Institute for Aerospace Studies
UNIVERSITY OF TORONTO

AER 1403: Project 1
Due: 2 November 2021

You are to design a composite plate that will support a desired load. The load is determined by your student number: take the last seven digits of your student number and represent them by $TUVWXYZ$, where each letter corresponds to one digit. The vector of applied loads which the composite plate must be designed to carry without failure is given by:

$$\left(N_x,\ N_y,\ N_{xy},\ M_x,\ M_y,\ M_{xy}\right)^T = \left(A\text{ kN/m},\ B\text{ kN/m},\ C\text{ kN/m},\ D\text{ N},\ 0,\ 0\right)^T$$

where the constants A, B, C and D are determined by:

$$A = 250 - 2 \times TU$$
$$B = 10 + 8 \times V$$
$$C = WX$$
$$D = -20 - YZ$$

Note that, for example, if $T = 2$ and $U = 0$, $TU = 20$. The composite material with which you are to design this laminate has the following properties: $E_1 = 125$ GPa; $E_2 = 9.8$ GPa; $G_{12} = 5.5$ GPa; $\nu_{12} = 0.24$; $\sigma_L^+ = 900$ MPa; $\sigma_L^- = 800$ MPa; $\sigma_T^+ = 55$ MPa; $\sigma_T^- = 170$ MPa and $\tau_{LT} = 90$ MPa. Each ply is 0.125 mm thick.

Your task is to design a composite laminate, using as many plies as necessary, that will support the applied load. In order to show this, you must calculate the stresses in each ply of your laminate and show that they do not fail according to both the Tsai-Hill or Tsai-Wu criteria. Inefficient laminates will be penalized: for each ply more than the number of plies necessary to support this load, a 2.5% deduction from your mark will be applied.

To complete this project, you must submit in a single pdf through Quercus:

1. the design of your laminate, including the number of plies and the stacking sequence;
2. a full stiffness matrix for the laminate;
3. the strain state at the mid-plane of the laminate and the strain state in global coordinates in each ply;
4. an analysis, ply by ply, of the stress state in all laminae and a comparison with the failure criteria;
5. all codes that you use to perform the calculations; and
6. additional comments on other considerations that you might use if you were to design this laminate in practice.