Name: _________________________________________________
(Legibly print last name, first name, middle name)

NetID: _________

Statement of integrity:
I did not, and will not, violate the rules of academic integrity
on this exam.

________________________________________ (Signature)

Circle your lecture time: 9:05 or 11:15

Circle your section instructor’s name:

<table>
<thead>
<tr>
<th>Tuesday</th>
<th>Wednesday</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:10</td>
<td>Utkarsh Prateek</td>
</tr>
<tr>
<td>11:15</td>
<td>Tim Condon</td>
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<tr>
<td>12:20</td>
<td>Stefan Ragnarsson</td>
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<td>1:25</td>
<td>Stefan Ragnarsson</td>
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<td>2:30</td>
<td>Josef Broder</td>
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<td>3:35</td>
<td>Josef Broder</td>
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<td>7:30</td>
<td>Vivek Maharajh</td>
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<td>8:35</td>
<td>Vivek Maharajh</td>
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Instructions:
- 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.
- Raise your hand if you have any questions.
- Use the backs of pages or ask for additional sheets of paper as necessary.
- Clarity, conciseness, and good programming style count for credit.
- If you supply multiple answers, we will grade only one.
- Use only MATLAB code. No credit for code written in other programming languages.
- Assume there will be no input errors.
- **Do not use arrays. Do not write user-defined functions.**
- Do not use `switch`, `try`, `catch`, or `break` statements.
- You may find the following MATLAB predefined functions useful:
  - `abs`, `sqrt`, `rem`, `rand`, `floor`, `ceil`, `input`, `fprintf`, `disp`

Examples:
- `rem(5,2) → 1`, the remainder of 5 divided by 2
- `rand(1) → a random real value in the interval (0,1)`
- `floor(6.9), floor(6) → 6`, rounds down to the nearest integer
- `ceil(8.1), ceil(9) → 9`, rounds up to the nearest integer
Question 1: (20 points)

Part (a): (12 points)
Suppose the following fragment has been executed:

```matlab
% The first interval [a1,b1] has these endpoints:
a1 = rand(1); b1 = a1+rand(1);
% The second interval [a2,b2] has these endpoints:
a2 = rand(1); b2 = a2+rand(1);
% Assume a1, b1, a2, and b2 are unique.
```

(i) Complete the following fragment so that it prints ‘Yes’ if the second interval is inside the first interval and ‘No’ otherwise.

```matlab
if _________________________________________________
    disp('Yes')
else
    disp('No')
end
```

(ii) Complete the following fragment so that it prints ‘No’ if the the intervals fail to intersect and ‘Yes’ otherwise.

```matlab
if _________________________________________________
    disp('No')
else
    disp('Yes')
end
```

Part (b): (8 points)
Write the loop condition below so that the fragment keeps prompting the user to enter a number until the value entered is positive and is a multiple of 3 or 5.

```matlab
n = input('Enter a number: ');
while _________________________________________________
    n = input('Enter a number: ');
end
```
Question 2: (10 points)

Part (a): (3 points)
What is the last line of output after executing the following fragment?

```plaintext
x = 2;
y = x*3;
while x<=6 && y<=6
    x = x + 2;
    disp(x)
end
```

**Answer:**

Part (b): (7 points)
The following fragment calculates and displays the first few Fibonacci numbers. When the fragment finishes execution, which Fibonacci numbers are stored in variables `f_old`, `f_cur`, and `f_new`? You can, but don’t have to, evaluate the Fibonacci numbers. For example, you can write $f_4$ instead of its value 3.

```plaintext
n = 2;
f_old = 1  % f(1)
f_cur = 1  % f(2)
for n = 3:5
    f_new = f_old + f_cur
    f_old = f_cur;
    f_cur = f_new;
end
```

<table>
<thead>
<tr>
<th>$f_{old}$:</th>
<th>$f_{cur}$:</th>
<th>$f_{new}$:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>
Question 3: (20 points)

A certain bacteria has a growth rate that is dependent on the ambient temperature. At or below 32°F, there is no growth. Above 32°F the growth rate follows the formula

\[ aT^2 + b \]

where \( T \) is ambient temperature in °F, and \( a = 0.01 \) and \( b = -10 \) are model parameters. When the temperature is very high, above 90°F, the rate estimated by the above formula must be corrected by a reduction of 10%.

Complete the fragment below to compute and display the growth rate.

```matlab
T = input('What is the temperature? ');

% Calculate and display the growth rate of the bacteria
```
Question 4: (20 points)

A unit hexagon centered at \((a, b)\) has vertices

\[
\begin{align*}
P_1 & : (a + \Delta_x, b + \Delta_y) \\
P_2 & : (a - \Delta_x, b + \Delta_y) \\
P_3 & : (a - 1, b) \\
P_4 & : (a - \Delta_x, b - \Delta_y) \\
P_5 & : (a + \Delta_x, b - \Delta_y) \\
P_6 & : (a + 1, b)
\end{align*}
\]

where \(\Delta_x = 1/2\) and \(\Delta_y = \sqrt{3}/2\). Assume that the function \texttt{DrawHex(a,b)} adds to the figure window a unit hexagon with center at \((a, b)\).

We say that a unit hexagon is “good” if it is entirely inside a square with vertices \((0,0)\), \((10,0)\), \((10,10)\), and \((0,10)\). Write a program fragment to randomly choose points from a square with vertices \((0,0)\), \((10,0)\), \((10,10)\), and \((0,10)\)—each coordinate is uniformly random in the interval \((0,10)\). Whenever there is a point that can be the center of a good hexagon, draw the hexagon. Your fragment should draw exactly 100 good hexagons. Do not write code to set up the figure window and axes.
Question 5: (30 points)

A unit hexagon has six unit hexagon neighbors with these centers:

$$
\begin{align*}
H_1 &: (a + 3\Delta_x, b + \Delta_y) \\
H_2 &: (a, b + 2\Delta_y) \\
H_3 &: (a - 3\Delta_x, b + \Delta_y) \\
H_4 &: (a - 3\Delta_x, b - \Delta_y) \\
H_5 &: (a, b - 2\Delta_y) \\
H_6 &: (a + 3\Delta_x, b - \Delta_y)
\end{align*}
$$

where $\Delta_x = 1/2$ and $\Delta_y = \sqrt{3}/2$. Assume that the function `DrawHex(a, b)` adds to the figure window a unit hexagon with center at $(a, b)$.

Complete the fragment below to draw $K$ columns of a “slanted” bee hive. Each column is made up of $n$ unit hexagons. Center the top left hexagon on the origin $(0,0)$. An example with 5 hexagons in each of 3 columns is shown below. Do not write code to set up the figure window and axes.

```matlab
n = input('How many hexagons in each column? ');
K = input('How many columns? ');

% Draw a slanted bee hive with n hexagons in each
% of K columns
```

![Diagram of a slanted bee hive with 5 hexagons in each of 3 columns]