	King Saud University College of Computer and Information Sciences Computer Science Department

CSC 339: Theory of Computation	**Final Exam: Second Semester 2020**

Duration: 3 Hours

Name:		ID:		Section:	**44084**

True/False Questions [8 pts]

1. If L is Turing-acceptable language; then $\bar{L}$ is not Turing-acceptable.	**True**
2. Halting problem is decidable.	**False**
3. Every two tapes Turing machine has an equivalent single tape Turing machine.	**True**
4. Universal Turing Machine are re-programmable.	**True**
5. All regular languages are Turing-decidable.	**True**
6. NP-Complete class includes all problems that can be solved only by exponential time algorithms.	**False**
7. The only way for a Turing machine to reject a string is to halt on a non-accepting state.	**False**
8. Every non-deterministic Turing machine has an equivalent deterministic Turing machine.	**True**

Multiple Choice Questions [12 pts]

9. All NP-complete problems are also P-complete.

    a. True b. False **c. Unknown**

10. Consider the following formal definition of the Turing machine in Figure 1: $M = (Q, \Sigma, \Gamma, \#, q_0, F, \delta)$ where $Q = \{q_0, q_1\}$, $\Sigma = \{0,1\}$, $\Gamma = \{0,1,\#\}$, and $F = \{\}$.

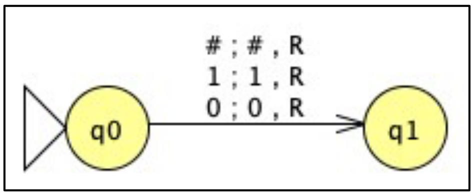

Figure 1: Turing Machine

The language ***decided*** by M is:

a. $\{\lambda\}$ c. $\emptyset$

b. $\{0\}$ d. $\emptyset^*$

11. Consider the following formal definition of the Turing machine in Figure 2: $M = (Q, \Sigma, \Gamma, \#, q_0, F, \delta)$ where $Q = \{q_0, q_1, q_2, q_3, q_4\}$, $\Sigma = \{a, b\}$, $\Gamma = \{a, b, \#\}$, and $F = \{q_4\}$.

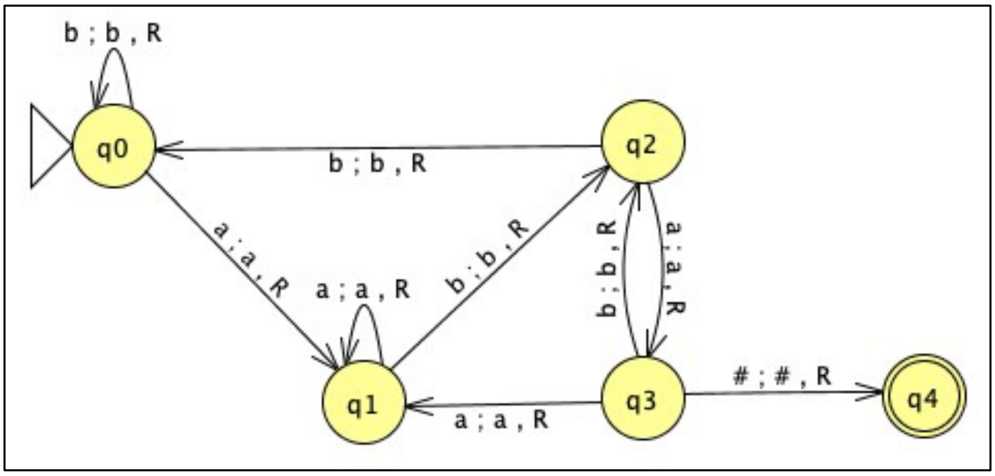

Figure 2: Turing Machine

The language ***accepted*** by M is:

a. $a^*b^*(a+b)$ c. $(a+b)^*bab$

b. $(a+b)^*aba$ d. $(a+b)^*a^*b^*$

12. Consider the following formal definition of the Turing machine in Figure 3: $M = (Q, \Sigma, \Gamma, \#, q_0, F, \delta)$ where $Q = \{q_0, q_1, q_2, q_3, q_4, q_5\}$, $\Sigma = \{a, b\}$, $\Gamma = \{a, b, x, \#\}$, and $F = \{q_5\}$.

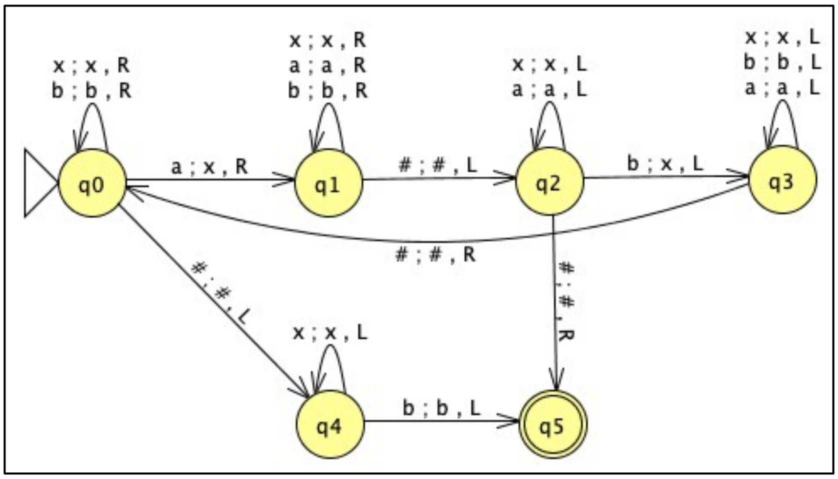

Figure 3: Turing Machine

The language ***accepted*** by M is:

a. $a^n b^n$

b. $a^n b^m \; where \; m > n$

c. $a^n b^m \; where \; n \neq m$

d. **None**

13. Consider the following formal definition of the Turing machine in Figure 4: $M = (Q, \Sigma, \Gamma, \#, q_0, F, \delta)$ where $Q = \{q_0, q_1, q_2, q_3, q_4, q_5\}$, $\Sigma = \{\text{a, b}\}$, $\Gamma = \{\text{a, b, x, y, \#}\}$, and $F = \{q_5\}$.

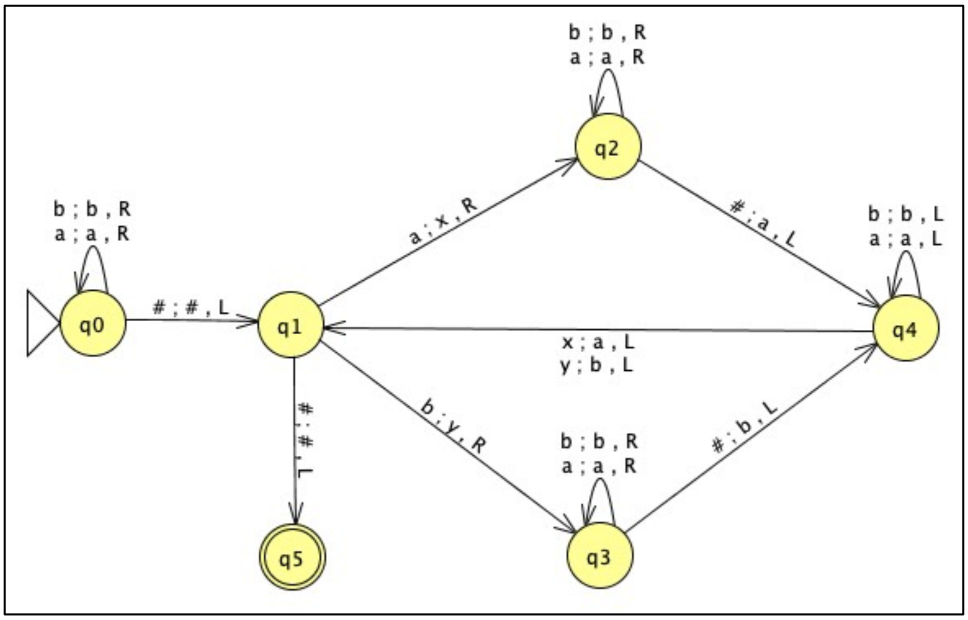

Figure 4: Turing Machine

What is the result configuration of the machine M if the initial configuration is $\#q_0w\#$?

a. $\boldsymbol{q_5\#\#ww^R\#}$

b. $q_5\#\#ww\#$

c. $q_5\#\#\#w\#$

d. None

14. Consider the following formal definition of the Turing machine in Figure 5: $M = (Q, \Sigma, \Gamma, \#, q_0, F, \delta)$ where $Q = \{q_0, q_1, q_2, q_3\}$, $\Sigma = \{0,1\}$, $\Gamma = \{0,1,\#\}$, and $F = \{q_3\}$.

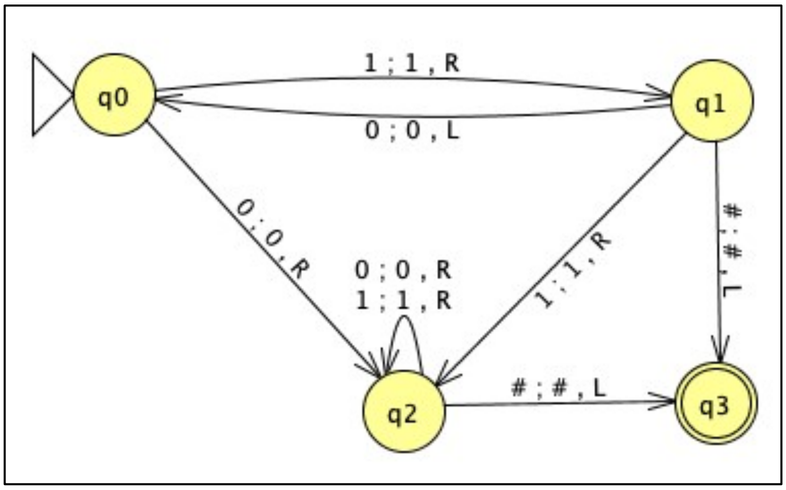

Figure 5: Turing Machine

Suppose the current configuration is $\#1q_1 0100\#$. The next configuration will be:

a. $\#10q_0 100\#$ c. $\#q_0 10100\#$
b. **$\#10q_2 100\#$** d. None

15. Consider the following formal definition of the Turing machine in Figure 5: $M = (Q, \Sigma, \Gamma, \#, q_0, F, \delta)$ where $Q = \{q_0, q_1, q_2, q_3\}$, $\Sigma = \{0,1\}$, $\Gamma = \{0,1,\#\}$, and $F = \{q_3\}$.

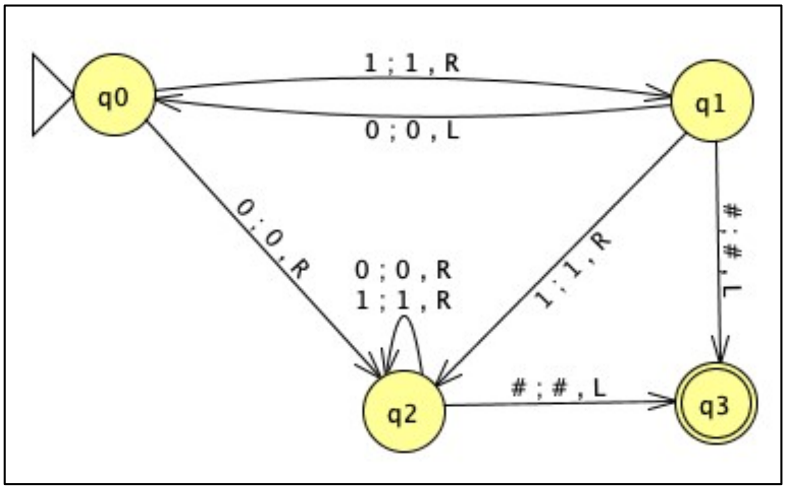

Figure 5: Turing Machine

Is the string 10100 accepted?

a. Yes **b. No**

16. Consider the following formal definition of the Turing machine in Figure 5: $M = (Q, \Sigma, \Gamma, \#, q_0, F, \delta)$ where $Q = \{q_0, q_1, q_2, q_3\}$, $\Sigma = \{0,1\}$, $\Gamma = \{0,1,\#\}$, and $F = \{q_3\}$.

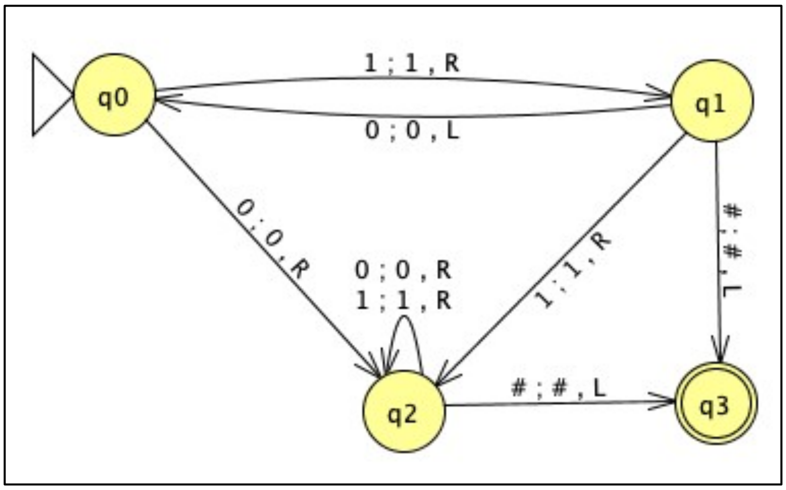

Figure 5: Turing Machine

Which statement is correct?

a. M halts on all inputs **c. M does not halt on any input**

b. M never halts on some inputs d. None

17. Consider the following formal definition of the Turing machine in Figure 5: $M = (Q,\Sigma, \Gamma,\#, q_0,F, \delta)$ where $Q = \{q_0,q_1,q_2, q_3\}$, $\Sigma = \{0,1\}$, $\Gamma = \{0,1,\#\}$, and $F = \{q_3\}$.

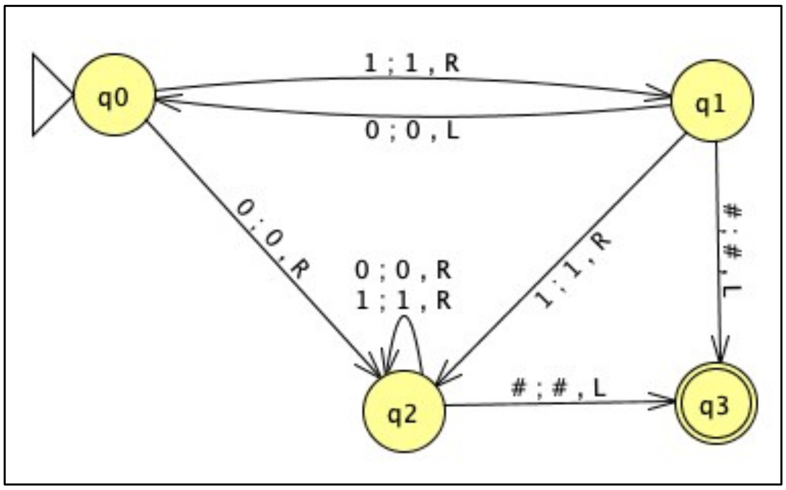

Figure 5: Turing Machine

The machine M is:

a. **A recognizer** b. A decider

18. Consider the following formal definition of the Turing machine in Figure 6: $M = (Q,\Sigma, \Gamma,\#, q_0,F, \delta)$ where $Q = \{q_0,q_1,q_2, q_3,q_4, q_5,q_6,q_7, q_8\}$, $\Sigma = \{0,1,\$\}$, $\Gamma = \{0,1,\$, A,B,\#\}$, and $F = \{q_8\}$.

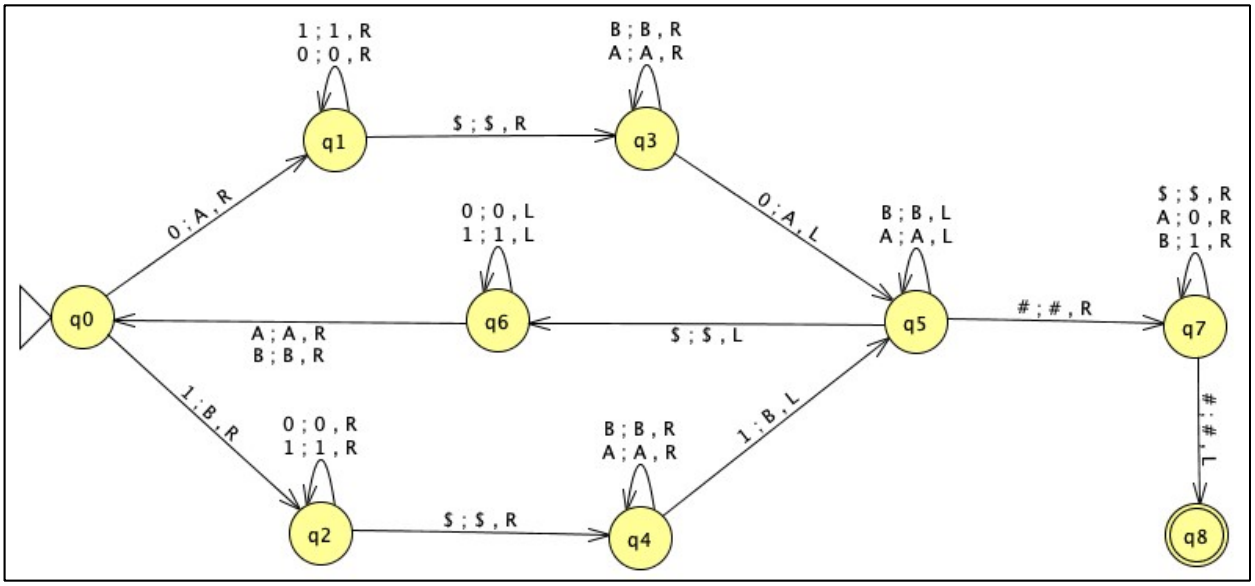

Figure 6: Turing Machine

The language accepted by M is:

a. $L = \{0^n\$1^n \mid n > 0\}$ c. $L = \{w\$w \mid w \in \{0,1\}^+\}$

b. $L = \{w\$w^R \mid w \in \{0,1\}^+\}$ **d. None**

19. Consider the following formal definition of the Turing machine in Figure 6: $M = (Q,\Sigma, \Gamma,\#, q_0,F, \delta)$ where $Q = \{q_0,q_1,q_2, q_3,q_4, q_5,q_6,q_7, q_8\}$, $\Sigma = \{0,1,\$\}$, $\Gamma = \{0,1,\$, A,B,\#\}$, and $F = \{q_8\}$.

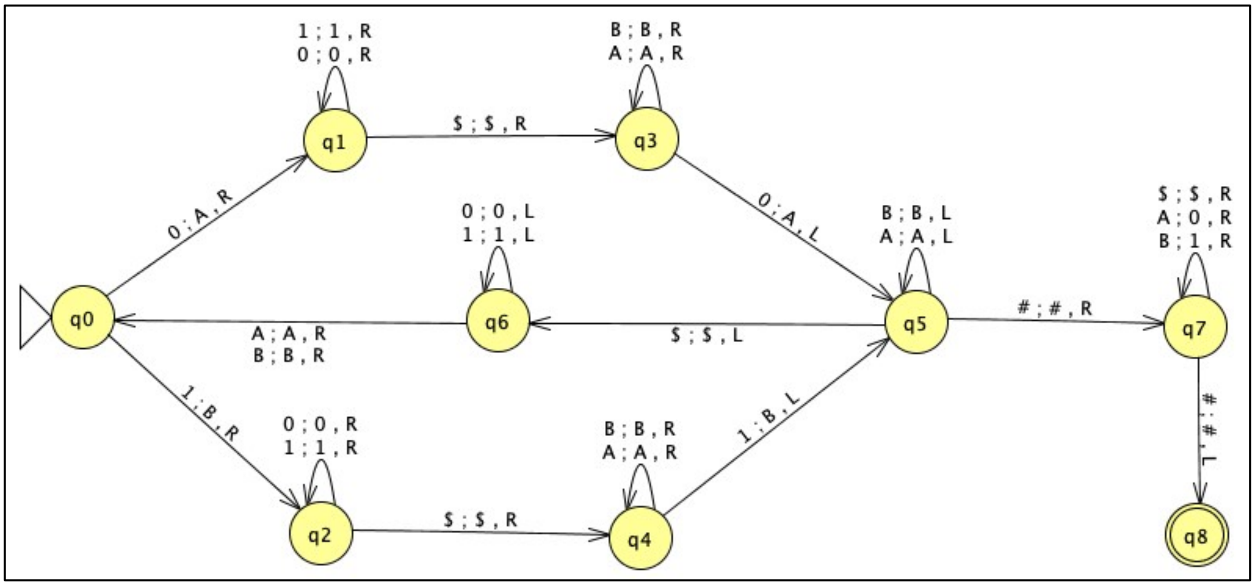

Figure 6: Turing Machine

What is the time complexity of the Turing machine above?

a. $O(n)$ c. $O(n^3)$
b. $O(n^2)$ d. None

20. Consider the following formal definition of the Turing machine in Figure 6: $M = (Q,\Sigma, \Gamma,\#, q_0,F, \delta)$ where $Q = \{q_0,q_1,q_2, q_3,q_4, q_5,q_6,q_7, q_8\}$, $\Sigma = \{0,1,\$\}$, $\Gamma = \{0,1,\$, A,B,\#\}$, and $F = \{q_8\}$.

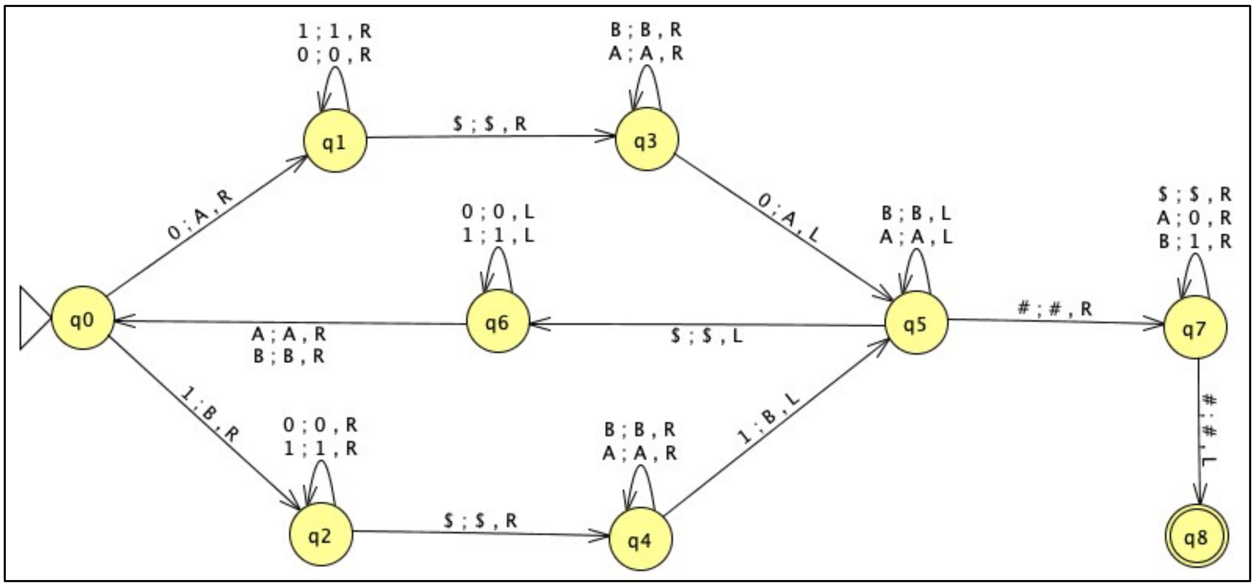

Figure 6: Turing Machine

Which class the time complexity of the given Turing machine belongs to?

a. $\boldsymbol{P}$ c. $NP - C$

b. NP d. None