Question 1: (20 points)

Part (a): (12 points)

Suppose the following fragment has been executed:

```
% 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.

```
if __________________  a1<a2 && b2<b1
    disp('Yes')
else
    disp('No')
end
```

Picture: —[a1—[a2—b2]—b1]—

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

```
if ___________________  b2<a1 || b1<a2
    disp('No')
else
    disp('Yes')
end
```

Non-intersecting scenario 1: —[a1—b1]—[a2—b2]—
Non-intersecting scenario 2: —[a2—b2]—[a1—b1]—

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.

```
n = input('Enter a number: ');
while  ______________________________
   n = input('Enter a number: ');

end
```

Solution:

```
    n<=0 ||  rem(n,3)~=0 && rem(n,5)~=0
 ~ ( n>0 && (rem(n,3)==0 || rem(n,5)==0) )   % Parentheses necessary since && has
                                             %  higher precedence than ||, but
                                             %  don't take points off this time
```

Question 2: (10 points)

Part (a): (3 points)

What is the last line of output after executing the following fragment?

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

Answer: **8**

Part (b): (7 points)

The following fragment calculates and displays the first few Fibonacci numbers. When the fragment finishes execution, which Fibonacci nubmers 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.

```
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
```

`f_old`: **3**, f_4	`f_cur`: **5**, f_5	`f_new`: **5**, f_5

Note: Need 2 out of 3 correct to get partial credit

Question 3: (20 points)

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

$$aT^2 + b$$

where T is ambient temperature in ^{o}F, and $a = 0.01$ and $b = -10$ are model parameters. When the temperature is very high, above 90^{o}F, the rate estimated by the above formula must be corrected by a reduction of 10%.

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

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

% Calculate and display the growth rate of the bacteria



  a = 0.01;   % model parameter, ok if student doesn't name this
  b = -10;    % model parameter, ok if student doesn't name this

  if T <= 32

      rate = 0;
  else

      rate = a*T^2 + b;
  end

  % Correct rate if necessary
  if (T > 90)

      rate = rate*0.9;
  end

  fprintf('BAX has growth rate %f\n', rate)
  % Any print format is ok
```

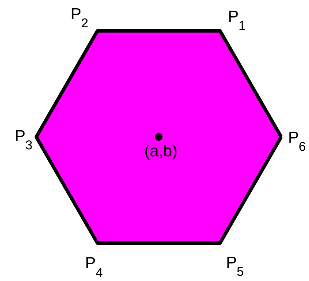
Do not write redundant (or useless) if or else branches; we took off points. See examples below.

```
a= 0;
if x<y
   a= rand(1);  % OK
elseif x==z
   a= a;        % BAD
else
                % BAD
end
```

Question 4: (20 points)

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

$$\begin{aligned} P_1 &: (a+\Delta_x, b+\Delta_y) \\ P_2 &: (a-\Delta_x, b+\Delta_y) \\ P_3 &: (a-1, b) \\ P_4 &: (a-\Delta_x, b-\Delta_y) \\ P_5 &: (a+\Delta_x, b-\Delta_y) \\ P_6 &: (a+1, b) \end{aligned}$$



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).

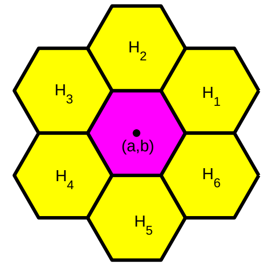
We say that a unit hexagon is "good" if it is entirely inside a square with vertices (0,0), (10,0), (10,10), and (0,10). Write a program fragment to randomly choose points from a square with vertices (0,0), (10,0), (10,10), and (0,10)—each coordinate is uniformly random in the interval (0,10). Whenever 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.

```
deltaY = sqrt(3)/2;  % OK if student doesn't name a constant

k = 0;
while  k < 100

    % Draw the k-th good hexagon
    a = 10*rand(1);
    b = 10*rand(1);

    if   0<=a-1 && a+1<=10 && 0<=b-deltaY && b+deltaY<=10
          % < instead of <= is OK;  check a, b separately OK

        DrawHex(a,b)
        k = k+1;
    end
end


% An alternate solution %%%%%%%%%%%%%%%%%%%%%%
for k = 1:100
    a = 10*rand(1);
    b = 10*rand(1);
    while a<1 || a>9 || b<deltaY || b>10-deltaY
        a = 10*rand(1);
        b = 10*rand(1);
    end   % Check a and b separately OK
    DrawHex(a,b)
end
```

Question 5: (30 points)

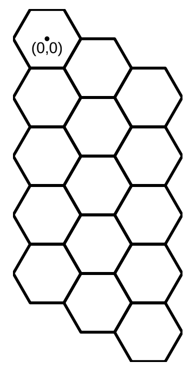
A unit hexagon has six unit hexagon neighbors with these centers

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



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.




```
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

% OK if student doesn't name these constants
xdist = 3/2;  % x-dist btw hex ctrs in adjacent cols
ydist = sqrt(3);  % y-dist btw hex ctrs in a column
deltaY = sqrt(3)/2;

for c = 1:K
    % In column c...
    x = (c-1)*xdist;
    yOffset= -(c-1)*deltaY;
    for r = 1:n
        % The rth hexagon...
        y = yOffset - (r-1)*ydist;
        DrawHex(x,y)
    end
end


% An alternate solution %%%%%%%%%%%%%%%%%%%%%%%%%

nShift = 0;  % How many deltaY's to shift down
for x = 0 : xdist : (K-1)*xdist
    ystart = nShift*deltaY;
    for y = ystart : -ydist : ystart-(n-1)*ydist
        DrawHex(x,y)
    end
    nShift = nShift-1;
end
```