AP Computer Science Principles
Unit 1B: Computing Mathematics
Test 2
Mr. Svitilla
Name: $\qquad$ Date: $\qquad$

## Part 1: Number Bases

1. Fill in the following decimal, hexadecimal binary table for 1 to 15 .
(4 points)

| Dec | Hex | Bin | Dec | Hex | Bin |
| ---: | :--- | :--- | :--- | :--- | :--- |
| 0 |  |  | 8 |  |  |
| 1 |  |  | 9 |  |  |
| 2 |  |  | 10 |  |  |
| 3 |  |  | 11 |  |  |
| 4 |  |  | 12 |  |  |
| 5 |  |  | 13 |  |  |
| 6 |  |  | 14 |  |  |
| 7 |  |  | 15 |  |  |

Convert the following. (3 pts each)
2. $10011100_{\text {bin }}$ to dec
3. B2D $2_{\text {hex }}$ to dec

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4. $4133_{\text {Five }}$ to dec
5. $289_{\text {dec }}$ to bin
6. $46080_{\text {dec }}$ to hex

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7. Convert the following binary number directly to a two-digit hexadecimal number: (3 points)
$11000011_{\text {bin }}$
8. Convert the following 2 digit hexadecimal number directly into an eight bit binary number. (3 points)

$$
62_{\text {hex }}
$$

Part 2: Modular Arithmetic (3 points each)
9. $22(\bmod 5) \equiv$
10. $5+8(\bmod 2) \equiv$
11. $10-2(\bmod 8) \equiv$
12. $88(\bmod 7) \equiv$
13. $185(\bmod 17) \equiv$
14. Define what it means for a whole number to be an even number and to be an odd number in terms of modular arithmetic. (2 points)

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Part 3: String Operators
Match each of the following string operators to its description by
writing the letter next to each operation (2 points each)

| 15. Two's Compliment | A. Left fill zeros till the string is <br> the desired length |
| :--- | :--- |
| 16. Reverse | B. The characters of a string <br> written in the opposite order |
| 17. Checksum | C. The leftmost bit <br> D. The rightmost bit |
| 18. String length | E. The sum of the bit values of <br> a string |
| 19. Most Significant Bit | F. Each bit of a binary string <br> changed to the opposite bit <br> value |
| 20. Least Significant Bit | G. Two strings combined into <br> one string with the first <br> string written to the left of |
| 21. Concatenate | H. The second string <br> in a string |
| 22. Pad | in characters |

23. Transpose the following strings four places. (4 points)
a. 11110100
b. balloon
24. Split the following strings into four strings. (4 points)
a. 10110011
b. 0123456789

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25. Given the following string 0110001010011101 (5 points)
a. What is the string length?
b. How many bytes of information does it contain?
c. What is the value of the most significant bit (MSB)?
d. What is the value of the least significant bit (LSB)?
e. What is the value of the checksum?

Part 4: Time Complexity
26. Below each of the following time complexity designations write the Big-O notation and write a number from 1 to 8 ordering them for describing the fastest to slowest algorithm. (10 points)
Linear Lin-Log Exponential

Factorial
Log
Constant

Polynomial Roots
27. The time complexity of an algorithm that runs in quadratic time is a special case of which other designation. (2 points)

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28. The tables below relates the complexity of an algorithm's input set to the number of steps the task requires to complete.
a. Below each set calculate the incremental change. (2 points)
b. Indicate whether the incremental change is near zero, near constant (non-zero), or increasing. (2 points)
c. Write the Big-O notation or function name representing the time complexity of the algorithm. (1 point)

Set A
Input Set Complexity Steps to complete

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 23 | 24 | 23 | 23 | 23 | 22 | 23 | 23 |

Set B
Input Set Complexity
Steps to complete

| 1 | 2 | 3 | 4 | 5 | 6 |
| ---: | ---: | ---: | ---: | ---: | ---: |
| 8 | 23 | 44 | 71 | 104 | 143 |

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29. Describe how a linear search and a binary search are completed for a given data set. Which runs faster if the data set is ordered? What time complexity is its worst case? (4 points)
30. What is the worst-case and average time complexity for searching a Hash Table? What do we call the number the hash function associates to the data point? (3 points)

## Bonus:

Write an encoding for a binary string that enables you to add an error check to a communication protocol. You and a partner could use this part of the protocol with the internet simulator to validate the integrity of each binary message you send each other. Assume you will be sending each other strings that are exactly eight bits long. The string contains both the message and the checksum. Determine which bits in the string will be used to represent the checksum and which are used to send information. What is the most number of bits you could use for a message while still having enough bits to represent the checksum out of the 8 total bits?

