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Courses » Rheology of Complex Materials

Announcements Course Ask a Question Progress Mentor

## Unit 13 - Week 11

### Course outline

Week 0 - Pre-requisites

Week 1

Week 2

Week 3

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Week 10

Week 11

● Yield stress and thixotropic materials

● Normal stresses and stress growth

● Rheometer demonstration

● Review of material functions 3

● Survey of material functions for multiphase macromolecular systems

○ Quiz : Assignment 11

### Assignment 11

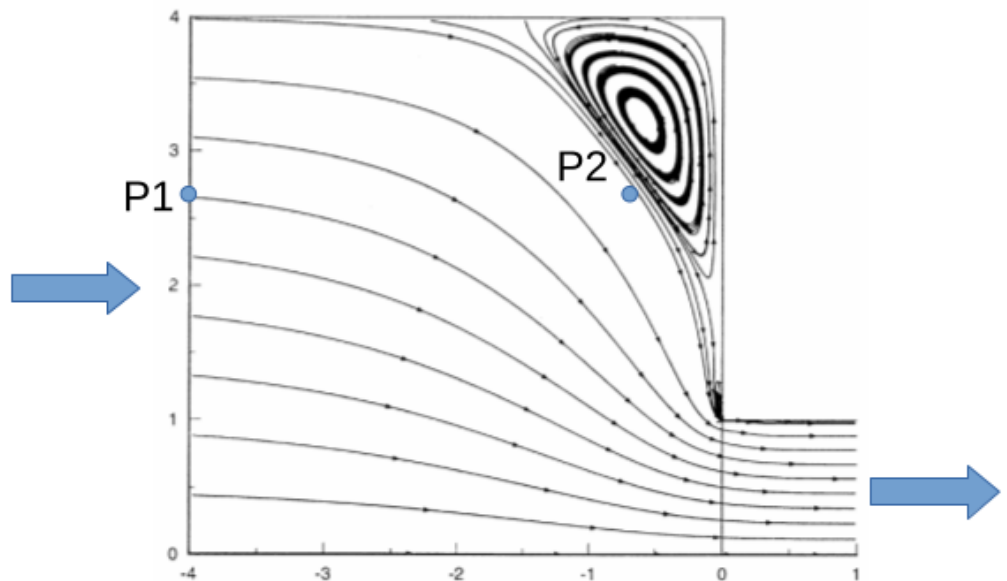
The due date for submitting this assignment has passed. **Due on 2018-04-11, 23:59 IST.**

#### Submitted assignment

Based on the data given in question 2, answer the following up to 6

1) Following is example of a geometry in which cross-sectional area changes along the direction of flow. This is called a sudden contraction flow, and is a benchmark flow to study flow behaviour of fluids.

2 points



Based on the components of velocity gradients, type of flow/s important at different points are

- P1 and P2 - shear flow only
- P1 and P2 - extensional flow only
- P2 - shear flow and P1 - shear/extensional flow
- P1 - shear flow and P2 - shear/extensional flow

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*P1 - shear flow and P2 - shear/extensional flow*

2) The following graph stress as a function of strain rate for a suspension of poly methyl methacrylate (PMMA) particles [Bonn et al, Review of Modern Physics, 2017]. The legend shows the volume fraction of PMMA particles.

2 points

- Week 11  
Feedback :  
Rheology of  
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Materials
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solutions

Week 12

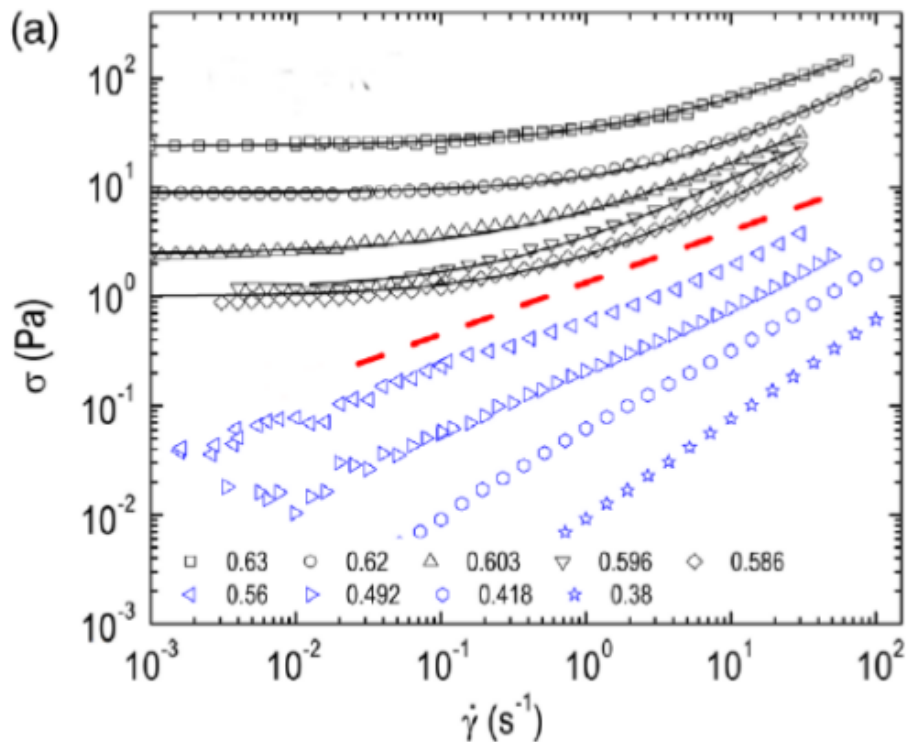
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VIDEOS

Interaction  
Session

MATLAB:  
Introduction

MATLAB: Vector  
and Matrix  
Operations

MATLAB:  
Advanced Topics



Match the following

**Behaviour**

- I. Constant viscosity
- II. Yield stress followed by constant viscosity
- III. Yield stress followed by shear thinning

**Volume fraction**

- a. 0.56
- b. 0.38
- c. 0.62

- I-b,II-c,III-a
- I-c,II-b,III-a
- I-b,II-a,III-c
- I-a,II-c,III-b

No, the answer is incorrect.

Score: 0

Accepted Answers:

I-b,II-a,III-c

3) Match the following

**Model**

- I. Herschel Bulkley
- II. Newtonian
- III. Bingham

**Volume fraction**

- a. 0.56
- b. 0.38
- c. 0.62

- I-b,II-c,III-a
- I-c,II-b,III-a
- I-b,II-a,III-c
- I-a,II-c,III-b

No, the answer is incorrect.

Score: 0

Accepted Answers:

I-c,II-b,III-a

4) The yield stress for volume fraction of 0.586 is \_\_\_\_\_ Pa. (to nearest integer)

2 points

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) 1

2 points

5) For the overall data in the graph, the maximum viscosity is \_\_\_\_\_ Pa s. (to nearest integer)

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Range) 20000,30000

2 points

6) For the overall data in the graph, the lowest viscosity is \_\_\_\_\_ Pa s. (to nearest three decimals)

No, the answer is incorrect.

Score: 0

Accepted Answers:

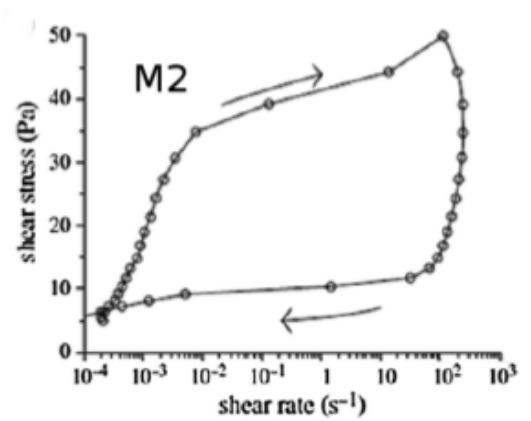
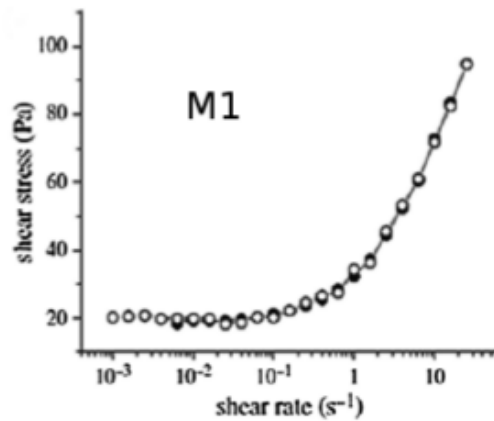
(Type: Range) 0.005,0.015

2 points

Based on the data given in question 7, answer the following up to 12

7) The graphs show experimental measurements for two different systems [Bonn et al, Review of Modern Physics, 2017].

1 point



Pick the correct measurements given the following behaviour

The sample has yield stress

- M1 only
- Both M1 and M2
- Neither M1 nor M2
- M2 only

No, the answer is incorrect.

Score: 0

Accepted Answers:

Both M1 and M2

8) The sample is thixotropic

1 point

- M1 only

- Both M1 and M2
- Neither M1 nor M2
- M2 only

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*M2 only*

9) The sample shows shear thinning after yield

**1 point**

- M1 only
- Both M1 and M2
- Neither M1 nor M2
- M2 only

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*Both M1 and M2*

10) The sample shows Newtonian fluid behaviour

**1 point**

- M1 only
- Both M1 and M2
- Neither M1 nor M2
- M2 only

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*Neither M1 nor M2*

11) The sample has microstructure breakup processes, and microstructure formation is instantaneous

**1 point**

- M1 only
- Both M1 and M2
- Neither M1 nor M2
- M2 only

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*M1 only*

12) The sample has microstructure breakup processes, and microstructure formation is not instantaneous

**1 point**

- M1 only
- Both M1 and M2
- Neither M1 nor M2
- M2 only

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*M2 only*

Based on the data given in question 13, answer the following

13 Following are components of Oldroyd B model for simple shear,

1 point

$$\begin{aligned}\tau_{xx} + \lambda_1 \left[ \frac{\partial \tau_{xx}}{\partial t} - 2 \frac{\partial v_x}{\partial y} \tau_{yx} \right] &= -4\eta\lambda_2 \frac{\partial v_x}{\partial y} D_{yx} \\ \tau_{yx} + \lambda_1 \left[ \frac{\partial \tau_{yx}}{\partial t} - \tau_{yy} \frac{\partial v_x}{\partial y} \right] &= 2\eta D_{yx} + 2\eta\lambda_2 \frac{\partial D_{yx}}{\partial t} \\ \tau_{yy} + \lambda_1 \frac{\partial \tau_{yy}}{\partial t} &= 0 \\ \tau_{zz} + \lambda_1 \frac{\partial \tau_{zz}}{\partial t} &= 0.\end{aligned}$$

State True/False.

When  $\lambda_2 = 0$ , the Oldroyd B model reduces to upper convected Maxwell model.

- True  
 False

No, the answer is incorrect.

Score: 0

Accepted Answers:

True

14 Starting with initial conditions of stress being zero, the governing equation for  $\tau_{yx}$  stress growth in simple shear flow at constant strain rate is, 2 points

- $\tau_{yx} + \lambda_1 \left[ \frac{\partial \tau_{yx}}{\partial t} - \tau_{yy} \frac{\partial v_x}{\partial y} \right] = 2\eta D_{yx} + 2\eta\lambda_2 \frac{\partial D_{yx}}{\partial t}$   
  $\tau_{yx} + \lambda_1 \left[ \frac{\partial \tau_{yx}}{\partial t} \right] = 2\eta D_{yx}$   
  $\tau_{yx} = 2\eta D_{yx} + 2\eta\lambda_2 \frac{\partial D_{yx}}{\partial t}$   
  $\tau_{yx} + \lambda_1 \left[ \frac{\partial \tau_{yx}}{\partial t} \right] = 2\eta D_{yx} + 2\eta\lambda_2 \frac{\partial D_{yx}}{\partial t}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\tau_{yx} + \lambda_1 \left[ \frac{\partial \tau_{yx}}{\partial t} \right] = 2\eta D_{yx}$$

15 State True/False.

1 point

Oldroyd B model can show non-monotonic stress growth or stress overshoot as a function of time, during a constant strain rate simple shear.

- True  
 False

No, the answer is incorrect.

Score: 0

Accepted Answers:

False

16 If  $\frac{\partial v_x}{\partial y} = \dot{\gamma}_{yx}$ , steady value of  $\tau_{xx}$  according to Oldroyd B model is 2 points

- 0  
  $2\eta\lambda_1 \dot{\gamma}_{yx}^2$   
  $2\eta(\lambda_1 - \lambda_2) \dot{\gamma}_{yx}^2$   
  $2\eta\lambda_2 \dot{\gamma}_{yx}^2$

No, the answer is incorrect.

Score: 0

**Accepted Answers:**

$$2\eta(\lambda_1 - \lambda_2)\dot{\gamma}_{yx}^2$$

17) The first normal stress difference coefficient, according to Oldroyd B model is

**1 point**

- 0
- $2\eta\lambda_1$
- $2\eta(\lambda_1 - \lambda_2)$
- $2\eta\lambda_2$

**No, the answer is incorrect.****Score: 0****Accepted Answers:**

$$2\eta(\lambda_1 - \lambda_2)$$

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