# 2022/09/01

Thursday, September 1, 2022 11:25 AM

Preferences				
<ul> <li>Preprocessor</li> <li>Element Type</li> <li>Real Constants</li> <li>Material Props</li> <li>Sections</li> <li>Modeling</li> <li>Create <ul> <li>Keypoints</li> <li>Lines</li> <li>Areas</li> <li>Arbitrary</li> <li>Rectangle</li> <li>By 2 Corners</li> <li>By Centr &amp; Corners</li> <li>By Dimensions</li> </ul> </li> </ul>	r	Create Rectangle by Dimensions          [RECTNG] Create Rectangle by Dimensions         X1,X2 X-coordinates         V1,V2 Y-coordinates         OK       Apply	Сапсеі Неір	STU SEP 11
X				
	<u>vv</u> orкнале на <u>r</u> ame	eters <u>M</u> acro me <u>n</u> uctris <u>H</u> eip		<u>ع</u> ق
Lile Select List Hot PlotCtris	<u>w</u> orкнаne на <u>r</u> ame	eters <u>M</u> acro Me <u>n</u> uctris Heip		<u>•</u>
LIIE SEIECT LIST MOTOTOTIS DEE BEER AN PETER Toolbar SAVE_DB RESUM_DB QUIT	<u>vv</u> orkPlane Pa <u>r</u> ame	eters <u>M</u> acro Me <u>n</u> uutris <u>H</u> eip		<u>•</u> <u>3</u> <u>•</u>
Lile Select List Hot Plot⊆tris D @ ■ @ @ @ ? ■ Toolbar SAVE_DB RESUM_DB QUIT Main Menu	<u>workHane</u> Harame	eters Macro Menuctris Heip		<u>ৰ</u> হ

List Plot PlotC	trls V	VorkPlane Paramet	ters <u>M</u> acro	MenuCtrls	Help
Files	•				
Status	•				
Keypoint	•	Coordinates Only			
Lines		Coords +Attribute	S		
Areas		Hard Points			
Volumes	1	AREAS			
Nodes		AREA NUM			
Elements	•				
Components					
Picked Entities	s +				
Properties	•	8			
Loads	•				
Results	•				
Other	•	18			
Arbitrany					
Rectangle					
A By 2 Corner	•	5.			
A By Centr & C	ornr	2.4			

We need to merge the keypoionts and after that the connecting lines will also merge





LIST ALL SELECTED KEYPOINTS. DSYS= 0

NC	). X,Y,Z	LOCATIC	N	KESI	ZE	NO	DE	ELE	ΕM	MAT	REAL	TYP
ESYS												
1	0.00	0.00	0.00	0.00	0	0	0	0	0	0		
2	10.0	0.00	0.00	0.00	0	0	0	0	0	0		
3	10.0	1.00	0.00	0.00	0	0	0	0	0	0		
4	0.00	1.00	0.00	0.00	0	0	0	0	0	0		
7	10.0	3.00	0.00	0.00	0	0	0	0	0	0		
8	0.00	3.00	0.00	0.00	0	0	0	0	0	0		

Dividing the top line to 5 segments so we can apply the load on the first



Boundary conditions

- We don't need to specify that the left edge is the axis of symmetry
- Fix the bottom line:





After fixing all dofs on the bottom surface



no need to define BC, here as this is FEM's defan

Apply the pressure on the top surface - first segment



□ Loads Analysis Type Define Loads Settings □ Apply Structural Displacement ■ Force/Moment Pressure P On Lines



### Meshing

First thing, we define material number for each area

-----

AICO AUTOULO	3
@ Pick	C Innick
	· onpres
Gingle     Single     Sin	C Box
C Polygon	← Circle
( Loop	
Count =	0
Maximum =	2
Area No =	1
ALES NO	
( List of	Items
C Min, Ma	x, Inc
5	
1	_
OK	Apply
Reset	Cancel
Pick All	Help
	(* Pick (* Single (* Polygon (* Loop Count = Maximum = Area No. = (* List of (* List of (* Min, Ha (* Min, Ha (* Min, Ha)) (* Min, Ha))

8	1,11	1.0	L10	9	L9	6	L5	6	L7	1
L8					A2					L6
					* 0					

_	🚰 Area Attributes		×
	[AATT] Assign Attributes to Picked Areas		ne
	MAT Material number	2 🔽	202
	REAL Real constant set number	None defined 💌	JDE
	TVPE Element type number	1 PLANE183	• 1 2
	ESYS Element coordinate sys	0 🔹	11:35
111	SECT Element section	None defined 💌	7
			LG
			3
			L2
			2
	OK Apply Cancel	Help	

# List the areas

LIST	AL	L SEI	ECTE	ED AR	EAS														
NUM	IBE	ER LO	DOP	LINES	;		AREA	ELEM S	IZE	#١	NOE	DES	#El	EM	MAT	REAL	TYP	ESYS	SECN
1	1	1	2	3	4	N/A	0.000	0	0	1		0	1	0	0				
2	1	3	6	7	5	N/A	0.000	0	0	2		0	1	0	0				
		9	10	11	8														

	MeshTool			
	Element Attrib	outes:		
	Global	•	Set	
	Smart Size	e		
	Fine	6	Coarse	
16	Size Controls:			1
20	Global	Set	Clear	
	Areas	Set	Clear	
	Lines	Set	Clear	
11:		Сору	Flip	
	Layer	Set	Clear	
7	Keypts	Set	Clear	
	Mesh: A	veas	•	
	Shape: C	Tri	Quad	
3	Free C	Mapped	C Sweep	
	3	or 4 sided	Ŧ	
2	Mesh	1	Clear	
				_
	Refine at F	lements	•	
		Pei	ine	
		her	ne	_
	Close		Help	

#### Pick all areas:



### Solution:



Postprocess:

□ General Postproc
 □ Data & File Opts
 □ Results Summary

-----

- Read Results
   Failure Criteria
- Plot Results
  - Deformed Shape



#### ----

### Contour plots

Choose 1st principle stress from the list of nodal contour plot:







Min and max sigma\_1 for the whole domain

Plotting the results for certain number of layers Select -> entities ->

de
Elements 💌
By Attributes 💌
• Material num
C Elem type num
C Real set num
C Elem CS num
C Section ID num
C Layer num
Min,Max,Inc
2,11,1
• From Full
C Reselect
C Also Select
C Unselect
Sele All Invert
Sele None Sele Belo
OK Apply
Plot Replot
Cancel Help
8

Here the plot for the bottom layer



# Specifying the range of contour plot:

Plot<u>C</u>trls <u>W</u>orkPlane Pa<u>r</u>ameters <u>M</u>acro Me<u>n</u>uCtrls <u>H</u>elp

Pan Zoom Rotate View Settings	,			
Symbols				
Style	<ul> <li>Hidden Line</li> </ul>	Options		
Font Controls Window Controls	Size and Sha Edge Option	ape 1s		<b>Ansys</b> 2022 R
Erase Options	<ul> <li>Contours</li> </ul>	•	Uniform Contours	1 2022
Animate Annotation	Graphs Colors	*	Non-uniform Contours Contour Style	11:56:13
Device Options	Light Source	•	Contour Labeling	

1	Contours Uniform Contours	× 21/
NODAL SOLUTION	[/CONT] Uniform Contours	57
STEP=1	WN Window number	Window 1 - 022 F
SUB =1 TIME=1	NCONT Number of contours	9 ENT
S1 (AVG)	Contour intervals	2022
DMX =.371E-03 SMN =- 044632		C Auto calculated
SMX =.018499		○ Freeze previous
		User specified
	User specified intervals	
	VMIN Min contour value	-0.05
	VMAX Max contour value	0.20
	VINC Contour value incr	
	[/REPLOT] Replot Upon OK/Apply?	Replot
2		
x		
	OK Apply	Cancel Help





FEM For motodici Balance laws  $\left( \right)$  $\sum_{\alpha,\omega} f_{\alpha}$ Subalanan Lemain. . \

ME517 Page 9

 $O_{z}$  t Subrianani CD > demail. Jourson dS + J pb = 0 body force what is it is arbhran > are will derive Strong form - (Partial) Differential Equation (PDE) 13 + gb =0 YXE29 8 ØX = 7.6 + ph r Ralder Weighted Residual Statement (WRS) V.6+pb)=()





Discontinuous Galerkin -> Different basis functions

FEM formulation in detail

1. Balance law

- Why start with a balance law?
  - They are the actual physics laws.
  - They contain more *information* than their corresponding PDEs.
  - Larger solution space than the PDEs.
- Can we directly start the FE formulation from a PDE?
  - Yes, FE formulation starts from a differential equation.
  - A PDE may not be derived from a balance law.



Balance of mass, force (linear momentum), energy, ...

Example of balance of force in discrete setting:





Continuum:

Balance of forces

 $\Sigma F_{0}O$ 

Types of forces: 1. Volumetric force

 $F_{V} = \sum_{i} AF_{V} = \sum_{i} AF_{V$  $\overline{(}$ 

メり

Sub Dimari

R

3

r ga

 ${}^{\chi}$ 

(



