

P14. i $x'(t) = 2x(t)(1-x(t))(2-x(t))(3-x(t))$
 $f(x) = 2x(1-x)(2-x)(3-x)$

$$x = 0, 1, 2, 3$$

iii. $f(x) = (2x - 2x^2)(2-x)(3-x)$
 $= (4x - 6x^2 + 2x^3)$

$$= (12x - 18x^2 + 6x^3 - 4x^2 + 6x^3 - 2x^4)$$

$$f(x) = -2x^4 + 12x^3 - 22x^2 + 12x$$

$$f'(x) = -8x^3 + 36x^2 - 44x + 12$$

$$f'(0) = 12$$

unstable

$$f'(1) = -4$$

stable

$$f'(2) = 4$$

unstable

$$f'(3) = -12$$

stable

P15. $x(n) = x(n-1)^3 + 2y(n-1)$

$$x(0) = 1$$

$$x(1) = 7$$

$$x(2) = 435$$

$$y(n) = x(n-1)^2 + 5y(n-1)^2$$

$$y(0) = 3$$

$$y(1) = 46$$

$$y(2) = 10629$$

```
> read "/Users/jjj104/Documents/DMB.txt";  
First Written: Nov. 2021
```

This is DMB.txt, A Maple package to explore Dynamical models in Biology (both discrete and continuous)

accompanying the class Dynamical Models in Biology, Rutgers University. Taught by Dr. Z. (Doron Zeilbeger)

*The most current version is available on WWW at:
<http://sites.math.rutgers.edu/~zeilberg/tokhniot/DMB.txt> .
Please report all bugs to: DoronZeil at gmail dot com .*

*For general help, and a list of the MAIN functions,
type "Help()". For specific help type "Help(procedure_name);"*

*For a list of the supporting functions type: Help1();
For help with any of them type: Help(ProcedureName);*

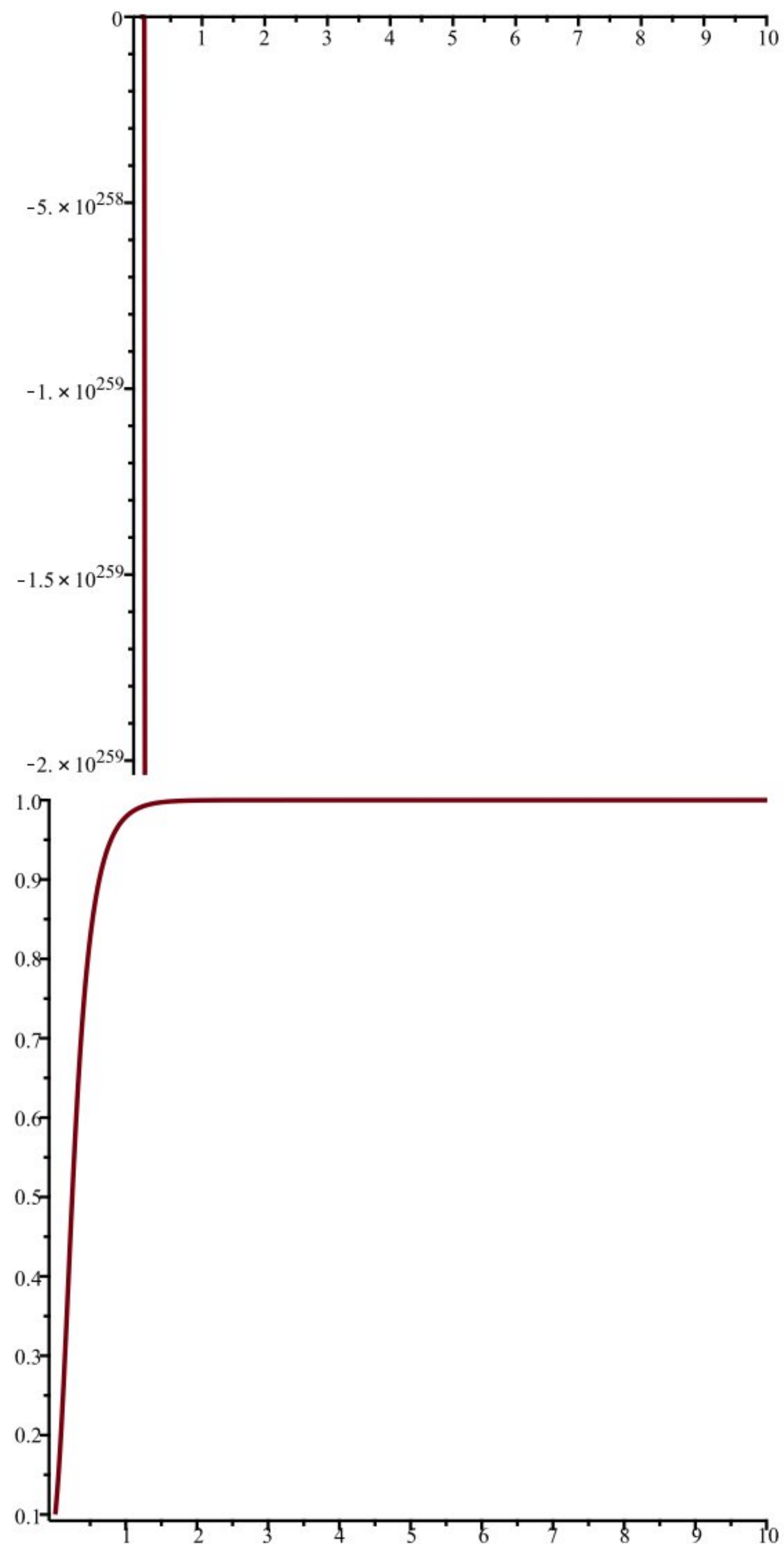
*For a list of the functions that give examples of Discrete-time dynamical systems (some famous),
type: HelpDDM());*

For help with any of them type: Help(ProcedureName);

*For a list of the functions continuous-time dynamical systems (some famous) type: HelpCDM());
For help with any of them type: Help(ProcedureName);*

(1)

```
> #P14 ii x=0, unstable  
TimeSeries([2·x·(1-x)·(2-x)·(3-x)], [x], [-0.9], 0.01, 10, 1);  
TimeSeries([2*x*(1-x)*(2-x)*(3-x)], [x], [0.1], 0.01, 10, 1)
```

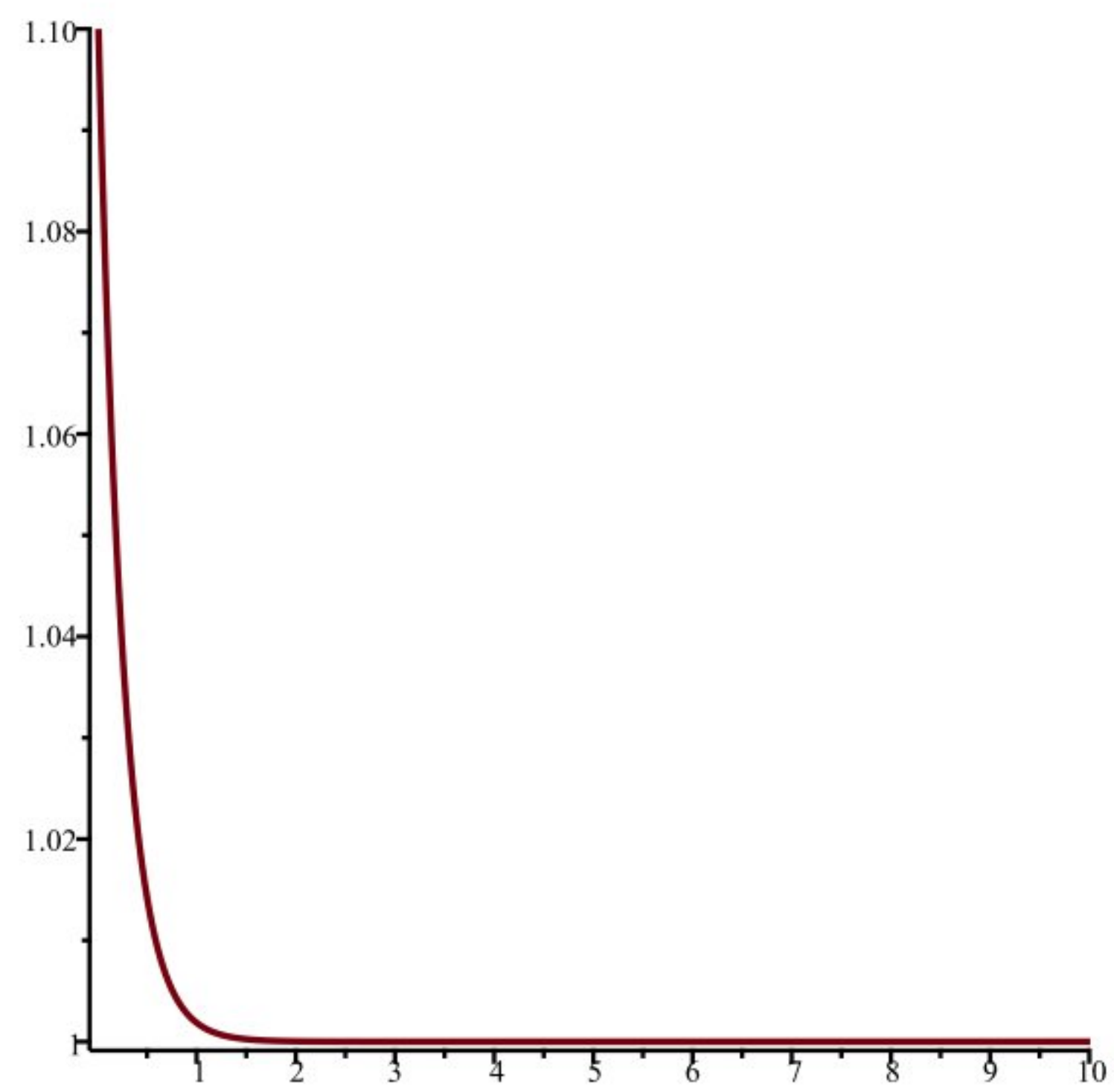
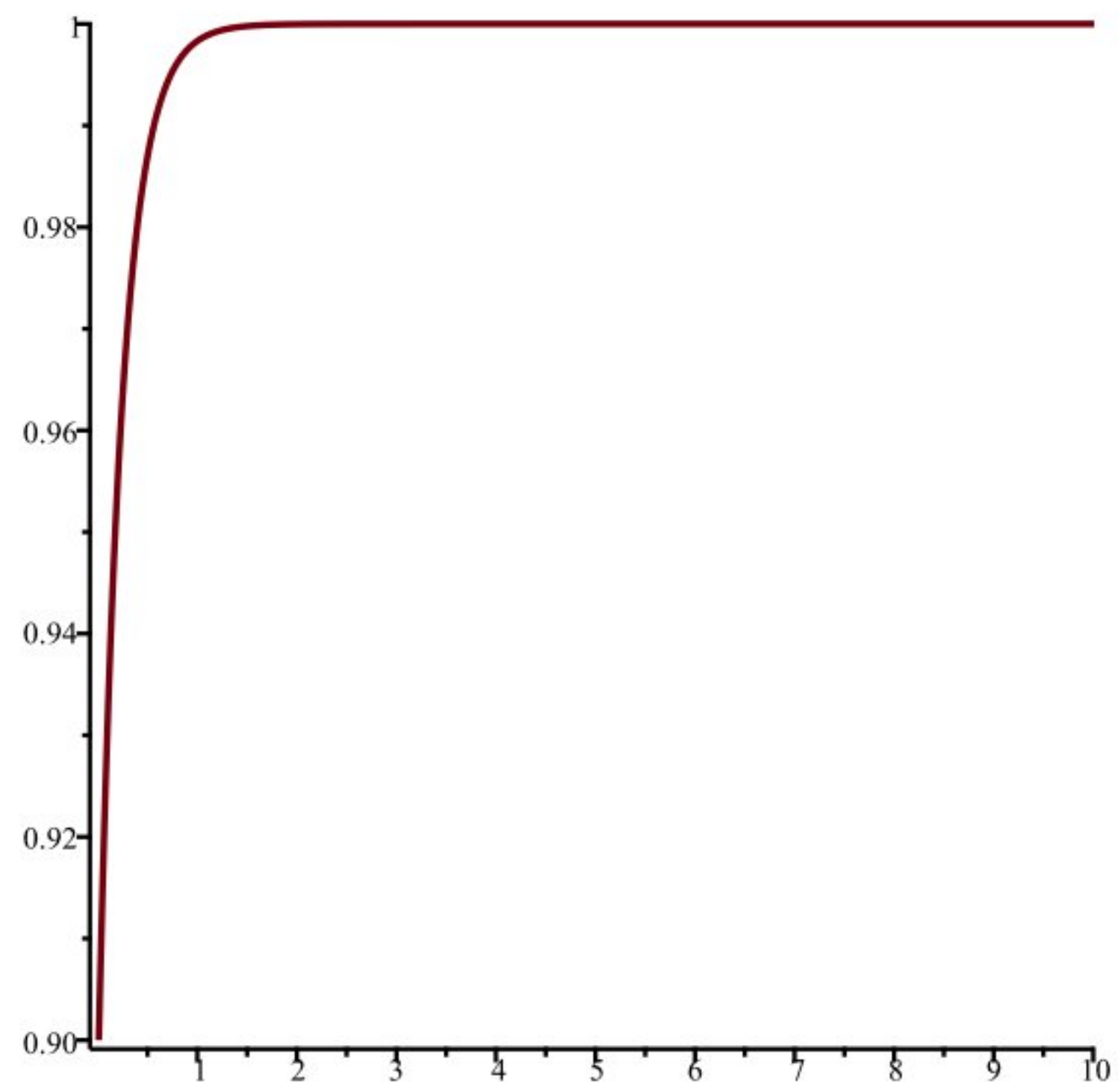


```

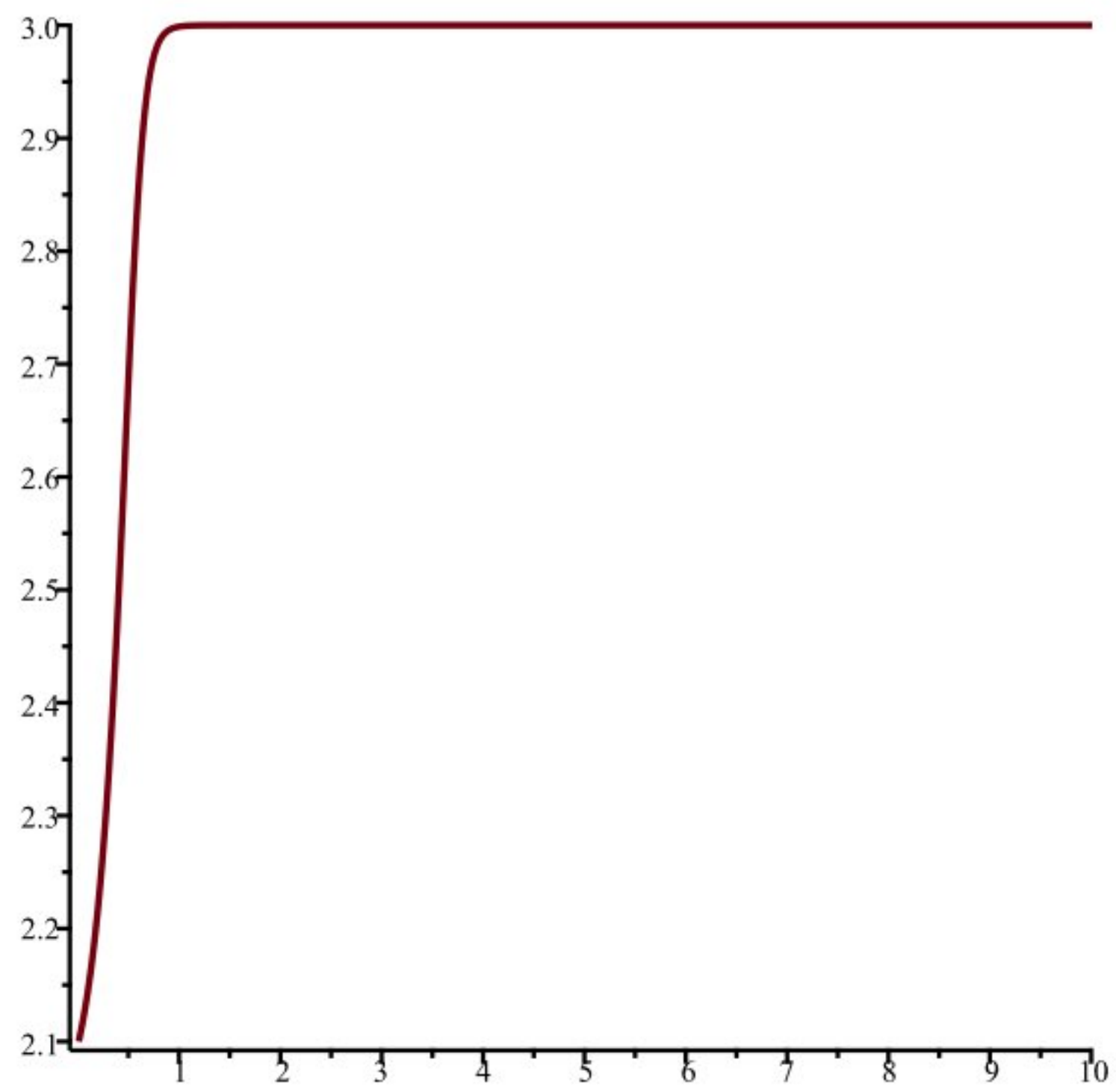
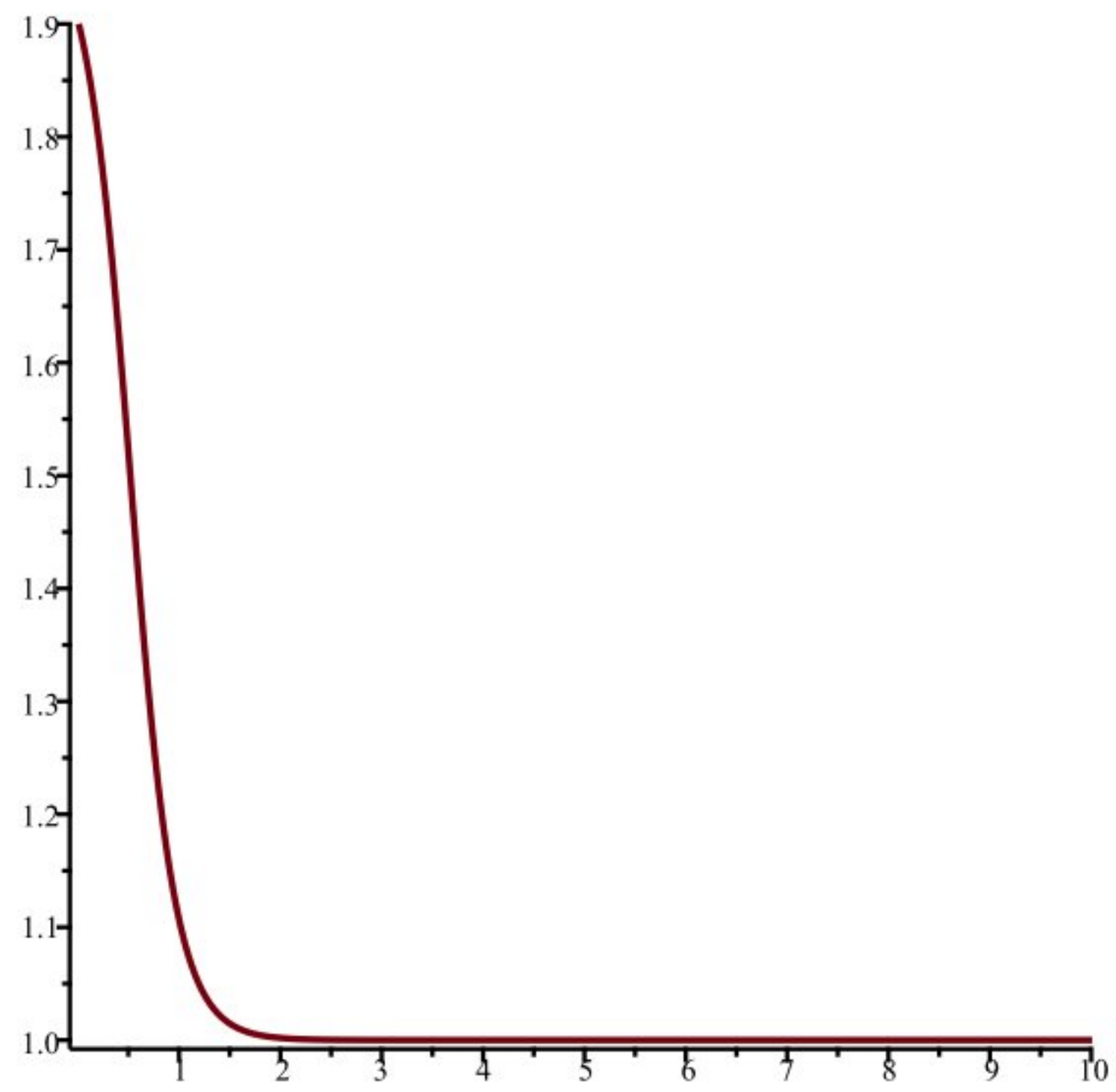
> #P14ii x=1 stable
TimeSeries([2 * x * (1 - x) * (2 - x) * (3 - x)], [x], [0.9], 0.01, 10, 1);

TimeSeries([2 * x * (1 - x) * (2 - x) * (3 - x)], [x], [1.1], 0.01, 10, 1);

```



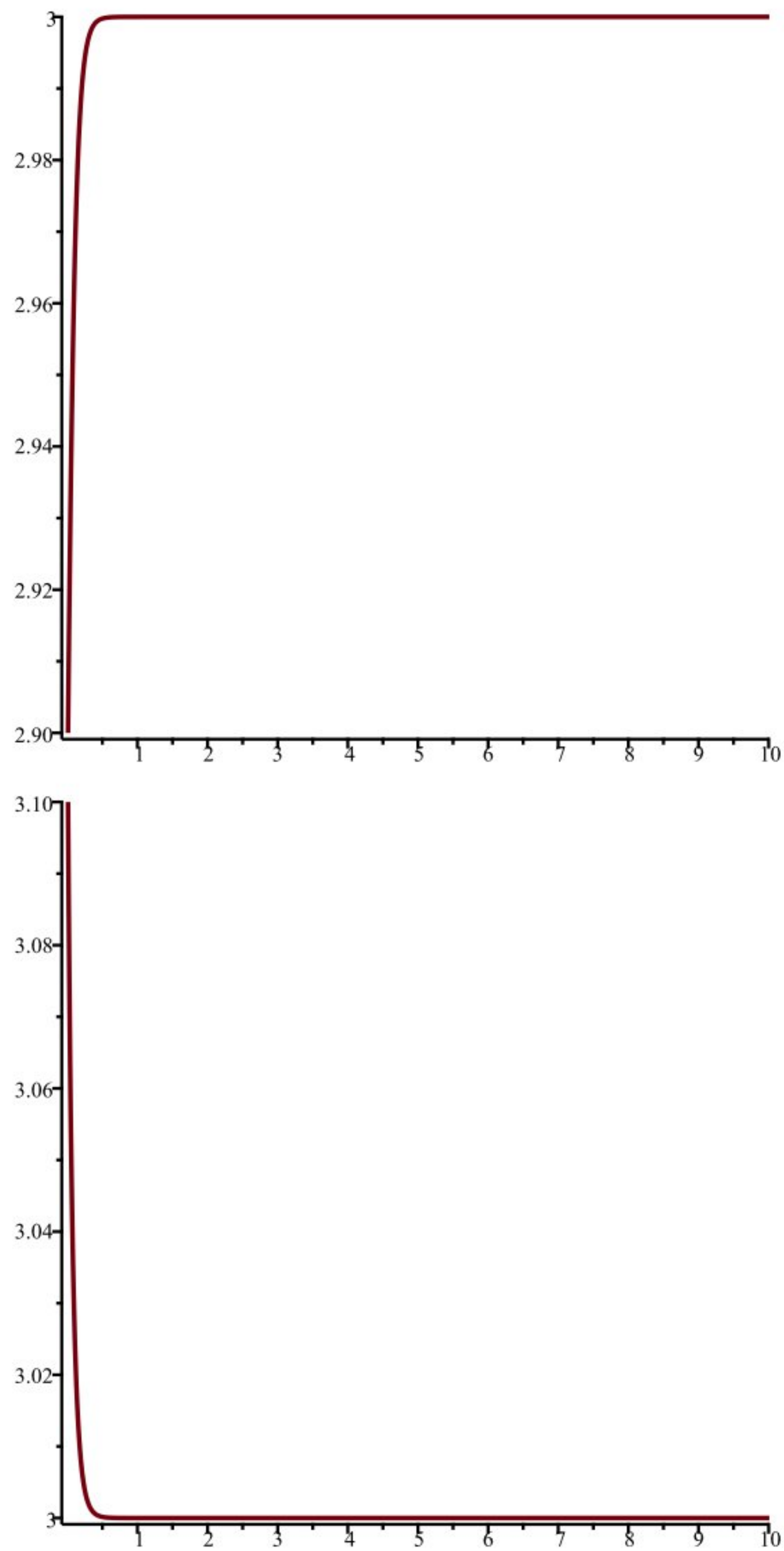
> #P14ii $x=2$ unstable
`TimeSeries([2 * x * (1 - x) * (2 - x) * (3 - x)], [x], [1.9], 0.01, 10, 1);`
`TimeSeries([2 * x * (1 - x) * (2 - x) * (3 - x)], [x], [2.1], 0.01, 10, 1);`



> #P14ii $x=3$ stable

```
TimeSeries([2 * x * (1 - x) * (2 - x) * (3 - x)], [x], [2.9], 0.01, 10, 1);
```

```
TimeSeries([2 * x * (1 - x) * (2 - x) * (3 - x)], [x], [3.1], 0.01, 10, 1);
```



> #P15

$Orb([x^3 + 2 \cdot y, x^2 + 5 \cdot y^2], [x, y], [1, 3], 0, 2);$
 $[[1, 3], [7, 46], [435, 10629]]$

(2)

> $F := \left[\frac{2 + x + y}{2 + 2 \cdot x + 2 \cdot y}, \frac{2 + x + y}{1 + 2 \cdot x + 2 \cdot y} \right];$

$SFP(F, [x, y]);$

$Orb(F, [x, y], [0.5, 0.4], 1000, 10001);$

$SFP\left(\left[\frac{2 + x + y}{2 + 2x + 2y}, \frac{2 + x + y}{1 + 2x + 2y} \right], [x, y]\right)$

$$\text{Orb}\left(\left[\frac{2+x+y}{2+2x+2y}, \frac{2+x+y}{1+2x+2y}\right], [x, y], [0.5, 0.4], 1000, 10001\right) \quad (3)$$

> #P17

TimeSeries([(1 - 2·x - 3·y)·(2 - 2·x - 3·y), (3 - x - 2·y)·(1 - x - 2·y)], [x, y], [-5.1, 4.1], 0.01, 20, 1);

TimeSeries([(1 - 2·x - 3·y)·(2 - 2·x - 3·y), (3 - x - 2·y)·(1 - x - 2·y)], [x, y], [-0.9, 0.9], 0.01, 20, 1);

