APPENDIX

1. MATLAB SCRIPT FOR CALCUATION OF RELATIVE ERROR AND PERCENTAGE ERROR OF EACH METHOD

We have stored the approximate solution vector of each method in the MATLAB workspace.

Workspace

Name	Value
u_collocation	<1x101 double>
u_exact	<1x101 double>
u_galerkin	<1x101 double>
u_least_sq	<1x101 double>

I have used following MATLAB script to display the errors.

```
%% Relative Errors
leastsq_relative_error=sum(u_exact-u_least_sq);
collocation_relative_error=sum(u_exact-u_collocation);
galerkin_relative_error=sum(u_exact-u_galerkin);

%% Percentage Errors
leastsq_percentage_error=leastsq_relative_error/sum(u_exact)*100;
collocation_percentage_error=collocation_relative_error/sum(u_exact)*100;
galerkin_percentage_error=galerkin_relative_error/sum(u_exact)*100;
%% Display results
clc
disp(' Relative Error');
fprintf(' Least Square method: %f',leastsq_relative_error);
fprintf('\n Collocation Method: %f',collocation_relative_error);
fprintf('\n Galerkin Method: %f\n\n',galerkin_relative_error);
disp(' Percenatage Error');
fprintf(' Least Square method: %f percent',leastsq_percentage_error);
fprintf('\n Collocation Method: %f percent',collocation_percentage_error);
fprintf('\n Galerkin Method: %f percent\n\n',galerkin_percentage_error);
```

2. CONSTITUTIVE MATRIX

For two-dimensional problem, constitutive matrix depends on the material property. If μ is the Poisson's ratio, E is the modulus of elasticity and G is the shear modulus, then for isotropy and plane stress condition $(\sigma_z = \tau_{xz} = \tau_{yz})$ the constitutive matrix can be written as

$$[E] = \frac{E}{1-\mu^2}\begin{bmatrix} 1 & \mu & 0 \\ \mu & 1 & 0 \\ 0 & 0 & \frac{(1-\mu)}{2} \end{bmatrix}$$

3. STRAIN DISPLACEMENT RELATIONS

There are three normal stresses in the three coordinate directions $(\sigma_x, \sigma_y, \sigma_z)$, and three shear stresses $(\tau_{xy},\ \tau_{zx}, \tau_{yz})$. Corresponding to these six stresses, there are six strains as well $(\epsilon_x, \epsilon_y, \epsilon_z, \gamma_{xy},\ \gamma_{zx}, \gamma_{yz})$. Let u, v, w be the nodal displacement in x, y, z directions. Then the six strains can be written as

$$\epsilon_x = \frac{\partial u}{\partial x}, \qquad \epsilon_y = \frac{\partial v}{\partial y}, \qquad \epsilon_z = \frac{\partial w}{\partial z}$$

$$\gamma_{xy} = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}, \qquad \gamma_{zx} = \frac{\partial w}{\partial z} + \frac{\partial u}{\partial x}, \qquad \gamma_{yz} = \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}$$

The three-dimensional strain-displacement relations can be written as

$$\begin{Bmatrix} \epsilon_x \\ \epsilon_y \\ \epsilon_z \\ \gamma_{xy} \\ \gamma_{zx} \\ \gamma_{yz} \end{Bmatrix} = \begin{bmatrix} \frac{\partial u}{\partial x} & 0 & 0 \\ 0 & \frac{\partial v}{\partial y} & 0 \\ 0 & 0 & \frac{\partial w}{\partial z} \\ \frac{\partial u}{\partial x} & \frac{\partial v}{\partial y} & 0 \\ \frac{\partial u}{\partial x} & 0 & \frac{\partial w}{\partial z} \\ 0 & \frac{\partial v}{\partial y} & \frac{\partial w}{\partial z} \end{bmatrix} \begin{Bmatrix} u \\ v \\ w \end{Bmatrix}$$

4.MATLAB GUI WITH ENHANCED INPUT FEATURE

The input section can be interactively managed using some GUI program. I have made a GUI that can handle all input computation. Since, the purpose of the project is quite away from aesthetics hence, I have not provided the source code for the GUI. The source code is very large and hence I have given some snapshots of the GUI.

Fig 9.1 Data Input GUI