

## 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. 10000000001

ANSWER: C

4. Which of the following is the binary representation of  $4 \frac{5}{8}$ ?

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

- A.  $\begin{array}{r} 0011 \\ + 1010 \\ \hline \end{array}$       B.  $\begin{array}{r} 0100 \\ + 0100 \\ \hline \end{array}$       C.  $\begin{array}{r} 1100 \\ + 1100 \\ \hline \end{array}$

ANSWER: B

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

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

ANSWER: A

9. 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

10. 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.  $-1 \frac{1}{2}$                       B.  $1 \frac{1}{2}$                       C.  $-\frac{3}{8}$                       D.  $\frac{3}{8}$

ANSWER: B

11. 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.  $2 \frac{1}{2}$  B.  $\frac{3}{16}$                       C. 7                      D.  $6 \frac{1}{4}$

ANSWER: D

121. 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

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

- A. Main memory                      B. Magnetic disk                      C. Optical CDs and DVDs

ANSWER: A

14. 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. Optical CDs and DVDs

ANSWER: C

15. 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

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

- A. 10110100                      B. 11000011                      C. 00011000                      D. 10001001

ANSWER: D

17. 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

18. 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

19. How many different symbols can be encoded using Unicode?

- A. 256    B. 4,096    C. 65,536    D. 1,046,476

ANSWER: C

20. 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

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

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

ANSWER: B

### 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. 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.  $2\frac{3}{8}$    C.  $\frac{1}{4}$    D. 17

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

- A. 7      \_\_\_\_\_
- B. 23      \_\_\_\_\_
- C.  $2\frac{1}{4}$       \_\_\_\_\_
- D.  $\frac{5}{8}$       \_\_\_\_\_

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

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

\_\_\_\_\_

ANSWER: 111.001

8. 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

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: 111101

10. 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)

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

\_\_\_\_\_

ANSWER: -7

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

\_\_\_\_\_

ANSWER: 10010110

13. 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

14. 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  $1 \frac{3}{4}$ . (Use normalized form.)

\_\_\_\_\_

ANSWER: 01011110

15. 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:  $7 \frac{1}{2}$  (represented as 01111111)

16. 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.  $2 \frac{1}{2} + 1 \frac{3}{8}$                       B.  $3 \frac{1}{2} + 4 \frac{1}{2}$                       C.  $7 + 3 \frac{3}{4}$

\_\_\_\_\_

ANSWER: A, B, and C

17. 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

18. 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

19. 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.

10110101   11110000   10010010   00000000   11111111   00001000   00111101

\_\_\_\_\_

ANSWER: Second, fourth, fifth, and sixth

20. 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.

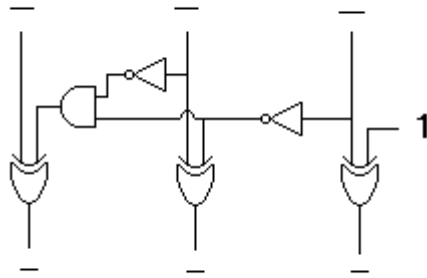
## Vocabulary (Matching) Questions

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
sector	A segment of a track in a mass storage system
zoned-bit recording	A means of increasing the storage capacity of a magnetic disk system
buffer	A storage area used to hold data on a temporary basis, often as a step in transferring the data from one device to another
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



### Input Pattern



### Output Pattern

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

5. Explain why such terms as kilobyte, megabyte, and gigabyte have acquired double meanings.

ANSWER: The prefixes kilo, mega, and giga are used traditionally to refer to units measured in powers of ten. However, due to the early misuse of the prefix kilo in reference to units of the size  $1024$ , these prefixes are now often used to refer to units that are powers of two—especially when referring to the capacity of main memories.

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.

$$\begin{array}{r} 6 \\ + 3 \\ \hline \end{array}$$

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?

- Run-length encoding
- 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  $-(m + 1)$ .

## Test Bank—Chapter Two (Data Manipulation)

The following table is from Appendix C of the text. It is included here so that it can be incorporated in tests for student reference. Questions in this test bank refer to this table as the “language description table.”

Op-code	Operand	Description
1	RXY	LOAD the register R with the bit pattern found in the memory cell whose address is XY. <i>Example:</i> 14A3 would cause the contents of the memory cell located at address A3 to be placed in register 4.
2	RXY	LOAD the register R with the bit pattern XY. <i>Example:</i> 20A3 would cause the value A3 to be placed in register 0.
3	RXY	STORE the bit pattern found in register R in the memory cell whose address is XY. <i>Example:</i> 35B1 would cause the contents of register 5 to be placed in the memory cell whose address is B1.
4	ORS	MOVE the bit pattern found in register R to register S. <i>Example:</i> 40A4 would cause the contents of register A to be copied into register 4.
5	RST	ADD the bit patterns in registers S and T as though they were two's complement representations and leave the result in register R. <i>Example:</i> 5726 would cause the binary values in registers 2 and 6 to be added and the sum placed in register 7.
6	RST	ADD the bit patterns in registers S and T as though they represented values in floating-point notation and leave the floating-point result in register R. <i>Example:</i> 634E would cause the values in registers 4 and E to be added as floating-point values and the result to be placed in register 3.
7	RST	OR the bit patterns in registers S and T and place the result in register R. <i>Example:</i> 7CB4 would cause the result of ORing the contents of registers B and 4 to be placed in register C.
8	RST	AND the bit patterns in register S and T and place the result in register R. <i>Example:</i> 8045 would cause the result of ANDing the contents of registers 4 and 5 to be placed in register 0.
9	RST	EXCLUSIVE OR the bit patterns in registers S and T and place the result in register R. <i>Example:</i> 95F3 would cause the result of EXCLUSIVE ORing the contents of registers F and 3 to be placed in register 5.
A	R0X	ROTATE the bit pattern in register R one bit to the right X times. Each time place the bit that started at the low-order end at the high-order end. <i>Example:</i> A403 would cause the contents of register 4 to be rotated 3 bits to the right in a circular fashion.
B	RXY	JUMP to the instruction located in the memory cell at address XY if the bit pattern in register R is equal to the bit pattern in register number 0. Otherwise, continue with the normal sequence of execution. (The jump is implemented by copying XY into the program counter during the execute phase.) <i>Example:</i> B43C would first compare the contents of register 4 with the contents of register 0. If the two were equal, the pattern 3C would be placed in the program counter so that the next instruction executed would be the one located at that memory address. Otherwise, nothing would

- be done and program execution would continue in its normal sequence.
- C 000      HALT execution.  
*Example:* C000 would cause program execution to stop.

### Multiple Choice Questions

1. Which of the following is not contained in a CPU?

- A. Instruction register      B. Program counter  
C. General-purpose register      D. Memory cell

ANSWER: D

2. Which of the following instructions (as described in the language description table) changes the contents of a memory cell?

- A. 10AB      B. 20AB      C. 30AB      D. 40AB

ANSWER: C

3. Which of the following instructions (as described in the language description table) places 00000000 in register A?

- A. 1A00      B. 2A00      C. 3A00      D. 200A

ANSWER: B

4. Which of the following instructions (as described in the language description table) places 00000000 in register 5?

- A. 25FFB. 9555      C. 15FFD. 8555

ANSWER: B

5. Which of the following instructions (as described in the language description table) will not change the contents of register 5?

- A. 1508      B. 2508      C. A503      D. A508

ANSWER: D

6. Which of the following instructions (as described in the language description table) is equivalent to requesting that register A be rotated to the left by three bits?

- A. AA05      B. AA03      C. AA08      D. AA01

ANSWER: A

7. Which of the following instructions (as described in the language description table) changes the contents of register 7?

- A. 4077      B. 4075      C. 4057      D. 37BB

ANSWER: C

8. Which of the following is not a form of parallel processing?

- A. SISD      B. MIMD      C. SIMD

ANSWER: A

9. In which of the following locations is information most readily available for manipulation by the CPU?

- A. General-purpose registers      B. Main memory      C. Mass storage

ANSWER: A

10. The bus in a computer is an example of which form of communication?

- A. Serial      B. Parallel      C. Neither A nor B

ANSWER: B

11. Which of the following instructions does not fall in the category of arithmetic/logic instructions?

- A. ROTATE      B. ADD      C. OR      D. JUMP

ANSWER: D

12. Which of the following instructions falls in the category of data transfer instructions?

- A. LOAD      B. AND      C. ROTATE      D. JUMP

ANSWER: A

13. Which of the following is not a component of a machine instruction?

- A. Op-code      B. Port      C. Operand

ANSWER: B

14. Which of the following is not an activity performed entirely within a CPU?

- A. Fetch instructions      B. Perform Boolean operations  
C. Perform arithmetic operations      D. Move data between registers

ANSWER: A

15. What mask in register F would cause the instruction 8AAF (refer to the language description table) to put a 0 in the most significant bit of register A without disturbing the other bits?

- A. 11111110      B. 00000001      C. 10000000      D. 01111111

ANSWER: D

16. What mask in register F would cause the instruction 7AAF (refer to the language description table) to put a 1 in the most significant bit of register A without disturbing the other bits?

- A. 11111110      B. 00000001      C. 10000000      D. 01111111

ANSWER: C

17. Which of the following instructions will not produce the same result as the other two? (Refer to the language description table.)

- A. A502      B. A506      C. A50A

ANSWER: B

18. Which of the following instructions will not produce the same result as the other two? (Refer to the language description table.)

- A. 9555      B. 2500      C. 1500

ANSWER: C

19. If register A contained the pattern 00000000, which of the following instructions could alter the contents of register 0? (Refer to the language description table.)

- A. 700A      B. 800A      C. 900A

ANSWER: B

20. Which of the following instructions (as described in the language description table) is essentially an unconditional jump?

- A. B033      B. B133C. B233D. B333

ANSWER: A

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

1. If register 0 contains the pattern 01101001 before executing the instruction A003 (see the language description table), what bit pattern will be in register 0 after the instruction is executed?

\_\_\_\_\_

ANSWER: 00101101

2. If registers 5 and 6 contain the bit patterns 5A and 58 respectively, what bit pattern will be in register 4 after executing the instruction 5456? (See language description table.)

\_\_\_\_\_

ANSWER: B2

3. If registers 5 and 6 contain the bit patterns 5A and 58 respectively, what bit pattern will be in register 4 after executing the instruction 6456? (See language description table and assume 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.)

\_\_\_\_\_

ANSWER: 69

4. Write the answer to each of the following logic problems.

10101010  
AND 11110000

10101010  
OR 11110000

10101010  
XOR 11110000

ANSWER: 10100000, 11111010, and 01011010

5. Suppose registers E and F contained AA and CC, respectively. What bit pattern would be in register D after executing each of the following instructions (see language description table)?

A. 7DEF \_\_\_\_\_

B. 8DEF \_\_\_\_\_

C. 9DEF \_\_\_\_\_

ANSWER: A. EE B. 88 C. 66

6. If registers 0, 1, and 2 contain the patterns A5, A5, and B7, respectively, which of the following instructions will result in a jump to location AA? (Refer to the language description table.)

A. B0AA B. B1AA C. B2AA

\_\_\_\_\_

ANSWER: A and B

7. If registers 0 and 1 contain the patterns B5 and F0, respectively, what will be in register 1 after executing each of the following instructions? (Refer to the language description table.)

A. A102 \_\_\_\_\_

B. 4001 \_\_\_\_\_

C. 4010 \_\_\_\_\_

ANSWER: A. 3C B. B5 C. F0

8. Suppose the instruction B1A5 (as described in the language description table) is stored in main memory at addresses E0 and E1. Moreover, suppose registers 0 and 1 both contain the pattern FF. What value will be in the CPU's program counter immediately after executing the instruction?

\_\_\_\_\_

ANSWER: A5

9. Suppose the instruction B1A5 (as described in the language description table) is stored in main memory at addresses E0 and E1. Moreover, suppose registers 0 and 1 contain the patterns FF and 75, respectively. What value will be in the CPU's program counter immediately after executing the instruction?

\_\_\_\_\_

ANSWER: E2

10. Encode each of the following commands in terms of the machine language described in the language description table.

- A. \_\_\_\_\_ LOAD register 7 with the value A5.
- B. \_\_\_\_\_ LOAD register 7 with the contents of the memory cell at address A5.
- C. \_\_\_\_\_ ADD the contents of registers 5 and 6 as though they were values in two's complement notation and leave the result in register 4.
- D. \_\_\_\_\_ OR the contents of registers 5 and 6, leaving the result in register 4.

ANSWER: A. 27A5   B. 17A5   C. 5456 (or 5465)   D. 7456 (or 7465)

11. Encode each of the following commands in terms of the machine language described in the language description table.

- A. \_\_\_\_\_ ROTATE the contents of register 7 to the right 5 bit positions.
- B. \_\_\_\_\_ JUMP to the instruction at address B2 if the content of register 2 equals that of register 0.
- C. \_\_\_\_\_ ADD the contents of registers 5 and 6 as though they were values in floating-point notation and leave the result in register 4.
- D. \_\_\_\_\_ AND the contents of registers 5 and 6, leaving the result in register 4.

ANSWER: A. A705   B. B2B2   C. 6456 (or 6465)   D. 8456 (or 8465)

12. Decode each of the following instructions that were encoded using the language description table.

- A. 4034 \_\_\_\_\_
- B. 8023 \_\_\_\_\_
- C. B288 \_\_\_\_\_
- D. 2345 \_\_\_\_\_

ANSWER: A. MOVE the contents of register 3 to register 4.  
B. AND the contents of registers 2 and 3, leaving the result in register 0.  
C. JUMP to the instruction at address 88 if the contents of register 2 equals that of register 0.  
D. LOAD register 3 with the pattern 45.

13. Decode each of the following instructions that were encoded using the language description table.

- A. A004 \_\_\_\_\_
- B. 1234 \_\_\_\_\_
- C. 5678 \_\_\_\_\_
- D. C000 \_\_\_\_\_

ANSWER: A. ROTATE the contents of register 0 to the right by four bit positions.  
B. LOAD register 2 with the bit pattern from the memory cell at address 34.

- C. ADD the contents of registers 7 and 8 as though they represented values encoded in two's complement notation and leave the result in register 6.
- D. HALT.

14. The following table shows a portion of a machine's memory containing a program written in the language described in the language description table. Answer the questions below assuming that the machine is started with its program counter containing 00.

address	content
00	21
01	0B
02	14
03	04
04	C0
05	00

- A. What bit pattern will be in register 4 when the machine halts?

\_\_\_\_\_

- B. What bit pattern will be in register 1 when the machine halts?

\_\_\_\_\_

ANSWER: A. C0 B. 0B

15. The following table shows a portion of a machine's memory containing a program written in the language described in the language description table. Answer the questions below assuming that the machine is started with its program counter containing 00.

address	content	address	content
00	10	07	00
01	02	08	C0
02	24	09	00
03	04	0A	C0
04	B4	0B	00
05	0A	0C	C0
06	C0	0D	00

- A. What bit pattern will be in register 0 when the machine halts?

\_\_\_\_\_

- B. What bit pattern will be in register 4 when the machine halts?

\_\_\_\_\_

- C. What bit pattern will be in the program counter when the machine halts?

\_\_\_\_\_

ANSWER: A. 24 B. 04 C. 08



16. The following table shows a portion of a machine's memory containing a program written in the language described in the language description table. Answer the questions below assuming that the machine is started with its program counter containing 00.

address	content	address	content
00	25	07	00
01	03	08	C0
02	20	09	00
03	F9	0A	C0
04	53	0B	00
05	05	0C	C0
06	33	0D	00

A. What bit pattern will be in register 5 when the machine halts?

\_\_\_\_\_

B. What bit pattern will be in register 0 when the machine halts?

\_\_\_\_\_

C. What bit pattern will be in register 3 when the machine halts?

\_\_\_\_\_

D. What bit pattern will be at memory location 00 when the machine halts?

\_\_\_\_\_

ANSWER: A. 03   B. F9   C. FC   D. FC

17. The following table shows a portion of a machine's memory containing a program written in the language described in the language description table. Answer the questions below assuming that the machine is started with its program counter containing 00.

address	content	address	content
00	25	07	00
01	03	08	34
02	A5	09	04
03	02	0A	B0
04	35	0B	03
05	03	0C	C0
06	24	0D	00

A. What bit pattern will be in register 5 when the machine halts?

\_\_\_\_\_

B. What bit pattern will be in the program counter when the machine halts?

\_\_\_\_\_

C. What bit pattern will be at memory location 04 when the machine halts?

\_\_\_\_\_

ANSWER: A. C0    B. 05    C. 00

18. Below is a short routine written in the machine language described in the language description table and stored in a machine's memory beginning at address 50. What must be in the memory cell at address 40 to avoid an unending loop?

Address	Instruction
50	2001
52	1340
54	8330
56	B352
58	...

---

ANSWER: Any bit pattern whose least significant bit is 0

19. The following table shows a portion of a machine's memory containing a program written in the language described in the language description table. Answer the questions below assuming that the machine is started with its program counter containing 00.

address	content	address	content
00	B0	07	C0
01	03	08	00
02	25	09	23
03	B0	0A	B0
04	0C	0B	03
05	C0	0C	B0
06	00	0D	07

A. How many instructions will be executed before the machine halts?

\_\_\_\_\_

B. What bit pattern will be in the program counter when the machine halts?

\_\_\_\_\_

ANSWER: A. 4    B. 09

20. The following table shows a portion of a machine's memory containing a program written in the language described in the language description table. Answer the questions below assuming that the machine is started with its program counter containing 00.

address	content	address	content
00	20	07	12
01	02	08	B2
02	21	09	0C
03	01	0A	B0
04	22	0B	06
05	01	0C	C0
06	52	0D	00

A. What bit pattern will be in register 2 when the machine halts?

\_\_\_\_\_

B. How many times will the instruction at address 06 be executed before the machine halts?

---

ANSWER: A. 02    B. 2

## 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 asked 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
op-code	The part of a machine instruction that identifies the basic operation to be performed
machine language	A means of encoding instructions
machine cycle	The process of fetching and executing instructions that is repeated over and over by the CPU
register	A location within a CPU for temporary data storage
masking	A means of isolating particular bits within a bit pattern
bus	The communication path between a CPU and main memory
memory-mapped I/O	The technique of communicating with peripheral devices as though they were memory cells
pipelining	A means of processing more than one instruction at a time
stored-program concept	A technique of recording programs in main memory from where they can be accessed and executed
program counter	Used by the CPU to keep its place in the program being executed
controller	main memory from where they can be retrieved and executed
modem	The interface between "a computer" and a peripheral device
port	Modulator-demodulator
USB	The "connection" through which a CPU communicates with a peripheral device
clock	A communication system by which a variety of peripheral devices can be connected to a computer
status word	Used to synchronize the operations within a computer
bps	A means by which a peripheral device reports its condition
CISC	A means of measuring the rate of data transfer
handshaking	A computer whose machine language contains many complex instructions
bandwidth	Refers to the two-way communication that takes place between a computer and a peripheral device
DMA	Refers to a communication path's maximum capacity for transferring data
	The ability of a peripheral device to communicate directly with a computer's main memory

## General Format Questions

1. Describe the machine cycle.

ANSWER: Fetch an instruction and increment the program counter, decode the instruction, and execute the instruction.

2. Explain the concept of throughput and techniques by which throughput is increased.

ANSWER: Throughput measures the amount of “work” performed by a computer rather than the speed with which the computer executes instructions. Throughput is increased by introducing parallel processing techniques such as pipelining or parallel processing via multiprocessor designs.

3. What is the difference between a conditional jump instruction and an unconditional jump instruction?

ANSWER: A conditional jump instruction will result in a “jump” to another location only under certain conditions whereas an unconditional jump instruction will result in a “jump” to another location under all conditions.

4. The following is a routine encoded in the machine language described in the language description table. Explain (in a single sentence) what the routine does. (Explain what the entire routine does as a unit rather than reciting what each instruction does.)

12A0  
32B0  
12A1  
32B1  
12A2  
32B2

ANSWER: It copies the contents of memory cells A0 through A2 to memory cells B0 through B2.

5. The following is a routine encoded in the machine language described in the language description table. Explain (in a single sentence) what the routine does. (Explain what the entire routine does as a unit rather than reciting what each instruction does.)

210F  
12A0  
8212  
32A0

ANSWER: It places 0s in the four most significant bits of memory cell A0 without disturbing the other four bits.

6. The following table shows a portion of a machine's memory containing a program written in the language described in the language description table. What will happen if the machine is started with its program counter containing 00?

address	content
00	21
01	B0
02	31
03	04
04	C0
05	00

ANSWER: The machine will change the last instruction to a jump instruction and continue to repeat the same routine over and over.

7. Using the machine language described in the language description table, write a sequence of instructions that will place the pattern FF in the memory cell at address A0.

ANSWER: 2XFF, 3XA0 (where X can be any register but must be the same in both instructions)

8. Using the machine language described in the language description table, write a sequence of instructions that will place a 1 in the most significant bit of the memory cell at address A0 without disturbing the other bits.

ANSWER: 2X80, 1YA0, 7YXY, 3YA0 (where X and Y can be any distinct registers)

9. Using the machine language described in the language description table, write a sequence of instructions that will add five to the value (represented in two's complement notation) stored at memory address A0.

ANSWER: 2X05, 1YA0, 5YXY, 3YA0 (where X and Y can be any distinct registers)

10. Using the machine language described in the language description table, write a sequence of instructions that will subtract one from the value (represented in two's complement notation) stored at memory address A0.

ANSWER: 2XFF, 1YA0, 5YXY, 3YA0 (where X and Y can be any distinct registers)

11. Using the machine language described in the language description table, write a sequence of instructions that will shift the contents of the memory cell at address A0 three bit positions to the right while filling the holes at the left end with 0s.

ANSWER: 1XA0, AX03, 2Y1F, 8XXY, 3XA0 (where X and Y can be any distinct registers)

## Test Bank—Chapter Three (Operating Systems)

### Multiple Choice Questions

1. Which of the following components of an operating system maintains the directory system?

- A. Device drivers      B. File manager      C. Memory manager

ANSWER: B

2. Which of the following components of an operating system handles the details associated with particular peripheral equipment?

- A. Device drivers      B. File manager      C. Memory manager

ANSWER: A

3. Which of the following components of an operating system is not part of the kernel?

- A. Shell      B. File manager      C. Scheduler

ANSWER: A

4. Multitasking in a computer with only one CPU is accomplished by a technique called

- A. Bootstrapping      B. Batch processing      C. Multiprogramming

ANSWER: C

5. Execution of an operating system is initiated by a program called the

- A. Window manager      B. Scheduler      C. Bootstrap

ANSWER: C

6. The end of a time slice is indicated by the occurrence of a signal called

- A. An interrupt      B. A semaphore      C. A login

ANSWER: A

7. A section of a program that should be executed by at most one process at a time is called a

- A. Utility      B. Critical region      C. Privileged instruction

ANSWER: B

8. Which of the following is not an attempt to provide security?

- A. Passwords      B. Privilege levels      C. Multitasking

ANSWER: C

9. Which of the following items of information would not be contained in an operating system's process table?

- A. The location of the memory area assigned to the process
- B. The priority of each process
- C. Whether the process is ready or waiting
- D. The machine language instructions being executed by the process

ANSWER: D

10. Which of the following events is detrimental to an operating system's performance?

- A. Deadlock
- B. Interrupt
- C. Booting

ANSWER: A

11. Which of the following is a technique for controlling access to a critical region?

- A. Spooling
- B. Time sharing
- C. Semaphore
- D. Booting

ANSWER: C

12. Which of the following is not involved in a context switch?

- A. Interrupt
- B. Process table
- C. Dispatcher
- D. Shell

ANSWER: D

13. Which of the following concepts is not associated with critical regions?

- A. Semaphores
- B. Mutual exclusion
- C. Bootstrap

ANSWER: C

14. Which of the following is not a role of a typical operating system?

- A. Control the allocation of the machine's resources
- B. Control access to the machine
- C. Maintain records regarding files stored in mass storage
- D. Assist the computer user in the task of processing digital photographs

ANSWER: D

15. Which of the following is a task that is not performed by the kernel of an operating system?

- A. Communicate with the user
- B. Schedule processes
- C. Allocate resources
- D. Avoid deadlock

ANSWER: A

16. Which of the following is not a means of performing multiple activities at the same time?

- A. Pipelining
- B. Multiprogramming
- C. Virtual memory
- D. Multiple processors

ANSWER: C (Caution: This problem uses terminology from Chapter 1.)

17. Which of the following components of an operating system is executed as the result of an interrupt signal?

- A. Dispatcher      B. Memory manager      C. File manager

ANSWER: A

18. Which of the following would be a concern of the file manager in a multi-user computer system that would not be a concern in a single-user system?

- A. Maintain records regarding the location of files  
B. Maintain records regarding the ownership of files  
C. Maintain records regarding the size of files  
D. None of the above

ANSWER: B

19. Which of the following would not require real-time processing?

- A. Typing a document with a word processor  
B. Navigation of an aircraft  
C. Forecasting world-wide trade for the next five year period  
D. Maintaining a airline reservation system

ANSWER: C

20. Which of the following statements is true?

- A. Allowing several processes to share time in a multiprogramming system is less efficient than executing each of them to completion one after the other.  
B. The use of passwords provides an impenetrable safeguard.  
C. Both A and B  
D. Neither A nor B

ANSWER: D

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

1. Suppose an operating system allocates time slices in 10 millisecond units and the time required for a context switch is negligible.

- A. How many processes can obtain a time slice in one second?

\_\_\_\_\_

- B. How many processes can obtain a time slice in one second if half of them use only half of their slice?

\_\_\_\_\_

ANSWER: A. 100      B. 150



2. If it takes one microsecond to perform a context switch and processes use only half of their allotted 10 millisecond time slices, what percent of a CPU's time is spent performing context switches rather than executing processes?

ANSWER: .02% (1/5000)

3. In contrast to early batch processing techniques, \_\_\_\_\_ allows the user to communicate with the computer while the user's application is being executed. In turn, this type of processing requires that the computer's responses to its environment be performed in a timely manner, a requirement known as \_\_\_\_\_.

ANSWER: Interactive processing, Real-time processing

4. Fill in the blanks below with the part on the operating system (file manager, memory manager, device drivers, window manager, scheduler, dispatcher) that performs the activity described.

- A. \_\_\_\_\_ Maintains a record of what is displayed on the computer's screen
- B. \_\_\_\_\_ Performs the switching from one process to another
- C. \_\_\_\_\_ Maintains the directory system
- D. \_\_\_\_\_ Creates virtual memory

ANSWER: A. Window manager      B. Dispatcher      C. File manager      D. Memory manager

5. Fill in the blanks below with the part on the operating system (file manager, memory manager, device drivers, window manager, scheduler, dispatcher) that performs the activity described.

- A. \_\_\_\_\_ Places new entries in the process table
- B. \_\_\_\_\_ Performs the actual communication with I/O units
- C. \_\_\_\_\_ Maintains a record of memory allocations
- D. \_\_\_\_\_ Protects files from unauthorized access

ANSWER: A. Scheduler      B. Device drivers      C. Memory manager      D. File Manager

6. Fill in the blanks below with the part on the operating system (file manager, memory manager, device drivers, window manager, scheduler, dispatcher) that performs the activity described.

- A. \_\_\_\_\_ Executes each time a time slice terminates
- B. \_\_\_\_\_ Removes entries from the process table
- C. \_\_\_\_\_ Maintains a record of available mass storage space
- D. \_\_\_\_\_ Displays icons on the computer screen

ANSWER: A. Dispatcher      B. Scheduler      C. File manager      D. Window manager

7. In each blank below write a term that might be considered the opposite of the term next to the blank.

A. \_\_\_\_\_ Interactive processing

B. \_\_\_\_\_ System software

C. \_\_\_\_\_ Waiting process

ANSWER: A. Batch processing      B. Application software      C. Ready process

8. What action is performed as a result of executing each of the following types of instructions?

A. Test-and-set \_\_\_\_\_

B. Interrupt disable \_\_\_\_\_

C. Interrupt enable \_\_\_\_\_

ANSWER: A. Checks to see if the contents of a memory cell is 0 or 1 and sets the value to a 1.

B. Causes the CPU to not recognize incoming interrupts.

C. Causes the CPU to begin recognizing incoming interrupts.

9. Which necessary condition for deadlock is removed by each of the following.

A. Require processes to request all required resources at once.

\_\_\_\_\_

B. Allow only one process at a time in the process table.

\_\_\_\_\_

C. Take all resources from processes when deadlock occurs and restart the processes.

\_\_\_\_\_

ANSWER: A. Resources must be requested on a partial basis.

B. There must be competition for nonshareable resources.

C. Resources cannot be forcibly retrieved.

10. List four resources whose access an operating system should coordinate.

A. \_\_\_\_\_ B. \_\_\_\_\_

C. \_\_\_\_\_ D. \_\_\_\_\_

ANSWER: Possible answers include: Memory space, mass storage space, printers, space in process table, CPU time, and many more

11. What problem could occur if, to allow more processes to share time in a multiprogramming environment, an operating system is designed to use very short time slices?

\_\_\_\_\_

ANSWER: The time spent switching between processes could become significant when compared to the time spent actually executing processes.

12. What is meant by the term *load balancing* in the context of multiprocessor computers?

---

ANSWER: Load balancing refers to the task of assigning tasks to the processors in a way that leads to efficient use of all processors.

13. A \_\_\_\_\_ is a set of instructions. In contrast, a \_\_\_\_\_ is the activity of executing those instructions.

ANSWER: program, process

14. List three features provided by modern CPUs that are used by operating systems to implement multitasking environments.

A. \_\_\_\_\_

B. \_\_\_\_\_

C. \_\_\_\_\_

ANSWER: Possible answers include: privilege levels, privileged instructions, test-and-set instructions, memory limit registers, and others.

15. List three popular operating systems.

A. \_\_\_\_\_

B. \_\_\_\_\_

C. \_\_\_\_\_

ANSWER: Possible answers include: UNIX, LINUX, and Microsoft's Windows series

## 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 asked 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
shell	The part of an operating system that communicates with the user
multiprogramming	A technique that allows multiprocessing on a computer with a single CPU
time sharing	The act of more than one user using a computer at the same time
process	The activity of executing a program
queue	A storage system in which the first entry in is the first entry out
virtual memory	Extended storage space created by the memory manager

ROM	Memory area whose contents cannot be altered
multitasking	The phenomenon of a user performing more than one activity at the same time
interactive processing	Allows the user to communicate with the computer system while the user's application is being performed
deadlock	A situation in which activities find themselves waiting on each other
GUI	A means of communicating with a computer user by means of images rather than words
mutual exclusion	The requirement that a process complete a block of instructions before another process is allowed to start the block
bootstrap	The program first executed when a computer is turned on
directory path	A sequence of folders each containing the next
kernel	The heart of an operating system
interrupt	A signal that suspends the CPU's current activities
auditing software	A tool used to monitor a computer system's activities
privilege levels	A means of restricting the capabilities of different processes

## General Format Questions

1. Explain the difference between application software and system software.

ANSWER: System software provides the infrastructure required by the application software. It includes the operating system and utilities. Application software provides the unique functionality required to perform the particular tasks for which the computer is used. Examples include word processors, spreadsheet systems, database systems, and image processing systems.

2. Describe a scenario that leads to deadlock in a computer system.

ANSWER: There are many possible answers. One would be the case of two processes in a multiprogramming environment, each of which needs to spawn additional processes to complete its task even though the process table is full. In this case, each process would hold a nonshareable resource (space in the process table) that the other needed to progress resulting in deadlock.

3. What conditions are necessary for deadlock to occur?

ANSWER: There must be competition for nonshareable resources, resources must be requested on a piecemeal basis, and resources, once allocated, cannot be forcibly retrieved.

4. What are privileged instructions?

ANSWER: Privileged instructions are machine language instructions that request activities that general application programs should not be allowed to perform. These instructions can only be executed when the CPU is operating in "privileged mode." Examples of privileged instructions include requests to change the CPU's current privilege level and requests to alter registers that control memory access limits.

5. What is the difference between a process that is waiting as opposed to a process that is ready?

ANSWER: A process that is waiting would not be able to advance if given a time slice (perhaps because it is waiting for a peripheral device to complete a task) whereas a process that is ready would be able to continue execution if given a time slice.

6. Describe the bootstrap process.

ANSWER: When the computer is first turned on, the bootstrap program stored in ROM is executed. This program directs the computer to load the operating system into main memory from mass storage. The bootstrap then executes a jump to the operating system, the operating system takes over.

7. Why is a “test-and-set” instruction included in most machine languages for CPUs designed for multitasking environments?

ANSWER: The “test-and-set” instruction are useful when bits in main memory are used to record whether various nonshareable resources have been allocated because they allow memory cells to be read and altered without fear of interruption.

8. Explain why the average length of a time slice would be reduced if the processes in an operating system’s process table perform lots of I/O operations.

ANSWER: Once a process requests an I/O operation, its time slice will be terminated, it will be labeled as a waiting process, and another process will be allowed to start another time slice. Thus, the first process’s effective time slice would be reduced.

9. In the sense of the term virtual memory, give an argument that multiprogramming creates virtual CPUs.

ANSWER: The term virtual memory refers to the illusion of a memory space that is larger than that actually present. This illusion is created by the operating system. Multiprogramming is a technique used by operating systems to create the illusion of more CPUs than are actually present.

10. Describe concerns that occur when designing a time-sharing/multitasking operating system that do not occur in the case of a single tasking system.

ANSWER: Possible answers include: The implementation of multiprogramming, the need to protect each process from malicious behavior of other processes, and the need to deal with the possibility of deadlock.

## Test Bank—Chapter Four (Networks and the Internet)

### Multiple Choice Questions

1. Which of the following is not a way of classifying networks?

- A. WAN versus LAN
- B. Closed versus open
- C. Router versus bridge
- D. Star versus bus

ANSWER: C

2. Ethernet is a means of implementing which of the following network topologies?

- A. Star
- B. WiFi
- C. Bus

ANSWER: C

3. Which of the following connects existing networks to form an internet?

- A. Bridge
- B. Router
- C. Switch
- D. Repeater

ANSWER: B

4. Which of the following is a protocol for controlling the right to transmit a message in a network?

- A. UDP
- B. CSMA/CD
- C. TCP
- D. FTP

ANSWER: B

5. Which of the following is not a means of performing interprocess communication over a network?

- A. Client/server
- B. ICANN
- C. Peer-to-peer

ANSWER: B

6. Which of the following is assigned the task of providing individual users access to the Internet?

- A. Tier-1 ISPs
- B. Tier-2 ISPs
- C. Access ISPs
- D. ICANN

ANSWER: C

7. Which of the following is not an application of the Internet?

- A. FTP
- B. Email
- C. Telnet
- D. CERT

ANSWER: D

8. The primary purpose of which of the following is not the enhancement of security?

- A. ICANN
- B. Firewall
- C. Encryption
- D. CERT

ANSWER: A

9. Which of the following is used to translate between IP addresses and mnemonic addresses?

- A. File server    B. Mail server    C. Name server    D. FTP server

ANSWER: C

10. Which of the following is not a means of connecting networks?

- A. Switch    B. Server    C. Router    D. Bridge

ANSWER: B

11. Which layer of the TCP/IP hierarchy actually transmits a message?

- A. Application    B. Transport    C. Network    D. Link

ANSWER: D

12. Which layer of the TCP/IP hierarchy chops messages into units whose size is compatible with the Internet?

- A. Application    B. Transport    C. Network    D. Link

ANSWER: B

13. Which layer of the TCP/IP hierarchy decides the direction in which message segments are transferred across the Internet?

- A. Application    B. Transport    C. Network    D. Link

ANSWER: C

14. Which layer of the TCP/IP hierarchy decides which application should receive an incoming message?

- A. Application    B. Transport    C. Network    D. Link

ANSWER: A

15. Which layer of the TCP/IP hierarchy presents incoming messages to the computer user?

- A. Application    B. Transport    C. Network    D. Link

ANSWER: A

16. Which layer of the TCP/IP hierarchy reassembles messages as their pieces arrive at the destination?

- A. Application    B. Transport    C. Network    D. Link

ANSWER: B

17. Which layer of the TCP/IP hierarchy is responsible for obtaining the correct address for a message's destination?

- A. Application    B. Transport    C. Network    D. Link

ANSWER: A

18. Which of the following identifies the application to which a message arriving from the Internet should be given?

- A. Protocol      B. Port number      C. Domain      D. Hop count

ANSWER: B

19. Which standards organization produced the OSI reference model for internet communication?

- A. ANSIB. IEEE      C. ISO

ANSWER: C

20. Which of the following is an Internet application that is named after its underlying protocol?

- A. EmailB. World Wide Web      C. FTP      D. UDP

ANSWER: C

21. Which of the following is not a means of implementing server-side activities?

- A. CGI      B. JSP      C. ASP      D. Applets

ANSWER: D

22. Which of the following is not a protocol used in the basic TCP/IP software hierarchy?

- A. POP3B. UDP      C. TCP      D. IP

ANSWER: A

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

1. List two network topologies.

A. \_\_\_\_\_

B. \_\_\_\_\_

ANSWER: star and bus

2. What are two protocols for implementing the transport level in the "TCP/IP hierarchy"?

A. \_\_\_\_\_ B. \_\_\_\_\_

ANSWER: TCP and UDP

3. Draw a circle the portion of the URL below that identifies the directory containing the file being addressed. Underline the portion that identifies the protocol that should be used when accessing the file. Draw a rectangle around the portion that identifies the file name itself.



`http://batcave.metropolis.com/heroes/superheroes/batpage.html`

ANSWER: Circle: superheroes, underline: http, rectangle: batpage.html (or just batpage)

4. Underline the portion of the URL below that identifies the classification (top-level domain) of the registered domain in which the pertinent Web server resides. Draw a rectangle around the portion that indicates the directory path the server should follow to find the designated document.

`http://batcave.metropolis.com/heroes/superheroes/batpage.html`

ANSWER: Underline: com, rectangle: heroes/superheroes

5. Draw a rectangle around the portion of the email address below that identifies the “person” who should receive the message. Underline the portion that identifies the location of the mail server that handles the mail for that person.

`Fido@dogmail.zoo.org`

ANSWER: Rectangle: Fido, underline: dogmail.zoo.org

6. What bit pattern is represented by 33.42.18 in dotted decimal notation?

\_\_\_\_\_

ANSWER: 00100001 00101010 00010010 (212A12 in hexadecimal)

7. Express the bit pattern 0001001000001100 in dotted decimal notation.

\_\_\_\_\_

ANSWER: 18.12

8. The main purpose of \_\_\_\_\_ and \_\_\_\_\_ ISPs is to provide a system of high-speed routers that serve as the Internet’s communication backbone, whereas \_\_\_\_\_ ISPs concentrate on providing Internet access to the Internet’s users.

ANSWER: Tier-1, tier-2, access

9. Name three kinds of servers.

A. \_\_\_\_\_

B. \_\_\_\_\_

C. \_\_\_\_\_

ANSWER: Possible answers include: name server, file server, mail server, Web server, etc.

10. List four top-level domains.

A. \_\_\_\_\_

B. \_\_\_\_\_

C. \_\_\_\_\_

D. \_\_\_\_\_

ANSWER: Possible answers include com, org, edu, gov, net, uk, ca, etc.

11. What terms in the following HTML document are linked to other documents?

```
<html>
<head>
<title>This is the title</title>
</head>
<body>
<h1>Favorite Animals</h1>
<p>Of all the animals in the world, the
<a href="http://pigs.org/pigs.html">pig</a> is
perhaps the most charming.</p><p>However, the
<a href="http://hippopotamuscitey.org/hippo.html">
hippopotamus</a> is also cute.</p>
</body>
</html>
```

ANSWER: pig, hippopotamus

12. Fill in the blanks in the HTML document below so that the term “Earth” will be linked to the HTML document “earthinfo.html” in the directory “earthdir” at “earthnews.com.”

```
<html>
<head>
<title>Earth page</title>
</head>
<body>
<p>The planet we live on is called

_____ Earth _____

</p>
</body>
</html>
```

ANSWER: <a href="http://earthnews.com/earthdir/earthinfo.html">, </a>

13. Fill in the blanks with the missing tags to the following HTML document.

```
<html>
<head>
_____ Title </title>
</head>

<p>Click on
<a href="http://this..org"> this. _____

_____
</body>
</html>
```

ANSWER: The following tags are missing: <title>, >, <body>, </a>, and </p>.

14. Fill in the blank in the following HTML document so that the image called dog.jpg will be displayed at the top of the page.

```
<body>
_____
```

```
<p>Above is a picture of Fido.</p>
</body>
```

ANSWER: <img src = "dog.jpg">

15. List two features of HTML that conform to the XML style.

A. \_\_\_\_\_

B. \_\_\_\_\_

ANSWER: Possible answer include: Tags are surrounded by < and >, tags that close an item are the same as the opening tag except that / is added, tag name are in lower case, and others.

16. Identify two protocols used in networks to determine the right to transmit an original message.

A. \_\_\_\_\_

B. \_\_\_\_\_

ANSWER: CSMA/CD and CSMA/CA

17. Identify a protocol used in the implementation of the network layer in the TCP/IP hierarchy.

\_\_\_\_\_

ANSWER: IP

18. In each blank below write the HTML tag that performs the indication function.

A. \_\_\_\_\_ Begins the part that describes what will appear on the computer screen

B. \_\_\_\_\_ Marks the end of the HTML document

C. \_\_\_\_\_ Marks the beginning of a paragraph

D. \_\_\_\_\_ Marks the end of a term that is linked to another document

ANSWER: A. <body>      B. </html>      C. <p>      D. </a>

19. The client/server model refers to a form of interprocess communication in which one process, known as the \_\_\_\_\_, runs continuously so that it can be contacted by other processes, known as \_\_\_\_\_, as needed. In contrast is the \_\_\_\_\_ model of interprocess communication in which two processes communicate as equals.

ANSWER: server, clients, peer-to-peer

20. Where would be the most likely place to put a firewall to provide each of the following services?

A. \_\_\_\_\_ Protect an entire domain from attacks from the cloud

B. \_\_\_\_\_ Protect an entire domain from spam

C. \_\_\_\_\_ Protect an individual machine from worms and viruses

ANSWER: A. At the gateway      B. At the domain's mail server      C. At the individual machine

21. Write the entire URL required to retrieve the Web document named bulldogs.html from the Web server at animals.org assuming that the document is stored in the directory named dogs.

ANSWER: `http://animals.org/dogs/bulldogs.html`

## 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 asked 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
internet	A network of networks
tier-1 ISP	An organization that provides the Internet's communication backbone
access ISP	An organization that provides access to the Internet
domain	A name registered with ICANN for identification purposes
protocol	A governing set of rules
cloud	The portion of the Internet lying outside one's domain
IP address	Identifies a machine on the Internet
HTML	A notational system for indicating how a Web document is to be displayed by a browser
firewall	A means of blocking undesired messages
packet	A message segment that is transmitted over the Internet independently
XML	A "format" for markup languages
FTP	A protocol for transferring files
router	A means of connecting networks to form an internet
dotted decimal	A notational system for representing bit patterns
URL	A means of identifying a document on the Web
search engine	A means of finding relevant information on the Web
Ethernet	A means of implementing a network with the bus topology
UDP	A protocol for the transport layer
IP	A protocol for the network layer

## General Format Questions

1. What is the difference between a repeater and a bridge?

ANSWER: Both repeaters and bridges are used to connect two buses, but a repeater transfers all messages whereas a bridge transfers only those messages destined for the other side.

2. What is the difference between hubs, switches, and routers?

ANSWER: A hub is merely a central (short) bus to which computers are connected to form a bus network. A switch connects several bus networks to form a larger network. A router connects two networks to form an internet in which the original two networks continue to function as independent networks.

3. Many people use the terms Internet and world-wide web interchangeably. What is the difference between the Internet and the world-wide web?

ANSWER: The Internet is the infrastructure used by the world-wide web. That is, the world-wide web is only one application of the Internet. Other applications include email, ftp, and telnet.

4. What are HTML and XML?

ANSWER: HTML is an actual markup language. XML is not a markup language itself. Instead it is a markup language “style.”

5. What are some distinctions between UDP and TCP?

ANSWER: UDP is a connectionless protocol whereas TCP establishes a two way communication between the origin and destination of a message. TCP is a reliable protocol in that the origin and destination work together to confirm that the entire message was successfully transferred. In contrast, UDP merely transmits the message without confirming its reception.

6. As an encryption system, what is unique about public-key encryption (that is, why is public-key encryption so named)?

ANSWER: In a public-key encryption system, knowing the encryption key does not allow one to decipher a message. Thus, the encryption key can be public knowledge without violating security.

7. Draw a sketch showing how the following HTML document would appear on the computer screen when displayed by a browser.

```
<html>
<head>
<title>This is the title</title>
</head>
<body>
<h1>Mud Art</h1>
</body>
</html>
```

ANSWER: The displayed page contains only the words “Mud Art” displayed as a major heading. The words “This is the title” are NOT part of the displayed page.

8. Draw a sketch showing how the following HTML document would appear on the computer screen when displayed by a browser.

```
<html>
<head>
<title>This is the title</title>
</head>
<body>
<h1>Favorite Animals</h1>
<p>Of all the animals in the world, the
<a href="http://pigs.org/pigs.html">pig</a> is
perhaps the most charming.</p><p>However, the
<a href="http://hippopotamuscitiy.org/hippo.html">
hippopotamus</a> is also cute.</p>
</body>
</html>
```

ANSWER: Something like this:

**Favorite Animals**  
Of all the animals in the world, the pig

is perhaps the most charming.  
However, the hippopotamus is also cute.

9. What would happen if a user clicked the mouse on the term “pig” while viewing the HTML document shown below?

```
<html>
<head>
<title>This is the title</title>
</head>
<body>
<h1>Favorite Animals</h1>
<p>Of all the animals in the world, the
<a href="http://pigs.org/pigs.html">pig</a> is
perhaps the most charming.</p><p>However, the
<a href="http://hippopotamuscity.org/hippo.html">
hippopotamus</a> is also cute.</p>
</body>
</html>
```

ANSWER: The browser would retrieve and display the document pigs.html.

10. To what do the terms “server side” and “client side” refer?

ANSWER: They indicate whether the identified activity is performed by the client or the server when using the client/server model for interprocess communication.

11. What assumptions are made when a URL is denoted by merely zoo.org?

ANSWER: It is assumed that the protocol is http and that the document desired is the default document in the default directory.

12. Briefly summarize the steps performed by each of the four layers in the TCP/IP hierarchy at the computer at which a message originates.

ANSWER: Application layer: originates the message and obtains destination’s IP address. Transport layer: chops message into segments and assigns sequence numbers. Network layer: determines intermediate address. Link layer: transmits message segments.

## Test Bank—Chapter Five (Algorithms)

### Multiple Choice Questions

1. Which of the following is an activity?

- A. Algorithm      B. Program      C. Process

ANSWER: C

2. Which of the following is a representation?

- A. Algorithm      B. Program      C. Process

ANSWER: B

3. Which of the following set of instructions defines an algorithm in the formal, strict sense?

- |  |  |  |
|--|--|--|
| A. $X \leftarrow 3;$<br>while $(X < 5)$ do<br>do<br>$(X \leftarrow X)$ | B. $X \leftarrow 3;$<br>while $(X < 5)$ do<br>$(X \leftarrow X + 1)$ | C. $X \leftarrow 3;$<br>while $(X < 5)$ do<br>$(X \leftarrow X - 1)$ |
|--|--|--|

ANSWER: B

4. Which of the following is not a means of repeating a block of instructions?

- A. Pretest loop      B. Posttest loop      C. Recursion      D. Assignment statement

ANSWER: D

5. When searching within the list

Lewis, Maurice, Nathan, Oliver, Pat, Quincy, Roger, Stan, Tom

which of the following entries will be found most quickly using the sequential search algorithm?

- A. Lewis      B. Pat      C. Tom

ANSWER: A

6. When searching within the list

Lewis, Maurice, Nathan, Oliver, Pat, Quincy, Roger, Stan, Tom

which of the following entries will be found most quickly using the binary search algorithm?

- A. Lewis      B. Pat      C. Tom

ANSWER: B

7. Which of the following lists would not be obtained at some point when applying the insertion sort algorithm to the list below?

Sylvia  
Nancy  
Lois  
Alice

A. Nancy	B. Alice	C. Alice	D. Lois	
Sylvia	Lois		Sylvia	Nancy
Lois		Nancy	Nancy	Sylvia
Alice		Sylvia	Lois	Alice

ANSWER: C

8. In general, an algorithm in which of the following categories is considered more efficient?

A.  $\Theta(\lg n)$       B.  $\Theta(n)$       C.  $\Theta(n \lg n)$       D.  $\Theta(n^2)$

ANSWER: B

9. The insertion sort algorithm is an example of an algorithm in which of the following classes?

A.  $\Theta(\lg n)$       B.  $\Theta(n)$       C.  $\Theta(n \lg n)$       D.  $\Theta(n^2)$

ANSWER: D

10. The binary search algorithm is an example of an algorithm in which of the following classes?

A.  $\Theta(\lg n)$       B.  $\Theta(n)$       C.  $\Theta(n \lg n)$       D.  $\Theta(n^2)$

ANSWER: A

11. Under the assumption that X takes on only integer values, which of the following is the termination condition for the following loop?

```
while (X < 5) do
  ( . . . )
```

A.  $X < 5$  B.  $X > 4$       C.  $X < 4$

ANSWER: B

12. Under the assumption that X takes on only integer values, which of the following is the termination condition for the following loop?

```
repeat ( . . . )
until (X < 5)
```

A.  $X < 5$  B.  $X > 4$       C.  $X > 5$

ANSWER: A

13. Under the assumption that N takes on only integer values, which of the following is the termination condition in the following recursive procedure?

```
procedure xxx (N)
if (N < 5) then (apply the procedure xxx to the value N + 1)
```



else (print the value of N)

A.  $N < 5$  B.  $N > 4$  C.  $N < 4$

ANSWER: B

14. Under the assumption that N takes on only integer values, which of the following is the termination condition in the following recursive procedure?

```
procedure xxx (N)
  if (N < 5) then (print the value of N)
    else (apply the procedure xxx to the value N - 1)
```

A.  $N < 5$  B.  $N > 4$  C.  $N > 5$

ANSWER: A

15. Which of the following is a loop invariant at the point at which the test for termination is performed in the following loop structure?

```
X ← 3;
while (X < 5) do
  (X ← X + 2)
```

A.  $X > 5$  B.  $X < 5$  C.  $X \geq 5$  D.  $X \leq 5$

ANSWER: D

16. Which of the following is a loop invariant at the point at which the test for termination is performed in the following loop structure?

```
X ← 3;
repeat (X ← X + 2)
until (X > 5)
```

A.  $X > 5$  B.  $X < 8$  C.  $X \geq 5$  D.  $X \leq 6$

ANSWER: B

17. Which of the following is the base case in the recursive procedure below?

```
procedure xxx (N)
  if (N = 0) then (print the value of N)
    else (apply the procedure xxx to the value N - 1)
```

A.  $N > 0$  B.  $N = 0$  C.  $N < 0$

ANSWER: B

18. Preconditions, postconditions, and loop invariants are examples of which of the following?

A. Pseudocode B. Iterative structures C. Assertions D. Recursion

ANSWER: C

19. Which of the following does not print the same sequence of numbers as the others?

<pre>A. X ← 5 while (X &lt; 6) do   (print the value of X;   X ← X + 1)</pre>	<pre>B. X ← 4 while (X &lt; 5) do   (X ← X + 1;   print the value of X)</pre>	<pre>C. X ← 5 repeat   (print the value of X;   X ← X + 1) until (X &gt; 6)</pre>
---	---	---

ANSWER: C

20. Which of the following is not a way of representing algorithms?

A. Stepwise refinement    B. Pseudocode    C. Flowchart    D. Programming language

ANSWER: A

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

1. Define each of the following terms.

A. Algorithm \_\_\_\_\_

B. Program \_\_\_\_\_

C. Process \_\_\_\_\_

ANSWER: A. An ordered collection of unambiguous, executable steps that defines a terminating process  
B. A representation of an algorithm (perhaps nonterminating algorithm)  
C. The action of executing a program (or algorithm)

2. List three of the primitives in the pseudocode developed in this chapter.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

ANSWER: Possible answers include: the assignment statement using  $\leftarrow$ , the if-then-else statement, the while statement, the repeat statement, and the definition and activation of procedures.

3. What sequence of values will be printed when the following instructions are executed?

```
X ← 5;
if (X < 7) then (print the value 6;
                Y ← 6)
              else (print the value 4;
                Y ← 4)
if (Y < 5) then (print the value 3)
              else (print the value 2)
```

---

ANSWER: 6, 2

4. What sequence of values will be printed when the following instructions are executed?

```
X ← 5;
while (X < 7) do
  (print the value of X;
   X ← X + 1)
print the value of X;
while (X > 2) do
  (print the value of X;
   X ← X - 2)
```

---

ANSWER: 5, 6, 7, 7, 5, 3

5. What sequence of values would be printed if the procedure xxx described below were executed with the value of N being 9?

```
procedure xxx (N)
  if (N < 4) then (print the value of N;
                  apply the procedure yyy to the value 7)
  else (apply the procedure yyy to the value 2;
        print the value of N)

procedure yyy (N)
  if (N < 5) then (print the value of N;
                  apply the procedure zzz to the value 6)
  else (apply the procedure zzz to the value 5)

procedure zzz (N)
  if (N = 5) then (print the value 7)
  else (print the value 8)
```

---

ANSWER: 2, 8, 9

6. When searching for the entry X within the list

R, S, T, U, V, W, Z

how many entries will be considered before discovering that the entry is not present? (Note that the list is in alphabetical order.)

---

ANSWER: 3

7. When searching for the entry X within the list

R, S, T, U, V, W, Z

how many entries will be considered before discovering that the entry is not present? (Note that the list is in alphabetical order.)

\_\_\_\_\_

ANSWER: 7

8. Suppose the binary search algorithm was being used to search for the entry Tom in the list

Nathan, Oliver, Pat, Quincy, Rodger, Stan, Tom

A. What would be the first entry in the list to be considered? \_\_\_\_\_

B. What would be the second entry in the list to be considered? \_\_\_\_\_

ANSWER: A. Quincy      B. Stan

9. At most, how many entries in a list of 5000 names will be interrogated when using the binary search algorithm?

\_\_\_\_\_

ANSWER: 13

10. At most, how many entries in a list of 5000 names will be interrogated when using the sequential search algorithm?

\_\_\_\_\_

ANSWER: 5000

11. Which of the sequential or binary search algorithms would find the name Kelly in the list

John, Kelly, Lewis, Maurice, Nathan, Oliver, Pat, Quincy, Roger, Stan, Tom

more quickly?

\_\_\_\_\_

ANSWER: Sequential

12. Which of the sequential or binary search algorithms would find the name Roger in the list

John, Kelly, Lewis, Maurice, Nathan, Oliver, Pat, Quincy, Roger, Stan, Tom

more quickly?

\_\_\_\_\_

ANSWER: Binary

13. What would be printed if the following instructions were executed?

```
X ← 3;  
print the value of X;
```

```
Y ← 5;
if (X < Y) then (print the value 6)
    else (print the value 7)
```

---

ANSWER: 3, 6

14. What would be printed if the following instructions were executed?

```
X ← 3;
while (X > 0) do
    (print the value of X;
    X ← X - 1)
```

---

ANSWER: 3, 2, 1

15. Answer the following questions in terms of the procedure xxx below.

```
procedure xxx (N)
if (N < 7) then (print the value of N)
    else (add 3 to the value of N and
        print the value of N)
```

A. What value would be printed if the following procedure were executed with the value of N being 4?

---

B. What value would be printed if the following procedure were executed with the value of N being 9?

---

ANSWER: A. 4      B. 12

16. What sequence of numbers would be printed if the following procedure were executed with the value of N being 0?

```
procedure xxx (N)
while (N < 4) do
    (print the value of N;
    N ← N + 2;
    print the value of N
    )
```

---

ANSWER: 0, 2, 2, 4

17. What sequence of numbers would be printed if the following procedure were executed with the value of N being 0?

```
procedure xxx (N)
```

```

print the value of N;
if (N < 5) then (apply the procedure xxx to the value N + 2);
print the value of N

```

---

ANSWER: 0, 2, 4, 6, 6, 4, 2, 0

18. What sequence of numbers would be printed if the following procedure were executed with the value of N being 0?

```

procedure xxx (N)
print the value of N;
if (N < 2) then (apply the procedure xxx to the value N + 1)
                else (print the value of N)
print the value of N

```

---

ANSWER: 0, 1, 2, 2, 2, 1, 0

19. What sequence of numbers would be printed if the procedure named xxx as described below were executed with the value of N being 2?

<pre> procedure xxx (N) print the value of N; if (N &lt; 3)     then (apply procedure yyy            to the value 4); print the value of N </pre>	<pre> procedure yyy (N) print the value of N; apply the procedure xxx to the value 5; print the value of N </pre>
---	---

---

ANSWER: 2, 4, 5, 4, 2

20. Circle the portion of the program below in which control of the loop is initialized. Draw a rectangle around the portion in which the test for termination is performed. Underline the portion in which the state of the loop is moved toward the termination condition.

```

X ← 3;
while (X < 9) do
    (X ← X + 1)

```

ANSWER: Circle:  $X \leftarrow 3$ , Rectangle: while ( $X < 9$ ), Underline:  $X \leftarrow X + 1$

21. Fill in the blank in the procedure below so that the procedure prints the integers from 0 up to the integer value it was given for N. That is, if the procedure is executed with the value of N being 3, it should print 0, 1, 2, 3.

```

procedure xxx (N)
if (_____) then (apply the procedure xxx to the value N - 1);
print the value of N

```

ANSWER:  $N > 0$

22. Identify a loop invariant associated with the point in the loop below at which a test for termination is performed.

```

X ← 0;
repeat (print the value of X;
        X ← X + 2)
until (X > 6)

```

---

ANSWER: Possible answers include:  $X > 0$ ,  $X < 9$ ,  $X$  is an even integer, and others

## 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 asked 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
algorithm	The fundamental concept in computer science
pseudocode	An informal notation for representing algorithms
assignment statement	A means of saving the result of a computation for future use
if-then-else statement	A means of producing different actions depending on a condition
stepwise refinement	A divide and conquer approach to problem solving
loop invariant	A statement that is true each time a specific point in a repetitive process is reached
procedure	A program segment isolated as a unit
recursion	The technique of applying a program segment within itself
pretest loop	Looks before it leaps
proof of correctness	A formal means of verifying software
sequential search	Less efficient than the binary method
primitive	A basic building block

## General Format Questions

1. Rewrite the following routine using a pretest while statement.

```

repeat (print the value of X;
        X ← X + 1)
until (X > 5)

```

ANSWER: One possible solution is:

```

print the value of X;
X ← X + 1;
while (X ≤ 5) do
    (print the value of X;
     X ← X + 1)

```

2. If numeric values are represented in two's complement notation, does the following program represent an infinite process? Explain your answer.

```
X ← 2
while (X > 0) do
  (X ← X + 1)
```

ANSWER: (CAUTION: This problem relies on material from Chapter 1.) No, the process will terminate because X will become negative due to overflow.

3. Identify a flaw in the control of the following loop.

```
X ← 3
while (X ≠ 8) do
  (X ← X + 2)
```

ANSWER: The termination condition will never be reached because X will always be odd.

4. Do the following instructions define an algorithm? Explain your answer.

Write down all the positive odd integers.  
Select the integer in the middle of the list.  
Print the even integer that is one less than the selected odd integer.

ANSWER: No, the instructions are not executable (not effective).

5. Use a repeat loop structure to produce a non-recursive program segment that prints the same sequence of numbers as the following recursive procedure.

```
procedure xxx (N)
  print the value of N:
  if (N < 5) then (apply the procedure xxx to the value N + 1)
```

ANSWER: repeat (print the value of N;  
                  N ← N + 1)  
          until (N > 6)

6. Use a while loop structure to produce a non-recursive program segment that prints the same sequence of numbers as the following recursive procedure.

```
procedure xxx (N)
  print the value of N:
  if (N < 5) then (apply the procedure xxx to the value N + 1)
```

ANSWER: print the value of N;  
          while (N < 6) do  
            (print the value of N;  
            N ← N + 1)

7. Use a repeat loop rather than a while loop to accomplish the same results as the following program segment. Assume that X will have only integer values. (You may also use an if statement if you like.)

```
while (X < 5) do
  (print the value of X;
  X ← X + 1)
```



ANSWER: 

```
if (X < 5) then (repeat (print the value of X;
                        X ← X + 1)
until (X = 5))
```

8. Suppose the statement “X is an integer and  $X < 5$ ” is a loop invariant at the point at which the test for termination is performed in the loop outlined below. What can be concluded about the value of X immediately after the loop is terminated?

```
repeat ( . . . )
until (X > 3)
```

ANSWER:  $X = 4$

9. The pseudocode used in this chapter included both an if-then statement and an if-then-else statement. Show how the statement

```
if (X = 5) then ( . . . )
else ( . . . )
```

can be simulated with a program segment using only if-then statements.

ANSWER: First pick a variable that does not already appear in the program. Call it Y. Then the following is a solution:

```
Y ← X
if (Y = 5) then ( . . . )
if (Y ≠ 5) then ( . . . )
```

(Note that “if (X = 5) then (...); if (X ≠ 5) then (...)” is not correct since the first then clause may change the value of X.)

10. The following procedure was designed to compute the largest integer whose square is no greater than N, where N is assumed to be a positive number. (If N is 5, then the procedure should report the value 2.) Find and correct the error.

```
procedure squareroot (N)
X ← 0;
while (X2 ≤ N) do
  (X ← X + 1);
report the value of X
```

ANSWER: The value reported should be X - 1.

## Test Bank—Chapter Six (Programming Languages)

### Multiple Choice Questions

1. Which of the following is an example of a language that is based on the functional paradigm?

- A. LISP                      B. PROLOG                      C. C                      D. C++

ANSWER: A

2. Which of the following is an example of a language that is based on the object-oriented paradigm?

- A. LISP                      B. PROLOG                      C. C                      D. C++

ANSWER: D

3. Most machine languages are based on the

- A. Imperative paradigm                      B. Declarative paradigm  
C. Functional paradigm                      D. Object-oriented paradigm

ANSWER: A

4. Which of the following is not a type of statement found in a typical high-level imperative programming language?

- A. Imperative statement                      B. Exclamatory statement  
C. Declarative statement                      D. Comment statement

ANSWER: B

5. Which of the following does not require a Boolean structure?

- A. If-then-else statement                      B. While loop statement  
C. Assignment statement                      D. For loop statement

ANSWER: C

6. Which of the following is not a control statement?

- A. If-then-else statement                      B. While loop statement  
C. Assignment statement                      D. For loop statement

ANSWER: C

7. Which of the following is not a control statement?

- A. If-then-else statement                      B. While loop statement  
C. Assignment statement                      D. For loop statement

ANSWER: C

8. Which of the following is not a step in the process of translating a program?

- A. Executing the program
- B. Parsing the program
- C. Lexical analysis
- D. Code generation

ANSWER: A

9. Which of the following is not associated with object-oriented programming?

- A. Inheritance
- B. Resolution
- C. Encapsulation
- D. Polymorphism

ANSWER: B

10. Which of the following is not associated with the concept of data type?

- A. Coercion
- B. Boolean
- C. Operator precedence
- D. Strongly typed language

ANSWER: C

11. Positions within arrays are identified by means of numbers called

- A. Indices
- B. Parameters
- C. Instance variables
- D. Constants

ANSWER: A

12. Which of the following is ignored by a compiler?

- A. Control statements
- B. Declarations of constants
- C. Procedure headers
- D. Comment statements

ANSWER: D

13. Which of the following is not a possible value of the expression  $4 + 6 \div 2 - 1$

- A. 4
- B. 5
- C. 6
- D. 10

ANSWER: B

14. Which of the following is not a way of referring to a value in a program?

- A. Variable
- B. Literal
- C. Constant
- D. Type

ANSWER: D

15. Which of the following is the scope of a variable?

- A. The number of characters in the variable's name
- B. The portion of the program in which the variable can be accessed
- C. The type associated with the variable
- D. The structure associated with the variable

ANSWER: B

16. Which of the following is a means of nullifying conflicts among data types?

- A. Inheritance
- B. Parsing
- C. Coercion
- D. Code optimization

ANSWER: C

17. Which of the following is not constructed by a typical compiler?

- A. Source code   B. Symbol table   C. Parse tree   D. Object program

ANSWER: A

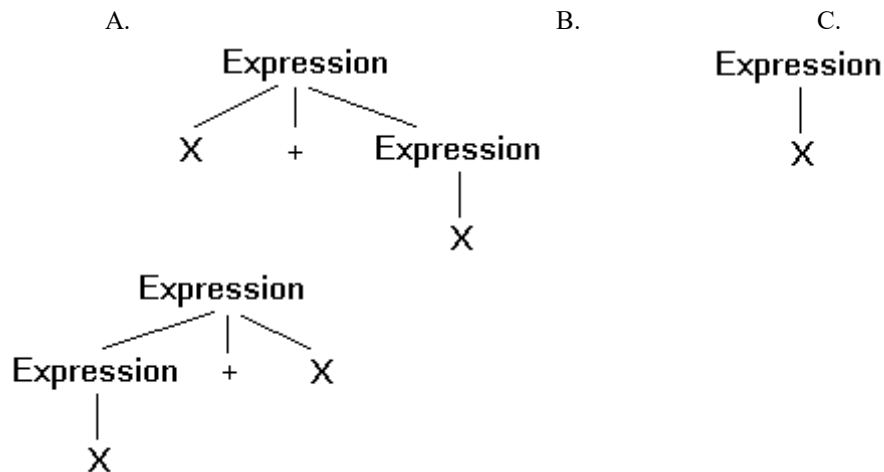
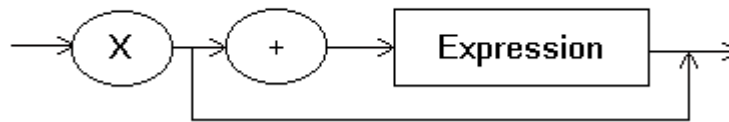
18. Which of the following is a means of defining similar yet different classes in an object-oriented program?

- A. Inheritance   B. Parsing   C. Coercion   D. Code optimization

ANSWER: A

19. Which of the following is not a parse tree of an expression based on the following grammar?

**Expression:**



ANSWER: C

20. Which of the following statements is not a resolvent of the following clauses?

P OR Q OR ¬R   ¬P OR T   ¬Q OR T   R OR T

- A. Q OR ¬R OR T   B. T OR P   C. P OR ¬R OR T   D. Q OR T

ANSWER: B

21. Which of the following can Prolog conclude from the following program?

parent(jill, sue).

```
parent(jill, sally).  
parent(john, sue).  
parent(john, sally).  
sibling(X, Y) :- parent(Z, X), parent(Z, Y).
```

- A. parent(jill, john)      B. sister(sue, sally)  
C. sibling(sue, sally)      D. sibling(jill, sue)

ANSWER: C

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

1. In contrast to \_\_\_\_\_ languages such as English and Spanish, programming languages are considered \_\_\_\_\_ languages and are rigorously defined by their grammars.

ANSWER: natural, formal

2. List two disadvantages of both machine languages and assembly languages that are overcome by high-level programming languages.

\_\_\_\_\_  
\_\_\_\_\_

ANSWER: They are machine dependent and they require that algorithms be expressed in small machine-related steps rather than larger application-oriented steps.

3. Indicate how each of the following types of programming languages is classified in terms of generation (first generation, second generation, or third generation).

- A. High-level languages \_\_\_\_\_  
B. Machine languages \_\_\_\_\_  
C. Assembly languages \_\_\_\_\_

ANSWER: A. Third generation      B. First generation      C. Second generation

4. List four data types that occur as primitive types in many high-level programming languages.

\_\_\_\_\_  
\_\_\_\_\_

ANSWER: Possible answers include: integer, real (or float), Boolean, and character.

5. What encoding system is commonly used to encode data of each of the following types?

- A. Integer \_\_\_\_\_  
B. Real \_\_\_\_\_

C. Character \_\_\_\_\_

ANSWER: (CAUTION: This question relies on material from chapter 1)

- A. Two's complement
- B. Floating-point
- C. ASCII or Unicode

6. A \_\_\_\_\_ array is an array in which all entries are of the same type whereas entries in a \_\_\_\_\_ array may be of different types.

ANSWER: homogeneous, heterogeneous

7. In programming languages that use + to mean concatenation of character strings, the expression

"2x" + "3x"

will produce what result?

\_\_\_\_\_

ANSWER: "2x3x"

8. Rewrite the following instructions using a single if-then-else statement.

```
        if (X = 5) goto 50
        goto 60
50     print the value of Z
        goto 100
60     print the value of Y
100    . . .
```

ANSWER: if (X = 5) then (print the value of Z) else (print the value of Y)

9. The following is a program segment and the definition of a procedure named sub.

```
        .
        .
X ← 3;           procedure sub (Y)
sub (X);         Y ← 5;
print the value of X;
        .
        .
```

A. What value will be printed by the program segment if parameters are passed by value?

\_\_\_\_\_

B. What value will be printed by the program segment if parameters are passed by reference?

\_\_\_\_\_

ANSWER: A. 3      B. 5

10. The following is a program segment and the definition of a procedure named sub.

.	procedure sub
.	.
X ← 8;	.
apply procedure sub;	X ← 2;
print the value of X;	.
.	.
.	.

A. What value will be printed by the program segment if X is a global variable?

\_\_\_\_\_

B. What value will be printed by the program segment if X is declared as a local variable within the procedure?

\_\_\_\_\_

ANSWER: A. 8      B. 2

11. To say that a grammar is ambiguous means that \_\_\_\_\_  
\_\_\_\_\_.

ANSWER: the grammar allows more than one parse tree for a single string

12. List three items of information that would be contained in a typical parser's symbol table.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

ANSWER: Possible answers include: names of variables, data types associated with variables, data structures associated with variables, and others.

13. Give three examples of key words that are often found in high-level imperative or object-oriented languages.

\_\_\_\_\_

ANSWER: Possible answers are numerous and include: if, while, for, class, int, etc.

14. In addition to the procedure's name, what other information is contained in a typical procedure header?

\_\_\_\_\_

ANSWER: A list of the formal parameters

15. In the context of the object-oriented paradigm, \_\_\_\_\_ are templates from which  
\_\_\_\_\_ are constructed. We say that the latter is an instance of the former.

ANSWER: classes, objects

16. In the context of the object-oriented paradigm, a \_\_\_\_\_ is an imperative program unit that describes how an object should react to a particular stimulus.

ANSWER: method (or member function for C++ programmers)

17. Based on the sketch of a class definition below, which methods can be invoked from outside an instance of the class?

```
class Example
{public void method1( )
  { . . . }
 private void method2( )
  { . . . }
 public void method3( )
  {...}
 private void method4( )
  { . . . }
}
```

---

ANSWER: method1 and method3

18. What clause would produce the resolvent

P OR R OR S

when resolved with the clause

P OR  $\neg Q$

---

ANSWER: Q OR R OR S

19. What general rule should be added to the Prolog program below so that Prolog can conclude that ice cream is better than spinach?

```
better(icecream, peanutbutter).
better(peanutbutter, spinach).
```

---

ANSWER: The equivalent of: `better(X, Z) :- better(X, Y), better(Y, Z).`

20. Based on the Prolog program below, what goal should be used to find the siblings of sue?

```
parent(jill, sue).
parent(jill, sally).
parent(john, sue).
parent(john, sally).
sibling(X, Y) :- parent(Z, X), parent(Z, Y).
```

---



ANSWER: Either `sibling(X, sue)` or `sibling(sue, X)`

## 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 asked 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
assembly language	A step up from machine language
programming paradigm	A program development methodology
structured programming	A methodology that applies well-designed control structures to produce well-organized software
grammar	The rules defining the syntax of a programming language
parse tree	A “pictorial” representation of the grammatical structure of a string
compiler	A program that translates other programs into machine language
interpreter	A program that executes other programs written in a high-level language without first translating them into machine language
high-level language	A notational system for representing algorithms in human compatible terms rather than in the details of machinery
semantics	Meaning as opposed to appearance
syntax	Appearance as opposed to meaning
operator precedence	Dictates the order in which operations are performed
data structure	A conceptual organization of information
parameter	A means of passing information to a procedure or function
data type	Encompasses both an encoding system and a collection of operations
syntax diagrams	A way of representing a grammar
source program	A program expressed in a high-level language

## General Format Questions

1. What does it mean to say that a programming language is machine independent?

ANSWER: It means that programs written in the language do not refer to properties of a specific machine and are therefore compatible with any computer.

2. Explain the distinction between the imperative and declarative programming paradigms.

ANSWER: The imperative paradigm requires that a programmer describe an algorithm for solving the problem at hand. The declarative paradigm requires that the programmer describe the problem.

3. Explain why the generation approach to classifying programming languages fails to capture the full scope of today’s languages.

ANSWER: The generation approach fails to reflect the array of distinct programming paradigms.

4. Explain the distinction between translating a program (in a high-level language) and interpreting the program.

ANSWER: To translate a program is to convert it to another (usually low-level) language without executing it. To interpret a program is to execute it directly from its high-level language form.

5. Why is the straightforward “goto” statement no longer popular in high-level programming languages?

ANSWER: Its use led to poorly structured programs that were hard to understand.

6. Explain the distinction between a formal parameter and an actual parameter.

ANSWER: A formal parameter is a term used in a subprogram unit to refer to data that will be given to the subprogram when it is executed. An actual parameter is the data that is given to the subprogram unit when it is executed. (A formal parameter is a “place holder” that is “filled in” with an actual parameter when the subprogram unit is executed.)

7. Explain the distinction between global and local variables.

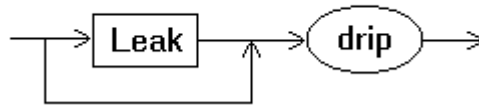
ANSWER: A global variable is readily accessible throughout the program whereas a local variable is accessible only within a specific area.

8. Explain the distinction between a procedure and a function.

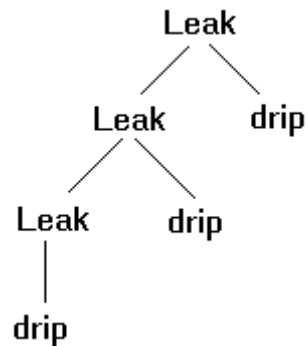
ANSWER: A procedure returns values via parameters and global variables whereas a function returns a value as “the value of the function.”

9. Based on the grammar below, draw a parse tree showing that the string “drip drip drip” is a Leak.

**Leak:**



ANSWER:

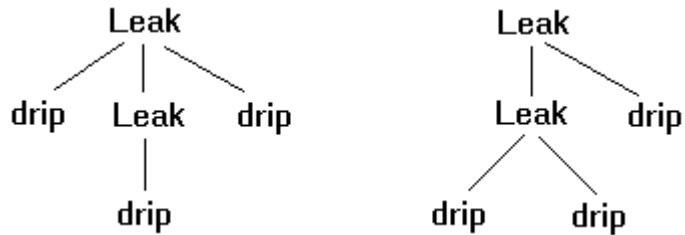


10. Show that the grammar below is ambiguous by drawing two distinct parse trees for the string “drip drip drip.”

**Leak:**



ANSWER: Possible answers include:



11. In the context of the object-oriented paradigm, what is a constructor?

ANSWER: A constructor is a special “method” that is executed when an object is first constructed, normally for the purpose of performing initialization activities.

12. Briefly describe the task of each of the following.

A. Lexical analyzer

B. Parser

C. Code Generator

ANSWER: A. Groups symbols together to form tokens

B. Ascertains the grammatical role of program’s components

C. Constructs object program

13. Explain why key words in a programming language are often reserved words.

ANSWER: Key words are used to help the parser identify grammatical structures in a program. Thus, using these words are used for other purposes could confuse the parser.

## Test Bank—Chapter Seven (Software Engineering)

### Multiple Choice Questions

1. Which of the following software engineering methodologies is the most rigid?

- A. Incremental model
- B. Waterfall model
- C. Extreme programming
- D. Evolutionary prototyping

ANSWER: B

2. Which of the following is a notational system for representing object-oriented designs?

- A. UML
- B. Structure charts
- C. Modular designs
- D. Dataflow diagrams

ANSWER: A

3. Which of the following is an attempt to construct software from off-the-shelf components as is done in other engineering fields?

- A. Extreme programming
- B. Evolutionary prototyping
- C. Component architecture
- D. Open-source development

ANSWER: C

4. Which of the following is most likely an example of a one-to-one relationship?

- A. Subscribers and magazines
- B. Birth dates and people
- C. Planets and their moons
- D. Dinner guests and table settings

ANSWER: D

5. Which of the following is most likely an example of a many-to-many relationship?

- A. Subscribers and magazines
- B. Birth dates and people
- C. Planets and their moons
- D. Dinner guests and table settings

ANSWER: A

6. Which of the following is not a feature of UML?

- A. Use case diagrams
- B. Class diagrams
- C. Dataflow diagrams
- D. Sequence diagrams

ANSWER: C

7. The use of design patterns in software engineering was adopted from what other field?

- A. Business administration
- B. Architecture
- C. Biology
- D. Chemistry

ANSWER: B

8. Which of the following is a form of glass-box testing?

- A. basis path testing      B. Boundary value analysis      C. Beta testing

ANSWER: A

9. Which of the following is a means of controlling the complexity of a software system?

- A. CRC cards      B. Modularity      C. Specifications      D. Beta testing

ANSWER: B

10. Which of the following is a way of testing the design of a software system?

- A. Entity-relationship diagram      B. Class diagram  
C. Structure chart      D. Structured walkthrough

ANSWER: D

11. Which of the following is not related to the others?

- A. Structure Chart      B. Imperative paradigm  
C. Class diagram      D. Procedure

ANSWER: C

12. Which of the following is the method proposed by UML for representing sequences of communication between objects?

- A. Class diagram      B. Use case diagram  
C. Sequence diagram      D. Generalization

ANSWER: C

13. Which of the following is not represented in a class diagram?

- A. Generalizations      B. The methods within a class  
C. The attributes within a class      D. The number of instances each class will have

ANSWER: D

14. Which of the following is least related to the Pareto principle?

- A. When it rains, it pours.  
B. Birds of a feather flock together.  
C. Better late than never.

ANSWER: C

15. The Pareto principle is traditionally applied during which phase of software development?

- A. Analysis      B. Design      C. Implementation      D. Testing

ANSWER: D

16. Which of the following is the oldest approach to software development?

- A. Component architecture
- B. Waterfall model
- C. Open-source development
- D. Extreme programming

ANSWER: B

17. Which of the following is not a tool for designing modular systems?

- A. Structure charts
- B. Data dictionaries
- C. Class diagrams
- D. Sequence diagrams

ANSWER: B

18. Which of the following is a stronger form of cohesion?

- A. Functional cohesion
- B. Logical cohesion

ANSWER: A

19. Which of the following appears to be the most functionally cohesive?

- A. A module that handles all of a customers banking needs
- B. A module that handles only transactions related to checking accounts
- C. A module that only records deposits to checking accounts
- D. A module that collects data for monthly statements

ANSWER: C

20. If a class diagram indicates a one-to-one relationship between class X and class Y, then

- A. there will be only one object in the system of “type” X.
- B. each object of “type” X will be associated with only one object of “type” Y.
- C. there will be exactly one object of “type” X and exactly one object of “type” Y.
- D. an object of “type” Y cannot occur without first constructing an object of “type” X.

ANSWER: B

21. Copyright laws were established

- A. to allow authors to distribute their work while maintaining certain ownership rights.
- B. to allow authors to maintain ownership of their ideas.
- C. to restrict access to publications to certain groups within society.
- D. to allow ideas to be traced back to their origins.

ANSWER: A

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

1. Identify the stage of software development in which each of the following activities is performed.

- A. \_\_\_\_\_ Programming is conducted.

B. \_\_\_\_\_ Class diagrams are drawn.

C. \_\_\_\_\_ User needs are analyzed.

ANSWER: A. Implementation    B. Design    C. Analysis

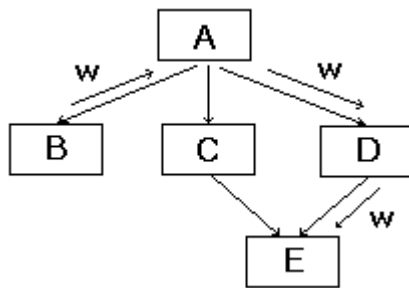
2. During the analysis stage of software development, user needs are identified in the form of non-technical \_\_\_\_\_ that are then converted into technical \_\_\_\_\_ .

ANSWER: requirements, specifications

3. Prototyping occurs in two forms. In one, called \_\_\_\_\_ prototyping the original prototype is slowly enhanced to become the final product. In the other, called \_\_\_\_\_ prototyping, the original prototype is used as an “experimental” system that is ultimately discarded.

ANSWER: Evolutionary, throwaway

4. Answer the following questions in terms of the structure chart below.



A. What modules directly use the services of module E?

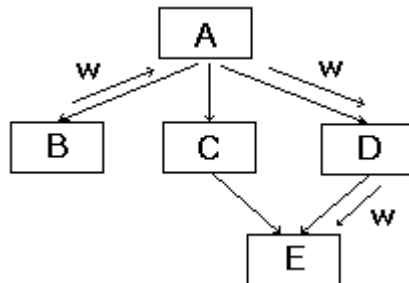
\_\_\_\_\_

B. The services of which modules are directly used by module A?

\_\_\_\_\_

ANSWER: A. C and D    B. B, C, and D

5. Based on the structure chart below, in which module does the data item w originate?



\_\_\_\_\_

ANSWER: B

6. In an object-oriented design using UML, \_\_\_\_\_ diagrams are used to represent classes and their basic relationships, whereas \_\_\_\_\_ diagrams are used to represent communication between objects.

ANSWER: Class, sequence

7. In each of the following, indicate whether the information would be represented within a use case diagram, a class diagram, or a sequence diagram.

- A. \_\_\_\_\_ The methods within a class
- B. \_\_\_\_\_ The ways in which the system will interact with its environment
- C. \_\_\_\_\_ The manner in which its internal objects will interact
- D. \_\_\_\_\_ Relationships among classes

ANSWER: A. Class diagram B. Use case diagram C. Sequence diagram D. Class diagram

8. \_\_\_\_\_ is a notational system for representing object-oriented designs. It includes standards for representing \_\_\_\_\_ diagrams that show how users interact with the proposed system as well as \_\_\_\_\_ diagrams that show how objects within the proposed system will interact.

ANSWER: UML, use case, sequence

9. Give an example of a one-to-many relationship.

\_\_\_\_\_

ANSWER: Answers may vary. Examples include: classrooms to chairs (a classroom has many chairs but each chair is in only one classroom), mothers to children (a mother may have many children but each child has only one mother), and many others.

10. In each case below indicate whether the activity relates to a structure chart or a class diagram.

- A. \_\_\_\_\_ Identifying actions to be performed
- B. \_\_\_\_\_ Identifying the types of objects in a system
- C. \_\_\_\_\_ Identifying relationships between “types” of objects
- D. \_\_\_\_\_ Identifying how activities performed by different procedures relate to one another

ANSWER: A. Structure chart B. Class diagram C. Class diagram D. Structure chart

11. In each case below indicate whether the activity relates to a sequence diagram or a dataflow diagram.



- A. \_\_\_\_\_ Identifying messages passed between objects
- B. \_\_\_\_\_ Identifying how data items are combined to produce new items
- C. \_\_\_\_\_ Identifying how tasks are performed via object interactions
- D. \_\_\_\_\_ Identifying how information and leaves a system

ANSWER: A. Sequence diagram B. Dataflow diagram C. Sequence diagram D. Dataflow diagram

12. In each case below indicate whether the phrase relates to coupling or cohesion.

- A. \_\_\_\_\_ The interaction between modules
- B. \_\_\_\_\_ Passing data from one module to another
- C. \_\_\_\_\_ Ensuring that a module performs a unique task in its entirety

ANSWER: A. Coupling B. Coupling C. Cohesion

13. Identify two forms of inter-module coupling.

\_\_\_\_\_  
\_\_\_\_\_

ANSWER: Data coupling and control coupling

14. In each case below indicate whether the activity is a form of glass-box testing or black-box testing.

- A. \_\_\_\_\_ Basis path testing
- B. \_\_\_\_\_ Boundary value analysis
- C. \_\_\_\_\_ Beta testing

ANSWER: A. Glass-box testing B. Black-box testing C. Black-box testing

15. In each case below indicate whether the activity relates to glass-box testing or black-box testing.

- A. \_\_\_\_\_ Testing to see if the system performs in a timely manner
- B. \_\_\_\_\_ Designing test data to ensure that each instruction is executed at least once
- C. \_\_\_\_\_ Testing to see if the software system meets the requirements identified during original analysis

ANSWER: A. Black-box testing B. Glass-box testing C. Black-box testing

16. State the Pareto principle in the context of software engineering.

\_\_\_\_\_

ANSWER: Errors in a software system tend to be concentrated in relatively small areas.

17. In each case below indicate whether the activity is primarily top-down or bottom-up.

- A. \_\_\_\_\_ Building software from previously constructed components
- B. \_\_\_\_\_ Dividing a module into smaller modules to obtain greater cohesion
- C. \_\_\_\_\_ Designing a dataflow diagram by successively adding more specificity

ANSWER: A. Bottom-up B. Top-down C. Top-down

18. As a general rule, one should strive to \_\_\_\_\_ (maximize or minimize) coupling between modules and to \_\_\_\_\_ (maximize or minimize) cohesion within modules.

ANSWER: minimize, maximize

19. Give two examples of recent advances in software engineering.

\_\_\_\_\_  
\_\_\_\_\_

ANSWER: There are many possible answers (and they vary depending on the interpretation of “recent.” Answers include: component architecture, the application of design patterns, open-source development, extreme programming, the use of prototypes, CASE tools, the development of UML, and others.

20. Identify two legal techniques that have been applied to protect a software developer’s ownership rights.

\_\_\_\_\_  
\_\_\_\_\_

ANSWER: Possible answers include copyright law, patent law, and nondisclosure agreements.

## 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 asked 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

metric  
software life cycle  
waterfall model  
prototyping

### Descriptive Phrase

A means of quantifying  
Develop, use, modify  
An older, rather rigid approach to software development  
An approach to software development in which partial systems are constructed

component architecture	A means of constructing software from prefabricated units
structure chart	A means of representing procedural dependencies
cohesion	The “glue” that holds a module together
sequence diagram	A diagram representing communication between objects
use case diagram	A diagram representing communication between a system and its users
UML	A standard notational system for representing object-oriented designs
global data	A means of implementing implicit coupling
modularity	A means of managing complexity within a large software system
structured walkthrough	A means of testing a design before it is implemented
beta testing	Allows potential users to experiment with preliminary versions of software
glass-box testing	Confirms that the internal structure of a software system is reliable
open-source development	A somewhat renegade methodology for software development
analysis	The beginning of the software development phase
specifications	System requirements translated into technical context
data dictionary	A central warehouse of information regarding data throughout a system
top-down	General to specific (as opposed to specific to general)
one-to-many	A type of relationship between entities

## General Format Questions

1. Identify two distinctions between software engineering and other traditional fields of engineering.

ANSWER: Possible answers include: In contrast to traditional fields of engineering, there is a lack of metrics for measuring quantities in software engineering. Software engineering does not involve tolerances in the sense of traditional engineering. Traditional engineering builds products from off-the-shelf components; this is still a goal in software engineering.

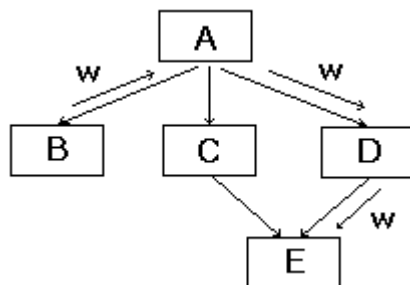
2. In what sense is the software life cycle different from the life cycle of other products?

ANSWER: Software does not wear out so rather than needing maintenance in the traditional sense, software requires modification due to changing environments or detection of errors.

3. Explain the distinction between open-source development and beta testing.

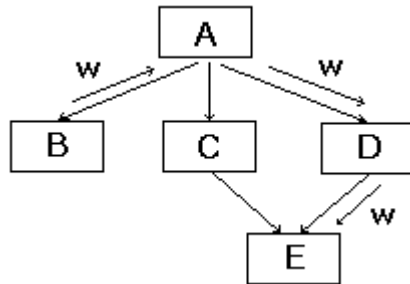
ANSWER: Open-source development involves “testers” to modify software whereas beta testing allows them only to report errors.

4. Describe the data coupling represented by the following structure chart.



ANSWER: The modules B, A, D, and E are coupled via the data item w. B creates w and passes it to A, A passes it to D, and D passes it to E.

5. Describe the control coupling represented by the following structure chart.



ANSWER: Module A can pass control to modules B, C, and D. Each of modules C and D can pass control to E.

6. Describe the process of a structured walkthrough.

ANSWER: A structured walkthrough is a “theatrical” exercise in which people play the roles of various software modules in order to identify flaws in the system’s design.

7. In what sense is the object-oriented paradigm ideal for implementing design patterns?

ANSWER: The object-oriented paradigm uses classes as templates for constructing objects. This “template” approach is a natural means of implementing design patterns.

8. Give an argument supporting the statement that modularity is the most important principle in software engineering.

ANSWER: Modularity, which is found in all software engineering paradigms, is the primary means of dealing with complexity.

9. Explain the distinction between structure charts and class diagrams.

ANSWER: The two are used in different design paradigms. Structure charts are used to represent the relationship between procedural modules in an imperative design. Class diagrams are used to represent the relationship between classes in an object-oriented design.

10. Explain some of the ways in which software engineering has benefited from the development of the object-oriented paradigm.

ANSWER: The concept of classes and objects provides an excellent modularizing tool. Moreover, it has provided a means of implementing design patterns so that software can be constructed from prefabricated units.

11. Explain the role of each of the following forms of documentation: user documentation, technical documentation, and system documentation.

ANSWER: User documentation explains how to use a system as an abstract tool. Technical documentation explains how to install a system, how to update the system, and perhaps how to customize the system. System documentation explains the internal construction of the system to support internal modifications.

12. Explain why inheritance may not be the best way of implementing generalizations among classes.

ANSWER: Inheritance introduces a strong coupling between classes that may cease to be valid in later software modifications.

## Test Bank—Chapter Eight (Data Abstractions)

### Multiple Choice Questions

1. Which of the following is a LIFO structure?

- A. Array B. Stack C. Queue D. Tree

ANSWER: B

2. Which of the following is a FIFO structure?

- A. Array B. Stack C. Queue D. Tree

ANSWER: C

3. Which of the following is static in the sense that it does not change size or shape as information is stored and retrieved?

- A. Array B. Stack C. Queue D. Tree

ANSWER: A

4. Suppose you were going to retrieve items of data that you would later need to process in the opposite order from that in which they were retrieved. Which of the following would be the best structure in which to store the items?

- A. Traditional linked list B. Stack C. Queue D. Tree

ANSWER: B

5. Suppose a binary tree contained the nodes W, X, Y, and Z. If W and X were children of Y, and Z had no children, which node would be the root?

- A. W B. X C. Y D. Z

ANSWER: C

6. Suppose a binary tree contained the nodes W, X, Y, and Z, and each node had at most one child. How many terminal nodes would be in the tree?

- A. One B. Two C. Three D. Undetermined

ANSWER: A

7. If the two-dimensional array X were stored in row-major order, then in the block of main memory containing X, which of the following would be true?

- A. The entry X[1,2] would appear before X[2,1].  
B. The entry X[1,2] would appear after X[2,1].  
C. The entry X[1,2] would be in the same location as X[2,1].  
D. None of the above

ANSWER: A

8. Which of the following is not used when determining the location of an entry in a two-dimensional homogeneous array stored in row-major order?

- A. Indices
- B. Number of rows in the array
- C. Address polynomial
- D. Number of columns in the array

ANSWER: B

9. Which of the following is not a means of locating an entry in a linked storage structure?

- A. Head pointer
- B. Child pointer
- C. Root pointer
- D. NIL pointer

ANSWER: D

10. If a stack contained the entries  $w, x, y, z$  (from top to bottom), which of the following would be the contents after two entries were removed and the entry  $r$  was inserted?

- A.  $w, x, r$
- B.  $y, z, r$
- C.  $r, y, z$
- D.  $r, w, x$

ANSWER: C

11. If a queue contained the entries  $w, x, y, z$  (from head to tail), which of the following would be the contents after two entries were removed and the entry  $r$  was inserted?

- A.  $w, x, r$
- B.  $y, z, r$
- C.  $r, y, z$
- D.  $r, w, x$

ANSWER: B

12. If the number of nodes in a binary tree is  $2^n$  (where  $n$  is a positive integer), then the entire tree would contain at least

- A.  $2^{n+1}$  nodes
- B.  $2^{2n}$  nodes
- C.  $2^{n+1} - 1$  nodes
- D.  $2^{n+2}$  nodes

ANSWER: C

13. If the longest path in a binary tree contained exactly four nodes, what is the maximum number of nodes that could be in the entire tree?

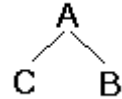
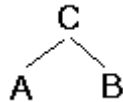
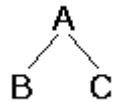
- A. 4
- B. 7
- C. 15
- D. 31

ANSWER: C

14. The nodes in which of the trees below will be printed in alphabetical order by the following recursive procedure?

```
procedure printTree (Tree)
if (Tree is not empty)
then (print the root node;
      apply the procedure printTree to the right subtree of Tree;
      apply the procedure printTree to the left subtree of Tree)
```

- A.
- B.
- C.



ANSWER: C

15. The nodes in which of the trees below will be printed in alphabetical order by the following recursive procedure?

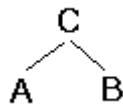
```

procedure printTree (Tree)
if (Tree is not empty)
then (apply the procedure printTree to the left subtree of Tree;
      apply the procedure printTree to the right subtree of Tree;
      print the root node)
  
```

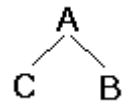
A.



B.



C.

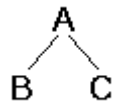


ANSWER: B

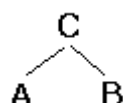
16. The table below represents a portion of a computer's main memory containing a binary tree. Each node consists of three cells, the first being data, the second being a pointer to the node's left child, and the third being a pointer to the node's right child. If the nil pointer is represented by 00 and the tree's root pointer contains 50, which of the following is a picture of the tree?

Address	Contents
50	A
51	56
52	53
53	B
54	00
55	00
56	C
57	00
58	00

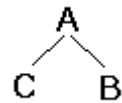
A.



B.



C.



ANSWER: C

17. Suppose a binary tree is implemented as a linked structure in which each node contains both a left child pointer and a right child pointer. Which of the following statements is false?

A. The number of nodes in the tree is always at least the number of nodes on the longest path in the tree.



- B. The number of NIL pointers in the tree is always greater than the number of nodes in the tree.
- C. Each terminal node in the tree is always at the end of a path that is as least as long as any other path in the tree.
- D. Both the left child and right child pointers of every terminal node are NIL.

ANSWER: C

18. The table below represents a portion of a computer's main memory containing a binary tree stored row by row in a contiguous block as described in the chapter. What is the left child of the node V?

Address	Contents
50	T
51	U
52	V
53	W
54	X
55	Y
56	Z

- A. W
- B. X
- C. Y
- D. Z

ANSWER: C

19. The table below represents a portion of a computer's main memory containing a binary tree stored row by row in a contiguous block as described in the chapter. What is the parent of the node Z?

Address	Contents
50	T
51	U
52	V
53	W
54	X
55	Y
56	Z

- A. T
- B. U
- C. V
- D. Y

ANSWER: C

20. In a machine language, the technique in which the data to be manipulated by an instruction is included within the instruction itself is called

- A. Immediate addressing
- B. Direct addressing
- C. Indirect addressing

ANSWER: A

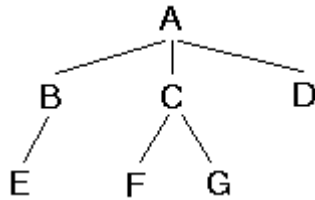
21. In a machine language, the technique in which an instruction contains the location of a pointer to the data to be manipulated is called

- A. Immediate addressing
- B. Direct addressing
- C. Indirect addressing

ANSWER: C

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

1. Answer the following questions in terms of the tree below.



- A. The root node is \_\_\_\_\_ .
- B. Three nodes that are siblings are \_\_\_\_\_ , \_\_\_\_\_ , and \_\_\_\_\_ .
- C. The terminal nodes are \_\_\_\_\_ .
- D. The node with only one child is \_\_\_\_\_ .

ANSWER: A. A    B. B, C, and D    C. E, F, G, and D    D. B

2. Two special forms of lists are the LIFO structures known as \_\_\_\_\_ , in which entries are inserted and removed from the \_\_\_\_\_ , and FIFO structures known as \_\_\_\_\_ , in which entries are removed from the \_\_\_\_\_ and inserted at the \_\_\_\_\_ .

ANSWER: stacks, top, queues, head, tail

3. Suppose the expression  $X[1, 1]$  referred to the first-row, first-column entry in a two-dimensional array with 5 rows and 7 columns. If the array is stored in row-major order beginning at memory address  $x$  and each entry in the array requires  $n$  memory cells, what address polynomial would be used to compute the address of the beginning of the entry  $X[I, J]$ ?

\_\_\_\_\_

ANSWER:  $x + n(7(I - 1) + J - 1)$

4. Suppose the expression  $X[0, 0]$  referred to the first-row, first-column entry in a two-dimensional array with 5 rows and 7 columns. If the array is stored in column-major order beginning at memory address  $x$  and each entry in the array requires  $n$  memory cells, what address polynomial would be used to compute the address of the beginning of the entry  $X[I, J]$ ?

\_\_\_\_\_

ANSWER:  $x + n(5J + I)$

5. If a queue contained the entries B, C, D (from head to tail), what would be the contents of the queue (again from head to tail) after one entry was removed and the entry A was inserted?

ANSWER: C, D, A

6. Suppose a queue contained the entries A, B, C, D (from head to tail) and suppose that the entries were removed and pushed on a stack one at a time until the queue was empty. What would be the contents of the queue (again from head to tail) if the entries were then popped from the stack and inserted back in the queue one at a time.

---

ANSWER: D, C, B, A

7. In which direction does an unchecked queue crawl through memory (in the direction of its head or in the direction of its tail)?

---

ANSWER: In the direction of its tail

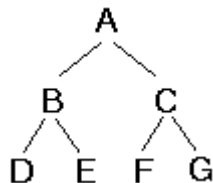
8. The table below represents a portion of a computer's main memory containing a linked list. Each list entry consists of two cells, the first being data and the second being a pointer to the next list entry. If the nil pointer is represented by 00 and the list's head pointer contains 56, what are the data entries in the list? (List the entries in the order they occur in the list.)

Address	Contents
50	AA
51	00
52	BB
53	58
54	CC
55	50
56	DD
57	54
58	EE
59	00

---

ANSWER: DD, CC, AA

9. What sequence of nodes from the tree



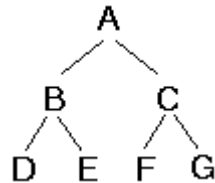
would be printed if the following recursive procedure were applied to it?

```
procedure printTree (Tree)
  if (Tree is not empty)
    then (print the root of Tree;
          apply the procedure printTree to the right subtree of Tree)
```

---

ANSWER: A, C, G

10. What sequence of nodes from the tree



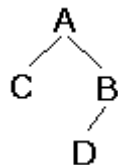
would be printed if the following recursive procedure were applied to it? (The procedure uses a global stack called Stack that is assumed to begin empty.)

```
procedure printTree (Tree)
  if (Tree is not empty)
    then (push the current node on Stack;
          apply the procedure printTree to the right subtree of Tree)
  if (Stack is not empty)
    then (pop an entry from Stack and print that node)
```

---

ANSWER: G, C, A

11. What sequence of nodes from the tree



would be printed if the following recursive procedure were applied to it? (The procedure uses a global stack called Stack that is assumed to begin empty.)

```
procedure printTree (Tree)
  push the left child of the root node on Stack;
  if (right branch of Tree is not empty)
    then (apply the procedure printTree to the right subtree of Tree)
  pop an entry from Stack and print that node.
```

---

ANSWER: D, C

12. The table below represents a portion of a computer's main memory containing a binary tree. Each node consists of three cells, the first being data, the second being a pointer to the node's left child, and the third being a pointer to the node's right child. If the nil pointer is represented by 00 and the tree's root pointer contains 56, what data is in the left child of the root node?

Address	Contents
50	AA

51	53
52	00
53	BB
54	00
55	00
56	CC
57	50
58	00

---

ANSWER: AA

13. The table below represents a portion of a computer's main memory containing a binary tree. Each node consists of three cells, the first being data, the second being a pointer to the node's left child, and the third being a pointer to the node's right child. If the nil pointer is represented by 00 and the tree's root pointer contains 53, how many terminal nodes are in the tree?

Address	Contents
50	AA
51	00
52	00
53	BB
54	00
55	56
56	CC
57	00
58	00

---

ANSWER: One

14. The table below represents a portion of a computer's main memory containing a binary tree. Each node consists of three cells, the first being data, the second being a pointer to the node's left child, and the third being a pointer to the node's right child. If the nil pointer is represented by 00 and the tree's root pointer contains 53, how many nodes are on the longest path in the tree?

Address	Contents
50	AA
51	56
52	00
53	BB
54	00
55	50
56	CC
57	00
58	00

---

ANSWER: Three

15. The table below represents a portion of a computer's main memory containing a binary tree stored row by row in a contiguous block as described in the chapter. What are the children of the node B?

Address	Contents
50	A
51	B
52	C
53	D
54	E
55	F
56	G

ANSWER: D and E

16. If the longest path in a binary tree contains five nodes, what is the maximum number of terminal nodes that could be in the tree?

\_\_\_\_\_

ANSWER: 16

17. If the variable named `Box` had the user-defined type `RectangleType` defined by

```
Define type RectangleType to be
{real  length;
 real  width;
 real  height
}
```

What expression would be used to reference the length of `Box`?

\_\_\_\_\_

ANSWER: `Box.length`

18. If the type `BananaSplit` was defined by a statement such as

```
define type BananaSplit to be
{int  Banana;
 int  IceCream;
 int  Chocolate;
 int  WhippedCream;
 int  Nuts;
 int  Cherry
}
```

what statement would probably be used to declare the variable `Desert` to be an instance of that type?

\_\_\_\_\_

ANSWER: `BananaSplit Desert;`

(The declaration of `Desert` would use the same syntax as the declarations using the primitive type `int`.)

19. Suppose the abstract data type `StackType` was defined as follows:

```
define type StackType to be
{int StackEntries[20];
 int StackPointer = 0;
```

```

procedure push(Value)
{StackEntries[StackPointer] ← Value;
  StackPointer ← StackPointer + 1;
}

```

A. What would be the value of the variable `StackPointer` associated with `Stack` after executing the statement

```
StackType Stack;
```

\_\_\_\_\_

B. Then, what would be the value of `StackPointer` associated with `Stack` after executing the statement

```
Stack.push(5);
```

\_\_\_\_\_

ANSWER:    A. 0            B. 1

20. Suppose the abstract data type `StackType` was defined as follows:

```

define type StackType to be
{int StackEntries[20];
  int StackPointer = 0;
  procedure push(Value)
  {StackEntries[StackPointer] ← Value;
    StackPointer ← StackPointer + 1;
  }
}

```

A. What would be the value of the variable `StackPointer` associated with `Stack2` after executing the statements

```

StackType Stack1, Stack2;
Stack1.push(5);
Stack2.push(6);
Stack2.push(7);

```

\_\_\_\_\_

B. What would be the value of `StackEntries[0]` associated with `Stack1` after executing the statements in part A?

\_\_\_\_\_

C. What would be the value of `StackEntries[0]` associated with `Stack2` after executing the statements in part A?

\_\_\_\_\_

ANSWER:    A. 2            B. 5            C. 6

21. The following represents a portion of a computer's main memory.

Address	Contents
50	51
51	56
52	53
53	57
54	58
55	50
56	57
57	52
58	53

A. What would be stored at address 50 after executing the instruction “Copy the contents of the memory cell at address 54 to address 50”?

\_\_\_\_\_

B. What would be stored at address 50 after executing the instruction “Copy the contents of the memory cell pointed to by the cell at address 54 to address 50”?

\_\_\_\_\_

ANSWER: A. 58 B. 53

## 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
pointer	Contains the address at which an entity is stored
address polynomial	Used to find entries in a homogeneous array
abstraction	The separation of internal implementation from external functionality
list	A general sequential storage structure
stack	A LIFO storage structure
queue	A FIFO storage structure
array	A “rectangular” storage structure that does not change in size or shape
tree	A storage structure that may contain siblings.
user-defined data type	A storage structure template built by combining primitive types
abstract data type	A custom-built data type including both data and operations
class	A “type” whose instances are objects
instance	An entity conforming to a type
linked structure	A data storage system in which items are connected via pointers
top	The “head” of a stack
root	The top node of a tree
NIL pointer	Indicates the end



## General Format Questions

1. What condition indicates that a linked list is empty?

ANSWER: An empty linked list is indicated by a NIL head pointer.

2. The table below represents a portion of a computer's main memory containing a linked list. Each entry consists of two cells, the first being data, the second being a pointer to the next entry. If the nil pointer is represented by 00 and the list's head pointer contains 52, modify the memory cells so the data at address 50 replaces the second entry in the list.

Address	Contents
50	AA
51	00
52	BB
53	58
54	CC
55	00
56	DD
57	00
58	EE
59	54

ANSWER: Change the cell at address 51 to 54 and change the cell at address 53 to 50.

3. The table below represents a portion of a computer's main memory containing a linked list. Each entry consists of two cells, the first being data, the second being a pointer to the next entry. If the nil pointer is represented by 00 and the list's head pointer contains 52, modify the memory cells so the data at address 56 is inserted at the end of the list.

Address	Contents
50	AA
51	00
52	BB
53	58
54	CC
55	00
56	DD
57	00
58	EE
59	54

ANSWER: Change the cell at address 55 to 56.

4. The table below represents a portion of a computer's main memory containing a binary tree. Each node consists of three cells, the first being data, the second being a pointer to the node's left child, and the third being a pointer to the node's right child. If the nil pointer is represented by 00 and the tree's root pointer contains 53, draw a picture of the tree showing the data in each node?

Address	Contents
50	AA
51	56
52	00

53	BB
54	00
55	50
56	CC
57	00
58	00

ANSWER:



5. Why is a queue normally implemented as a circular queue?

ANSWER: To keep it from crawling through memory unchecked.

6. What is the distinction between a user-defined data type and an abstract data type?

ANSWER: A user-defined data type is merely a “data storage template” whereas an abstract data type includes procedures for manipulating the data as well.

7. Define each of the following:

- A. Primitive data type      B. User-defined data type      C. Abstract data type

ANSWER: A. A data type provided as a predefined feature of a programming language.

B. A data arrangement template defined in a program.

C. An extension of a user-defined type that incorporates procedures for manipulating the data.

8. What is the distinction between a type and an instance of that type?

ANSWER: A type is a collection of characteristics. An instance of that type is an entity with those characteristics. (A type is a template from which an instance of that type is constructed.)

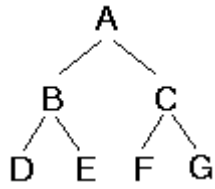
9. What is the distinction between direct addressing and indirect addressing?

ANSWER: When using direct addressing, the address of the data to be manipulated is included in the instruction. When using indirect addressing, the location of a pointer to the data to be manipulated is included in the instruction.

10. The table below represents a portion of a computer’s main memory containing a binary tree stored row by row in a contiguous block as described in the chapter. Draw a picture of the tree.

Address	Contents
50	A
51	B
52	C
53	D
54	E
55	F

ANSWER:



11. In a machine language, what advantage does indirect addressing offer over immediate and direct addressing?

ANSWER: Indirect addressing allows the same instruction to be used to perform the same operation on different items of data merely by changing the value of the pointer referenced in the instruction.

## Test Bank—Chapter Nine (Database Systems)

### Multiple Choice Questions

1. Which of the following accesses a database in terms of a database model?

- A. Application software    B. Database management system    C. Actual database

ANSWER: A

2. Which of the following describes only the portion of a database available to a particular user?

- A. Database model    B. Schema    C. Subschema    D. DBMS

ANSWER: C

3. Which of the following relational operations combine data from more than one relation?

- A. SELECT    B. PROJECT    C. JOIN

ANSWER: C

4. Which of the following relational operations extracts entire columns from a relation?

- A. SELECT    B. PROJECT    C. JOIN

ANSWER: B

5. Which of the following relational operations extracts entire rows from a relation?

- A. SELECT    B. PROJECT    C. JOIN

ANSWER: A

6. Which of the following relational operations is performed by the SQL statement below?

```
select A, B, C
from X
```

- A. SELECT    B. PROJECT    C. JOIN

ANSWER: B

7. Given the relation X below

X:	<u>A</u>	<u>B</u>	<u>C</u>
	2	5	7
	3	3	3
	4	3	2
	5	2	8

what value will be extracted by the following query?

```
TEMP ← SELECT from X where B > C
```

RESULT  $\leftarrow$  PROJECT A from TEMP

A. 2                      B. 3                      C. 4                      D. 5

ANSWER: C

8. Given the relation X below

X:	<u>A</u>	<u>B</u>	<u>C</u>
	2	5	7
	3	3	3
	4	4	2
	5	2	8

what value will be retrieved by the following query?

TEMP  $\leftarrow$  SELECT from X where B = C  
 RESULT  $\leftarrow$  PROJECT B from TEMP

A. 2                      B. 3                      C. 4                      D. 5

ANSWER: B

9. Given the relation below

X:	<u>A</u>	<u>B</u>	<u>C</u>
	2	5	7
	3	3	6
	4	4	2
	5	2	2

what values will be retrieved by the following SQL statement?

```
select A, B
from X
where X.B = X.C
```

A. 2, 5                      B. 3, 6                      C. 2, 2                      D. 5, 2

ANSWER: D

10. Given the two relations X and Y below

X:	<u>A</u>	<u>B</u>	Y:	<u>C</u>	<u>D</u>
	7	s		t	3
	2	z		r	2

what value would be retrieved by executing the following SQL statement?

```
select Y.C
from X, Y
where X.A < Y.D
```

A. s                      B. z                      C. t                      D. r

ANSWER: C

11. Which of the following is not a potential problem caused by multiple transactions manipulating a database at the same time?

- A. Lost update problem    B. Clustering    C. Deadlock    D. Incorrect summary problem

ANSWER: B

12. Which of the following features within a DBMS is not provided to maintain database integrity?

- A. Concurrent transaction processing    B. Log  
C. Locking protocol    D. Commit points

ANSWER: A

13. Which of the following data mining techniques would be applied when trying to identify traits that characterize the citizens of a democracy who fail to vote?

- A. Class description    B. Class discrimination  
C. Cluster analysis    D. Association analysis

ANSWER: A

14. Which of the following data mining techniques would be applied when trying to identify traits that predict whether a citizen in a democracy will or will not vote?

- A. Class description    B. Class discrimination  
C. Cluster analysis    D. Association analysis

ANSWER: B

15. Which of the following data mining techniques would be applied when trying to identify any underlying heterogeneity within housing patterns in a community?

- A. Class description    B. Class discrimination  
C. Cluster analysis    D. Association analysis

ANSWER: C

16. Which of the following data mining techniques would be applied when trying to identify common properties between different groups of shoppers?

- A. Class description    B. Class discrimination  
C. Cluster analysis    D. Association analysis

ANSWER: D

17. Which of the following file structures is most efficient in cases in which the file is always processed in its entirety a predetermined order?

- A. Sequential    B. Indexed    C. Hash

ANSWER: A

18. Which of the following file structures is commonly used for the storage of text files?

- A. Sequential                      B. Indexed                      C. Hash

ANSWER: A

19. Which of the following file structures is associated with the problem of clustering?

- A. Sequential                      B. Indexed                      C. Hash

ANSWER: C

20. Which of the following file structures requires a small “auxiliary” storage system that must be updated as entries in the file are inserted or deleted.

- A. Sequential                      B. Indexed                      C. Hash

ANSWER: B

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

1. In a relational database, information is presented as though it were stored in tables called

\_\_\_\_\_, each of which has columns called \_\_\_\_\_ and rows called \_\_\_\_\_.

ANSWER: Relations, attributes, tuples

2. Identify two database models.

\_\_\_\_\_  
\_\_\_\_\_

ANSWER: Possible answers include: relational and object-oriented

3. The term “lossless decomposition” refers to a decomposition of one relation into several relations such

that \_\_\_\_\_.

ANSWER: no information is lost

4. Suppose a relation X had the attributes PartID (part identification number), StockGoal (quantity held when fully stocked), and CurrentQuantity (quantity actually in stock). Complete the following statement to obtain information about those parts that are not fully stocked.

Result ← SELECT from X where \_\_\_\_\_

ANSWER: StockGoal ≠ CurrentQuantity

5. Suppose a relation X had the attributes Name, EmployeeID, and Address. Complete the following statement to obtain a list of the names and addresses of all employees.

Result  $\leftarrow$  \_\_\_\_\_ from X

ANSWER: PROJECT Name, Address

6. Given the two relations X and Y below

X:	<u>A</u>	<u>B</u>	Y:	<u>C</u>	<u>D</u>
	2	s		t	1
	5	z		r	3
				w	2

what values would be in the tuple produced by the following statement?

Result  $\leftarrow$  JOIN X and Y where X.A < Y.D

\_\_\_\_\_

ANSWER: 2, s, r, 3

7. Given the two relations X and Y below

X:	<u>A</u>	<u>B</u>	Y:	<u>C</u>	<u>D</u>
	2	s		t	1
	5	z		r	3
				w	2

what values would be in the tuple produced by the following statements?

Temp  $\leftarrow$  JOIN X and Y where X.A = Y.D  
 Result  $\leftarrow$  PROJECT X.B, Y.C from Temp

\_\_\_\_\_

ANSWER: s, w

8. Given the two relations X and Y below

X:	<u>A</u>	<u>B</u>	Y:	<u>C</u>	<u>D</u>
	7	s		t	1
	3	z		r	2
	1	u			

what values would be retrieved by executing the following statement?

select X.A, X.B, Y.C  
 from X, Y  
 where X.A < Y.D

\_\_\_\_\_

ANSWER: 1, u, t



9. Given the three relations X, Y, and Z below

X:	<u>A</u>	<u>B</u>	Y:	<u>C</u>	<u>D</u>	Z:	<u>E</u>	<u>F</u>
	7	s		t	4		2	w
	3	z		r	2		3	q
	1	u						

what values would be retrieved by executing the following statement?

```
select X.B, Y.C, Z.F
  from X, Y, Z
 where X.A > Y.D and X.A = Z.E
```

---

ANSWER: z, r, q

10. Which of the operations SELECT, PROJECT, and JOIN are actually used when executing the following SQL instruction?

```
select A, B
  from X
 where C = D
```

---

ANSWER: SELECT, PROJECT

11. Given the relation Employees containing the attributes Name, Address, and BirthDate, what question is answered by the following sequence of operations?

```
Temp ← SELECT from Employees where BirthDate < "January 4, 1975"
Result ← PROJECT Name from Temp
```

---

ANSWER: Which employees were born before January 4, 1975?

12. Given the relation Employees containing the attributes Name, Address, and CurrentJobID and the relation Jobs containing the attributes JobID, SkillRating, Department, what question is answered by the following sequence of operations?

```
Temp1 ← JOIN Employees and Jobs
        where Employees.CurrentJobID = Jobs.JobID
Temp2 ← SELECT from Temp1 where Department = "Personnel"
Result ← PROJECT Name from Temp2
```

---

ANSWER: Which employees work in the personnel department?

13. Given the relation Employees containing the attributes Name, Address, and CurrentJobID and the relation Jobs containing the attributes JobID, SkillRating, Department, what question is answered by the following SQL statement?

```
select SkillRating
  from Employees, Jobs
 where Employees.Name = "Joe Smith"
    and Employees.CurrentJobID = Jobs.JobID
```

---

ANSWER: What is the skill rating of Joe Smith's job?

14. Place an X in the space before those requests below that require data mining techniques rather than traditional database techniques. Leave the other spaces blank.

- ☐ Identify all shoppers who bought dog food last week.
- ☐ Identify items that tend to be purchased by common shoppers.
- ☐ Identify any correlation between time-of-day and items purchased.
- ☐ Identify the items purchased during the first hour after opening the store.

ANSWER: Second and third

15. Place an X in the space before those issues that are not problems associated with data mining. Leave the other spaces blank.

- ☐ Cascading rollback
- ☐ Deadlock
- ☐ Incorrect summary problem
- ☐ Lost update problem

ANSWER: All of them

16. Place an X in the space before those questions whose answers might be obtained by means of sequential pattern analysis. Leave the other spaces blank.

- ☐ What are progressing stages in youthful behavior that led to criminal activity?
- ☐ What are the symptoms of the various stages of a particular progressing disease?
- ☐ What crimes does a particular judge punish most harshly?
- ☐ What items had the highest sales volume last week?

ANSWER: First and second

17. Place an X in the space before those questions whose answers might be obtained by means of outlier analysis. Leave the other spaces blank.

- ☐ Which are the flawed parts on a production line conveyor belt?
- ☐ What items have not sold during the last two days?

\_\_\_\_\_ What sales region generated the most orders over the last sales period?

\_\_\_\_\_ Which shoppers in a busy shopping mall are potential shoplifters?

ANSWER: First and last

18. Place an X in the space before those structures that are designed to provide efficient access to randomly chosen items. Leave the other spaces blank.

\_\_\_\_\_ Sequential file

\_\_\_\_\_ Indexed file

\_\_\_\_\_ Hash file

\_\_\_\_\_ Hash table

ANSWER: Second, third, and fourth

19. Suppose you were going to construct a hash file with 20 to 25 buckets using the division hash function discussed in the text. How many buckets should you actually use?

\_\_\_\_\_

ANSWER: 23

20. List four data mining techniques.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

ANSWER: Possible answers include: class description, class discrimination, cluster analysis, association analysis, outlier analysis, and sequential pattern analysis.

## 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 asked 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

database model

schema

DBMS

SQL

### Descriptive Phrase

A conceptual organization of data within databases

A "road map" of a particular database's design

Performs database operations requested by application software

A popular language that implements relational database operations

relation	A structural unit (with rows and columns) in a popular database model
relational operations	Select, project, and join
roll back	To “unwind” a transaction
commit point	The time at which a DBMS guarantees that a transaction’s actions will be reflected in a database
locking protocol	A system to guard against database errors due to performing transactions concurrently
data mining	The process of extracted hidden information
data warehouse	The information system to which data mining techniques are applied
hash file	A storage structure that provides efficient access to randomly chosen items
clustering	A major problem when manipulating hash files
sequential file	A storage structure that associates a specific order with its contents
index	A means of locating a particular record within a file
key field	An item used to identify records uniquely

## General Format Questions

1. What information is available from a relational database containing one relation with the attributes Name, Employee identification number, and Address that is not available from a database containing two relations, one with attributes Name and Address and the other with attributes Address and Employee identification number? Explain your answer.

ANSWER: The connection between an employee’s name and identification number may not be available in the second database because two employees may have the same address.

2. Given the two relations X and Y below

X:	<u>A</u>	<u>B</u>	Y:	<u>C</u>	<u>D</u>
	2	s		t	1
	5	z		r	3
				w	2

draw the relation Result that would be produced by the following statements?

```
Temp ← JOIN X and Y where X.A > Y.D
Result ← PROJECT X.B, Y.C from Temp
```

ANSWER:

<u>X.B</u>	<u>Y.C</u>
s	t
z	t
z	r
z	w

3. Translate the following query into a single SQL statement.

```
Temp ← SELECT from X where A = B
Result ← PROJECT A, C from Temp
```

ANSWER: select A, C from X where A = B

4. Given a relation called `People` whose attributes are `Name`, `Father`, and `Mother` (containing each person's name as well as the name of that person's parents), write an SQL statement to obtain a list of all the children of Nathan.

```
ANSWER: select Name
        from People
        where Father = "Nathan"
```

5. Given the relation `Parts` containing the attributes `PartName`, `PartNumber`, and `SupplierID` as well as the relation `Suppliers` containing the attributes `SupplierID`, `Address`, `FaxNumber`, write an SQL statement to obtain the supplier identifications and fax numbers for all the suppliers that supply the part whose part number is X4J26.

```
ANSWER: select Suppliers.SupplierID, Suppliers.FaxNumber
        from Parts, Suppliers
        where Parts.PartNumber = "X4J26"
           and Parts.SupplierID = Suppliers.SupplierID
```

6. Given the relation `Parts` containing the attributes `PartName`, `PartNumber`, and `SupplierID` as well as the relation `Suppliers` containing the attributes `SupplierID`, `Address`, `FaxNumber`, write a sequence of `SELECT`, `PROJECT`, and `JOIN` operations to obtain the supplier identifications and fax numbers for all the suppliers that supply the part whose part number is X4J26.

```
ANSWER: Temp1 ← SELECT from Parts
           where PartNumber = "X4J26"
        Temp2 ← JOIN Temp1 and Suppliers
           where Temp1.SupplierID = Suppliers.SupplierID
        Result ← PROJECT Suppliers.SupplierID, Suppliers.FaxNumber
           from Temp2
```

7. If a database contained a relation containing information about individual people (name, address, birthday, etc.) and another relation containing information about music composers (name, style, education level, etc.), how would you extend the database's design to include links between each individual and his or her favorite composer?

ANSWER: The main idea would be to add a new relation providing the links. It might contain the attributes `IndividualName` and `ComposerName`. The problem with this approach is that individual names may not be unique throughout the database so it may be necessary to add an identification number attribute to the "individuals" relation. This uniqueness issue also arises in the case of composer names.

8. Describe a scenario in which computing the total deposits in a bank while also transferring \$100 from account X to account Y would result in a final sum that is \$100 too great. Then describe a scenario in which the final sum turns out to be \$100 too small.

ANSWER: The first occurs if the process of computing the total checks account X before the funds are withdrawn and account Y after the funds are deposited. The second occurs if account Y is checked before the funds are deposited and X is checked after the funds are withdrawn.

9. Describe the wound-wait protocol.

ANSWER: Young transactions must release data items they are using when the items are needed by older transactions. The young transactions are then rolled back.

10. Describe the distinction between a traditional database and a data warehouse.

ANSWER: A traditional database is dynamic in the sense that it is subject to change as updates are made. In contrast, a data warehouse is static in the sense that no updates are made. Moreover, a data warehouse may encompass more than one database.

11. Describe the distinction between class description and cluster analysis.

ANSWER: Class description attempts to find traits that characterize a known class, whereas cluster analysis attempts to find traits that identify previously unknown classes.

12. What does it mean to say that an object is persistent?

ANSWER: A persistent object is one that is saved for future reference as opposed to existing merely during the execution of a single program. (An object-oriented database consists of persistent objects.)

## Test Bank—Chapter Ten (Computer Graphics)

### Multiple Choice Questions

1. Which of the following is not associated with a parallel projection?

- A. Projection plane
- B. Projectors
- C. Center of projection
- D. All of the above

ANSWER: C (Note that a parallel projection is produced by drawing projectors that are parallel to the projection plane.)

2. The image is stored in the

- A. Image window
- B. Z-buffer
- C. Center of projection
- D. Frame buffer

ANSWER: D

3. The shape of an object is usually represented by

- A. A sphere
- B. A polygonal mesh
- C. A triangle
- D. A texture map

ANSWER: B

4. A polygonal mesh consists of

- A. Planer patches
- B. Pixels
- C. Spheres
- D. Bezier curves

ANSWER: A

5. Which of the following is not a way of constructing a polygonal mesh?

- A. Digitizing
- B. Procedural model
- C. Texture mapping
- D. Particle system

ANSWER: C

6. Which of the following is not contained in a scene graph?

- A. Models of the objects in the scene
- B. Information about the camera
- C. Information about lighting
- D. The view volume

ANSWER: D

7. The incidence angle is measured relative to

- A. The line normal to the surface
- B. A line parallel to the surface
- C. The line followed by the reflected ray
- D. None of the above

ANSWER: A

8. The phenomenon of a light ray bending as it passes through materials of different density is called
- A. Reflection
  - B. Incidence
  - C. Refraction
  - D. Ray tracing

ANSWER: C

9. Which of the following is not naturally handled by a local lighting model?
- A. Specular light
  - B. Diffuse light
  - C. Ambient light
  - D. Shadows

ANSWER: D

10. Which of the following is not a step in the traditional rendering pipeline?
- A. Scan conversion
  - B. Rasterization
  - C. In-betweening
  - D. Clipping

ANSWER: C

11. Which of the following is associated with clipping?
- A. Phong shading
  - B. The view volume
  - C. Texture mapping
  - D. Bump mapping

ANSWER: B

12. Which of the following is not associated with scan conversion?
- A. A z-buffer
  - B. The painter's algorithm
  - C. Digitizing
  - D. Pixel positions

ANSWER: C

13. Another name for scan conversion is
- A. Rasterization
  - B. Digitizing
  - C. Bump mapping
  - D. Ray tracing

ANSWER: A



14. Hidden-surface removal is the process of
- A. Discarding those objects that fall outside the view volume
  - B. Applying a parallel projection rather than a perspective projection
  - C. Identifying parts of surfaces that are in a shadow
  - D. Identifying surfaces that are blocked from the camera's view

ANSWER: D

15. Which of the following is the simplest shading technique?
- A. Phong shading
  - B. Flat shading
  - C. Gouraud shading
  - D. Bump mapping

ANSWER: B

16. Which of the following is an advantage of ray tracing over the traditional rendering pipeline?
- A. It is less time consuming.
  - B. It implements a local lighting model.
  - C. It can be implemented in real time.
  - D. It implements a global lighting model.

ANSWER: D

17. Which is not a feature of radiosity?
- A. Objects tend to appear dull rather than shiny.
  - B. Moving the camera position does not require massive changes.
  - C. Specular light is easily simulated.
  - D. It is a computationally complex undertaking.

ANSWER: C

18. Which of the following is not a property of the rendering pipeline?
- A. It relies on recursive ray tracing.
  - B. It implements a local lighting model.
  - C. It is often implemented in firmware.
  - D. Its use leads to efficient rendering systems.

ANSWER: A

19. Producing a sequence of frames to fill the gap between key frames is called
- A. Storyboarding
  - B. Morphing
  - C. In-betweening
  - D. Motion capture

ANSWER: C

20. Motion capture is a means of applying
- A. A global lighting model
  - B. A local lighting model
  - C. Dynamics
  - D. Kinematics

ANSWER: D

21. Avars are used to
- A. Adjust a character's shape
  - B. Simulate textured surfaces
  - C. Locate objects in a scene graph
  - D. Reposition the camera

ANSWER: A

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

1. The subfield of computer graphics that involves producing images of virtual worlds is called \_\_\_\_\_.

ANSWER: 3D graphics

2. The modeling process concludes with the construction of a \_\_\_\_\_, which is a data structure containing models of all the objects in a scene as well as camera information.

ANSWER: Scene graph

3. The shape of an object is typically represented by means of a \_\_\_\_\_, which represents the shape as a collection of flat surfaces.

ANSWER: Polygonal mesh

4. Suppose each row below represents the vertices of a planar patch. What three vertices would describe a planar patch that would complete the polygonal mesh?

_____	_____	_____
(0, 0, 0)	(1, 0, 0)	(0, 0, 1)
(0, 0, 0)	(0, 1, 0)	(0, 0, 1)
(0, 0, 0)	(0, 1, 0)	(1, 0, 0)

ANSWER: (1, 0, 0)      (0, 1, 0)      (0, 0, 1)      (Note: Order is not important.)

5. A \_\_\_\_\_ is a procedural model that uses numerous small particles to simulate an object.

ANSWER: Particle system

6. The shading technique called \_\_\_\_\_ produces a faceted image.

ANSWER: Flat shading

7. Bright highlights on an object are produced by \_\_\_\_\_ light.

ANSWER: Sepcular

8. Clipping is the process of restricting attention to objects (or parts of objects) that are within the \_\_\_\_\_.

ANSWER: View volume

9. Another name for scan conversion is \_\_\_\_\_.

ANSWER: Rasterization

10. The \_\_\_\_\_ represents the portion of the projection plane that will contribute to the final image. A bit map of that image is stored in the \_\_\_\_\_.

ANSWER: Image window, Frame buffer

11. A storage area called a \_\_\_\_\_ is often used to record distance information to be used in hidden-surface removal.

ANSWER: Z-buffer

12. The \_\_\_\_\_ algorithm is a simple approach to performing hidden-surface removal.

ANSWER: Painter's

13. A line perpendicular to a surface is called a \_\_\_\_\_.

ANSWER: Normal (or perhaps a normal line)

14. An alternative to flat shading is \_\_\_\_\_.

ANSWERS: Any of the following are acceptable: Gouraud shading, Phong shading, bump mapping.

15. The steps of clipping, hidden-surface removal, and shading are often referred to collectively as the \_\_\_\_\_.

ANSWER: Rendering pipeline

16. Although \_\_\_\_\_ implements a global lighting model, it is time consuming and gives undue emphasis to specular light.

ANSWER: Ray tracing

17. Although \_\_\_\_\_ implements a global lighting model, it is time consuming and gives undue emphasis to diffuse light.

ANSWER: Radiosity

18. Each of the images used to produce an animated sequence is called a \_\_\_\_\_.

ANSWER: Frame

19. An animation project usually starts by constructing a \_\_\_\_\_, which consists of a collection of images that represent significant points in the sequence.

ANSWER: Storyboard

20. Producing animation frames by computing the effects of forces is an application of \_\_\_\_\_.

ANSWER: Dynamics

21. Producing animation frames by simulating the movements of joints and appendages is an application of \_\_\_\_\_.

ANSWER: Kinematics

### 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 asked 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
image window	The region of the projection plane containing the image
frame buffer	Contains a bit map of the image
polygonal mesh	Represents an object's shape
procedural model	A means of constructing an object's shape
texture mapping	A means of associating a predetermined image with a surface
scene graph	Contains models of all the objects in a scene
specular light	Produces the appearance of bright highlights on a surface
diffuse light	Light that is reflected in many directions
rendering pipeline	A collection of relatively standard rendering activities
clipping	Reducing attention to only those objects that may appear in an image
scan conversion	Associating pixel positions with points in a scene
painter's algorithm	An elementary means of hidden surface removal
z-buffer	Contains information regarding distance from camera to objects
bump mapping	A means of simulating texture by varying the orientation of a surface
local lighting model	Disregards light interactions among objects
ray tracing	A means of implementing a global lighting model
storyboard	A means of outlining an entire animation sequence
dynamics	A means of analyzing motion based on laws of physics

### General Format Questions

1. Design a polygonal mesh for a cube. Represent each planar patch as a list of vertices in traditional rectangular coordinates.

ANSWER: The most obvious answer would be something like this:

(0, 0, 0)	(1, 0, 0)	(1, 1, 0)	(0, 1, 0)
(0, 0, 0)	(1, 0, 0)	(1, 0, 1)	(0, 0, 1)
(0, 0, 0)	(0, 1, 0)	(0, 1, 1)	(0, 0, 1)
(0, 0, 1)	(1, 0, 1)	(1, 1, 1)	(0, 1, 1)
(0, 1, 0)	(0, 1, 1)	(1, 1, 1)	(1, 1, 0)
(1, 0, 0)	(1, 1, 0)	(1, 1, 1)	(1, 0, 1)

2. Compare the application of dynamics and kinematics in the field of animation.

ANSWER: Dynamics is based on laws of physics whereas kinematics is based on the possible positions of joints and appendages.

3. Compare various approaches to shading.

ANSWER: Topics that the student might address include flat shading, Gouraud shading, Phong shading, and bump mapping.

4. Summarize the rendering pipeline.

ANSWER: The student should display an understanding of clipping, scan conversion, and shading, and perhaps should mention the efficiency gained by implementing the pipeline in firmware.

5. Discuss some fundamental differences between the process of constructing models and assembling a scene graph as opposed to rendering the scene.

ANSWER: One significant distinction is that the former is largely a creative process whereas the latter is a computational intense process.

## Test Bank—Chapter Eleven (Artificial Intelligence)

### Multiple Choice Questions

1. Which of the following is an example of procedural knowledge?

- A. Knowing the rate of growth of the world's population
- B. Knowing how to tie your shoes
- C. Knowing your name
- D. Knowing the exchange rate of different national currencies

ANSWER: B

2. Which of the following is not a component of a production system?

- A. Control system
- B. Collection of states
- C. Associative memory
- D. Collection of productions

ANSWER: C

3. Which of the following is actually constructed during a heuristic search?

- A. State graph
- B. Search tree
- C. Production system

ANSWER: B

4. A heuristic is applied during a search process in hopes of producing a

- A. Depth-first search
- B. Breadth-first search

ANSWER: A

5. If the heuristic being used is the-number-of-tiles-out-of-place, which of the following eight-puzzle will be given priority for further consideration by a heuristic search?

- |    |       |    |       |    |       |    |       |
|----|-------|----|-------|----|-------|----|-------|
| A. | 1 2 3 | B. | 2 3   | C. | 1 3   | D. | 1 3   |
|    | 4 5   |    | 1 5 6 |    | 4 2 6 |    | 4 2 6 |
|    | 7 8 6 |    | 4 7 8 |    | 7 5 8 |    | 7 5 8 |

ANSWER: A

6. If a heuristic search is used to solve the eight-puzzle from the starting configuration below using the-number-of-tiles-out-of-place as the heuristic, which of the following nodes will not be considered during the search?

- |    |   |   |   |    |   |   |   |
|----|---|---|---|----|---|---|---|
|    | 1 | 2 |   |    |   |   |   |
|    | 4 | 5 | 3 |    |   |   |   |
|    | 7 | 8 | 6 |    |   |   |   |
| A. | 1 | 2 |   | B. | 1 | 5 | 2 |
|    | 4 | 5 | 3 |    | 4 |   | 3 |
|    | 7 | 8 | 6 |    | 7 | 8 | 6 |
|    |   |   |   | C. | 1 | 5 | 2 |
|    |   |   |   |    |   | 4 | 3 |
|    |   |   |   |    |   | 7 | 8 |
|    |   |   |   | D. | 1 | 2 | 3 |
|    |   |   |   |    |   | 4 | 5 |
|    |   |   |   |    |   | 7 | 8 |

ANSWER: C

7. Which of the following learning technique results in an agent merely performing a pre-recorded sequence of steps?

- A. Imitation      B. Supervised training      C. Reinforcement

ANSWER: A

8. In an artificial neural network, which of the following pairs of weights would cause a processing unit with two inputs and a threshold value of 3 to produce an output of 1 only when both of its inputs are 1?

- A. 0, 0      B. 2, 0      C. 0, 2      D. 2, 2

ANSWER: D

9. In an artificial neural network, which of the following pairs of weights would cause a processing unit with two inputs and a threshold value of 2 to produce an output of 0 only when both of its inputs are 0?

- A. 0, 0      B. 3, 0      C. 0, 3      D. 3, 3

ANSWER: D

10. In an artificial neural network, what must be true about the threshold value of a processing unit that processes an output of 1 when all of its inputs are 0?

- A. It is less than -2.  
B. It is not positive.  
C. Both A and B are true.  
D. Nothing can be determined without knowing the weights.

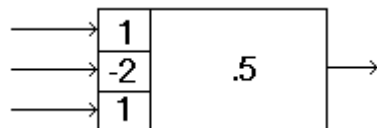
ANSWER: B

11. A memory system that is able to provide related information is called

- A. Read-only memory (ROM)      B. Associative memory  
C. An artificial neural network      D. Main memory

ANSWER: B

12. In an artificial neural network, what input values will cause the processing unit below to produce an output of 1.



- A. All three 0  
B. All three 1  
C. Any combination in which the center input is 0 and at least one other input is 1  
D. Any combination in which at least one input is 1

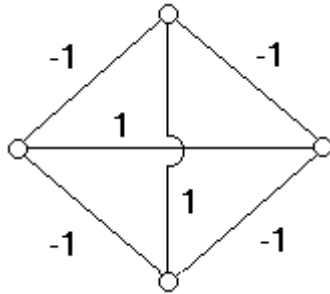
ANSWER: C

13. In an artificial neural network, which of the Boolean operations AND, OR, and XOR can a single processing unit with two inputs be programmed to compute?

- A. AND only    B. OR only    C. XOR only    D. AND and OR only

ANSWER: D

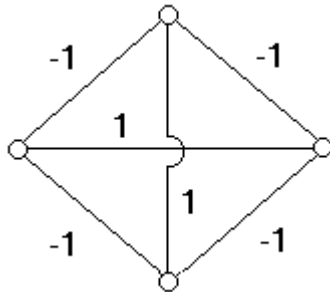
14. The diagram below represents an associative memory as described in the text. If each unit has a threshold value of 0.5, what stable state will the system reach if it is initiated with the top and bottom units excited and the others inhibited?



- A. All units excited    B. Only the side units excited  
C. No units excited    D. Only the top and bottom units excited

ANSWER: D

15. The diagram below represents an associative memory as described in the text. If each unit has a threshold value of 0.5, what stable state will the system reach if it is initiated with the top and left-most units excited and the others inhibited?

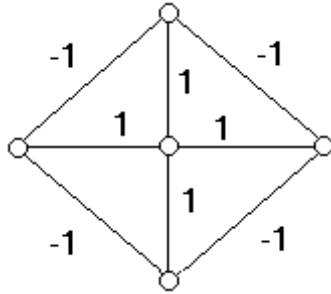


- A. All units excited    B. No stable state will be reached.  
C. No units excited    D. Only the top and left-most units excited

ANSWER: C

16. The diagram below represents an associative memory as describe in the text. If the center unit has a threshold value of 2.5, under what condition will it become excited?





- A. Any of the other units excited
- B. Will never be excited
- C. Any two of the other units excited
- D. At least three of the other units excited

ANSWER: D

17. Which of the following programming methodologies seeks to develop software by a “trial and error” approach?

- A. Object-oriented programming
- B. Structured programming
- C. Evolutionary programming
- D. Declarative programming

ANSWER: C

18. At what “stage” of analysis is the meaning of a pronoun such as he or she identified?

- A. Syntactic analysis
- B. Semantic analysis
- C. Contextual analysis

ANSWER: C

19. At what “stage” of analysis are the sentences

There were exactly twelve books on the table.  
and  
There were twelve books on the table, no more and no less.

recognized as saying the same thing?

- A. Syntactic analysis
- B. Semantic analysis
- C. Contextual analysis

ANSWER: B

20. At what “stage” of analysis is the meaning of the word ball in the following sentence determined?

- A. Syntactic analysis
- B. Semantic analysis
- C. Contextual analysis

ANSWER: C

21. Which of the following is a statement of the closed-world assumption?

- A. The database contains only partial information.
- B. The database contains only true statements.
- C. If a statement is not a consequence of information in the database, then the statement is false.
- D. The database contains all the information known to humans.

ANSWER: C

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

1. List two types of agent actions/responses that are more complex than mere reflect actions.

\_\_\_\_\_  
\_\_\_\_\_

ANSWER: Possible answers include: goal-directed actions and knowledge-based actions.

2. In each blank below place a P or an S to indicate whether the associated activity is performance oriented (P) or simulation oriented (S).

- \_\_\_\_\_ Writing a program that applies a particular economic theory to see if that theory leads to realistic consequences.
- \_\_\_\_\_ Writing a program to allow a database system to receive requests verbally.
- \_\_\_\_\_ Writing a program to control an automated aircraft landing system.
- \_\_\_\_\_ Writing a program to handle a university's registration system.

ANSWER: S, P, P, P

3. Place an X in the blanks below that are associated with tasks that could likely be performed by means of relatively simple pattern matching methods as opposed to requiring advanced image analysis techniques.

- \_\_\_\_\_ Identifying characters on a printed page
- \_\_\_\_\_ Identifying one domino from another
- \_\_\_\_\_ Distinguishing the parts of a photograph that represent living organic entities as opposed to inert objects.
- \_\_\_\_\_ Distinguishing photographs of family outings from those of business meetings

ANSWER: First and second

4. A production system consists of a collection of \_\_\_\_\_ representing various configurations of the problem at hand, a collection of \_\_\_\_\_ representing potential steps from one "configuration" to another, and a \_\_\_\_\_ whose task is to find a solution to the problem at hand.

ANSWER: States, productions, control system

5. Suppose the task of solving the equation  $3x + 2 = 17$  were analyzed as a production system.

A. What would be the goal state?

---

B. What would be the production that would probably be applied first?

---

ANSWER: A. Any set of valid equations containing  $x = 5$ .  
 B. The most likely answer would be “subtract 2 from both sides of the equation.” Another possibility is “divide both sides of the equation by 3.”

6. How many nodes would be in the search tree generated by a heuristic search when solving the eight-puzzle from the starting configuration below if the-number-of-tiles-out-of-place were used as the heuristic?

	1	2
4	5	3
7	8	6

---

ANSWER: 7 or 8 (depending on whether the student counts both of the final options or stops with only the goal)

7. Suppose the search tree below is being constructed to solve the eight-puzzle using the-number-of-tiles-out-of-place as the heuristic. In each blank under a terminal node, write the heuristic value of the associated node. Then, circle the node that the search would pursue next.

	1	3	
	4 2 6		
	7 5 8		
	/		\
1 3	1 2 3	1 3	
4 2 6	4	6 4 2 6	
7 5 8	7 5 8	7 5 8	

---

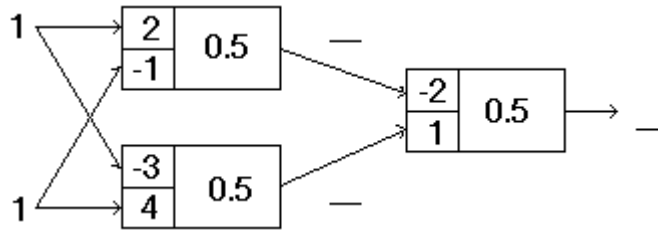
ANSWER: 4, 2, 4. Circle: center node

8. What is the effective input of an artificial neuron whose inputs are 1, 0, 1 and whose associated weights are 3, -3, -1, respectively?

---

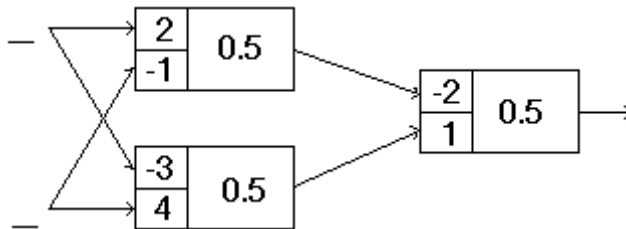
ANSWER: 2

9. Fill in the blank at the output end of each processing unit in the artificial neural network below to show the output value of the corresponding unit.



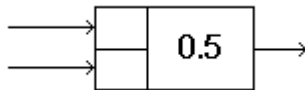
ANSWER: Input units are both 1, output unit is 0.

10. Fill in the blanks with input values that will cause the artificial neural network below to produce an output of 1.



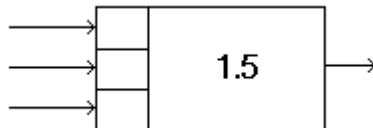
ANSWER: Upper input: 0, lower input: 1

11. Fill in the weights in the processing unit below so that the unit produces an output of 1 only when the upper input is 1 and the lower input is 0.



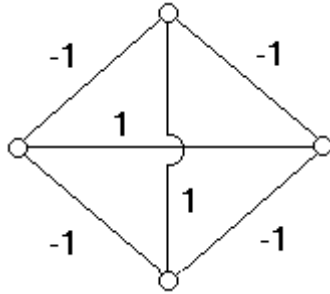
ANSWER: 1, -1 is a possible answer.

12. Fill in the weights in the processing unit below so that the unit produces an output of 1 only when the upper two inputs are 1 and the lower input is 0.



ANSWER: 1, 1, -1 is a possible answer.

13. The diagram below represents an associative memory as described in the text. What threshold value could be assigned to all the units to ensure that no unit would ever be excited by the others?



ANSWER: Any value bigger than 1

14. The field of research known as \_\_\_\_\_ seeks to apply survival-of-the-fittest theories to the problem solving process. In particular, \_\_\_\_\_ is the subfield that seeks to apply such evolutionary principles to the programming process.

ANSWER: Genetic algorithms, evolutionary programming

15. In each blank below, write syntactic, semantic, or contextual to indicate which form of analysis is required to perform the associated task.

\_\_\_\_\_ Identify the subject in the sentence "John ate the ice cream."

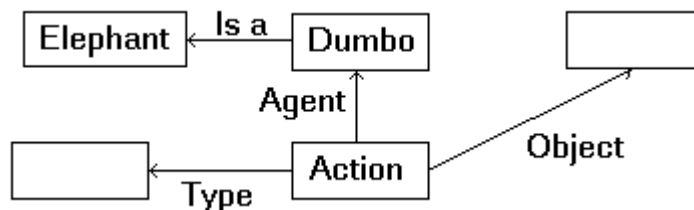
\_\_\_\_\_ Recognize that the sentence "John ate the ice cream" means the same as the sentence "The ice cream was eaten by John."

\_\_\_\_\_ Identify the object in the sentence "John ate the ice cream."

\_\_\_\_\_ Identify the person referred to by the pronoun he in the sentence "He ate the ice cream."

ANSWER: Syntactic, semantic, syntactic, contextual

16. Fill in the blank entries in the semantic net below to reflect the meaning of the sentence "Dumbo ate peanuts."



ANSWER: The type is "eat," and the object is "peanuts."

17. Place an X in each blank below that is associated with a conclusion that would require the closed-world assumption in the context of a database that contained a list of subscribers to the New York Times.

- \_\_\_\_\_ John Doe subscribes to the New York Times.
- \_\_\_\_\_ John Doe does not subscribe to the New York Times.
- \_\_\_\_\_ Either Mary Doe or John Doe does not subscribe to the New York Times.
- \_\_\_\_\_ Either Mary Doe or John Doe subscribes to the New York Times.

ANSWER: Second and third

18. Place an X in each blank below that is associated with a statement that would be considered true by a closed-world database containing only the statement “Kermit is a frog OR Miss Piggy is an actress.”

- \_\_\_\_\_ Kermit is a frog.
- \_\_\_\_\_ Miss Piggy is not an actress.
- \_\_\_\_\_ Kermit is not a frog AND Miss Piggy is not an actress.
- \_\_\_\_\_ Kermit is not a frog.

ANSWER: Second, third, and fourth

## 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
agent	A responsive entity
Turing test	A means of measuring a machine’s ability to perform like a human
image analysis	The task of understanding an image
template matching	To identify by comparing to predefined patterns
production system	A “universal” approach to the construction of reasoning systems
heuristic	A tool for simulating intuition
breadth-first search	The result of considering all options equally important
state graph	A “picture” of all states and productions
inference rule	A means of obtaining a statement that is a logical consequence of other statements
real-world knowledge	The “database” used by an intelligent system to support its reasoning
artificial neural network	A multiprocessor computer consisting of many simple processors
genetic algorithms	A field of artificial intelligence that applies evolutionary theories to the software development process
associative memory	The ability to recall related information
expert system	A software package for solving problems within a particular field
semantic net	A means of representing knowledge
contextual analysis	To relate a sentence to its environment
linguistics	The study of human communication

## General Format Questions

1. Explain the distinction between declarative knowledge and procedural knowledge.

ANSWER: Declarative knowledge is knowing facts, whereas procedural knowledge is being able to perform a task.

2. Explain the distinction between image processing and image analysis.

ANSWER: Image processing deals with the issue of clarifying the image such as removing flaws and identifying regions. Image analysis deals with the issues of extracting information from the image.

3. Describe the distinction between a state graph and a search tree.

ANSWER: A state graph is a picture of the entire “problem space” whereas a search tree contains only the part of the “problem space” relevant to the problem at hand.

4. Draw the search tree that would be generated by a heuristic search when solving the eight-puzzle from the starting configuration below assuming that “the number of tiles out of place” were used as the heuristic.

```

1  2  3
   5  6
4  7  8

```

ANSWER:

```

      1 2 3
        5 6
      4 7 8
        /  |  \
    2 3 1 2 3 1 2 3
    1 5 6 4 5 6 5 6
    4 7 8 7 8 4 7 8
          |
        1 2 3
        4 5 6
        7 8
          /  \
    1 2 3 1 2 3
    4 6 4 5 6
    7 5 8 7 8

```

5. Draw the search tree that would be generated by a breadth-first search when solving the eight-puzzle from the starting configuration below.

```

1  2  3
4  5  6
   7  8

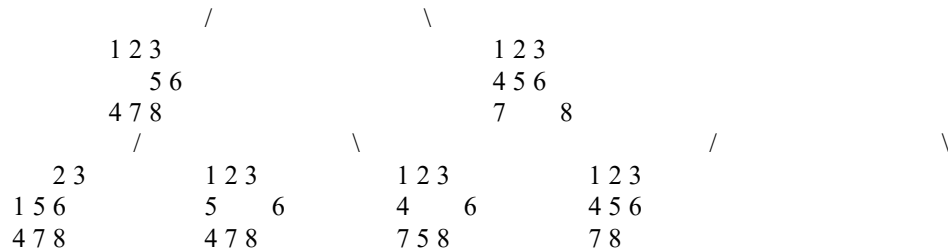
```

ANSWER: (The order of the rows may vary.)

```

      1 2 3
      4 5 6
        7 8

```



6. Explain the distinction between weak AI and strong AI.

ANSWER: Weak AI is the conjecture that machines can be programmed to appear to be intelligent. Strong AI is the conjecture that machines can be programmed to be intelligent.

7. Why would the search process used in the text to solve the eight-puzzle not be applicable in cases of competitive games such as chess or checkers?

ANSWER: In a competitive game, the “puzzle solver” does not get to choose every move but must alternate with an opponent who is trying to reach different goals.

8. Suppose the eight-puzzle was extended to a four-by-four tray containing 11 tiles with the solved puzzle appearing as below.

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	

What problem would occur if our heuristic search (using the-number-of-tiles-out-of-place) was applied to solve the puzzle start from the configuration below? How could that problem be overcome?

1	11	15	12
5	6	7	8
9	10	2	3
13	14		4

ANSWER: The search will repeatedly move the 2, 3, and 4 tiles around in the bottom right corner because doing otherwise would cause an additional tile to be moved out of its correct position. A solution is to rate the various options by the sum of the heuristic value and the number of moves required to reach the current position rather than merely the heuristic. This allows moves that increase the heuristic to ultimately look better than continuing to repeat moves that do not increase the heuristic.

9. How does the process of “programming” an artificial neural network differ from the traditional programming process?

ANSWER: The traditional programming process involves giving a machine specific instructions as to what it is to do, whereas “programming” an artificial neural network is a training process involving numerous trial-and-error steps.

10. When trying to understand a natural language, what are the distinctions between syntactic analysis, semantic analysis, and contextual analysis?

ANSWER: Syntactic analysis seeks to identify the grammatical role of each word, semantic analysis seeks to identify the meaning of the sentence, and contextual analysis seeks to resolve ambiguities in meaning by considering the context of the sentence.



11. Do you believe the weak AI conjecture, the strong AI conjecture, or neither? Support your choice.

ANSWER: Answers will vary but all should reflect an understanding of what the conjectures are.

12. What is the frame problem?

ANSWER: It is the problem of keeping information up-to-date in an environment in which changes have indirect consequences.

## Test Bank—Chapter Twelve (Theory of Computation)

### Multiple Choice Questions

1. Which of the following Bare Bones programs is self-terminating?

- A. while X not 0 do;  
end;  
B. while X not 0 do;  
  decr X;  
end;  
C. decr X;  
  while X not 0 do;  
  end;

ANSWER: B

2. An unsolvable problem is a problem for which

- A. no solution exists.  
B. no one knows the solution.  
C. no algorithm exists for finding the solution.  
D. no one wants to know the solution.

ANSWER: C

3. Turing machines represent

- A. an effort to define the limits of algorithmic systems.  
B. a class of machines that can compute very little.  
C. a class of machines that are now out of date and no longer important.  
D. a class of machines that can compute all functions.

ANSWER: B

4. What action is performed by the Turing machine described below?

Current <u>state</u>	Current <u>cell content</u>	Value <u>to write</u>	Direction <u>to move</u>	New <u>state</u>
START	*	*	*	left X
X	1	0	0	left X
X	0	0	0	right Y
Y	0	0	0	right Y
Y	*	*	*	no move HALT

- A. It replaces any string of consecutive 1s to the left of an \* with 0s.  
B. It leaves the tape unchanged.  
C. It places an \* at the left end of any string of consecutive 1s appearing to the left of an \*.  
D. It complements the string of 0s and 1s appearing to the left of an \*.

ANSWER: A

5. What action is performed by the Turing machine described below?

Current <u>state</u>	Current <u>cell content</u>	Value <u>to write</u>	Direction <u>to move</u>	New <u>state</u>
START	*	*	*	left X
X	1	1	1	left X
X	0	*	*	right Y
Y	1	1	1	right Y

Y	*	*	no move	HALT
---	---	---	---------	------

- A. It replaces any string of consecutive 1s to the left of an \* with 0s.  
 B. It leaves the tape unchanged.  
 C. It places an \* at the left end of any string of consecutive 1s appearing to the left of an \*.  
 D. It complements the string of 0s and 1s appearing to the left of an \*.

ANSWER: C

6. Suppose the variables X and Y in the following Bare Bones program have the values 3 and 2, respectively, when execution begins.

```
clear Z;
while X not 0 do;
    while Y not 0 do;
        decr Y;
        incr Z;
    end;
    incr Z;
    decr X;
end;
```

What will be the value of Z when the program terminates?

- A. 0      B. 1      C. 5      D. 6

ANSWER: C

7. Which of the following best describes what the following Bare Bones program does?

```

copy X to Z;
clear X;
incr X;
while Z not 0 do;
    clear X;
    decr Z;
end;

```

- A. It changes the value of X to 1.  
B. If the starting value of X is 0, it sets the value of X to 0. Otherwise, it sets the value of X to 1.  
C. If the starting value of X is 0, it sets the value of X to 1. Otherwise, it sets the value of X to 0.  
D. It ultimately leaves X the same as it was when the program started.

ANSWER: B

8. Which of the following statements is false?

- A. If a problem can be solved by a Bare Bones program, then it can be solved by a Turing machine.
- B. If a problem can be solved by a Turing machine, then it can be solved by a Bare Bones program.
- C. The halting problem cannot be solved by a Bare Bones program.
- D. The halting problem can be solved only by using a universal programming language.

ANSWER: D

9. Which of the following statements is true?

- A. The Bare Bones programming language would still be a universal language if the `clear` statement was removed.
- B. The Bare Bones programming language would still be a universal language if the `incr` statement was removed.
- C. The Bare Bones programming language would still be a universal language if the `decr` statement was removed.
- D. The Bare Bones programming language would still be a universal language if the `while` statement was removed.

ANSWER: A

10. Which of the following systems does not process the same computational capabilities as the others?

- A. Turing machines
- B. Universal programming languages
- C. Algebraic expressions
- D. The Bare Bones language

ANSWER: C

11. What is the time complexity of the problem of searching for a particular entry in a list?

- A.  $\Theta(\lg n)$
- B.  $\Theta(n)$
- C.  $\Theta(n \lg n)$
- D.  $\Theta(n^2)$

ANSWER: A

12. What is the time complexity of the problem of sorting a list?

- A.  $\Theta(\lg n)$
- B.  $\Theta(n)$
- C.  $\Theta(n \lg n)$
- D.  $\Theta(n^2)$

ANSWER: C

13. Which of the following questions has not yet been answered by researchers?

- A. Is P contained in NP?
- B. Is NP contained in P?
- C. Are all the problems in NP solvable?
- D. Are all the problems in P solvable?

ANSWER: B

14. The class of problems known as NP is so named because it is composed of which of the following?

- A. Non-polynomial problems
- B. Non-programmable problems
- C. Non-universal problems
- D. Non-deterministic polynomial problems

ANSWER: D

15. Which of the following algorithms represents an optimal solution (in terms of time complexity) for sorting a list?

- A. Insertion sort
- B. Bubble sort
- C. Selection sort
- D. Merge sort

ANSWER: D

16. Which of the following is the most precise classification of a problem X?

- A. X is in NP.
- B. X is in P.
- C. X is in  $O(n^2)$ .
- D. X is in  $\Theta(n^2)$ .

ANSWER: D

17. If a solution with time complexity  $\Theta(n^2)$  is known to exist, then the problem is known to be in which of the following?

- A.  $\Theta(n^2)$
- B.  $O(n^2)$
- C.  $\Theta(n^3)$
- D.  $\Theta(n)$

ANSWER: B

18. The precise time complexity of which of the following problems has not yet been established by researchers?

- A. Sorting a list
- B. Searching through a list for a particular entry
- C. The traveling salesman problem
- D. Listing all possible subcommittees within a given committee

ANSWER: C

19. If an RSA public key encryption system were based on the primes  $p = 3$  and  $q = 7$ , which of the following pairs of values would be suitable for the encryption and decryption keys  $e$  and  $d$ ?

- A. 2 and 6
- B. 5 and 29
- C. 4 and 9
- D. 7 and 23

ANSWER: B

20. Which of the following sets of values constitutes a valid RSA public key encryption system?

- A.  $p = 5, q = 11, n = 55, e = 17, d = 13$
- B.  $p = 5, q = 11, n = 83, e = 17, d = 13$
- C.  $p = 5, q = 11, n = 83, e = 10, d = 13$
- D.  $p = 5, q = 11, n = 55, e = 10, d = 13$

ANSWER: A

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

1. A \_\_\_\_\_ is a relationship between input and output values such that any input is associated with only one output. If the output can be determined algorithmically from the input, the relationship is

said to be \_\_\_\_\_ .

ANSWER: function, computable

2. Identify a problem that does not have an algorithmic solution.

\_\_\_\_\_

ANSWER: The most likely answer is the halting problem.

3. Give an example of a universal programming language.

\_\_\_\_\_

ANSWER: The most likely answer is Bare Bones although almost any programming language is universal and thus a correct answer.

4. Place a T in the blank before each of the following statements that are true. Leave the other blanks blank.

\_\_\_\_\_ All Bare Bones programs that do not contain a while statement are self-terminating.

\_\_\_\_\_ All Bare Bones programs that contain a while statement are not self-terminating.

\_\_\_\_\_ Some Bare Bones programs are both self-terminating and not self-terminating.

\_\_\_\_\_ No Bare Bones program is both self-terminating and not self-terminating.

ANSWER: First and fourth

5. Suppose the variable X in the following Bare Bones program has the value 3 when execution begins.

```
clear Y;  
decr X;  
while X not 0 do;  
  decr X;  
  incr Y;  
end;
```

A. What will be the value of X when the program terminates?

\_\_\_\_\_

B. What will be the value of Y when the program terminates?

\_\_\_\_\_

ANSWER: A. 0      B. 2

6. Suppose the variables X and Y in the following Bare Bones program have the values 3 and 2, respectively, when execution begins. What will be the value of Z when the program terminates?

\_\_\_\_\_

```
clear Z;
```

```

while X not 0 do;
  decr X;
  incr Z;
end;
while Y not 0 do;
  decr Y;
  incr Z;
end;

```

ANSWER: 5

7. Suppose the variables X and Y in the following Bare Bones program have the values 3 and 2, respectively, when execution begins. What will be the value of Z when the program terminates?

---

```

clear Z;
while X not 0 do;
  clear W;
  while Y not 0 do;
    decr Y;
    incr W;
  end;
  while W not 0 do;
    incr Z;
    incr Y;
    decr W;
  end;
  decr X;
  incr Z;
end;

```

ANSWER: 6

8. Place an F in the blank before each of the following statements that are false. Leave the other blanks blank.

- \_\_\_\_\_ No one has discovered a problem that cannot be solved by a Turing machine.
- \_\_\_\_\_ The Bare Bones programming language would not be a universal language if the `clear` statement were removed.
- \_\_\_\_\_ The only problem that cannot be solved by a Turing machine is the halting problem.
- \_\_\_\_\_ Some problems cannot be solved by any Turing machine.

ANSWER: First, second, and third

9. Place an X in the blank before each of the following statements that contradict the Church-Turing thesis. Leave the other blanks blank.

- \_\_\_\_\_ All functions are computable.
- \_\_\_\_\_ Some functions that are not computable by Turing machines are computable by other means.
- \_\_\_\_\_ All computable functions are Turing-computable.

\_\_\_\_\_ Some problems cannot be solved by any Turing machine.

ANSWER: First and second

10. Give an example of a problem in NP that may not be in P.

\_\_\_\_\_

ANSWER: The traveling salesman problem is one answer. (The knapsack problem is also mentioned in the text.)

11. A. Give an example of an algorithm for sorting a list with time complexity in  $\Theta(n^2)$ .

\_\_\_\_\_

B. Give an example of an algorithm for sorting a list with time complexity in  $\Theta(n \lg n)$ .

\_\_\_\_\_

ANSWER: A. insertion sort B. merge sort

12. Place an X in the blank before each of the following statements that guarantees that a problem is in P.

\_\_\_\_\_ The problem is in  $O(n^2)$ .

\_\_\_\_\_ The problem is in  $O(2^n)$ .

\_\_\_\_\_ The problem is in  $O(\lg n)$ .

\_\_\_\_\_ The problem is in  $O(n^3)$ .

ANSWER: First, third, and fourth

13. List the following complexity classes in order of increasing complexity.

$\Theta(n^3)$     $\Theta(2^n)$     $\Theta(\lg n)$     $\Theta(n)$

\_\_\_\_\_

ANSWER:  $\Theta(\lg n)$ ,  $\Theta(n)$ ,  $\Theta(n^3)$ ,  $\Theta(2^n)$

14. Suppose a problem in  $\Theta(n^3)$  has been solved in 1 second. How long should you expect the same machine to require to solve a new instance of the problem with input that is twice the size as before?

\_\_\_\_\_

ANSWER: 8 seconds

15. List the letters associated with the following problems in the order of increasing complexity of the problems.

A. Sorting a list

B. The halting problem



C. Searching through a list for a particular entry

ANSWER: C, A, B

16. Complete the following sentence.

An NP-complete problem is a problem in NP for which \_\_\_\_\_  
\_\_\_\_\_.

ANSWER: ... the existence of a deterministic polynomial time solution would imply that  $P = NP$ .

17. Place a T in the blank before each of the following statements that are true. Leave the other blanks blank.

- \_\_\_\_\_ P is contained in NP.
- \_\_\_\_\_ All solvable problems are in P.
- \_\_\_\_\_ The traveling salesman problem is in NP.
- \_\_\_\_\_ The traveling salesman problem is not solvable.

ANSWER: First and third

18. If we were using RSA encryption with the public keys  $n = 91$  and  $e = 5$ , what would be the encrypted version of the message whose bit pattern is 11?

ANSWER: 111101 (which is binary for 61)

19. If we were using RSA encryption with the private keys  $n = 133$  and  $d = 5$ , what would be the decrypted version of the encrypted message whose bit pattern is 11?

ANSWER: 1101110 (which is binary for 110)

20. If the prime numbers underlying an RSA encryption system are small, the system is not secure. For example, suppose you were told that the public keys of a system were  $n = 15$  and  $e = 13$ .

A. What are the two prime numbers on which the system is based?

B. What is the value of the decryption key  $d$ ?

ANSWER: A. 3 and 5      B. 5

## 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 asked 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
computable function	A relationship between input and output values that can be determined algorithmically
Turing machine	An elementary, yet universal, computing device
Church-Turing thesis	The conjecture that the Turing-computable functions are the same as the computable functions
Turing computable	Solvable by a Turing machine
halting problem	An example of an unsolvable problem
universal language	Allows a solution to any solvable problem to be expressed
unsolvable problem	A problem with no algorithmic solution
NP	A class of problems whose time complexity is not yet completely understood
P	The problems that have a polynomial time solution
nonpolynomial problems	Problems with a high time complexity
nondeterministic algorithm	May not perform the same if repeated in the identical environment
merge sort algorithm	Has time complexity of $\Theta(n \lg n)$
traveling salesman problem	An NP complete problem
private keys	The decryption values in a public key encryption system
RSA	A public key encryption system
$23 \pmod{7}$	The remainder after division

## General Format Questions

1. State the Church-Turing thesis.

ANSWER: The Turing-computable functions are the same as the computable functions.

2. What was Alan Turing's purpose when developing the concept of the Turing machine?

ANSWER: The purpose was to design a system that could compute any computable function.

3. What is a universal programming language?

ANSWER: A universal programming language is a programming language with which a solution to any solvable problem can be expressed.

4. Write a sequence of statements in the Bare Bones language that is equivalent to the statement

if  $X \neq 0$  then  $S_1$  else  $S_2$

where  $S_1$  and  $S_2$  are sequences of Bare Bones statements.

ANSWER: One solution would be the following:

```

copy X to Y;
clear Z;
incr Z;
while Y not 0 do;
  S1;
  clear Y;
  clear Z;
end;
while Z not 0 do;
  S2;
  clear Z;
end;

```

5. Write a program in Bare Bones that will add one to the variable X if X is not 0 and leave X unchanged otherwise.

ANSWER: One solution would be the following:

```

copy X to Z;
while Z not 0 do;
  incr X;
  clear Z;
end;

```

6. Is the following Bare Bones program self-terminating? Explain your answer.

```

copy X to Z;
decr Z;
while Z not 0 do;
  decr Z;
  decr X;
end;
while X not 0 do;
end;

```

ANSWER: No. If the program is run with X and Z containing the program's encoded value, then the last loop will be reached with the variable X assigned the value 1 so the last loop will execute forever.

7. Write a program in Bare Bones that terminates with the variable Z equal to 1 if the variables X and Y start with non-zero values and with Z equal to 0 otherwise.

ANSWER: One solution would be the following:

```

clear Z;
copy X to V;
copy Y to W;
while V not 0 do;
  while W not 0 do;
    incr Z;
    clear W;
  end;
  clear V;
end;

```

8. Explain the distinction between time complexity and space complexity.

ANSWER: Time complexity measures the amount of time required to solve a problem. Space complexity measures the amount of storage space required to solve a problem.

9. Is a problem in  $O(n^3)$  more complex than a problem in  $O(n^2)$ ? Explain your answer.

ANSWER: Not necessarily. To say that a problem is in  $O(n^3)$  merely means that it is no more complex than  $\Theta(n^3)$ . Thus, a problem in  $O(n^3)$  may actually be in  $\Theta(n)$ .

10. Are all problems in P solvable in a reasonable amount of time? Explain your answer.

ANSWER: No. Simply because the time complexity of a problem is bounded by a polynomial does not mean that the problem can be solved quickly. If the degree of the polynomial is large, the time required could be enormous—even for small inputs.

11. Why is a public key encryption system based on the RSA algorithm secure?

ANSWER: It is secure because no one knows a fast way to find the prime factors of the public key  $n$ .