ABE 30300

Homework 7 – Fall 2017 (Optional – count for extra points)

Due Friday December 8 (100 marks)

Problem 1 (20 marks)

A rheological test is carried out using a cone and plate geometry with a cone angle of 2° and a cone radius of 30mm. The following experimental data was obtained:

Ω (rad/sec)	Torque M (mN-m)
0.63	1.3
1.9	3
5.7	6.3
11	9
15	11
22	16
30	18

(a) Convert raw data into shear rate and shear stress
(b) Determine the rheological parameters of the liquid

Problem 2 (40 points)

(a) Explain in your own words **a relaxation experiment** and derive an expression to describe the stress relaxation behavior of a ***Maxwell model***.
(b) Explain in your words a **creep experiment** and derive an expression to describe the creep behavior of a ***Kelvin-Voigt*** model.
(c) Describe in a few sentences what methodology you will use to estimate the rheological properties of a viscoelastic food dessert.
(d) Find **two** (2) scientific articles in where viscoelastic tests are used to characterize the viscoelasticity of a biomaterial. In your answer include the complete reference and briefly discuss the experimental approach used and the main findings. **Please try to work alone in this question**, it is important that you learn how to look for technical information, critically examine it and extract useful conclusions from that information. You can discuss that information with others including me, but the work has to be an individual work. You can use the tool Google Scholar linked to Purdue library to directly retrieve the articles.

Problem 3 (20 points)

You need to estimate a relaxation time t_R to scale a mixer to be used to mix a viscoelastic material. The table below gives data from a relaxation test as *G(t)* versus *t*. *G(t)* is known as the relaxation modulus estimated as $\sigma(t)/\gamma_0$, where γ_0 is the value of the strain applied in the text. From the data estimate the value of t_R.

Hint: you could assume that the material behaves as an ideal Maxwell viscoelastic material

t, seconds	*G(t), MPa*
1E-3	27.0
2E-3	26.9
5E-3	26.5
1E-2	25.9
5E-2	22.0
1E-1	18.4
5E-1	8.75
1	5.68
2	3.29
5	1.53
10	0.795
20	0.30
50	0.045
70.8	0.015
100	3.4E-3
158	1.81E-4
200	2.32E-5

Problem 4 (20 points)

Oscillatory tests on a biomaterial gave the viscoelastic materials a function of frequency illustrated given in the following table.

Frequency ω, rad/s	G*, Pascal	$\tan\delta$
9.4E-3	9.81E3	47.2
1.43E-2	1.49E4	29.3
3.3E-2	3.44E4	14.0
2.18E-1	1.91E5	2.77
8.44E-1	5.94E5	0.88
2.33	6.67E5	0.41
3.92	7.46E5	0.28
8.30	8.0E5	0.15

Determine the relaxation times and other associated parameters for this material assuming that the material can be modeled as a Generalized Maxwell model with three elements.