Phys 6900 Assignment 2 – due Wed, Sep 25, 2008.

Problem 1.
Derive Equation 3.6 from the differential equation Equation 3.5.

Problem 2.
Equation 3.10 has a typo in it (I think). Derive the correct form of Equation 3.10 from Equation 3.9.

Problem 3
Derive Eq. 3.35 from the Maxwell model (Eq. 3.9) and using Equations 3.33 and 3.34.

The next three problems are data analysis. Place close attention to significant figures, and the principles of linear least-squares fitting.

Problem 4.
Plot the data in Table 4.2 (page 40 of Drosg). You will get a result like Figure 4.3.
Provide in your answer the values for the best fit line with uncertainties (and paying attention to significant figures). Also draw the lines corresponding to the 1σ confidence intervals. Explain how those lines are obtained.

Problem 5.
(a) Plot the data in Table 3A.1 (see next page of this assignment for tables) on a log-log (base 10) scale. Use a fitting programme to identify the regime (if it exists) that corresponds to linear visco-elasticity in oscillatory shear. State why you identify this regime as linear visco-elastic. In case there is disagreement, discuss where there is agreement and where not.

(b) Devise a method to determine the upper cut-off for the linear regime (if it exists) based on the linear regression [Hint: Do not judge the end of the linear regime by eye]

Problem 6.
Plot the data in Table 3A.2 on a log-log (base 10) scale. Use a fitting programme to identify the regime (if it exists) that corresponds to linear visco-elasticity in oscillatory shear. State why you identify this regime as linear visco-elastic. State why you identify this regime as linear visco-elastic. In case there is disagreement, discuss where there is agreement and where not.

The process is as important as the answers.

TABLE 3A.1 / Polybutadiene Data

ω (rad/s)	G' (Pa)	G'' (Pa)	$\lvert G^*\rvert$ (Pa)
0.1	53.7	3460.0	3460.0
0.1778	176.0	6280.0	6285.0
0.3162	414.0	1.12×10^4	1.13×10^4
0.5623	1110.0	2.00×10^4	2.01×10^4
1.00	2970.0	3.55×10^4	3.56×10^4
1.778	8500.0	6.23×10^4	6.29×10^4
3.162	2.40×10^4	1.07×10^5	1.10×10^5
10.0	1.52×10^5	2.46×10^5	2.89×10^5
17.78	2.84×10^5	2.88×10^5	4.05×10^5
31.62	4.21×10^5	2.83×10^5	5.07×10^5
56.23	5.30×10^5	2.53×10^5	5.87×10^5
100.00	6.19×10^5	2.23×10^5	6.58×10^5
177.8	6.92×10^5	2.06×10^5	7.22×10^5
316.2	7.69×10^5	1.87×10^5	7.92×10^5

TABLE 3A.2 / Polyisobutylene Data[a]

ω (rad/s)	G' (Pa)	G'' (Pa)	$\lvert G^*\rvert$ (Pa)
0.000316	1.05×10^5	4.68×10^4	1.15×10^5
0.001	1.32×10^5	4.57×10^4	1.40×10^5
0.00316	1.62×10^5	4.37×10^4	1.68×10^5
0.01	1.78×10^5	3.98×10^4	1.82×10^5
0.0316	2.00×10^5	3.02×10^4	2.02×10^5
0.1	2.24×10^5	2.82×10^4	2.26×10^5
0.316	2.40×10^5	2.75×10^4	2.42×10^5
1.0	2.63×10^5	2.51×10^4	2.64×10^5
3.16	2.75×10^5	2.63×10^4	2.77×10^5
10.0	2.95×10^5	3.09×10^4	2.97×10^5
31.6	3.02×10^5	5.62×10^4	3.07×10^5
100.0	3.24×10^5	1.12×10^5	3.43×10^5
316.0	4.07×10^5	2.40×10^5	4.73×10^5
10^3	5.75×10^5	5.13×10^5	7.71×10^5
3.16×10^3	9.12×10^5	1.07×10^6	1.41×10^6
10^4	1.59×10^6	2.34×10^6	2.83×10^6
3.16×10^4	3.09×10^6	4.90×10^6	5.79×10^6
10^5	6.76×10^6	1.05×10^7	1.25×10^7
3.16×10^5	1.45×10^7	2.19×10^7	2.62×10^7
10^6	3.09×10^7	4.37×10^7	5.35×10^7
3.16×10^6	6.46×10^7	8.32×10^7	1.05×10^8
10^7	1.29×10^8	1.45×10^8	1.94×10^8
3.16×10^7	2.51×10^8	2.29×10^8	3.40×10^8
10^8	4.37×10^8	3.16×10^8	5.39×10^8
3.16×10^8	6.61×10^8	3.24×10^8	7.36×10^8
10^9	8.51×10^8	2.46×10^8	8.86×10^8

[a]Ferry, 1980