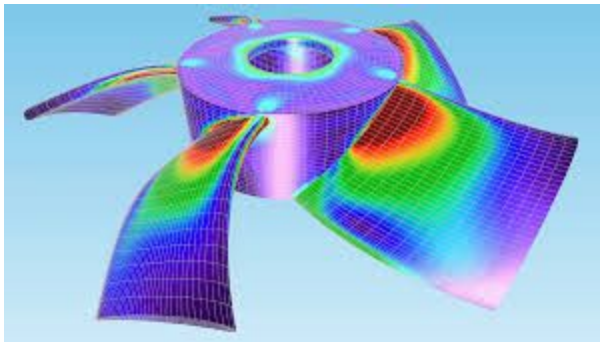
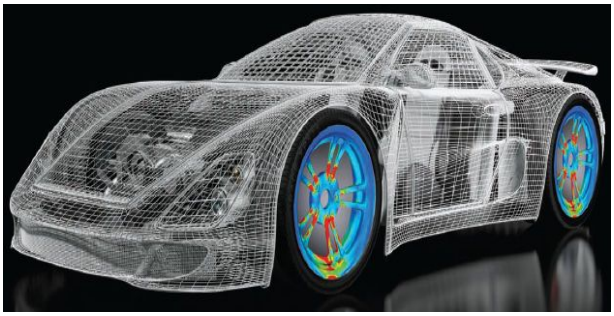
CONSISTENT NODAL LOAD ANALYSIS

- Finite Element Method Project





Project by

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Problem Statement :

Develop a MATLAB App (GUI, Graphical User Interface) which finds consistent nodal loads on n-noded bar element corresponding to a given distributed loading.

Specifications :

- Length of bar element and coordinates of n no. of nodes in the element should be input to the App. Nodes are not uniformly-spaced, in general.
- Type of distributed loading: Either standard function (such as uniform, linear,quadratic, sinusoidal etc.) or combination of standard functions or generic loading which is input as a table.
- Behind the screen: required integrals should be formulated and evaluated numerically to yield the consistent nodal loads, which should be displayed on the screen along with the element and arrows at the nodes representing consistent nodal point loads.

Assumptions:
1) 1-D elastic bar element
2) Bar is assumed to be on x-axis. Hence, the y-coordinates of all the nodes is equal to zero.

Theoretical Background :

Consider a n-noded bar element whose x-coordinates are given by $[x_1\ x_2\ x_3\ \ldots\ x_n]$
Length of the element = $L = x_n - x_1$

Shape functions are given by the following conditions
$N_i(x_n) = 1$ if $i=j$
$= 0$ if $i \neq j$

Hence,

$N_i(x) = 0$ for $x < x_{i-1}$
$= (x - x_{i-1})/(x_i - x_{i-1})$ for $x_{i-1} < x < x_i$
$= (x - x_{i+1})/(x_i - x_{i+1})$ for $x_i < x < x_{i+1}$
$= 0$ for $x > x_{i+1}$

Loads acting on the element can be in any form

a) Linear
b) Uniform

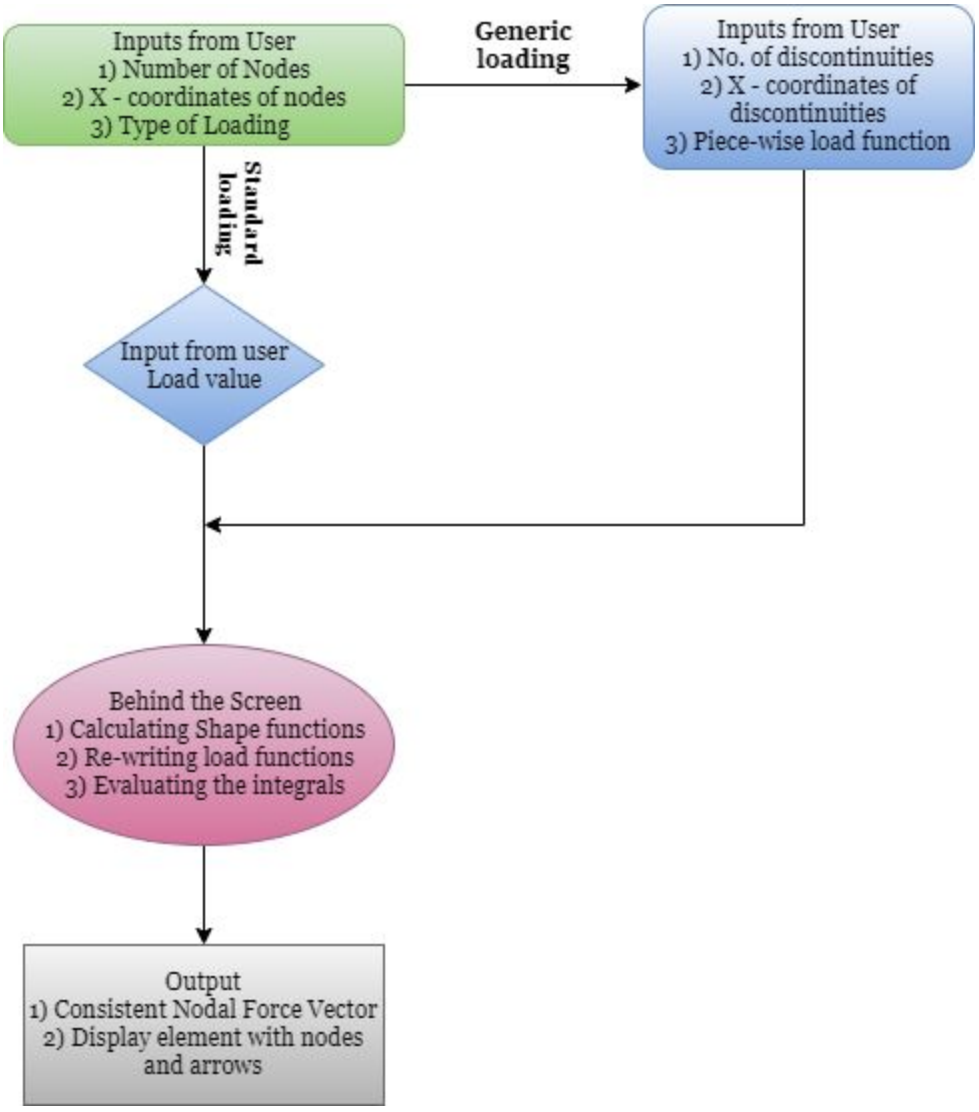
c) Quadratic
d) Sinusoidal
e) Generic

Generic load can be anything, it can be a combination of standard loadings or random. It can also be defined as piecewise functions specifying discontinuities.

Equivalent Force at ith node due to the applied load can be calculated by Force-displacement method and is given by

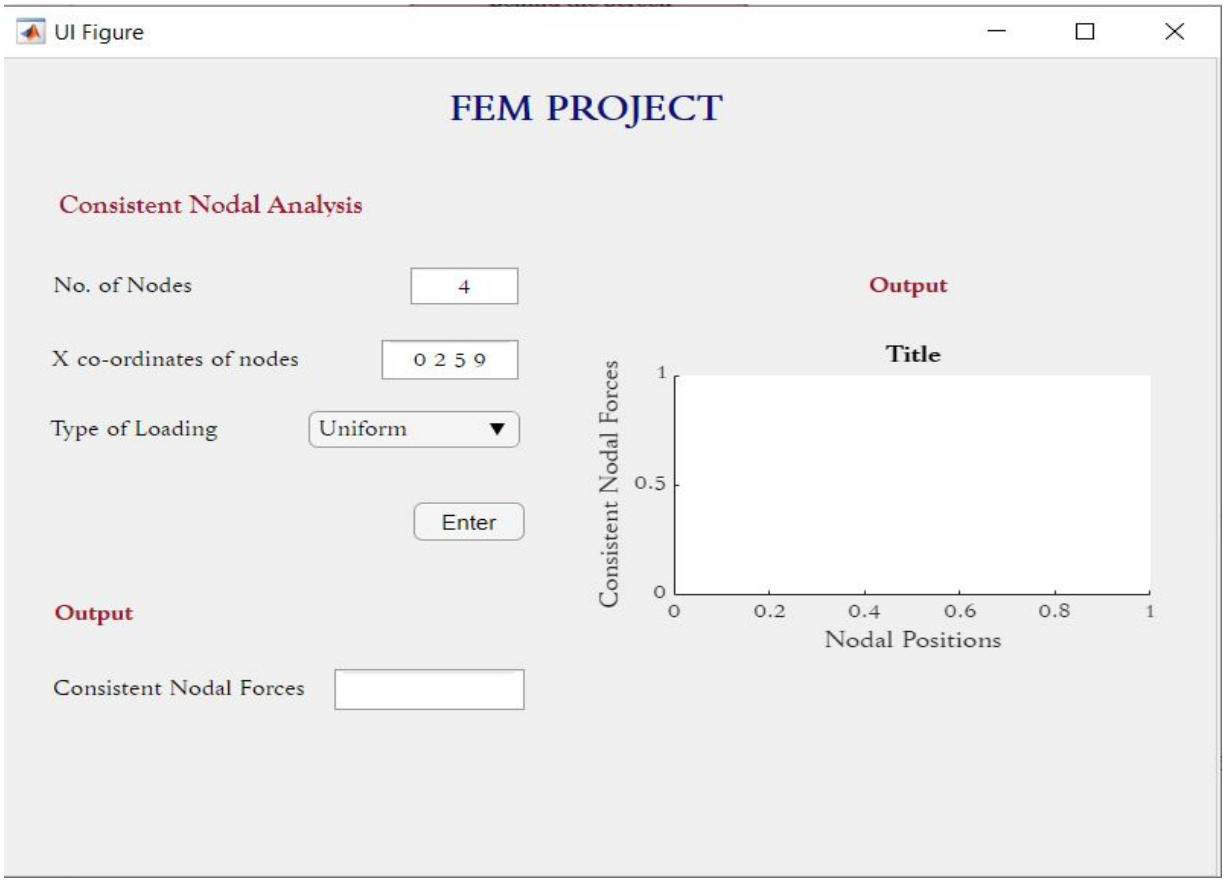
$$f_i = \int N_i(x) * p(x).dx$$

Algorithm :



MATLAB GUI :

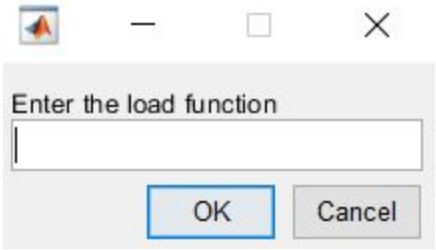
MATLAB App is made using the above mentioned algorithm. Multiple inputs must be given in an array in the app.



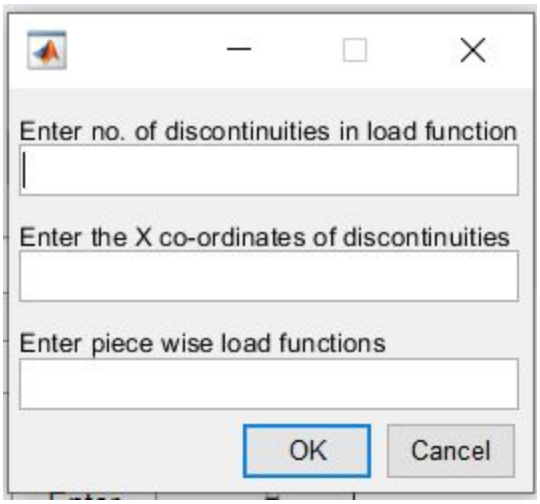
The inputs asked must be entered such as no. of nodes and coordinates of nodes along with the type of loading.

If the loading is standard, then a dialog box appears asking for the value of the load function.

1) Uniform
2) Linear
3) Quadratic
4) sinusoidal



If the loading is generic, then a dialog box appears asking for the discontinuities in load function



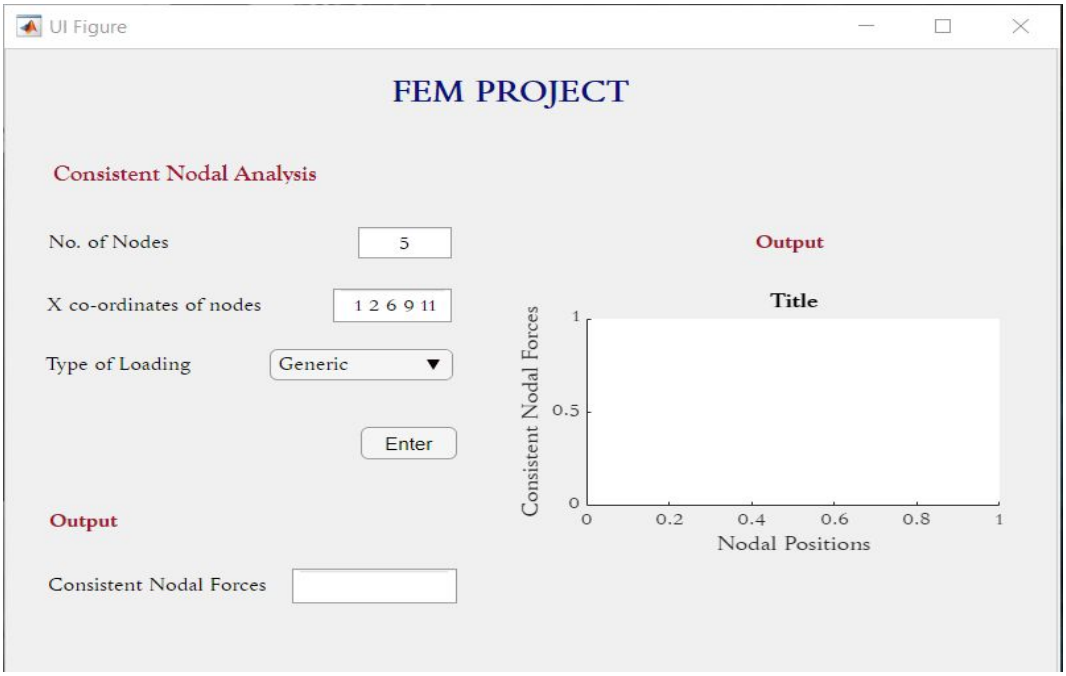
In the above dialogue box, user must enter the number of discontinuities and coordinates of discontinuities in load function along with the load function matrix.

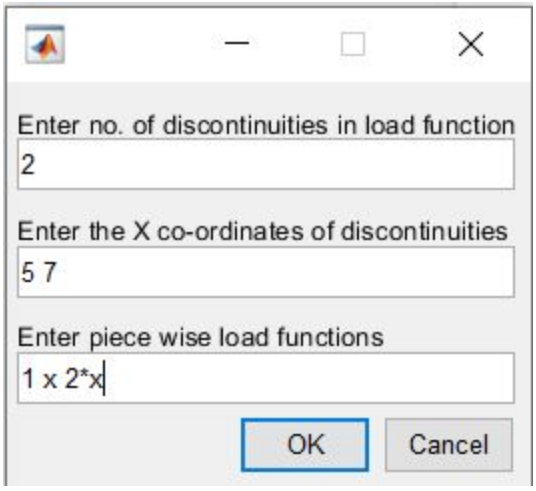
Working of App :

Working of app is verified for all kind of loads but in this report only one among standard loadings is mentioned along with the generic loading case

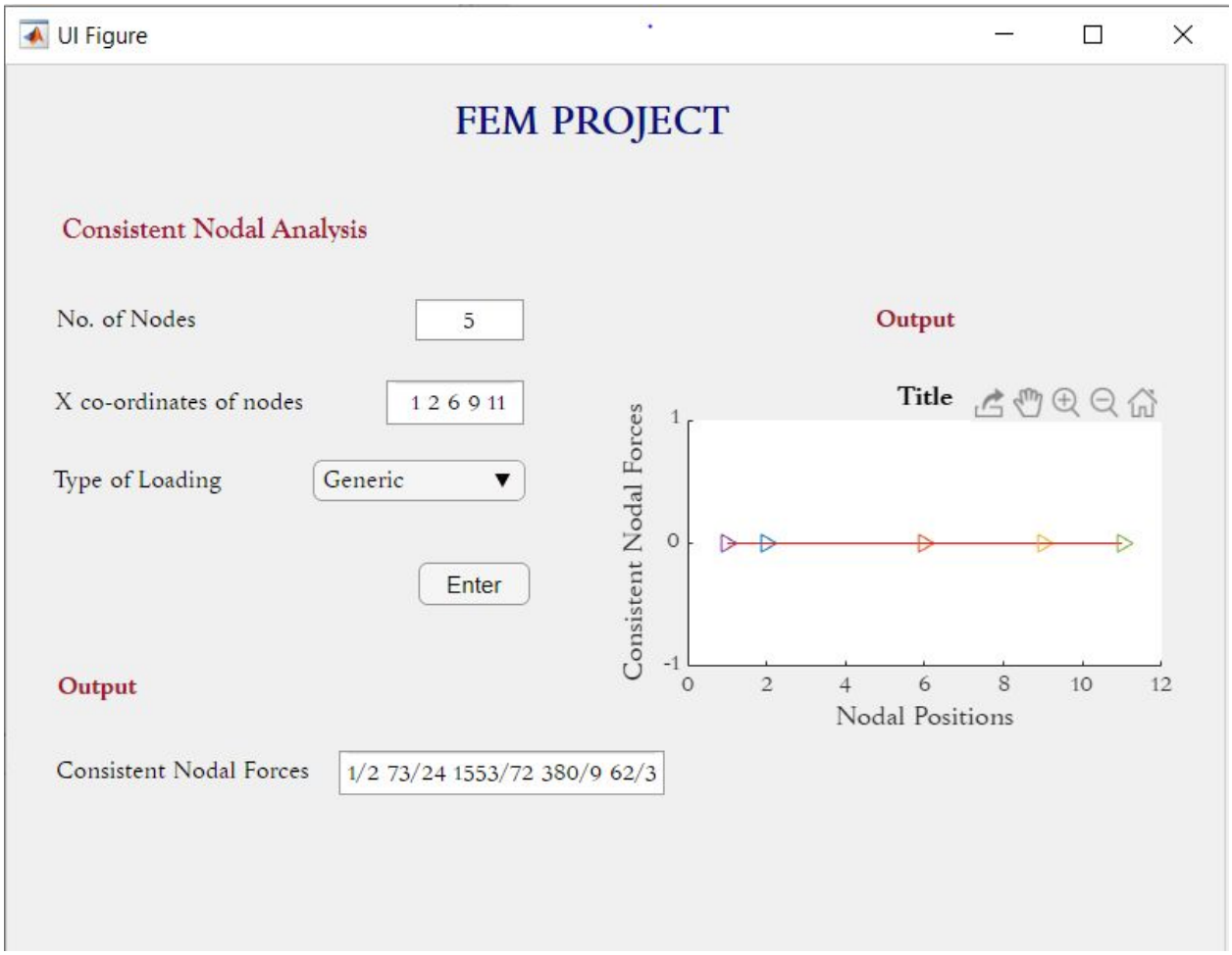
Generic Loading :

Input :





Output

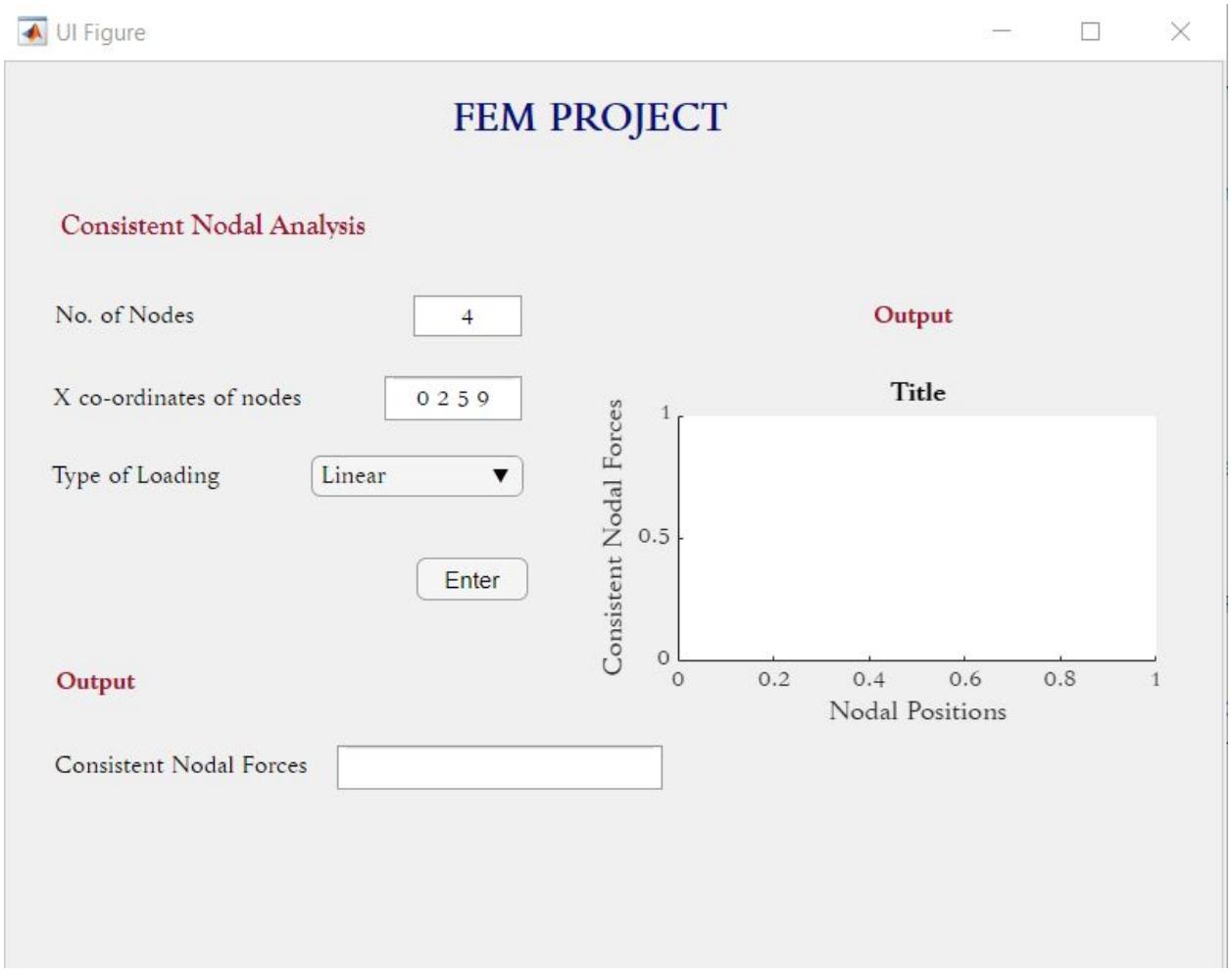


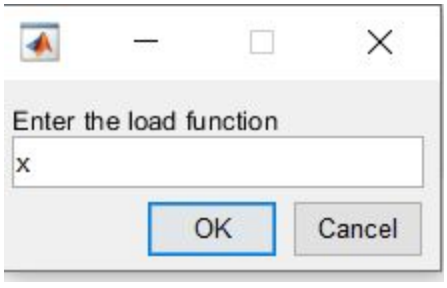
Output returns the consistent nodal forces matrix along with the element in the plot with representing arrows at the nodes

Standard loading :

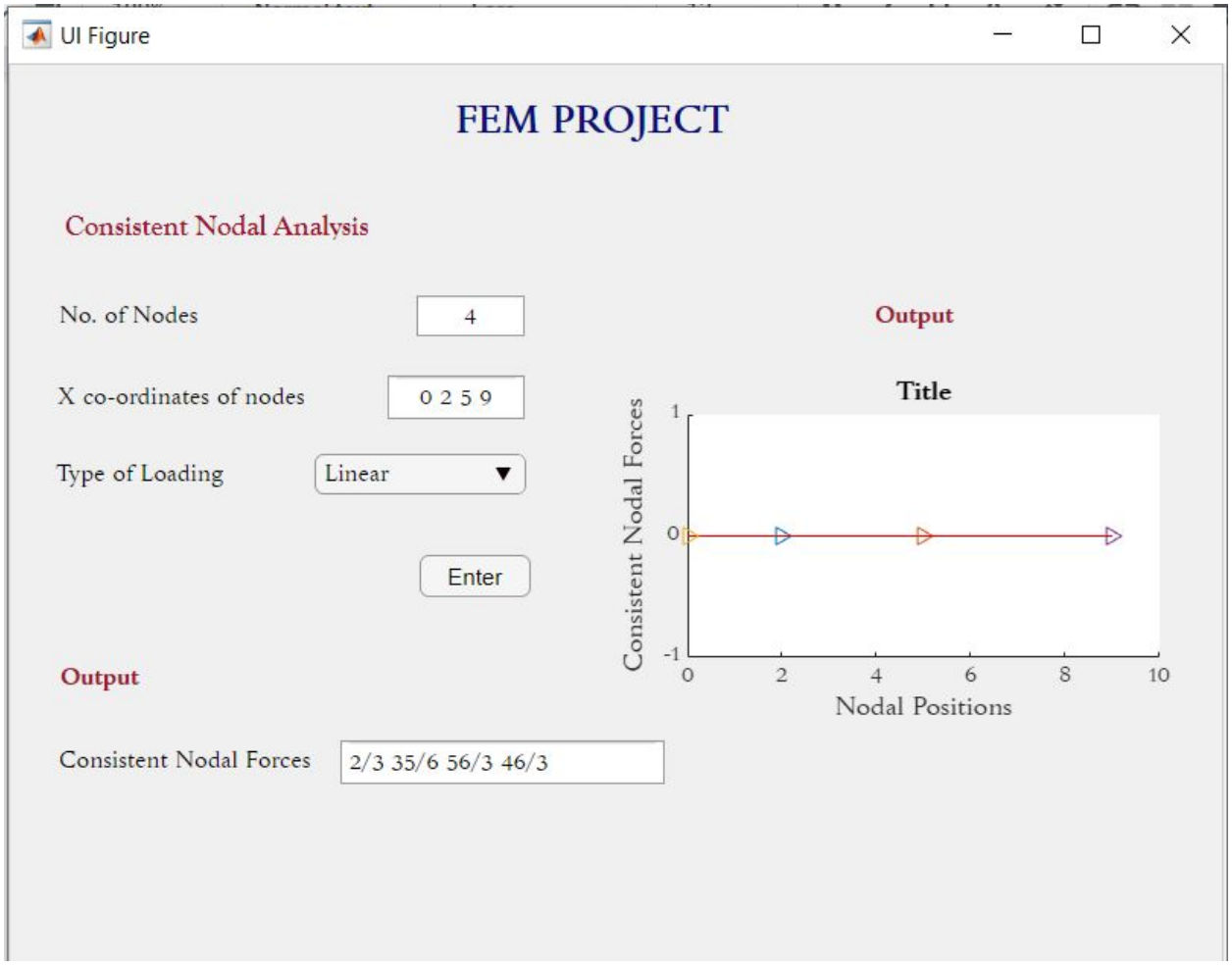
Linear :

Input :





Output :



Output returns the consistent nodal forces matrix along with the element in the plot with representing arrows at the nodes

Conclusion :

Hence, the app is made using MATLAB GUI to calculate consistent nodal forces.