Midterm 1 consists of 25 multiple choice questions. For each question you are asked to select a single answer, i.e. the best / most complete answer. Each question is worth 4 points.

INSTRUCTIONS
Fill in the header of the FIRST page of the assignment text with the required information:
- Your Last Name and First Name
- Your purdue mail account (e.g. lmartino)
- Your Recitation Section: find your recitation section in the table below, and put the value of the last column in the header
- Signature: your signature

Fill in the bubble sheet fields as follows:
- TEST FORM field: mark the letter corresponding to the version (A or B) of your assignment. IMPORTANT!!! : if you do not mark properly this filed you will get 0.
- student ID: use the 10 digit ID number on your Purdue ID card. DO NOT USE YOUR SOCIAL SECURITY NUMBER!
- Last Name and First Name
- Test/Quiz: put 01
- Course: 177
- Section number: find your recitation section in the table below and put in the scantron card the value of the last column

<table>
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<tr>
<th>Recitation Section</th>
<th>Day and Time</th>
<th>TA</th>
<th>Recitation section to be used in the header and in the scantron card</th>
</tr>
</thead>
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<td>Nadya Ortiz</td>
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<td>Xi Tan</td>
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<td>R07</td>
<td>F 11:30PM</td>
<td>Nadya Ortiz</td>
<td>0007</td>
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</table>
Q1. What is the decimal (i.e. base 10) representation of the hexadecimal number 3F\textsubscript{16}?
   
   A. 31  
   B. 67  
   C. 63  
   D. 55  
   E. None of the above

Q2. What is the value of P[2][3] in the following 2D array?

   
   Array P
   
   \begin{array}{cccc}
   10 & 16 & 23 & 7 \\
   5 & 11 & 39 & 51 \\
   6 & 44 & 29 & 13 \\
   35 & 17 & 25 & 36 \\
   \end{array}

   
   A. 44  
   B. 13  
   C. 25  
   D. 39  
   E. None of the above

Q3. How many elements are in a 3-D array of size 2 x 5 x 4

   A. 14  
   B. 50  
   C. 20  
   D. 35  
   E. None of the above
Q4. Put the following steps in order for finding the largest element in an array \( A \) of length \( n \).

1. \textbf{return} \( \max \)
2. \( \max = A[0] \)
3. \textbf{for} \( i = 0 \) \textbf{to} \( n-1 \)
4. \hspace{1em} \( \max = A[i] \)
5. \hspace{1em} \textbf{if} \( A[i] > \max \) \textbf{then}

   \begin{align*}
   &A. \ 2, 3, 5, 4, 1 \\
   &B. \ 3, 2, 5, 4, 1 \\
   &C. \ 5, 2, 3, 4, 1 \\
   &D. \ 3, 2, 4, 5, 1 \\
   &E. \ \text{None of the above}
   \end{align*}

Q5. Convert the binary number 1000 1011 1100\(_2\) to its hexadecimal (base 16) representation:

   \begin{align*}
   &A. \ ABC_{16} \\
   &B. \ 216_{16} \\
   &C. \ 1FA_{16} \\
   &D. \ \boxed{8BC}_{16} \\
   &E. \ \text{none of the above}
   \end{align*}

Q6. You want to create a one dimensional array in which each element can hold any decimal number from 0 to 32 (0 and 32 included). How many bits do you need for each element of the array?

   \begin{align*}
   &A. \ 5 \\
   &B. \ \boxed{6} \\
   &C. \ 4 \\
   &D. \ 7 \\
   &E. \ \text{none of the above}
   \end{align*}
Q7. What is the minimum number of nodes in a binary tree with a height of 5?

A. 4  
B. 32  
C. 6  
D. 31  
E. none of the above

Q8. Use the following lines of pseudo code to construct an algorithm for finding the sum of all elements in a 2D array A with $m$ rows and $n$ columns. Which is the correct sequence of instructions?

1. $\textbf{for } j = 0 \textbf{ to } n-1$
2. $\quad \text{sum} = \text{sum} + A[i][j]$
3. $\textbf{return } \text{sum}$
4. $\textbf{for } i = 0 \textbf{ to } m-1$
5. $\quad \text{sum} = 0$

A. 5 4 1 2 3  
B. 5 1 2 3 4  
C. 1 5 3 2 4  
D. 2 4 1 3 5  
E. none of the above
Q9. Which is the correct adjacency matrix for the following graph?

A. 

\[
\begin{array}{cccc}
0 & 1 & 2 & 3 \\
0 & 1 & 1 & 1 & 0 \\
1 & 1 & 1 & 0 & 1 \\
2 & 1 & 0 & 1 & 1 \\
3 & 0 & 1 & 1 & 1 \\
\end{array}
\]

B. 

\[
\begin{array}{cccc}
0 & 1 & 2 & 3 \\
0 & 0 & 1 & 1 & 1 \\
1 & 1 & 0 & 1 & 1 \\
2 & 1 & 1 & 0 & 1 \\
3 & 1 & 1 & 1 & 0 \\
\end{array}
\]

C. 

\[
\begin{array}{cccc}
0 & 1 & 2 & 3 \\
0 & 0 & 1 & 0 & 1 \\
1 & 1 & 0 & 1 & 0 \\
2 & 0 & 1 & 0 & 1 \\
3 & 1 & 0 & 1 & 0 \\
\end{array}
\]

D. 

\[
\begin{array}{cccc}
0 & 1 & 2 & 3 \\
0 & 1 & 0 & 0 & 0 \\
1 & 0 & 1 & 0 & 0 \\
2 & 0 & 0 & 1 & 0 \\
3 & 0 & 0 & 0 & 1 \\
\end{array}
\]

E. none of the above
Q10. Which of the following are advantages of digital data?

1. Digital data can be replicated without loss
2. Any copy of the data is as good as the original
3. Digital data can be processed by computers
4. Digital data always captures the full complexity of the real world

A. 1, 2, 3, and 4
B. 2, and 4
C. 1, 2, 3
D. 1, 3
E. None of the above

Q11. Match the data you wish to represent to an appropriate data structure:

1. Set of hourly temperature readings
2. A subway route map
3. A stack of CAT scan slices
4. A JPEG image

I. 2-D Array
II. 3-D Array
III. Graph
IV. 1-D Array

A. (1, I), (2, II), (3, III), (4, IV)
B. (1, IV), (2, II), (3, III), (4, I)
C. (1, IV), (2, II), (3, I), (4, III)
D. (1, IV), (2, III), (3, II), (4, I)
E. (1, IV), (2, I), (3, II), (4, III)
Q12. Given the array:

\[ A = \{7, 5, 2, 9, 1, 12, 45, 9\} \]

Which of the following statements is true?


Q13. Which of the following statements about the binary tree data structure is true?

A. Every node has exactly 3 children
B. Every node has exactly 2 children
C. A leaf has at least one child
D. A node can have any number of children
E. An internal node has at least one child

Q14. What is an advantage of using arrays?

A. Simple extension to store an additional piece of data.
B. Good flexibility for modeling irregular, non-uniform data
C. Fast, direct access to any of the elements
D. Simple way of removing a piece of data.
E. None of the above
Q15.

```
for i = 0 to n
    for j = 0 to n
        for k = 0 to n
            print k
        endFor
    endFor
endFor
```

What is the running time for the algorithm above?

A. constant time  
B. $n \log_n$  
C. $n$  
D. $n^2$  
E. $n^3$

Q16. Graphs can only be represented with adjacency lists.

A. True  
B. False

Q17. The index used to access the first value in an array is 1.

A. True  
B. False
Q18. In a 3D array, the maximum number of immediate neighbors of an element is 27.

A. True

B. False

Q19. Base 16 is used to make binary easier to read by programmers.

A. True

B. False

Q20. Complete the blanks in the sentence below given the following equation:

\[((10 + 8) / (7 - 1)) * ((1 / 4) + (15 * 5))\]

The binary tree has a height of ______ with ______ leaves, and ______ internal nodes.
The total number of nodes is ______.

A. 3, 8, 7, 15
B. 3, 7, 8, 14
C. 2, 7, 8, 15
D. 3, 7, 8, 14
E. 2, 8, 8, 15
Q21. Complete the last row of the adjacency matrix.

Indices: 0=India, 1=Romania, 2=Switzerland, 3=Turkey, 4=USA

A. 0 | 0 | 1 | 0 | 1
B. 0 | 1 | 1 | 0 | 0
C. 1 | 0 | 1 | 0 | 0
D. 1 | 1 | 0 | 0 | 0
E. 1 | 0 | 0 | 1 | 0

Q22. A color image stores a red, a green, and a blue channel (i.e. value) for every pixel. If one byte per channel is used, how much storage space is needed for an image with 1,920 x 1,080 pixels?

A. 0.2MB
B. 5.9MB
C. 9.1MB
D. 12.1MB
E. 19MB
Q23.

Consider the following adjacency matrix M of airports:

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<thead>
<tr>
<th></th>
<th>DFW</th>
<th>JFK</th>
<th>IND</th>
<th>LAX</th>
<th>ATL</th>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<tr>
<td>JFK</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>IND</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>LAX</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>ATL</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

An element $M[i][j]$ of 1 means that there is a direct flight from airport $i$ to airport $j$. Is there a one-stop flight from ATL to JFK?

A. Yes
B. No

Q24. You just created a 1D array with 80 elements. If each element is 8 bits, then what is the size, in bytes, of the entire array?

A. Less than 1 byte
B. 8 bytes
C. 10 bytes
D. 80 bytes
E. 640 bytes
Q25. Consider the images and formula below.

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</table>

Image X

<table>
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<tbody>
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<td>0 0 0</td>
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<tr>
<td>0 2 6</td>
<td>8 6 2</td>
<td>0 0 0</td>
<td>0 0 0</td>
<td>0 0 0</td>
</tr>
<tr>
<td>0 2 8</td>
<td>Z 8 2</td>
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<td>2 2 0</td>
<td>0 0 0</td>
<td>0 0 0</td>
<td>0 0 0</td>
</tr>
</tbody>
</table>

Image Y

Image Y is generated with the following formula:

i. \( Y[i][j] = 0 \), if \( i \) equals 0 or 6, or if \( j \) equals 0 or 6

ii. \( Y[i][j] = (X[i][j] + X[i-1][j] + X[i][j-1] + X[i][j+1] + X[i+1][j]) / 5 \)

What is the value of \( Z \) in Image Y (element \( Y[3][3] \))?

A. 0
B. 20
C. 10
D. 8
E. 100
Q26. Traverse the following binary tree and print out the node labels according to the following rules:

a. When you visit a node for the first time, visit its left child.
b. Then visit its right child.
c. Then print its label.
d. Then go back up.

A. abdgheicfjk
B. ghdiebjkfca
C. gdhbieajfkc
D. abcdefghijk
E. abdgdhdbiebacfjfkfca
Q27. What line needs to be inserted into the algorithm below to convert 2-D array A into 2-D array B.

\[
\begin{array}{cccc}
1 & 0 & 2 & 0 \\
2 & 1 & 2 & 0 \\
0 & -1 & 1 & -1 \\
0 & 0 & 0 & 1 \\
\end{array}
\quad
\begin{array}{cccc}
0 & 0 & 0 & 0 \\
0 & -1 & 3 & 0 \\
0 & 1 & -4 & 0 \\
0 & 0 & 0 & 0 \\
\end{array}
\]

Array A  
Array B

\[
\text{for } i = 0 \text{ to 3} \\
\quad \text{for } j = 0 \text{ to 3} \\
\quad \quad \text{if } (i == 0) \text{ or } (j == 0) \text{ or } (i == 3) \text{ or } (j == 3) \\
\quad \quad \quad \text{B}[i][j] = 0 \\
\quad \quad \text{else} \\
\quad \quad \quad \quad \text{***LOCATION OF LINE TO BE INSERTED***} \\
\quad \quad \quad \text{endif} \\
\quad \text{endFor} \\
\text{endFor}
\]

A. \( B[i][j] = A[i-1][j+1] \times 3 - A[i][j] \)
B. \( B[i][j] = A[i-1][j+1] \times 3 - A[i-1][j] \)
C. \( B[i][j] = A[i-1][j+1] - A[i+1][j-1] \times 3 \)
D. \( B[i][j] = A[i][j+1] - A[i+1][j+1] \times 3 \)
E. None of the above