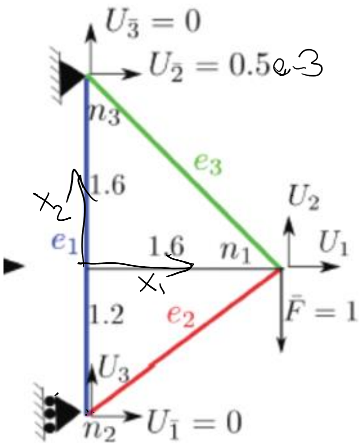
FEM20240821

Wednesday, August 21, 2024 12:48 PM

First problem:



	x	y
n_1	1.6	0
n_2	0	-1.2
n_3	0	1.6

element Connectivity

e #	node 1	node 2
1	2	3
2	1	2
3	1	3

each element has A (area) & E (Elastic modulus)

2 materials

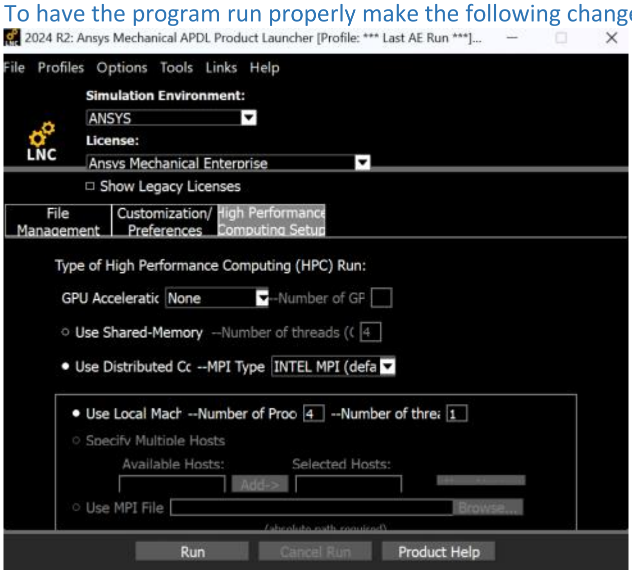
Material #	E
1	10000
2	10^5

section #	A
1	0.1
2	1.0

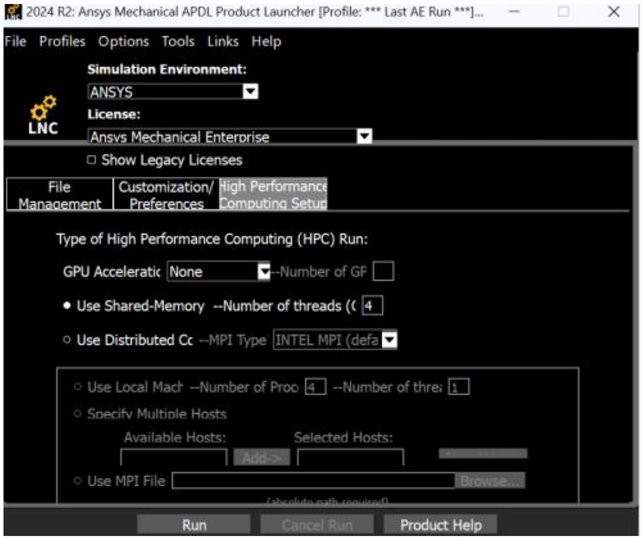
element #	material #	section #
1	1	1
2	1	1
3	2	2

Install Ansys, student version:
https://www.ansys.com/academic/students

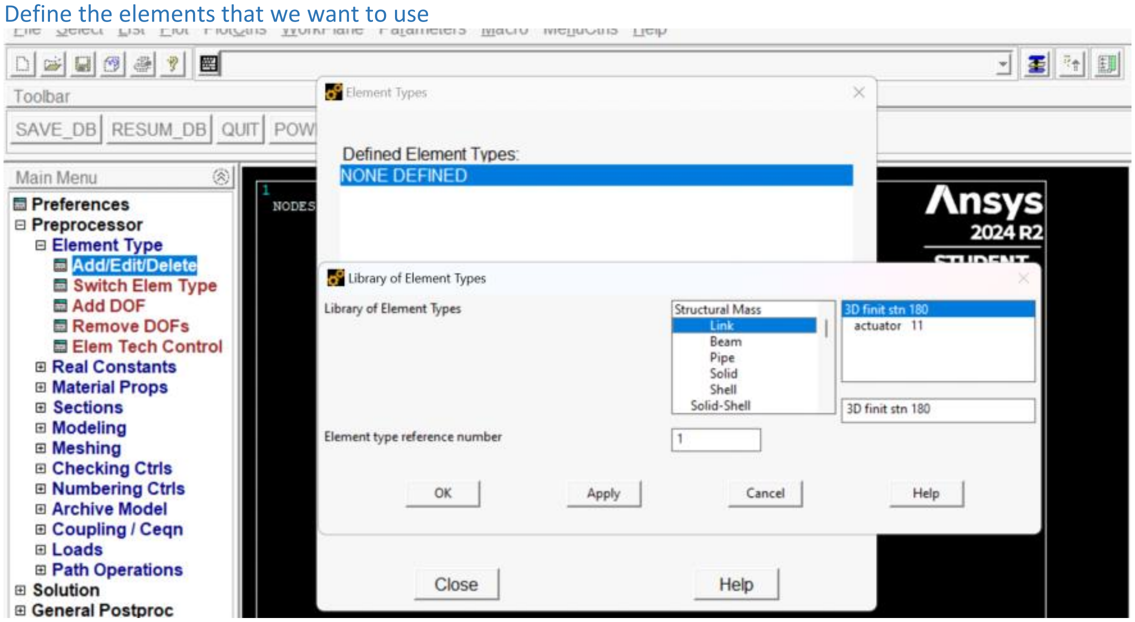
To have the program run properly make the following change:



To

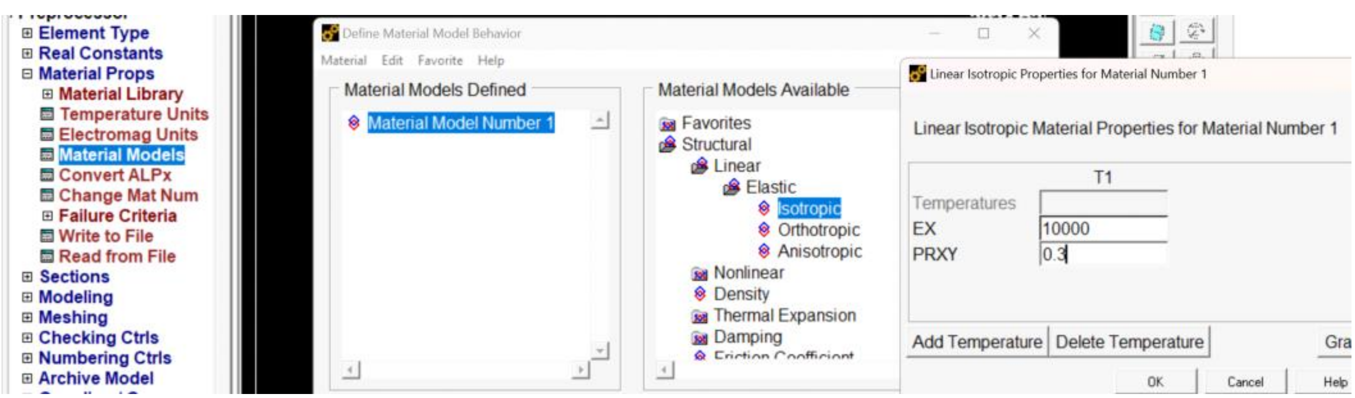


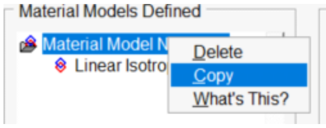
- Define the elements that we want to use

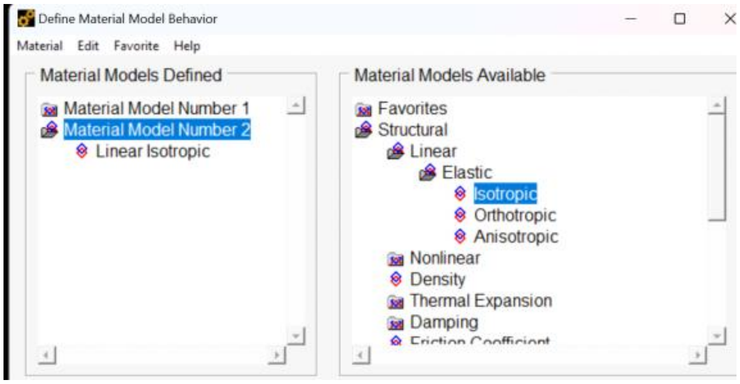


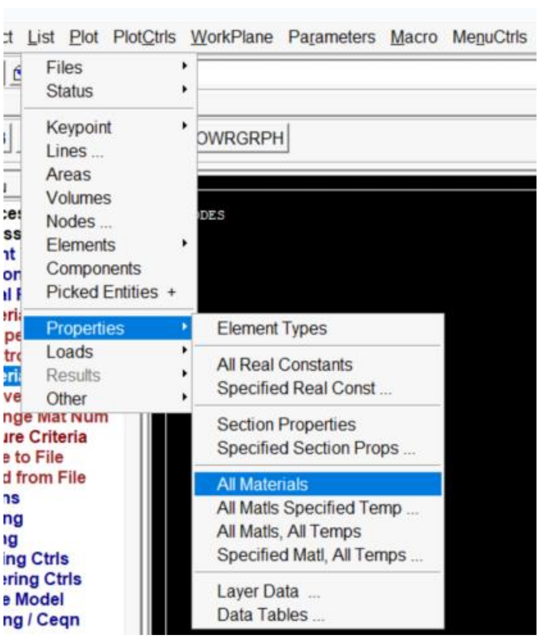
- Define the two materials

Material #	E
1	10000
2	10^5







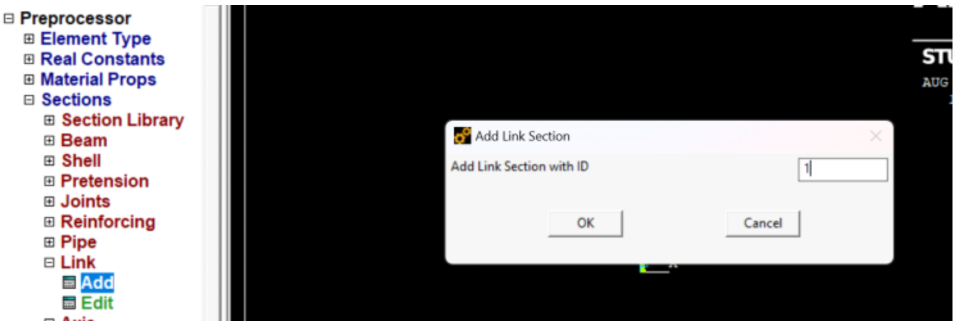


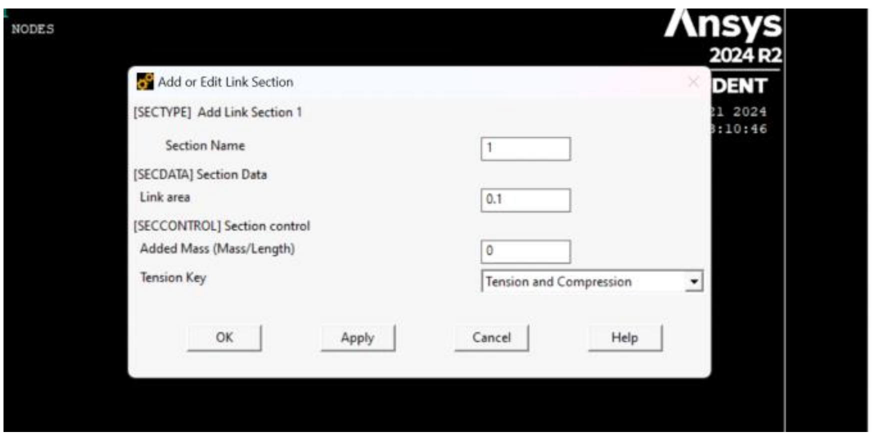
MATERIAL NUMBER =   1 EVALUATED AT TEMPERATURE OF
0.0000
EX   =   10000.
PRXY = 0.30000

MATERIAL NUMBER =   2 EVALUATED AT TEMPERATURE OF
0.0000
EX   = 0.10000E+06
PRXY = 0.30000

-Define the sections

section #	A
1	0.1
2	1.0

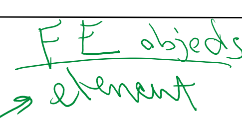




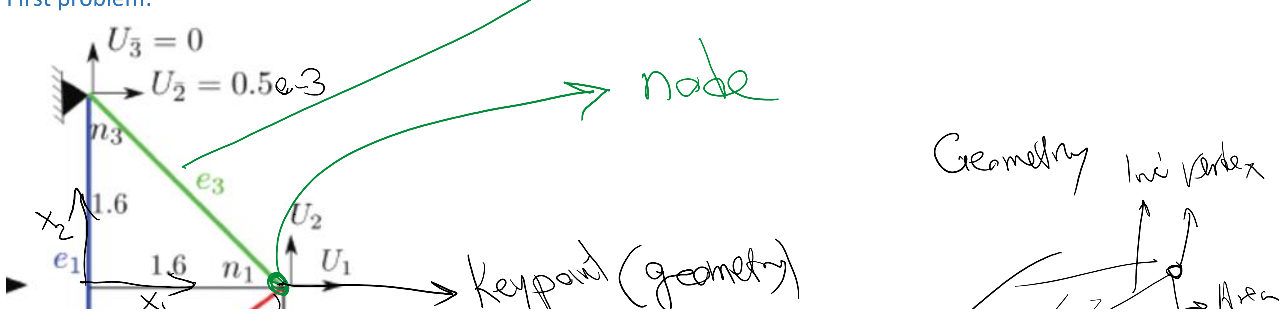
LIST SECTION ID SETS 1 TO 2 BY 1

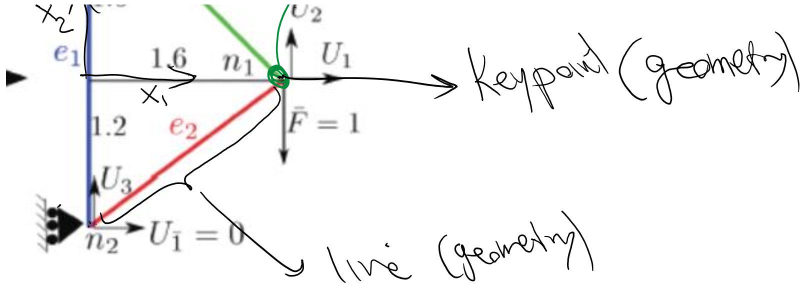
SECTION ID NUMBER: 1
LINK SECTION NAME IS: 1
Link Area = 0.10000

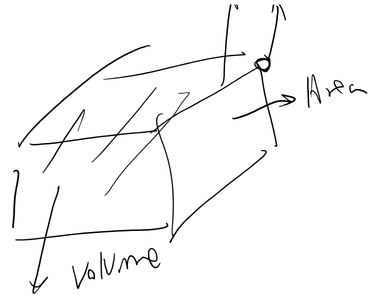
SECTION ID NUMBER: 2
LINK SECTION NAME IS: 2
Link Area = 1.0000



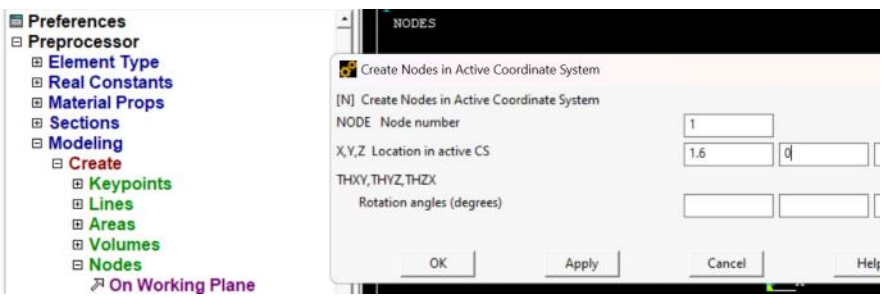
Creating the elements:
First problem:
First problem:





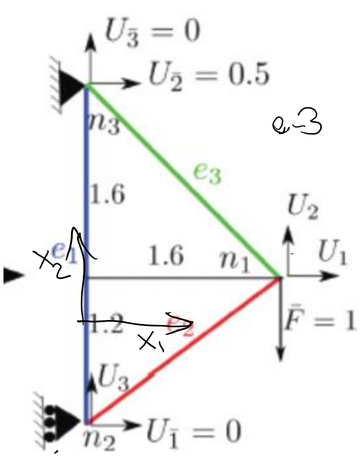


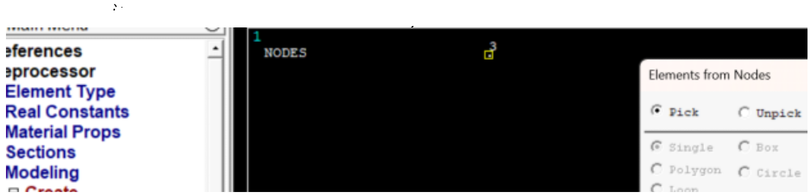
For 1D elements we skip geometry creation (Vertex, lines..)
& directly create FE objects.

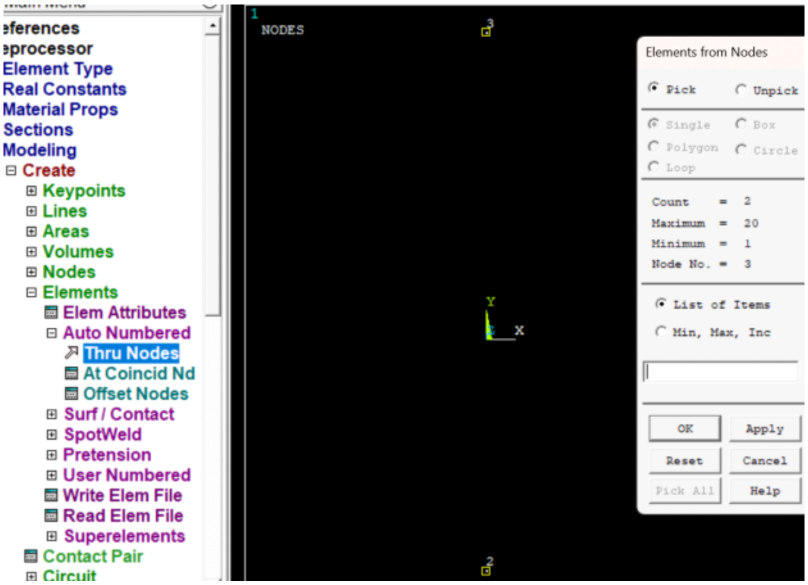


Create the elements

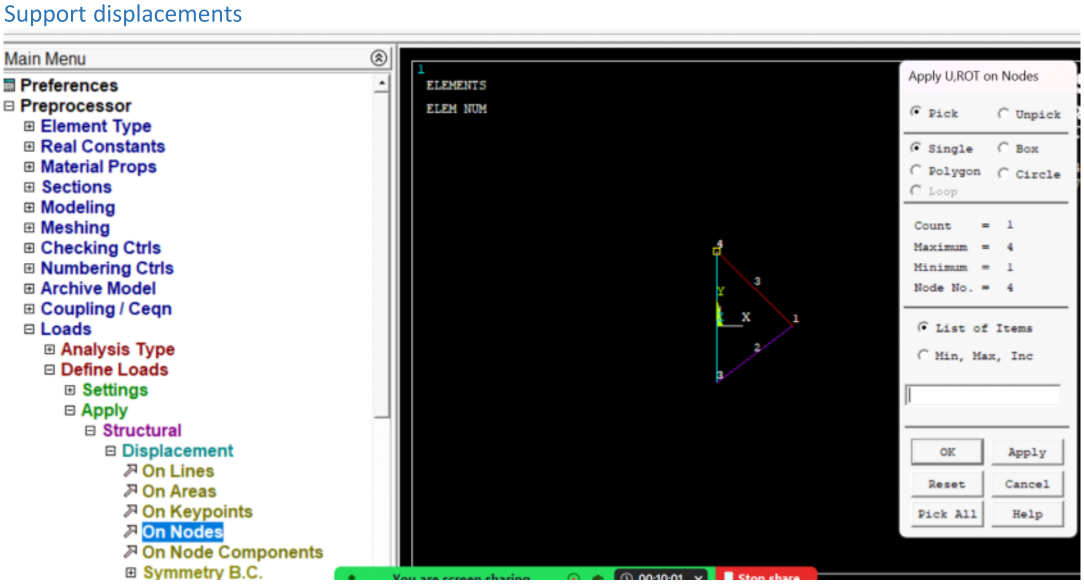
e #	node 1	node 2
1	2	3
2	1	2
3	1	3

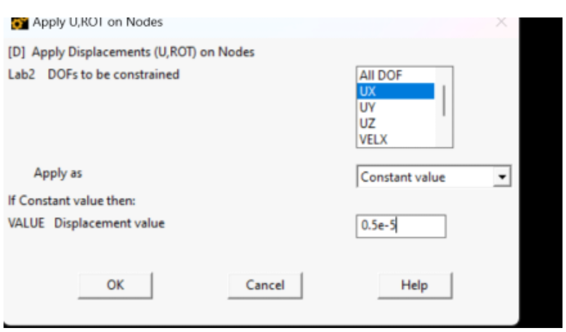


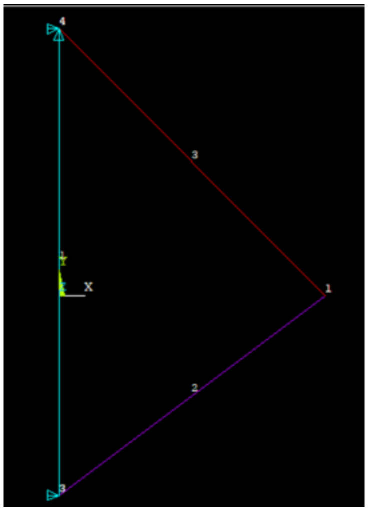




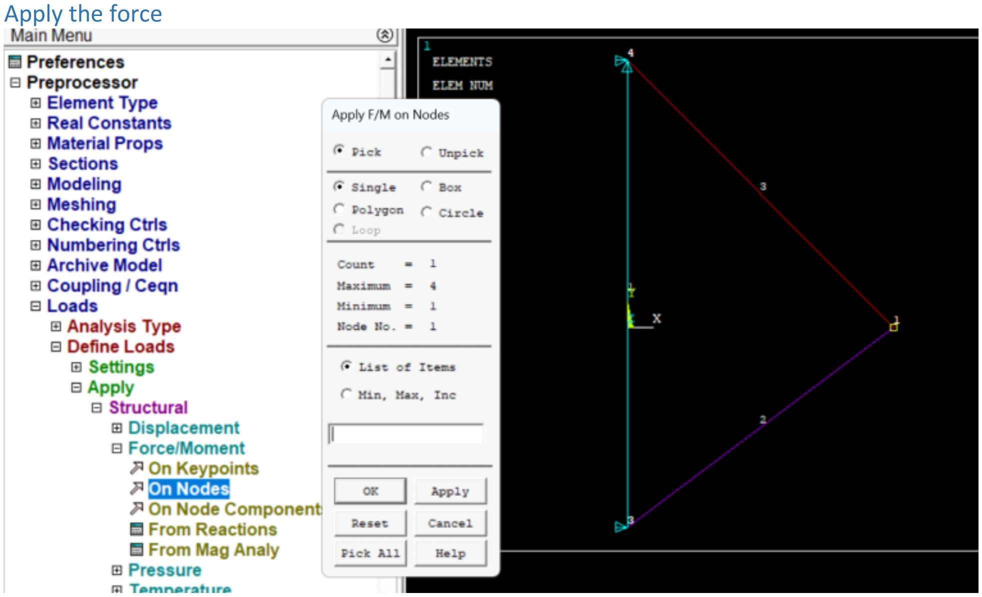
Boundary conditions:
Support displacements

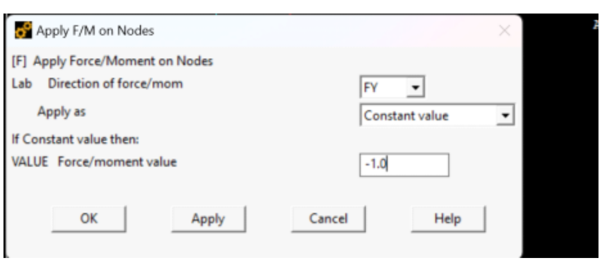






Apply the force

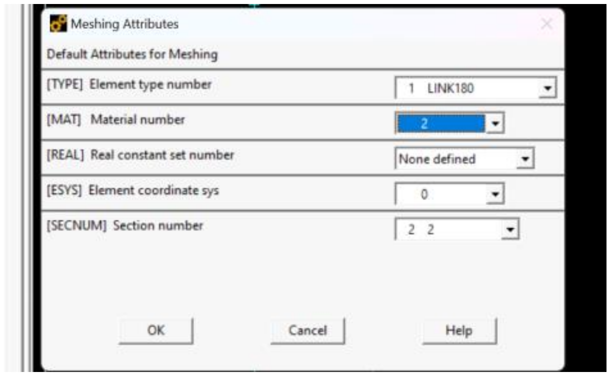


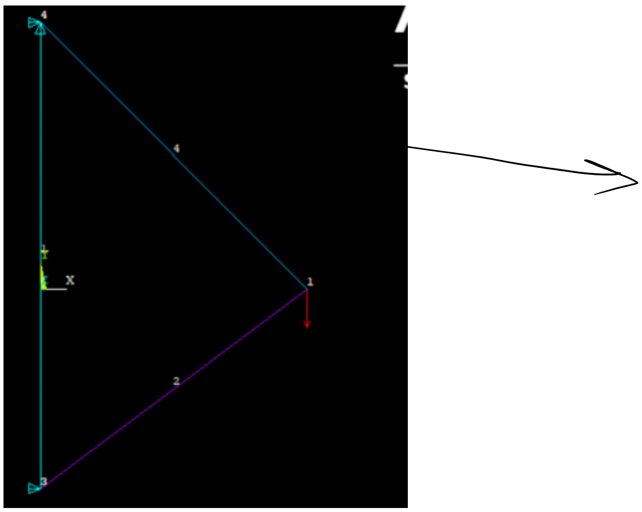


Assign material properties and section numbers to elements

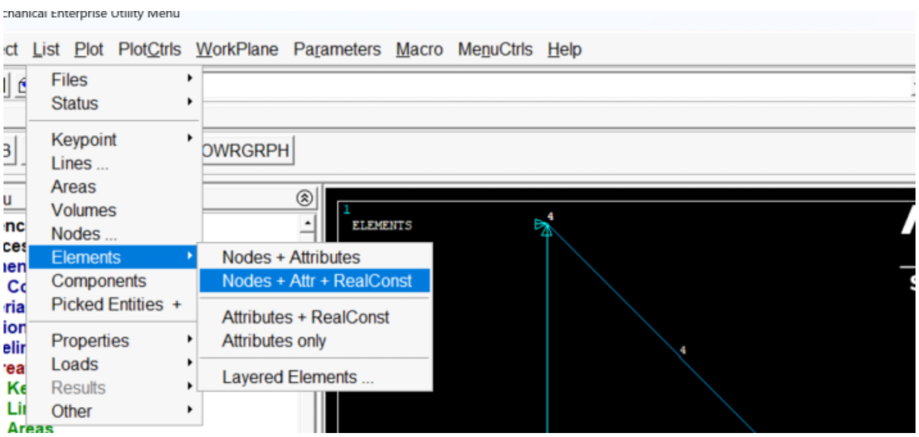
This is what we need to do as we create elements. When section or material changes, we need to change the default and then create the next elements

Before creating element 3 here, we need to change defaults to 2 and 2:

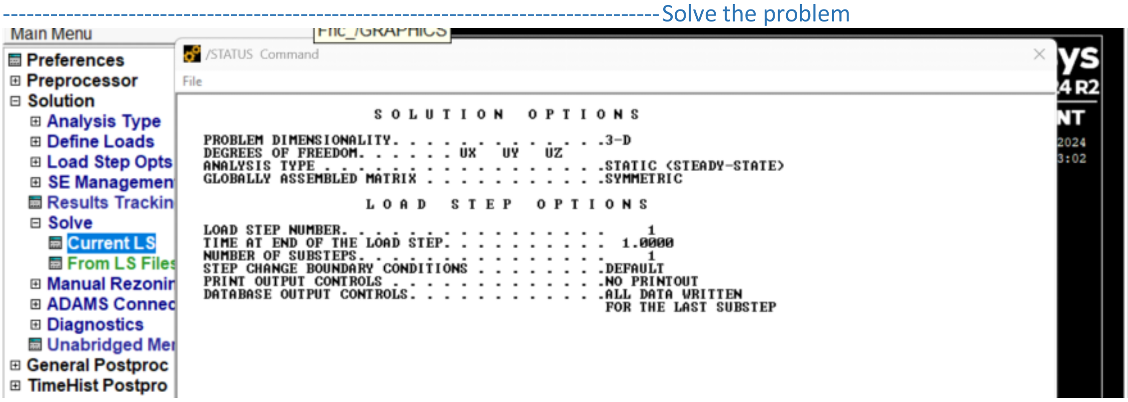




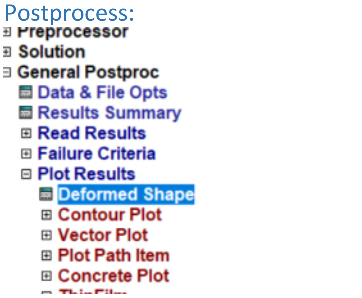
has the right properties

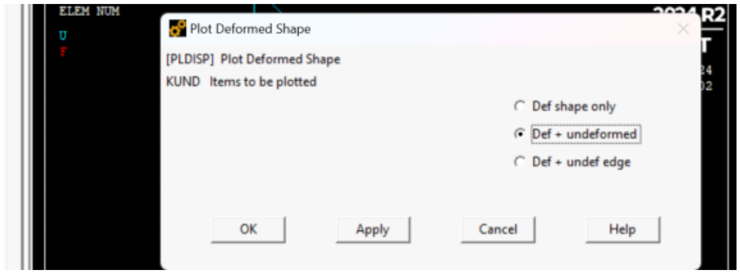


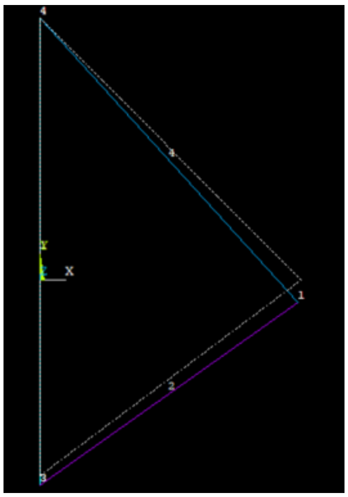
---Solve the problem



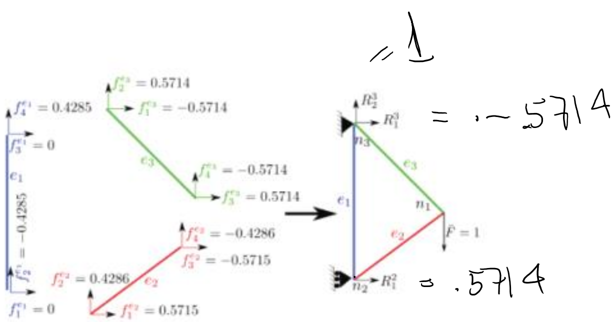
Postprocess:







Reaction forces



- First, we compute reaction forces by adding up forces from individual elements that contribute to reaction forces:

$$R_1^2 = f_1^{e1} + f_1^{e2} = 0 + 0.5715 = 0.5715 \quad (397a)$$

$$R_1^3 = f_3^{e1} + f_1^{e3} = 0 + -0.5714 = -0.5714 \quad (397b)$$

$$R_2^3 = f_4^{e1} + f_2^{e3} = 0.4285 + 0.5714 = 0.9999 \quad (397c)$$

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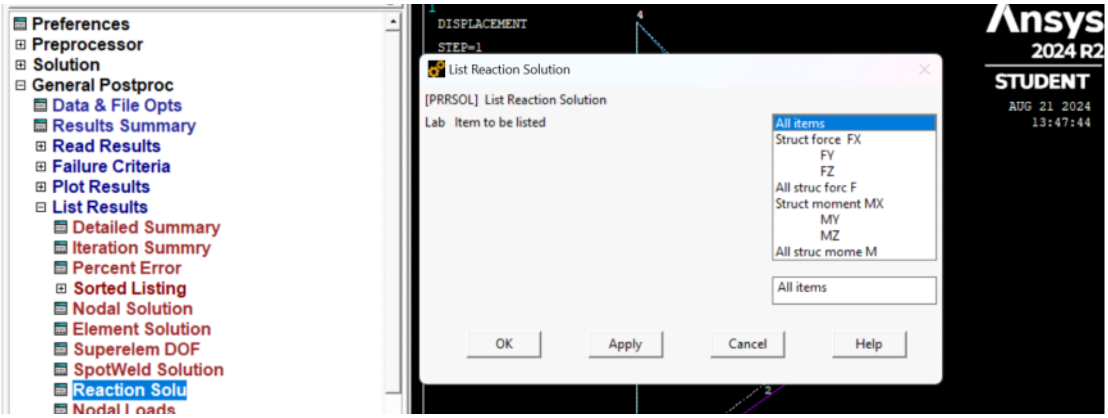
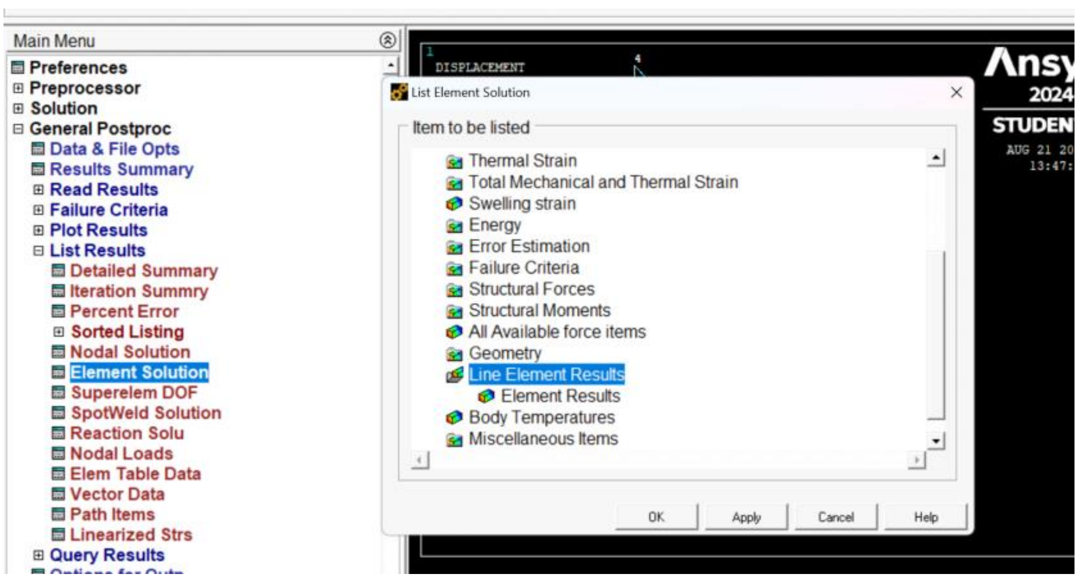


TIME= 1.0000 LOAD CASE= 0

THE FOLLOWING X,Y,Z SOLUTIONS ARE IN THE GLOBAL COORDINATE SYSTEM

NODE	FX	FY	FZ
3	0.57143		
4	-0.57143	1.0000	

TOTAL VALUES			
VALUE	0.0000	1.0000	0.0000




```
PRINT ELEM ELEMENT SOLUTION PER ELEMENT

***** POST1 ELEMENT SOLUTION LISTING *****

 LOAD STEP     1  SUBSTEP=     1
 TIME=    1.0000          LOAD CASE=  0

EL=      1 NODES=        3       4 MAT=     1  XC,YC,ZC=  0.000      0.2000      0.000      AREA= 0.10000                  LINK180
 FORCE= 0.42857      STRESS=  4.2857      EPEL= 0.42857E-03
 TEMP=    0.00      0.00  EPTH=  0.0000

EL=      2 NODES=        3       1 MAT=     1  XC,YC,ZC= 0.8000     -0.6000      0.000      AREA= 0.10000                  LINK180
 FORCE=-0.71429      STRESS= -7.1429      EPEL=-0.71429E-03
 TEMP=    0.00      0.00  EPTH=  0.0000

EL=      4 NODES=        1       4 MAT=     1  XC,YC,ZC= 0.8000      0.8000      0.000      AREA= 0.10000                  LINK180
 FORCE= 0.80812      STRESS=  8.0812      EPEL= 0.80812E-03
 TEMP=    0.00      0.00  EPTH=  0.0000
```

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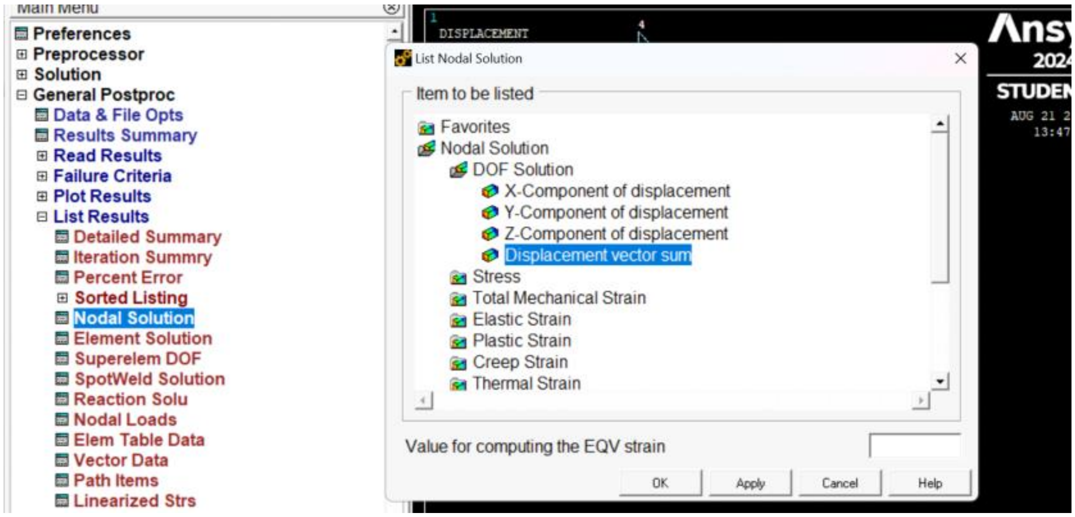
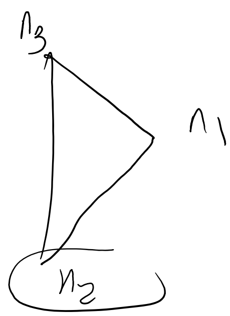
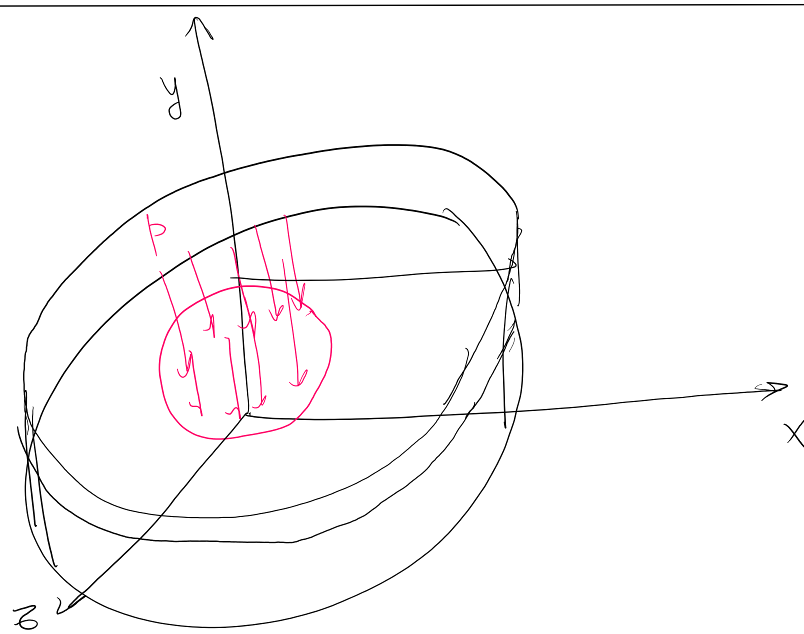
T^e	$T^{e_1} = \frac{1 \times 1}{2.8}\{0 \times (0.5 - 0)$ $+1 \times (0 + 1.2)\} = 0.4286$	$T^{e_2} = \frac{1 \times 1}{2}\{0.8 \times (-0.2123 - 0)$ $+0.6 \times (-3.2928 + 1.2)\} = -0.7128$	$T^{e_3} = \frac{1 \times 1}{1.6\sqrt{2}}\{\frac{1}{\sqrt{2}} \times (-0.2123 - 0.5)$ $-\frac{1}{\sqrt{2}} \times (-3.2928 - 0)\} = 0.8064$



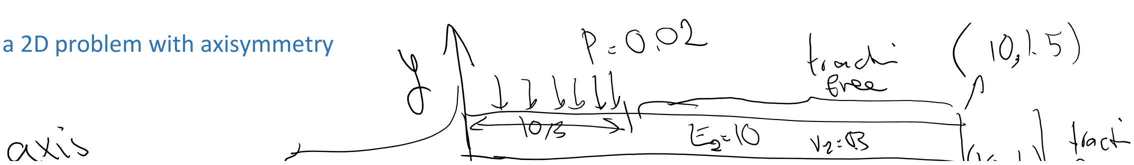

```
PRINT U    NODAL SOLUTION PER NODE

 ***** POST1 NODAL DEGREE OF FREEDOM LISTING *****

 LOAD STEP=     1  SUBSTEP=     1
  TIME=    1.0000      LOAD CASE=   0

 THE FOLLOWING DEGREE OF FREEDOM RESULTS ARE IN THE GLOBAL COORDINATE SYSTEM

   NODE       UX          UY          UZ           USUM
      1 -0.42427E-003-0.30153E-002  0.0000       0.30450E-002
  2   3   0.0000      -0.12000E-002  0.0000       0.12000E-002
  3   4  0.50000E-005  0.0000        0.0000       0.50000E-005
```

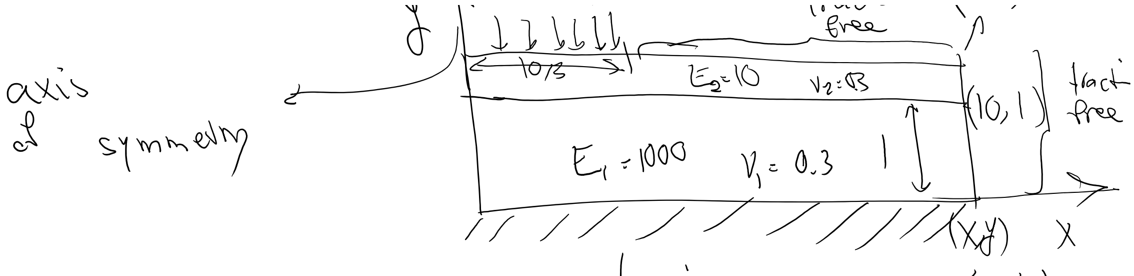


2nd problem

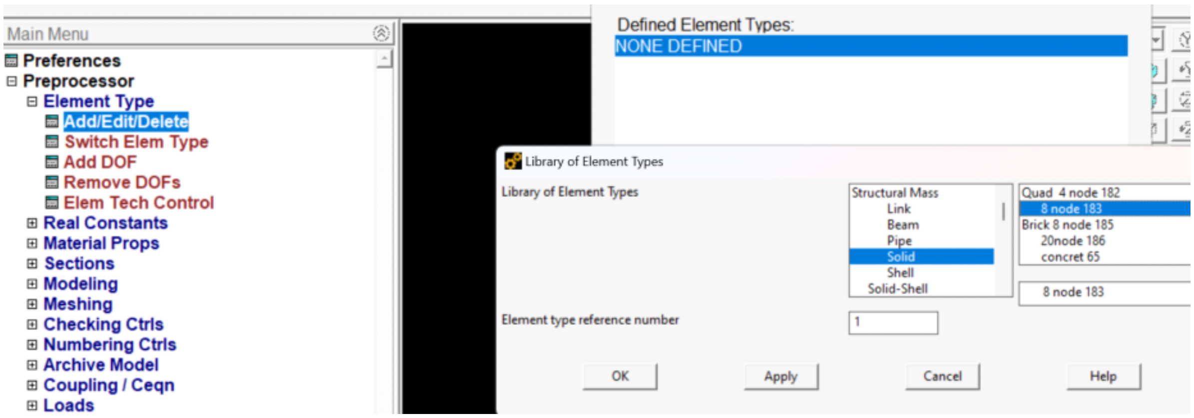


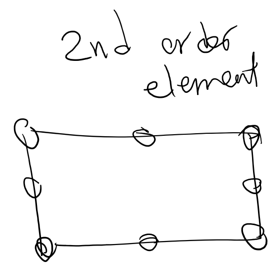
We solve it as a 2D problem with axisymmetry

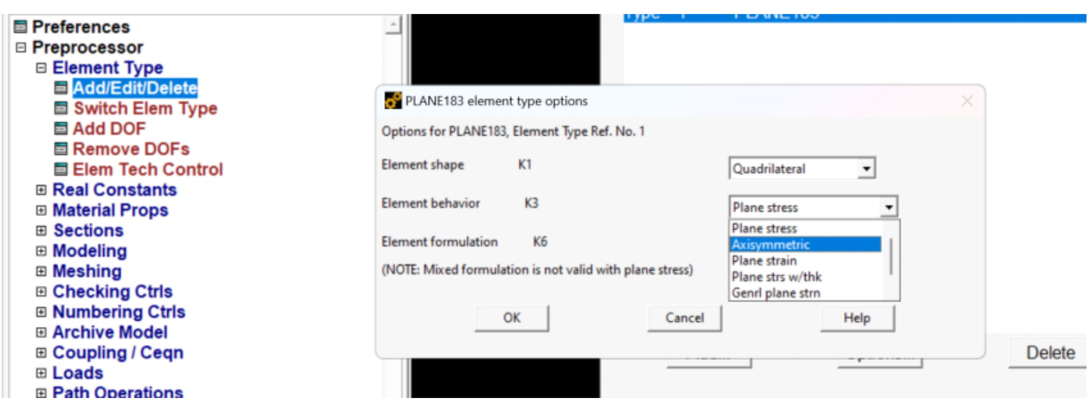




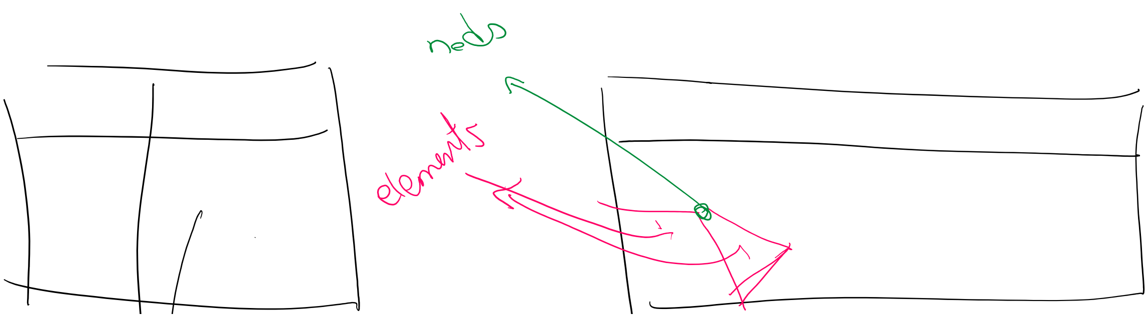
In FE programs any surface by default is traction-free, so we only specify other BCs

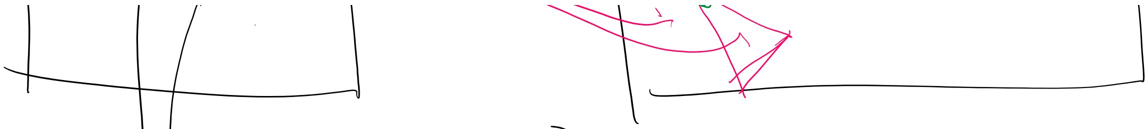






Define materials 1 and 2





areas ⟹ ask the program to "mesh" it