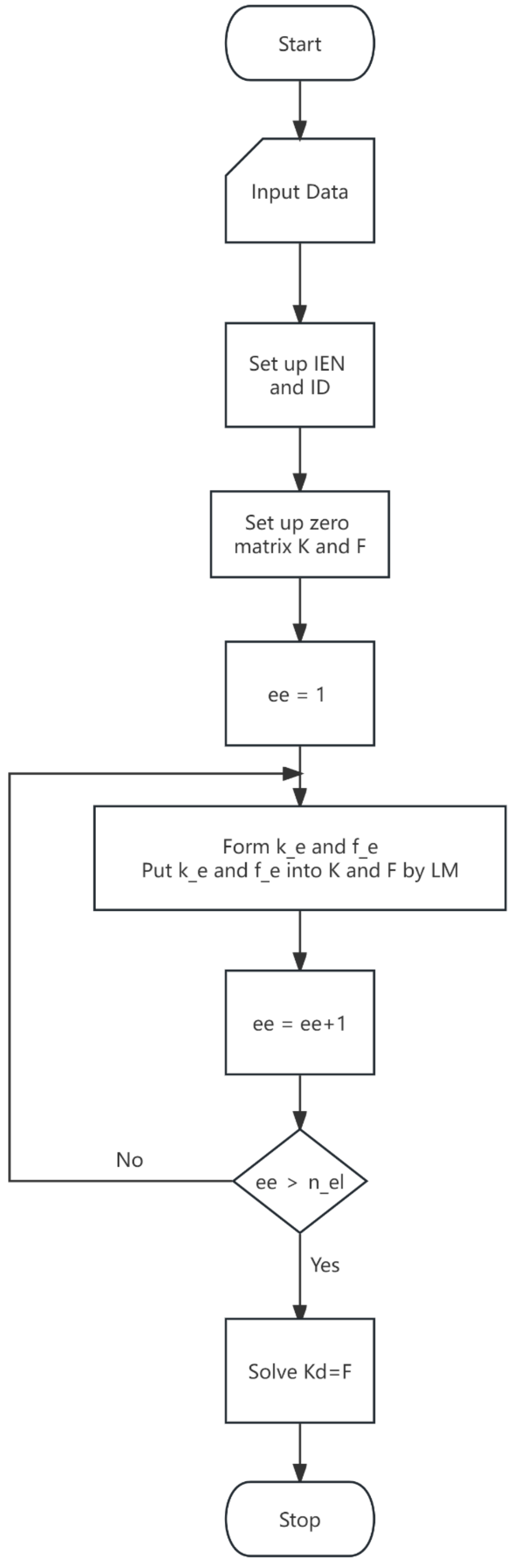
FEM HW5

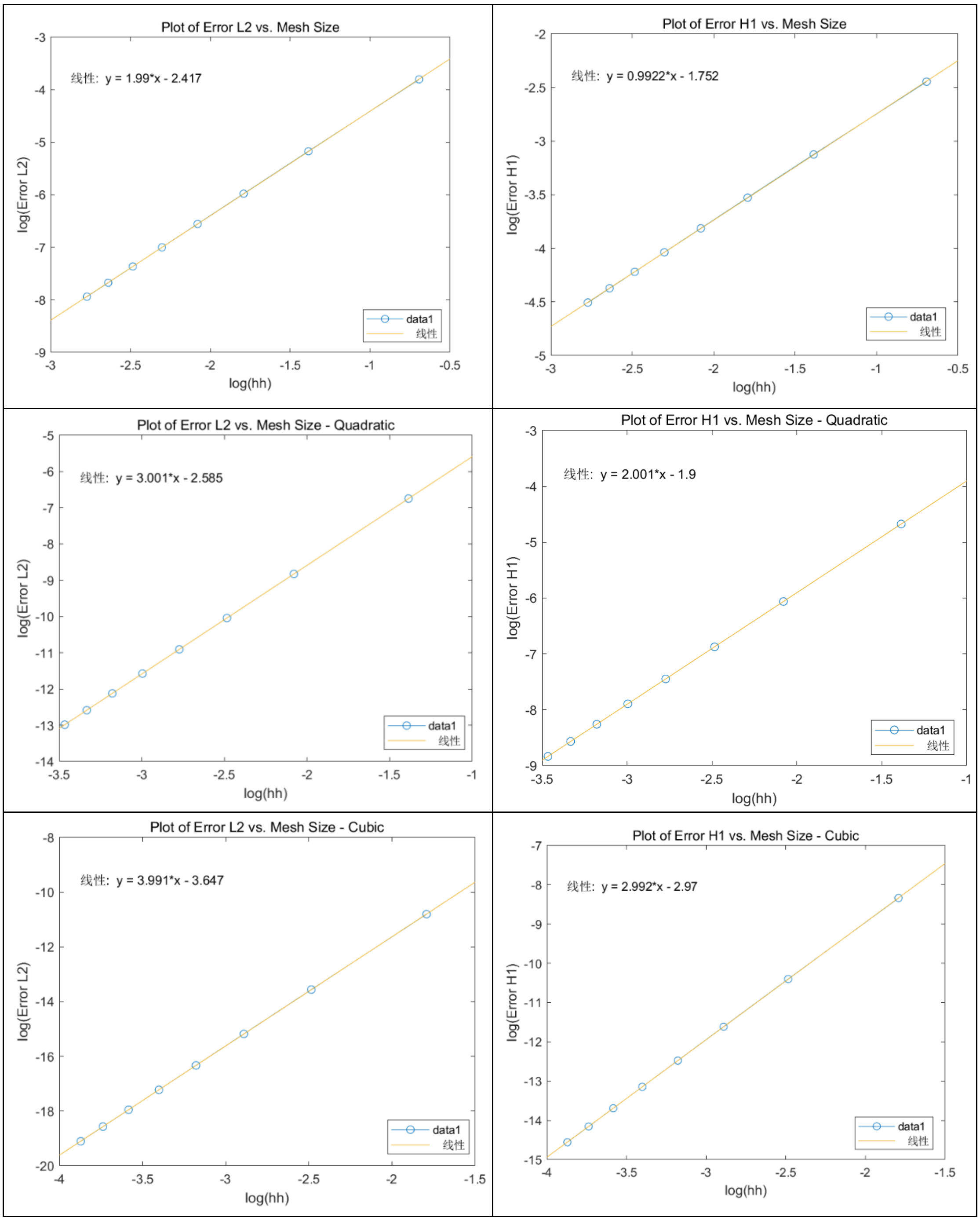
2.

a) Read the code and draw a detailed flowchart of it.



b) Plot the relative errors against the mesh size in the log-log plot (i.e., plot log(error) against log(h)). Determine the slope of the curves.

c) Enable the code for higher-order elements using quadratic and cubic elements. Modify the code. Repeat the calculation of the errors using the two higher order elements.



d) The usage of the command gmres in Matlab. Set restart=maxit=10000. Set the value of tol to be 1e-2, 1e-4, and 1e-6, and compare the solutions against those obtained by the direct method (i.e. LU factorization). Give your comments.

The results with different tol values are all equal.

```matlab
% Solve the linear system using gmres with different tols
for i = 1:length(tol_values)
    tol = tol_values(i);
    x = gmres(K, F, restart, tol, maxit);
    solutions_gmres{i} = x;
    Comparasion{i}= x-uh;
end

Differrence = Comparasion{2}-Comparasion{1};
Differrence2 = Comparasion{3}-Comparasion{2};
%Both of them are zero
```

e) Run the code with the element of degree 3 (i.e. cubic element). Experiment the code with 1,2,3,4,5,6 quadrature points, respectively. Report your observations and make comments.

The results with 1 and 2 quadrature points have “The matrix is close to a singular value, or is incorrectly scaled. The results may not be accurate.”, the other three test cases obtain the close results.

solutions

6x1 cell

	1
1	[-1.1618e+18;-2.1460e+16;2.1456e+16;-3.1027e+15;1.7097e+14;2.8588e+14;0.8415]
2	[-0.1663;-1.2560e+15;1.2560e+15;0.4187;-4.9029e+14;4.9029e+14;0.8415]
3	[4.0818e-08;0.1659;0.3272;0.4794;0.6184;0.7402;0.8415]
4	[-1.5304e-11;0.1659;0.3272;0.4794;0.6184;0.7402;0.8415]
5	[5.9893e-15;0.1659;0.3272;0.4794;0.6184;0.7402;0.8415]
6	[3.1071e-17;0.1659;0.3272;0.4794;0.6184;0.7402;0.8415]