \{q_5\})$$

2. **Construct a Turing Machine that replaces every 0 in a binary string with 1 and e[...] with 0 (binary negation).**

Solution:

δ	0	1	X	Y	B
$\rightarrow q_0$	(q_1, X, R)	(q_2, Y, R)	E	E	(q_5, B, R)
q_1	$(q_1, 0, R)$	$(q_1, 1, R)$	E	E	$(q_3, 1, L)$
q_2	$(q_2, 0, R)$	$(q_2, 1, R)$	E	E	$(q_4, 0, L)$
q_3	E	E	$(q_0, 1, L)$	$(q_0, 1, L)$	(q_5, B, R)
q_4	E	E	$(q_0, 0, L)$	$(q_0, 0, L)$	(q_5, B, R)
$*q_5$	–	–	–	–	–

$M = (\{q_0, q_1, q_2, q_3, q_4, q_5\}, \{0,1\}, \{0,1,X,Y,B\}, \delta, q_0, B, \{q_5\})$

sign a Turing Machine that accepts the language L = {a^n b^m c^k | n + m = k}.

	a	b	X	Y	B
	(q_1, X, R)			(q_0, Y, R)	(q_5, B, R)
	(q_1, a, R)	(q_2, Y, R)		(q_1, Y, R)	(q_5, B, L)
q_2		(q_2, b, R)	(q_3, Y, R)	(q_2, Y, R)	(q_5, B, L)
q_3			(q_3, c, R)	(q_4, y, L)	(q_4, B, L)
q_4	(q_4, a, L)	(q_4, b, L)		(q_0, X, R)	(q_4, y, L)
q_5	—		—	—	—

$M = (\{q_0, q_1, q_2, q_3, q_4, q_5\}, \{a, b, c\},$
$\{a, b, c, x, y, B\}, \delta, q_0, B, \{q_5\})$

Date	

Viva – Questions:

1. Describe the components of a Turing machine.

Solution:

A Turning machine consists of an Infinite tape & read- write head (to read & write symbols) a finite set of states, transition function.

2. What is the difference between a deterministic Turing machine (DTM) and a non-deterministic Turing machine (NDTM)?

Solution:

A deterministic turning machine has a single possible action for each state and input, following a predictable path. a Non-deterministic Turing Machine can choose from multiple actions for a state and input.

(For Evaluator's use only)

Comment of the Evaluator (if Any)	Evaluator's Observation
	Marks Secured: out of 50 Full Name of the Evaluator: Signature of the Evaluator Date of Evaluation: