Process model formulation and solution, 3E4

Assignment 4(b)

Kevin Dunn, dunnkg@mcmaster.ca **Due: 08 November 2010**

Questions 1, 2 and 3 will be posted at the end of the semester in assignment 4(a).

Question 4 [2]

The viscosity of sulphuric acid, ν, varies with purity, p in the following manner:

p [%]	20	60	80
ν [millipascal]	1.40	5.37	17.4

1. Express $\nu(p)$ as a quadratic function using Lagrange interpolating polynomials. Do not simplify the polynomial.
2. Express $\nu(p)$ as a quadratic function using Newton interpolating polynomials. Do not simplify the polynomial.
3. Fit a cubic spline through the data points: clearly show your $\mathbf{Xa} = \mathbf{y}$ linear system of equations, then solve them using computer software; finally report your spline coefficients.
4. Use computer software to plot:
   - the Newton interpolating polynomial
   - the cubic spline,
   - and the 3 data points on the same graph.
5. What is the estimated viscosity at $p = 40\%$ purity using linear interpolation?
6. Which of the estimation procedures that you used above has the closest estimate to the true value of 2.51 millipascal?

Question 5 [2]

The following data are collected from a bioreactor experiment, during the growth phase.

Time [hours]	0	1.0	2.0	4.0	6.0
C [g/L]	0.1	0.341	1.102	4.95	11.24

Fit a natural cubic spline for these data and use it to estimate the number of cells at time 3, 5, and 7 hours.

Show your matrix derivation for the linear system of equations, and solve it using computer software. Plot the cubic spline over the time range 0 to 8 hours.

Bonus question [0.5]

Use the cubic spline from the previous question and find the time where the cell count was approximately 10.0 g/L. Do not solve the equation by hand, but investigate MATLAB's or Python's polynomial root finding function: `roots(...)`

END