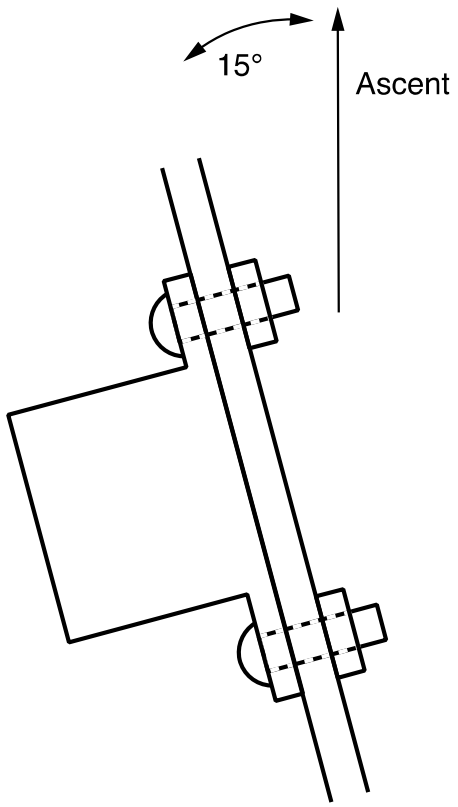
Handed Out: 2/13/24
Due: 2/27/24 11:59 pm

DESIGN PROBLEM #1

A 2,100 kg orbital package is mounted within the space shuttle on a mating platform. The platform is at an angle of 15° with the ascent axis of the shuttle. The package is circular and has an outside rim through which holes can be drilled and bolts mounted for attachment. Shuttle astronauts will need to detach this package from the mating platform during an EVA while in orbit.

The vertical flight phase of the shuttle involves a peak vertical acceleration of 3.0 g. The specified factor of safety is 1.3. In addition, the package will be carried across country to the launch site on a transport aircraft. The part can be mounted in any manner on the airplane.



Several different types of bolt/nut combinations are under consideration. Their capability is summarized below:

Bolt/nut type	Mass [grams]	Shear capacity [N]	Pullout capacity [N]	Cost per lb [$]
A	200	7000	7000	20
B	200	8000	6000	25
C	150	6000	4000	10
D	125	5000	2500	20
E	125	6000	5000	115
F	100	5000	3000	50

You have been hired as a consultant to determine the bolt/nut type(s) that should be used. Bolt/nut types can be mixed. Your team may assume that loads (shear and pullout) are shared equally between bolts. This assumption would later be checked in a refined analysis of the chosen design.

Your submission is to be in the form of a memo to the "Head of Orbital Packages" supported by necessary calculations and associated work properly referenced and included (generally as an attached appendix). Be sure to clearly give your reasoning. It is suggested you show the number of bolts of each type needed and find the expected margin of safety (Note that the "capacity" values have been determined from experiments). You should discuss considerations such as cost, weight, assembly, complexity, and safety as appropriate. Identify options with any possible unknowns and/or drawbacks.