

# MAT 1630 Midterm Exam

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## Problem 1

Write a while loop that prints all positive numbers that are divisible by 3 and 4, and are less than  $n$ . For example, take  $n = 112$ .

## Solution 1:

First I set  $n$  to 112 and our counter,  $i$ , to 1. Then I ran the while loop and ran the counter from 1 to whatever  $n$  is set to. If ' $i$ ' divided by 3 and ' $i$ ' divided by 4 don't have any remainder, then I have asked the program to print out those values while increasing 1 by 1 until it reaches the  $n$  value

```
1  n = 112
2  i = 1
3
4  while i < n:
5      if i % 3 == 0 and i % 4 == 0:
6          print(i)
7      i += 1
```

12  
24  
36  
48  
60  
72  
84  
96  
108

## Problem 2

Write a Python function `div(n)` that takes a positive integer `n` and returns the list of divisors of `n`. Use a list comprehension to implement the Python function. Apply your function to `n = 1111`. **Hint:** Your function should only be one line long.

### Solution 2:

First I created the function `div` that takes in integer `n`. I then created a list comprehension asking to return any `n` in range 1 to `n` that is divisible by 11. Then I ran 1111 on the `div` function.

```
1 def div(n):
2     return [i for i in range(1, n+1) if n % i == 0]
3
4 div(1111)
```

```
[1, 11, 101, 1111]
```

## Problem 3

Based on the list `names = ["Washington", "Adams", "Jefferson", "Madison", "Lincoln", "Grant"]`, use a list comprehension to extract a list named `result` with the names containing the letter "n".

### Solution 3:

First I initialized the `names` list. Then the list comprehension cycles through the words ("w") in the `names` list to see if any words ("w") contain the letter 'n' and return them.

```
1 names = ["Washington", "Adams", "Jefferson", "Madison", "Lincoln", "Grant"]
2
3 [w for w in names if 'n' in w]
```

```
['Washington', 'Jefferson', 'Madison', 'Lincoln', 'Grant']
```

#### Problem 4

Let  $a_1 = 1$  and  $a_n = 3a_{n-1} - 1$  for  $n \geq 1$ . Define a Python function `a(n)` recursively, and compute  $a_8$ . You can use either a classical or inline if-else statement.

#### Solution 4:

First I create the function `a` and request the input `n`. Since  $a_1 = 1$ , we know that if  $n \leq 1$ , we should only return 1. For anything larger, we need to recursively cycle through  $3*a(n-1)-1$ .

```
1 def a(n):
2     return 1 if n <= 1 else 3*a(n-1)-1
3
4 a(8)
```

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#### Problem 5

Plot the graph of the **logistic** function  $f(x)$  on the interval  $[0, 250]$ :

$$f(x) = \frac{L}{1 + ce^{-kx}}$$

with the following parameter values  $L = 175$ ,  $c = 40$ ,  $k = 0.05$ . Use 300 plotting points.

- Using the plotted graph, can you find the value of  $\lim_{x \rightarrow \infty} f(x)$ ?

#### Solution 5:

First i imported the proper packages, in this case `matplotlib.pyplot` as `plt` and `numpy` as `np`. Then I initialize the variables given in the equation. I use `np.linspace` to create the x axis with 300 plotting points. I also need `np.exp` to create the exponent in the variable `y`.

Then i create my plot using `x` and `y`, and some stylistic techniques to add labels, a title and a grid.

Finally i show the graph, which displays that the limit as `x` approaches infinity is **175**.

```
1 import matplotlib.pyplot as plt
2 import numpy as np
3
```

```

4  L = 175
5  c = 40
6  k = 0.05
7  x = np.linspace(0,250,300)
8  y = (L) / (1 + c*np.exp(-k*x))
9
10 plt.plot(x,y)
11 plt.ylabel('L')
12 plt.xlabel('X Axis')
13 plt.title('Question 5: Logistics')
14 plt.grid()
15 plt.show()

```

