

Project1 Report




Scientia Manu et Mente

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21/04/2021

MATH2301 — Mathematical Computing Term 1 - 2021 Group Project

- **Due in Labs Week 10 Wednesday (11:00am), Thursday (1:00pm or 5:00pm) .**
- During your allocated 5 minutes online presentation time, you and your team have to demonstrate that your Matlab programs work correctly.
- Please submit your Matlab code through Moodle, under Assessment folder.
- Please submit your project report **typed** through Moodle.
- Please include **THIS COVER SHEET** with your submitted report.

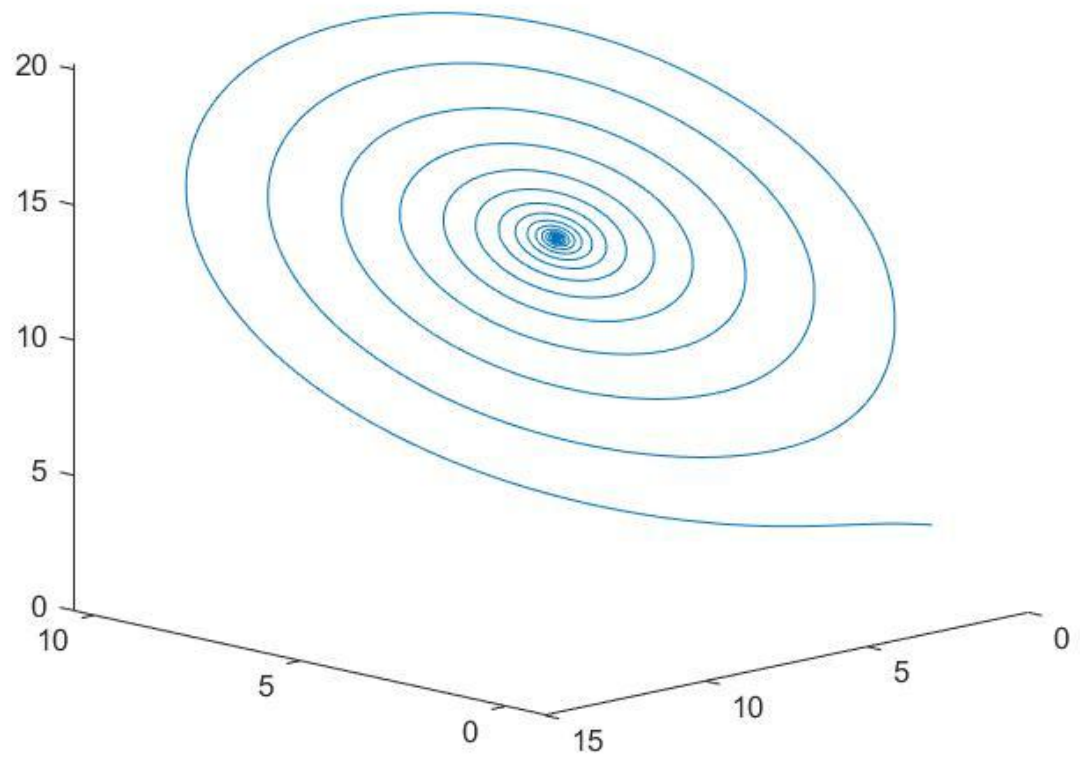
Declaration: We, undersigned below, hereby declare that this project report, submitted by us, is our own work and has not been submitted to any other organisation earlier.

Name	Student number	%	Contributed to which tasks	Signature
1.WenHong Ma	z5252794	33.3	1,2,4(**)	
2.Tina Tang	z5286383	33.4	1(*), 3,4,5(*), 6	
3.Zijian Yue	z5188675	33.3	1(*), 2(*), 3(*),5,6	

¹In the third column, % means the contribution percentage of each member of the group to the whole work.

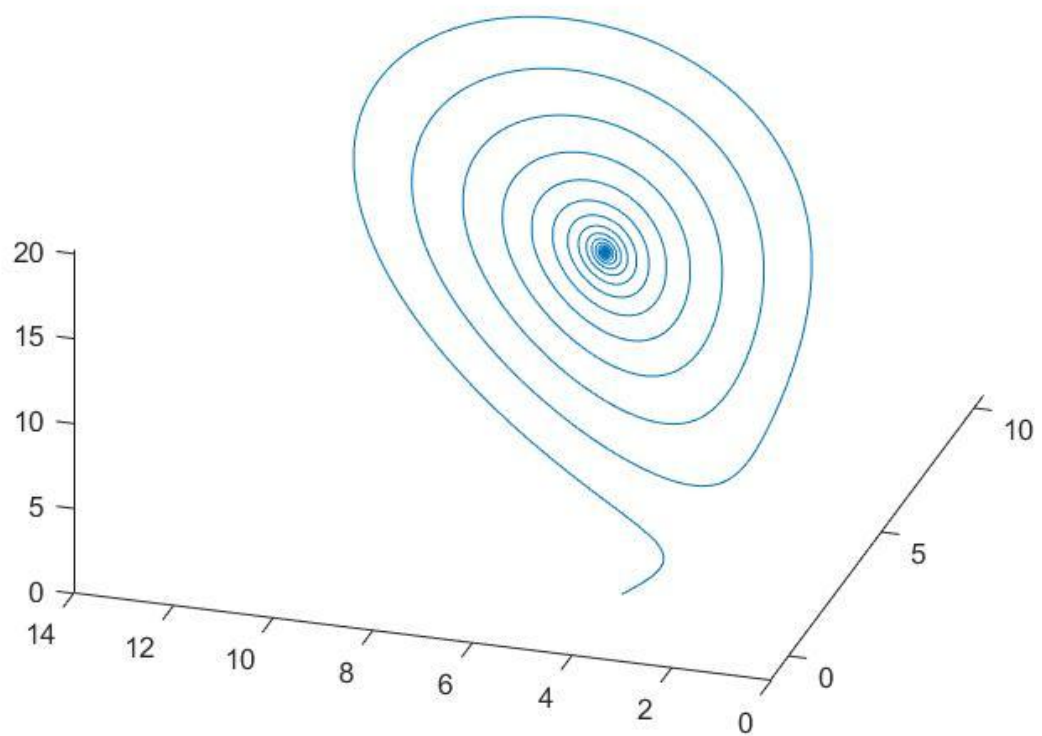
The graphs

RK4 figure



A 3D plot of the numerical solution with
 $(\rho, \sigma, \beta) = (14, 10, 8/3)$, $t_{\text{final}} = 100$
using the explicit Runge-Kutta method with $h = 10^{-3}$

IRK4 figure



A 3D plot of the numerical solution with
 $(\rho, \sigma, \beta) = (14, 10, 8/3)$, $t_{\text{final}} = 100$
using the implicit Runge-Kutta method with $h = 10^{-3}$

Deduce the order of convergence

Euler method

```
Euler's method
data:
k = 2 h = 10^(-2) max_error = 9.0907
k = 3 h = 10^(-3) max_error = 0.7681
k = 4 h = 10^(-4) max_error = 0.0770
k = 5 h = 10^(-5) max_error = 0.0077
k = 6 h = 10^(-6) max_error = 7.7069e-04
Convergence:
k2 -> k3 = log10(E2/E3)/log10(10) = 1.0732
k3 -> k4 = log10(E3/E4)/log10(10) = 0.9989
k4 -> k5 = log10(E4/E5)/log10(10) = 1
k5 -> k6 = log10(E5/E6)/log10(10) = 0.9996
Max Convergence = 1.0732
This implies the order of convergence of Euler's methods is O(1).
```

Runge Kutta method

```
Runge Kutta method
data:
k = 1 h = 10^(-1) max_error = 3.9076
k = 2 h = 10^(-2) max_error = 5.9983e-04
k = 3 h = 10^(-3) max_error = 5.8287e-08
k = 4 h = 10^(-4) max_error = 5.9588e-12
Convergence:
k1 -> k2 = log10(E1/E2)/log10(10) = 3.8139
k2 -> k3 = log10(E2/E3)/log10(10) = 4.0125
k3 -> k4 = log10(E3/E4)/log10(10) = 3.9904
Max Convergence = 4.0125
This implies the order of convergence of Runge Kutta method is O(4).
```

Implicit Runge Kutta method

```
Implicit Runge Kutta method
data:
k = 1 h = 10-1 max_error = 0.7748
k = 2 h = 10-2 max_error = 1.1436e-04
k = 3 h = 10-3 max_error = 1.1490e-08
k = 4 h = 10-4 max_error = 1.3198e-12
Convergence:
k1 -> k2 = log10(E1/E2)/log10(10) = 3.8309
k2 -> k3 = log10(E2/E3)/log10(10) = 3.9980
k3 -> k4 = log10(E3/E4)/log10(10) = 3.9398

Max Convergence = 3.9980
This implies the order of convergence of Implicit Runge Kutta method is O(4).
```

Project log:

Task1:

- Wenhong(main contributor)
- Zijian(fix the code)
- Tina(fix the code)

Task2:

- Wenhong(main contributor)
- Zijian(fix the code)

Task3:

- Tina

Task4:

- Tina

Task5:

- Zijian

Task6:

- Zijian, Tina

*Note: back up version of task 4(Wenhong)

*Note: report proofreading(Zijian)

2/April/2021:

First group meeting

11/April/2021:

Wenhong:

Draft of Task 1?

Draft of Task 2?

Tina:

Draft of Task 4

2/April/2021:

Tina:

Draft of Task 3

Zijian:

Add comments to task 3,4

Draft of task 5

Create a report template

19-20/April/2021:

Tina,Zijian:

fix task 1,2,3,4,5

finish task 6

finalise the report

Wenhong:

work on the backup version of task 4

21/April/2021:

Zijian: proofreading the report

verify the program for the last time