QUIZ 3: 60 Minutes

Last Name: ____________________

First Name: ____________________

RIN: ____________________

Section: ____________________

Answer **ALL** questions.
NO COLLABORATION or electronic devices. Any violations result in an F.
NO questions allowed during the test. Interpret and do the best you can.

GOOD LUCK!

Circle at most one answer per question.
10 points for each correct answer

You **MUST** show **CORRECT** work to get full credit.

When in doubt, TINKER.

Total
200

INSTRUCTIONS

1. This is a **closed book** test. No electronics, books, notes, internet, etc.
2. The test will become available in Submitty at 8am on the test date.
3. Your PDF is due in Submitty by 2pm.
4. By submitting the test you attest that:
   – the work is entirely your own.
   – you obeyed the time limits of the exam.
5. Your submission *must* be typed and submitted as a PDF. The test time is for solving the problems. You may take extra time to type your answers and explanations. During the extra time, you cannot change answers or explanations.
6. You *must* show your work for *every* answer immediately after the answer. The format for what you hand in is something like:

(1)	A Because x is even, therefore ...
(2)	B Because $\sqrt{2}$ is irrational, therefore ...
(3)	C The number of links is the sum$1+2+\cdots+10$, which using the common sum $\frac{1}{2}(n)(n+1)=55$.
(4)	D By the law of total expectation, $\mathbb{E}[\mathbf{X}]=\cdots$
⋮	
(20)	A We proved in class that $\ell=n-1$. Therefore ...

   – Some problems may be "easy", so give a short explanation.
   – Some problems may require a detailed reasoning.
   – `3*3+1+3=13` is **not** an explanation. Everyone knows that `3*3+1+3=13`.
   Why this equation? Where do the numbers come from?

7. **If you don't show correct work, you won't get credit.**
8. Be careful. This is multiple choice.
   – Correct answers get 10 points.
   – Wrong answers or correct answers without correct justification get 0.
9. Submit with plenty of time to spare. A late test won't be accepted.

1. How many injective (1-to-1) functions map $\{a, b, c, d\}$ to $\{1, 2, 3\}$?

A 0.

B 36.

C 42.

D 81.

E None of the above.

2. How many surjective (onto) functions map $\{a, b, c, d\}$ to $\{1, 2, 3\}$?

A 0.

B 36.

C 42.

D 81.

E None of the above.

3. An injective function f maps a set $\mathcal{A}$ to $\mathbb{N}$, $f : \mathcal{A} \mapsto \mathbb{N}$. Which is not true?

A $\mathcal{A}$ can be finite.

B $\mathcal{A}$ can be infinite.

C $\mathcal{A}$ must be a subset of $\mathbb{N}$, $\mathcal{A} \subseteq \mathbb{N}$.

D $\mathcal{A}$ can be the set of all possible finite computer programs in python.

E All of the above is true.

4. A computing problem is a language. The cardinality of the set of all possible computing problems is:

A Finite.

B Countable.

C Infinite but countable.

D Uncountable.

E None of the above.

5. The language $\mathcal{L} = \{0, 00, 000\} \bullet \{\varepsilon, 1, 11\}$. Which string is not in $\mathcal{L}$?

A 0.

B 011.

C 100.

D 001.

E They are all in $\mathcal{L}$.

6. For languages $\mathcal{L}_1 = \{1\}^*$ and $\mathcal{L}_2 = \{1\} \bullet \{0, 1\}^*$, which is true? ($\{\}^*$ is Kleene star.)

A $\mathcal{L}_1 \subseteq \mathcal{L}_2$.

B $\mathcal{L}_2 \subseteq \mathcal{L}_1$.

C $\mathcal{L}_1 = \mathcal{L}_2$.

D The regular expressions describing $\mathcal{L}_1$ and $\mathcal{L}_2$ are not valid regular expressions.

E None of the above are true.

7. Which regular expression describes all the strings with at least two bits? ($\Sigma = \{0, 1\}$.)

A $\Sigma \bullet \Sigma$.

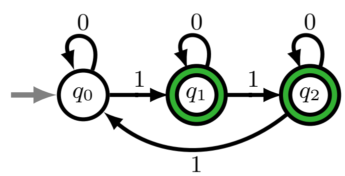
B Σ^*.

C $\Sigma^* \bullet \Sigma^*$.

D $(\Sigma \bullet \Sigma)^*$.

E None of the above.

8. What is the final resting state for the DFA with input 110010.



A q_0.

B q_1.

C q_2.

D This is not a valid DFA.

E None of the above.

9. How many 6 bit strings are in the (YES)-set of the DFA in problem 8.

A 19.

B 22.

C 39.

D 42.

E None of the above.

10. Which is the computing problem solved by the DFA in problem 8

A $\mathcal{L} = \{\text{strings with a number of 1s divisible by 3}\}$.

B $\mathcal{L} = \{\text{strings with a number of 1s not divisible by 3}\}$.

C $\mathcal{L} = \{\text{strings with three more 1s than 0s.}\}$.

D $\mathcal{L} = \{\text{strings with three more 0s than 1s}\}$.

E None of the above.

11. Which computing problem *cannot* be solved by a DFA (deterministic finite automata)?

[A] $\mathcal{L} = \{\text{strings with no 1s}\}$.

[B] $\mathcal{L} = \{\text{strings with no 1s or an even number of 0s}\}$.

[C] $\mathcal{L} = \{\text{strings with a number of 1s } \textit{not} \text{ divisible by 3}\}$.

[D] $\mathcal{L} = \{\text{strings which begin and end in different bits}\}$.

[E] Each problem above can be solved by a DFA.

12. The main limitation of the DFA which prevents it from solving $\mathcal{L} = \{0^n 1^n | n \geq 0\}$ is:

[A] The DFA is not a very fast machine so it would take too long.

[B] The DFA can't have more than one yes-state.

[C] The input string can be arbitrarily long.

[D] The DFA can go into an infinite loop.

[E] The DFA cannot remember how many 0s have gone by because it has only finitely many states.

13. Which string *cannot* be generated by the CFG: $S \to \varepsilon \mid 0 \mid 0S$.

[A] ε.

[B] 00.

[C] 000.

[D] 0001.

[E] They can all be generated.

14. Which string cannot be generated by the CGF shown?

$1 : S \to B1A \mid B1A1B$
$2 : A \to \varepsilon \mid B1B1B1B \mid AA$
$3 : B \to \varepsilon \mid 0B$

[A] 011101

[B] 110101

[C] 111100

[D] 011100

[E] They can all be generated.

15. What is the difference between a Turing machine decider and a Turing machine recognizer?

[A] Both are the same thing.

[B] A decider cannot write to the tape, a recognizer can.

[C] A decider can write to the tape, a recognizer cannot.

[D] A decider has a finite number of states, a recognizer can have infinitely many states.

[E] A decider must always halt, saying (YES) or (NO). A recognizer may not halt.

16. Consider the computing problem $\mathcal{L} = \{w\#w | w \in \{0,1\}^*\}$ (# is punctuation). Which claim is true?

[A] A DFA can solve $\mathcal{L}$.

[B] A DFA with a top-access stack can solve $\mathcal{L}$.

[C] A Turing machine decider can solve $\mathcal{L}$.

[D] A Turing machine decider cannot solve $\mathcal{L}$.

[E] None of the above.

17. The theory of computing and the Church-Turing thesis define computing problems and algorithms as:

[A] A computing problem is a string. An algorithm is a recognizer.

[B] A computing problem is a set of finite binary strings. An algorithm is a recognizer.

[C] A computing problem is a Turing Machine. An algorithm is a decider.

[D] A computing problem is a set of finite binary strings. An algorithm is a person.

[E] A computing problem is a set of finite binary strings. An algorithm is a decider.

18. The Ultimate Debugger, which we discussed in class solves, what problem?

[A] $\mathcal{L} = \{\langle M \rangle \# w | M$ halts on input $w\}$.

[B] $\mathcal{L} = \{\langle M \rangle \# w | M$ does not halt on input $w\}$.

[C] $\mathcal{L} = \{\langle M \rangle | M$ halts and says yes on some input$\}$.

[D] $\mathcal{L} = \{\langle M \rangle | M$ halts and says no on some input$\}$.

[E] None of the above.

19. Any decider for problem $\mathcal{L}_A$ can be used to decide problem $\mathcal{L}_B$. Which conclusion is not true?

[A] We found out $\mathcal{L}_A$ is decidable. We concluded $\mathcal{L}_B$ must be decidable.

[B] We found out $\mathcal{L}_A$ is undecidable. We concluded $\mathcal{L}_B$ could still be decidable.

[C] We found out $\mathcal{L}_B$ is decidable. We concluded $\mathcal{L}_A$ could still be undecidable.

[D] We found out $\mathcal{L}_B$ is undecidable. We concluded $\mathcal{L}_A$ must be undecidable.

[E] All of the above are true.

20. Let $\mathcal{M}$ be the set of all possible Turing Machines. Which statement is not true?

[A] Every Turing Machine in $\mathcal{M}$ can be uniquely encoded into a finite binary string.

[B] All Turing Machines in $\mathcal{M}$ can be listed: $\{\langle M_1 \rangle, \langle M_2 \rangle, \langle M_3 \rangle, \langle M_4 \rangle, \ldots, \}$.

[C] $\mathcal{M}$ is countable.

[D] There is an injection from $\mathcal{M}$ to $\mathbb{N}$.

[E] All of the above are true.

SCRATCH