

Due 10/23/2023, 11:30 a.m.

Solve the following problems and staple your solutions to this cover sheet. (Computer outputs must be put in the appropriate place in the solution, not attached as an appendix. You may physically cut and paste the output in the problem or allow appropriate space in the printout to add your hand written work.)

1. Sec 3.2, Prob 2(a). To formulate the model state what type of model is sought and what conditions it must meet. To solve for the parameters, see the Mathematica commands below or Section 3.4 notebook in the course website. Also, find the maximum absolute deviation so you can use in in problem 3.3.2(a).
2. Sec 3.2, Prob 2(b). To formulate the model state what type of model is sought and what conditions it must meet. To solve for the parameters, see the Mathematica commands below or the Mathematica Notebook for Section 3.4 in the course website.
3. Sec 3.3, Prob 2(a). Must do hand calculations!
4. Sec 3.4, Prob 1. Do not find bounds for  $c_{\max}$ . See the Mathematica commands below or the Mathematica Notebooks for Chapter 3 and Section 3.4 in the course website.
5. Sec 3.4, Prob 7. See the Mathematica command below or the Mathematica Notebook for Chapter 3 in the course website.
6. Let  $d$  be the average distance, in millions of miles, of planets in our solar system from the Sun and let  $T$  years be the corresponding period (time for one complete revolution around the Sun) of each planet.

Planet	$d$	$T$
Mercury	35.96	0.24084
Venus	67.20	0.6152
Earth	92.90	1.0000
Mars	141.6	1.8808
Jupiter	483.3	11.8620
Saturn	886.2	29.4580
Uranus	1783	84
Neptune	2793	164.8

Using the straightness of the transformed data as the indicator, develop an exponential or power model of  $T$  as a function of  $d$  which best fits the data.

Note: You may use the Mathematica commands below or the Mathematica Notebook for Chapter 3 in the course website.

7. Let  $L$  represent the length of a simple pendulum in centimeters and let period  $T$  be the corresponding time, in seconds, in which the pendulum completes one swing back and forth. Note: Assuming a pendulum is not allowed to swing too far from the vertical, its period  $T$  is independent of the angle it swings through.

$L$	5	10	15	20	25	30	35
$T$	0.45	0.63	0.78	0.89	1.00	1.10	1.19

Using the straightness of the transformed data as the indicator, develop an exponential or power model of  $T$  as a function of  $L$  which best fits the data.

Note: You may use the Mathematica commands below or the Mathematica Notebook for Chapter 3 in the course website.

8. Let  $P$  represent the U.S. population size, in millions, at census years 1790 to 1890.

Year	1790	1800	1810	1820	1830	1840	1850	1860	1870	1880	1890
$P$	3.929	5.308	7.240	9.638	12.866	17.069	23.192	31.443	38.558	50.156	62.948

Using the straightness of the transformed data as the indicator, develop an exponential or power model of  $P$  as a function of time which best fits the data.

Notes: You may want to start with setting year 1780 as time zero. Then the dates will transform to times 10 to 110. In Mathematica you can do this by `time=year-1780` where `year` is the list of the years: `year={1790, 1800, ...}`. You may use the Mathematica commands below or the Mathematica Notebook for Chapter 3 in the course website.

9. Free points!
10. Free points!

**Mathematica Commands**

Three versions of `FindFit` can be used to minimize the largest absolute deviation, to minimize the sum of absolute deviations and to minimize the sum of squares of deviations.

To find the best fit function that minimizes the largest absolute deviation do the following.

```
FindFit[List of data points, Function type, List of parameters to be estimated,
        List of independent variables, NormFunction -> (Norm[#, Infinity] &)]
```

For example, to find the best fit function of the form  $f(x) = ax + b$  for data set `data` which minimizes the largest absolute deviation, input the following.

```
FindFit[data, {a x + b}, {a, b}, {x}, NormFunction -> (Norm[#, Infinity] &)]
```

To find the best fit function that minimizes the sum of absolute deviations do the following.

```
FindFit[List of data points, Function type, List of parameters to be estimated,
        List of independent variables, NormFunction -> (Norm[#, 1] &)]
```

For example, to find the best fit function of the form  $f(x) = ax + b$  for data set `data` which minimizes the the sum of absolute deviations, input the following.

```
FindFit[data, {a x + b}, {a, b}, {x}, NormFunction -> (Norm[#, 1] &)]
```

To find the best fit function that minimizes the sum of squares of deviations do the following.

```
FindFit[List of data points, Function type or variables,
        List of parameters to be estimated, List of independent variables)]
```

For example, one way to find the best fit function of the form  $f(x) = ax + b$  for data set `data` which minimizes the sum of squares of deviations, input the following.

```
FindFit[data, {a x + b}, {a, b}, {x}]
```

Another way to find the best fit function of the form  $f(x) = ax + b$  for data set `data` which minimizes the sum of squares of deviations, input the following.

```
Fit[data, {1, x}, {x}]
```

In the above, `{1, x}` represents a function of a constant and variable  $x$ : a linear function.