The Robert Gordon University
Faculty of Design and Technology
School of Engineering

EN2701 Mechanics of Solids
Coursework – Torsion

1. Determine the shear modulus, G, for an aluminium alloy and compare it with published values, explaining what you did. Use the following procedure:

(a) Go to website: http://instruct1.cit.cornell.edu/Courses/virtual_lab/intro.shtml
(b) Read the "Chalk Talks" on Basic Theory, Testing System and Engineered Materials.
(c) Watch the "Virtual Tests" for aluminium (aluminum).
(d) From the "Test Data" for aluminium choose the samples allocated to you in the table (on Moodle), carefully noting the dimensions.
(e) Using the data in the Excel file for the chosen samples, calculate the shear modulus, G. Some of the information in the "Chalk Talks" on Engineering Materials and "Lab Manual" – Instructions will help you.
(f) **Compare your calculated values with published data* and discuss the possible reasons for any differences.**

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2. A 2.4 m long structural aluminium pipe (series 6063-T6) is used as part of a roof structure. As part of the design process it is required to assess the suitability of different sizes of pipe. Analyse the pipe allocated to you in the table (on Moodle) answering the questions below. Relevant data is given in Table 1.

(a) Calculate the maximum torque that can be applied to the shaft if the maximum allowable yield stress and angle of twist are to be complied with.
(b) The architect now wants to replace the aluminium pipe with a solid circular aluminium bar. Calculate the minimum diameter required for the bar to resist the same torque as in (a) without exceeding the maximum allowable shear stress or angle of twist.
(c) Calculate the ratio of the weight of the pipe to the weight of the solid bar. Comment on the **significance** of your answers.

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3. It is suggested that the aluminium pipe in Q2 is replaced by one made of steel from the choice available in Table 3. The steel pipe must carry the same torque and be of the same length as the aluminium one.

Determine whether a steel pipe is available which will satisfy these requirements and support your answer with calculations. Comment on any advantages or disadvantages of the replacement if available.

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Notes:

1. See Coursework Guidance document on Moodle.

2. The coursework does not have to be word processed but marks will be lost for careless / illegible work.

3. Explanations should be given for all formulae and procedures used.

4. ***References should be given for all external sources of data. Again, see Coursework Guidance.

Table 1 Dimensions of Aluminium Pipe

6063-T6 Structural Aluminium Pipe	Nominal Size (mm)	Outside Diameter (mm)	Wall Thickness (mm)	Weight Per Unit Length (kg/m)
AP1	12.70	21.34	2.77	0.4337
AP2	19.05	26.67	2.87	0.5762
AP3	25.40	33.40	3.38	0.8555
AP4	31.75	42.16	3.56	1.158
AP5	38.10	48.26	3.68	1.395

Table 2 Aluminium and Steel Property Data

	6063-T6 Structural Aluminium Pipe	Steel Continuous Weld Pipe
Shear modulus, G (GPa)	27	78
Density, ρ (kg/m^3)	2750	7850
Poisson's ratio, ν	0.35	0.3
Yield stress, σ_Y (MPa)	172	490
Maximum allowable shear stress, τ_{all} (MPa)	0.4 σ_Y	0.25 σ_Y
Maximum allowable angle of twist, θ_{all} (deg)	15	15

Table 3 Dimensions of Steel Pipe

Steel Continuous Weld Pipe	Nominal Size (mm)	Outside Diameter (mm)	Wall Thickness (mm)	Weight Per Unit Length (kg/m)
SP1	3.175	10.29	1.73	0.3125
SP2	3.175	10.29	3.20	0.4087
SP3	6.350	13.72	2.24	0.6250
SP4	6.350	13.72	3.03	0.8125
SP5	9.525	17.15	2.31	0.8483
SP6	9.525	17.15	3.74	1.103
SP7	12.70	21.34	2.87	1.682
SP8	12.70	21.34	3.91	2.188