Task 3

Shape Functions and Interpolation

Q) Implement shape functions and interpolation schemes for various element types (e.g., linear, quadratic) in MATLAB.

MATLAB Code:

For Linear Elements:

```
function [Q, dQ_dx] = linearShapeFunctions(zaidi)
    Q = [0.5*(1 - zaidi), 0.5*(1 + zaidi)];
    dQ_dx = [-0.5, 0.5];
end
```

For Quadratic Elements:

```
function [Q, dQ_dx] = quadraticShapeFunctions(zaidi)
    Q = [0.5*zaidi*(zaidi - 1), 1 - zaidi^2, 0.5*zaidi*(zaidi + 1)];
    dQ_dx = [zaidi - 0.5, -2*zaidi, zaidi + 0.5];
end
```

Final Code for Implementation:

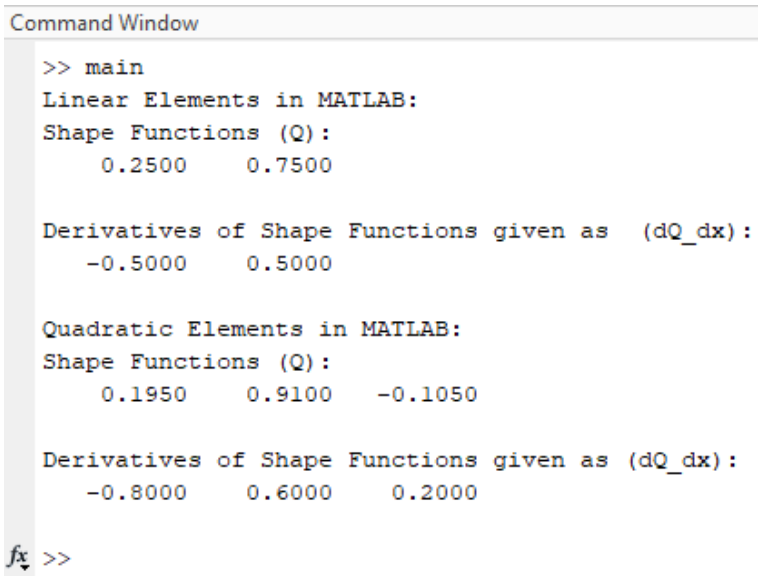
```
zaidi_linear = 0.5;
[Q_linear, dQ_dx_linear] = linearShapeFunctions(zaidi_linear);

disp("Linear Elements in MATLAB:");
disp("Shape Functions (Q):");
disp(Q_linear);
disp("Derivatives of Shape Functions given as  (dQ_dx):");
disp(dQ_dx_linear);

zaidi_quadratic = -0.3;
[Q_quadratic, dQ_dx_quadratic] = quadraticShapeFunctions(zaidi_quadratic);

disp("Quadratic Elements in MATLAB:");
disp("Shape Functions (Q):");
disp(Q_quadratic);
disp("Derivatives of Shape Functions given as (dQ_dx):");
disp(dQ_dx_quadratic);
```

Final Output on MATLAB:



Q)Verify the correctness of the shape functions by computing interpolations for different points within the elements.

MATLAB Code:

```
zaidi_values = [-1, -0.5, 0, 0.5, 1];


disp("Linear Elements in MATLAB:");
for i = 1:length(zaidi_values)
   zaidi = zaidi_values(i);
    [Q_linear, ~] = linearShapeFunctions(zaidi);

    interpolated_value = Q_linear * [10; 20];
    disp(['Interpolated value at zaidi = ', num2str(zaidi), ':']);
    disp(interpolated_value);
end


disp("Quadratic Elements in MATLAB:");
for i = 1:length(zaidi_values)
   zaidi = zaidi_values(i);
    [Q_quadratic, ~] = quadraticShapeFunctions(zaidi);

    interpolated_value = Q_quadratic * [10; 20; 30];
    disp(['Interpolated value at zaidi = ', num2str(zaidi), ':']);
    disp(interpolated_value);
end
```

Final Output on MATLAB:

Command Window

```
>> modified_main
Linear Elements in MATLAB:
Interpolated value at zaidi = -1:
    10

Interpolated value at zaidi = -0.5:
   12.5000

Interpolated value at zaidi = 0:
    15

Interpolated value at zaidi = 0.5:
   17.5000

Interpolated value at zaidi = 1:
    20

Quadratic Elements in MATLAB:
Interpolated value at zaidi = -1:
    10
```

Command Window

```
Interpolated value at zaidi = -0.5:
   12.5000

Interpolated value at zaidi = 0:
    15

Interpolated value at zaidi = 0.5:
   17.5000

Interpolated value at zaidi = 1:
    20
```

```
Quadratic Elements in MATLAB:
Interpolated value at zaidi = -1:
    10

Interpolated value at zaidi = -0.5:
    15

Interpolated value at zaidi = 0:
    20

Interpolated value at zaidi = 0.5:
    25

Interpolated value at zaidi = 1:
    30
```