Description of Composites Coursework

Title: **Design and Analysis of a Laminated Composite Tube**

Arrangement: This is a group coursework. Each group will form from a maximum of 3 students among students themselves. The mark achieved in this coursework will be shared by each of the members in the group. You are allowed to complete the coursework on your own if you wish.

Report submission: One group only needs to submit one report (with names of all members). Please submit the report to Blackboard by
18:00 Tuesday 17 March 2020 (For lab session on 3 March 2020)
18:00 Wednesday 18 March 2020 (For lab session on 4 March 2020)
18:00 Friday 20 March 2020 (For lab session on 6 March 2020)

General description and requirements:

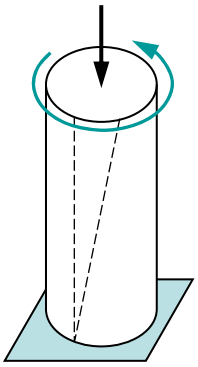
A cylindrical tube of 4 layers of composite with a layup of $[\alpha/\beta/\alpha/\beta]$ is to be designed and by winding tapes cut from a UD carbon-epoxy prepreg sheet on to a cylindrical mandrel of a 25mm radius. For the consideration of practicality, the range of these two winding angles will have to fall in [–75°, –30°] or [+30°, +75°] to the axis of the tube, e.g. $-75° \le \alpha \le -30°$ or $+30° \le \alpha \le +75°$. The thickness of the prepreg is 0.25mm. The tube should be made to a length of 300mm.

(1) By selecting appropriate winding angles α and β, the tube will be designed to sustain the following loading conditions separately based on maximum stress failure criteria:

a) An internal pressure of p =3 MPa before burst when both ends are closed but free to deform, assuming no leakage takes place before burst.

b) Axial compression of P =25 kN.

(2) In addition to the above requirements, the layup of the tube should be designed to achieve an angle of twist under axial compression in a specified direction as indicated in the diagram on the right.



(3) Among all the winding angles which enable the tube to withstand the axial load and the internal pressure, your design should aim to find one set of α and β values which will achieve a maximum angle of twist for the tube in the required direction when the tube is subjected to axial compression.

Material properties:

E_1=236 GPa	$\sigma_{1t}^{*} = Xt = 3800\,\text{MPa}$	$\sigma_{1c}^{*} = Xc = 689\,\text{MPa}$
E_2=5 GPa	$\sigma_{2t}^{*} = Yt = 41\,\text{MPa},$	$\sigma_{2c}^{*} = Yc = 107\,\text{MPa},$
G_{12}=2.6 GPa	$\tau_{12}^{*} = S = 69\,\text{MPa}$	
ν_{12}=0.25		

* The design loads are higher than the working loads (i.e. safety factor already considered)

MathCAD work sheet

A work sheet on the use of mathematical software, MathCAD, for the particular design problem has been attached for your information. A computing lab session has been scheduled which is designated to help you with your use of the work sheet and MathCAD. Demonstrators will be present to offer help. Please check your lab schedule.

You are free to use any other software, such as Matlab, to do this coursework. In this case, you don't have to attend the computer lab session, as no support will be offered.

Report

A standard report is required (maximum length: 8 pages) and the coursework report should address the followings:

1) Design approach and theory. [55 marks]

All the equations used for the design analysis and solution are required (including those derivation made by you if there are any). The equations must be in the format as those in the lecture notes, NOT as those in the MATHCAD handout. This is to ensure that you know which equations are employed. Please don't include un-necessary equations.

A clear design analysis procedure, i.e, Step X, define [Q]. Step XX, find [A], ….

2) Results for your design. [45 marks]

Convincing results and analysis/explanation are needed to prove that your design satisfies the design requirements.

There is no need to include trivial numerical results such as [*Q*], [*A*], [T] etc. However, results for stress $\{\sigma\}$, failure analysis and twist angle should be included in the report.

3) Please attach your program, such as Matlab, as appendix (not in the page limit) if you do not use Mathcad to complete the coursework.