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EE 105

Lab1

3.) Matrices and Arrays

```
%create vector, A.
A = [sqrt(2); 1; exp(pi)];
%create vector, B.
B = [3; 5; 7];

%Matrix multiplication
C= transpose(A) *B
C;
```

Fig1: Terminal Output

```
C =

  171.2275
```

5.) Scripts

```
% a.) clear memory
clear

% b.) defines matrixes
A = [sqrt(2); 1; exp(pi)];
B = [3; 5; 7];

C= transpose(A)*B
C;

% c.) for loop
D=0;
for i = 1:3
    D = D + A(i)*B(i)
end
D;
```

Fig2: Terminal Output

```
D =

  171.2275
```

6.) More advanced Scripts

i.) Code: “function1.m”

```
function y = f(x)

    y = cos(x) ./ (1 + exp(3 .* x));
end
```

ii.) Fig3: N = 200.

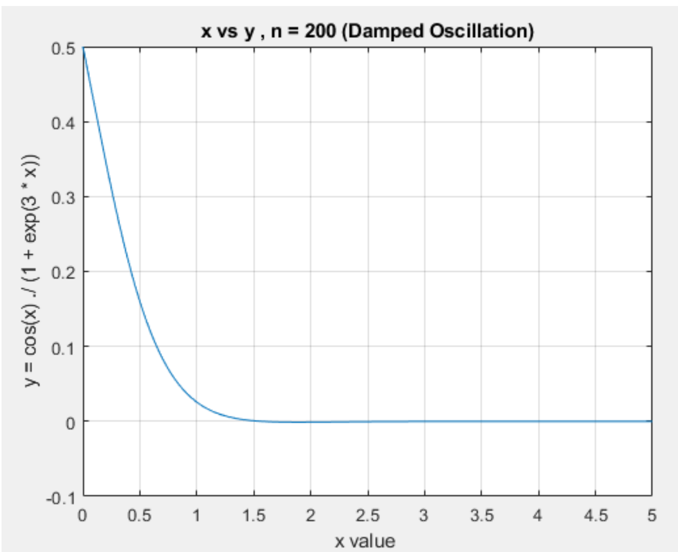


Fig4: N = 10

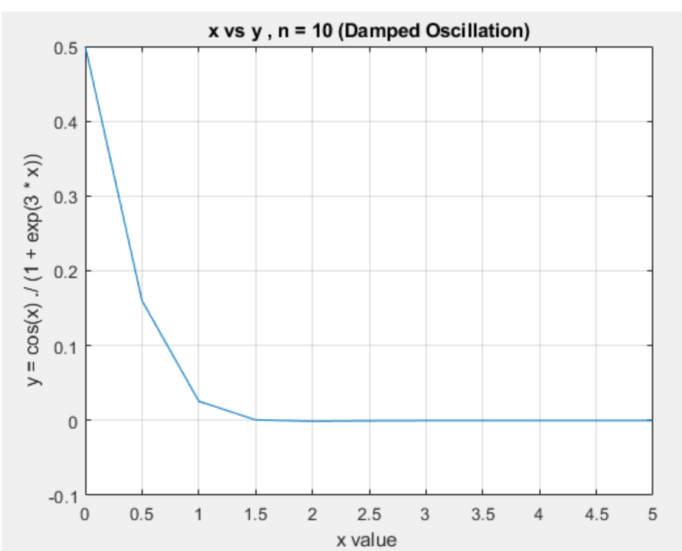
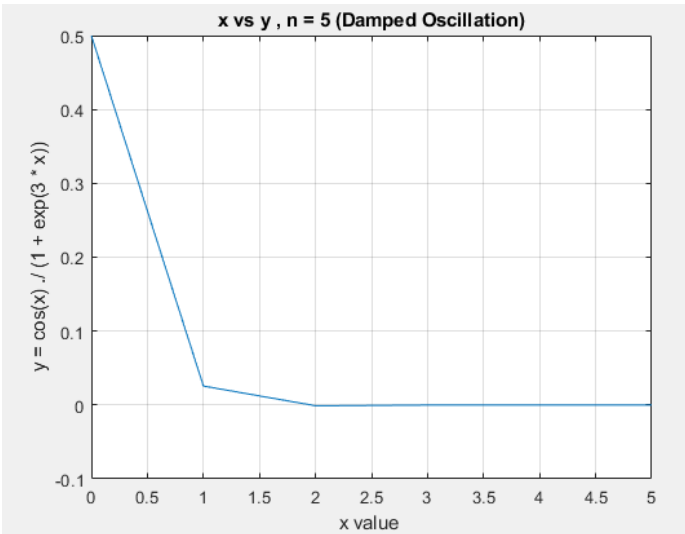


Fig5: N = 5.



Code: “function1.m”

```
clear;
N = 200;
% dx = 5 / N;
x = linspace(0, 5, N + 1);
y = function1(x);


plot(x, y);
grid on;

xlabel('x value ');
ylabel('y = cos(x) ./ (1 + exp(3 * x))');

title(['x vs y , n = ',  num2str(N), ' (Damped Oscillation)']);
```

7.)

a.)

```
area = quad(@function1,0,5);

disp(area);
```

Fig6: area

```
>> integral
    0.2013
```

b.) i.)

```
N=25;
dx = 5/N;
x = dx:dx:5;
y = function1(x);

bar(x-dx/2, y, 1, 'green');
xlabel('Input x');
ylabel('function1');
title(['N = ', num2str(N), ' dx = ', num2str(dx)]);
hold on;
x1= 0:1/1000:5;
y1= function1(x1);
plot(x1,y1,'blue');
```

Fig7: N = 10 (large dx)

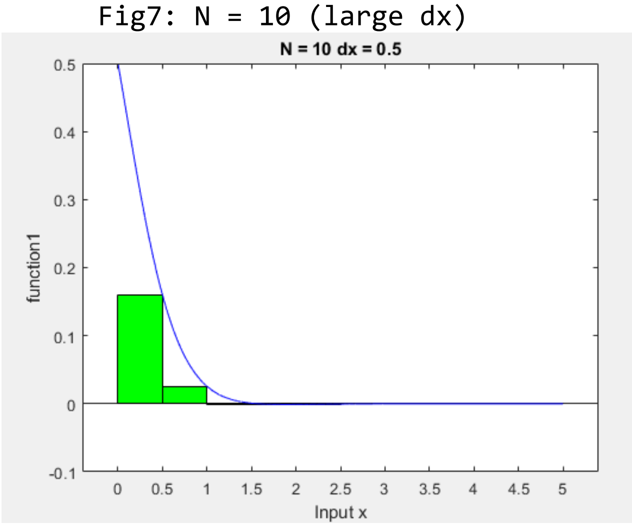


Fig8: N = 25

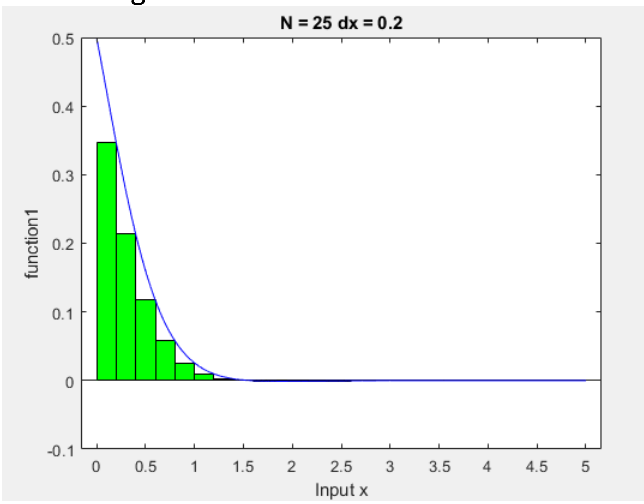
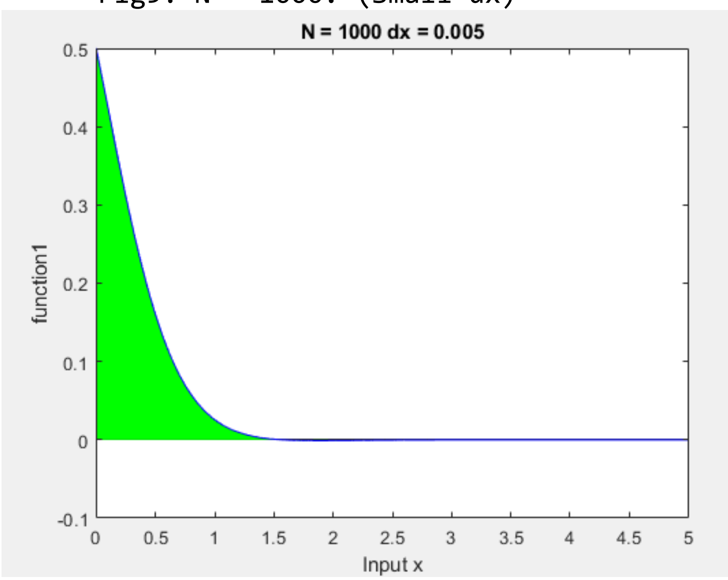


Fig9: N = 1000. (Small dx)



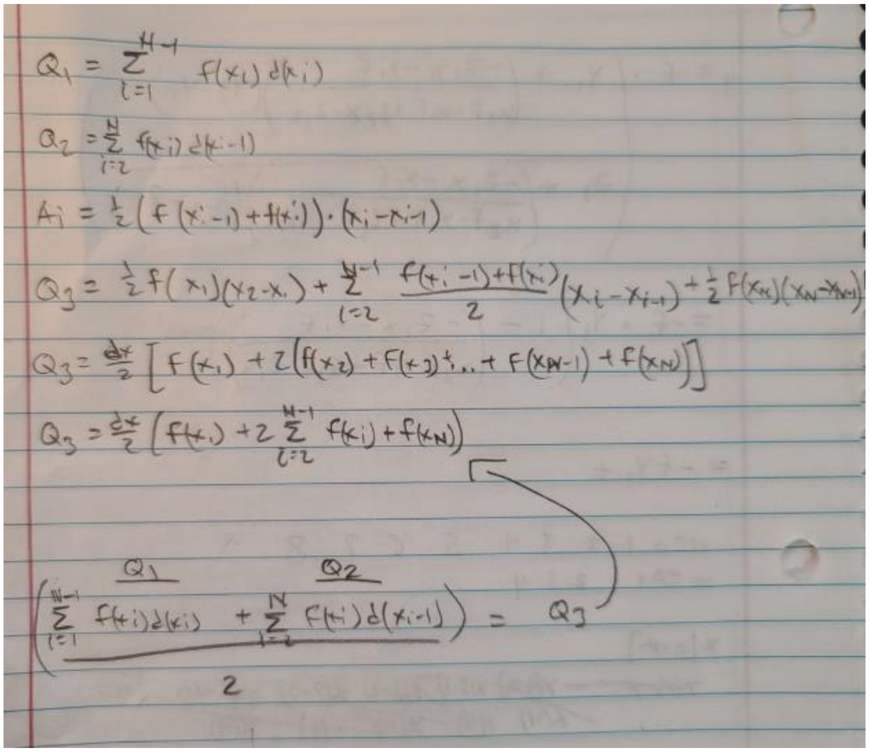
Explanation: Large dx divides the area under the curve into too few rectangles, and thus, leads to an inaccurate approximation of an integral of a curve.

ii.)

The trade offs between dx to accuracy is that when dx gets smaller, there are more computations, but the calculation is more accurate as you are taking more measurements. Smaller differential distance, dx, the more measurements are taken, and the calculated area under the curve better represents the actual area.

iii.)

A.) Fig10: Q3 derivation



$$Q_1 = \sum_{i=1}^{N-1} f(x_i)\, d(x_i)$$

$$Q_2 = \sum_{i=2}^{N} f(x_i)\, d(x_{i-1})$$

$$A_i = \frac{1}{2}\left(f(x_{i-1}) + f(x_i)\right)\cdot(x_i - x_{i-1})$$

$$Q_3 = \frac{1}{2} f(x_1)(x_2 - x_1) + \sum_{i=2}^{N-1} \frac{f(x_{i-1}) + f(x_i)}{2}(x_i - x_{i-1}) + \frac{1}{2} f(x_N)(x_N - x_{N-1})$$

$$Q_3 = \frac{dx}{2}\left[f(x_1) + 2\left(f(x_2) + f(x_3) + \dots + f(x_{N-1})\right) + f(x_N)\right]$$

$$Q_3 = \frac{dx}{2}\left(f(x_1) + 2\sum_{i=2}^{N-1} f(x_i) + f(x_N)\right)$$

$$\frac{\overbrace{\sum_{i=1}^{N-1} f(x_i)\, d(x_i)}^{Q_1} + \overbrace{\sum_{i=2}^{N} f(x_i)\, d(x_{i-1})}^{Q_2}}{2} = Q_3$$

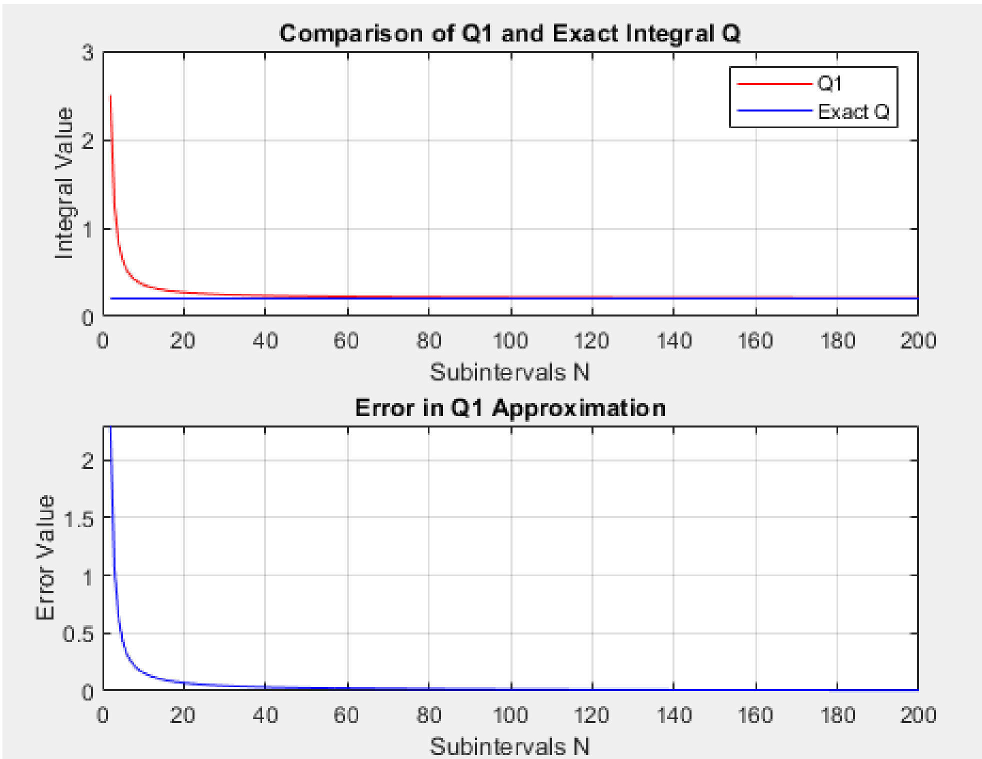
B.) Q1 is all the f(xi)dx terms from i=1 to I = N-1. Q2 is all the f(xi)dx terms from i=2 to I = N. Q1 and Q2 overlap from i=2 to i=N-1, thus there are 2x the inner terms(i=2 to i= N-1) and 1x of each the first(i=1) and last term(i=N). (refer to fig 10)

c.) Code: Q1

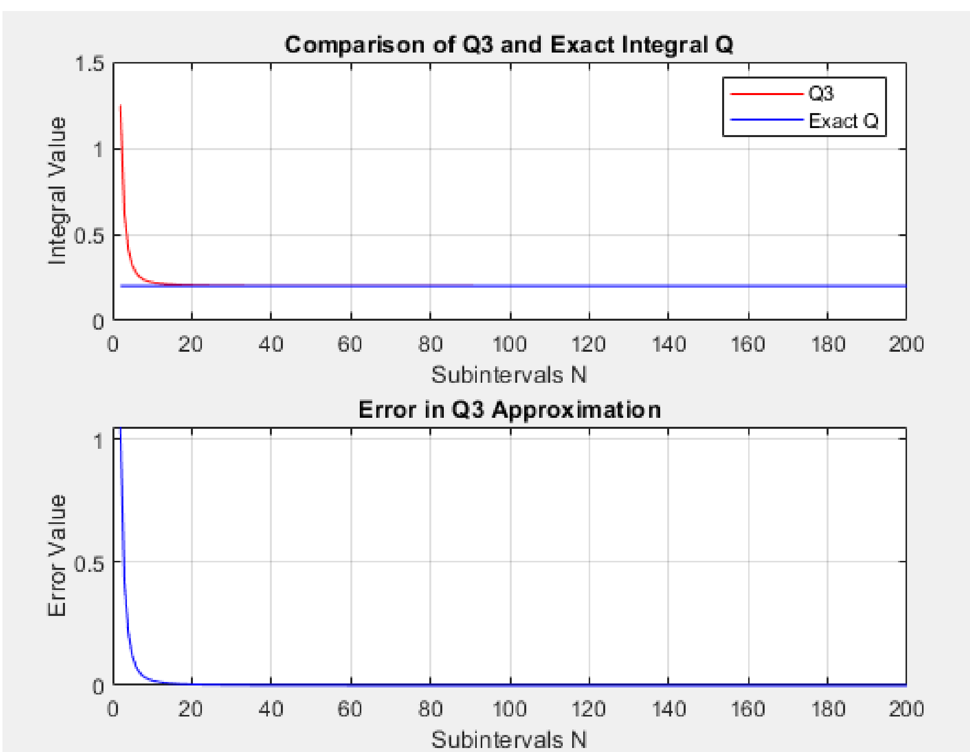
```
function Q1_out = Q1(N)
    dx = (5-0)/(N-1);
    x = 0:dx:5;
    y=function1(x);
    A = [ones(N-1,1);0];

    Q1_out = y*A*dx;
end
```

Fig11: Q1 values for N = 2 to 200 and Error.



d.) Fig12: Q3 values for N = 2 to 200 and Error.



Question: Yes, they should converge to the same value