Warmup 6: TMs, Recursive, R.e., Decidable and Undecidable

Testlet 6 will be administered on Canvas. There are 15 questions, a few True/False but mostly MultipleChoice. Each answer is locked as soon as you go to the next question. Any question not answered will be graded as incorrect. Time Limit = 20 minutes.

1. True/False: If a language is the output of some Printer-TM, then it must be r.e.
   - True

2. Which of the following is generated by a context-sensitive grammar but not by any unrestricted grammar?
   - (a) $0^n1^n$
   - (b) $A_{tm}$
   - (c) $S_{tm}$
   - (d) None of the above
   - D. Does not exist.

3. What is the best description of the following grammar?
   - $S \rightarrow abS$
   - $bS \rightarrow Sc$
   - $SS \rightarrow a$
   - (a) Regular grammar
   - (b) Context-sensitive grammar
   - (c) Kelsey grammer
   - (d) Unrestricted grammar
   - D

4. In which of the following is it essential that we use parallelism?
   - (a) The proof that recursive languages are closed under star
   - (b) The proof that recursive languages are closed under intersection
   - (c) The proof that r.e. languages are closed under star
   - (d) The proof that r.e. languages are closed under intersection
   - C

5. Which of the following problems is decidable for a regular language?
   - (a) Is it infinite?
   - (b) Does it contain the string TIGER?
   - (c) Is it equal to its complement?
   - (d) All of the above
   - D
6. Which of the following problems is decidable for context-free grammars?
   (a) Does the grammar generate the string ORANGE?
   (b) Does the grammar generate everything?
   (c) Do two grammars generate the same language?
   (d) All of the above

7. Which of the following is true about the language $A_{tm}$?
   (a) It is recursive
   (b) It is r.e.
   (c) It is finite
   (d) It consists of the encodings $\langle M \rangle$ such that $M$ accepts $\langle M \rangle$

8. True/False: The complement of $A_{tm}$ is also r.e.

9. True/False: $S_{tm}$ is defined as the set of representations of TMs that do not halt on their own representation.

10. Which of the following statements is true about the proof that $S_{tm}$ is not r.e.
    (a) It relies on the fact that a TM cannot recognize its own representation
    (b) It relies on the fact that a TM can simulate another TM
    (c) It relies on the fact that the sky is green
    (d) All the above

11. Which of the following decision problems is decidable?
    (a) The halting problem for TMs
    (b) The halting problem for nondeterministic TMs
    (c) The halting problem for DFAs
    (d) The halting problem for 2-PDAs

12. Diagonalization was invented by
    (a) Cantor
    (b) Deacon
    (c) Priestley
    (d) Pope
13. When one performs diagonalization on the following grid, what is the result?

<table>
<thead>
<tr>
<th>P</th>
<th>O</th>
<th>N</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>T</td>
<td>A</td>
<td>H</td>
</tr>
<tr>
<td>A</td>
<td>C</td>
<td>H</td>
<td>E</td>
</tr>
<tr>
<td>N</td>
<td>A</td>
<td>V</td>
<td>Y</td>
</tr>
</tbody>
</table>

(a) TEST
(b) ROFL
(c) QUIZ
(d) GAGA

14. Assume that language $A$ reduces to language $B$ and language $B$ reduces to language $C$. Assume that $A$ is recursive and $C$ is r.e. What can we say about language $B$?

(a) It is recursive
(b) It is r.e. but not recursive
(c) It is r.e. and might or might not be recursive
(d) The given situation is impossible

C. $B$ might actually be $A$ or $C$

15. Which of the following sets is NOT countable?

(a) Binary strings
(b) CFGs
(c) Languages
(d) REs

C