

Name: _____ NetID: _____
 (Legibly print last name, first name, middle name)

Statement of integrity:

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Circle your discussion section:

	Wednesday	Thursday
9:40 AM	Aravind Suresh Babu	Aravind Suresh Babu
11:25 AM	Subham Sahoo	Subham Sahoo
1:00 PM	Claire Liang	-
2:45 PM	Claire Liang	-

Instructions:

- Check that this packet has 7 double-sided sheets.
- This is a 90-minute, closed-book exam; no calculators are allowed.
- The exam is worth a total of 100 points, so it's about one point per minute!
- Read each problem completely, including any provided code, before starting it.
- Do not modify any *given* code unless asked to do so.
- Raise your hand if you have any questions.
- Use the back of the pages if you need additional space.
- Clarity, conciseness, and good programming style count for credit.
- Indicate your final answer. If you supply multiple answers, you may receive a *zero* on that question.
- Use only MATLAB code. No credit for code written in other programming languages.
- Assume there will be no input errors.
- Write user-defined functions and subfunctions only if asked to do so.
- Do not use `switch`, `try`, `catch`, `break`, `continue`, or `return` statements.
- Do not use built-in functions that have not been discussed in the course.
- You may find the following MATLAB predefined functions useful: `abs`, `sqrt`, `rem`, `min`, `max`, `floor`, `ceil`, `rand`, `zeros`, `ones`, `sum`, `length`, `size`, `fprintf`, `disp`, `uint8`, `double`, `char`, `strcmp`, `str2double`, `cell`

Examples: `zeros(1,4)` → 1 row 4 columns of zeros, type double
`cell(3,2)` → a 3-by-2 cell array, each cell is the empty numeric vector `[]`
`length([2 4 8])` → 3, length of a vector
`[nr,nc,np]=size(M)` → dimensions of M: nr rows, nc columns, np layers
`strcmp('cat','Cat')` → 0, the two strings are not identical
`str2double(' -2.6 ')` → -2.6, a type double scalar
`uint8(4.7)` → the integer (type uint8) value 5

Use this page for scratch work.

Question 1 (17 points)

(1.1) Write the output given by each disp statement below.

```
x = {'a' 'dog'};  
disp( length(x) )           % What is the output? -----
```

```
disp( length([x{1} x{2}]) ) % What is the output? -----
```

```
disp( length({x{1} x{2}}) ) % What is the output? -----
```

(1.2) Assume that variables r and s each stores a type uint8 value. Complete the blank to assign to variable d the difference (absolute value) between r and s. d should have the type uint8.

d = _____

(1.3) Complete the following function as specified:

```
function h = distHistogram(z)  
% z is a type double matrix storing coordinates of some points on the Cartesian  
% plane. z has two columns: column 1 stores x-coordinates; column 2 stores  
% y-coordinates. Each row represents one point. z has at least one row.  
% h is the data (vector) for drawing a bar graph showing the distribution of  
% distance from the origin: h(1) is the number of points a distance 1 or less  
% from the origin, h(2) is the number of points whose distance is >1 and <=2 from  
% the origin,..., h(100) is the number of points whose distance is >99 and <=100  
% from the origin. Do not count the points whose distance from the origin is >100.  
  
h= zeros(1,100);  
x= z(:,1);  
y= z(:,2);  
dist= sqrt(x.^2 + y.^2);  
% Add your code below
```

```
bar(1:100, h); title('Distribution of distance')  
xlabel('Distance from the origin'); ylabel('Number of points')
```

Use this page for scratch work.

Question 2 (18 points)

A matrix is “symmetric” if it is the same as its transpose. A matrix is “antisymmetric” if it is the negative of its transpose. For example,

$$\begin{bmatrix} 2 & -3 \\ -3 & 5 \end{bmatrix} \text{ is symmetric; } \begin{bmatrix} 0 & -1 & 2 \\ 1 & 0 & 4 \\ -2 & -4 & 0 \end{bmatrix} \text{ is antisymmetric.}$$

A matrix can be both symmetric and antisymmetric; an example is $\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$. Implement the following function to determine if a *submatrix* is symmetric and if it is antisymmetric. Do *not* use the transpose operator or the transpose function.

Hint: recall the “mirror positions” or “transpose positions” across the main diagonal of a square matrix.

```
function [sym, antisym] = checkSubmatrix(M, L, R)
% Determine if a square submatrix of M is symmetric and if it is antisymmetric.
% M is a non-empty matrix of integer real values. M may not be square.
% L, R are valid row and column indices of M. L < R.
% Determine if the submatrix from row L to row R and column L to column R of M
% is symmetric and if it is antisymmetric.
% sym is 1 (or true) if the submatrix is symmetric; otherwise 0 (false).
% antisym is 1 (or true) if the submatrix is antisymmetric; otherwise 0 (false).
```

Use this page for scratch work.

Question 3 (20 points)

A pixel of an image is said to be “red-dominant” if its red intensity is strictly greater than its green and blue intensities. Implement the following function as specified:

```
function Q = removeRedDominance(P)
% P is a 3-d uint8 array of image data. P is not empty.
% Q is P with only the red-dominant pixels modified: each red-dominant
% pixel is assigned a new red intensity that is the average value
% (arithmetic mean) between the green and blue intensities. The green and
% blue intensities do not change.
```

Use this page for scratch work.

Question 4 (15 points)

Complete the following function as specified:

```
function w = reverseSubvec(v, k, n)
% Reverse a subvector of v, with a maximum subvector length of n, starting
%   at index k
% v: a type char row vector.  v is not empty.
% k: a valid index of v
% n: the maximum length of the subvector to reverse.  n is an integer > 0.
%   If the longest subvector of v starting at index k is shorter than n,
%   then reverse the elements from index k to the end of v.
% w: v with the appropriate subvector reversed
%
% Examples:
%   reverseSubvec('amigo!', 3, 3)  returns  'amogi!'
%   reverseSubvec('amigo!', 3, 5)  returns  'am!ogi'
%   reverseSubvec('amigo!', 2, 1)  returns  'amigo!'
%   reverseSubvec('amigo!', 6, 8)  returns  'amigo!'

w= v;
% Add your code below.  Do NOT use vectorized code.
```

Use this page for scratch work.

Question 5 (30 points)

The gameboard for a certain game is represented as a matrix `G` storing type `char` values. In one step of the game, the gameboard is possibly scrambled by having some row vectors (or subvectors) reversed. The proposed changes to the gameboard `G` are stored in a 2-d cell array `P`. Each row of `P` is a proposed change:

- The first cell stores the index of the row in `G` to consider changing.
- The second cell stores a search target. If the target is found in that row of `G`, then reverse the elements in that row of `G` from the beginning of that row to the end of the *first* target found in that row. Otherwise that row of `G` should not be changed.

Consider the following example gameboard `G` and example proposed changes `P`:

<pre>G= ['isthereafullmoon'; ... 'timeforalunytune'; ... 'mooncakeonaspoon'; ... 'batbaboonoraloon'] % 1234567890123456</pre>	<pre>P= { 2, 'un'; ... 1, 'mooncake'; ... 4, 'bat'}</pre>
---	---

Then the updated gameboard given `P` would be

```
['isthereafullmoon'; ...  
 'nularofemitytune'; ...  
 'mooncakeonaspoon'; ...  
 'tabbaboonoraloona'];
```

Observe that the first proposed change, on row 2 of `G`, was made because the target `'un'` was found. The second proposed change was not made because `'mooncake'` was not found on row 1 of `G`. The last proposed change was made because `'bat'` was found on row 4 of `G`.

Implement the function on the following page as specified. For full credit, make effective use of function `reverseSubvec` from Question 4 (assume it has been implemented correctly). Built-in functions `find`, `strfind`, and `findstr` are forbidden.

Use this page for scratch work.

Question 5, continued

```
function H = updateBoard(G, P)
% Update gameboard G given the proposed changes in P.
% G: a 2-d simple array of type char representing the gameboard. G is not empty.
% P: a 2-d cell array with 2 columns. The first column stores valid and
%   distinct row indices of G. The second column stores search targets.
%   Each row of P is a proposal to change one row of G. P has at least
%   one row.
% H: the gameboard updated based on the given rules. H has the same size
%   and type as G.

% For full credit, make effective use of function reverseSubvec from Question 4.
% Built-in functions find, strfind, and findstr are forbidden.
```

Consider the following example gameboard G and example proposed changes P:

<pre>G= ['isthereafullmoon'; ... 'timeforalunytune'; ... 'mooncakeonaspoon'; ... 'batbaboonoraloon'] % 1234567890123456</pre>		<pre>P= { 2, 'un'; ... 1, 'mooncake'; ... 4, 'bat'}</pre>
---	--	---

Then the updated gameboard given P would be

```
['isthereafullmoon'; ...
 'nularofemitytune'; ...
 'mooncakeonaspoon'; ...
 'tabbaboonoragoon'];
```

Use this page for scratch work.