

Problem 1. (10 points):

Consider the source code below, where M and N are constants declared with #define.

```
int mat1[M][N];
int mat2[N][M];

int sum_element(int i, int j)
{
    return mat2[i][j] += mat1[j][i];
}
```

A. Suppose the above code generates the following assembly code:

```
sum_element:
1      movslq    %edi, %rdi
2      movslq    %esi, %rsi
3      leaq      0(,%rdi,8), %rax
4      subq      %rdi, %rax
5      leaq      (%rdi,%rax,4), %rdx
6      leaq      (%rsi,%rsi,8), %rax
7      leaq      (%rsi,%rax,2), %rax
8      addq      %rsi, %rdx
9      leaq      (%rax,%rdi), %rdi
10     movl      mat2(,%rdx,4), %eax
11     addl      mat1(,%rdi,4), %eax
12     movl      %eax, mat2(,%rdx,4)
      ret
```

Handwritten notes for assembly code:

- Line 1: $\text{return} = 8i$
- Line 2: $\text{return} = \text{return} - j$ (ret = 7i)
- Line 3: $\text{rdx} = i + 4 \cdot \text{ret}$
- Line 4: $\text{ret} = j + (8j)$
- Line 5: $\text{ret} = (j + 2 \cdot \text{ret})$
- Line 6: $\text{rdx} = \text{rdx} + j$
- Line 7: $i = (\text{ret} + j)$
- Line 8: $\text{ret}[30] = \text{mat2} + (4i)$
- Line 9: $\text{ret}[30] = \text{ret}[30] + \text{mat1} + 4i$
- Line 10: $\text{mat2} + 4(\text{rdx}) = \text{ret}[30]$

Handwritten notes for assembly code:

- Line 1: $\text{rdi} = i$, $\text{rsi} = j$
- Line 2: i
- Line 3: j
- Line 4: $8i$
- Line 5: $7i$
- Line 6: $i + 4(7i)$
- Line 7: $4j$
- Line 8: $2(4j) + j$
- Line 9: $i + 4(7i) + j$
- Line 10: $2(4j) + j + i$
- Line 11: $19j + i$
- Line 12: $29j + j$

What are the values of M and N?

M = 19

N = 29

$$\text{mat2}[i][j] = 29j + j$$

$$\text{mat1}[j][i] = 19j + i$$

$$j = 29$$

$$i = 19$$