function convection\_diffusion\_fem\_pe(NP, base\_u, L, base\_k, alpha, Pe\_values)

% Additional Input:

% Pe\_values - Array of Peclet numbers for which to plot the solution

% Initialize plot

figure;

hold on;

for Pe = Pe\_values

% Adjust k to control the Peclet number

if Pe > 0

k = base\_u \* L / (Pe \* NP);

else

k = base\_k; % Use the base diffusion coefficient for Pe = 0

end

% Now proceed with the calculations as in the original function

NE = NP - 1; % Number of elements

h = L / NE; % Length of each element

x = linspace(0, L, NP); % Mesh points

% Initialize global stiffness matrix and force vector

K\_global = zeros(NP, NP);

F\_global = zeros(NP, 1);

% Connectivity matrix

intma = zeros(NE, 2);

for i = 1:NE

intma(i, :) = [i, i+1];

end

% Assembly of element matrices

for i = 1:NE

% Local-to-global mapping

node1 = intma(i, 1);

node2 = intma(i, 2);

% Element convection and diffusion matrix

emat\_convection = (base\_u/2) \* [-1 1; -1 1];

emat\_diffusion = (k/h) \* [1 -1; -1 1];

emat\_pg = (alpha \* base\_u/2) \* [-1 1; -1 1]; % Petrov-Galerkin part

% Total element matrix

emat = emat\_convection + emat\_diffusion + emat\_pg;

% Assemble into global matrix

K\_global([node1, node2], [node1, node2]) = ...

K\_global([node1, node2], [node1, node2]) + emat;

end

% Apply boundary conditions

K\_global(1, :) = 0; K\_global(1, 1) = 1; F\_global(1) = 1; % Dirichlet BC at x=0

K\_global(NP, :) = 0; K\_global(NP, NP) = 1; F\_global(NP) = 0; % Dirichlet BC at x=L

% Solve the system of equations

phi = K\_global \ F\_global;

% Plotting for each Peclet number

plot(x, phi, 'DisplayName', ['Pe = ', num2str(Pe)]);

end

% Finalize plot

title('Solution of Convection-Diffusion Equation for Different Peclet Numbers');

xlabel('Domain Length (x)');

ylabel('Scalar Variable (\phi)');

legend show;

grid on;

hold off;

end

% Specify the Peclet numbers to be plotted

Pe\_values = [0.1, 0.5, 1, 2, 5, 10, 20, 50, 100, 500, 1000, 5000, 10000];

% Call the modified function

convection\_diffusion\_fem\_pe(10, 1, 1, 0.1, 0.5, Pe\_values);