AE4509 Advanced design and optimization of composites
Assignments

1. Let N_{sand} be the buckling load of a simply supported sandwich panel under compression. The panel has dimensions a and b with a parallel to the applied loading. You are to determine an analytical expression for the stiffener properties of a stiffened panel such that the stiffened panel has the same panel buckling load as the sandwich panel. You can approximate the number of half-waves for the stiffened panel as a real number (not necessarily integer) and the number of stiffeners as the width divided by the stiffener spacing. Assume the stiffener has an open cross-section.

2. In relation to part 1, assume now that a=1 m and b=0.4 m. Assume you can only use (0/90) and/or (±45) plies with at least two plies per facesheet. Determine the lowest weight sandwich panel when the applied compressive load is: 10N/mm, 50N/mm and 500N/mm. Make sure you account for all possible failure modes. Material properties are as follows:

 Facesheet

E_x = 55.152E9 Pa
E_y= 55.152E9 Pa
ν_{xy}= 0.05
G_{xy}= 4.826E9 Pa
t_{ply}= 0.4191 mm
X^t= 534.3 MPa
X^c= 577.7 MPa
Y^t= 534.3 MPa
Y^c= 577.7 MPa
 S = 70.3 MPa
density = 1636 kg/m^3

Core (x is ribbon direction)
E_c=1.86 MPa
G_{xz} = 117.2 MPa
G_{yz} = 48.2 MPa
Z_c = 1.86 MPa (out-of-plane compression strength)
Z_{xz} = 1.03 MPa (shear strength in ribbon direction)
Z_{yz}=0.52 MPa (shear strength perp ribbon direction)
density = 48 kg/m^3
Adhesive density= 0.293 kg/m^2

3. Bonus. Attempt to come up with a stiffened panel design that is lighter than the best sandwich design of question 2. Obviously, if the skin of the stiffened panel has 4 plies or more, it will be heavier than the sandwich because it is highly unlikely that the stiffeners will be lighter than the core. Therefore, try with either two plies (both of which must be the same for a symmetric layup) or three plies. Use the results from question 1 to determine a value for a parameter involving EI and ds. Then, assuming 2 or 3 plies per

stiffener and an "L" cross-section where the flange is no less than 10 mm wide, try to come up with a configuration that has the same weight as the best design in question 2. Do this only for the applied load of 500 N/mm case. Check only for global and bay buckling failure of your stiffened panel. You can only use the composite material in question 2.