Faith morrison understanding rheology pdf

The rheology - the study of deformation and the flow of matter - deals primarily with the stresses generated during the flow of complex materials, including polymers, colloids, foam and gels. A rapidly growing and industrially important area, it plays a significant role in polymer processing, food processing, coating and printing, and many other manufacturing processes. Developed as the main text for advanced undergraduate or master's courses in reology or polymer reology, Understanding Rheology is also an ideal guide to self-teach training for practicing engineers and scientists who find reological principles applicable to their work. Covering the most important aspects of elementary modern reology, this detailed and accessible text opens with an introduction to the field, and then provides extensive reference chapters on vector and tentor operations and Newtonian fluid mechanics. It continues with the coverage of topics such as: Standard Streams for Reology Material Functions Experimental Observations Of Generalized Newtonian Fluids Generalized Linear-Visco-Elastic Fluids Nonlinear Constitutive Equations Reometry, including Reo-Optics Understanding of Reology includes useful pedagogical tools, including numerous problems for each chapter, many worked It also contains useful applications to the nomenclature. Understanding the reology of Oxford University Press, 2001. Available from Amazon.com Dr. Faith A. Morrison, associate professor of chemical engineering at Michigan Technological University 1400 Townsend Drive Houghton, MI 49931-1295 email fmorriso@mtu.edu This web page also includes additional problems (see below in red) and additional tables that are not included in the text. Errata for Understanding Reology Foreword Chapter 1 Chapter 2 Chapter 3 Chapter 4 Chapter 5 Chapter 5 Chapter 7 Chapter 8 Chapter 9 Chapter 9 Appendix Appendix B Appendix C Appendix E Appendix F Links Foreword p. xi, line 23. Add link 139 to the list, Ronald G. Larson, Structure and Properties complex liquids, Oxford, New York, 1999. Chapter 1 page 1, line 18; delete link 61 from the second list of links. Chapter 2 page 13, line 8 from below. Change the speed of light to the speed of light in a vacuum. 13, figs 21. Change Chapter 4: Standard Fluids on Chapter 4: Standard Threads. p.16: Vector product is not associative. p.31 - equation 2.102; there should be two underbars on the a. p. p.39 awning, the definition of the tenor in the equation 2.174 correctly, I believe (no transposing); he disagrees with the bird, Armstrong, and Hassager Dynamics of polymer fluids, which says: A:AT (p. 566, equation A.3-11), but he agrees with the magnitude of the deformation rate of tensor in the same book on the page Since the deformation rate tentor is symmetrical, the difference of opinion by definition in this case has no effect. A definition that contains A:A seems preferable to me because it is related to invariant tensor. The amount of A:AT is not associated with tensor invariant, when tensor is not symmetrical, although it is always real, while the invariant may not be real. All this does not stand up, the definition of A:AT is on the Internet (see Wikipedia); I can't explain that discrepancy. 42, equation 2.189, the first term should be a cube, not a square. Compare with the C.83, p476 equation. page 52, line 5 from below. Change Table C.7 to Table C.3. 53, Line 20. Change Tables C.7 and C.8 for Tables C.3 and C.4. page 54-55 Leibniz should be written by Leibniz throughout this discussion and in the content table for this section. p.58 - Problem 2.40. The definition for the second invariant is shown, not the first invariant. See definitions on page 40 (equation2.180). Additional problems: 2.48 Calculate the invariants of Tensor A, given in problem 2.11 using the view of Tensor A in the coordinate system 123 and definitions given in equations 2.185-2.187 on page 40 text. Also, make the same calculation (based on traces of A, A2, and A3) using view A in the new coordinate system (problem 2.11 results as stated above in problem 3). What do you notice? Explain. (Ref HW1 2005) 2.49 Are the following vectors the basis? u'(1, 3, 0)xyz; (2, 1, -1)xyz; VD (1, 0, -1)xyz. If so, write the vector (1, 1, 1)xyz at the base formed by u, v, and w. (Ref HW1 2003) 2.50 Write the product of two tents BC . A in Einstein's notation, where A is a tensor. What is the 13th component of transpons B.C. And? (Ref HW1 2003) Chapter 3 page 59, last line. Change the mass in - mass from 0 to mass in - mass of - mass of - mass accumulation. p.69 - equation 3.58; Tensor Pi should have a double underline. page 81, Line 4. Remove space in d x2. p.92 - equation 3.215; The z in the denominator should be L and the term before the plus sign should be muliplied z. The equation is essentially the same as the equation 7.84 on page 241. p.99 - Problem 3.7 - Two problems were run together during the set. The first problem ends in a period after viscosity. The second problem starts is equivalent pressure . . . and goes all the way to the end of the problem. The second problem is not addressed in the instructor's manual. p.100 - Problem 3.17 - Calculate the speed profile and flow rate per unit of width . . . Additional problems: 3.26 Starting with the balance of momentum with stress (Cauchy Momentum equation or motion equation, equation 3.96), receive the Navier-Stokes equation (equation 3.104). Please use notation to prove their steps. (Ref HW3 2003) Chapter 4 p.109 - Equation 4.8 - Division into 2 should be within the square root, i.e. the same expression as equation 2.174. p110 - There is a problem of dialing types into the equation matrix 4.12. p.116 - Equation 4.28, the left side of the equation should be a scalable gamma point (without double emphasis). p.118 - figure 4.12b; On the right side, the bottom point should be marked P2 instead of P1; There is also a 0, which should be subscripted in the length equation (left side of figure b). p.118, the last line, partial v in relation to T should be a substantial derivative of vector v, i.e. Dv/Dt. p.119, Equation 4.42, the first vector amount should be replaced by an expression for substantial derivative v, i.e. partial v/partial t q v dot del v. The number of second and third vectors is correct. p.119, Equation 4.43, the first vector amount should be replaced by an expression for substantial derivative v, i.e. partial v/partial t q v dot del v. In the second vector, the x1 vector component should be v1 partial v1/partial x1. The final number of vectors is correct (zero vector). page 124, the last and second-last lines in the paragraph. Changing the voltage coordinates of the tendor to the voltage components of the tentor. p.128 - Problem 4.6, the word there must be is; Also change are given. below. Additional problems: 4.19 Write down the expression in equation 9.194 (p. 336 text, derivative of the top bucket) in the form of a component (i.e. using Einstein's notation for each vector and tentor in the equation, perform point products. Please note that there is a point product in the definition of a significant derivative. Then put all the terms together to make them look like a complex expression of a scalal factor multiplied by the core vectors. Note that there is a typo in equation 9.194: a significant derivative should be DA/Dt (small t not capital T). (Ref HW3 2005) 4.20 Why do we discuss normal voltage differences instead of normal stresses directly? Why not just make the easier thing and talk about naked normal stresses? (Ref HW3 2004) 4.21 Material features in the haircut stream are written in terms of t21, t11, t22 and t33. Why are the other five components of the stress tentor not included in the definition of the functions of the haircut material? (Ref HW3 2004) 4.22 Which flow, haircut or single-axis extension, exposes fluid particles to a more severe deformation? Explain your answer. 4.23 What is the difference between single-axis elongation and biaxis lengthening? 4.24 Creep is a type of haircut stream. How does creep differ from other types of haircut flow? Chapter 5 p. 134. In the offer after eq. 5.7 The change is made in the reometer on is made near the wall in the reometer. page 135, footnote. Add in addition to the Reology Nomenclature Society. D. M. Husband, Journal of Reology 36, 409-410 (1992). p. 157 In equation 5.141 I used negative infinity time for the strain; it's not right. If you use zero for the countdown time and then gently take the real part (see footnote at the bottom of the page), you will get the same answer to the 5.143 equation, however. page 167,. 5.12. Change the ratio of amplitude deformation to 90 degrees outside the phase with the amplitude of stress to stress on the ratio of amplitude deformation to 90 degrees from the stress phase to the amplitude of stress. Additional problems: 5.19 Why are there so many material functions? Why not just identify the steady viscosity of the haircut and do with it? Please answer up to 5 or so suggestions. (Ref HW4 2005) 5.20 Calculate and draw three tangible features of a stable haircut for the composite equation below. Please comment on your answers. where A and B are the model's permanent scalization parameters. Make suggestions on how to improve the model based on what you know about polymer behavior. (This composite equation is a simple version of the Rainer-Rivlin equation; see the dynamics of polymeric fluids from the bird, Armstrong and Hassager, 2nd edition of page 504) (Ref HW4 2003) 5.21 Calculate and sketch (in time function) three material functions of the breakdown of haircut stress (stress relaxation in figure 5.2) for the special composite equation proposed below: where the function of M is given and, m, and are the permanent parameters of the scale of the model. In your sketch, the plot is material functions, and for multiple haircut speed values as a function of time. For the guide, see the example on page 138 and the sketch in figure 5.3. (Ref HW4 2003) Chapter 6 p.201 - The last line on this page hyphen is missing from Williams-Landel-Ferry. p.218 - No page number. p. 222, prob. 6.5 Change Plot of Your Results. on the plot your results are for shifted module functions and for damping function versus amplitude warp. page 222,. 6.6 and page 223, signature to figs. 6.70. Change two monosipses polymers into two monodispersed polymers of the same type. Additional problems: 6.9 viscosity sketch compared to haircut rate and first normal stress factor compared to haircut rate for a typical polymer. Please be sure to mark your axis (magazine, or no journal that is being built, etc.) . Please include any key features on the chart. (Ref HW5 2004) Chapter 7 p.227 - Equation 7.1 for tensor del V is not a gamma point. page 232, line 15. Changing fluid flows with constant viscosity to fluid viscosity is approaching constant. page 251, prob. 7.18 Change complex viscosity to dynamic viscosity. page 252, problem 7.24. The range for building is given omega range from 0.001 to It should be a number of gamma_dot, not omega. page 230, figure 7.1, Newton line has gamma-dot-superscript-0; it doesn't have to have a superscript-0, but should just be a gamma point. p. 252 problem 7.24 Missing units of gamma point of haircut speed (mistakenly called omega); And units in two viscosity parameters are incorrect. it should be Pa s. p 254. problem 7.28, part c. It is said to build a speed profile as v_x/v_x, av vs h/H. What is meant compared to y/H, where u is the direction of the coordinates through the thickness of the liquid. Additional problems: 7.36 Will the liquid that follows the power of the law of the generalized Newtonian fluid composite equation exhibit the rod climb? Why or why not? (Exam1 2003) 7.37 For the Law of Power, a generalized Newtonian liquid, decide for a speed profile for a steady flow between wide parallel plates when the top plate moves backwards at V speed and there is a imposed negative pressure gradient. The problem is outlined in this pdf file, and the solution is given here. Chapter 8. 273, eq. 8.90. Change the epsilon point to epsilon point (t) zgt; 0. page 298, Line 3. Change the assistant to help. page 300 - Problem 8.4. In this problem I say: All the composite equations that we have studied so far predict stress tensor tau, proportional to the raith of the gamma-ray. That's not quite right. In the model of power law we allow nonlineary in the form of viscosity, which depends on the size of the gamma-tentor. I mean, they're all something that multiplies the gamma tenor. p.303 - Problem 8.28, Part B is unclear. The best formulation would be for Maxwell's one-on-one model and for the evidence discussed in the example in section 8.3, 1/omega_crossover, was roughly equal to the longest relaxation time lambda_1. Is this true for the data in this problem? Is it a good idea to associate 1/omega_crossover with the longest relaxation time in all cases? p.303 - Problem 8.31, instead of G' and G' it should read G' and G'' p.304 - Problem 8.34 Gi should be gi, parameters of the generalized Maxwell model. p.304 - Problem 8.34, part a. You need to choose two options. The two good options are gi'G'1000Pa and l1'10s. p.304 - Problem 8.34, Part B is unclear. The best wording would be on the high frequencies (behind the terminal mode), what is the logG' tilt against omega log and logG' against omega magazine for the full Rouse model? For more information about the Rouse model click here. Additional problems: 8.36 For a material that has a linear-viscous-visco-political spectrum, given in problem 8.23, predict measured haircut stress as a function of time for step strain 2. Plot your prognosis. (Ref CBE614 HW4) 8.37 Compare and compare generalized Newtonian chapter 7 fluid models and generalized linear Chapter 8. When is each useful? List three material behaviors (as discussed in Chapter 6) that are correctly captured by these models, and list three material behaviors that are misunderstood by these models. (Ref HW62007) Chapter 9 p.311 - in equations 9.29, 9.31 and 9.34 derivatives should be partial derivatives (at 9.31 only the derivative after the point product is mistaken; dr and dr' are correct). p.324 - the line after the equation 9.120 should be where gamma -gamma (i.t.0) - integral from t to 0 gamma-dot_0 dt' - gamma-dot_0 t. page 324 - equation 9.121 after the second equal sign should have a negative mark p.325 - Figure 9.6 - Line for haircut stress should be marked -tau_21 (no negative sign). p. 329 - Table 9.3 signature at the bottom. The psi angle is the angle from r(t')r' to r(t) in counterclockwise, rotating around the axis of e_3 (not the other way around). p.333 - equation 9.166; y (bar) should be y(bar)' (with premier) p.336 - equation 9.194; in a substantial derivative denominator should be Dt, not DT p.351 - equation 9.295; Capital pi should have a wide hat not a small hat and subscription x should have a small hat not a wide hat. p.364 - equation 9.329; Stress in the square term in the Giesekus equation should be preceded by a negative sign (minus) rather than a plus. p.367 - The FK symbol defined in equation 9.333 and used on this page is not the same number as defined in equation 9.332. Another symbol had to be used. 368, eq. 9.342. Change the probability that the end-end chain of the R vector crosses the surface dA to the probability that the final R vector crosses the dA surface. page 368, line 13. Change to take into account the conformation distribution function for this nonequilibrium configuration distribution function. 369, eq. 9.344. Change the probability that the end-end chain of the R vector crosses the surface dA to the probability that the final R vector crosses the dA surface. p.370 - In the first line should be . <R r=>p. 372, eq. 9.359. Remove commas. page 373, eq. 9.367 and 9.368. Change the probability by probability. page 376, Line 9. Change the reverse tensor deformation to reverse deformation gradient tensor. Additional problems: 9.59 Second-order fluid (see page 456) is a nonlinear composite equation that predicts normal stress in the snor. The second order of liquid (SOF) is a special case of Oldroyd 8-permanent liquid. What are the 8 constants of Odroid will give the SOF version shown on page 456? (Ref CBE614 HW5) 9.60 We saw that the elastic dumbbell model predicts the top convected Maxwell (UCM) model. We also saw that the model of the green-Tobolsky temporary network predicted the UCM model. How is it possible that two different molecular pictures одно и то же составное уравнение? (Реф CBE614</R> </RR> </RR> 9.61 Show that the movement (movement) of the mechanical system shown in figure 9.12 is governed by a differential equation similar to the Jeffreys model (equation 9.311). 9.62 What is an affinity movement? (Ref CBE614 HW5) 9.63 In Glossary, page 456 gives a second-order fluid equation. Compare the shape of this equation with the other advanced founding equations we discussed in Chapter 9. What equations does that look like? In what sense is it different? (Ref HW7 2005) 9.64 What is the tension associated with the GLVE model? If we fix the GLVE model by replacing the voltage tensor, we will get a new model, the Lodge Rubber liquid model. What is wrong with the GLVE strain awning that it needs to be fixed? (Ref HW7 2005) 9.65 What is the generalized model of linear viscoselliatic fluid (GLVE) useful for? What are the problems with this model? (Ref HW7 2005) 9.66 What molecular composite equations are the mathematical equivalent (based on fluid mechanics) of Maxwell's upper convex model? Comment on this comment. (HW7 2004) Chapter 10 p.391 - Equation 10.44 should be marked as the shee rate in the capillary flow of any homogeneous liquid. page 393, line 10 from below. Change K to K/R3. p. 435 - Problem should be read: For the data on figure 10.8 calculate the true drop of pressure as function L/R. p.436 - In the problem 10.19 parts b) and c) the specified haircut speed should be 10 s-1 (in both cases missing s) Additional problems: 10.37 Appendix A p. 443. For β add 9.4.2.1 No2 and 3/(2Na2). page 445. Add the ψ0 (R) 9.4.2.1 configuration distribution function and the ψ (R) 9.4.2.1 nonequibrium configuration distribution function. Appendix B Appendix C p466 - In the C.4-8 equation, the component should be. p467 - In table C6, the movement equation in cylindrical coordinates is correct for symmetrical voltage. For tensor voltage, which is not symmetrical, r- and theta components should be replaced by equations below (help: Dynamics of polymeric liquids bird, Armstrong, and Hassager). the z-component is correct as printed for both cases. (C.6-4) (C.6-5) p467 - In Table C6, all three components of the movement equation in spherical coordinates contain errors (link: The dynamics of the polymer fluids of Byrd, Armstrong and Hasager, although, as printed, it corresponds to Stewart and Lightfoot Transport phenomena; I'm still checking). The correct (according to DPL) components are below. (C.6-7) (C.6-8) (C.6-9) p. 468, eq. C.7-9. Change -vf/(r2 sin q) to -vf/(r2 sin2q) page 468, last line. Change the nabo to the nabo in the square. Appendix D App E Appendix F Links page 523, ref. 5a. Changing the Matrix to the Matrix. 524, referee 21. Change T. G Fox on T. G. Fox. p528 - Help 110, the year should be 1954, not 1964; also change Gaza to Gaza Return on THE CM4650 Home Page of Michigan Chemical Engineering(U.S.) Michigan Tech Home understanding rheology faith a. morrison pdf. understanding rheology faith a. morrison