Assignment 6

Due on 2019-11-21, 23:59:59 IST.

1. Describe an operation that takes two boolean values and returns a single boolean value, which is true if and only if the two input values are different.

2. Write a program that takes a list of integers and returns a new list containing only the elements that are divisible by 7.

3. Implement a function that computes the factorial of a non-negative integer using recursion.

4. Write a class that represents a stack data structure with the following methods: push, pop, and size.

5. Describe the difference between a queue and a stack.

6. Consider the following graph:

   A -- B -- C -- D
   |       |       |
   E -- F

   a) Describe the breadth-first search (BFS) traversal of this graph.
   b) Describe the depth-first search (DFS) traversal of this graph.

7. Explain the difference between a directed graph and an undirected graph.

8. Consider the following recursive function:

   def factorial(n):
       if n == 0:
           return 1
       else:
           return n * factorial(n-1)

   a) Trace the execution of `factorial(5)`.
   b) Discuss the time complexity of this function.

9. Consider the following non-regular language:

   `{a^n b^n | n \geq 1}`

   a) Does this language belong to the class of regular languages? Why or why not?
   b) Design a Turing machine that recognizes this language.

10. Describe the concept of a nondeterministic Turing machine.

11. Explain the difference between a deterministic and a nondeterministic Turing machine.

12. Explain the concept of a Turing machine with a read-only tape.


14. Consider the following grammar:

   S \rightarrow aSb | a
   A \rightarrow a

   a) Is this grammar LL(1)? Why or why not?
   b) Design a parser for this grammar.

15. Consider the following language:

   `{a^{2^n} | n \geq 0}`

   a) Is this language regular? Why or why not?
   b) Describe a Turing machine that recognizes this language.

16. Explain the concept of a finite automaton.

17. Consider the following finite automaton:

   ![Finite Automaton Diagram]

   a) Does this automaton accept the language `{a^n b^n | n \geq 1}`?
   b) Describe the languages accepted by this automaton.

18. Explain the concept of a transition function in a finite automaton.

19. Consider the following regular expression:

   `(a|b)*c(a|b)*`

   a) Construct the equivalent finite automaton.
   b) Describe the languages accepted by this regular expression.

20. Explain the concept of a regular language.

21. Consider the following deterministic finite automaton:

   ![Deterministic Finite Automaton Diagram]

   a) Does this automaton accept the language `{a^n b^n | n \geq 1}`?
   b) Describe the languages accepted by this automaton.

22. Explain the concept of a homomorphism in the context of formal languages.

23. Consider the following language:

   `{a^n b^n | n \geq 1}`

   a) Is this language context-free? Why or why not?
   b) Design a pushdown automaton that recognizes this language.

24. Explain the concept of a context-free language.

25. Consider the following context-free grammar:

   S \rightarrow aSb | a
   A \rightarrow a

   a) Is this grammar context-free? Why or why not?
   b) Design a pushdown automaton that recognizes this grammar.

26. Explain the concept of a context-sensitive language.

27. Consider the following language:

   `{a^n b^{2n} | n \geq 0}`

   a) Is this language context-sensitive? Why or why not?
   b) Design a Turing machine that recognizes this language.

28. Explain the concept of a recursively enumerable language.

29. Consider the following language:

   `{a^n b^n c^n | n \geq 0}`

   a) Is this language recursively enumerable? Why or why not?
   b) Describe a Turing machine that recognizes this language.

30. Explain the concept of a decidable language.

31. Consider the following language:

   `{a^{2^n} | n \geq 0}`

   a) Is this language decidable? Why or why not?
   b) Describe a Turing machine that recognizes this language.

32. Explain the concept of a recursively enumerable language.

33. Consider the following language:

   `{a^n b^{2n} | n \geq 0}`

   a) Is this language recursively enumerable? Why or why not?
   b) Describe a Turing machine that recognizes this language.

34. Explain the concept of a decidable language.

35. Consider the following language:

   `{a^n b^n c^n | n \geq 0}`

   a) Is this language decidable? Why or why not?
   b) Describe a Turing machine that recognizes this language.

36. Explain the concept of a recursively enumerable language.

37. Consider the following language:

   `{a^{2^n} | n \geq 0}`

   a) Is this language recursively enumerable? Why or why not?
   b) Describe a Turing machine that recognizes this language.

38. Explain the concept of a decidable language.

39. Consider the following language:

   `{a^n b^{2n} | n \geq 0}`

   a) Is this language decidable? Why or why not?
   b) Describe a Turing machine that recognizes this language.

40. Explain the concept of a recursively enumerable language.

41. Consider the following language:

   `{a^n b^n c^n | n \geq 0}`

   a) Is this language recursively enumerable? Why or why not?
   b) Describe a Turing machine that recognizes this language.

42. Explain the concept of a decidable language.