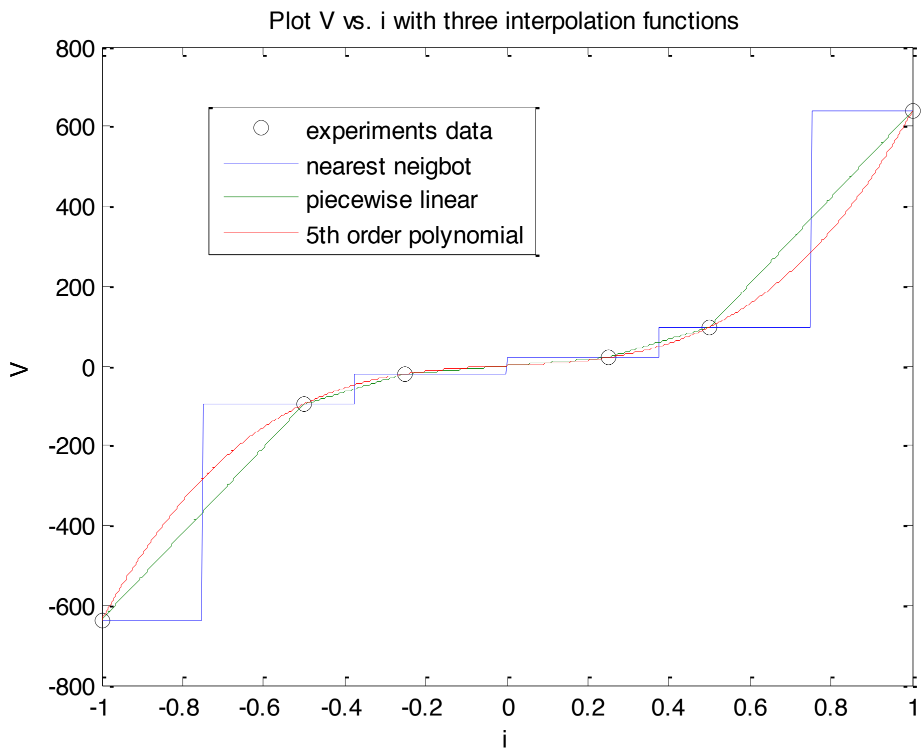
Sample: Mat LAB Mathematica MathCAD Maple - Interpolation Assignment

9.4.1 Based on Chapra 17.12, p. 426

Using the data from this problem, first create a graph showing the experimental values as black circles. Generate 1000 interpolated values for the voltage using three different kinds of interpolation - nearest neighbor, piecewise linear, and 5th order polynomial - and add these to the graph. Be sure to use different line styles for each of the three models and include a legend. Then, determine the estimates for the voltage across the resistor when the current is 0.1 A and 0.9 A for each of the models and present them clearly in your report.



i	V0, nearest neighbor	V1, linear	V5, 5th order polynomial
0.1	20.5000	8.2000	5.092
0.9	637.0000	528.9000	472.0680

9.4.2 Based on Chapra 17.20, p. 428

Using the data from this problem, you are going to generate some interpolated surfaces as well as predictions for temperature at a particular location on the late. You can use the code:

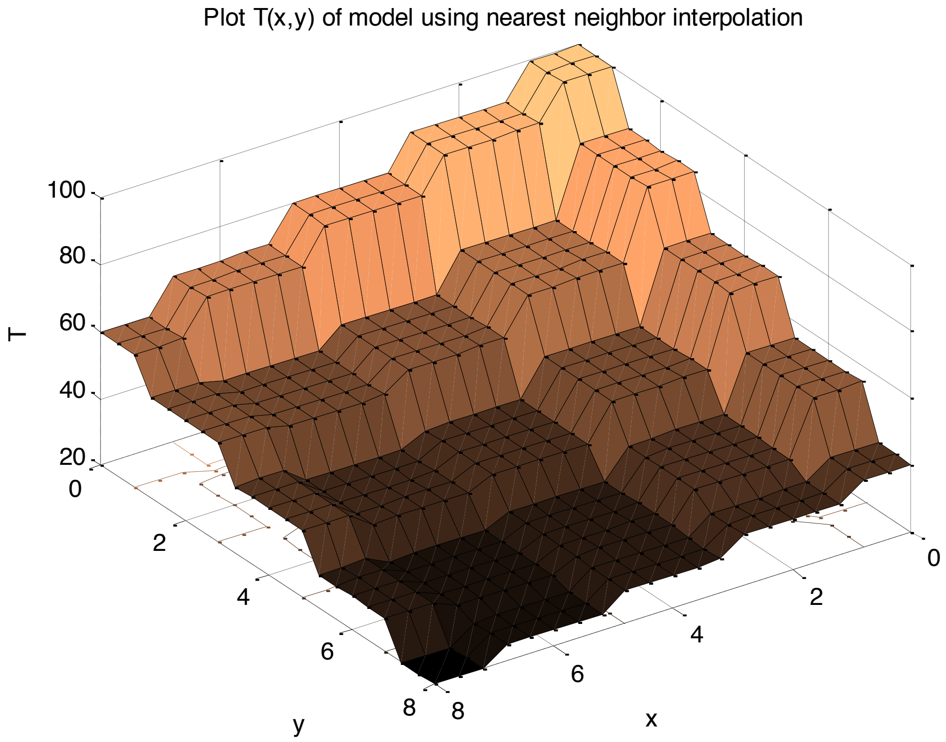
[x, y] = meshgrid (0:2:8);

to get the independent data values but will need to code the temperature values yourself. Think carefully about how you need to build the matrix of temperature data. In terms of creating a surface of interpolated values, use:

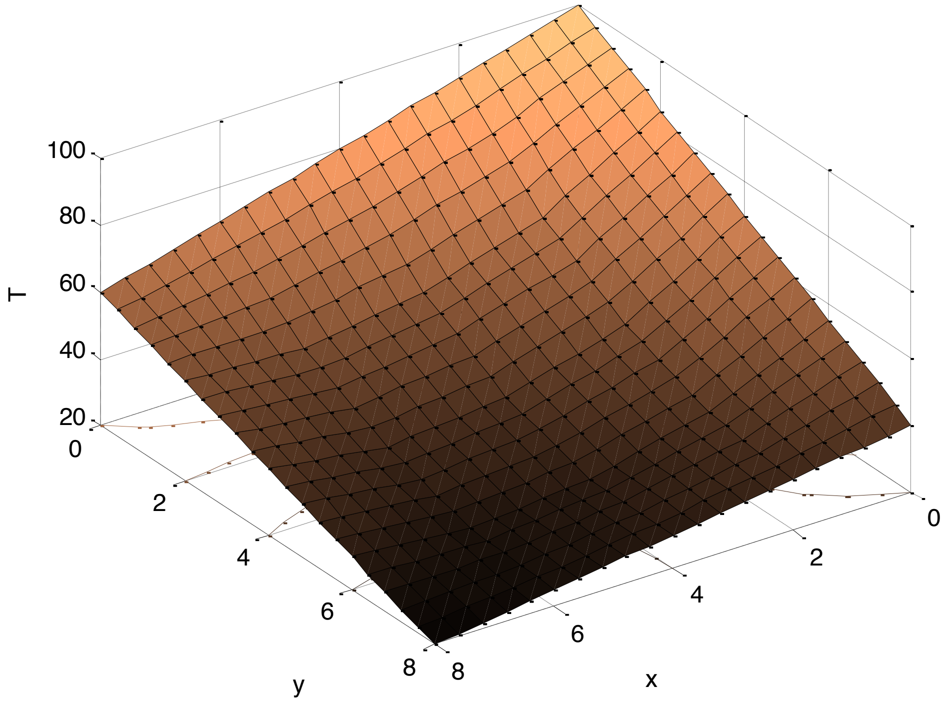
[xmodel , ymodel] = meshgrid(linspace(0, 8, 21));

to generate two 2-D model grids on which to base the interpolation. This will hit all of the data points and will add four additional nodes between each data point in each direction. Using the interp2 function, create models for the temperature using nearest neighbor, bilinear, and spline interpolation. Graph each of these in their own figure windows using the surfc command and use the commands colormap copper and view([145 15]) to better visualize the information. Be sure to add labels and a title to each graph.

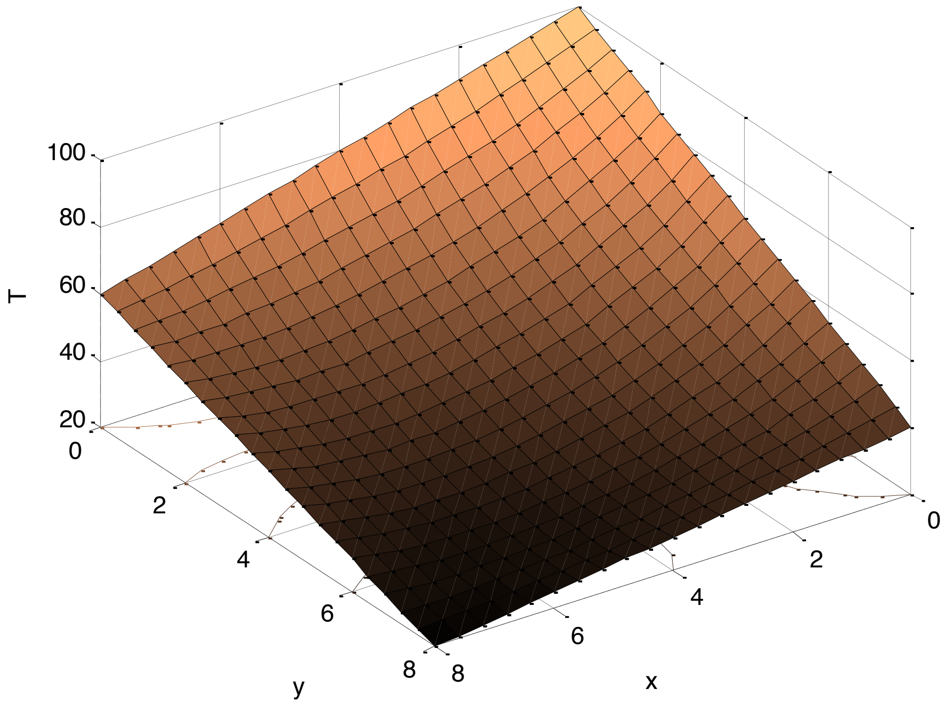
Finally, generate estimates for the temperatures at the locations given in the problem using each of the three interpolation methods listed above. Document these estimates in your lab report. Be sure to indicate both the location you are reporting the temperature for and the interpolation method used to generate an estimate.



Plot T(x,y) of model using bilinear interpolation



Plot T(x,y) of model using spline interpolation



x	y	T0, nearest neighbor	T1, bilinear	TS, spline
4	3.2	38.4300	44.4580	43.4483
4.3	2.7	53.5000	47.5254	46.1507

9.4.3 Based on Chapra 17.21, p. 428

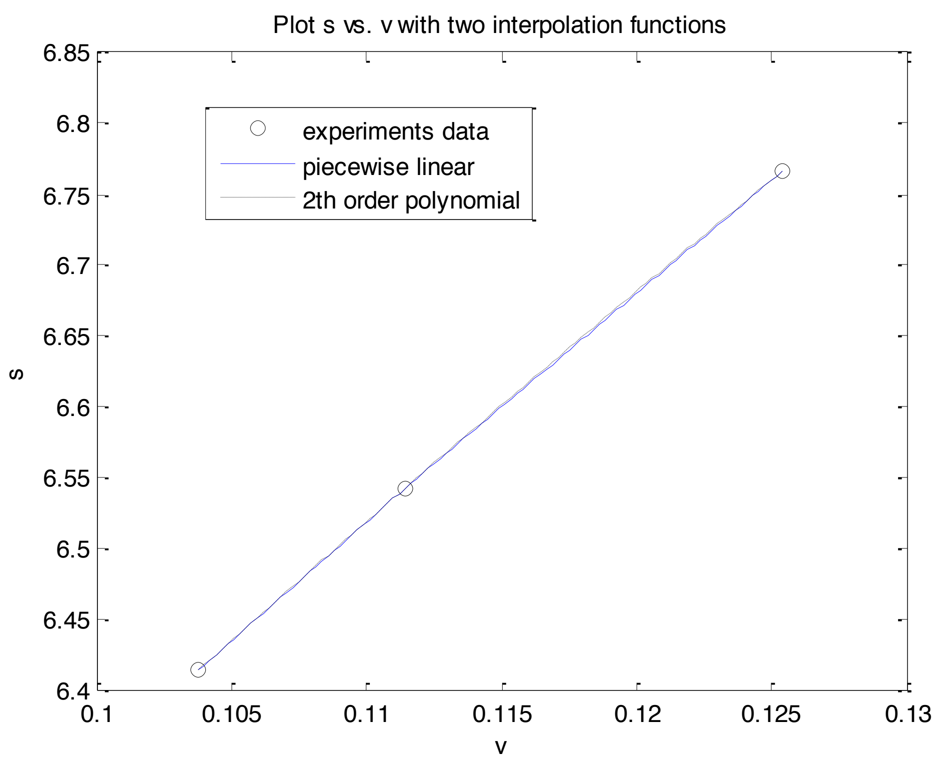
Using the data from this problem, first create a graph showing the experimental values as black circles.

Generate 100 interpolated values for the entropy using two different kinds of interpolation – piecewise linear and 2nd order polynomial - and add these to the graph. Be sure to use two different line styles for each of the two models and include a legend.

Next, make the predictions for v=0.108 m3/kg using each interpolation method and put these in your report. For the third part of the problem - inverse interpolation - you will be effectively solving a root-finding problem where:

s(v) = 6.6 –→ s(v) – 6.6 = 0

where s(v) is your interpolation function. In this case, you will only need to do the inverse interpolation on the quadratic interpolation. Determine the coefficients of the interpolation itself, re-write the equation as a root-finding problem, and then use whatever root-finding technique you want to determine the appropriate values of v. This may involve either the roots command or the fzero command. Present your estimate for v in the lab report.



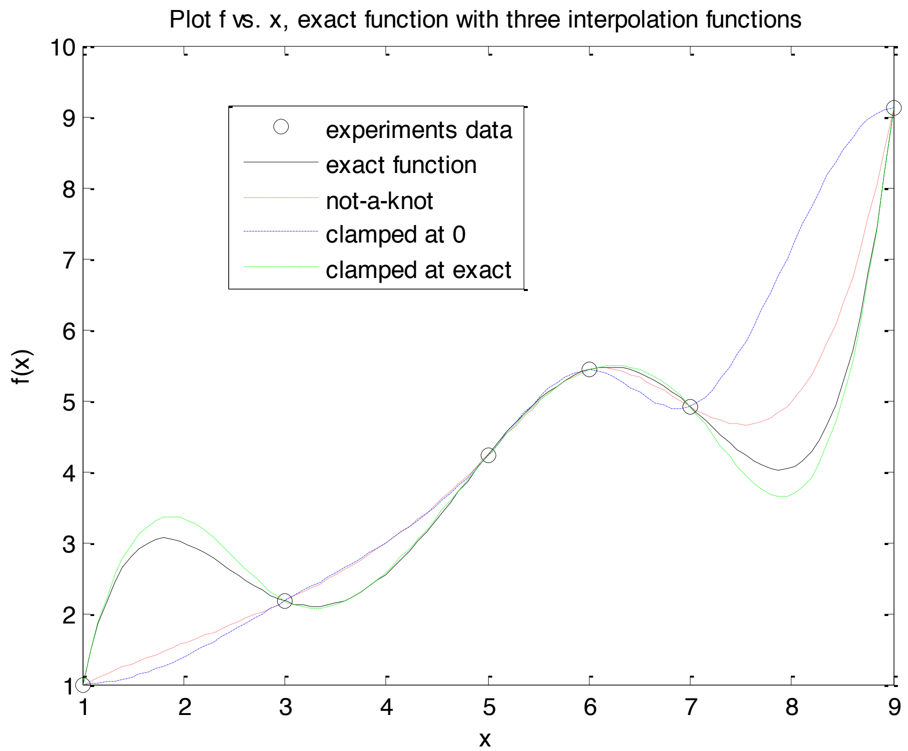
v	s1, piecewise linear	s2, 2th order polynomial
0.108	6.4856	6.4862

The volume of 0.115 corresponds to an entropy of 6.6 using inverse quadratic interolaiton:

s	v, inverse of 2th order polynomial
6.6	0.115

9.4.4 Based on Chapra 18.7, p. 457

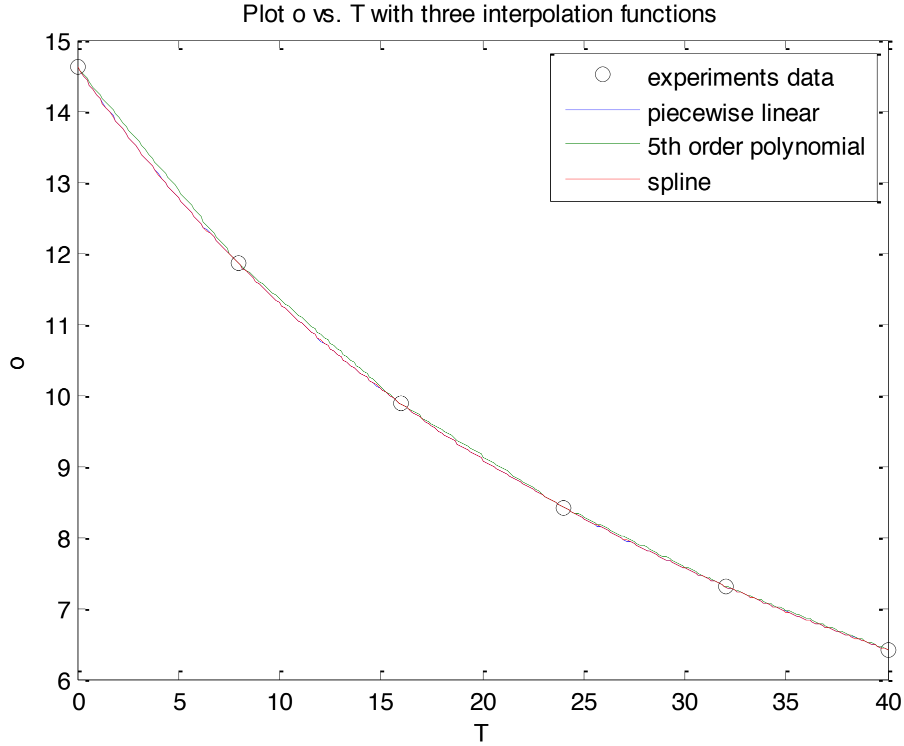
Using the function from this problem, first create a graph showing the six analytical values as black circles. Generate 100 interpolated values for the function using the not-a-knot and clamped conditions specified, then also add a set of values assuming the derivatives at the end are clamped at 0 instead of the values calculated using the derivative at the end points. Plot the exact function as a solid black line, the not-a-knot interpolation as a dotted line, the "clamped at 0" interpolation as a dash-dot line and the "clamped at exact derivative values" as a dashed line. Be sure to label and title the graph and include a legend. The legend will have five components since it will also include a notation for the six data points. Discuss the similarities and differences among the different interpolations.



We observe that the best approximation we get using the clamped end conditions where the end slopes are set the exact values as determined by differentiating the function.

9.4.5 Based on Chapra 18.9, p. 457

Using the data from this problem, first create a graph showing the experimental values as black circles. Generate 250 interpolated values for the concentration using four different kinds of interpolation – nearest neighbor, piecewise linear, cubic spline, and 5th order polynomial - and add these to the graph. Be sure to use different line styles for each of the four models and include a legend. Then, determine the estimates for the oxygen concentration in the fresh water when the temperature is 27 ◦C for each of the four models and present them in your report. Which of the four is closest to the actual value?

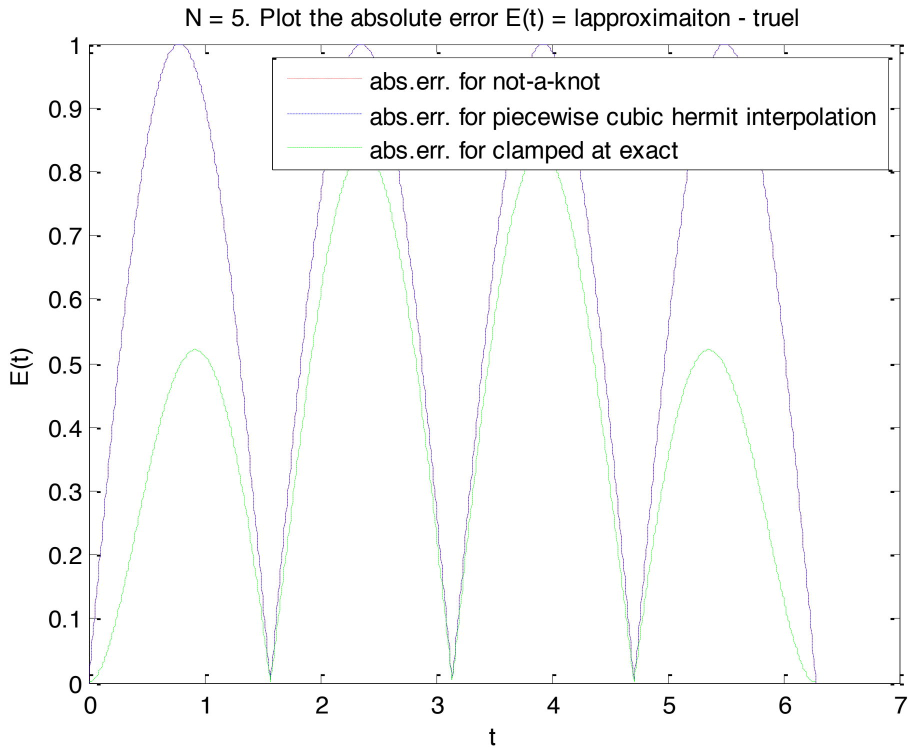


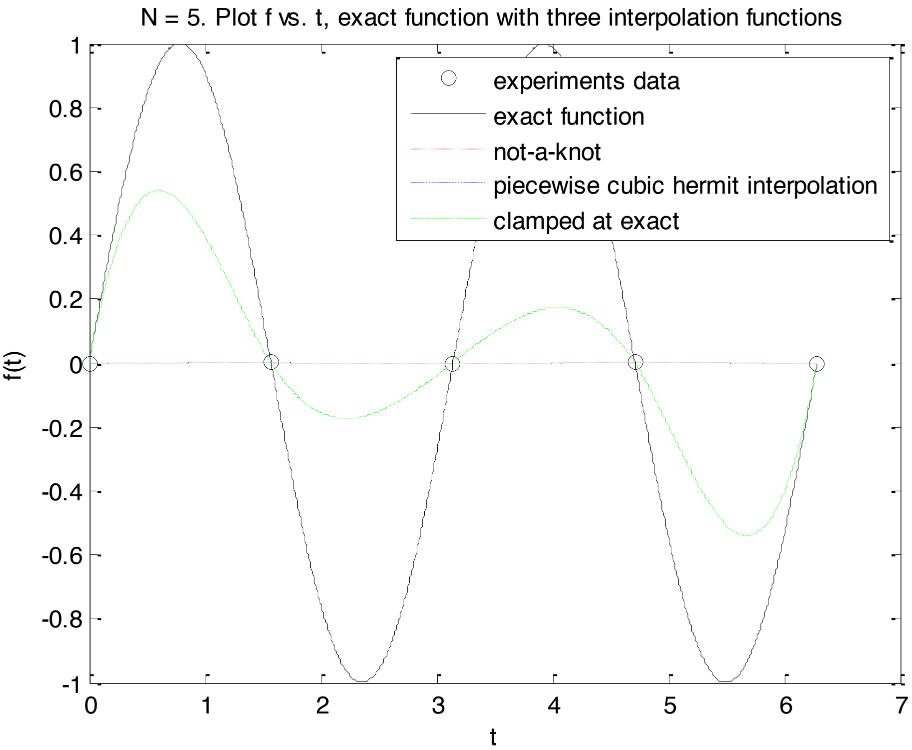
x	o, exact	o1, linear	o5,5th order polynomial	oS, spline
27	7.986	8.0011	7.9689	8.4187

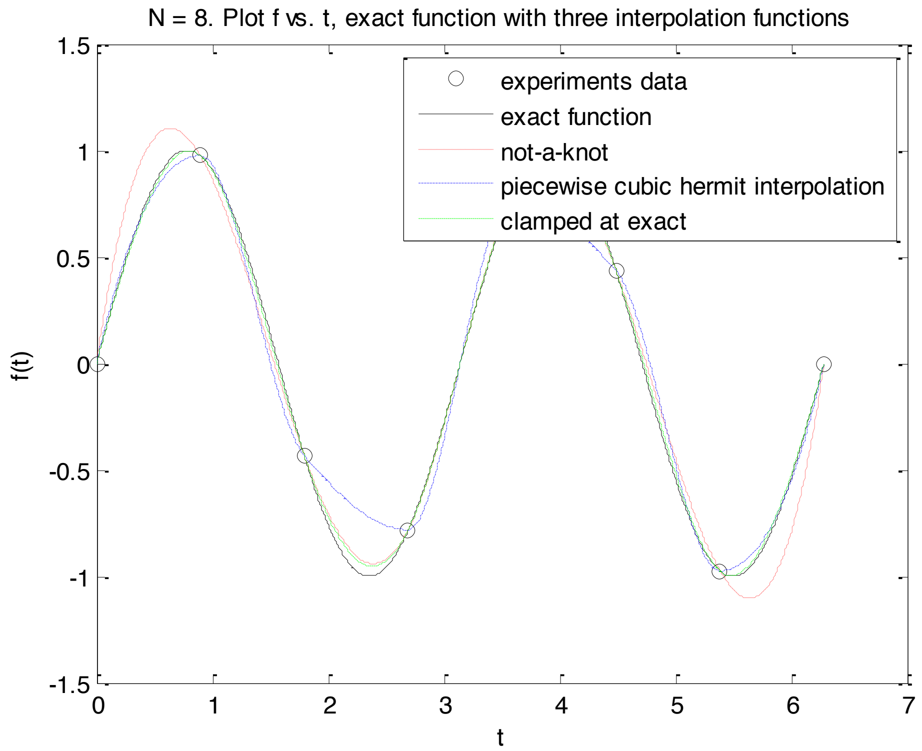
The value8.0011is closest to the actual value we get using the 5th order polynomial interpolation.

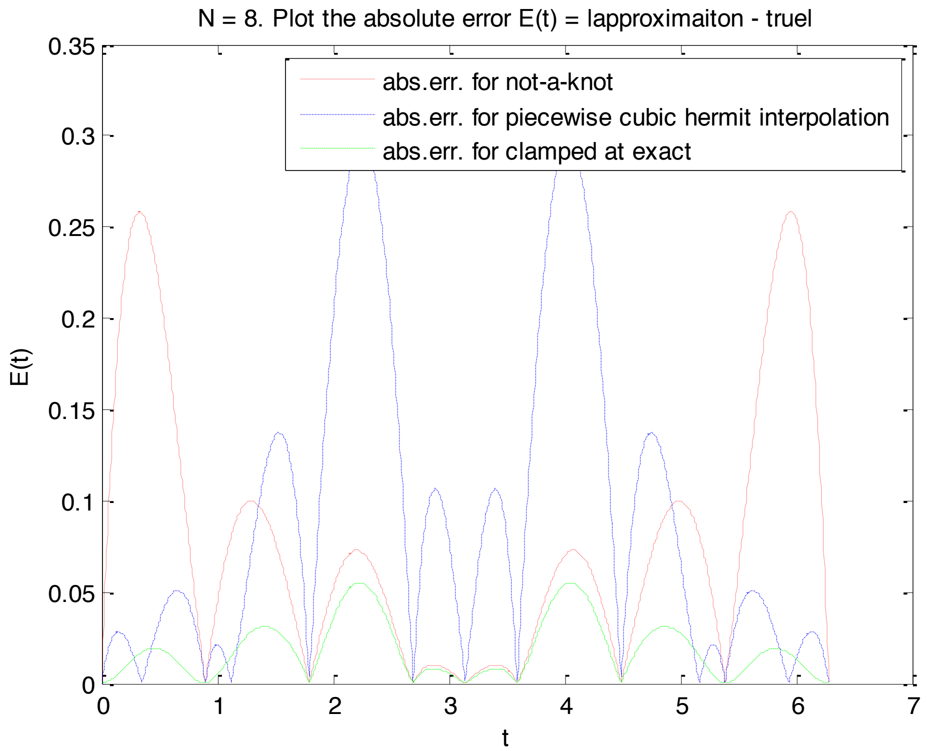
9.4.6 Based on Chapra 18.12, p. 457

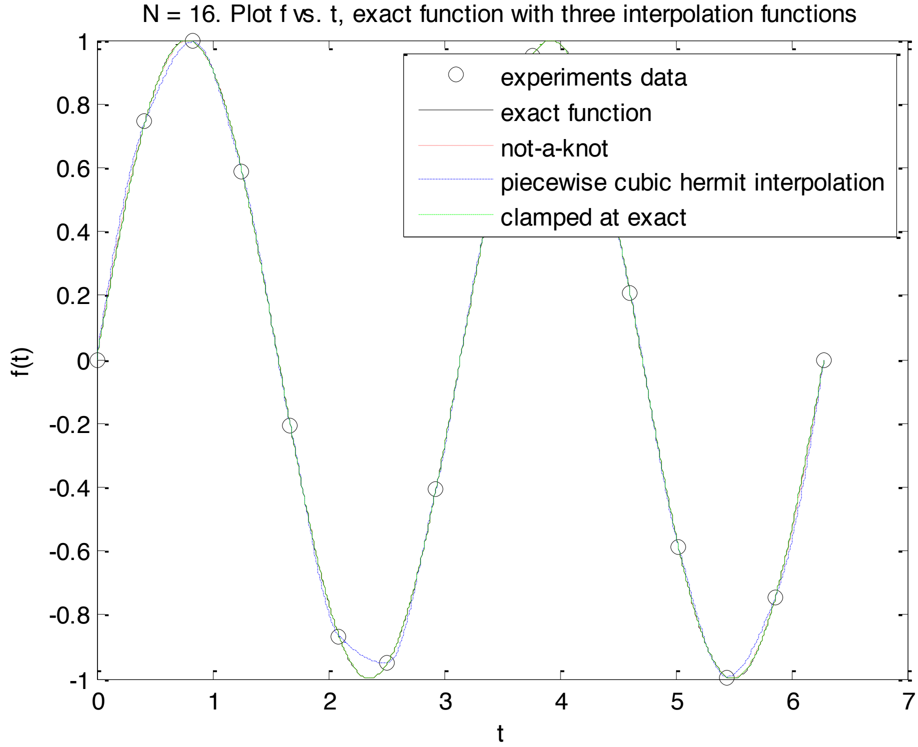
Using the function from this problem, first create a graph showing the eight analytical values (later called "basis points") as black circles. Generate 1000 interpolated values for the functions specified in the problem and put those three on the same graph with three different line styles. Also a graph of the actual function for those 1000 points with a solid black line. Be sure to include a legend. Then make a second figure with the three absolute errors and be sure to include a legend there as well. Each graph should have appropriate axis labels and a title. Use the same line styles for the models in each graph. How does clamping the endpoints change the interpolations and errors? Finally, repeat this process twice more: once using 16 basis points (instead of 8) and once using 5 basis points. You can re-use the original program - just change the names of the files where you are saving the plots and change the number of basis points. The code you include in your lab report can be for 5, 8, or 16 basis points. How does changing the number of basis points change the interpolations and errors?

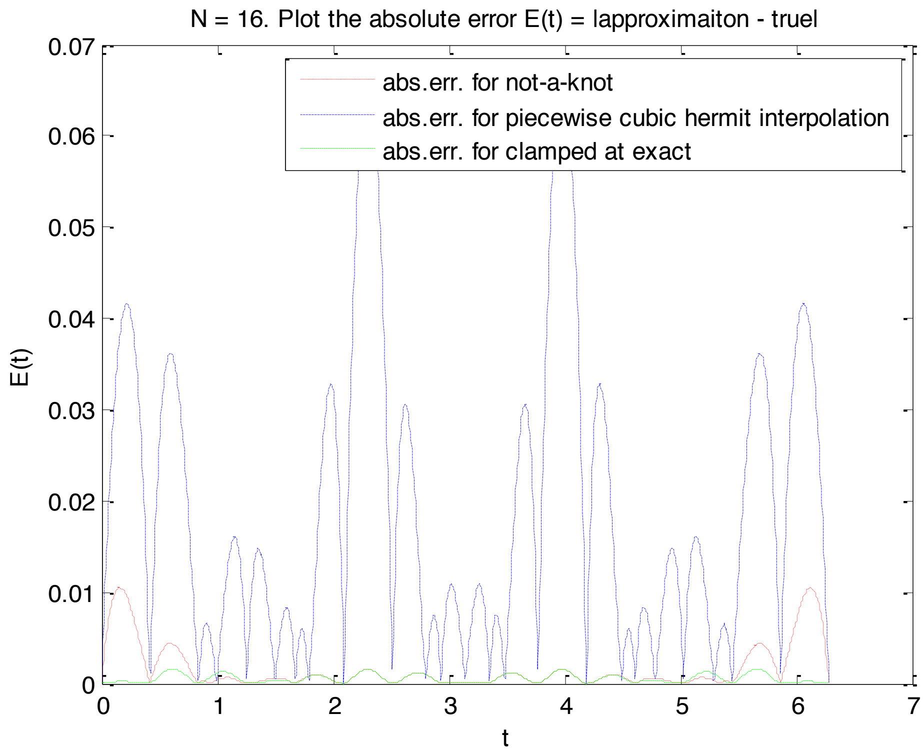





N = 8. Plot f vs. t, exact function with three interpolation functions
experiments data
exact function
not-a-knot
piecewise cubic hermit interpolation
clamped at exact
f(t)
t
1.5
1
0.5
0
-0.5
-1
-1.5
0
1
2
3
4
5
6
7


N = 8. Plot the absolute error E(t) = lapproximaiton - truel
abs.err. for not-a-knot
abs.err. for piecewise cubic hermit interpolation
abs.err. for clamped at exact
E(t)
t
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
1
2
3
4
5
6
7


N = 16. Plot f vs. t, exact function with three interpolation functions
experiments data
exact function
not-a-knot
piecewise cubic hermit interpolation
clamped at exact
f(t)
t
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0 1 2 3 4 5 6 7


N = 16. Plot the absolute error E(t) = |approximaiton - true|
abs.err. for not-a-knot
abs.err. for piecewise cubic hermit interpolation
abs.err. for clamped at exact
E(t)
t
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0 1 2 3 4 5 6 7