READ and complete the following:

- Bubble your Scantron only with a No. 2 pencil.
- On your Scantron (shown in the figure below), bubble:
  1. Your Name
  2. Your NetID
  3. Form letter "A"
  4. Bubble the corresponding 3-digit code (shown below) for your lab section on your Scantron.

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00-10:50</td>
<td>101</td>
<td>104</td>
<td>107</td>
<td>109</td>
</tr>
<tr>
<td>11:00-12:50</td>
<td>102</td>
<td></td>
<td>110</td>
<td></td>
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<tr>
<td>1:00-2:50</td>
<td></td>
<td>105</td>
<td>111</td>
<td></td>
</tr>
<tr>
<td>3:00-4:50</td>
<td>103</td>
<td>106</td>
<td>108</td>
<td>112</td>
</tr>
</tbody>
</table>

- No electronic devices, books, notes, or cheat sheets are allowed while taking this exam.
- Please fill in the most correct answer on the provided Scantron sheet.
- We will not answer any questions during the exam.
- Each question has only ONE correct answer.
- You must stop writing when time is called by the proctors.
- Hand in both these exam pages and the Scantron.
- DO NOT turn this page UNTIL the proctor instructs you to.
1. How would you use the `linspace` function to create a row vector with five values ranging from 2 to 10 inclusive?

(a) `linspace(2, 5, 10)`
(b) `linspace(5, 2, 10)`
(c) `linspace(2, 10, 6)`
(d) `linspace(2, 10, 5)`

2. Given the vector,

\[
\begin{align*}
>> x &= [1 \ 3 \ 5 \ 7 \ 9];
\end{align*}
\]

which of the Matlab commands shown below would create a vector `y` from `x` that would display the following output?

\[
\begin{align*}
y &= \\
&= 9 \ 7 \ 5
\end{align*}
\]

(a) `>> y = x(end : end - 2)`
(b) `>> y = x(end : -1 : 3)`
(c) `>> y = y(5 : 3)`
(d) `>> y = y(end : end - 2)`

3. Which arithmetic operator, replacing the blank shown below,

\[
\begin{align*}
>> x &= [6 \ 8 \ 12]; \\
>> y &= [3 \ 2 \ 4]; \\
>> x \ ? \ y
\end{align*}
\]

produces the following result?

\[
\begin{align*}
\text{ans} &= \\
&= \begin{bmatrix} 2 & 4 & 3 \end{bmatrix}
\end{align*}
\]

(a) `\`
(b) `\ .\`
(c) `/`
(d) `\ ./`
4. Assume that the following commands are entered at the Matlab prompt.
   
   ```
   >> a = 4;
   >> b = 3;
   >> b = [1 1 2];
   ```

   What result will the following command produce when typed at the Matlab prompt?
   
   ```
   >> 5a + b
   ```

   (a) 23
   (b) [21 21 22]
   (c) [25 25 30]
   (d) A Matlab ERROR

5. What is the output from the following commands typed at the Matlab prompt?
   
   ```
   >> x = [4 1 8];
   >> y = [2; 3; 5];
   >> x * y
   ```

   ans =

   (a) 51
   (b) [8 3 40]
   (c) [40 3 8]
   (d) A Matlab ERROR

6. Which of the Matlab commands below opens the editor window for writing your own function?

   (a) who
   (b) what
   (c) edit
   (d) syms

7. Which of the following is TRUE about FUNCTION files?

   (a) The first executable line in a function file is ( must be ) the function definition line
   (b) The non-global variables in the function file are local.
   (c) "%" symbol can be used to write a comment in a program.
   (d) All of the above
8. Given the code for the function named `func` as shown below,

```matlab
function out = func(x, y)
    out = x * y;
```

circle a correct way to call the function named `func`. By correct way we mean a way that does **NOT** produce a Matlab *ERROR*.

(a) `>> result = func(2012)`

(b) `>> result = func([1, 2, 3], [3, 4, 5])`

(c) `>> func(2, 4)`

(d) `>> func()`

9. Given an arbitrary m by n matrix named `A` which of the following Matlab commands will add all the values in the matrix `A`?

(a) `>> sum(A)`

(b) `>> sum(A) + sum(A')`

(c) `>> sum(sum(A'))`

(d) `>> max(sum(A))`

10. The code for a script shown below is typed into a file. When the script is run what is the output?

```matlab
A = [1, 2, 3; 4, 5, 6; 7, 8, 9];
flag = 1;
i = 1;
while flag == 1
    if i < 4
        output(i) = A(i, i);
        i = i + 1;
    else
        flag = 0;
    end
end
disp(output)
```

(a) `[1, 5, 9]`

(b) `[1, 4, 7]`

(c) `[7, 8, 9]`

(d) `[1, 2, 3]`
11. You are given a function named add_to_y defined below.

```matlab
function x = add_to_y(y)
    c = 3;
    x = y + c;
    y = 10;
```

If we type the following lines in the Matlab command window, what will be the values of x, y and c?

```
>> c = 5;
>> y = 5;
>> x = add_to_y(y);
>> x
x =
    __________
>> y
y =
    __________
>> c
c =
    __________
```

(a) x = 8, y = 5, c = 5

(b) x = 10, y = 10, c = 5

(c) x = 13, y = 5, c = 5

(d) x = 8, y = 10, c = 3

12. Which of the following should be used to plot the vector of values named X vs the vector of values named Y with crosses marking the position of the data values in green color without a line connecting the data values?

(a) plot(X, Y, 'g', 'x');

(b) plot(X, Y, 'g', 'y', 'none');

(c) plot(X, Y, 'gxnone');

(d) plot(X, Y, 'gx');
13. Which of the lines of code below is the function definition line for a function named *horse* which takes as input two variables *horn* and *hoof* in this order and outputs a variable called *unicorn*. Your task is to write down the first line of code that comprises the function definition of this function.

(a) function unicorn = horse(horn, hoof)

(b) function horse = horse(horn, hoof)

(c) function unicorn(horn, hoof)

(d) function horse unicorn(horn, hoof)

14. In any job, the contracts are given to the lowest bidder (provided some basic standards are met). Consider the following bids (in $ millions).

\[
\texttt{>> x = [10, 17, 15, 19, 20, 21, 12];}
\]

Assuming that the bid values are all distinct, which of the scripts shown below will narrow the list to the three lowest bidders?

(a) while length(x) ~= 3
   \[
x = x(x ~= \text{max}(x));
   \]
   end

(b) while length(x) >= 3
   \[
x = x(x ~= \text{max}(x));
   \]
   end

(c) while length(x) >= 4
   \[
x = x(x == \text{max}(x));
   \]
   end

(d) while length(x) > 4
   \[
x = x(x == \text{max}(x));
   \]
   end
15. The code for a script shown below is typed into a file. When the script is run what is the output? Hint: The `diff` function is used here to compute the derivative.

\[
\begin{align*}
&\text{\texttt{>> syms x}} \\
&\text{\texttt{>> y = [x x.∧2 x.∧3 x.∧4];}} \\
&\text{\texttt{>> z = [1 2*x 3*x.∧2 x.∧4];}} \\
&\text{\texttt{>> z == diff(y)}} \\
&\text{\texttt{>> ans =}} \\
&\text{\texttt{(a) [1, 1, 1, 1]}} \\
&\text{\texttt{(b) [1, 1, 1, 0]}} \\
&\text{\texttt{(c) [0, 0, 0, 0]}} \\
&\text{\texttt{(d) [0, 1, 1, 1]}}
\end{align*}
\]

16. Which of the commands below produces the following matrix?

\[
\begin{bmatrix}
1 & 2 & 3 & 4 \\
1 & 2 & 3 & 4 \\
1 & 2 & 3 & 4
\end{bmatrix}
\]

(a) \texttt{>> repmat(1:4, 3, 3)}

(b) \texttt{>> repmat(1:4, 3, 1)}

(c) \texttt{>> repmat(3, 3, 1:4)}

(d) \texttt{>> repmat(3, 1, 1:4)}

17. Which of the commands below produces the following matrix?

\[
\begin{bmatrix}
1 & 2 & 3 & 4 \\
1 & 2 & 3 & 4 \\
1 & 2 & 3 & 4
\end{bmatrix}
\]

(a) \texttt{>> cumsum(ones(3,4))}

(b) \texttt{>> cumsum(ones(3,4))'}

(c) \texttt{>> cumsum(ones(4,3))}

(d) \texttt{>> cumsum(ones(4,3))'}
18. Given the scalar value $x$ you are required to compute the following sum,

$$1 + x + x^2 + x^3 + x^4 + x^5 + x^6 + x^7 + x^8 + x^9 + x^{10}$$

Which of the following is the correct way to compute this sum?

(a) $\text{polyval}(\text{ones}(1,11), x)$
(b) $\text{polyval}(\text{ones}(1,10), x)$
(c) $\text{sum}(x .^\wedge (1:11))$
(d) $\text{sum}(x .^\wedge (1:10))$

19. Given that matrix $A$ has the values shown below,

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 5 & 6 & 7 & 8 \\ 9 & 10 & 11 & 12 \\ 13 & 14 & 15 & 16 \end{bmatrix}$$

what is the result of the following Matlab statement?

$>> B = A(1:2:3, \text{end})$

(a) $B = \begin{bmatrix} 4 \\ 12 \end{bmatrix}$
(b) $B = \begin{bmatrix} 4 \\ 8 \\ 12 \end{bmatrix}$
(c) $B = \begin{bmatrix} 1 & 3 \\ 5 & 7 \\ 9 & 11 \\ 13 & 15 \end{bmatrix}$
(d) Matlab error statement: "Index exceeds matrix dimensions."
20. You are required to write a function named `solve` that solves the linear system of equations,

\[ A \times x = b \]

where the user supplies the vector \( b \) (\( m \times 1 \) in size) and matrix \( A \) (\( m \times n \) in size). Your function `solve` returns \( x \) (\( n \times 1 \) in size). Which of the following is the correct way to write this function?

(a) function solve(x)
    solve = A\b;

(b) function y = solve(x)
    y = A/b;

(c) function y = solve(A,b)
    y = A\b;

(d) function y = solve(A,b)
    y = A/b;

21. We have a function named `func1` saved in a file named `func1.m` shown below.

```matlab
function z = func1(w)
    G = 5 * w;
    z = G + 10 * w;
```

The following sequence of commands is entered at the Matlab prompt. Which are the correct values that Matlab returns for the variables named \( a \) and \( G \)?

```matlab
>> clear
>> global G
>> G = 1;
>> a = func1(G + 5);
>> a
a = _________
>> G
G = _________
```

(a) \( a = 60, G = 30 \)
(b) \( a = 90, G = 1 \)
(c) \( a = 90, G = 30 \)
(d) \( a = 60, G = 1 \)
22. Which of the following commands will **NOT** plot the function named `func3` (saved in the file `func3.m` shown below) on the interval [0, 10]?

```matlab
function y = func3(x)
y = 5 * x.^2 + 7;
```

(a) `fplot('func3',[0,10])`
(b) `fplot('func3(x)',[0,10])`
(c) `fplot(@(func3,[0,10])`
(d) `fplot(@(func3(x)),[0,10])`

23. In CS101 you learned how to approximate the value of definite integrals of single-variable functions \( \int_{a}^{b} f(x) \, dx \) using both `trapz` and `quadl`. Which of the following statements/choices below is the most correct?

(a) The functions `trapz` and `quadl` can be used interchangeably because both can numerically approximate a definite integral.
(b) The function `trapz` can only be used if an explicit expression for \( f(x) \) is given.
(c) The algorithm that `quadl` uses to approximate \( \int_{a}^{b} f(x) \, dx \) is inherently more accurate than the one used by `trapz`.
(d) The function `quadl` can integrate any real single-valued function.
24. You are a safety test engineer for a big car manufacturer. One of your jobs is to analyze the effectiveness of the car’s airbags. To do this, you attach accelerometers to the head of a crash-test dummy to quantify the effects of an impact with the airbag. You want to use Matlab to analyze acceleration data from the accelerometer. Specifically, how would you integrate the acceleration data in the table below to determine the velocity at which the dummy’s head impacts the airbag?

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>0</th>
<th>0.015</th>
<th>0.03</th>
<th>0.045</th>
<th>0.06</th>
<th>0.075</th>
<th>0.09</th>
<th>0.105</th>
<th>0.12</th>
<th>0.135</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceleration (m/s²)</td>
<td>0</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>400</td>
<td>300</td>
<td>325</td>
<td>290</td>
<td>100</td>
<td>20</td>
</tr>
</tbody>
</table>

Which of the following, when entered into the Matlab command window, will integrate the given data, treating time as the independent variable, and store the answer in the variable `final_velocity`? You may assume that velocity = 0 at time t = 0 and that the dummy’s head strikes the air bag at time equals 0.135 sec. The values for both time( t) and acceleration( a) have been entered at the Matlab prompt shown below. Hint: The formula for calculating `final_velocity` is given by,

\[
final\_velocity = \int_{0}^{final\_time} a(t) \, dt
\]

```matlab
>> t = [0 0.015 0.03 0.045 0.06 0.075 0.09 0.105 0.12 0.135];
>> a = [0 50 100 200 400 300 325 290 100 20];

(a) >> final_velocity = quadl(t,a);
(b) >> final_velocity = trapz(t,a);
(c) >> final_velocity = trapz(a,linspace(0,0.135,10));
(d) >> final_velocity = quadl(a,0,0.135);
```
The differential equation that describes the motion of a mass $m$ suspended by a spring (with Hook’s coefficient $k$) from a ceiling (without friction forces) can be expressed using the following equations:

$$\frac{dy}{dt} = v$$
$$\frac{dv}{dt} = -\frac{k}{m}y$$

where $y = 0$ is the position of the mass when at rest hanging from the spring which is attached to the ceiling. Given this, you create the following Matlab function that fully describes the above differential equation:

```matlab
function dydv = derivatives(t,yv)
m = 10; % mass in Kg
k = .1; % spring constant
y = yv(1);
v = yv(2);
dydv = [v; -(k/m)*y];
```

Which choice below will correctly solve the differential equation with `ode45`, using the following initial condition: $y(0) = -0.05$ (in meters) and $v(0) = 0$, over the time interval from zero to 100 seconds?

(a) $[t,yv] = \text{ode45}(@\text{derivatives},[0, 100],[0.05; 0])$;

(b) $[t,yv] = \text{derivatives}(@\text{ode45},[0, 100],[0; -0.05])$;

(c) $[t,yv] = \text{derivatives}(@\text{ode45},[0; -0.05],[0, 100])$;

(d) $[t,yv] = \text{ode45}(@\text{derivatives},[0, 100],[0; -0.05])$;
Extra Credit

Answering the question below correctly will add points to your exam total. Answering incorrectly or not answering will not add points to your exam total.

26. Given the function named \( f \) has the following code saved in the file named \( f.m \),

\[
\text{function } x = f(y) \\
\quad x = 2.\times y + 3;
\]

What is the output the following command produces when typed at the Matlab prompt?

\[
\text{>> y = f(fzero(@f, 2))} \\
\text{y = } \text{????}
\]

(a) \( y = 7 \)
(b) \( y = 3 \)
(c) \( y = 0 \)
(d) \( y = -0.5 \)