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ME-2850 SP-16 MIDTERM 1

This is an open books (MATLAB book, Numerical Methods book), closed notes examination

1-22  
2-22  
3-22  
4 9  
75  
78

1. The following is a MATLAB program in a script file:

```
A=[4 -2 4 3 1; 2 5 2 -2 3; -1 -2 1 4 -5; 3 3 5 2 4]
[r, c]=size(A); [4, 5]
for j=1:c
    M(j)=A(1,j);
    for i=2:r
        M(j)=M(j)+A(i,j);
    end
end
M
```

$$\begin{bmatrix} 4 & -2 & 4 & 3 & 1 \\ 2 & 5 & 2 & -2 & 3 \\ -1 & -2 & 1 & 4 & -5 \\ 3 & 3 & 5 & 2 & 4 \end{bmatrix}$$

What is displayed in the Command Window when the program is executed?

•  $j=1$   
 $M(1) = A(1,1) = 4$   
 $i=2$   
 $M(1) = 4 + A(2,1) = 4 + 2 = 6$   
 $i=3$   
 $M(1) = 6 + A(3,1) = 6 + (-1) = 5$   
 $i=4$   
 $M(1) = 5 + A(4,1) = 5 + 3 = 8$

•  $j=2$   
 $M(2) = A(1,2) = -2$   
 $i=2$   
 $M(2) = -2 + A(2,2) = -2 + 5 = 3$   
 $i=3$   
 $M(2) = 3 + A(3,2) = 3 + (-2) = 1$   
 $i=4$   
 $M(2) = 1 + A(4,2) = 1 + 3 = 4$

•  $j=3$   
 $M(3) = A(1,3) = 4$   
 $i=2$   
 $M(3) = 4 + A(2,3) = 4 + 2 = 6$   
 $i=3$   
 $M(3) = 6 + A(3,3) = 6 + (-2) = 4$

$i=4$   
 $M(3) = 4 + A(4,3) = 4 + 5 = 9$

•  $j=4$   
 $M(4) = A(1,4) = 3$   
 $i=2$   
 $M(4) = 3 + A(2,4) = 3 + (-2) = 1$   
 $i=3$   
 $M(4) = 1 + A(3,4) = 1 + 4 = 5$   
 $i=4$   
 $M(4) = 5 + A(4,4) = 5 + 2 = 7$

•  $j=5$   
 $M(5) = A(1,5) = 1$   
 $i=2$   
 $M(5) = 1 + A(2,5) = 1 + 3 = 4$   
 $i=3$   
 $M(5) = 4 + A(3,5) = 4 + (-5) = -1$   
 $i=4$   
 $M(5) = -1 + A(4,5) = -1 + 4 = 3$

M =

8 4 12 7 3

2. The following are two user-defined MATLAB functions.

```
function [D, T] = BtoDandT(b)
n=length(b); % 5
D=0;
for i=1:n
    D=D+b(i)*2^(n-i);
end
Dc=D; % 29
for j=1:4
    T(j)=0;
    p=3^(4-j);
    if 2*p <= D
        T(j)=2;
        D=D-2*p;
    end
    if p <= D
        T(j)=1;
        D=D-p;
    end
end
end
```

```
i=1, D=0
D = D + b(1) * 2^(5-1)
D = 0 + 1 * 2^4 = 16
i=2
D = 16 + b(2) * 2^(5-2)
D = 16 + 1 * 2^3 = 24
i=3
D = 24 + b(3) * 2^(5-3)
D = 24 + 1 * 2^2 = 28
i=4
D = 28 + b(4) * 2^(5-4)
D = 28 + 0 = 28
i=5
D = 28 + b(5) * 2^(5-5)
D = 28 + 1 * 2^0 = 29
```

What is displayed in the Command Window when the following commands are entered?

```
>> W=[1 1 1 0 1];
>> [R, S] = BtoDandT(W)
```

```
i=1
T(1)=0
P=3^(4-1)
P=3^3
P=27
• IF 2*27 <= 29 X
• IF 27 <= 29 ✓
✓ T(1)=1
D=29-27
D=2

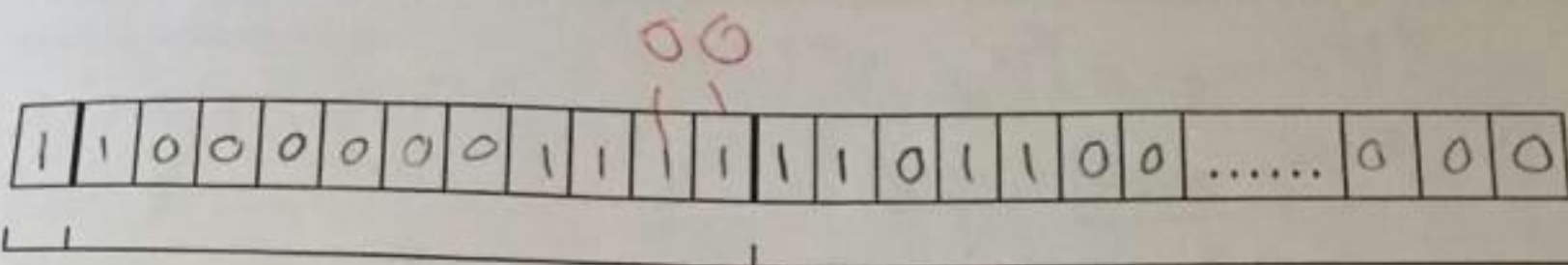
• j=2
✓ T(2)=0
P=3^(4-2)
P=3^2
P=9
• IF 2*9 <= 2 X
• IF 9 <= 2 X

• j=3
✓ T(3)=0
P=3^(4-3)
P=3
```

```
• IF 2*3 <= 2 X
• IF 3 <= 2 X
• j=4
T(4)=0
P=3^(4-4)
P=1
• IF 2*1 <= 2 ✓
✓ T(4)=2
D=2-2*1
D=0
• IF 1 <= 0 X
```

S = 2 22  
 S = 1 0 0 2

3. Write the number 15,104 in the form of 64-bit double-precision string. (follow the IEEE-754 standard)



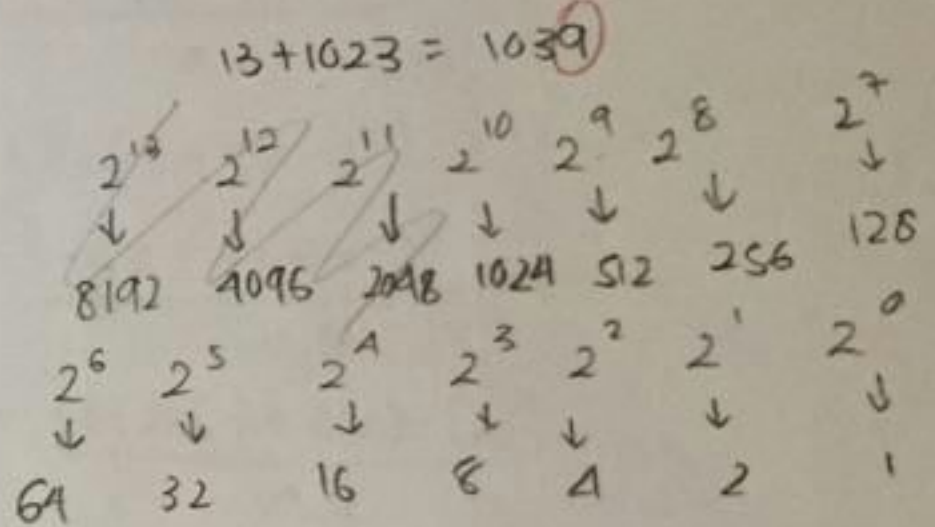
Sign  
1 bit

Exponent 11 bits

Mantissa 52 bits

$$\frac{15,104}{2^{13}} \cdot 2^{13} = 1.84375$$

MANTISSA → 0.84375 × 2 → 1.6875 → 1  
 0.6875 × 2 → 1.375 → 1  
 0.375 × 2 → 0.75 → 0  
 0.75 × 2 → 1.5 → 1  
 0.5 × 2 → 1 → 1



10000001111

22

0

4. The function  $f(x) = 0.2x^3 + x^2 - 3x - 3$  has a root between  $x = 2$  and  $x = 3$ . Determine the root using the fixed-point iteration method. Start the iterations with  $x = 3$  and carry out the first three iterations.

case 1  $\frac{0.2x^3 + x^2 - 3}{3} = x$   $x' = \frac{3(0.6x^2 + 2x)}{9}$

\* case 2  $x = (-0.2x^3 + 3x + 3)^{1/2}$   $x' = \frac{-0.6x^2 + 3}{2\sqrt{-0.2x^3 + 3x + 3}}$

$f'(2) = 2.133$

$f'(3) = 3.8$

$f'(2) = \frac{.6}{5.44} = 0.11028$

$f'(3) = \frac{-2.4}{5.138} = -0.467$

$|f'(2)| < 1$   $|f'(3)| < 1$

using case 2:

①  $x_2 = \sqrt{-0.2(3)^3 + 3(3) + 3} = 2.569$

②  $x_3 = \sqrt{-0.2(2.569)^3 + 3(2.569) + 3} = 2.7048$

③  $x_4 = \sqrt{-0.2(2.7048)^3 + 3(2.7048) + 3} = 2.6752$

case 3  $\left(\frac{-x^2 + 3x + 3}{0.2}\right)^{1/3} = x$   $x' = \frac{1}{3} \left(\frac{-x^2 + 3x + 3}{0.2}\right)^{-2/3} \left(\frac{0.2(-2x + 3)}{0.04}\right)$   
0.01874

$f'(2) = -0.2262$

$f'(3) = -0.2811$

$|f'(2)| < 1$

$|f'(3)| < 1$

using case 3 ✓

①  $x_2 = \left(\frac{-3^2 + 3(3) + 3}{0.2}\right)^{1/3} = 2.466$

②  $x_3 = 2.784$

③  $x_4 = 2.6209$

using case 3 converges to an answer. using case 3 is my answer and the third iteration gives  $x_4 = 2.6209$