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**BIOMED 201 - Programming & Modeling for BME**

Midterm Exam, 2012.05.08, Instructor: Ahmet Sacan

Sign the honor code below. **No credit will be given for the exam without a signed pledge.**

*I have neither given nor received aid on this examination.*  
Signed: \_\_\_\_\_

There are 9 questions in this exam. **Turn in Questions 1-7 before you start working on Questions 8-9.** Submit your programs for Questions 8-9 on ProgrammingBank, in addition to turning in your paper exam. Sign off your submission before exiting the room.

**Q1 (5 pts).** *Indexing.* Let **A** be a square matrix with at least 3 rows. Write a single statement that will assign into **B**, the 6 elements located in the first two rows and last 3 columns of **A**. After your statement executes, **B** should become a 2x3 matrix. Do not use loops.

```
B = A ( 1:2, end-2:end)
```

**Q2 (5 pts).** *Linear Indexing.* If matrix **M** has 5 rows and 8 columns, **M(4,3)** can equivalently be expressed as **M(x)**. What is the value of **x**?

```
14
```

**Q3 (5 pts).** *Creating vectors.* Use colon operator “:” to create a vector **X** that has values [15 10 5 0 -5 -10]. Create another vector **Y** that has the same values, using the linspace function.

```
X = 15:-5:-10  
Y = linspace ( 15,-10,6 )
```

**Q4 (5 pts).** *Logical Indexing.* Let **X**, **Y**, and **Z** be numerical column vectors, each with **N** elements and let  $X_i$  denote the  $i^{\text{th}}$  element of **X**. First construct a logical vector **I** that also has **N** elements and where  $I_i$  is **true** when  $X_i * Y_i = Z_i$  and  $X_i \leq Y_i$ ; and **false** otherwise. Next, construct a matrix **M** that has 3 columns and contains in each column only those elements of X, Y, Z for which  $I_i$  is true.

```
I = (X .* Y == Z) & (X <= Y)
M = [ X(I) Y(I) Z(I) ];
```

**Q5 (10 pts).** *Variable scope.* The function apple is as given below. Fill in the blanks in the output.

```
>> x = 5; y = 6;
>> y = apple( x );
>> a = 2; b = 3;
>> b = apple (a);

>> fprintf('x=%d y=%d a=%d b=%d\n', x,y,a,b);

x=5 y=20 a=2 b=8
```

```
function y = apple( x )
x = x * 2;
y = x * 2;
```

**Q6 (10 pts).** *Nested for loops.* Fill in the blanks in the output below.

```
>> x = zeros(2,0);
>> for a = [ 1 2 3 ]
>>     for b = [ 4 5 ]
>>         x(:,end+1) = [ a b ];
>>     end
>> end
>> disp ( x )
1 1 2 2 3 3
4 5 4 5 4 5
```

**Q7 (5 pts).** *Operator precedence.* Fill in the blanks in the output below.

```
>> x=0;
>> disp(-3 <= x <= 3 )

1
```

```
>> disp( 'e'=='d' + 1 )

1
```

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**Q8 (5 pts).** *Binary and hexadecimal numbers.* In the first box below, write down the binary representation of the decimal number **35**. In the second box, write down the decimal value of the number given in hexadecimal notation.

|               |              |
|---------------|--------------|
| $35 = 100011$ | $0xF3 = 243$ |
|---------------|--------------|

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*I have neither given nor received aid on this examination.*

*Time of submission:* \_\_\_\_\_

*Signed:* \_\_\_\_\_

**Q8 (25 pts).** *Selection statements, loops or vectorized code.* A magic square is defined as a square matrix with  $n$  rows, containing numbers from 1 to  $n^2$ , and whose rows and columns sum up to the same number. Write a function **ismagic(M)** that takes a matrix **M** as input and returns true only if **M** is a magic square. Hints: sum, unique.

```
>> ismagic( [8 1 6; 3 5 7; 4 9 2] )
ans =
     1

>> ismagic( [2 2; 2 2] )
ans =
     0

>> ismagic( [8 1 6; 3 5 7] )
ans =
     0
```

**Q9 (25 pts).** *Loops or vectorized code.* Write a function **eulernumber(n)** that takes a positive number **n** and calculates an approximation to mathematical constant  $e$ , the base of the natural logarithm, using the following formula. Hints: sum, factorial.

$$e \approx 1 + \frac{1}{1} + \frac{1}{1 * 2} + \frac{1}{1 * 2 * 3} + \frac{1}{1 * 2 * 3 * 4} + \dots + \frac{1}{1 * 2 * \dots * n}$$

```
>> disp( eulernumber(2) )
     2.5000
>> disp( eulernumber(4) )
     2.7083
```