

**AUSTRALIAN DEFENCE FORCE ACADEMY
SCHOOL OF
AEROSPACE AND MECHANICAL ENGINEERING**

**Course: AMEC 3508 Mechanics of Solids 2B
AMEC 3706 Aircraft Structures 1B**

Assignment # 2 (30%)
Due date: Friday, October 26, 2001, 23:59

Thickness Optimisation of a Fuel Tank

Don't start working before reading the whole assignment sheet and understanding what is required. Treat this assignment as any exam with limited time to work and pace yourself to meet the due date. DO NOT miss the tutorial sessions to work on this assignment.

Use the ANSYS Parametric Design Language (APDL) wherever possible, especially for the calculation of coordinates and lengths that are not explicitly given.

The fuel tank in Figure 1 is made of steel and is rigidly supported as shown. Given the properties of steel and the fluid contained within, calculate using ANSYS the thickness of the plate at which a targeted safety factor **TSFFACT** is achieved.

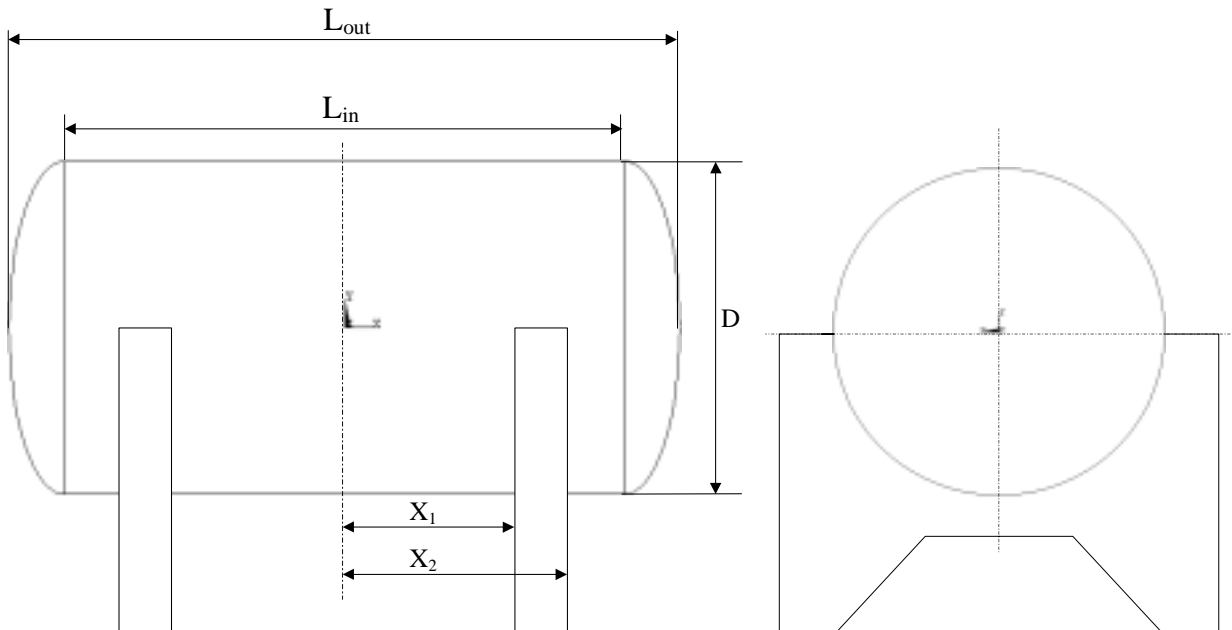


Figure 1. Fuel Tank

Note that the supporting structure will not be analysed, instead the supporting nodes on the tank will be constrained in all directions.

Hints:

- Write a macro that accepts all the input parameters and incorporates all the required tasks. It will be named **A2-YourStudentID** to be later submitted electronically.
- You can first issue commands from the menu then use the log file generated by ANSYS and copy the relevant parts to build your macro
- The distances X_1 and X_2 are so that they coincide with the mesh. The number of subdivisions along L_{in} being 10, it follows that $X_1 = 3*L_{in}/10$ and $X_2 = 4*L_{in}/10$.
- The caps at both ends of the cylinder are ellipsoidal. Use the provided macro ELLIPSE to create the keypoints of the elliptic quadrants.
- Use B-splines to create elliptic curves through the keypoints created by ELLIPSE.
- Join the created elliptic curves with a straight line at the top.
- Sweep the joined curves to form the tank's surface.
- Use simple bisection technique to find the thickness at which the targeted safety factor is achieved. This means extra macro coding. Follow the flow-chart that will be discussed in the next lecture (Friday 13/10/2000).
- Refer to previous tutorials as needed.

Specifics:

Dimensions: $L_{in} = \text{variable}$ $L_{out} = \text{variable}$ $D = \text{variable}$
 $X_1 = 3*L_{in}/10$ $X_2 = 4*L_{in}/10$

Geometry: **Number of segments on the surface of revolution:** 36

Mesh: **Element type:** SHELL63
NDIV along L_{in} : 10 **NDIV along the elliptical curves:** 6
Body mesh type: MAPPED **Caps mesh type:** FREE

Material Properties for steel: **EX** = 209 GPa **NUXY** = 0.27 **S_y** = 250 MPa
SDENSITY = 8750 Kg.m⁻³

Material Properties for fuel : **FDENSITY** = *variable*

Targeted Safety Factor: **TSFFACT** = *variable*

Gravitational Acceleration: **g** = 9.81 m.s⁻²

Loading: Pressure loading by fuel on tank surface through pressure gradient, and gravity load.

Constraints: ALL DOFs set to zero at all support contact nodes.

Assessment and requirements:

The macro **A2-YourStudentID** should run without human intervention by accepting the following input parameters (arguments) in the given order:

INPUT PARAMETERS:

<i>Argument</i>	<i>Parameter</i>	<i>Description</i>
ARG1	FDENSITY	Fuel Density
ARG2	LIN	Length of the cylindrical section of the tank
ARG3	LOUT	End to end length of the tank
ARG4	D	Diameter of the tank
ARG5	TSFFACT	Targeted Safety Factor
ARG6	MAXITER	Maximum number of iteration before giving-up
ARG7	THICK1	lower guess value of the thickness
ARG8	THICK2	upper guess value of the thickness
ARG9	PERROR	Allowed Percent Error

REQUIRED VARIABLES:

- THICK:** which is the plate thickness at the end of each iteration
- CSFFACT:** which is the calculated safety factor at the end of each iteration
- SMAX:** which is the maximum von Mises stress at the end of each iteration
- TOTITER:** last iteration number
- THICKS:** array in which the tried thickness value for each iteration is stored
- SFACTS:** array in which the safety factor value for each iteration is stored
- SEQVS:** array in which the maximum von Mises stress for each iteration is stored

Marking:

- Successful generation of the geometry 20%
- Successful application of the constraints 5%
- Successful application of the loads 5%
- Successful generation of a the mesh 10%
- Successful solution of at least 1 iteration with correct results
(**THICK, CSFFACT and SMAX**) 10%
- Successful extraction of **TOTITER** when **CSFFACT = TSFFACT** 10%
- Successful extraction of **THICKS** 10%
- Successful extraction of **SFACTS** 10%
- Successful extraction of **SEQVS** 10%
- Successful display of **SFACTS** versus iteration plot 10%

PAY ATTENTION TO THE VARIABLE NAMES, IF THEY DON'T MATCH THEY WON'T BE ASSESSED!!! And please, no pet names for variables elsewhere.

Submission:

E-mail the macro file “A2-YourStudentID” to m.tahtali@adfa.edu.au as an e-mail attachment with subject “[FEM2001A2]” **before** midnight Friday, October 26, 2001.

And pay attention to the subject field, it is not FEM2000-A2 or FEM2001, it is [FEM2001A2]