

### Task 1 (10 points)

```
def factorial(n):  
    result = 1  
    for i in range(2, (n+1)):  
        result = result * i;  
  
    return result
```

Consider the `factorial` function above, implemented in Python. What is the time complexity of this function, in  $\Theta$  notation?

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### Task 2 (10 points)

Re-implement (in Python or Matlab) the factorial function of Task 1 so that it uses a recursive function call instead of using any loops (like while loops and for loops). Do not call any built-in or library functions for computing the factorial. You do NOT need to do any error-checking (like checking if the input argument is negative).

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### Task 3 (10 points)

```
def foo(n):  
    result = 0  
    for i in range(1, n+1):  
        for j in range(1, i+1):  
            result = result + 1  
    return result
```

Consider the `foo` function above, implemented in Python. What is the time complexity of this function, in  $\Theta$  notation?

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### Task 4 (10 points)

Consider matrices A and B defined as:

$$A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}, \quad B = \begin{pmatrix} e \\ f \end{pmatrix}$$

What is the result of matrix multiplication  $A*B$ ? Specify the values at all positions of the result matrix.

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**Task 5 (30 points)**

Consider function  $f(x) = 3x^2 + 5x - 7$ .

**Part a:** What is the first derivative  $f'(x)$ ? Provide a specific formula as a function of  $x$ .

**Part b:** What is  $f'(5)$ ? Your answer should be a real number.

**Part c:** What is the second derivative  $f''(x)$ ? Provide a specific formula as a function of  $x$ .

**Part d:** What is  $f''(5)$ ? Your answer should be a real number.

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**Task 6 (30 points)**

In this task, we denote by  $P(x)$  the probability of event  $x$ .  $A$  and  $B$  are two events that are independent of each other.  $P(A) = 0.3$  and  $P(B) = 0.6$ .

Compute the following quantities:

- $P(A \text{ and } B)$ .
  - $P(A \text{ or } B)$ .
  - $P(\text{not}(A))$ .
  - $P(A | B)$  (i.e., the conditional probability of  $A$  given  $B$ ).
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