Assuming that the wing-fuselage joint has two lugs each on the top and bottom (see sketch and figure in attachments), calculate the forces in each of the lugs and based on these forces, check for the lug failure margins for **axial failure, shear failure and bearing failure.** The methodology as discussed in class is provided in the relevant sections of Bruhn's text attached here. Use BOTH Method 1 and Method 2 as given in the attachment.

The material to be used is Al2124 and its properties are provided in the attachments. The initial trial dimensions for the lug are provided in the attachment. (Note: this is just a typical set of dimensions and so this could be too strong or too weak depending on the type of aircraft you are designing)

Deliverables: Prepare a presentation which is clear and self-explanatory which includes the details of the load used for the design, the methodology used and the margins obtained based on it for the final lug dimensions (NOT the initial dimensions given!).

Axial failure

Failure in Tension

$$P_{u(tension)} = F_{tu}\,(2R - D)t \quad - - - - - - - - - (2)$$

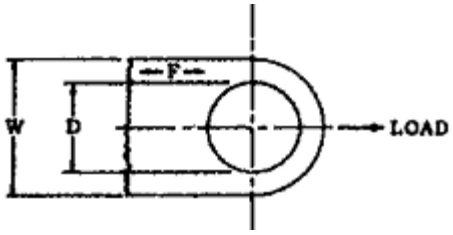
where F_{tu} = ultimate tensile strength of plate material.

R=75mm
D=25mm
t=25mm
F_{tu}=489.52 MPa
$P_u=F_{tu}*(0.15-0.05)*0.025=1.2238 * 10^6$ N
Tension across the net section

$$P_u = K_t\, F_{tu}\, A_t \quad - - - - - - - - - - - - - - - - (6)$$

where K_t is the stress concentration factor as found from Fig. D1.12 and Table D1.3. F_{tu} = ultimate tensile strength of the material and A_t = net tension area.

$P_u=K_tF_{tu}A_t$
$A_t=(0.15-0.05)*0.025$
F_{tu}=489.52 MPa



For W/D=150mm/50mm=3
K_t=0.9
P_u=1.1014*10^6 N

Shear Failure

Failure by bolt shear

$$P_{u(\text{bolt shear})} = F_{su} \cdot A \cdot 2 \quad - - - - - - - - - - (1)$$

where F_{su} = ultimate shearing stress for bolt material.
A = cross-sectional area of bolt.

$P_u=F_{su}$*A*2
A=Bolt area=pi*0.025^2=0.0019625
F_{su}= 331 MPa
P_u=1.299* 10^6 N

Bearing Failure

Failure by bearing of bolt bushing

$$P_u = F_{br}\ D\ t \quad - - - - - - - - - - - - - - - - -$$

where F_{br} = allowable bearing stress
D = diameter of bushing
t = plate thickness

$P_u=F_{br}$*D*t
P_u=489.52*10^6*0.05*0.025=6.119*10^5 N

Shear out Bearing Strength

$P_{bru} = K_{bru} F_{tu} A_{br}$ - - - - - - - - - - - - -

The values of K_{bru}, the shear-bearing efficiency factor, is given by curves in Fig D1.13.

$P_{bru}=K_{bru}*F_{tu}*A_{br}$

$P_{bru}=0.6*489.52*10^{6}*(0.05*0.025)=3.67*10^{5}$ N