Test Bank—Chapter One (Data Representation)

Multiple Choice Questions

1. Which of the following Boolean operations produces the output 1 for the fewest number of input patterns?

A. AND B. OR C. XOR

ANSWER: A

2. Which of the following best describes the NOR operation?

A. An XOR followed by a NOT B. An OR followed by a NOT
C. A NOT followed by a NOT C. An AND followed by a NOT

ANSWER: B

3. Which of the following bit patterns cannot be expressed in hexadecimal notation?

A. 11111111 B. 1001 C. 110011 D. 100000000001

ANSWER: C

4. Which of the following is the binary representation of 4 5/8?

A. 100.11 B. 10.011 C. 110.101 D. 100.101

ANSWER: D

5. Which of the following bit patterns represents the value 5 in two's complement notation?

A. 00011010 B. 11111011 C. 00000101 D. 11111011

ANSWER: C

6. Which of the following bit patterns represents the value -5 in two's complement notation?

A. 00011010 B. 11111011 C. 00000101 D. 11111011

ANSWER: D

7. What is the result of the following addition problem (using two's compliment notation)?

```
  00001111
+ 10101010
```

A. 011000101 B. 10111001 C. 01010101 D. 10110101

ANSWER: B

8. What is the result of the following subtraction problem (using two's compliment notation)?

```
  00001111
- 10101010
```

A. 011000101 B. 10111001 C. 01010101 D. 10110101

ANSWER: A

9. In which of the following addition problems (using two's complement notation) does an overflow error occur?

A. 0011 + 1010 B. 0100 + 0100 C. 1100 + 1100

ANSWER: B

10. Which of the following representations in two's complement notation represents the largest value?

A. 00000010 B. 11111111 C. 00000001 D. 11111110

ANSWER: A

11. Which of the following representations in two's complement notation represents the smallest value?

A. 00000010 B. 11111111 C. 00000001 D. 11111100

ANSWER: D

12. Which of the following bit patterns (represented in hexadecimal notation) represents a negative number in two's complement notation?

A. 7F B. 55 C. A6 D. 08

ANSWER: C

13. Which of the following bit patterns (represented in hexadecimal notation) represents a positive number in two's complement notation?

A. 7F B. F7 C. A8 D. 8A

ANSWER: A

14. What value is represented by the bit pattern 01011100 when interpreted using floating-point format in which the most significant bit is the sign bit, the next three bits represent the exponent field in excess notation, and the last four bits represent the mantissa?

A. -1 1/2 B. 1 1/2 C. -3/8 D. 3/8

ANSWER: B

15. Which of the following values cannot be stored accurately using a floating-point format in which the most significant bit is the sign bit, the next three bits represent the exponent field in excess notation, and the last four bits represent the mantissa?

A. 2 1/2 B. 3/16 C. 7 D. 6 1/4

ANSWER: D

16. Which of the following bit-patterns represents the smallest value using the floating-point format in which the most significant bit is the sign bit, the next three bits represent the exponent field in excess notation, and the last four bits represent the mantissa?

A. 01001000 B. 01011000 C. 00101000 D. 01111000

ANSWER: C

17. Which of the following data storage systems provides the most efficient random access to individual data items?

A. Main memory B. Magnetic disk C. CDs/DVDs D. Flash drives

ANSWER: A

18. Which of the following storage systems is best suited for storing and retrieving long strings of data that are processed in their sequential order?

A. Main memory B. Magnetic disk C. CDs/DVDs

ANSWER: C

19. Which of the following mass storage system does not require physical motion?

A. Magnetic tape B. Magnetic disk C. DVDs D. Flash drives

ANSWER: D

20. Assuming that each of the following bit patterns originally had even parity, which one contains an error?

A. 100110100 B. 110000011 C. 000011000 D. 100001001

ANSWER: D

21. How many errors per pattern could be corrected when using an error-correcting code in which any two code patterns differ by a Hamming distance of 8?

A. 3 B. 4 C. 5 D. 6

ANSWER: A

22. Which of the following is a possible LZW compression of the message “xyz xyz xyz”?

A. 1234 B. 1234545 C. 232 D. 12

ANSWER: B

ANSWER: C

23. Which of the following systems is least efficient when encoding numeric values?

A. Two’s complement notation B. Excess notation
C. ASCII D. Floating-point notation

ANSWER: C

24. Which of the following is a means of encoding music?

A. ASCII B. MIDI C. JPEG D. GIF

ANSWER: B

25. Which of the following provides a compressed representation of an image by limiting the number of different pixel colors to 256, thereby enabling each pixel in an image to be represented by a single byte whose value indicates which of a palette of entries represents the pixel's color?

A. ASCII B. MPEG C. JPEG D. GIF

ANSWER: D

Fill-in-the-blank/Short-answer Questions

1. A computer's main memory consists of numerous memory cells, each of which contains _____ bits. Each memory cell is identified by a numeric value called the cell's _____.

ANSWER: eight, address

2. Represent the bit pattern 1011010010011111 in hexadecimal notation.

_____

ANSWER: B49F

3. A7DF is the hexadecimal representation for what bit pattern?

_____

ANSWER: 1010 0111 1101 1111

4. How many different bit patterns can be formed if each must consist of exactly 6 bits?

_____

ANSWER: 64

5. How many bits are needed to represent 1024 different bit patterns?

_____

ANSWER: 10

6. Translate each of the following binary representations into its equivalent base ten representation.

A. 1100 _____

B. 10.011 _____

C. 0.01 _____

D. 10001 _____

ANSWER: A. 12 B. 2 3/8 C. 1/4 D. 17

7. Rewrite each of the following values (represented in base ten notation) in binary notation.

A. 7 _____

B. 23 _____

C. 2 1/4 _____

D. 5/8 _____

ANSWER: A. 111 B. 10111 C. 10.01 D. 0.101

8. If the patterns 101.11 and 1.011 represent values in binary notation, what is the binary representation of their sum?

_____

ANSWER: 111.001

9. Using a two's complement notation system in which each value is represented by a pattern of six bits, represent the value 3.

_____

ANSWER: 000011

10. Using a two's complement notation system in which each value is represented by a pattern of six bits, represent the value -3.

_____

ANSWER: 111101

11. What is the largest positive integer that can be represented in a two's complement system in which each value is represented by eight bits?

_____

ANSWER: 127 (represented by 01111111)

12. What is the smallest negative integer that can be represented in a two's complement system in which each value is represented by eight bits?

_____

ANSWER: -128 (represented by 10000000)

13. In a two's complement system, what value is represented by the pattern 1111111111111001?

_____

ANSWER: -7

14. When using two's complement notation, what bit pattern represents the negation of 01101010?

_____

ANSWER: 10010110

15. What value is represented by each of the following patterns in excess notation?

A. 10000 ____ B. 0110 ____ C. 1011 ____

ANSWER: A. 0, B. -2, C. 3

16. Using an 8-bit floating-point format in which the most significant bit is the sign bit, the next three bits represent the exponent field in excess notation, and the last four bits represent the mantissa, write the bit pattern that represents the value 1 3/4. (Use normalized form.)

_____

ANSWER: 01011110

17. What is the largest value that can be represented in a floating-point system in which each value is encoded by a byte whose most significant bit is the sign bit, the next three bits represent the exponent field in excess notation, and the last four bits represent the mantissa?

_____

ANSWER: 7 1/2 (represented as 01111111)

18. Which of the following addition problems cannot be solved accurately when using a floating-point system in which each value is encoded by a byte whose most significant bit is the sign bit, the next three bits represent the exponent field in excess notation, and the last four bits represent the mantissa?

A. 2 1/2 + 1 3/8 B. 3 1/2 + 4 1/2 C. 7 + 3/4

_____

ANSWER: A, B, and C

19. The following is an error-correcting code in which any two patterns differ by a Hamming distance of at least three.

Symbol	Representation
A	000000
B	001111
C	010011
D	011100
E	100110
F	101001
G	110101
H	111010

Decode each of the following patterns

010011 _____ 101010 _____ 011000 _____ 101101 _____

ANSWER: C, H, D, F

20. How many errors in a single code pattern could be corrected when using an error-correcting code in which each code pattern is a Hamming distance of at least seven from any other code pattern?

_____

ANSWER: 3

21. The following is a message that was originally encoded so that each pattern had odd parity. Circle the patterns in which an error has definitely occurred.

101110101 111110000 100010010 000000000 111111111 010001000 100111101

_____

ANSWER: First, fourth, sixth, and seventh

22. Data compression techniques apply various principles to reduce the size of data. One, called _____, avoids repeating long strings of the same data item. Another, called _____, encodes the difference between consecutive blocks of data rather than encoding each block in its entirety. Still another, called _____, uses short bit patterns to encode frequently occurring items and longer patterns to encode less frequent items.

ANSWER: Run-length encoding, relative encoding, and frequency-dependent encoding.

Vocabulary (Matching) Questions

The following is a list of terms from the chapter along with descriptive phrases that can be used to produce questions (depending on the topics covered in your course) in which the students are ask to match phrases and terms. An example would be a question of the form, "In the blank next to each phrase, write the term from the following list that is best described by the phrase."

Term	Descriptive Phrase
bit	Binary digit
Boolean operation	AND, OR, XOR, NOT
address	A numeric value used to identify a memory cell
hexadecimal notation	An efficient way of representing bit patterns
track	A circle on the surface of disk platter on which data is written/read
sector	A segment of a track in a mass storage system
cylinder	A set of tracks at a given position of the read/write heads
seek time	The time required to move the read/write heads from one track to another
latency time	The average amount of time required for the desired data to rotate around to the read/write head
transfer rate	The rate at which data can be written to or read from a device
zoned-bit recording	A means of increasing the storage capacity of a magnetic disk system
ISO	An international organization for establishing standards
ANSI	A major standardization organization within the United States
ASCII	A system developed by the American Standards Institute for encoding text.
flip-flop	A digital circuit capable of holding a single digit
two's complement notation	A means of encoding whole numbers
floating-point notation	A means of encoding numeric values that may involve fractions

truncation	An error that may occur when using floating-point notation
pixel	A small part of an image
GIF	A means of compressing an image file by restricting the number of colors available
JPEG	A means of compressing images by blurring the boundaries between different colors while maintaining all brightness information
Unicode	A means of encoding text in which each symbol is represented by 21 bits which may be encoded in UTF-8, UTF-16, or UTF-32 formats.
SD card	An application of flash technology
Flash memory	A mass storage device that traps electrons in tiny chambers of silicon dioxide
LZW	An example of adaptive dictionary encoding
MIDI	A means of encoding music in terms of notes and instruments rather than actual audio
VLSI	A means of constructing complex circuitry in a very small space.

General Format Questions

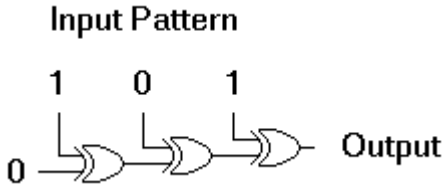
1. Describe how a computer can produce an incorrect answer when performing numerical computations even though it has not malfunctioned.

ANSWER: Most students will probably refer to overflow and truncation errors.

2. Describe how the concept of Hamming distance is used to produce an error-correcting code.

ANSWER: By designing a code in which each pattern has a Hamming distance of *n* from any other pattern, patterns with fewer than *n*/2 errors can be corrected by replacing them with the code pattern that is closest.

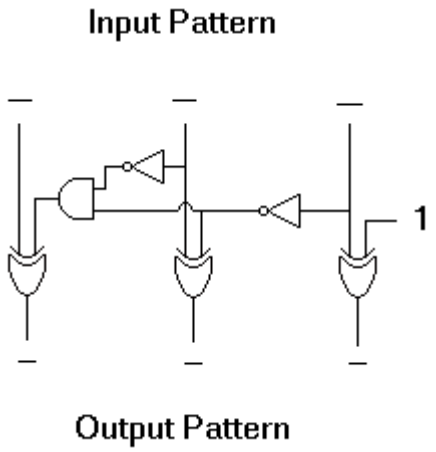
3. a. What is the output of the circuit below?



b. In general, how does the three-bit input pattern across the top of the diagram relate to the circuit's output?

ANSWER: a. 0 b. The output is 0 if the input parity is odd; the output is 1 if the input parity is even.

4. If the input and output bit patterns in the circuit below are interpreted as binary representations of numeric values, what operation does the circuit perform?



ANSWER: The circuit subtracts one (except for the case of the input being 000).

5. Explain why such terms as kilo, mega, and giga have acquired double meanings.

ANSWER: The prefixes kilo, mega, and giga are used traditionally to refer to units measured in powers of thousand. However, in reference to memory capacities these prefixes are used to reference units that are powers of two. For example, one kilobyte is 2^{10}, which is 1024 bytes.

6. Convert the following addition problem into two's complement notation (using four bits per value), perform the addition, convert the answer back into base ten notation, and explain the results.

```
  6
+ 3
```

ANSWER: In two's complement notation the problem is to add 0110 and 0011. The sum is 1001 which translates to -7. This answer is incorrect due to overflow.

7. Under what condition is each of the following data compression techniques most effective?

a. Run-length encoding
b. Relative encoding

ANSWER: a. Compresses most when data consists of long strings of the same entry.
b. Compresses most when each block of data differs little from the previous block.

8. What is frequency-dependent encoding?

ANSWER: Frequency-dependent encoding is an encoding system that uses short bit patterns to represent data items that occur most often and longer patterns to represent less frequently occurring items. The result is that entire blocks of data can be represented in less space than would be required if each data item were represented by the same size bit pattern.

9. Construct the entire two's complement scale in which each value is represented by three bits.

ANSWER:

3	011
2	010
1	001
0	000
-1	111

-2 110
-3 101
-4 100

10. To what does the term “normalized form” refer in the context of floating-point notation?

ANSWER: Normalized form refers to a standard for positioning the bit pattern within the mantissa field. Many values can be represented in floating-point notation by different bit patterns, only one of which is in normalized form. Hence, restricting representations to normalized form assures that each value is represented by a unique pattern.

11. Explain why the final version of the dictionary need not be transmitted with a message encoded using LZW compression.

ANSWER: The dictionary can be constructed during decompression in the same way it was constructed during compression.

12. Among the Boolean operations AND, OR, EXCLUSIVE OR, and NOT, which is least like the others? Explain your answer.

ANSWER: There is not really a right or wrong answer. The student’s explanation is the most important part. Most students will probably answer NOT because it has only one input whereas the others have two.

13. If a term paper consisted 42 pages, each containing 40 lines of 100 symbols each (counting each space as a symbol), was to be encoded using Unicode, how many bytes of storage space would be required?

ANSWER: 336,000 bytes (168,000 symbols times 2 bytes per symbol)

14. Explain why adding only a few characters to a text file may increase the file’s size by several hundred bytes and at other times may not increase the file’s size at all.

ANSWER: File space is allocated in terms of physical records, each of which is several hundred bytes in size. Thus, the size of a file grows by physical record units rather than by byte size units.

15. In a two’s complement system, what value can be added to any other value without causing an overflow? How many values in the system have this property? Explain your answer.

ANSWER: Adding the value 0 to any other value will not produce an overflow. However, if m is the largest positive integer that can be represented in the system, then any value in the range 1 to m will produce an overflow when added to m, and any value in the range -1 to -(m + 1) will produce an overflow when added to -(m + 1).

16. Why is the rightmost bit in a string of bits considered to be the least significant bit?

ANSWER: It is the least significant digit in a number. A change to this bit will have the least effect on the value of the number. A change to any other bit will have a greater effect on the value of the number.