**Scientific Computing Lab MA – 322 Lab – 11**

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**Roll Number –** 210123072

**Branch –** Mathematics and Computing

For each part of all the questions, the five plots are as follows:

(i) t versus actual and approximate solutions

(ii) t versus absolute error

(iii) N versus Order of Convergence

(iv) loglog plot of t versus absolute error

(v) log(EN) versus log(N)

Where, N = (b-a)/h = Number of intervals

Order of convergence = log2(EN/E2N), where EN and E2N and the maximum errors obtained during the computation for that specific value of N

1)

The following methods are implemented:

(i) Implicit-Euler Method

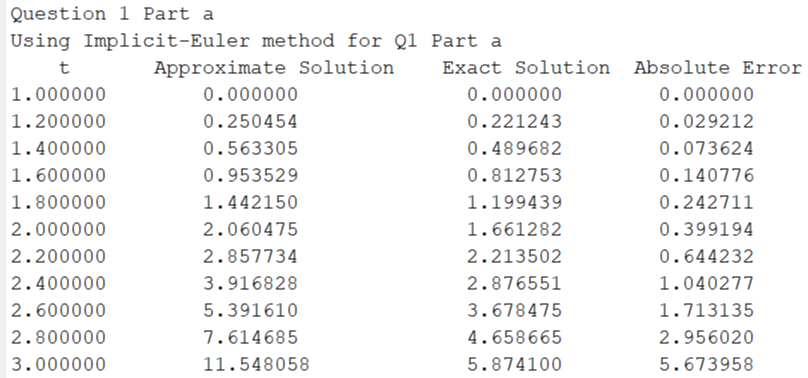
(ii) Second-order Runge-Kutta method with:

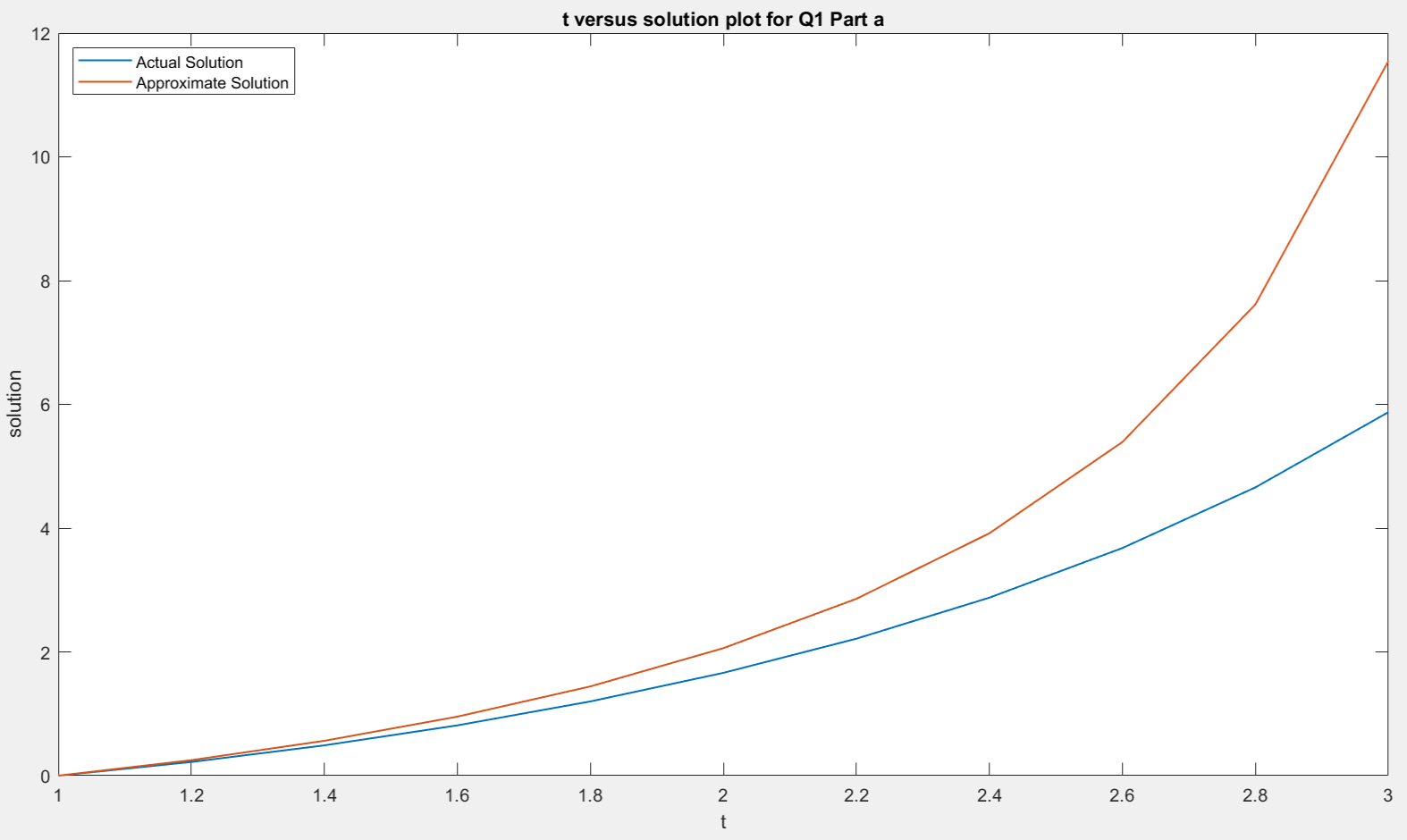
* c2 = 1/2 (Improved Tangent Method)
* c2 = 2/3 (Optimal Method)
* c2 = 1  (Euler-Cauchy Method)

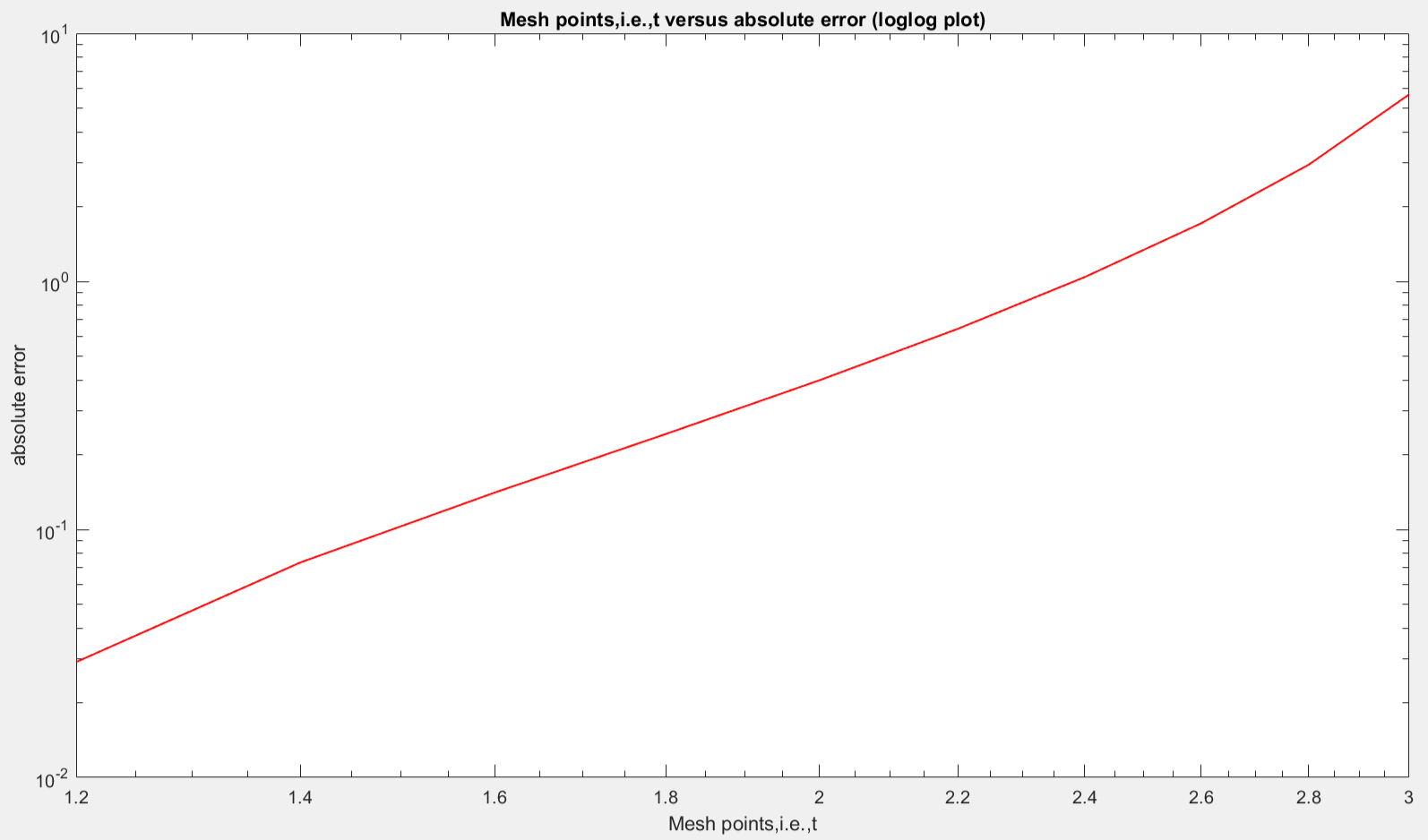
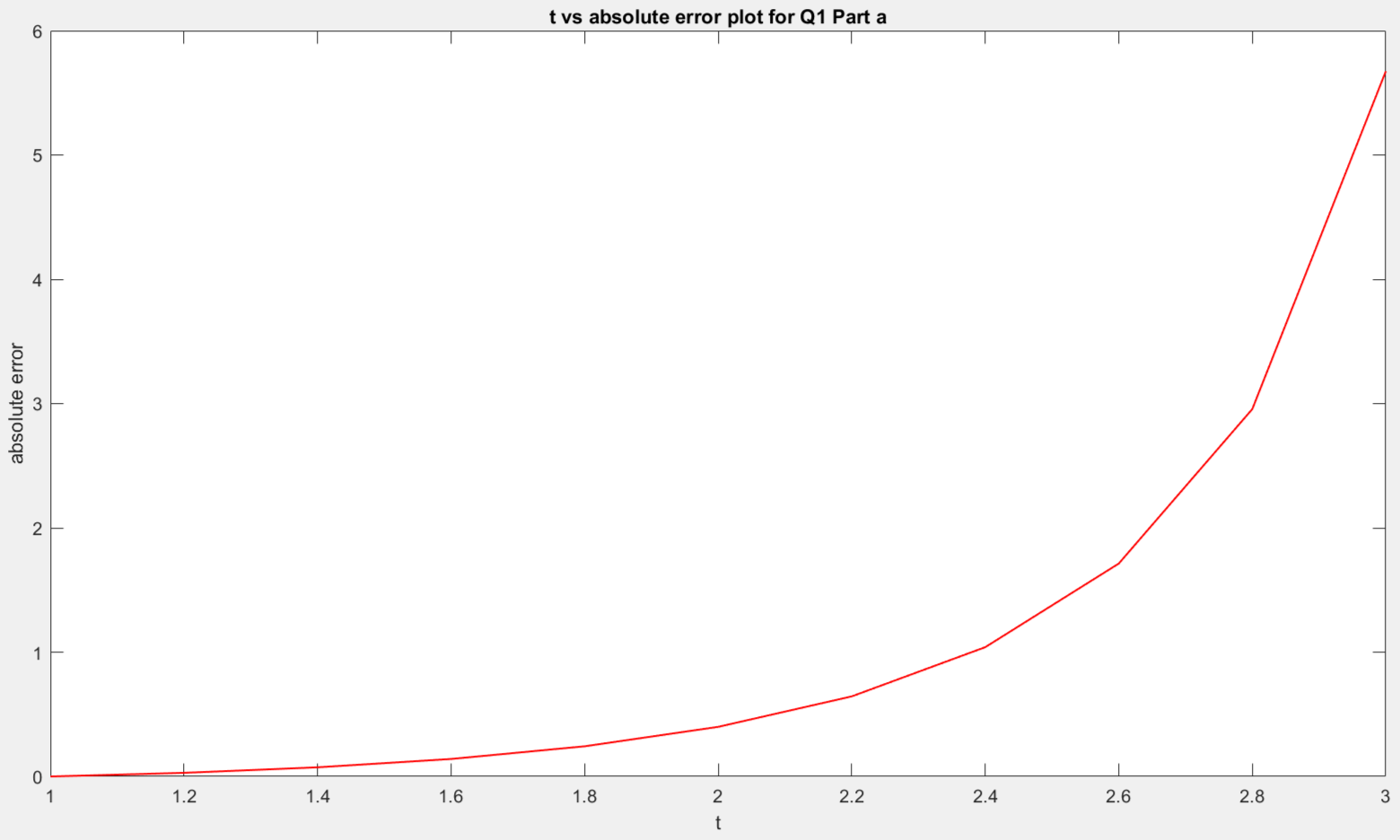
(iii) Fourth-order Runge-Kutta method with:

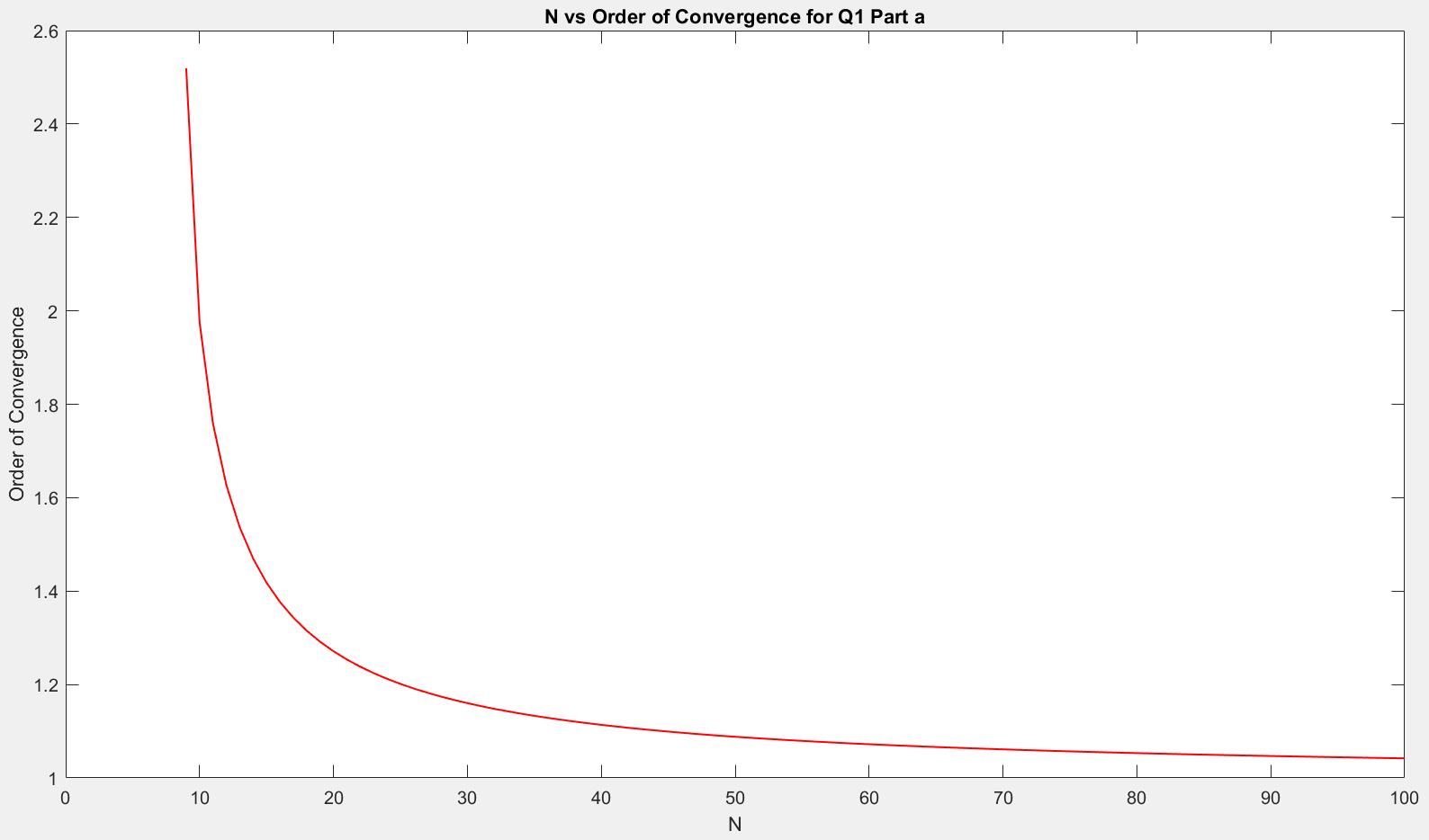
* c2 = 1/2, c3 = 1/2, c4 = 1 (Classical Method)
* c2 = 1/3, c3 = 2/3, c4 = 1 (Kutta Method)

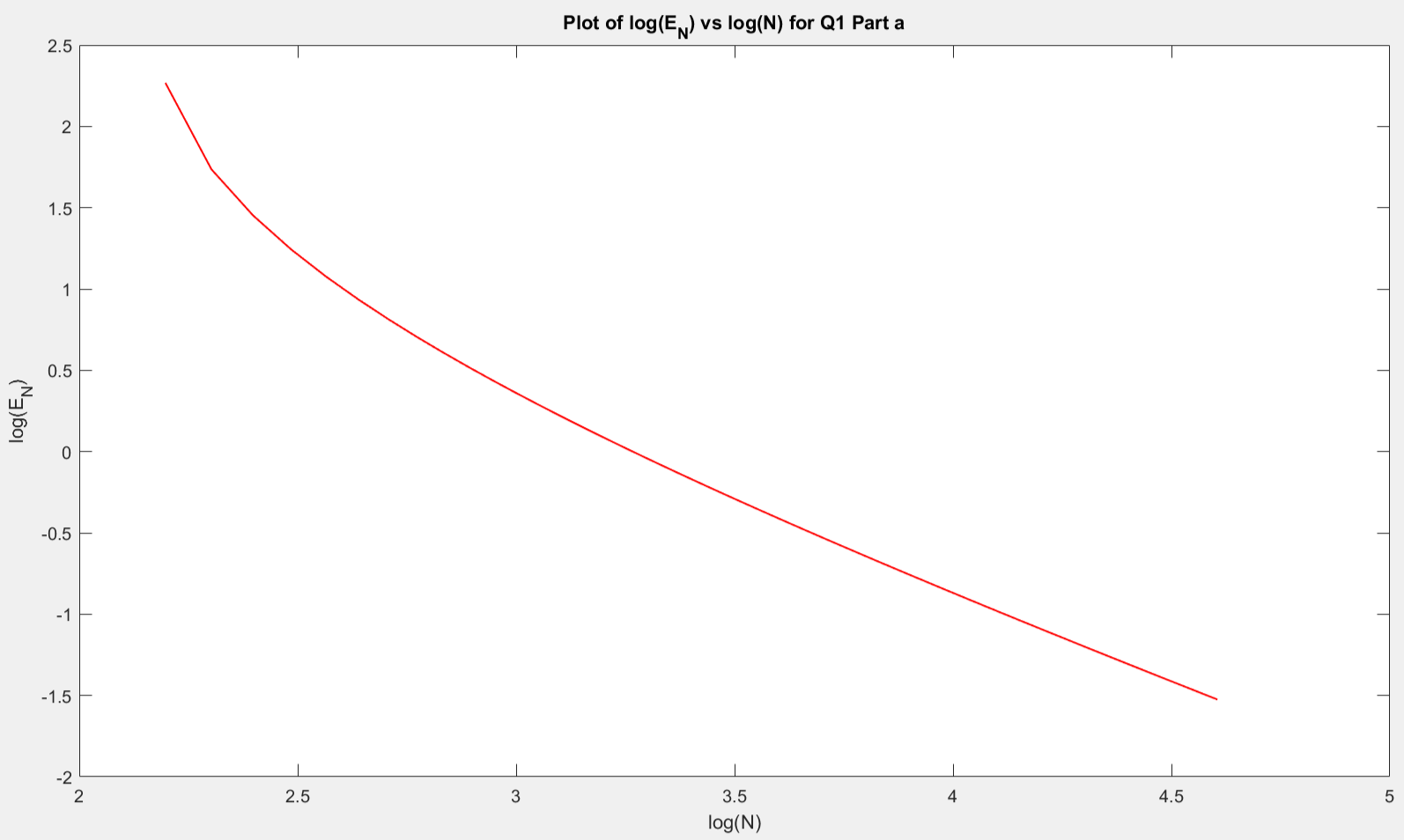
a)

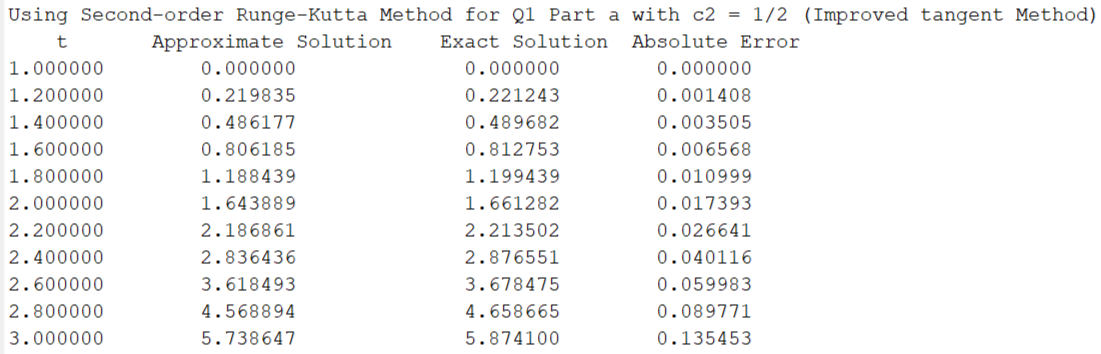


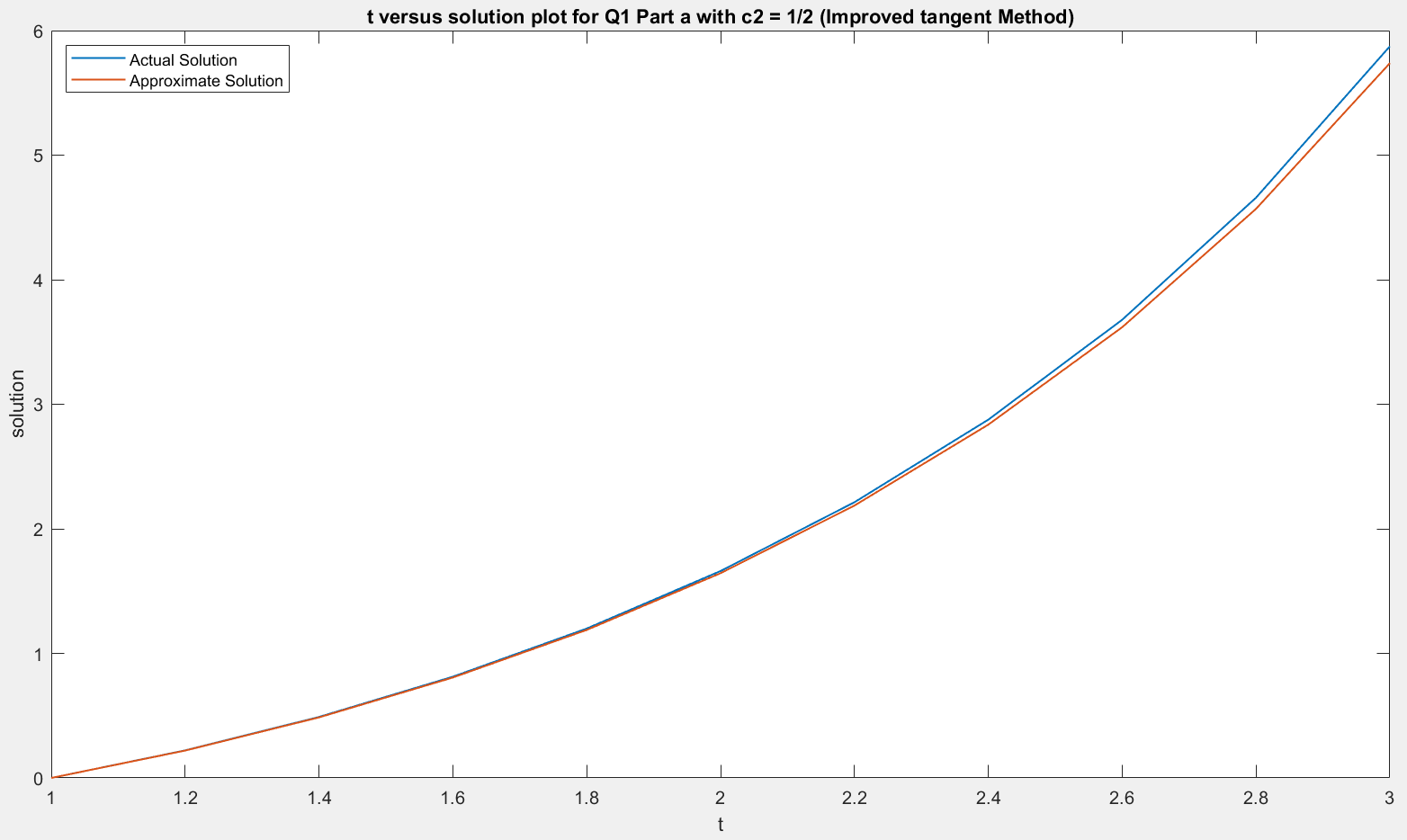


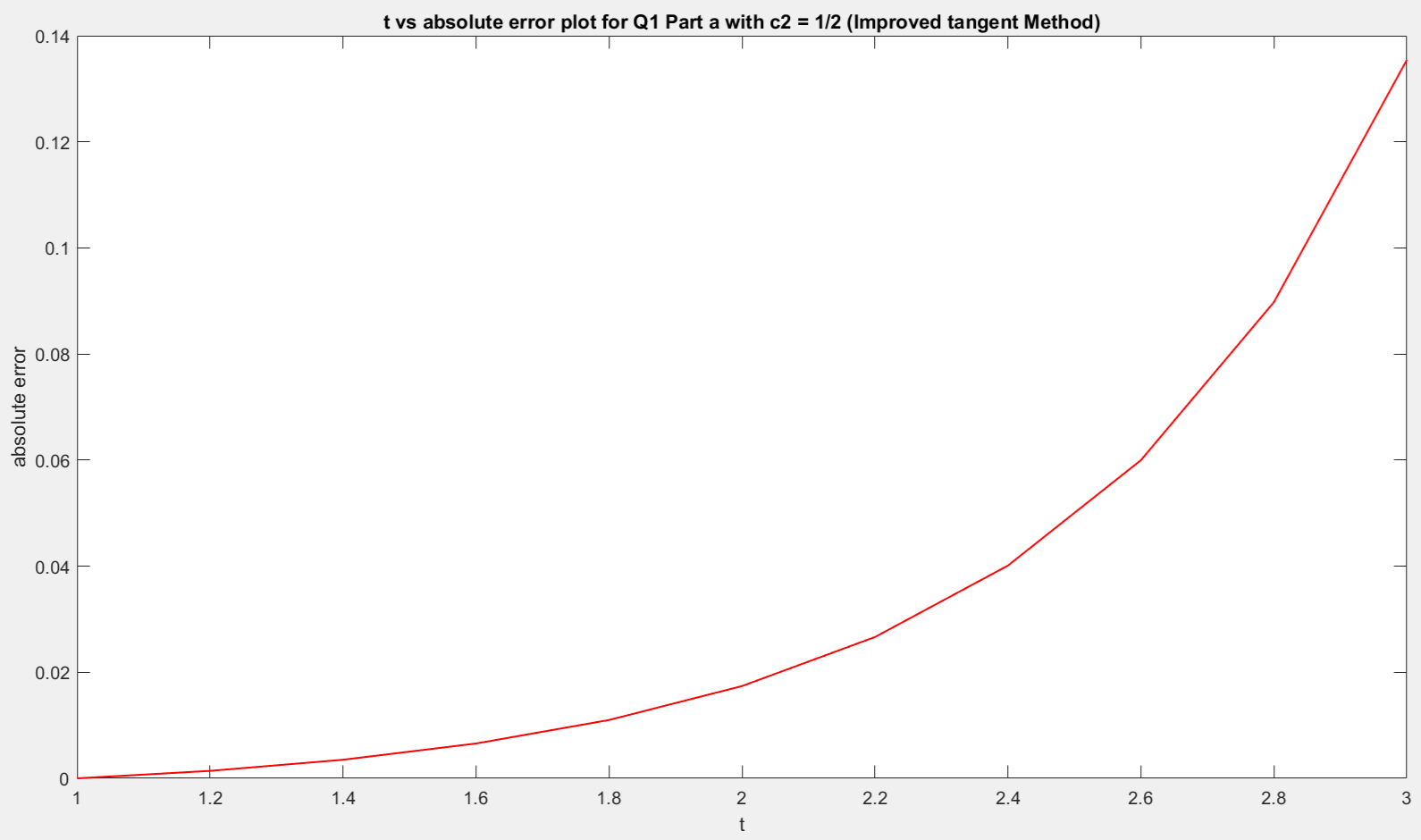


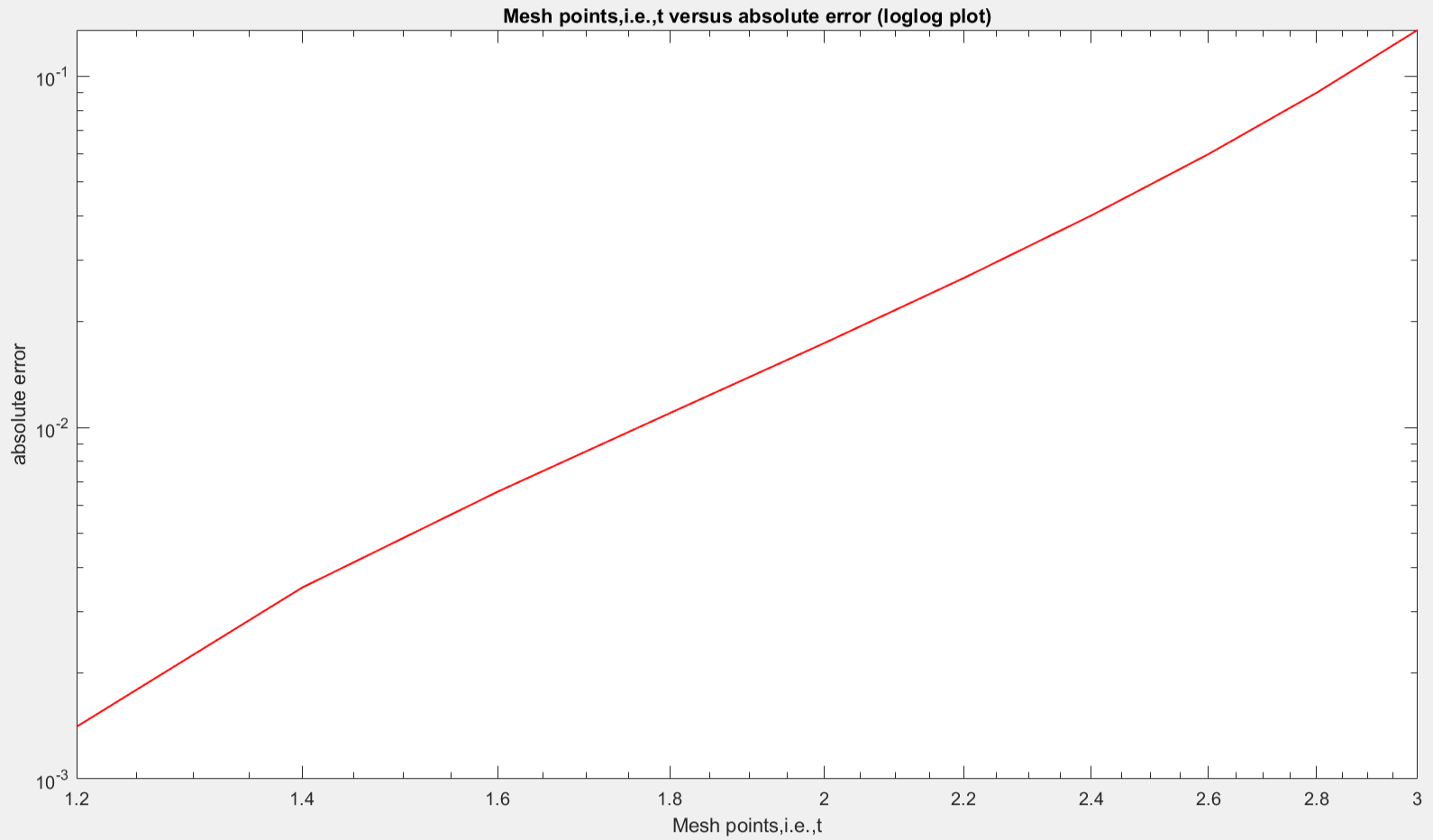


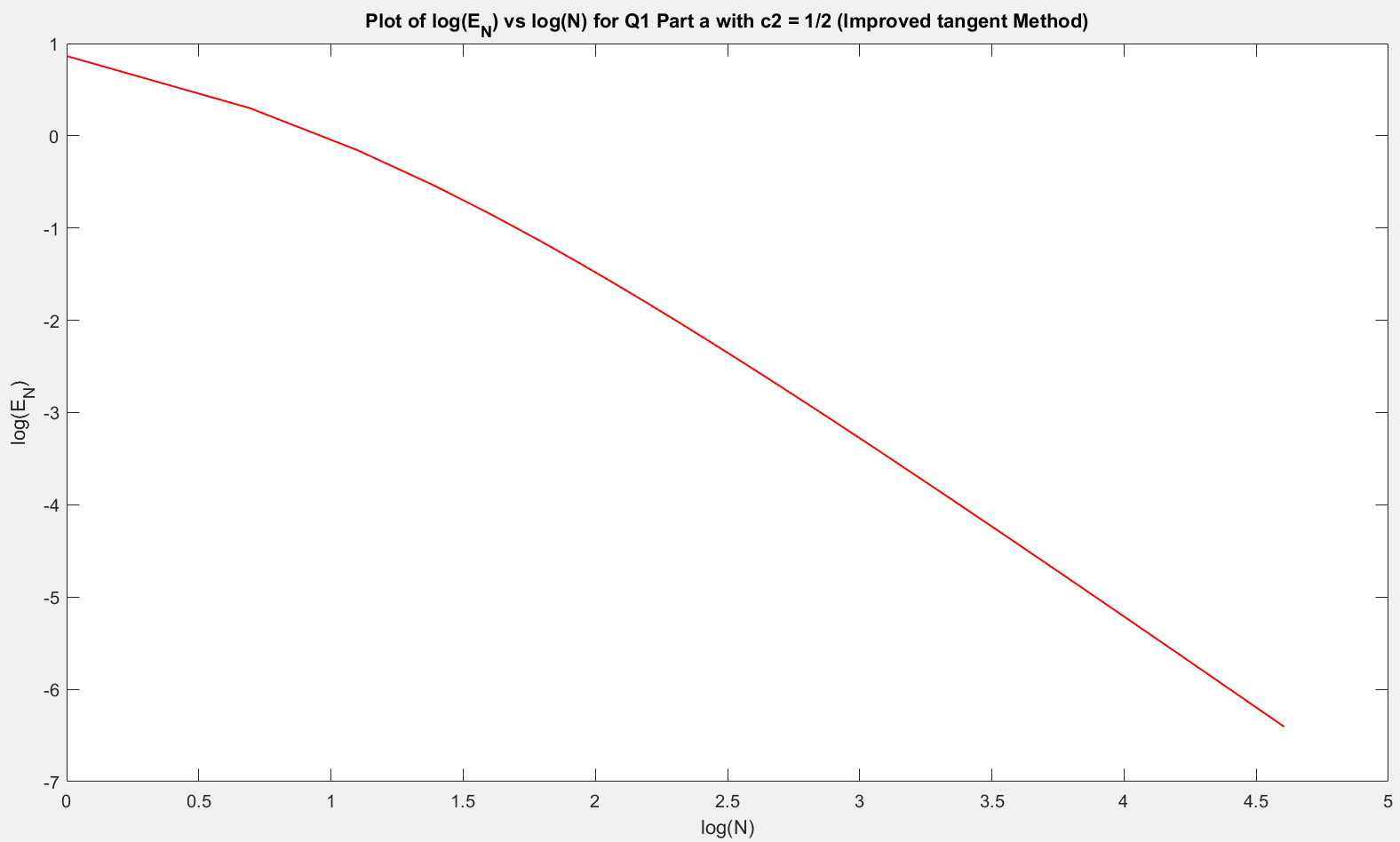
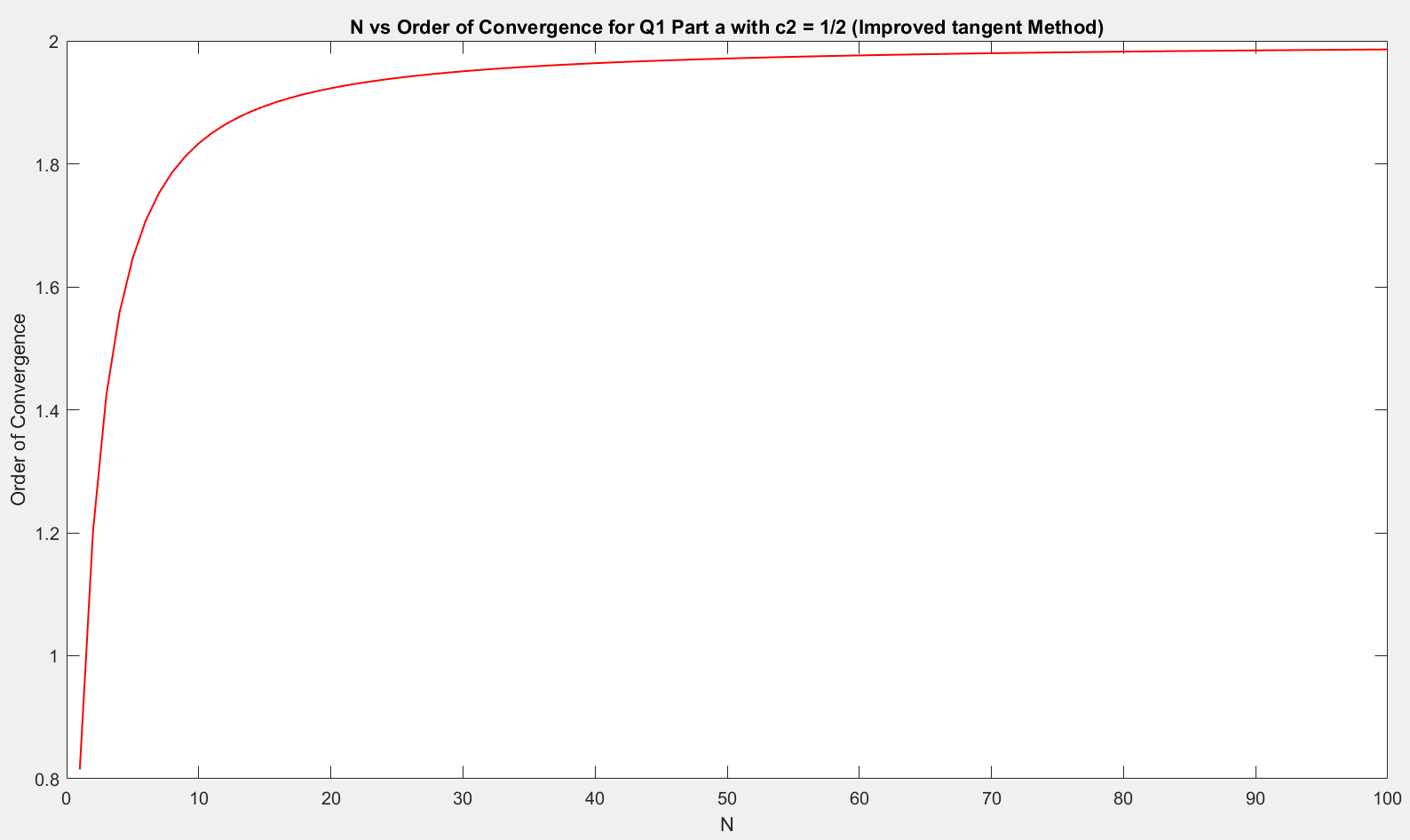


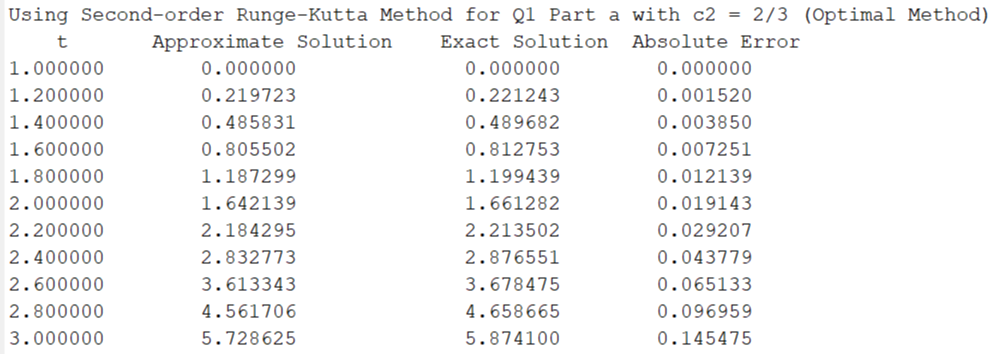


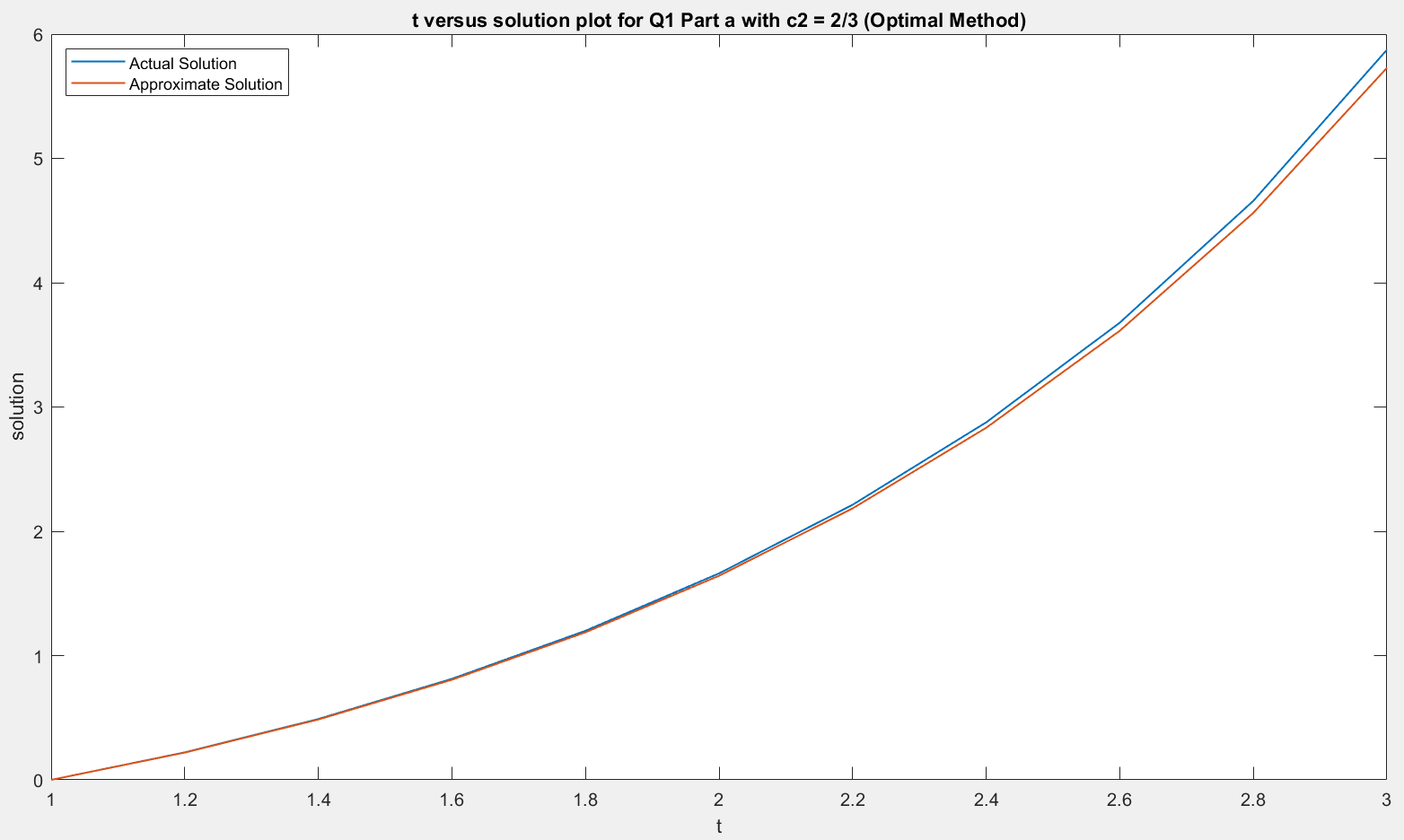


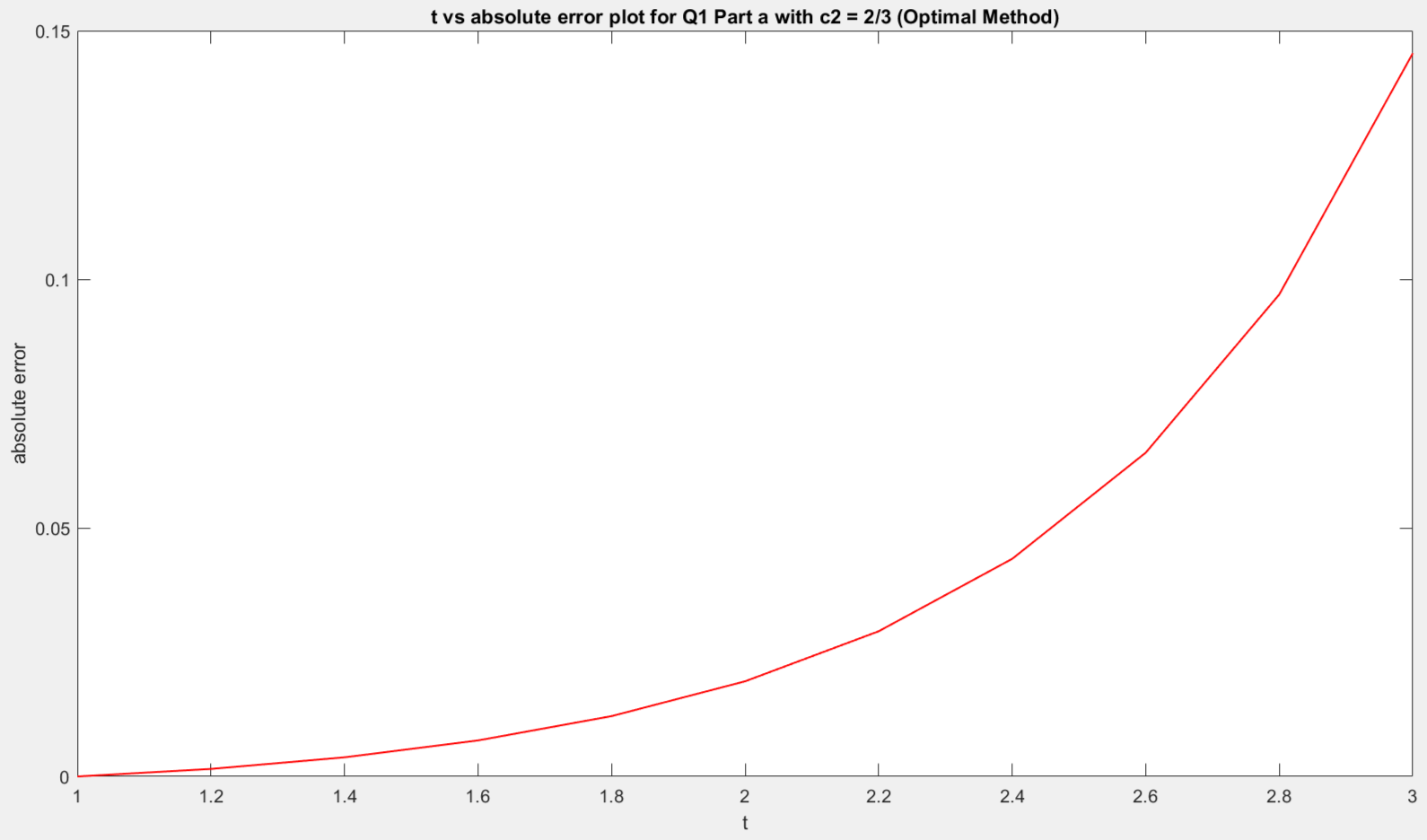


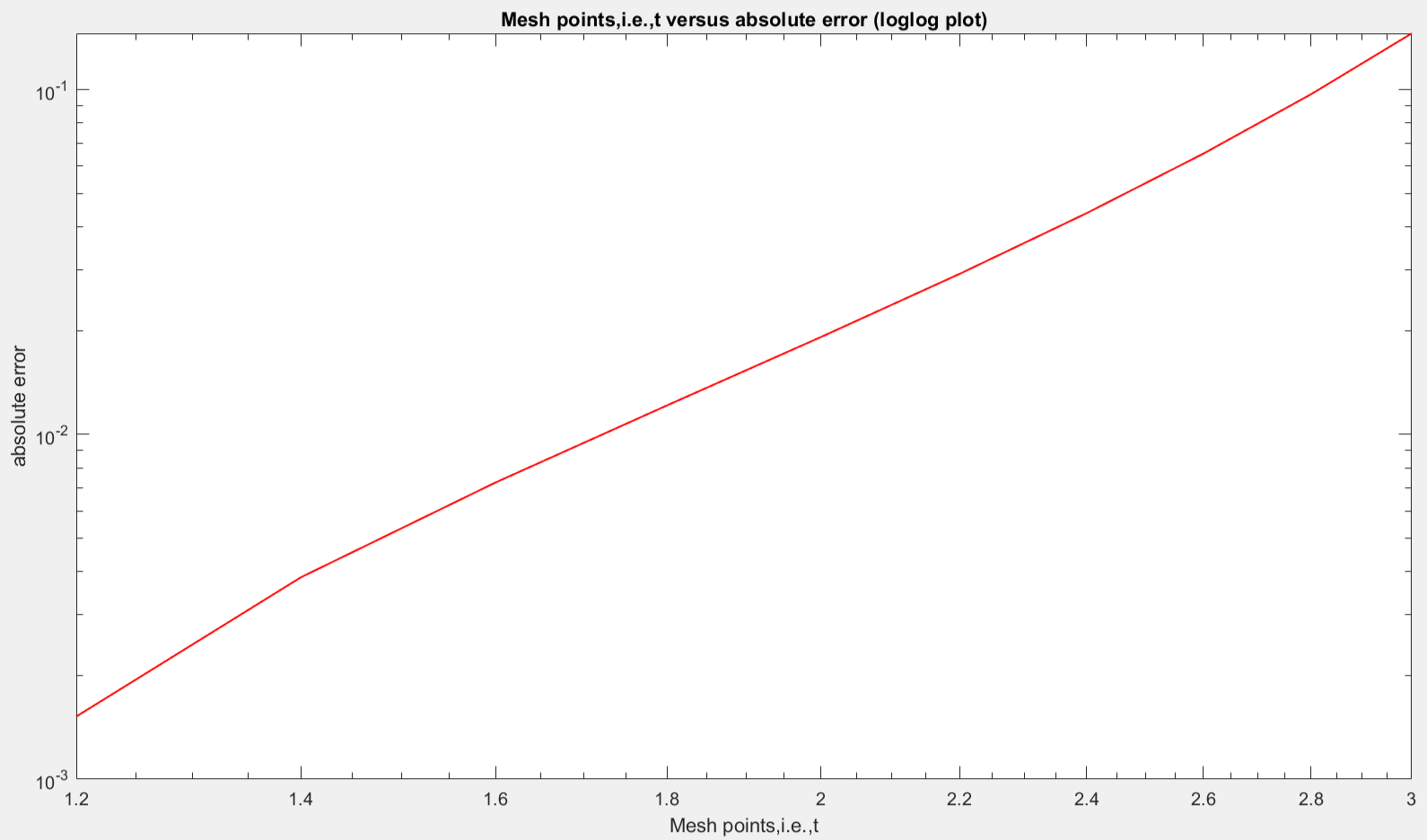


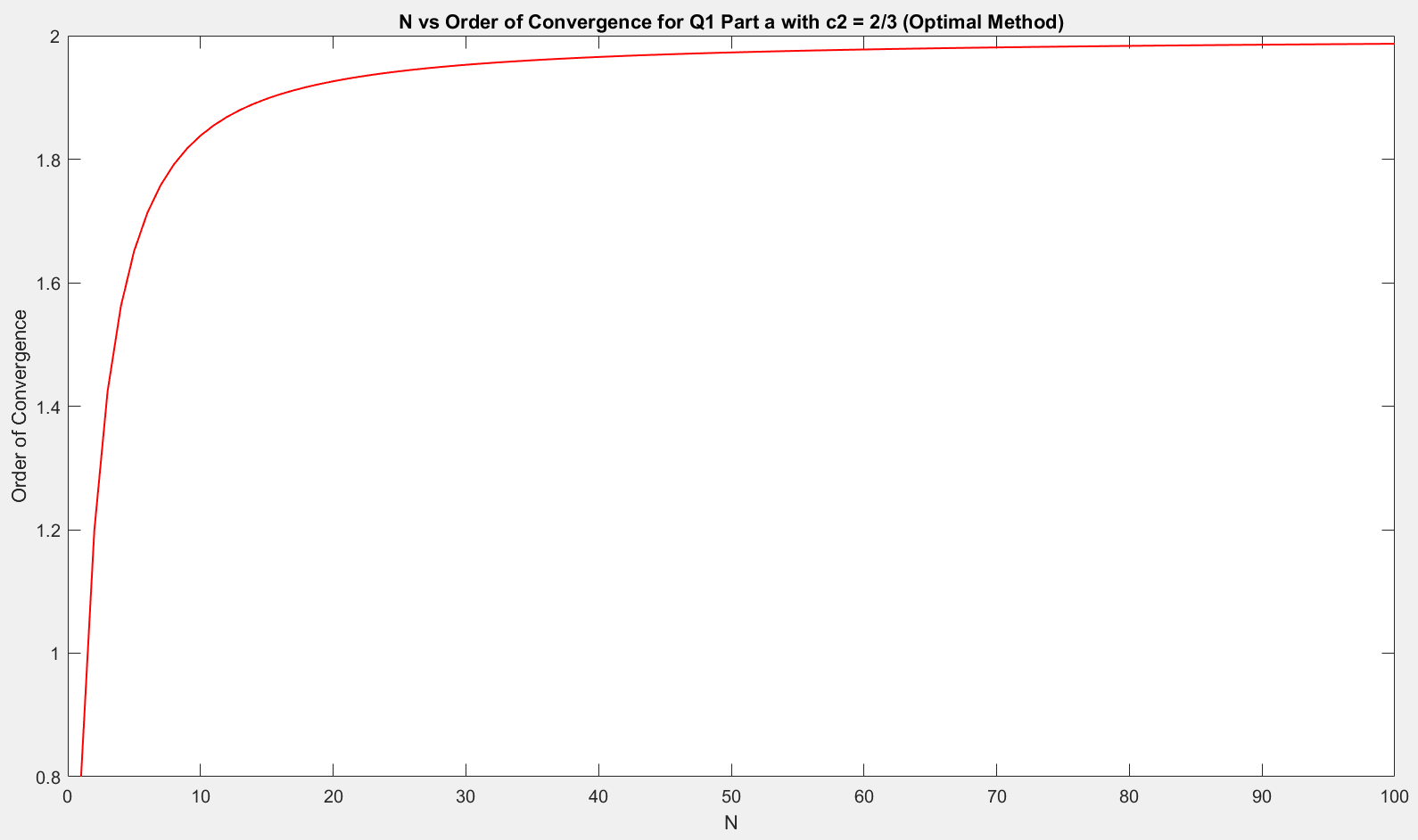


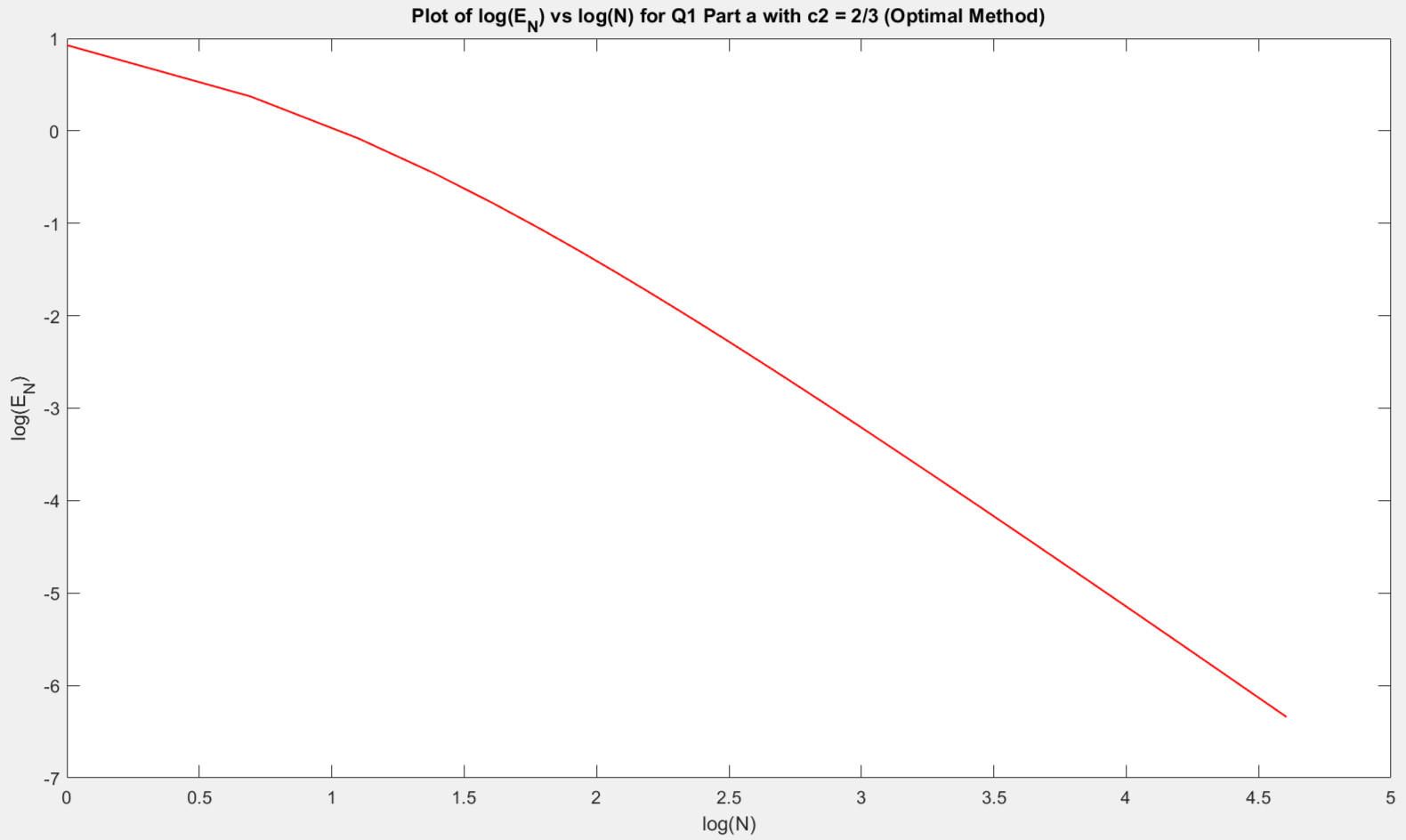


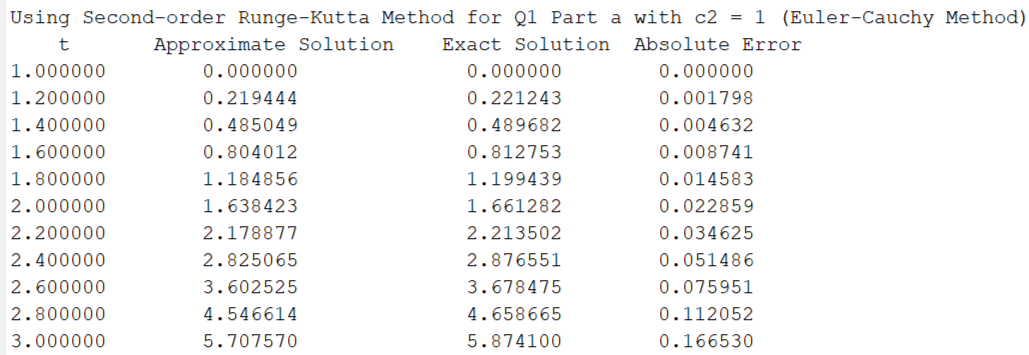


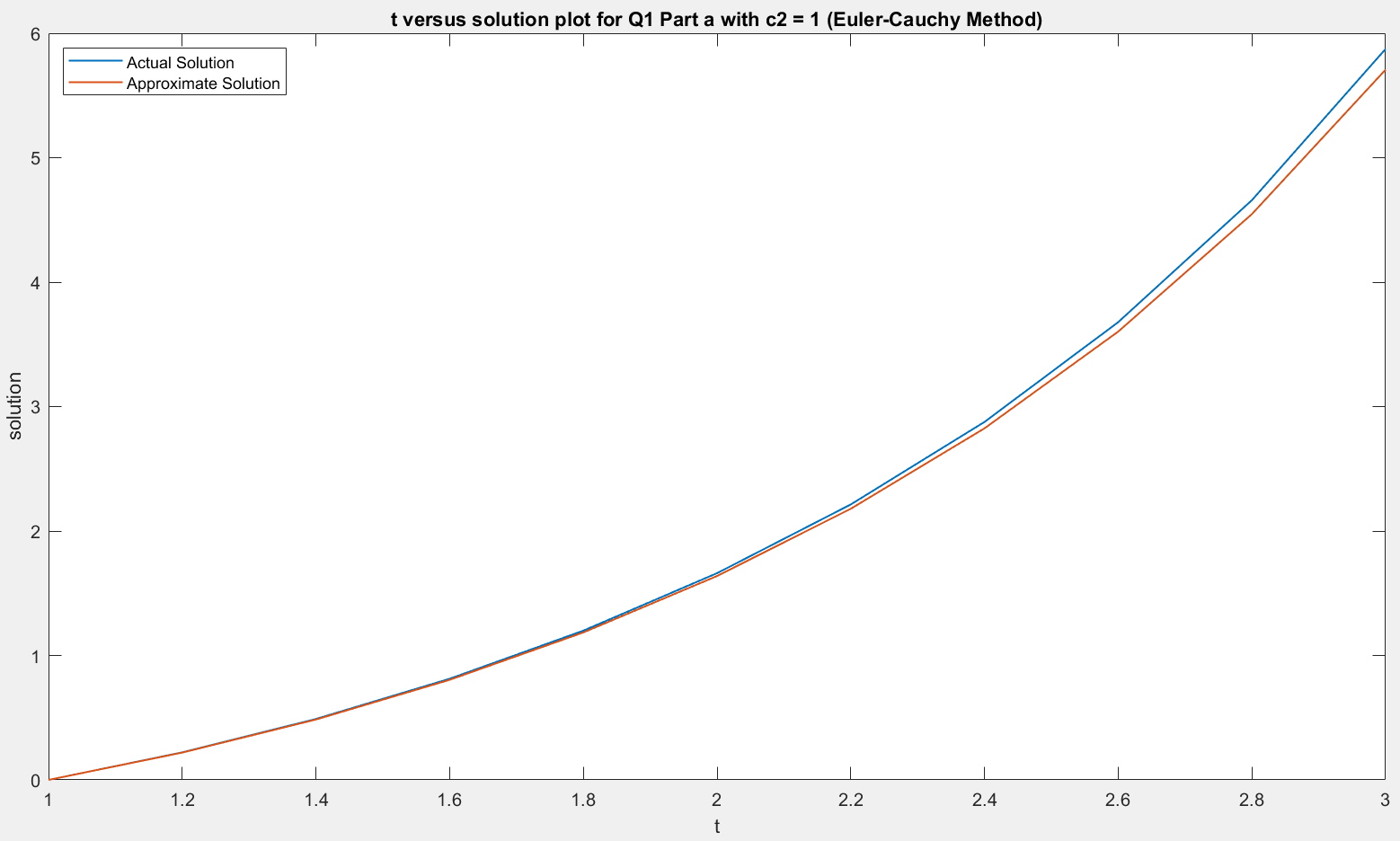


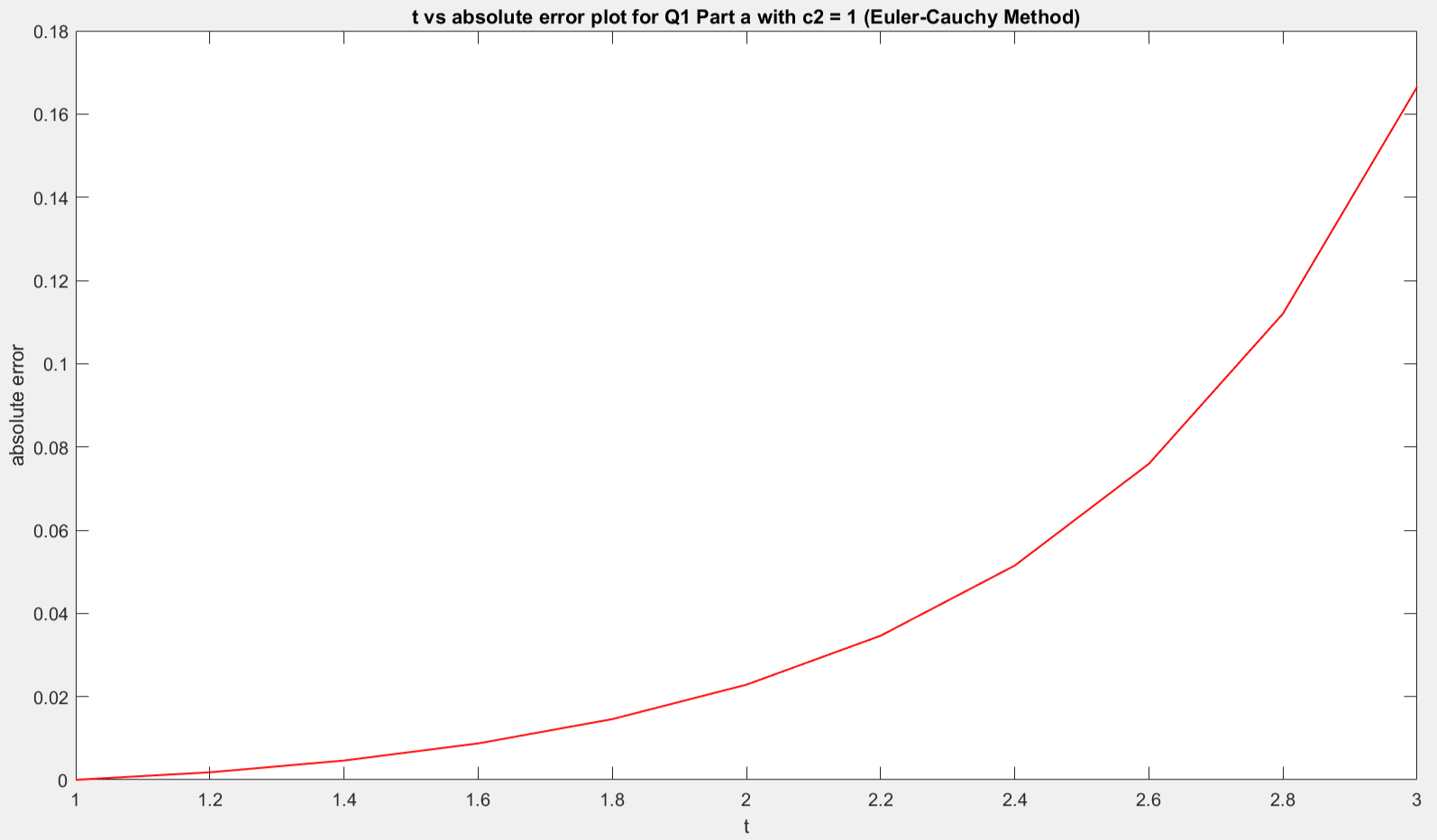


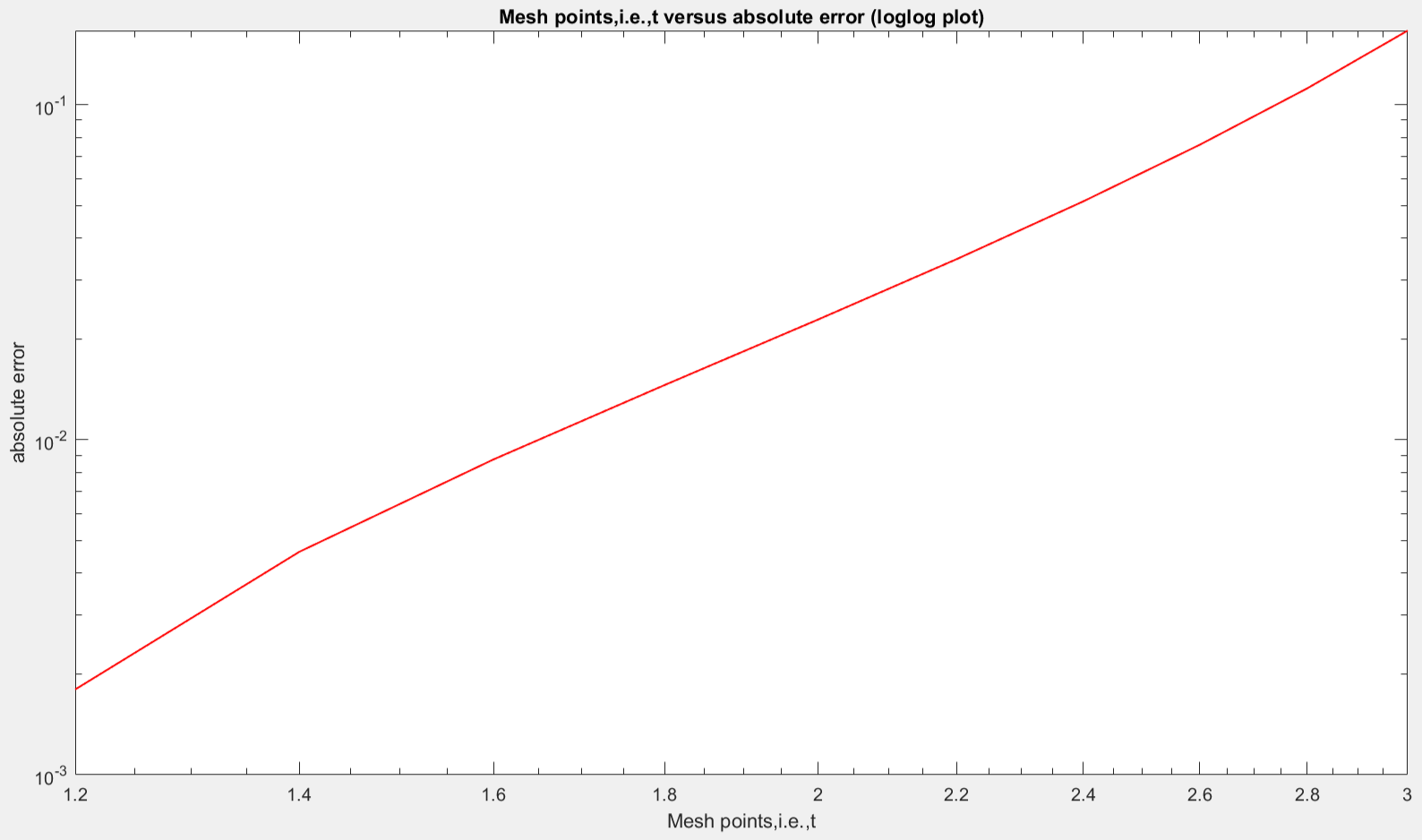


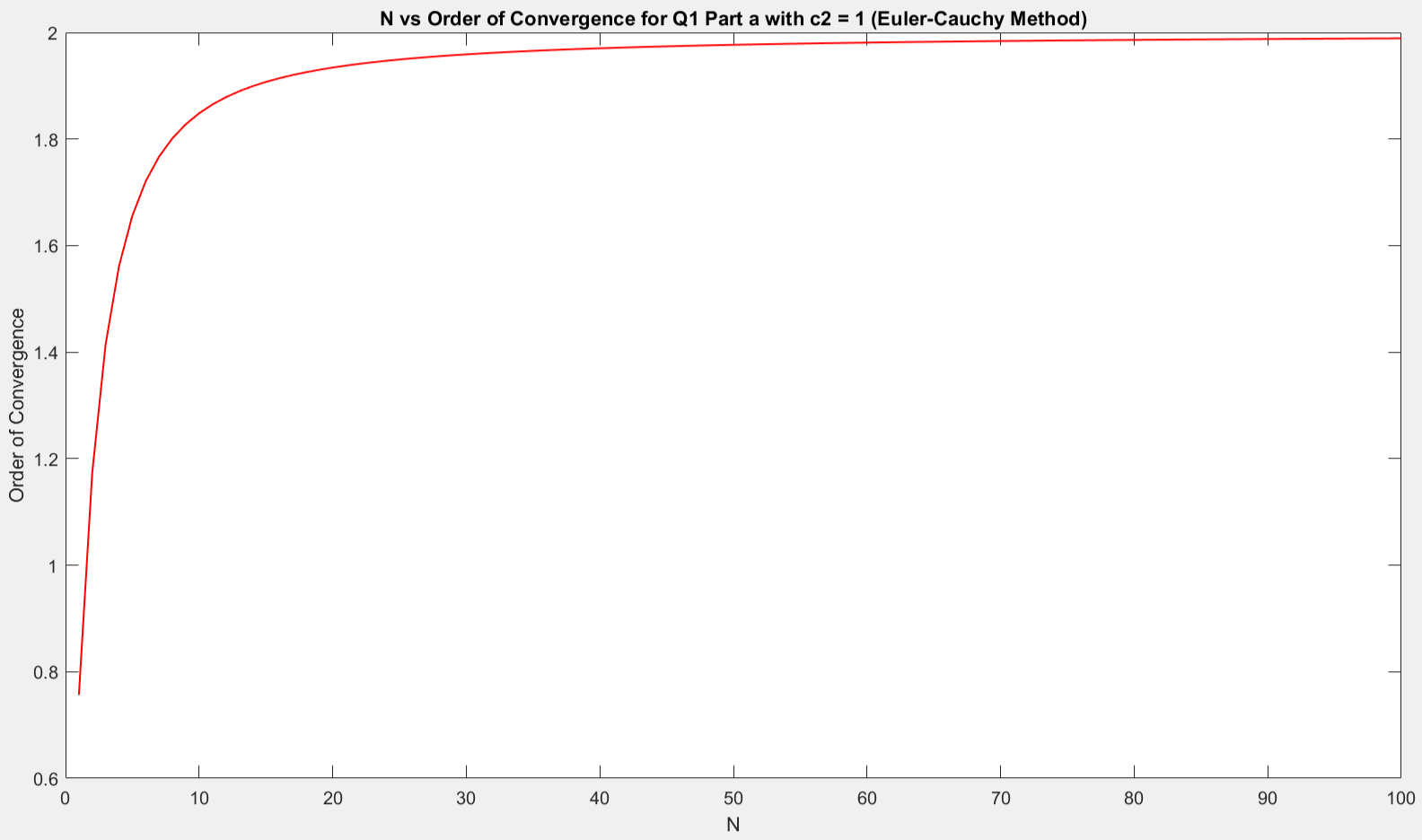


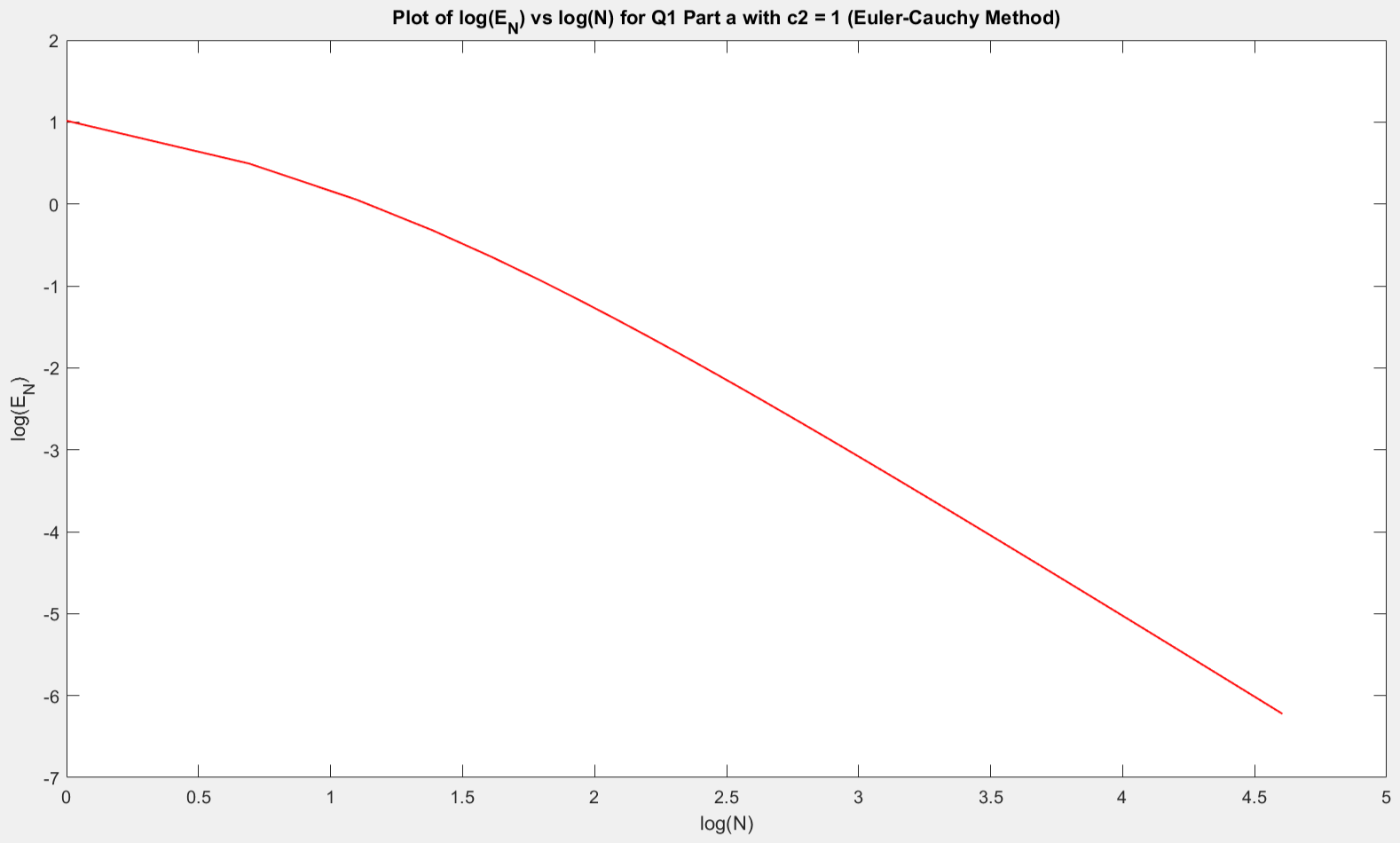


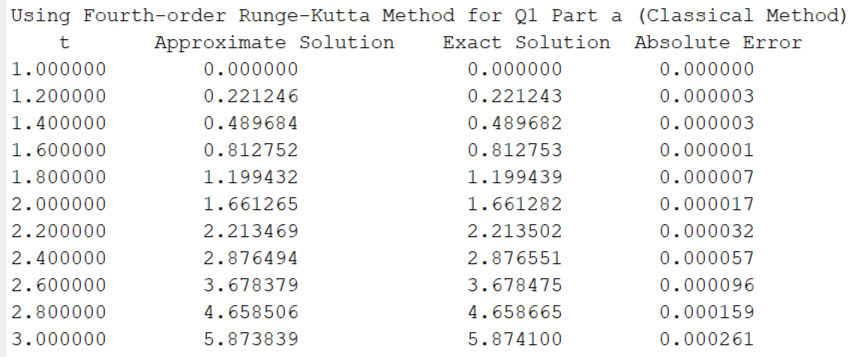


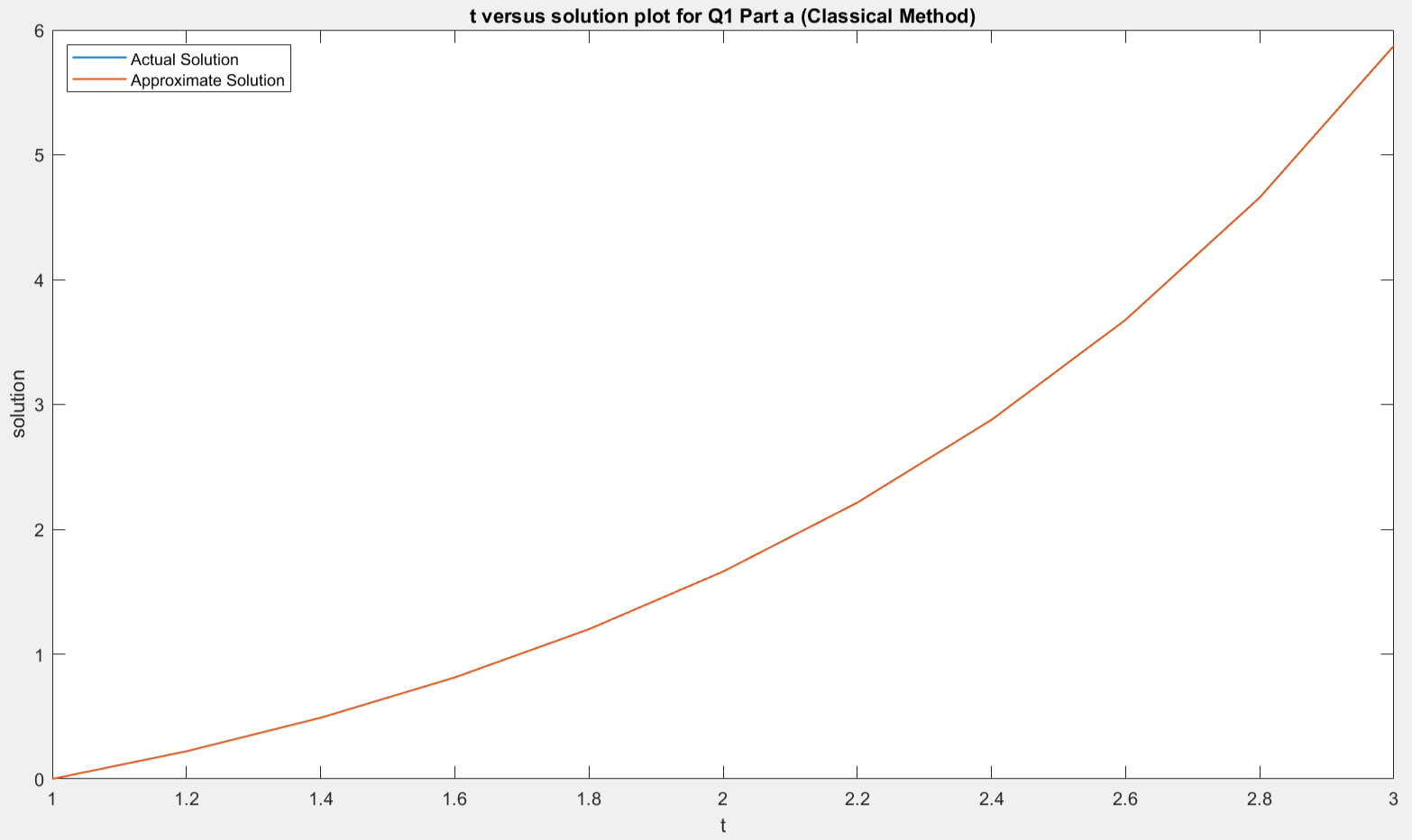


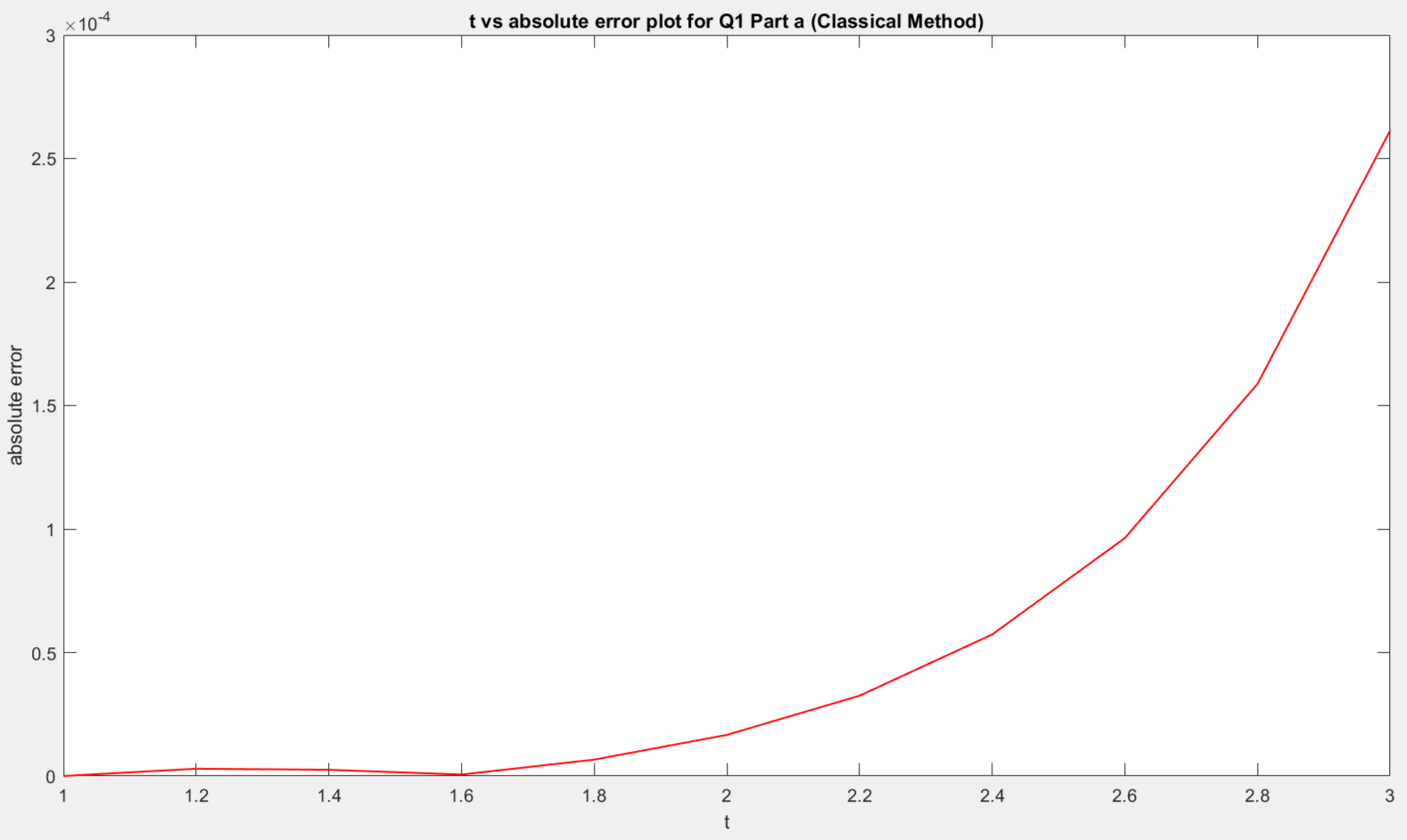


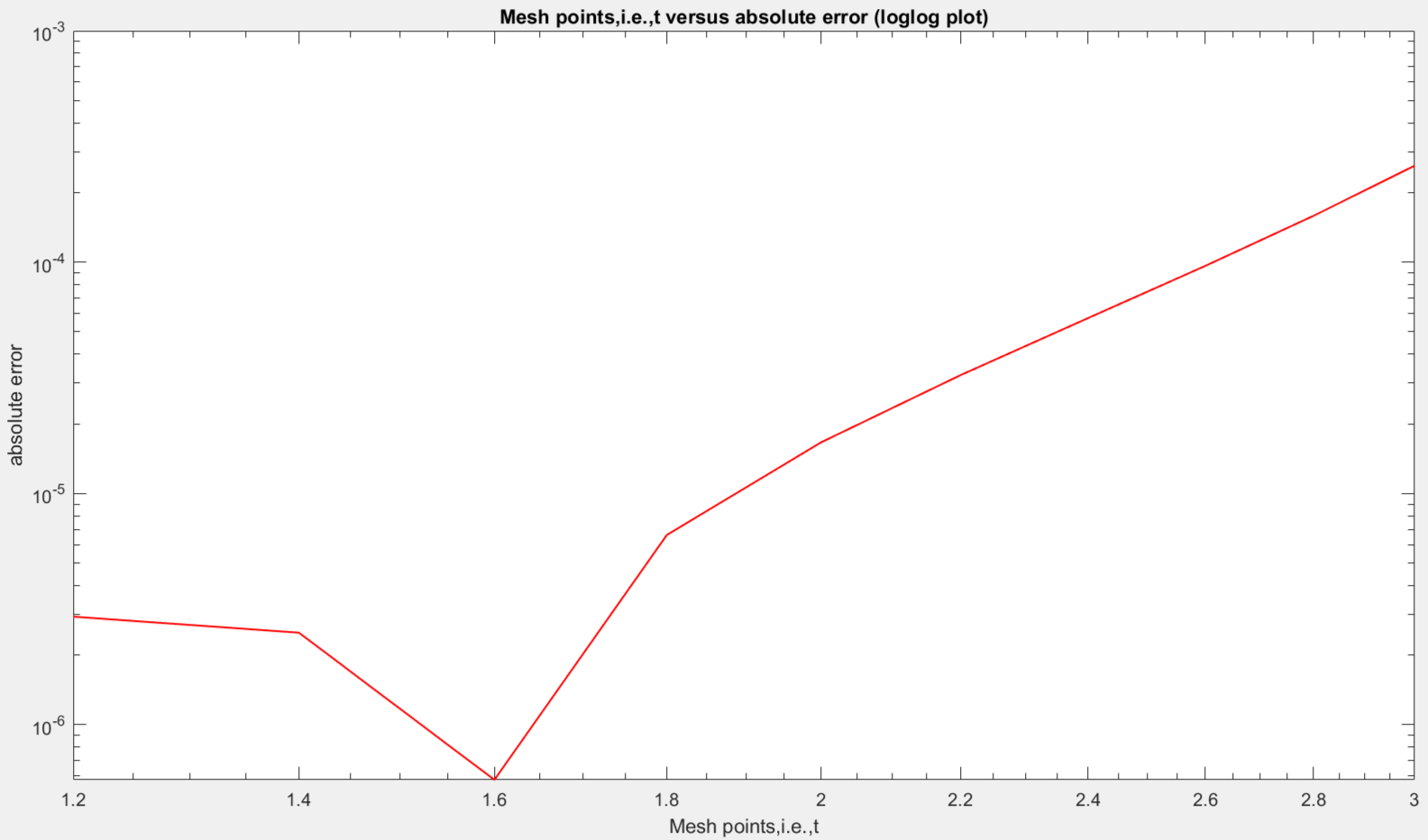


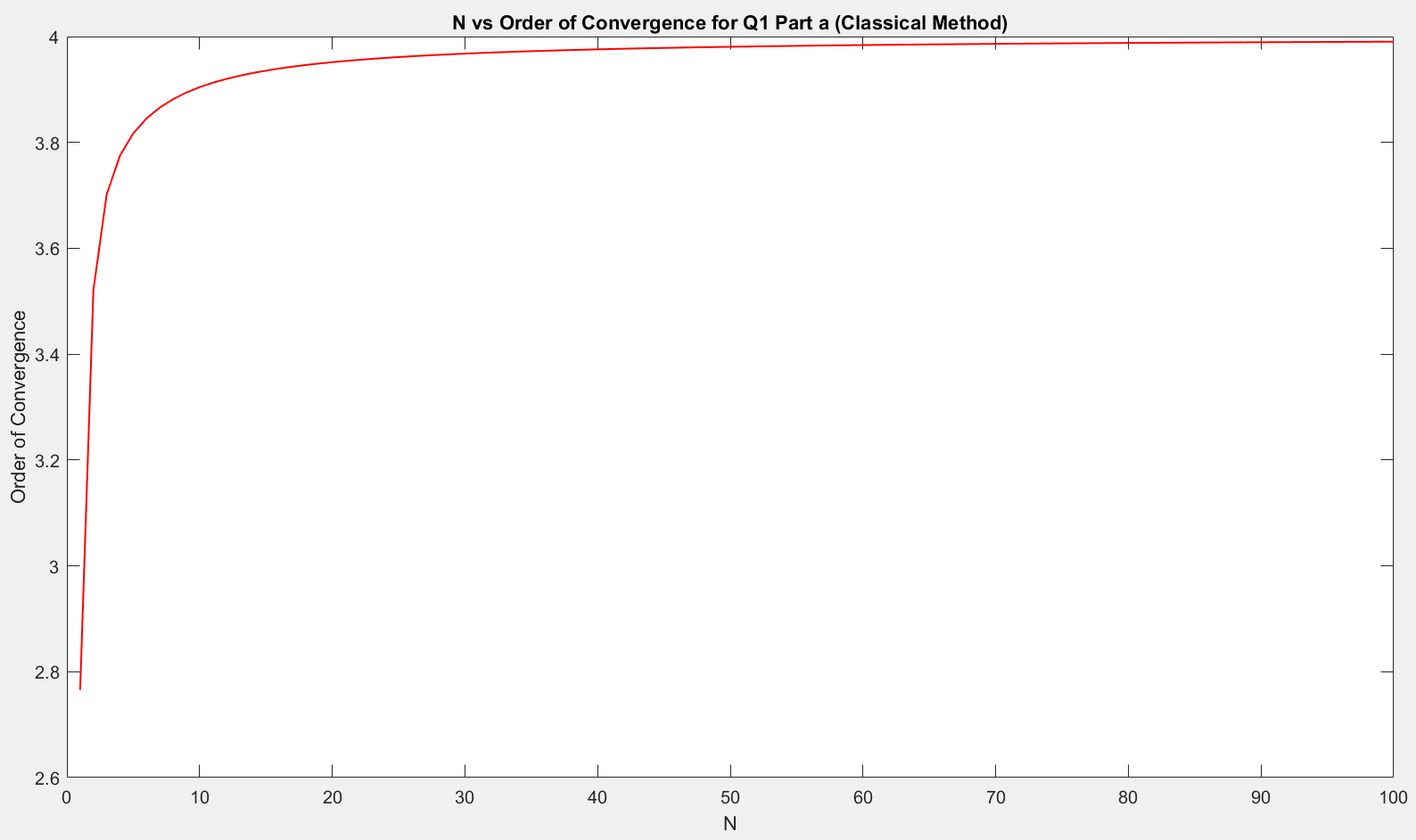


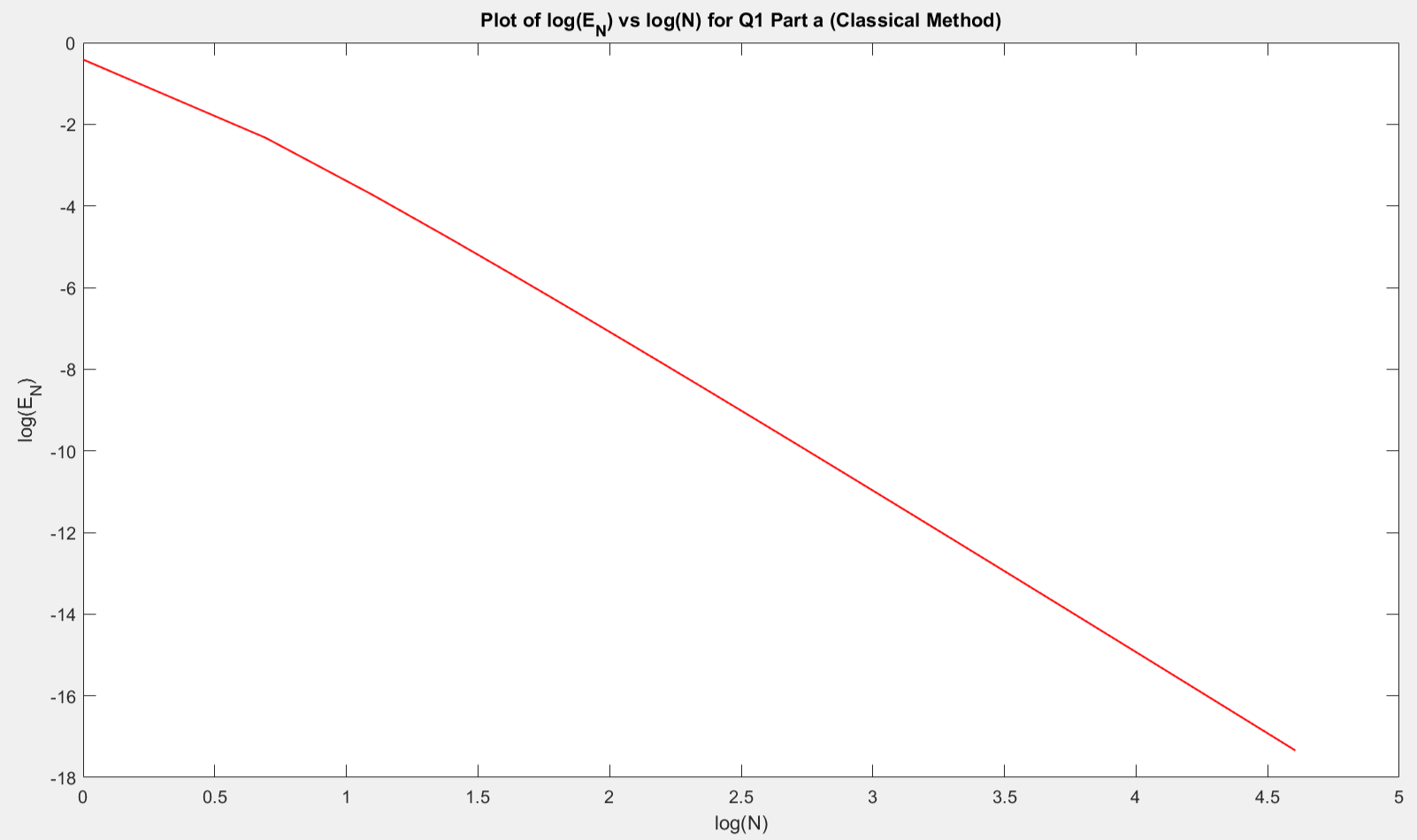


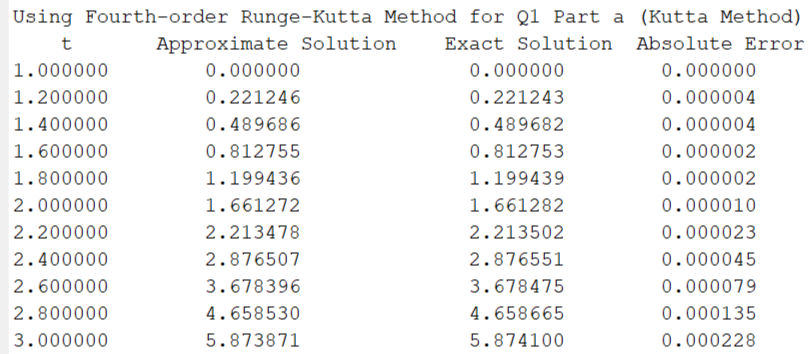


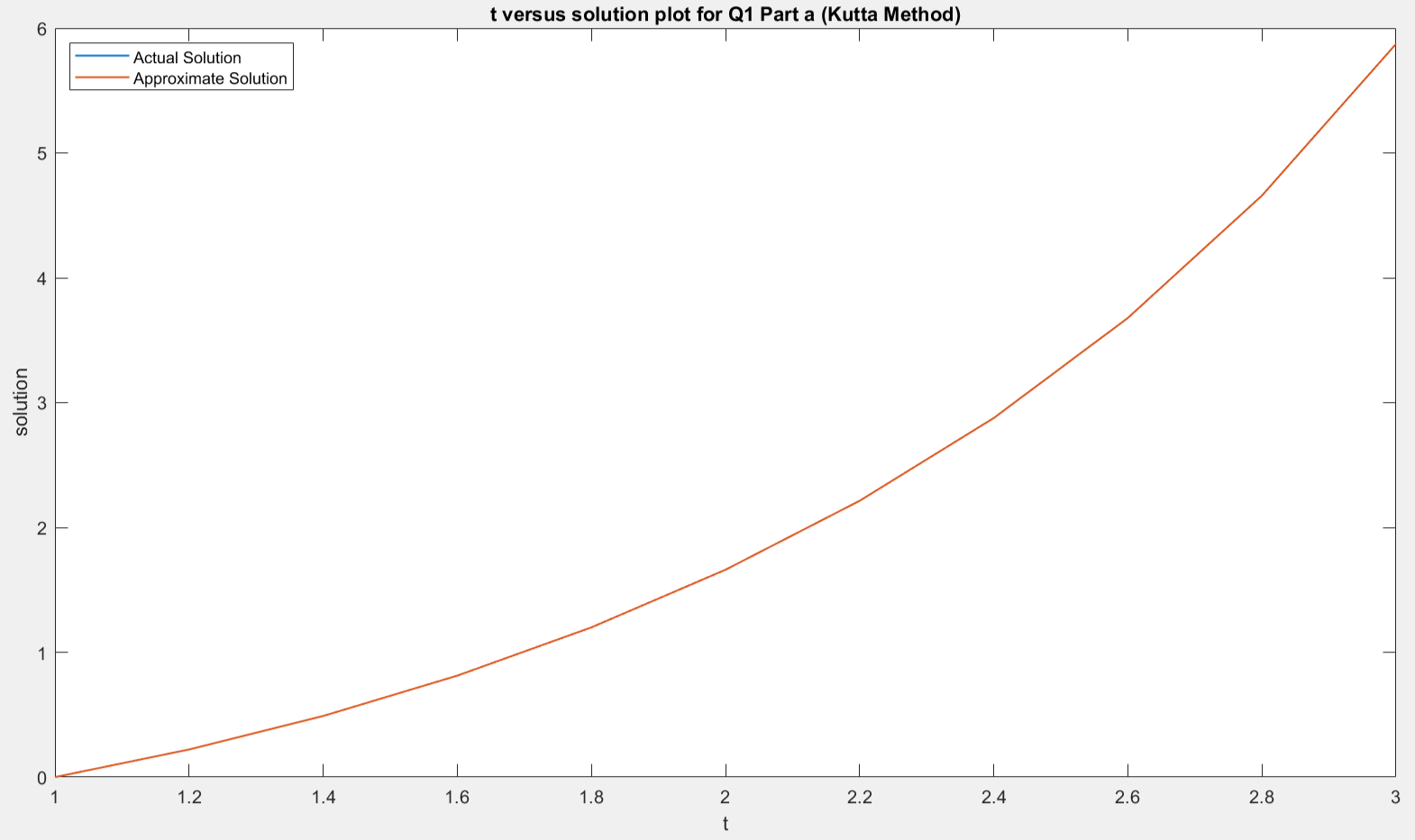


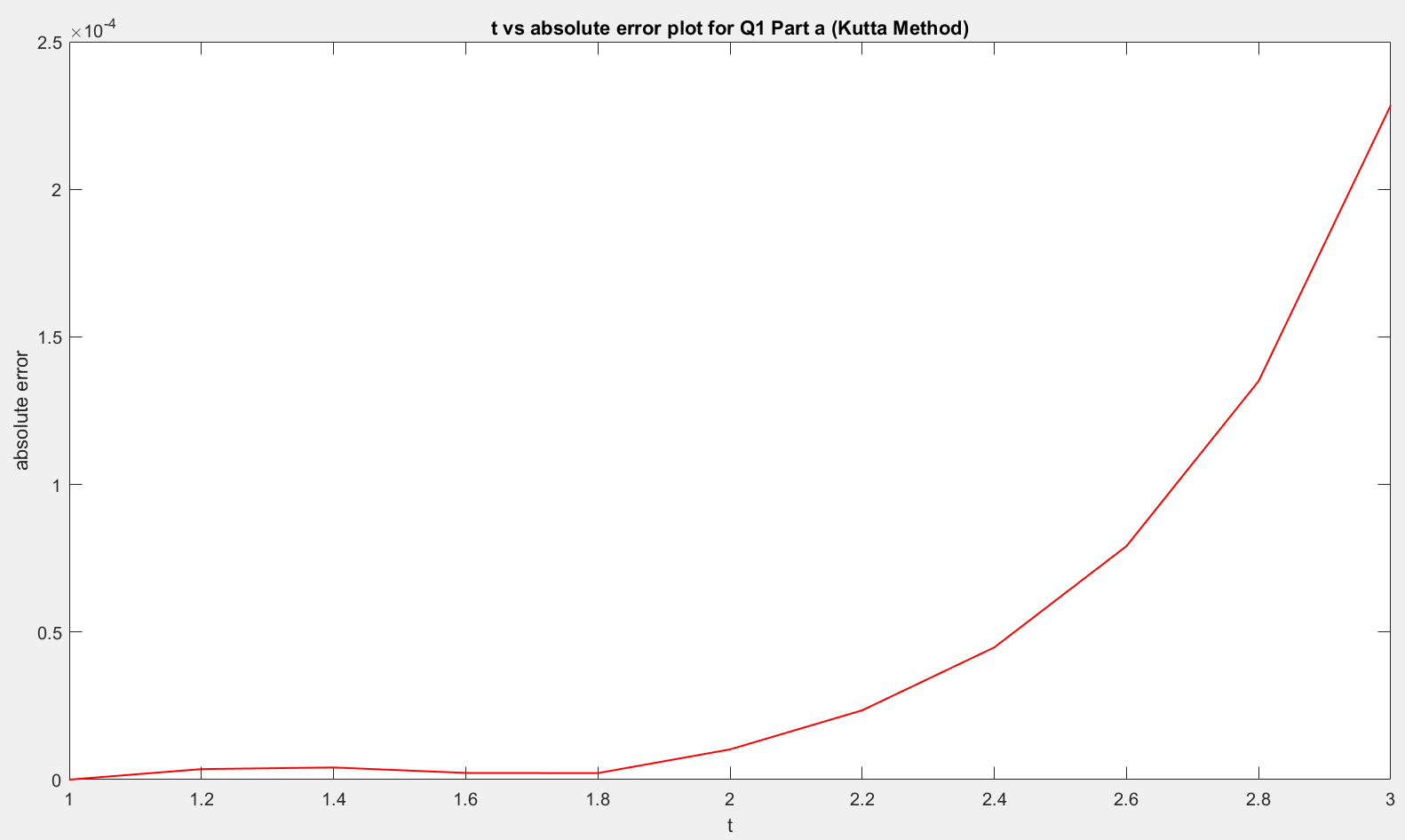


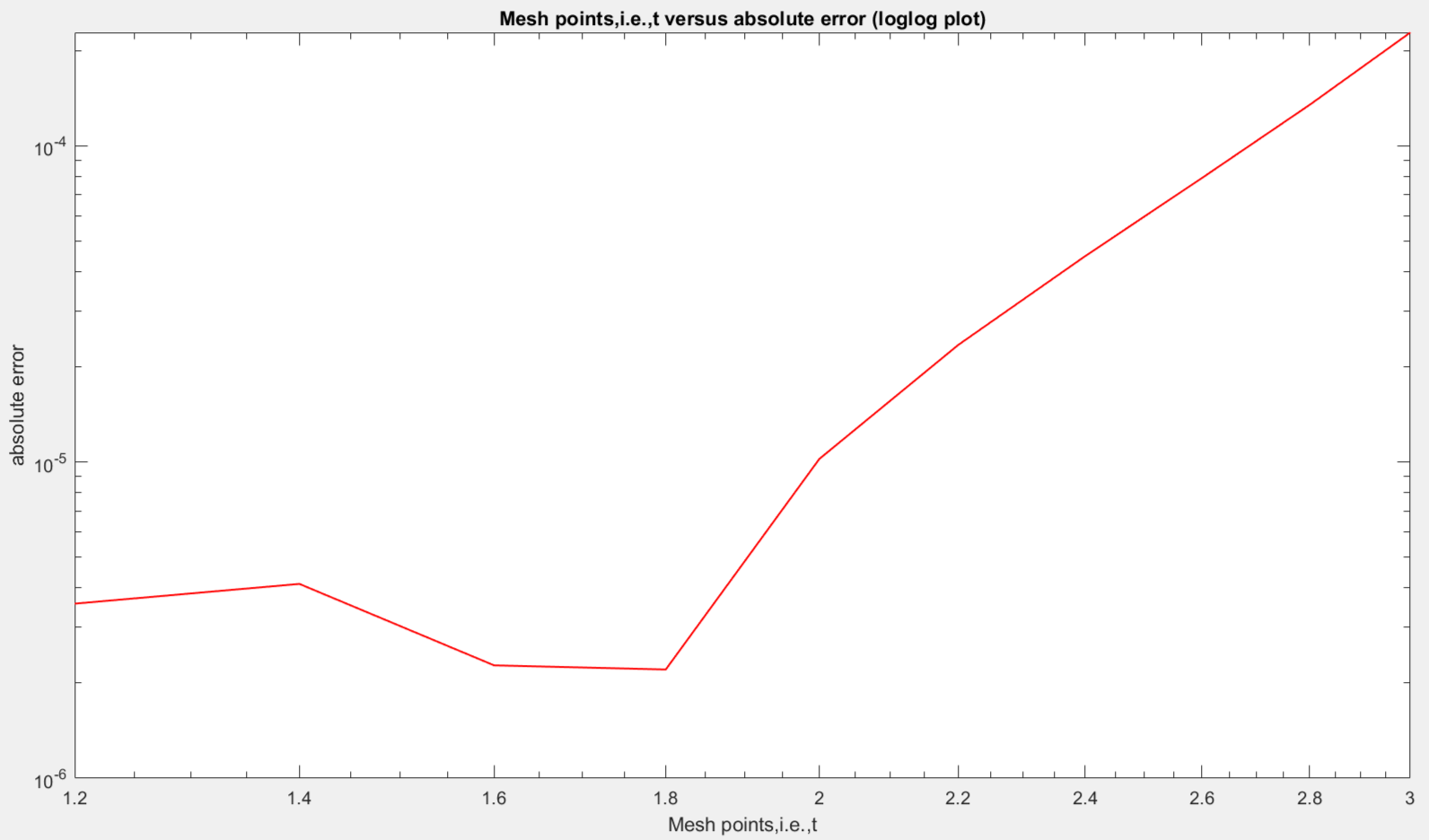


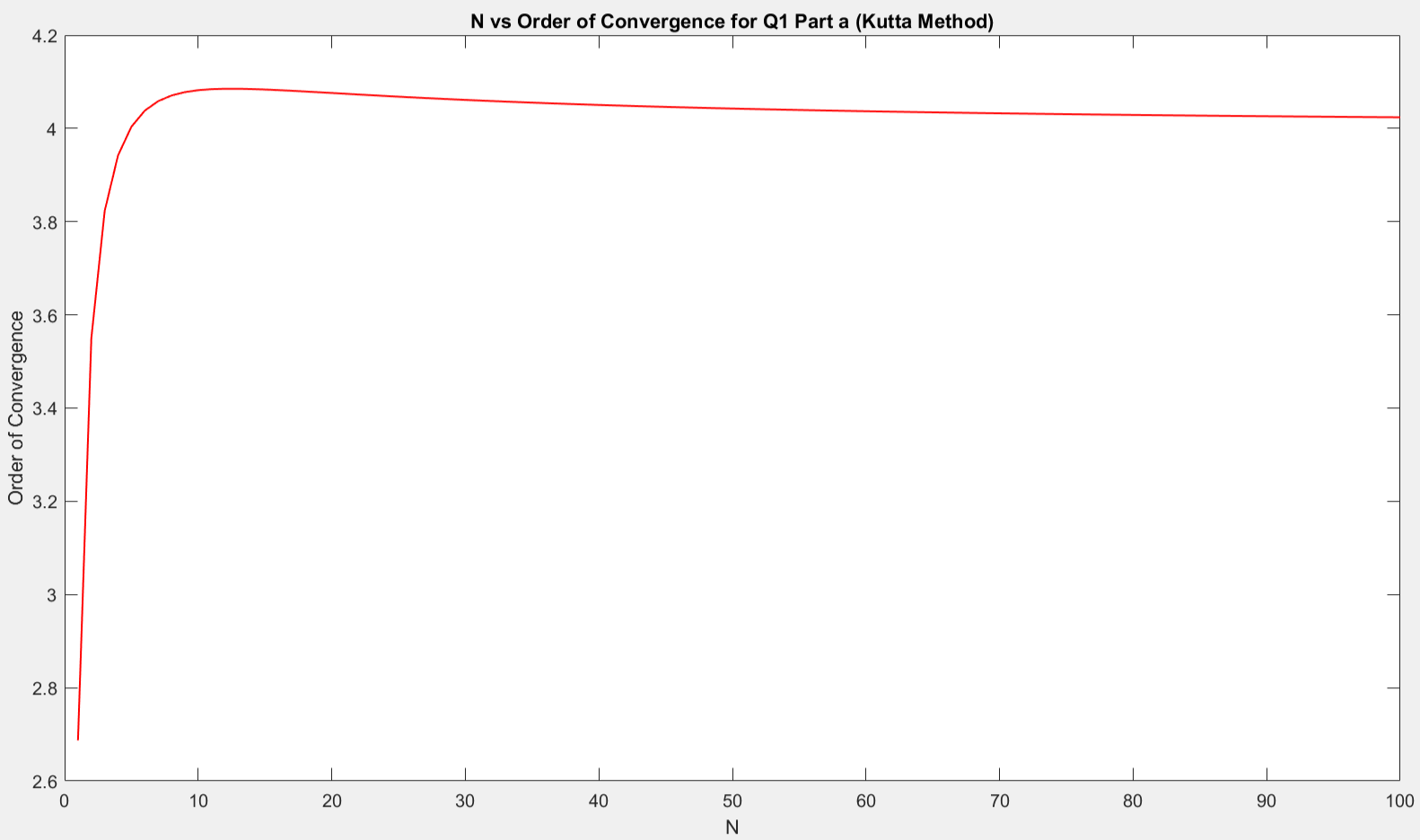


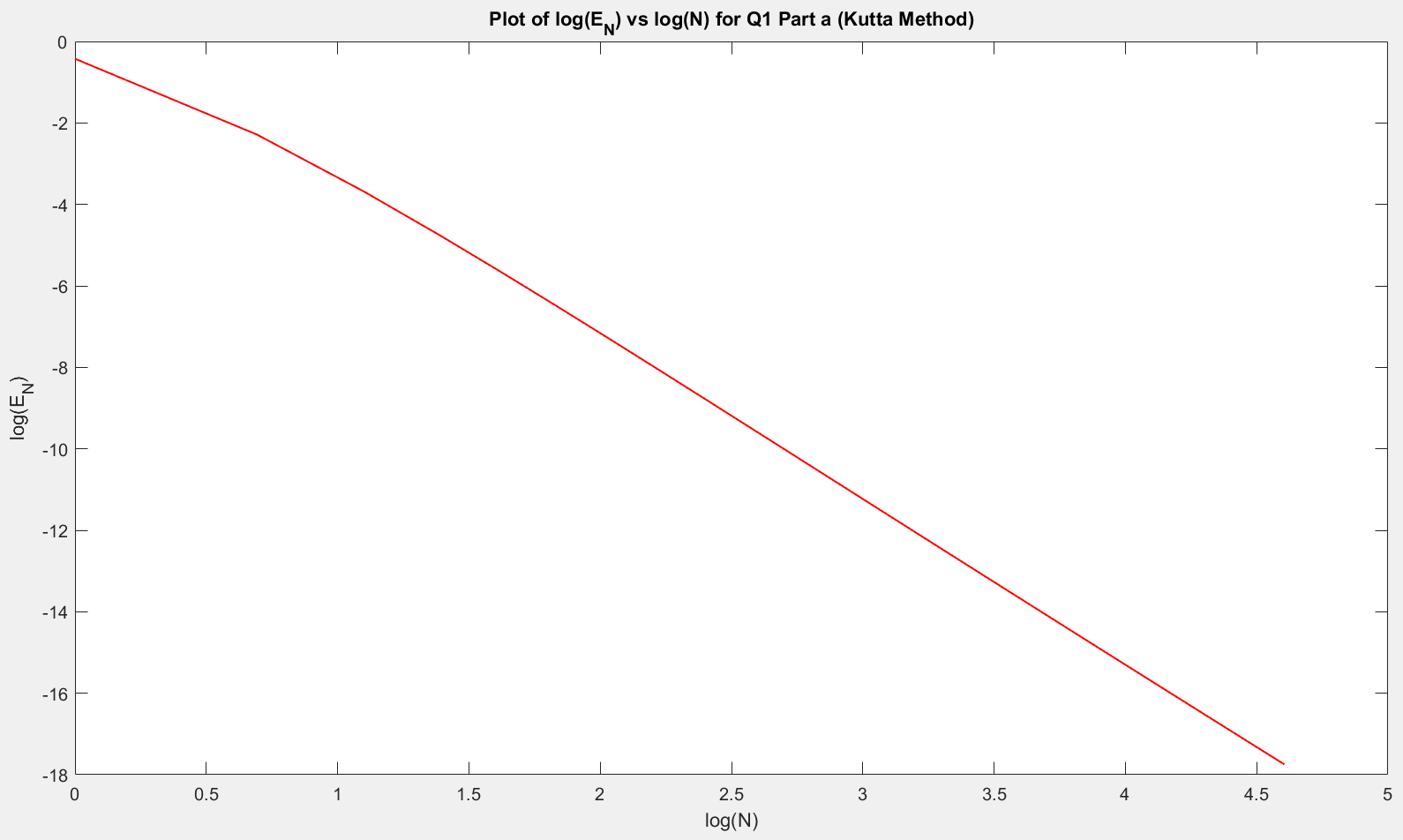




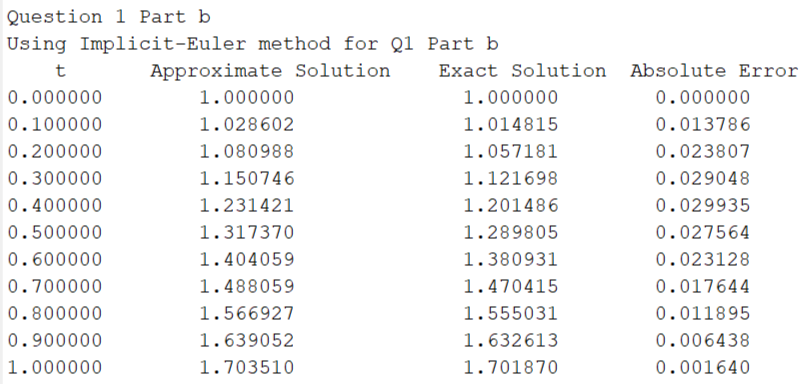


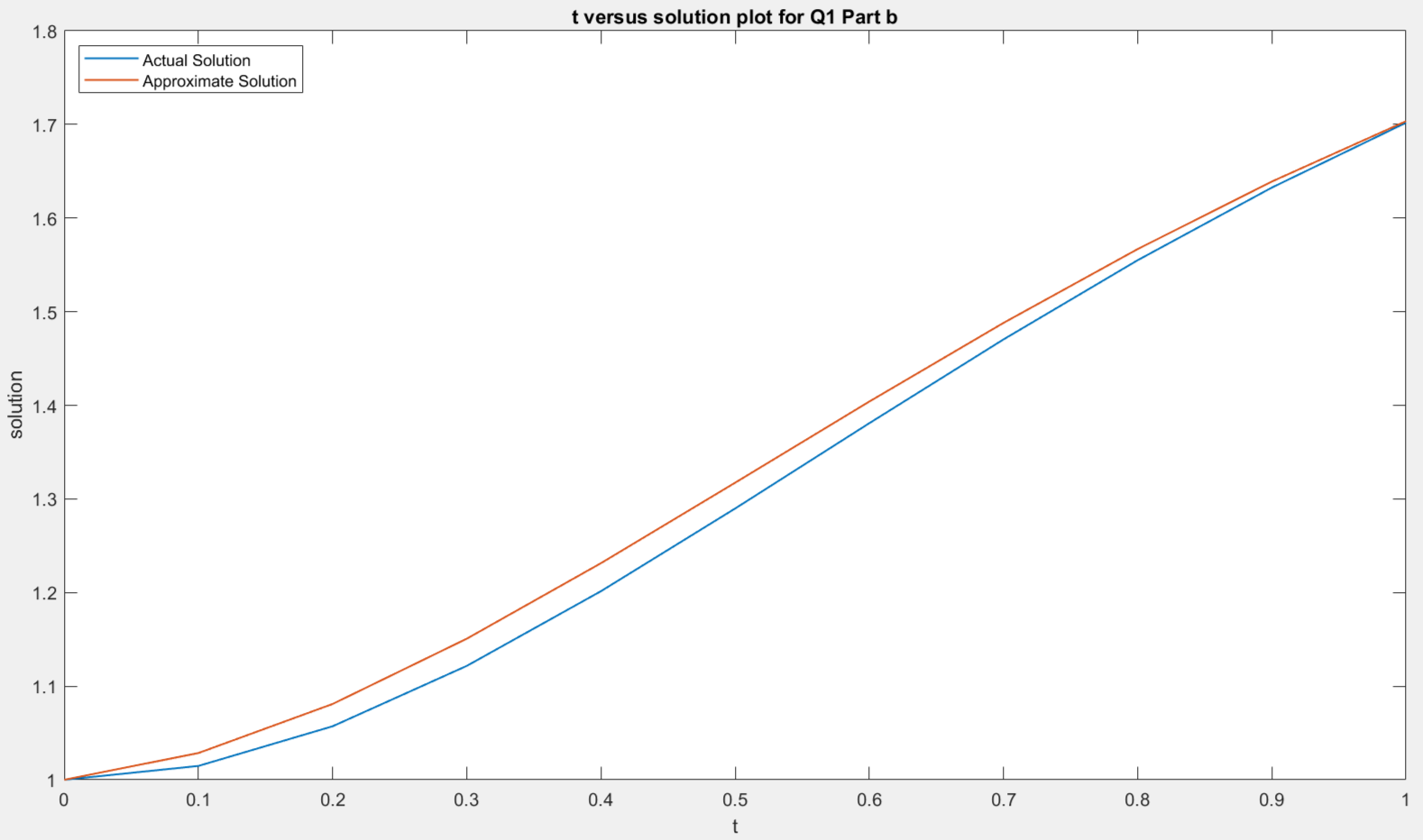


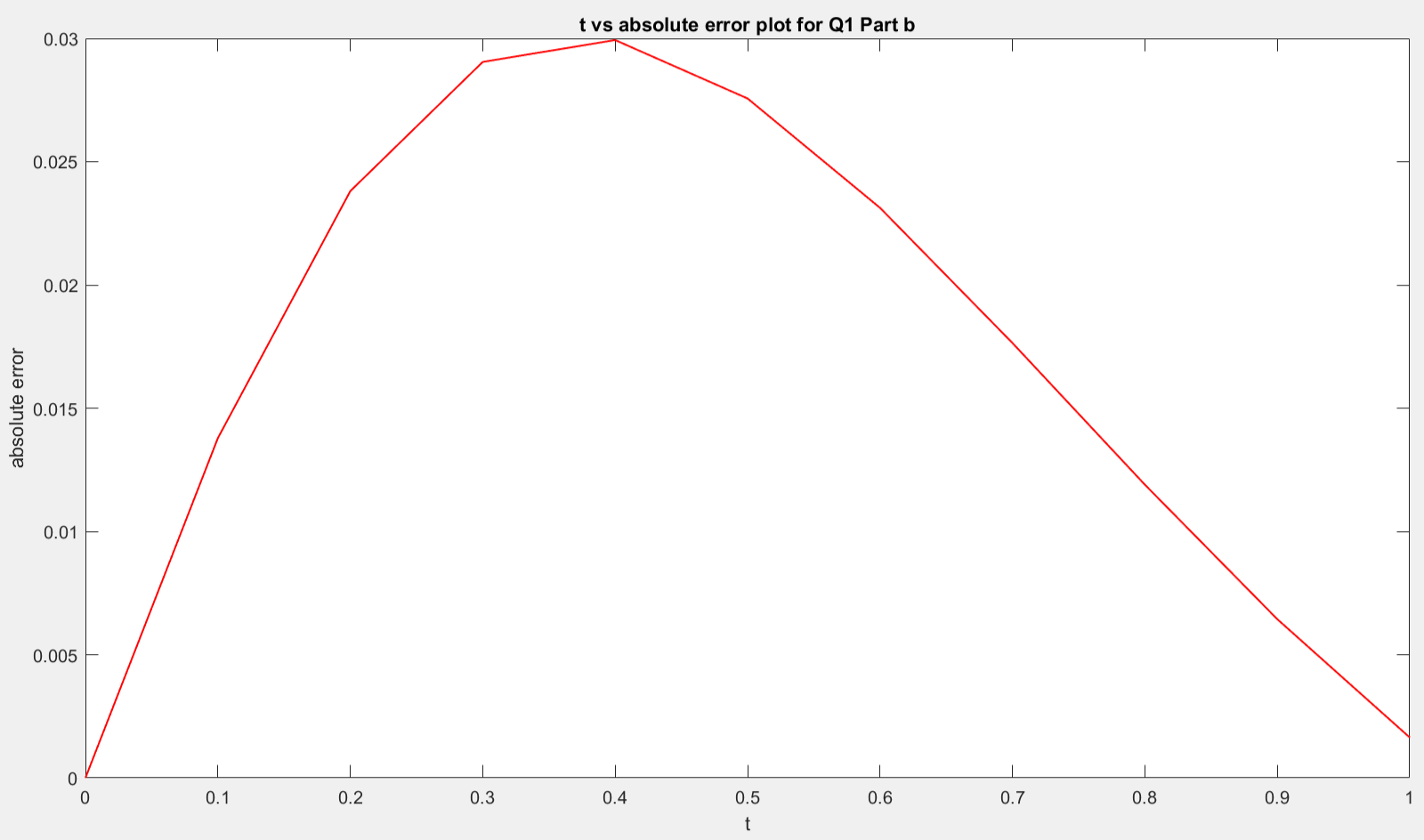


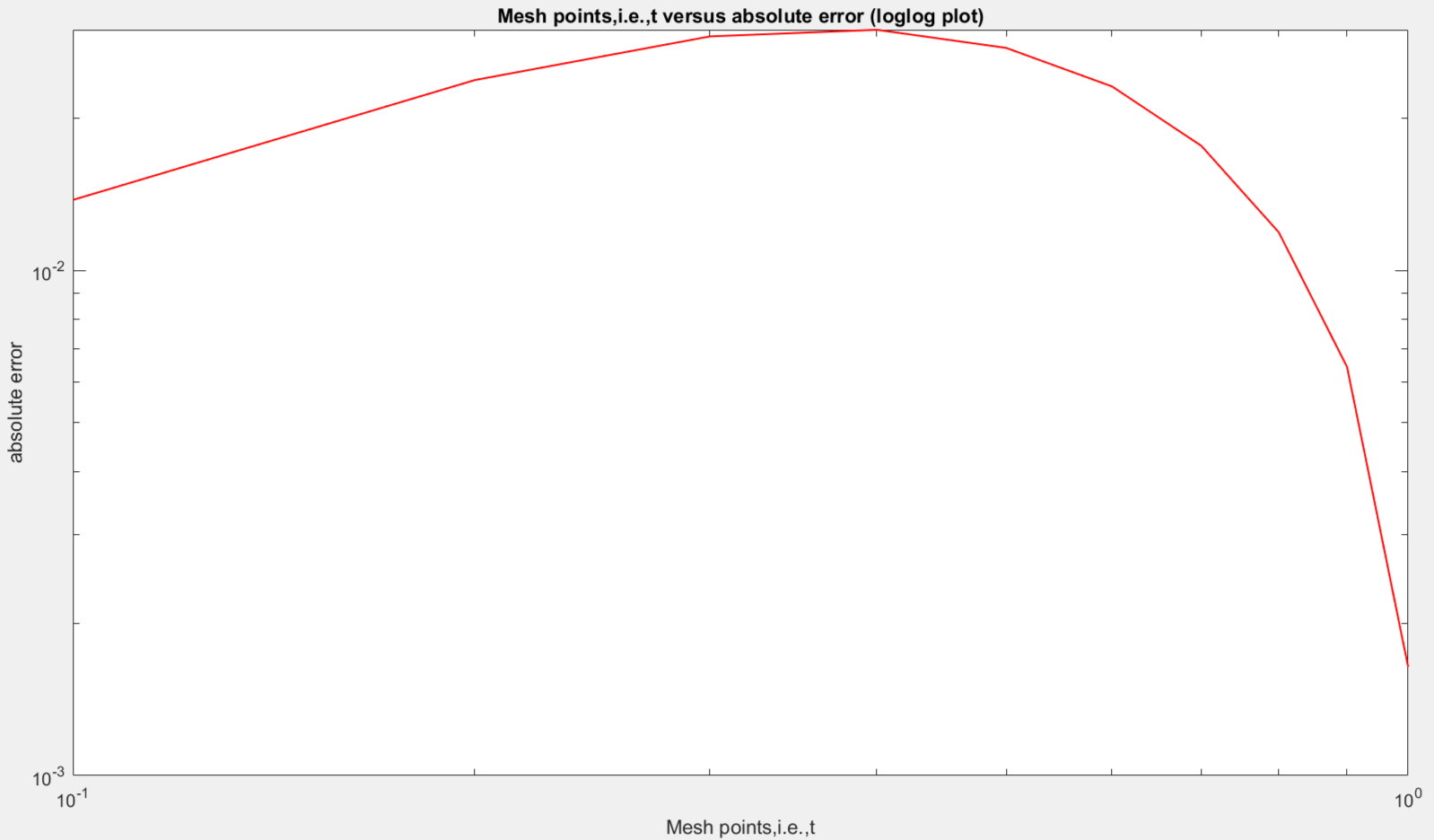


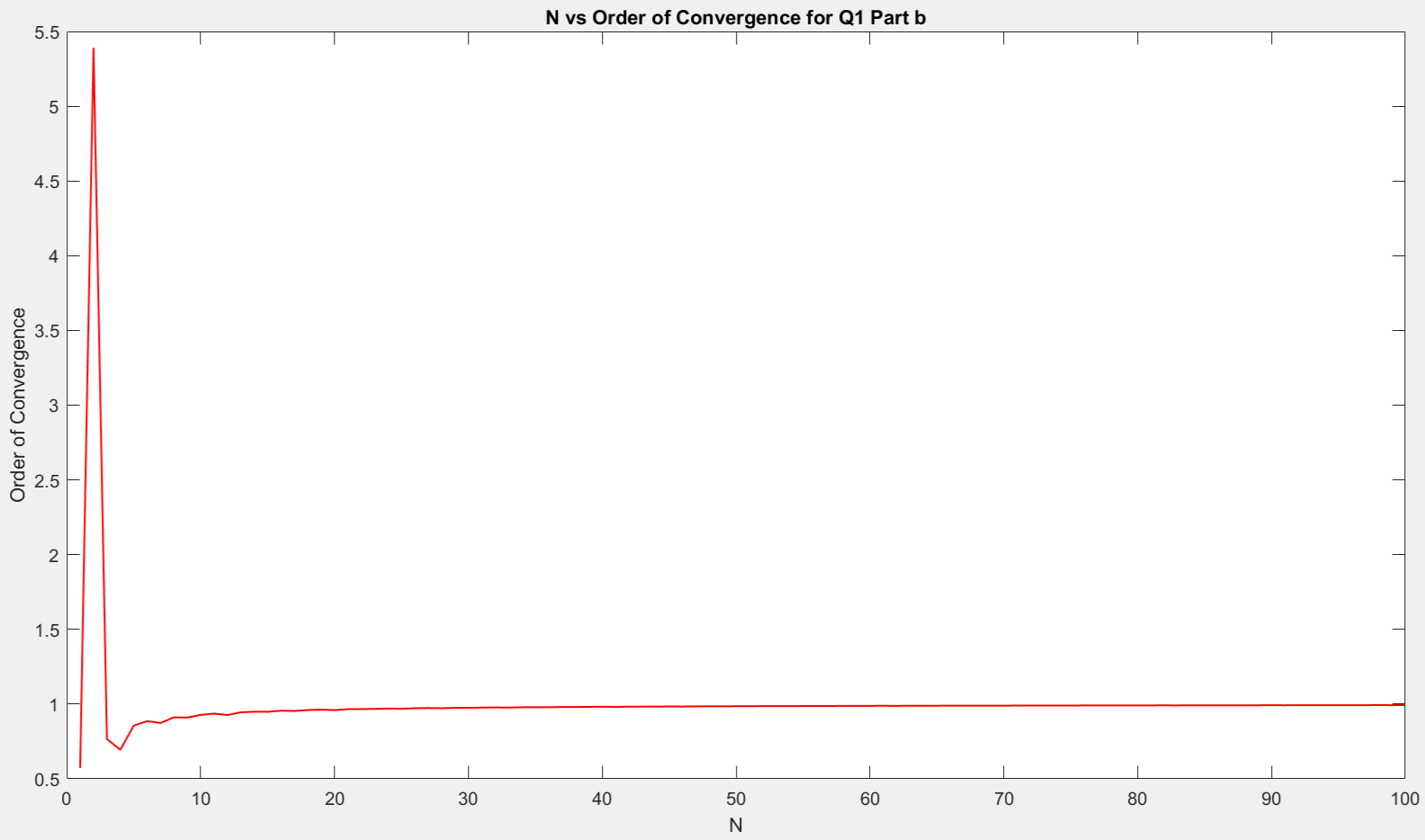
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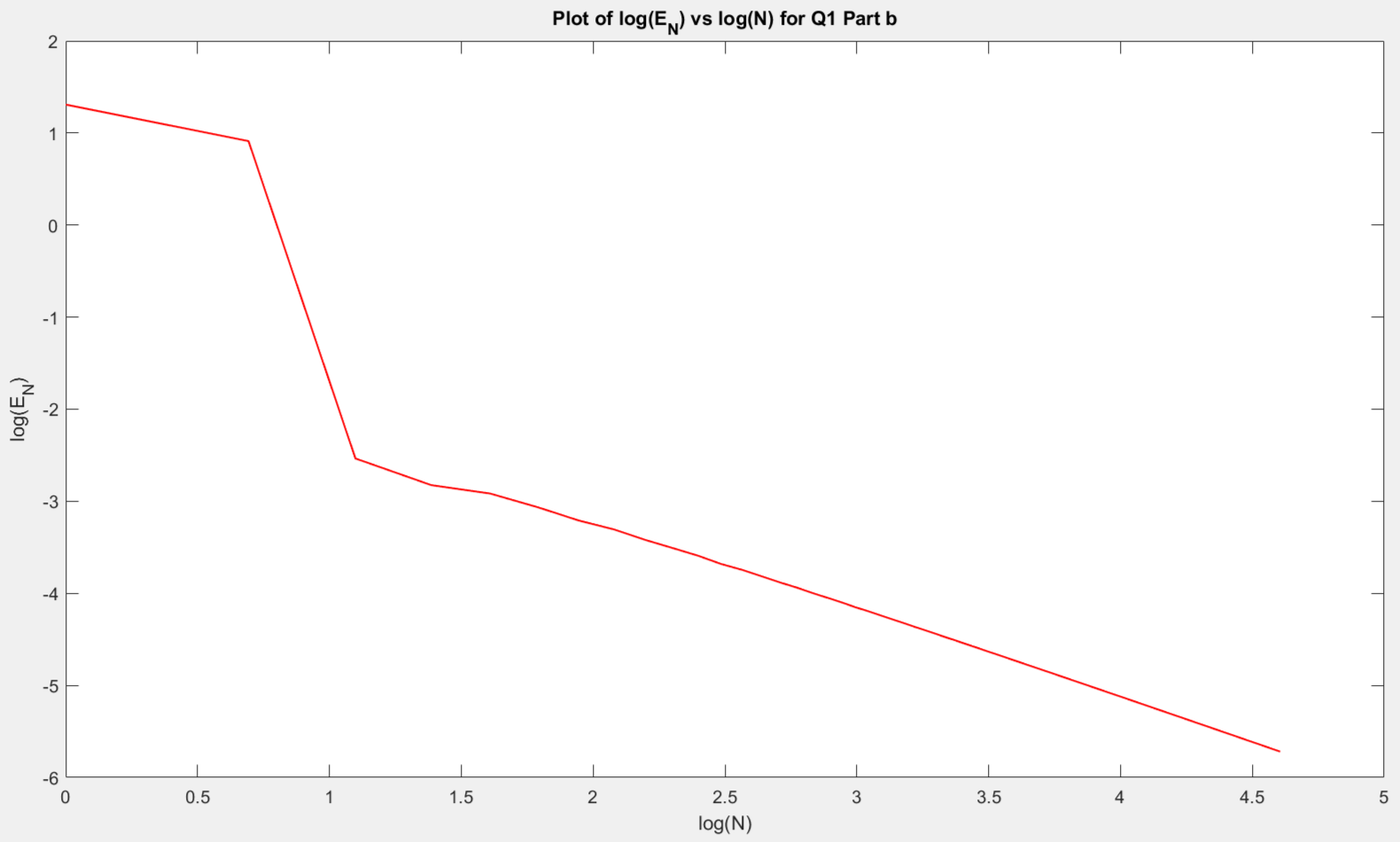


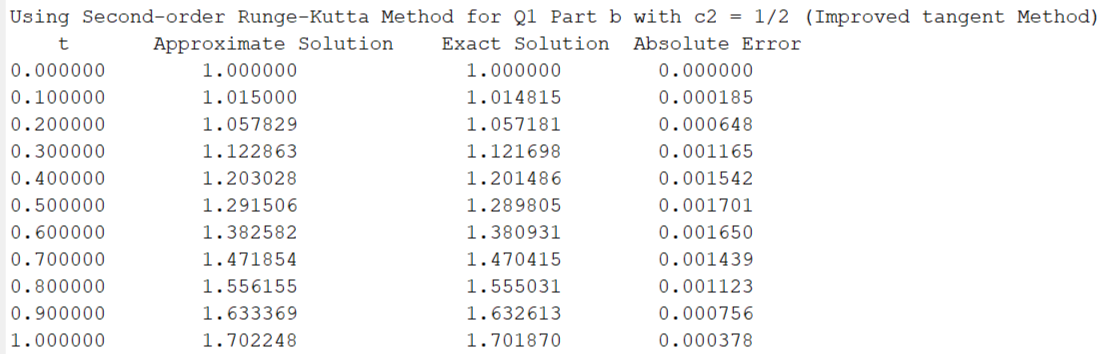


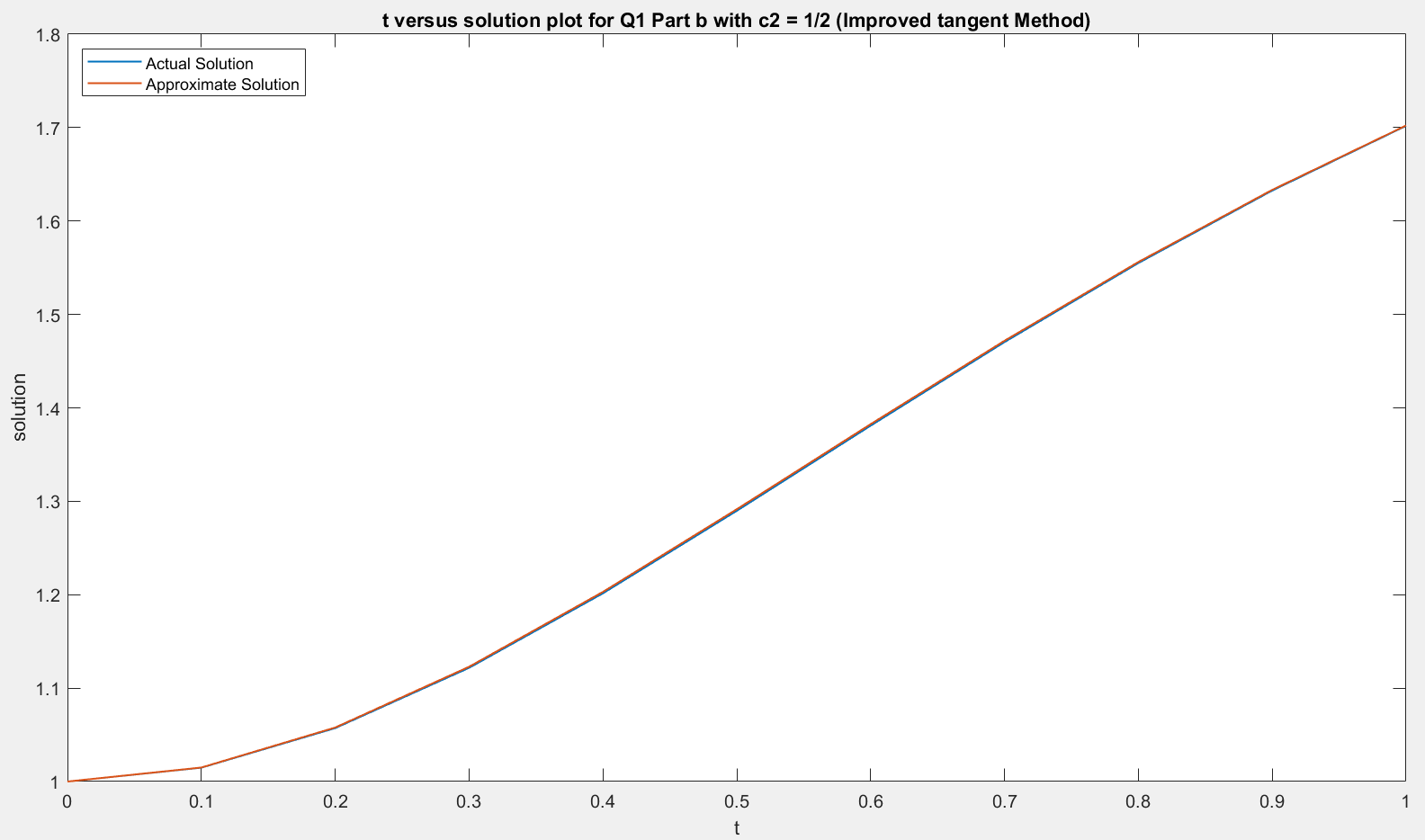


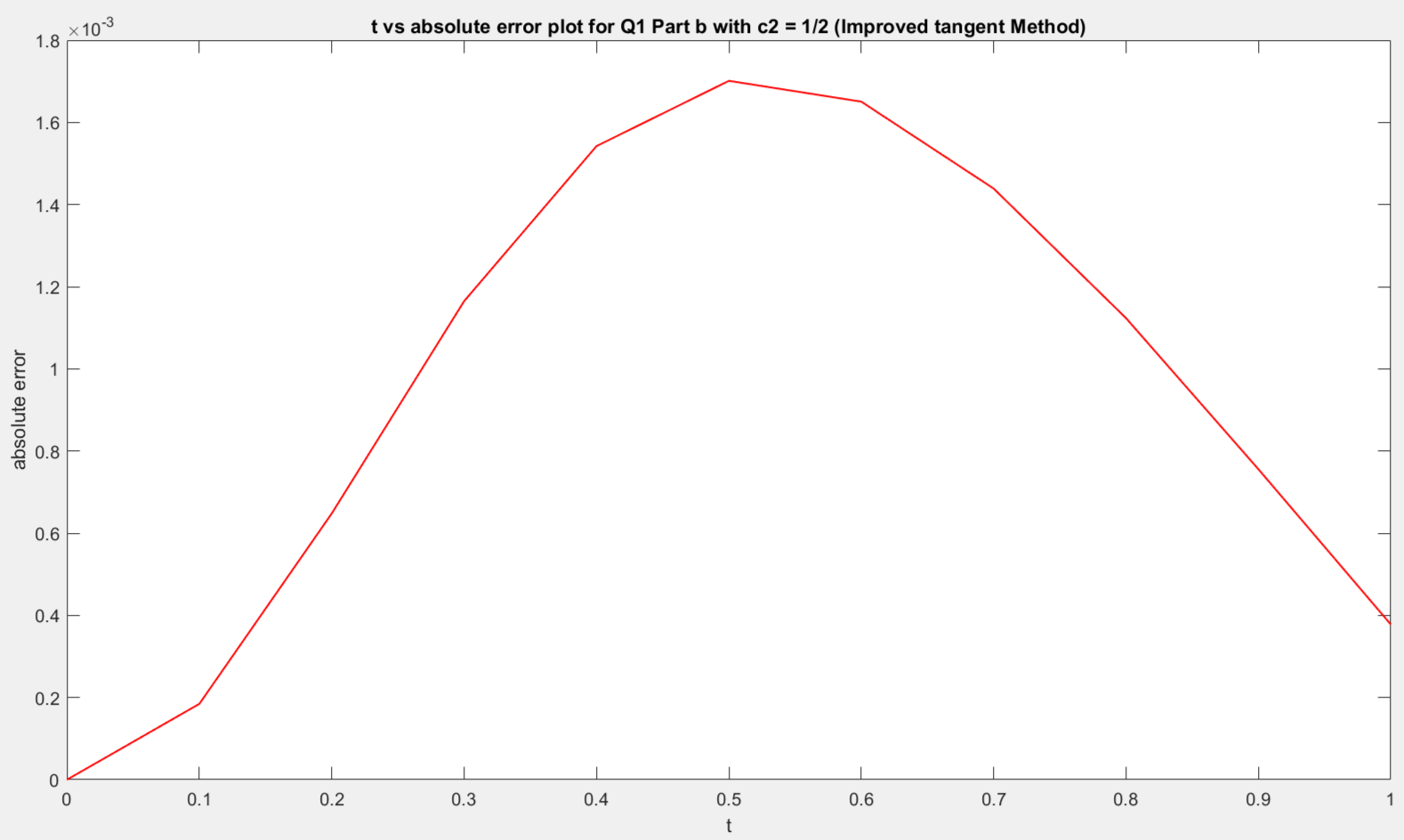


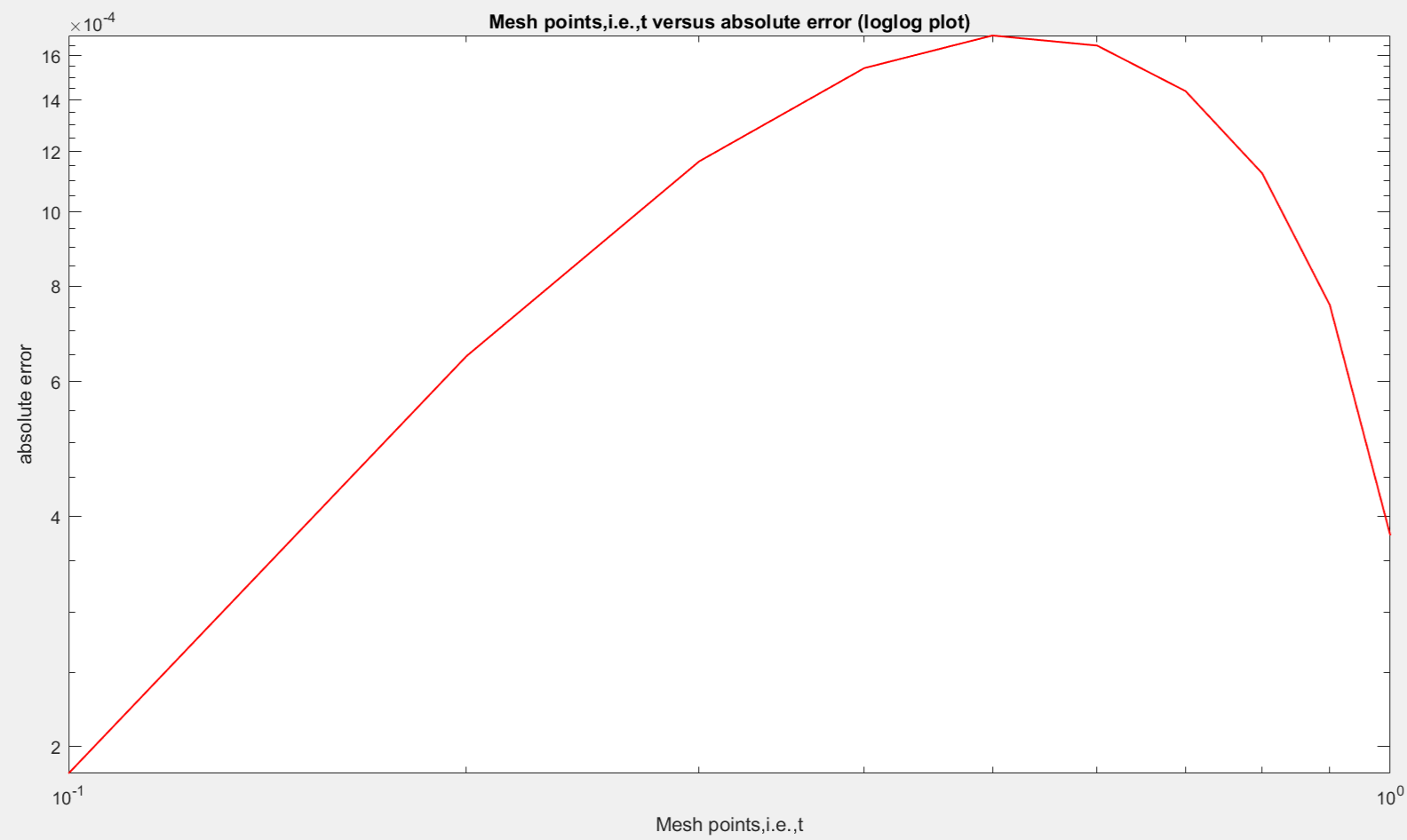


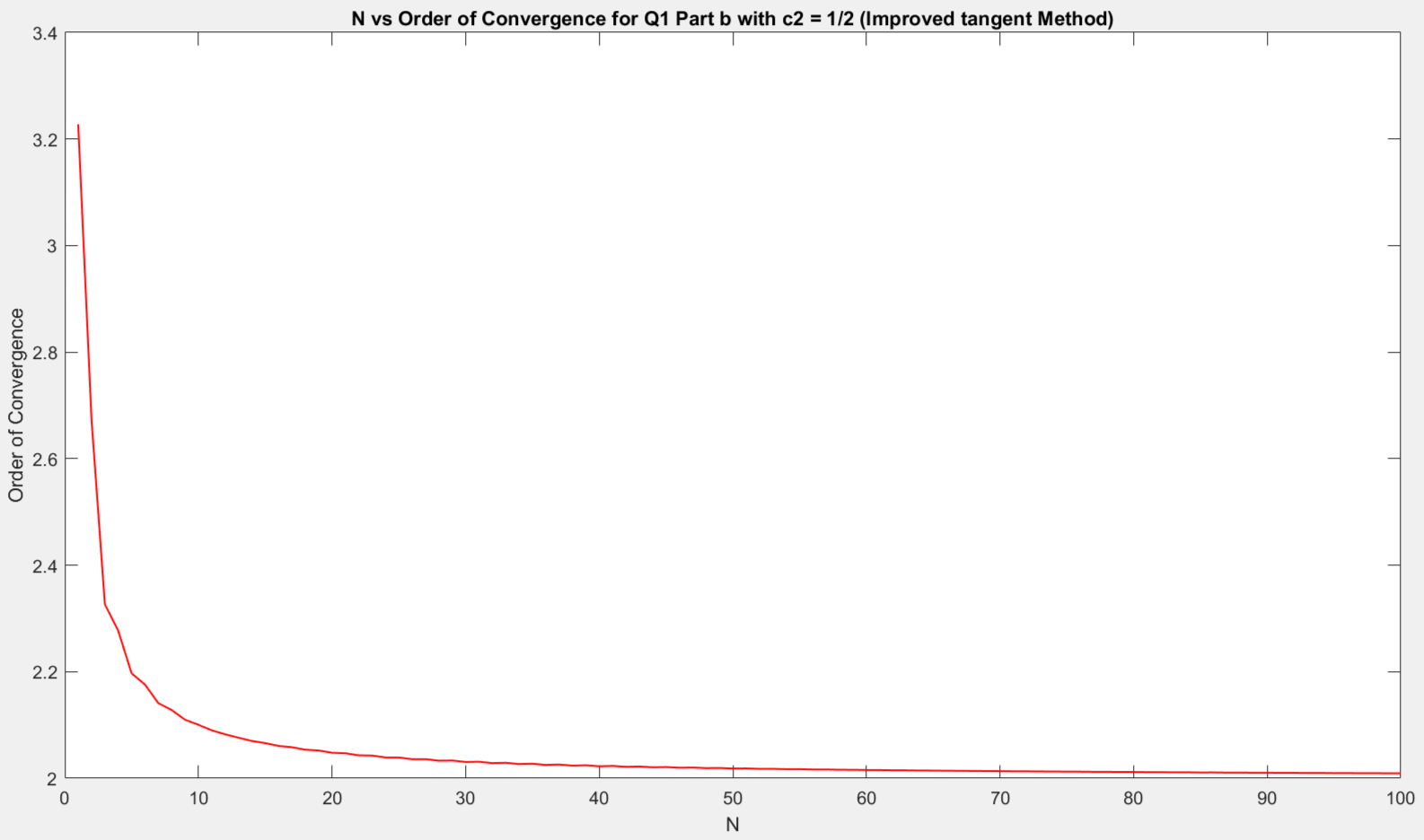


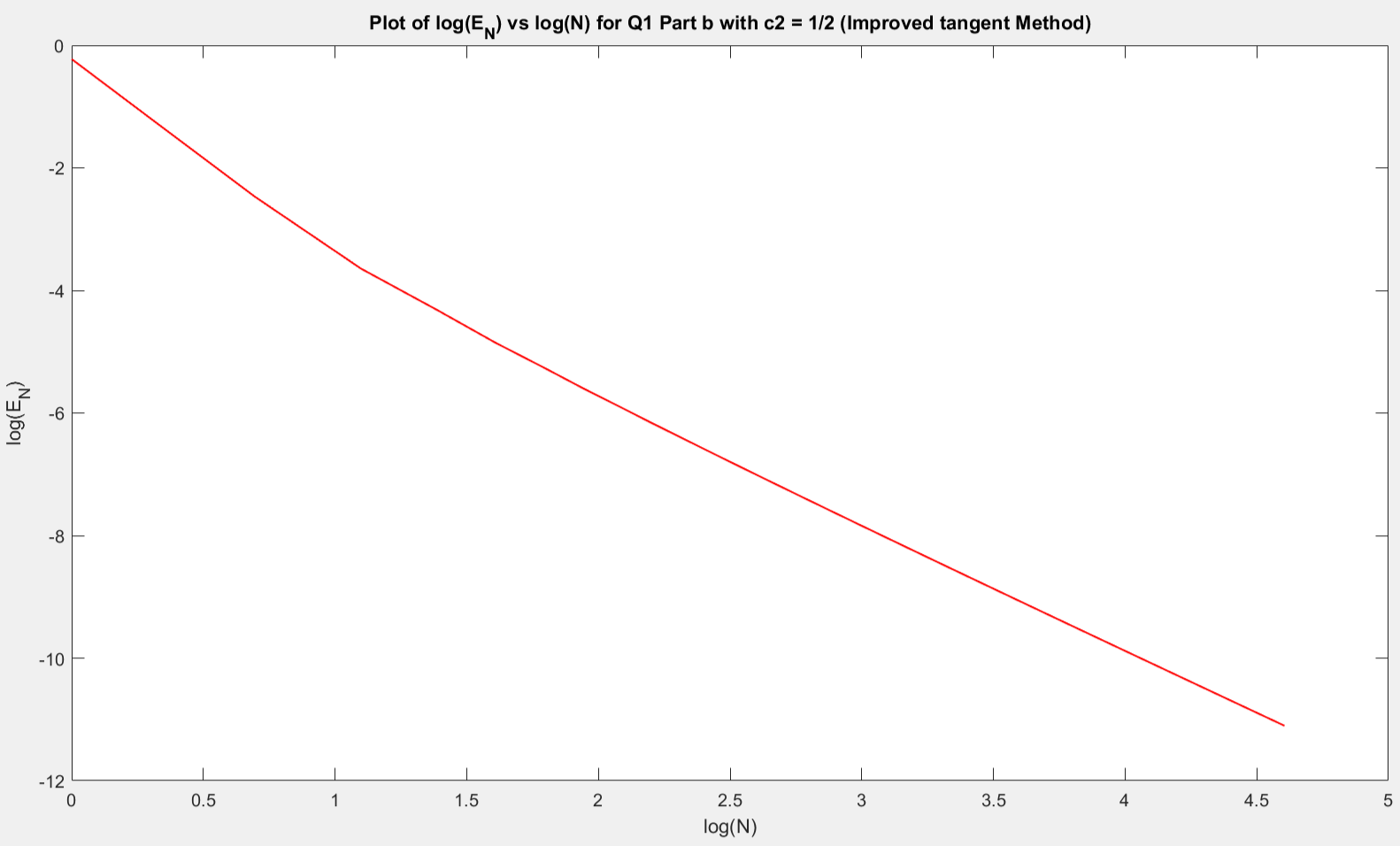


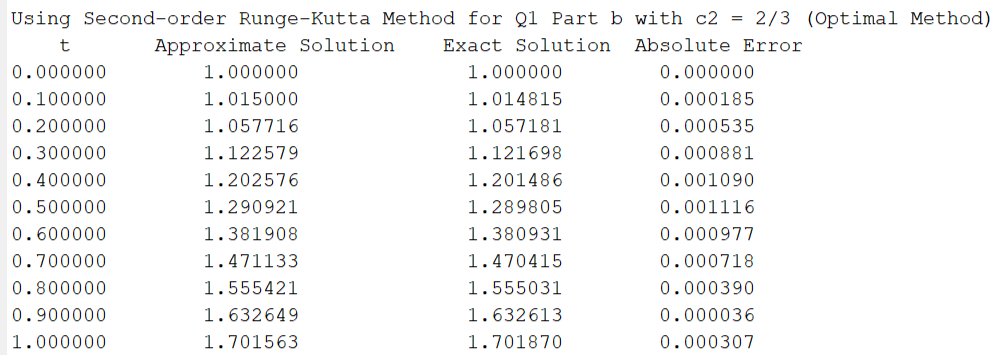


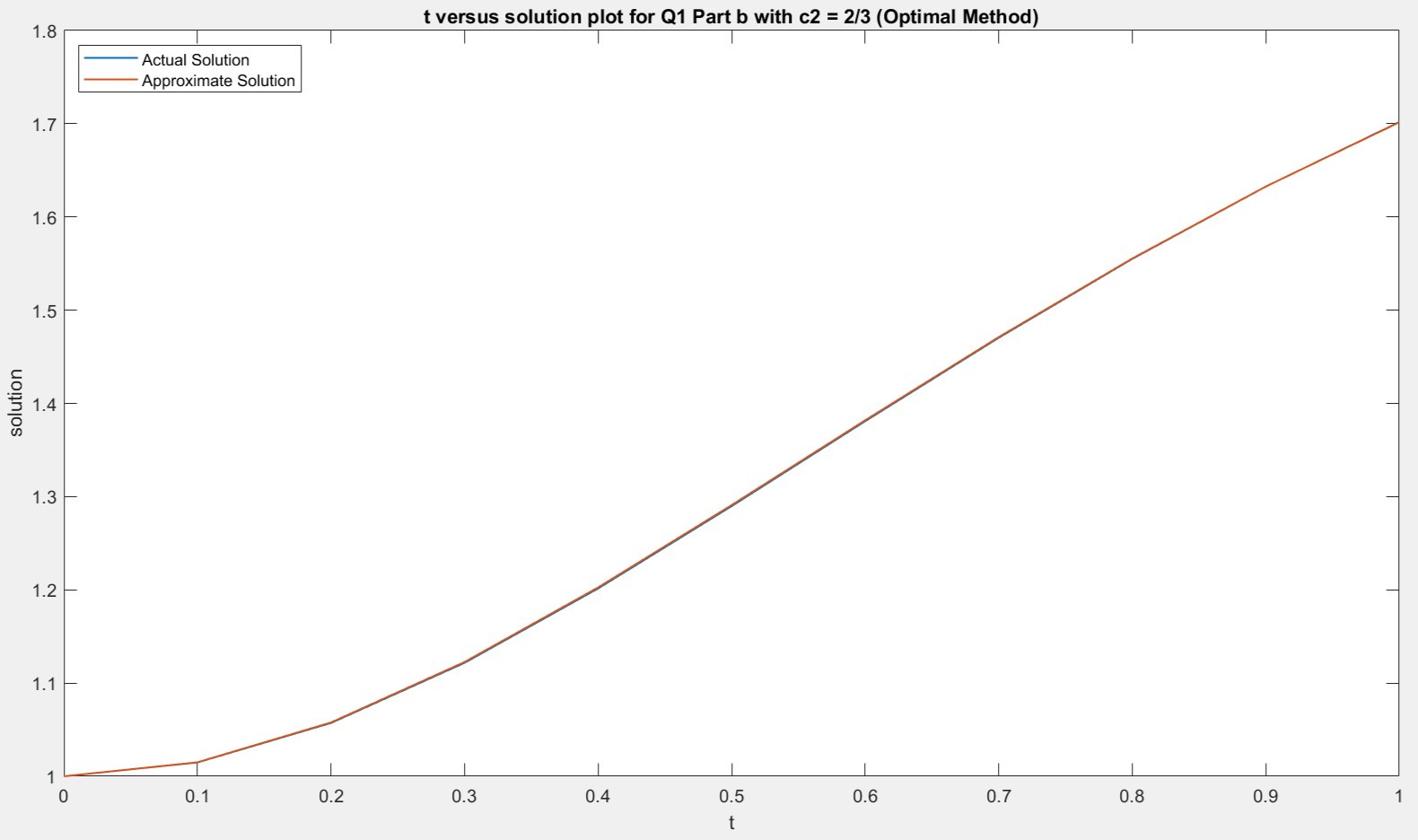


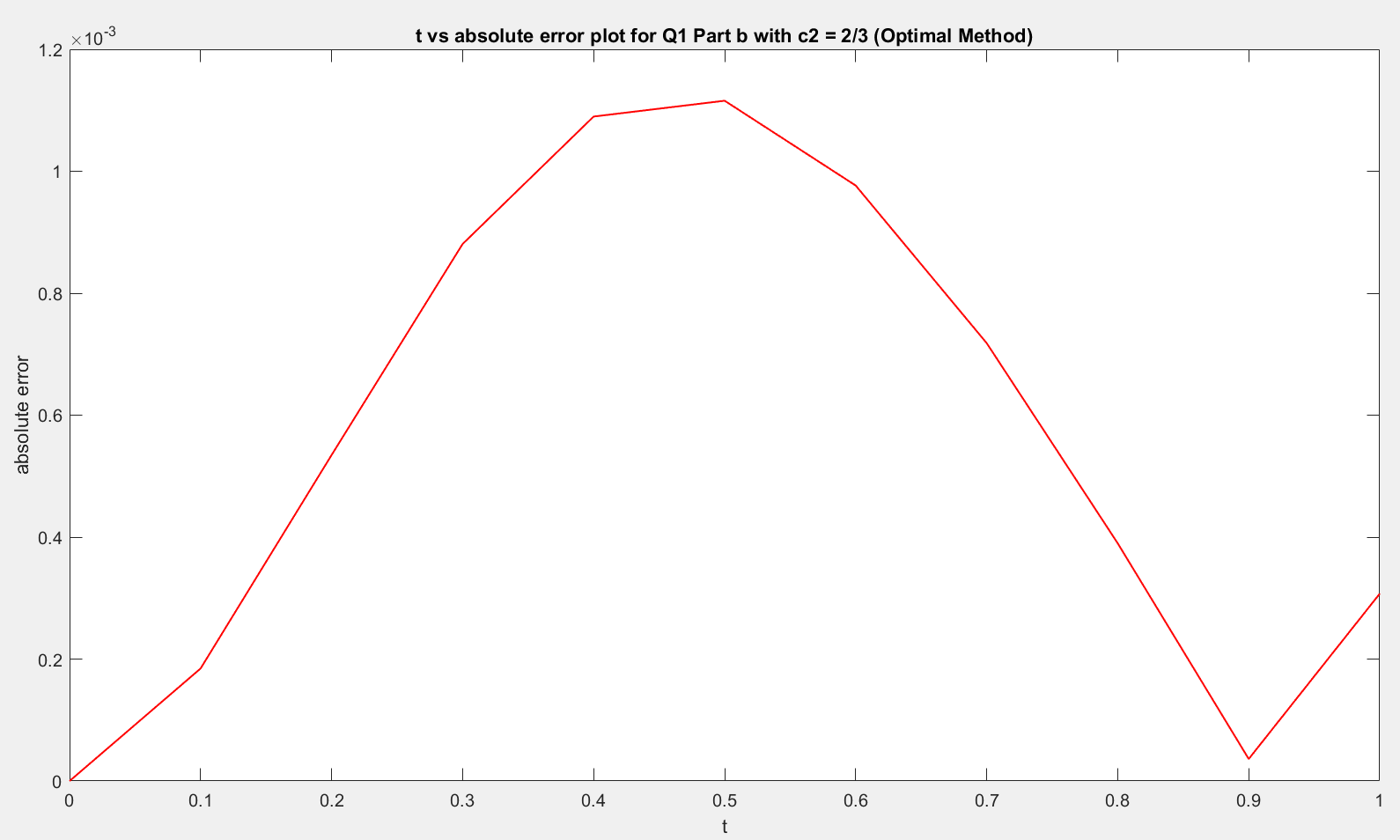


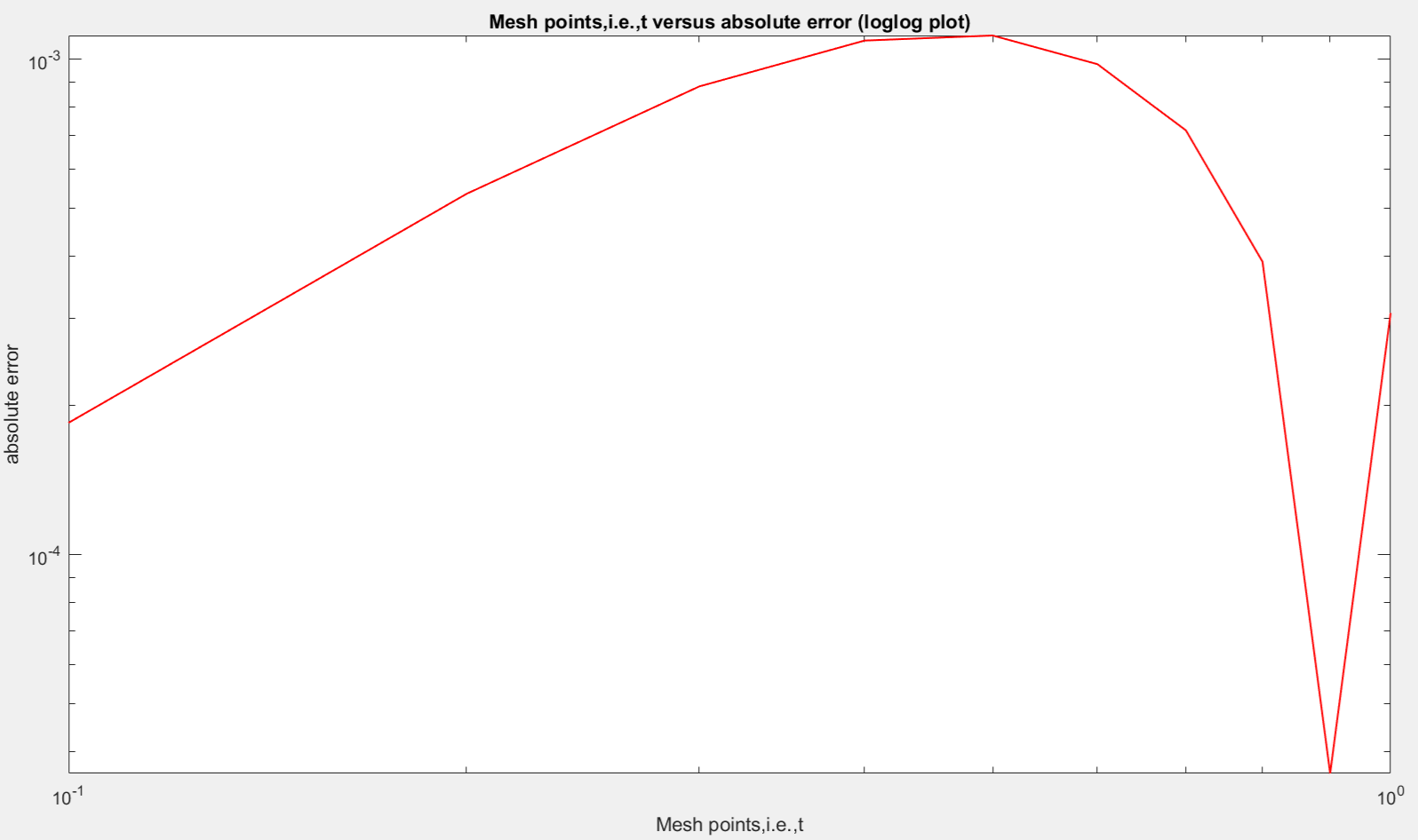


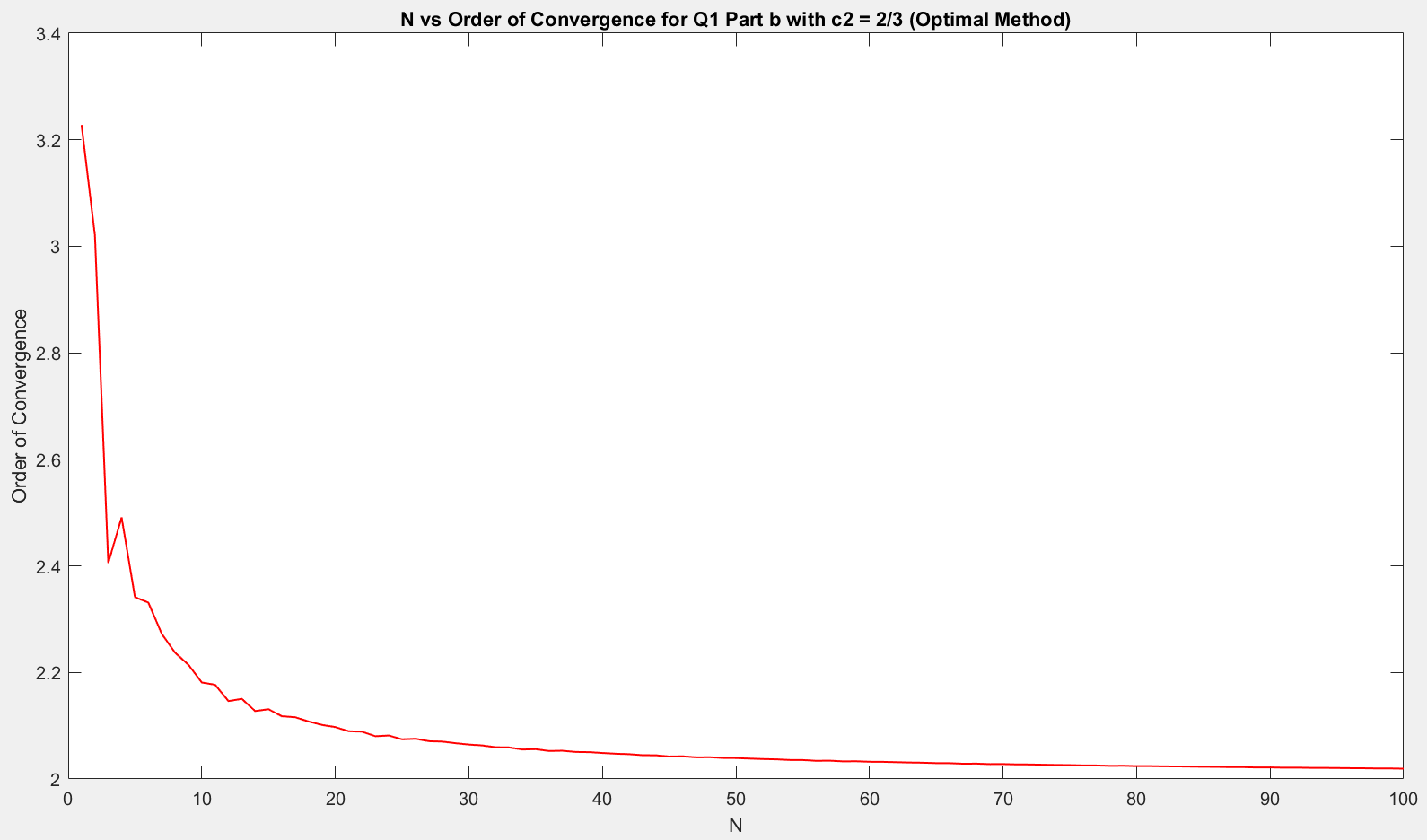


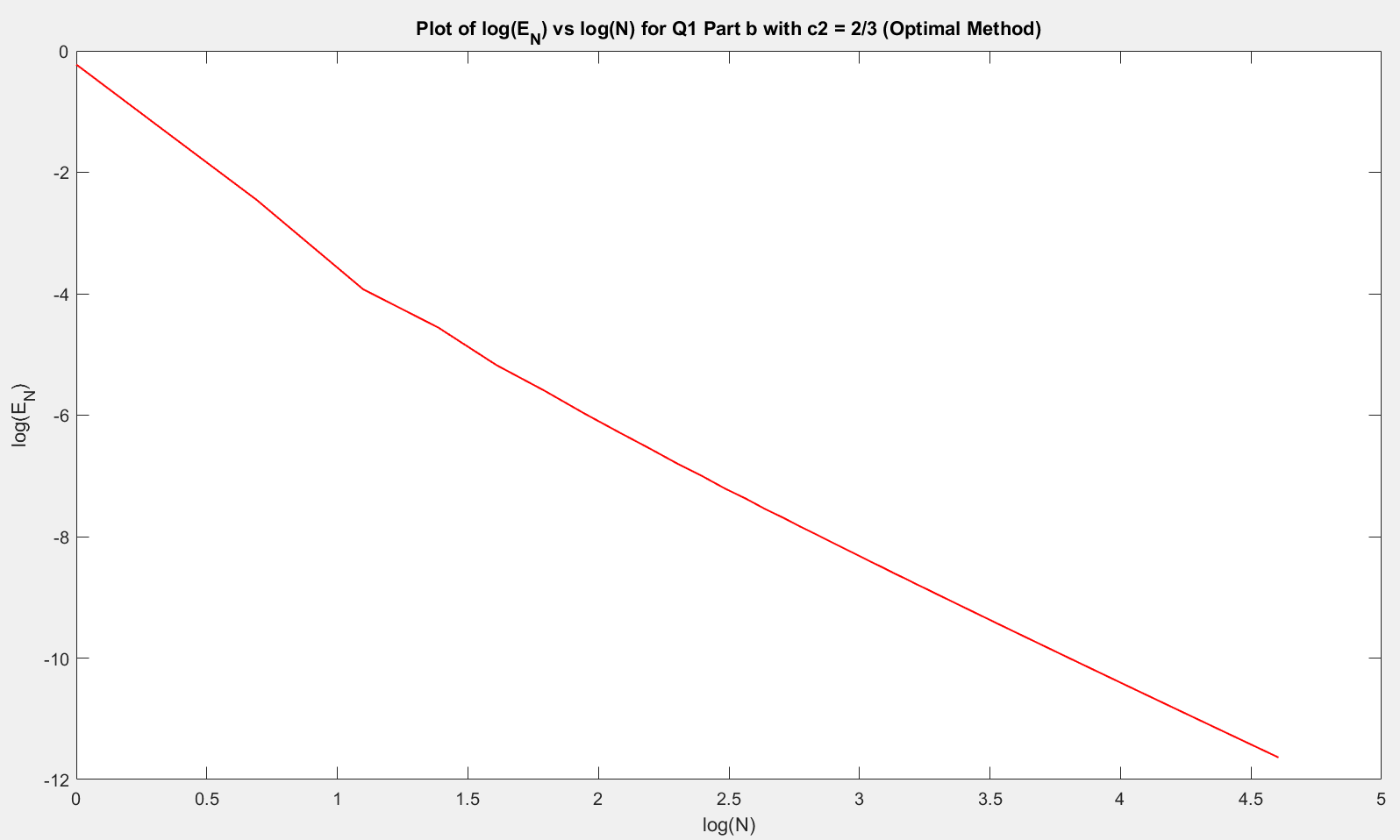


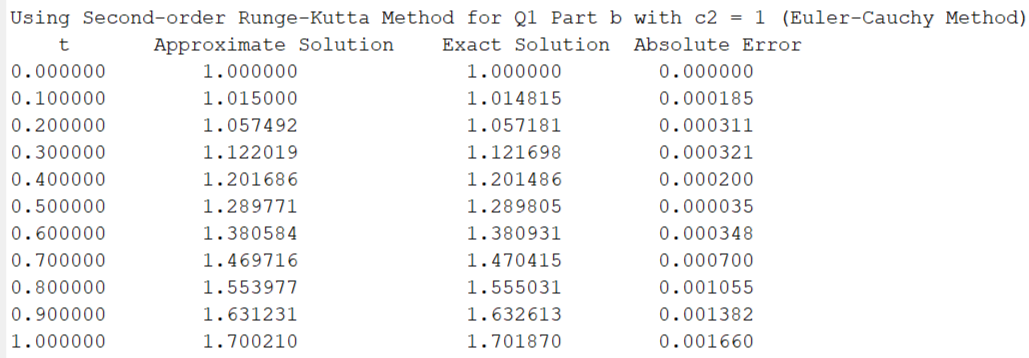


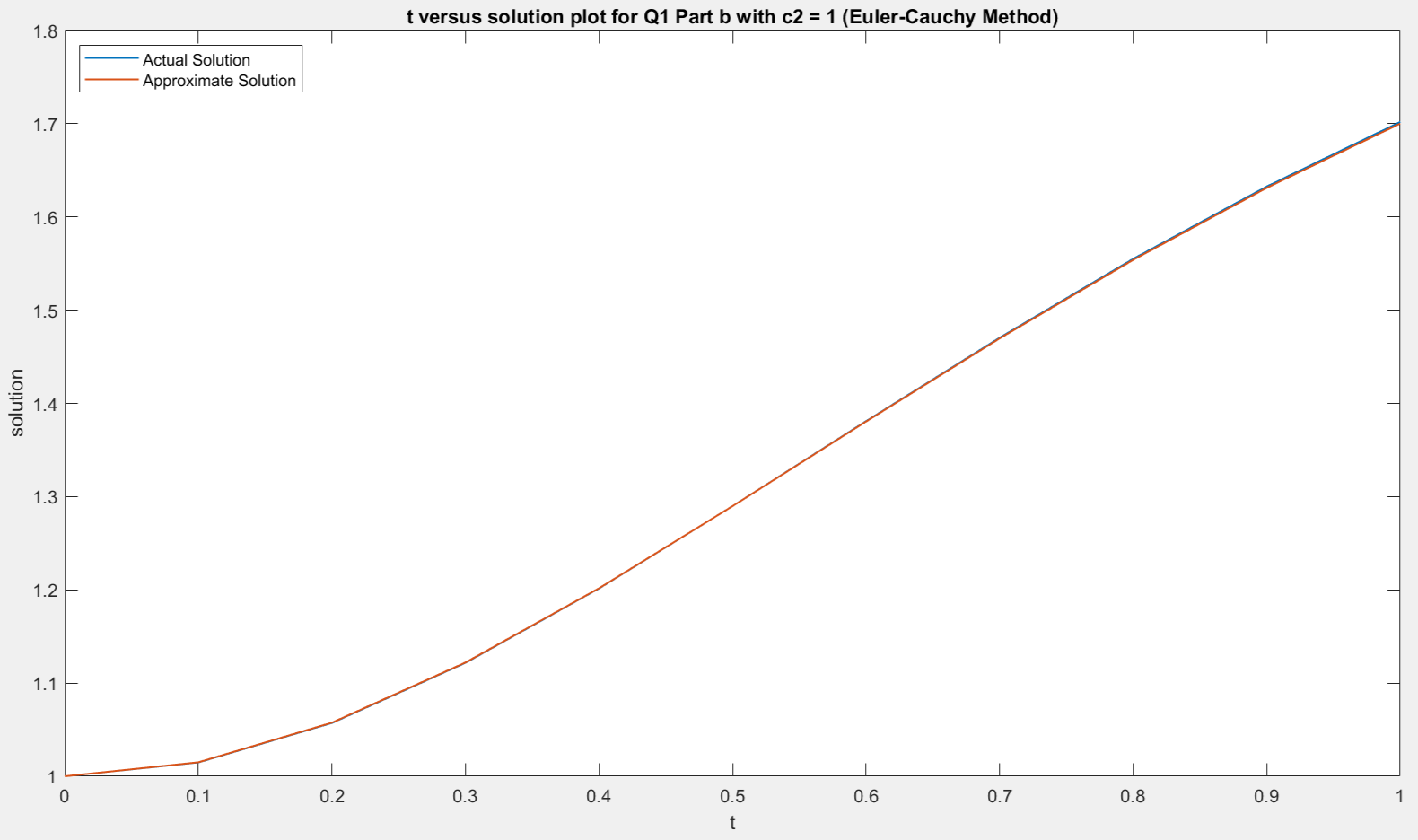


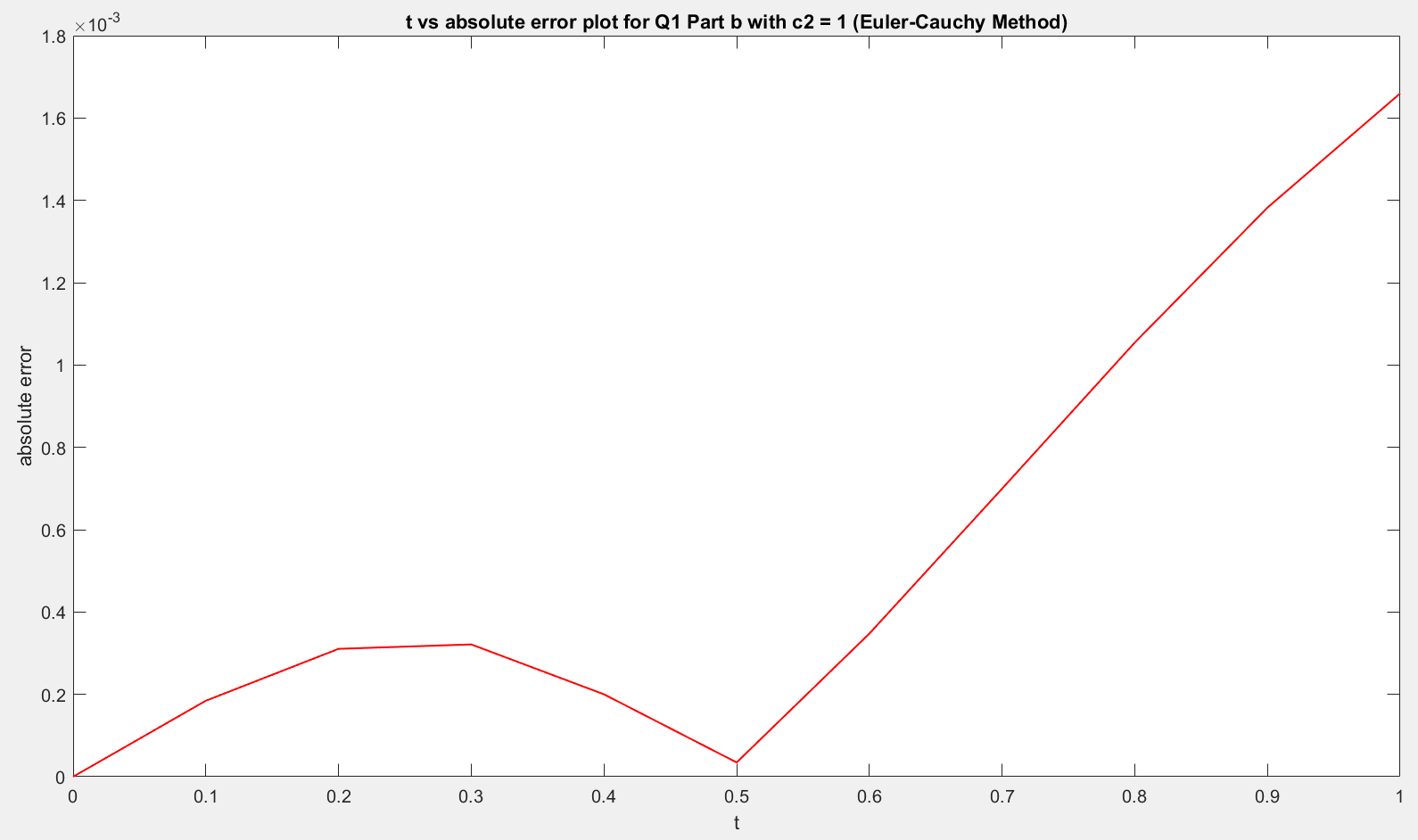


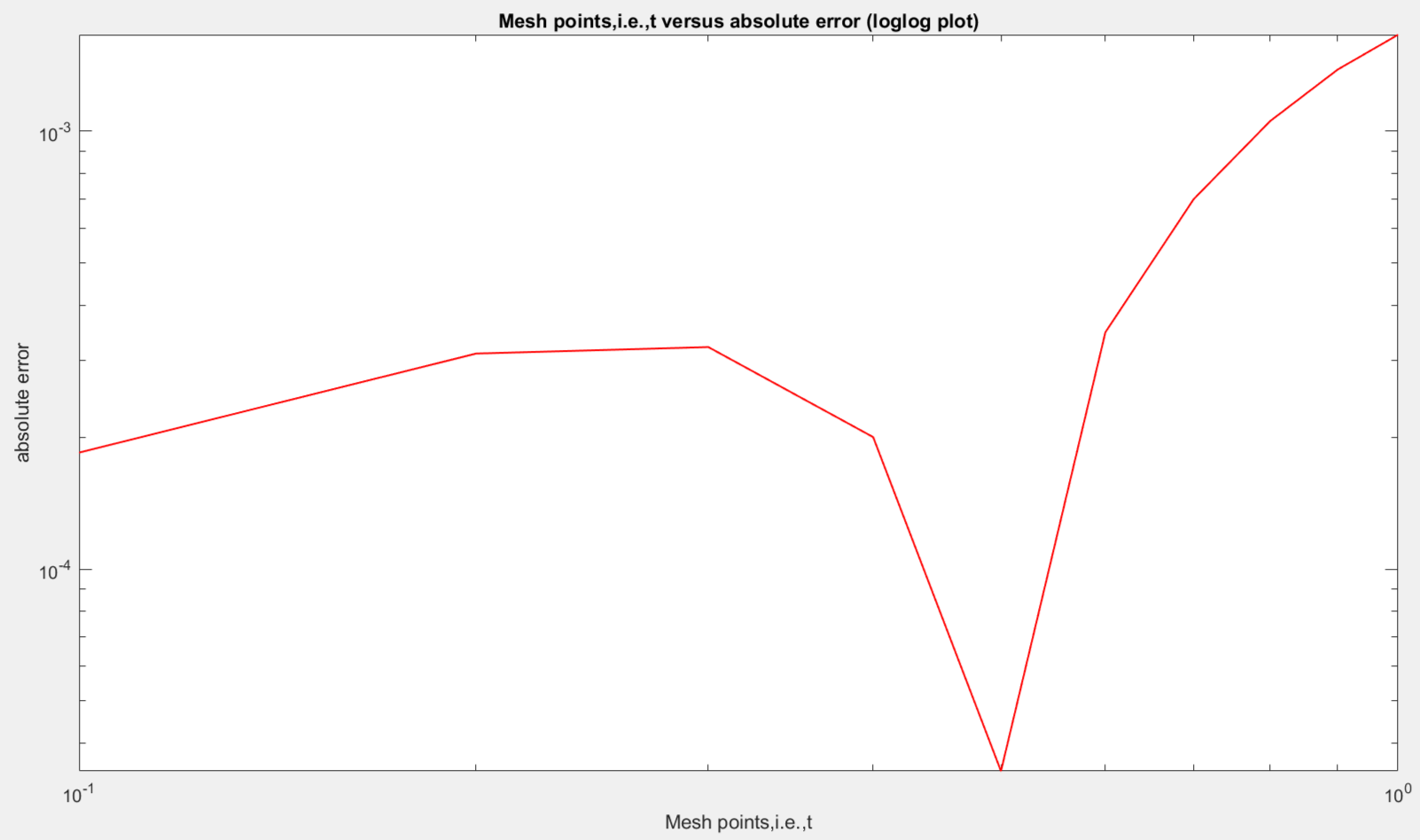


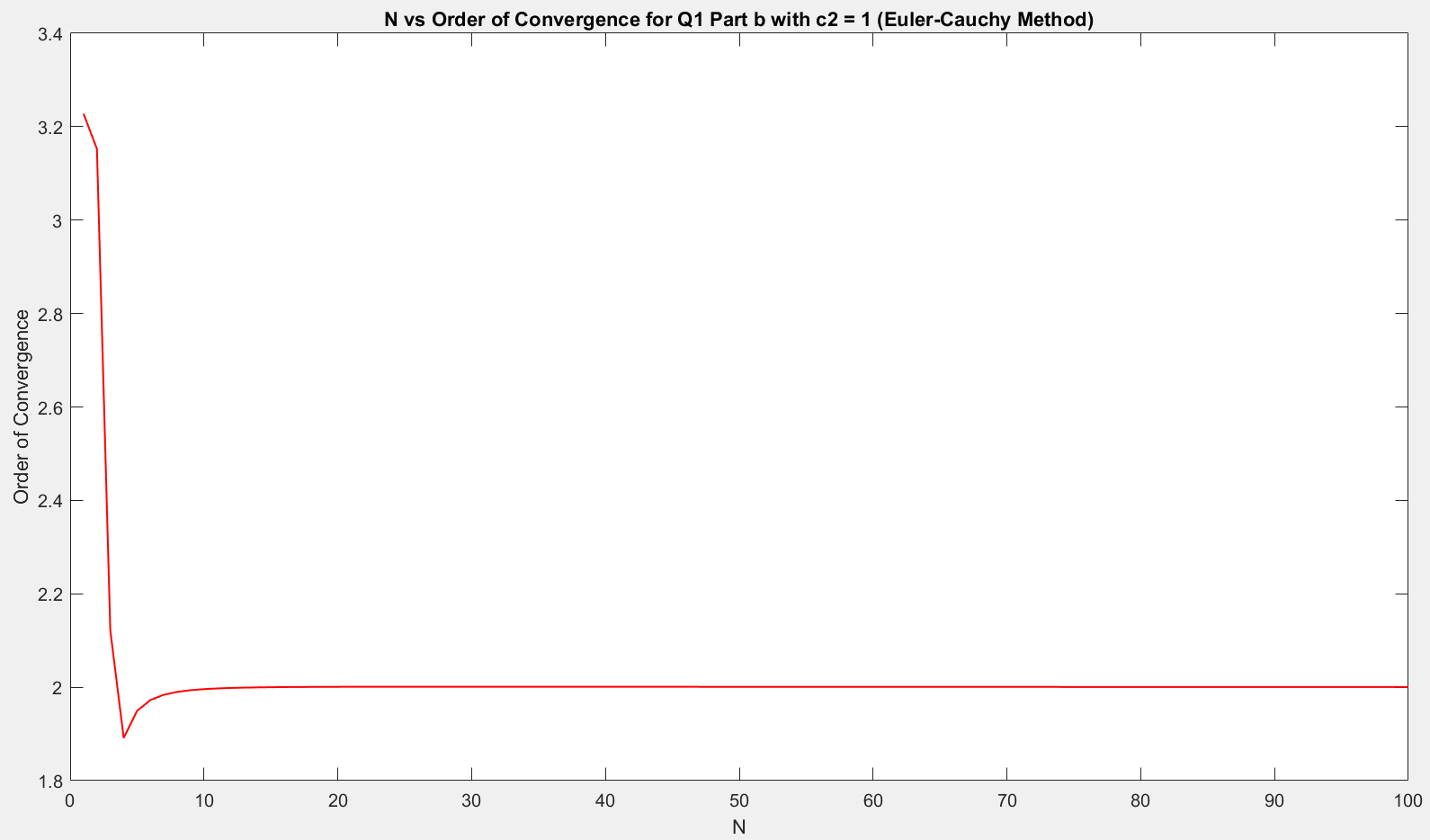


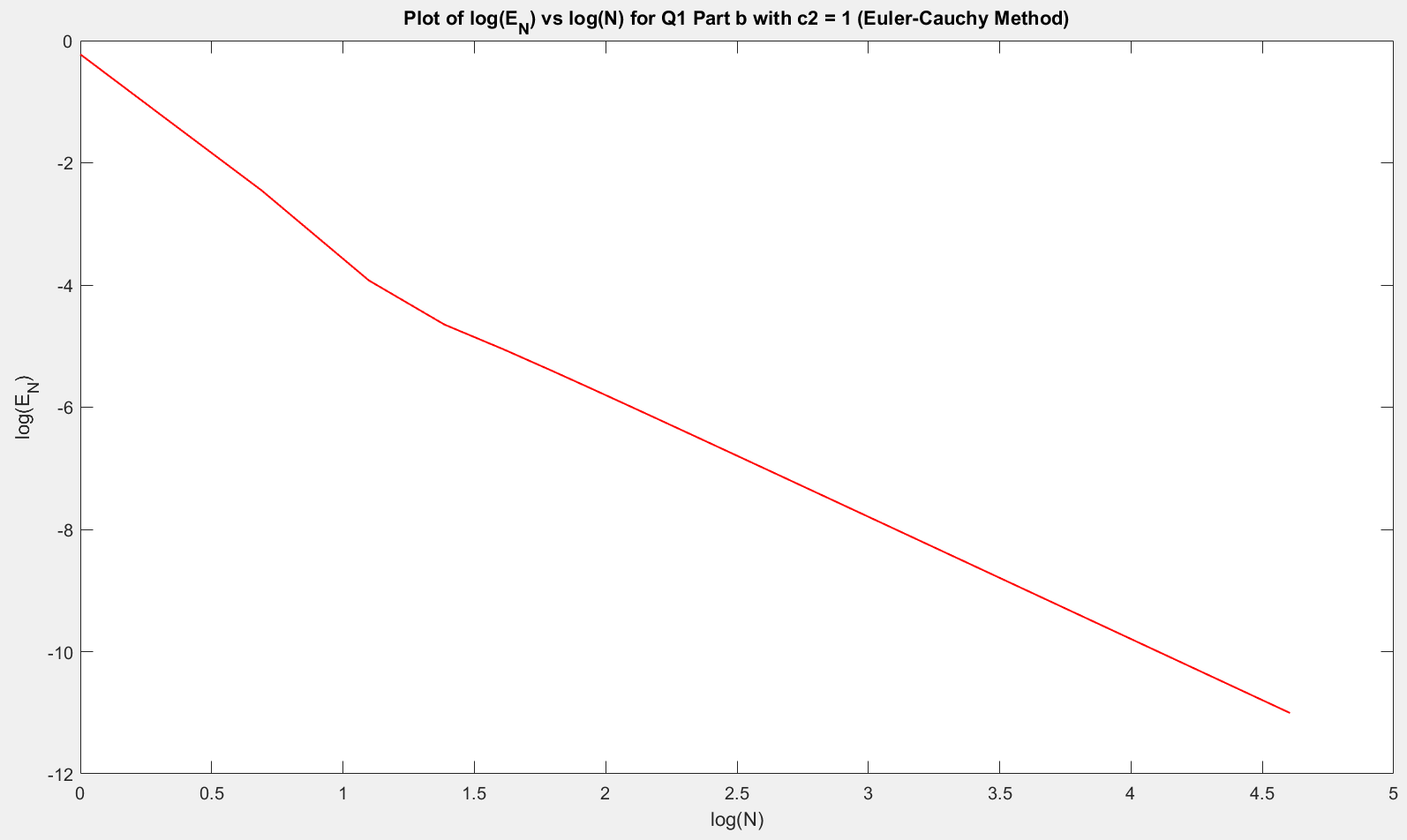


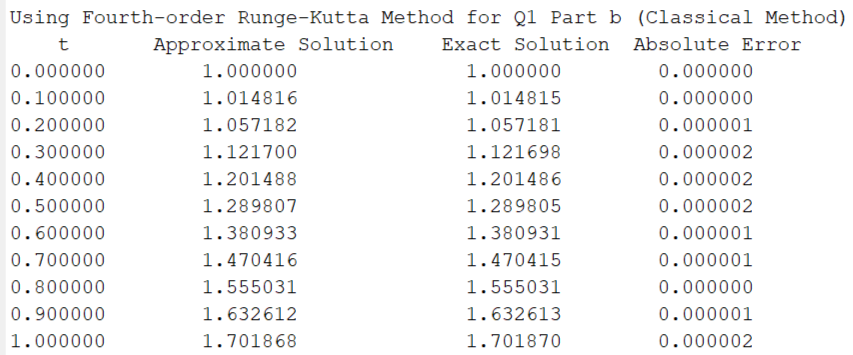


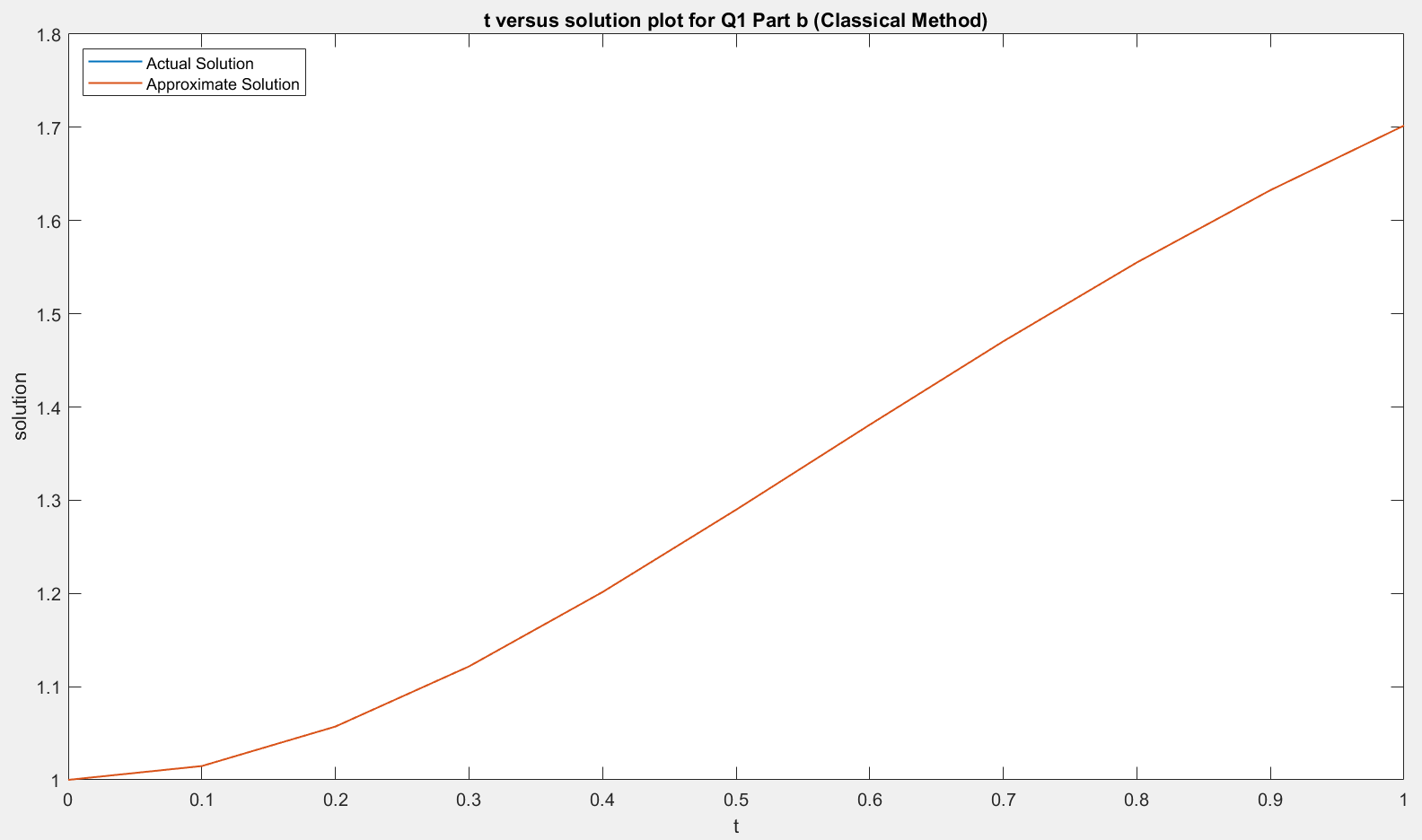


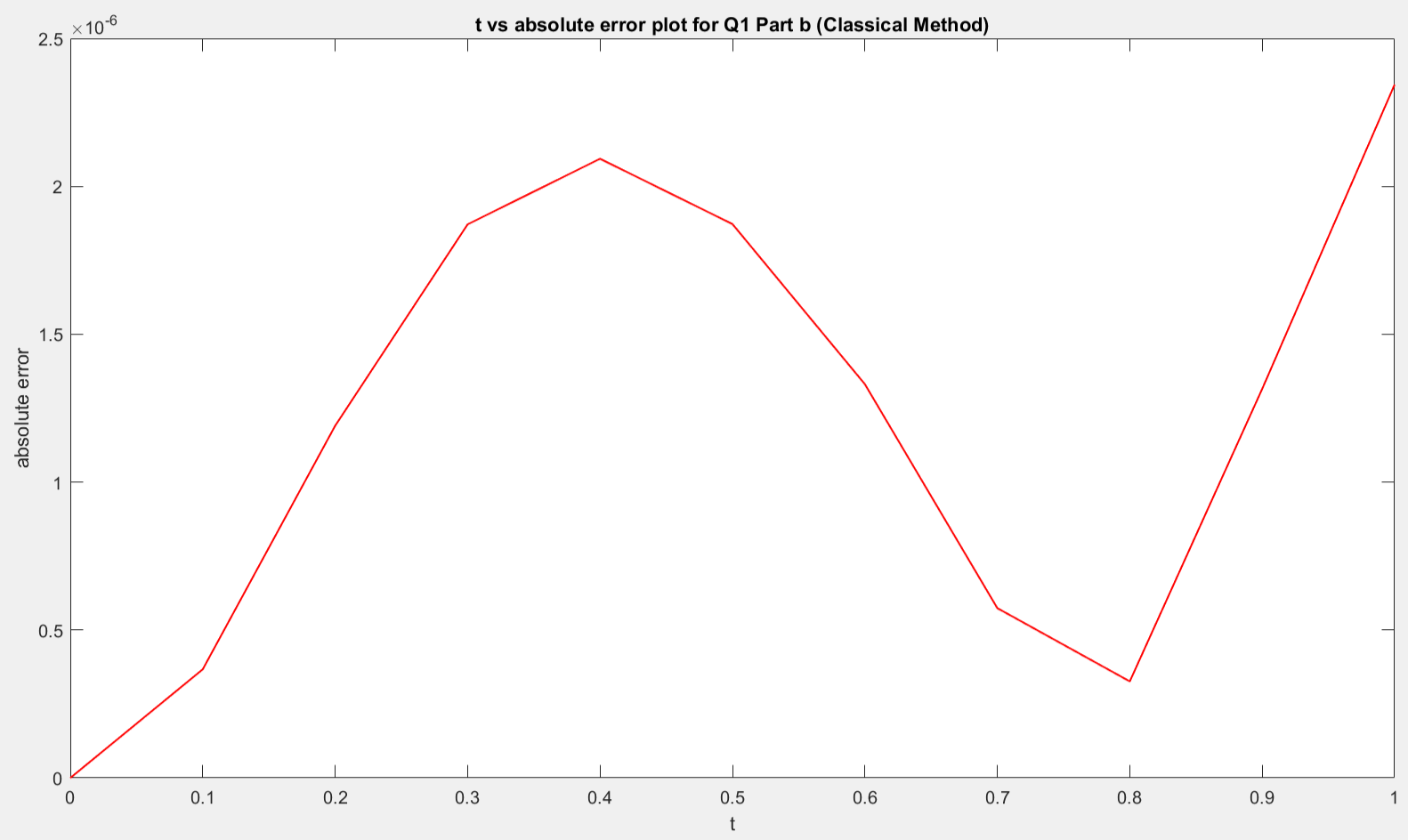


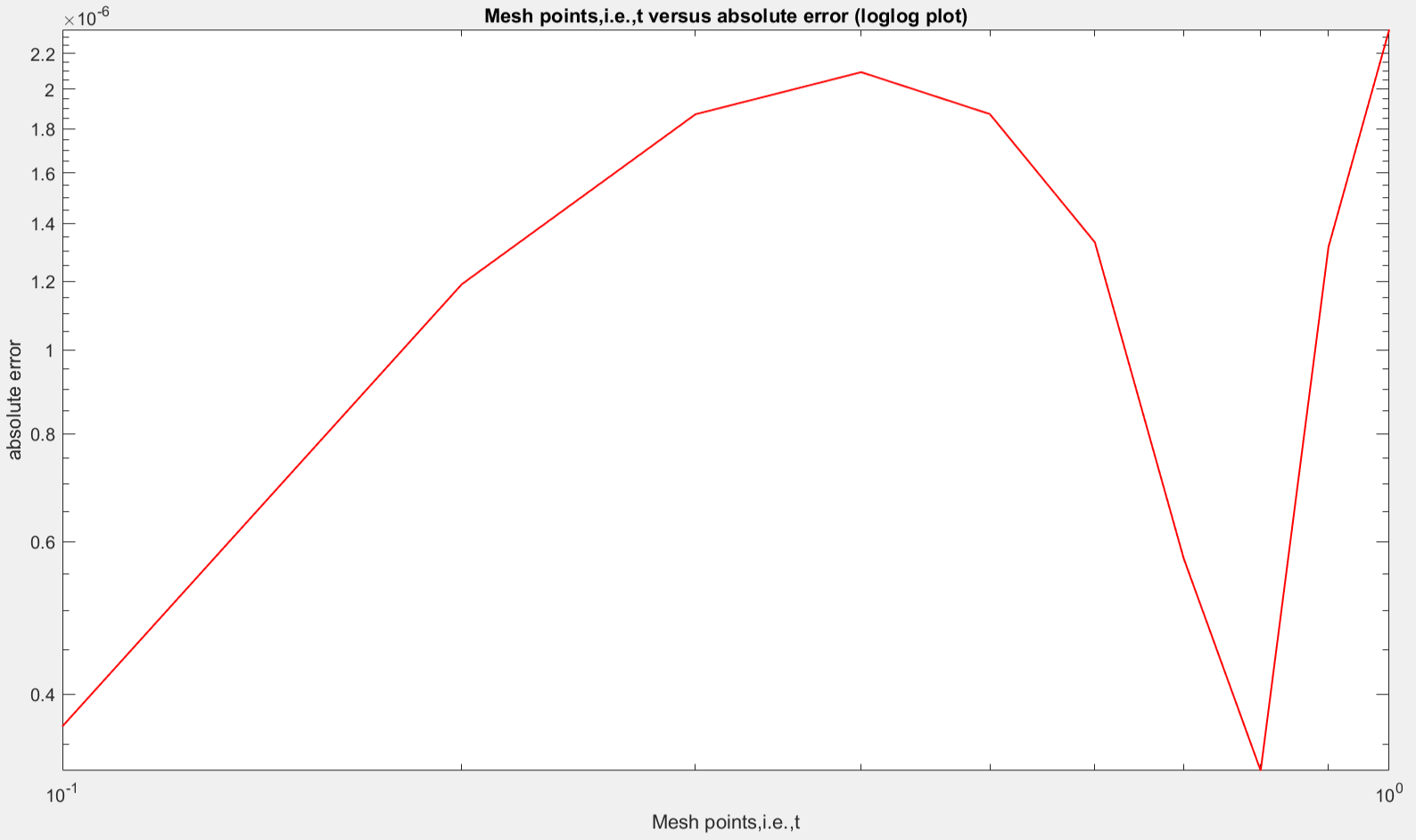


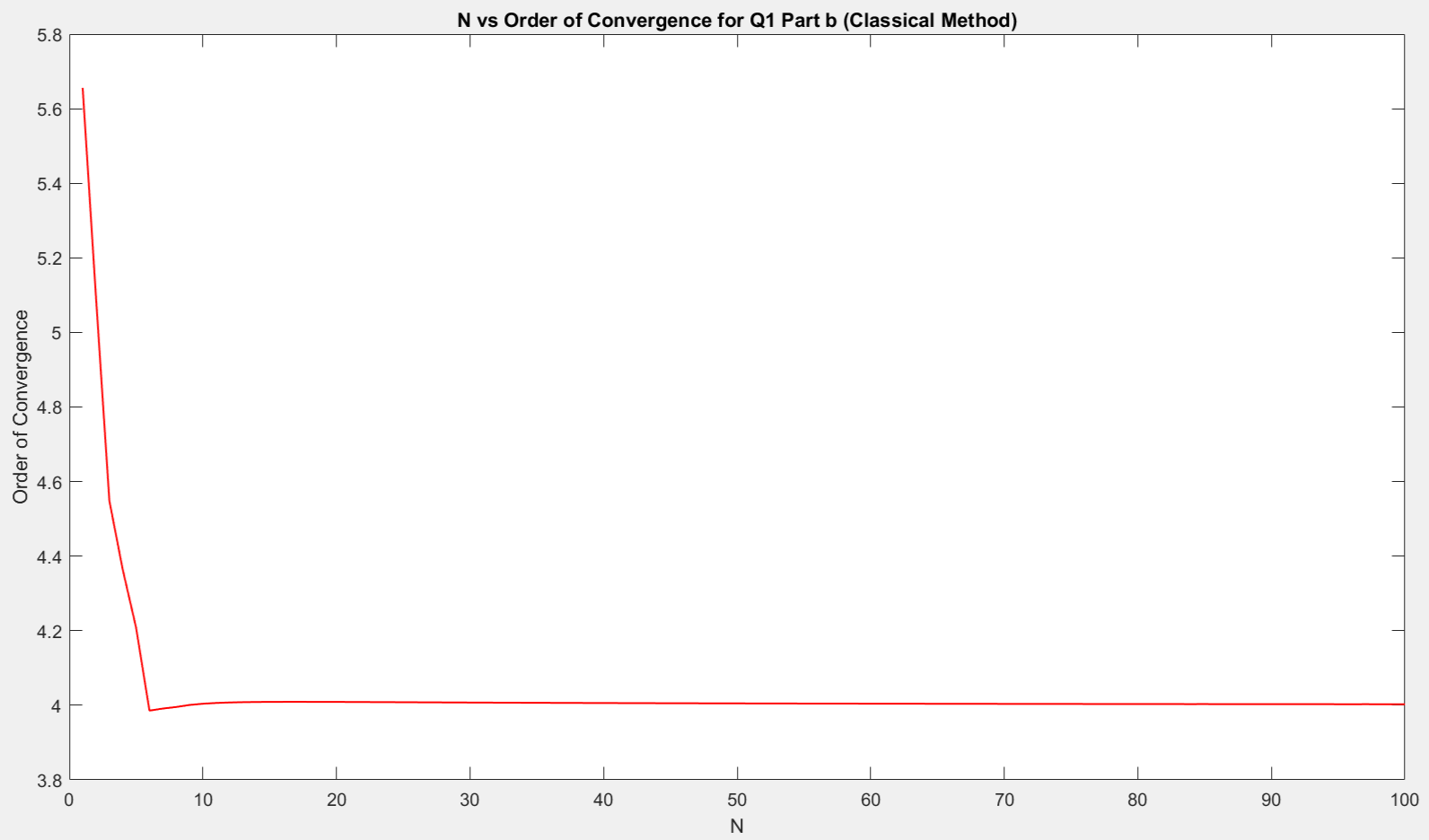


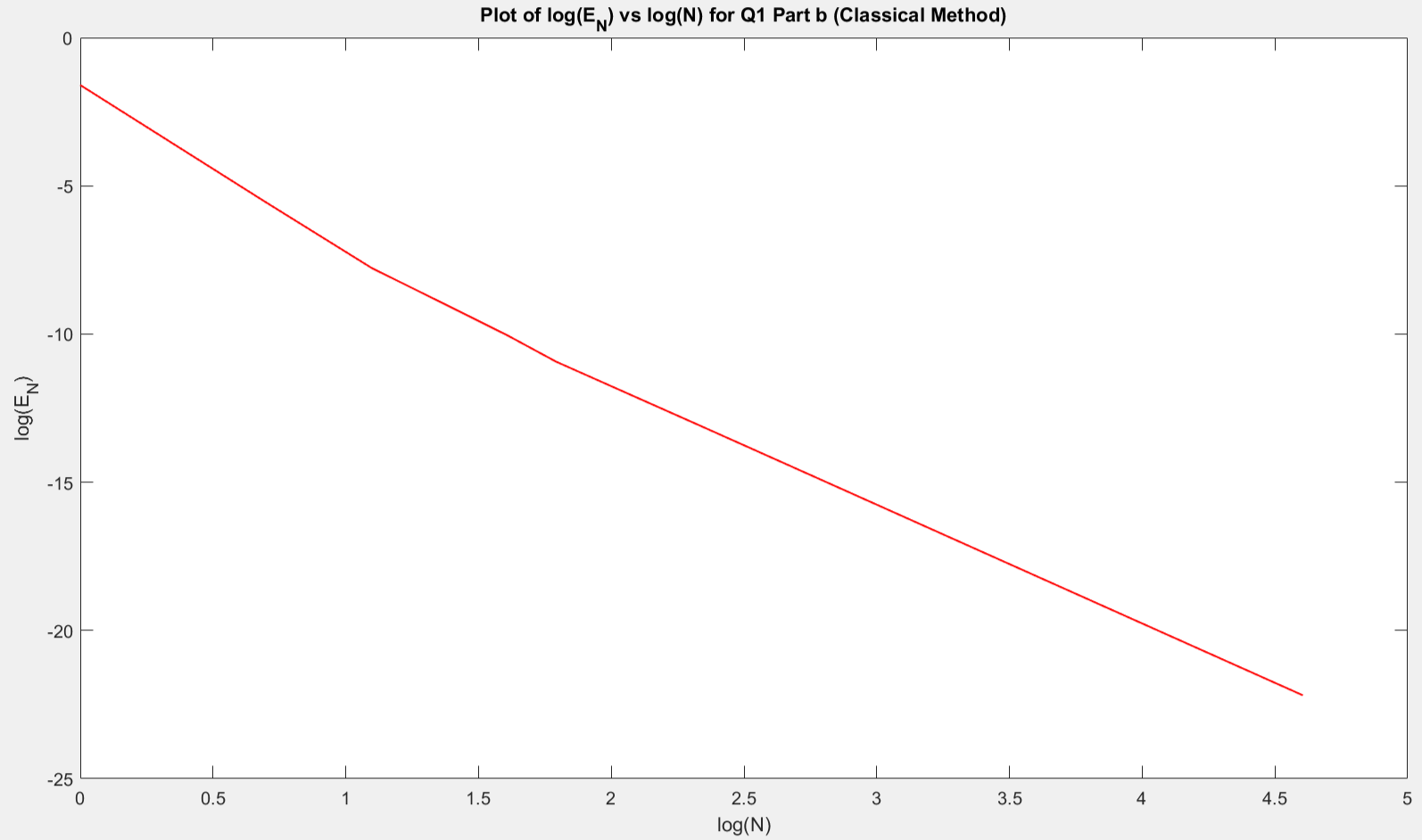


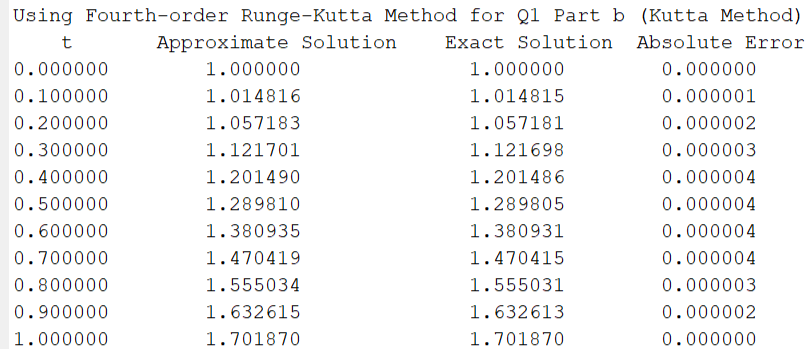


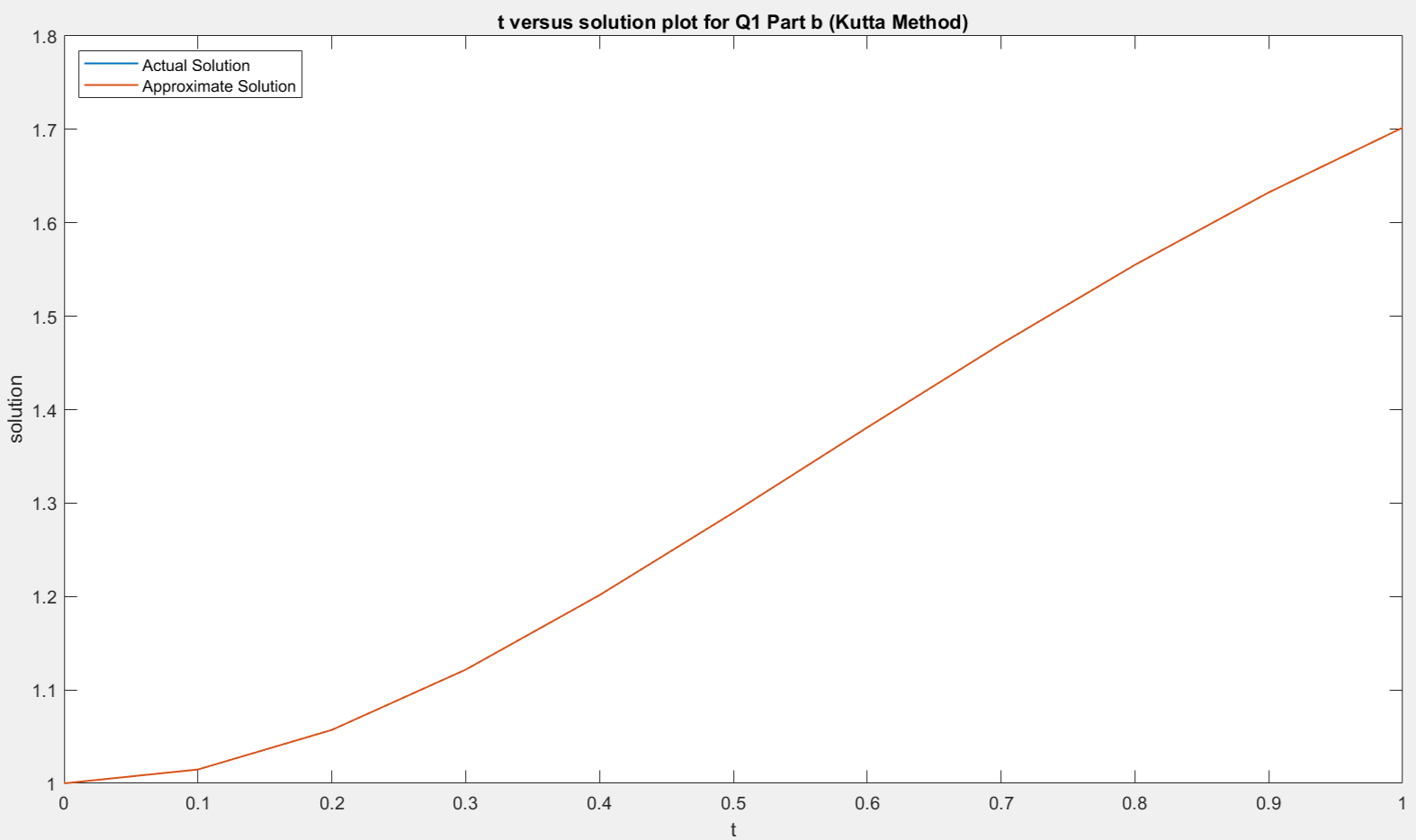


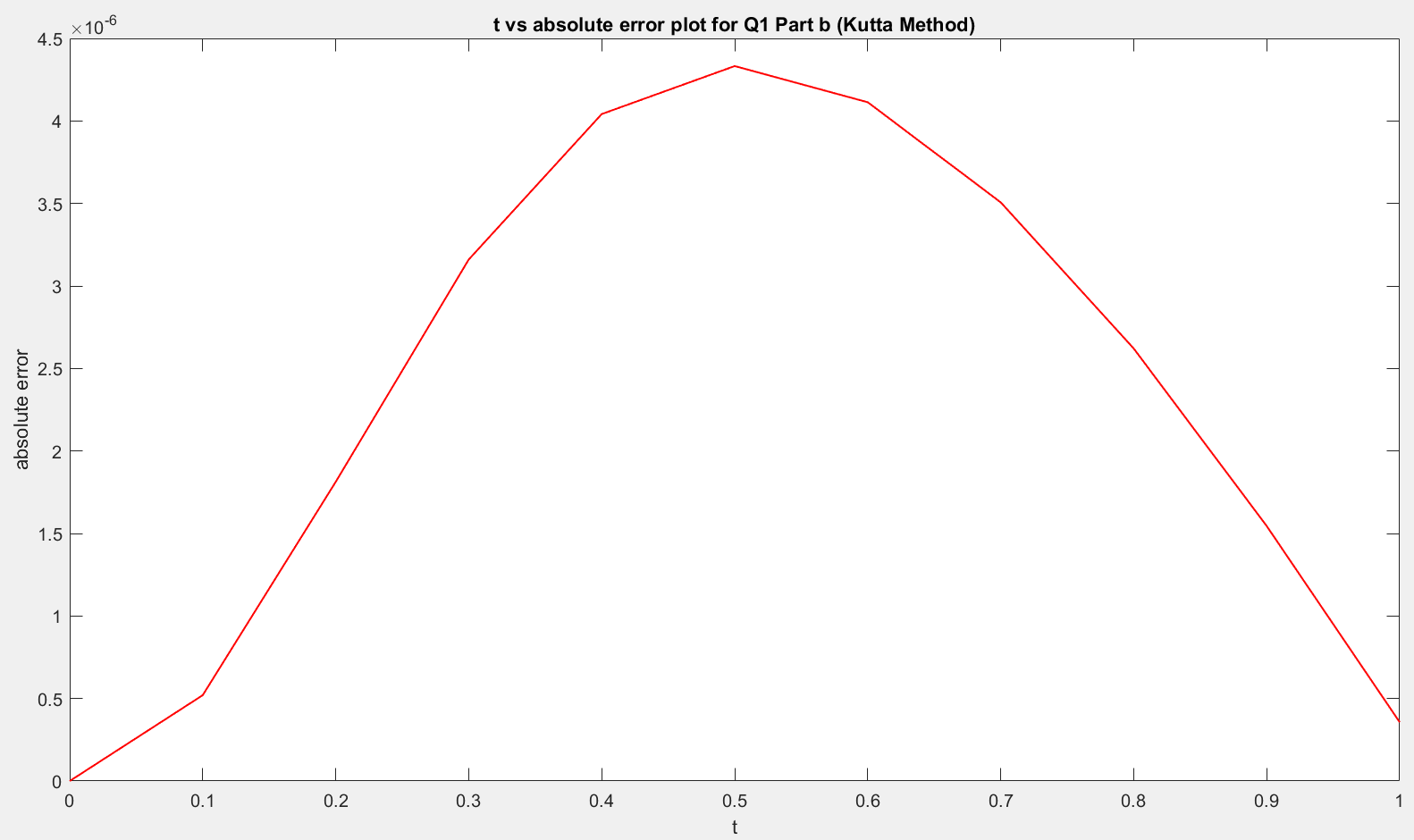


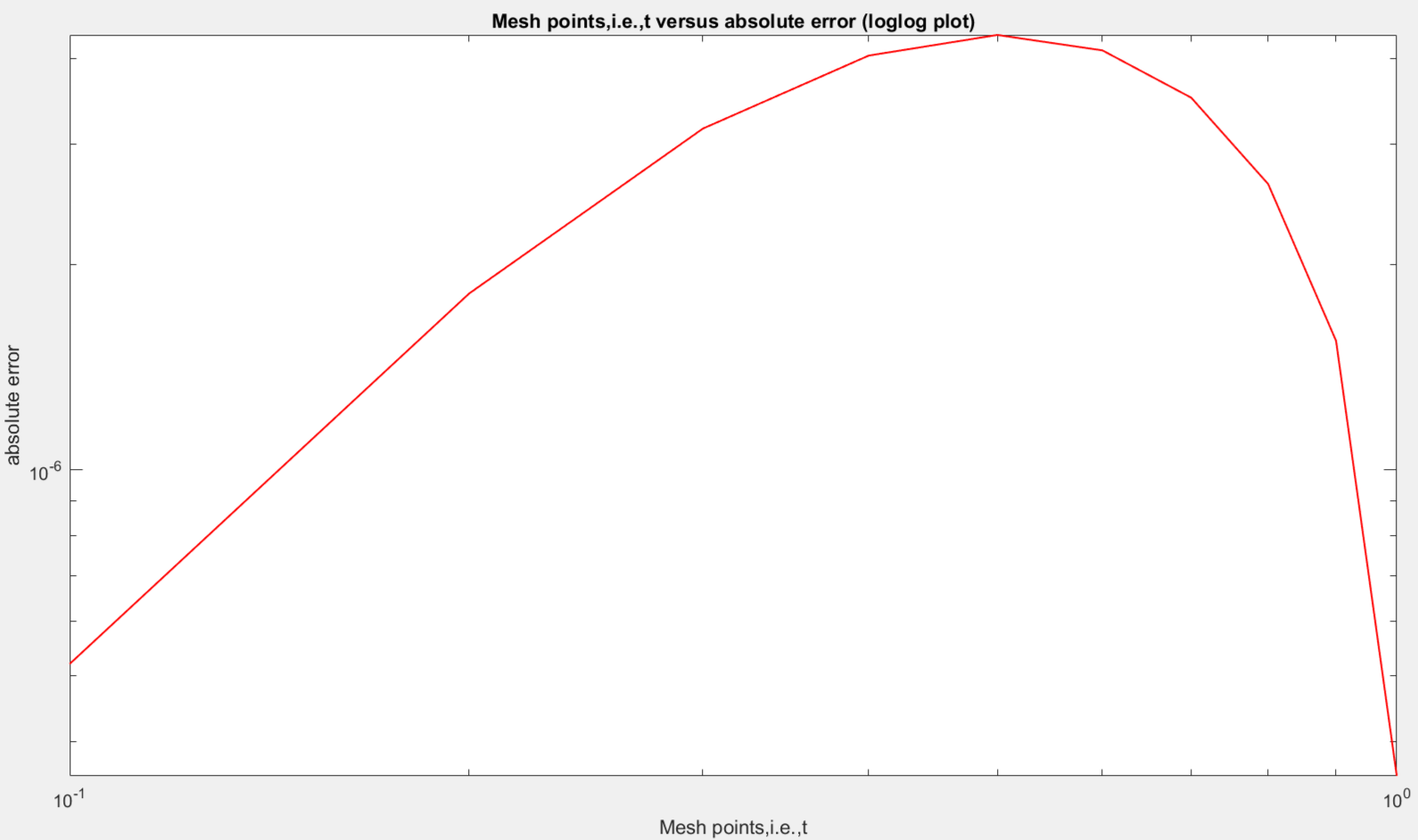


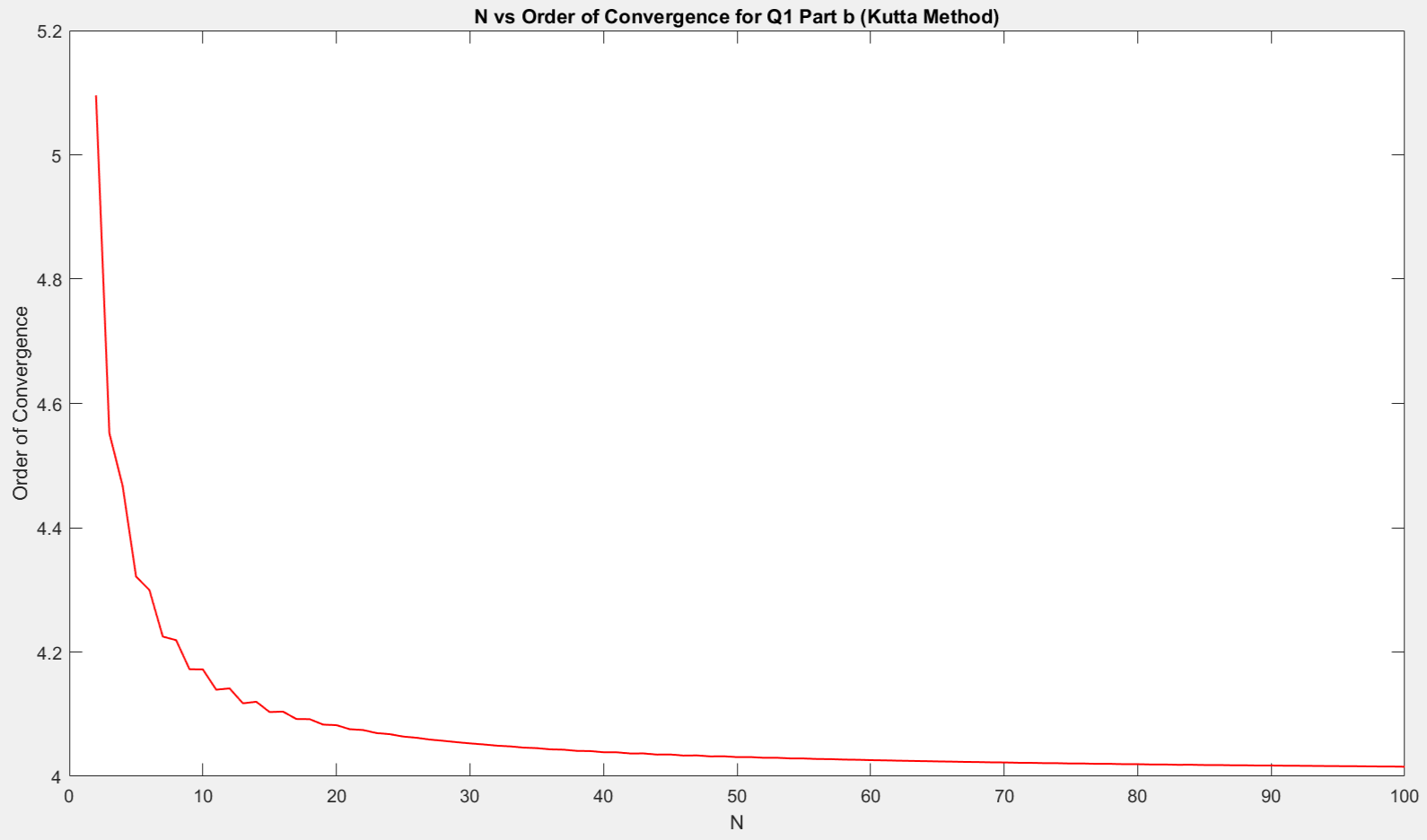


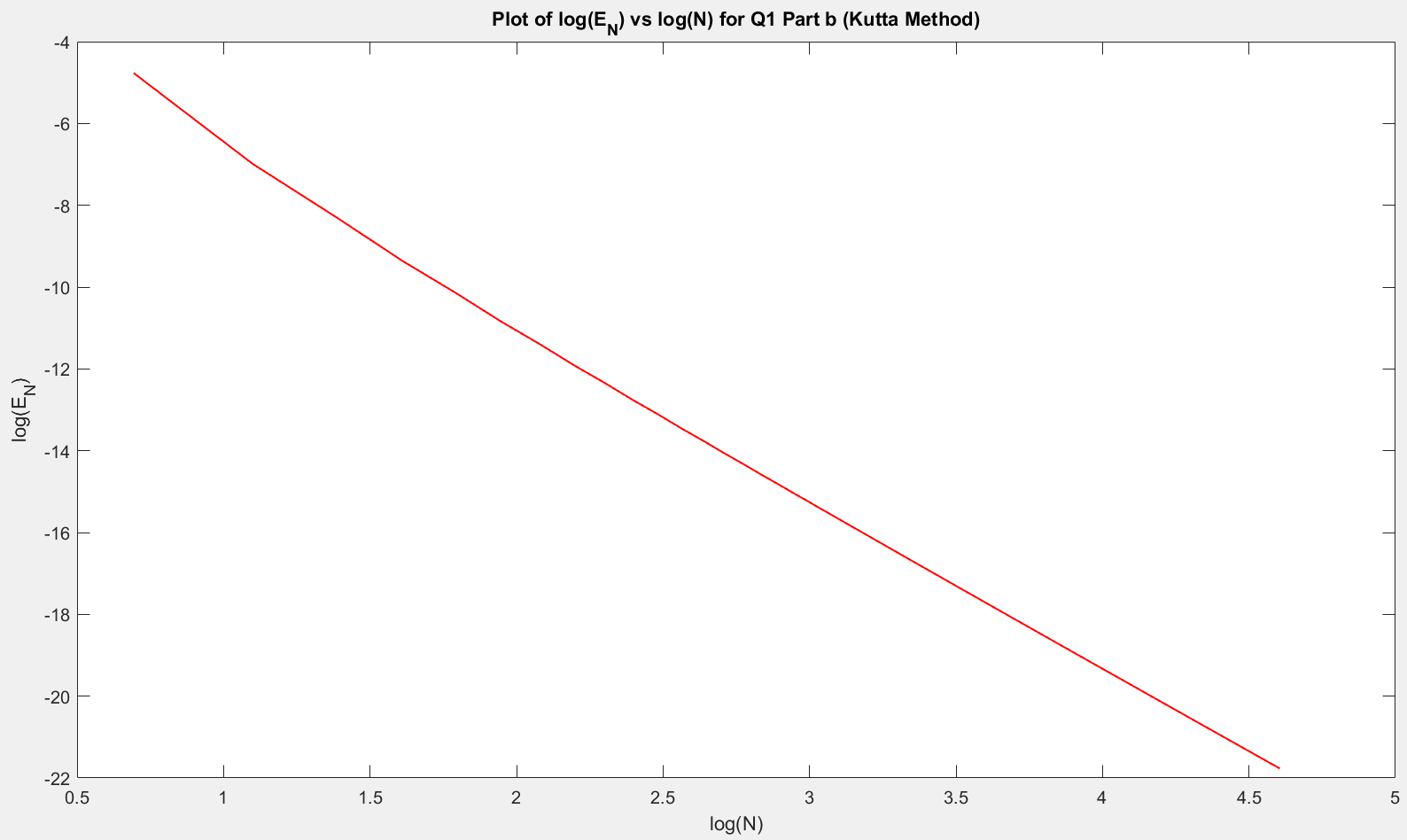












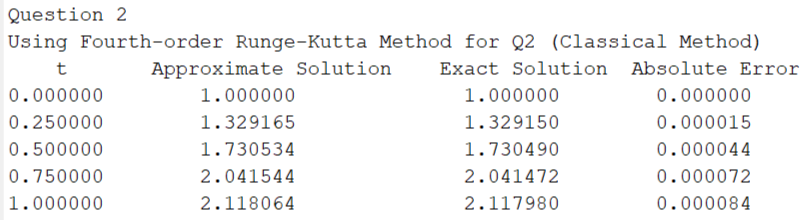
The graphs for actual and approximate solutions are almost coinciding in the case of Fourth Order Runge-Kutta methods. For the given initial-value problems, performance of: Implicit-Euler Method < Second-order Runge-Kutta Methods < Fourth-order Runge-Kutta Methods, which is as expected.

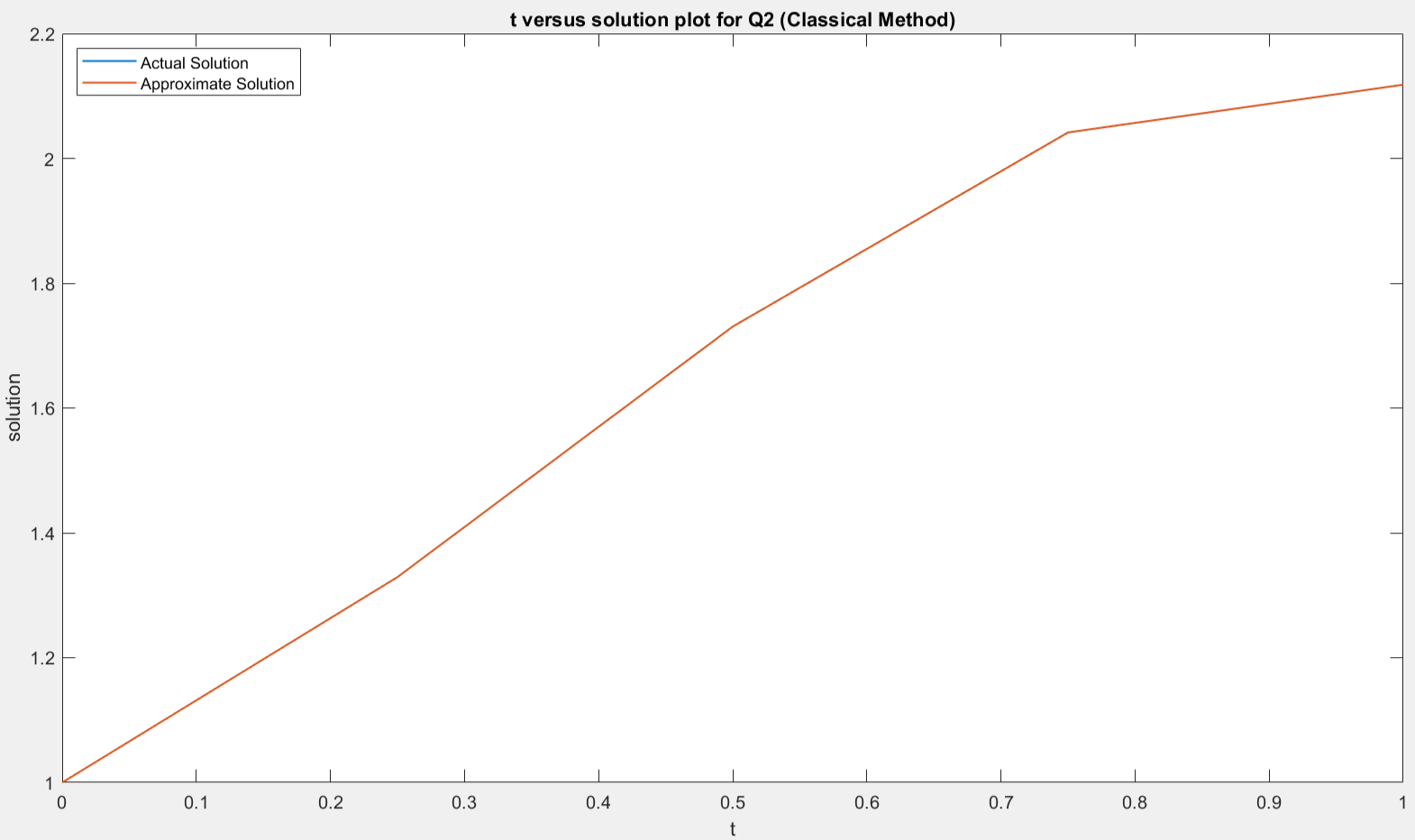
2)

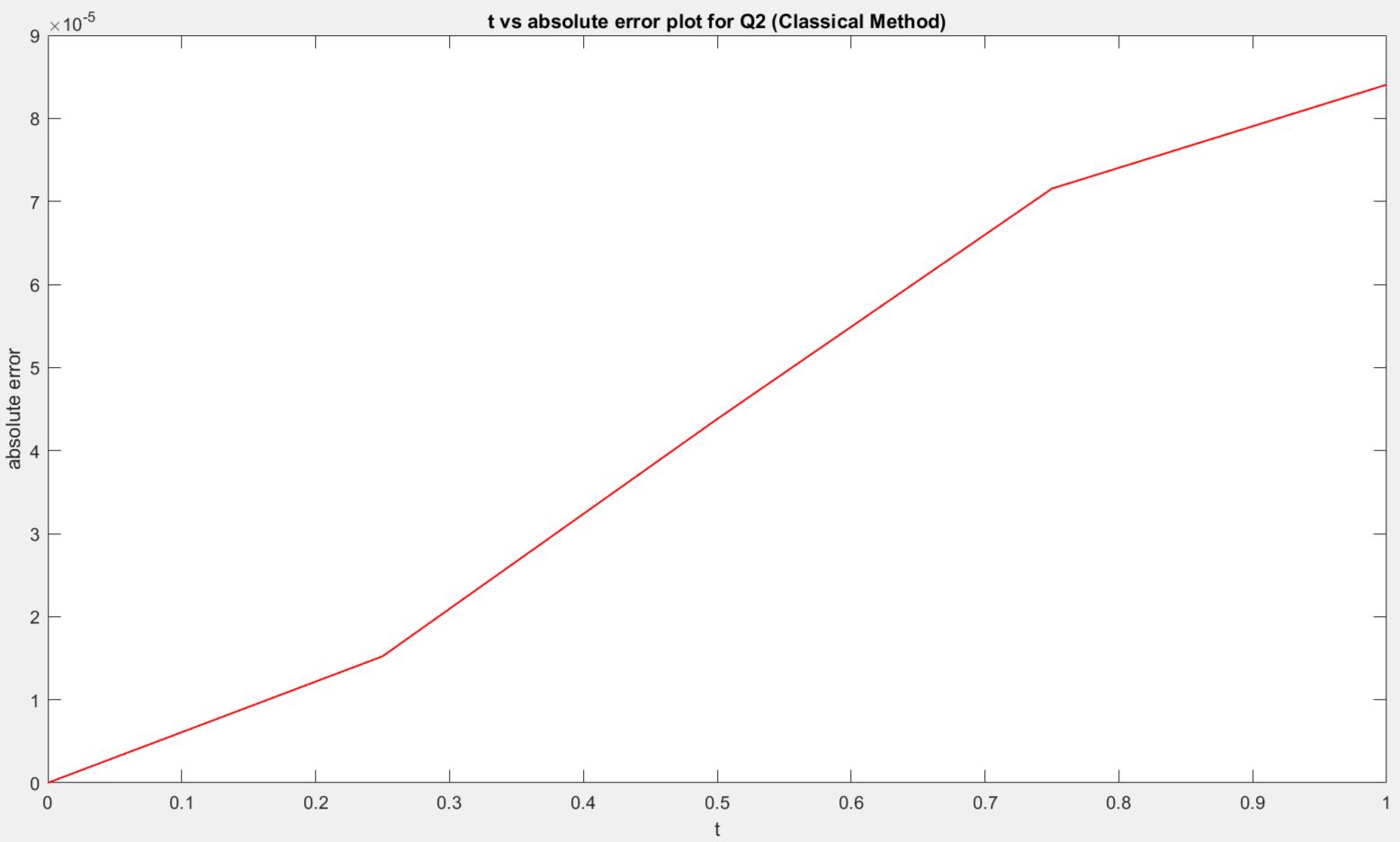
The following methods are implemented:

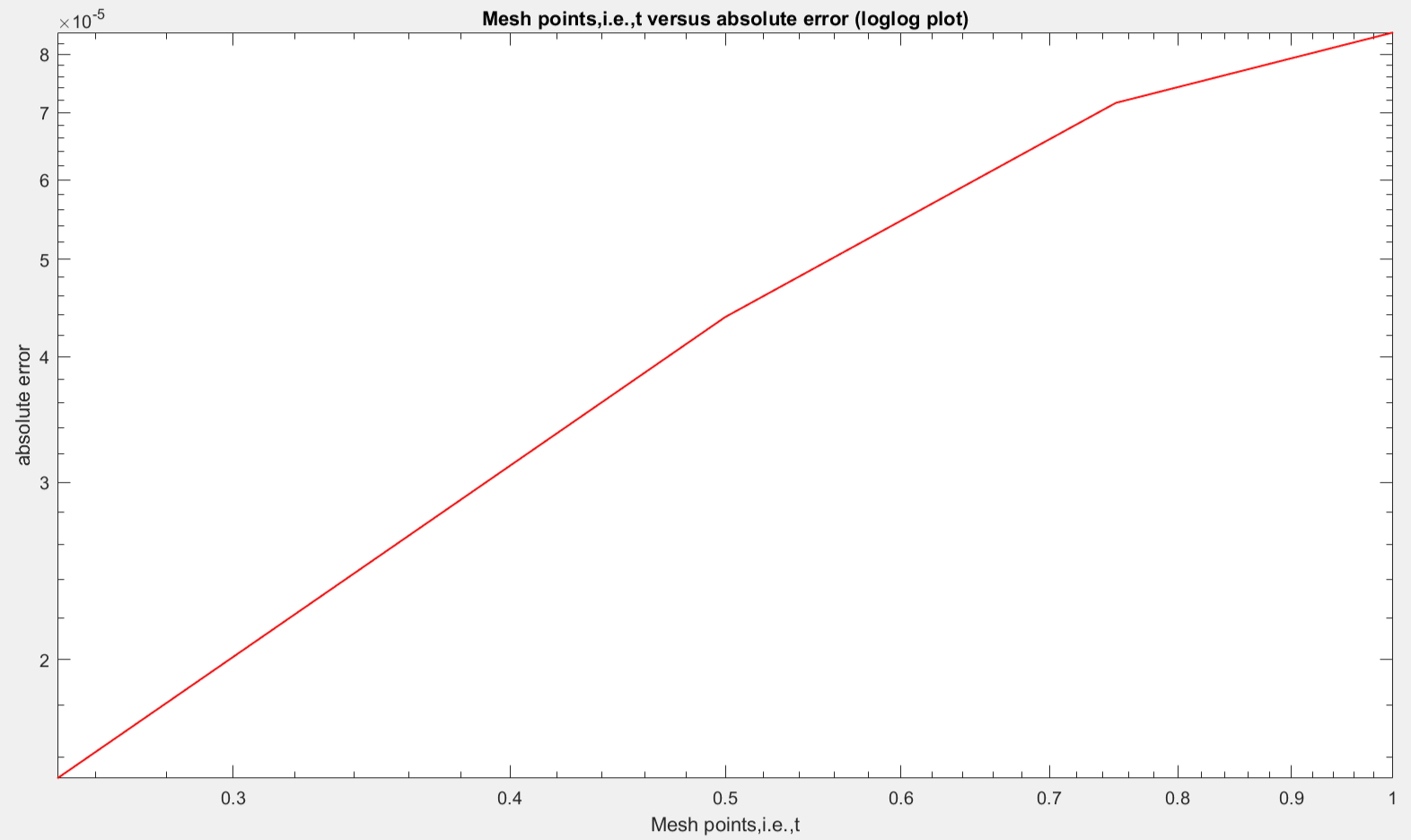
(i) Fourth-order Runge-Kutta method with:

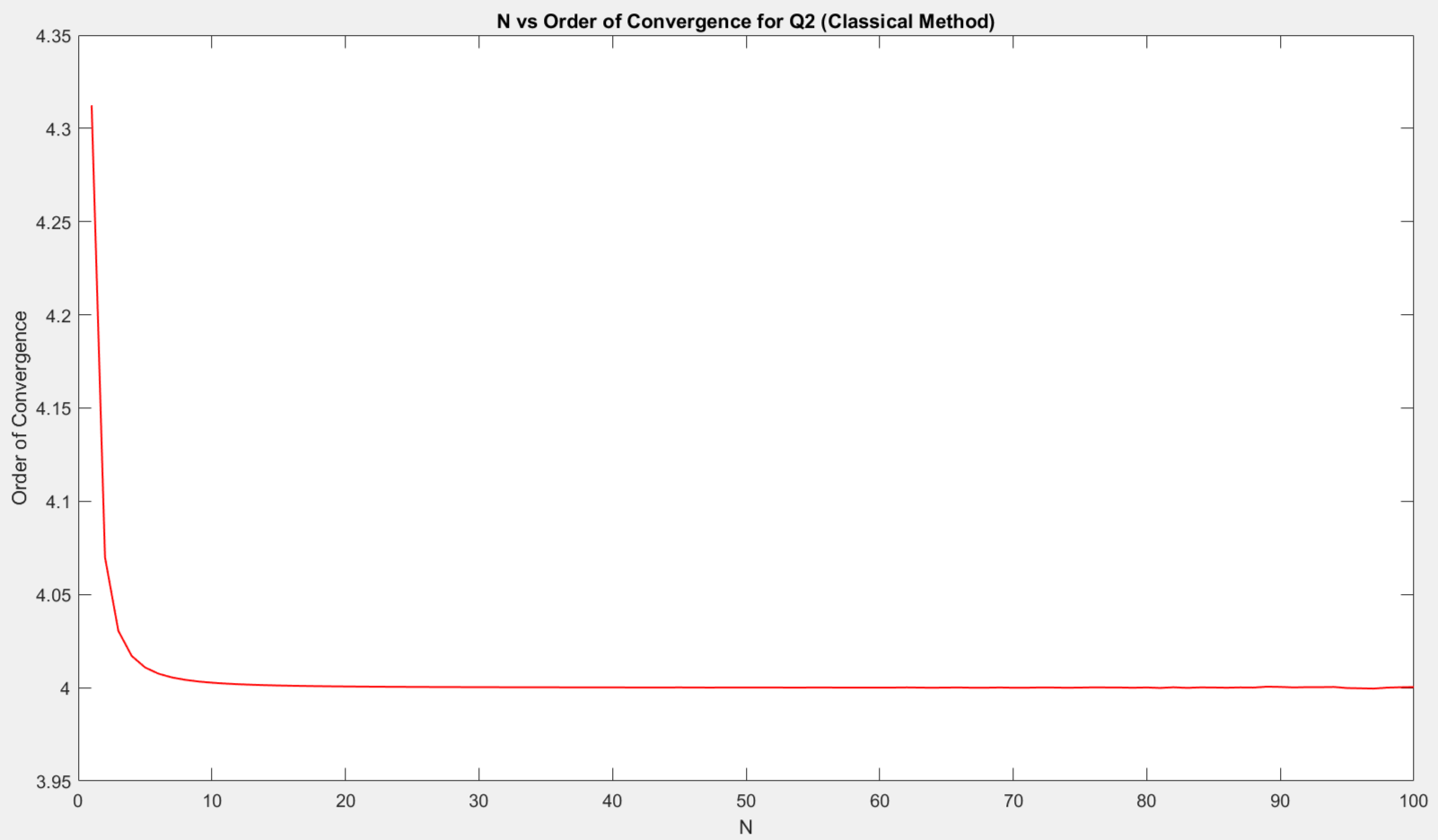
* c2 = 1/2, c3 = 1/2, c4 = 1 (Classical Method)
* c2 = 1/3, c3 = 2/3, c4 = 1 (Kutta Method)

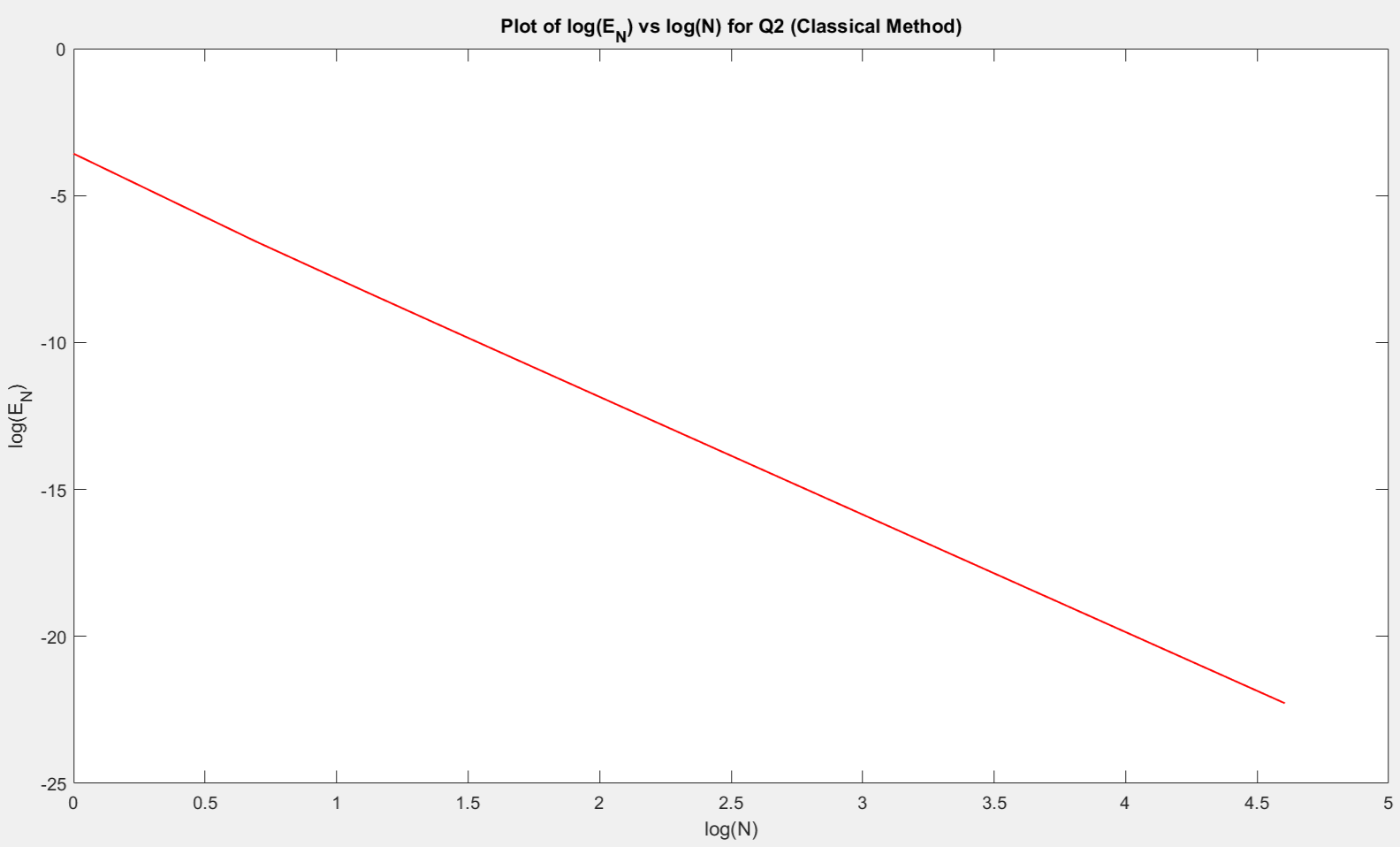


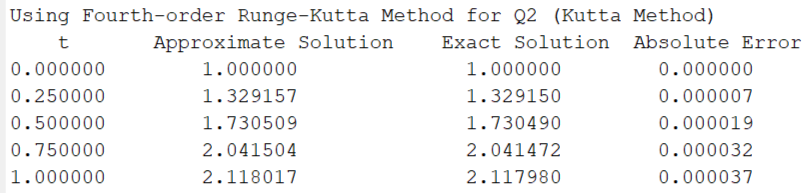


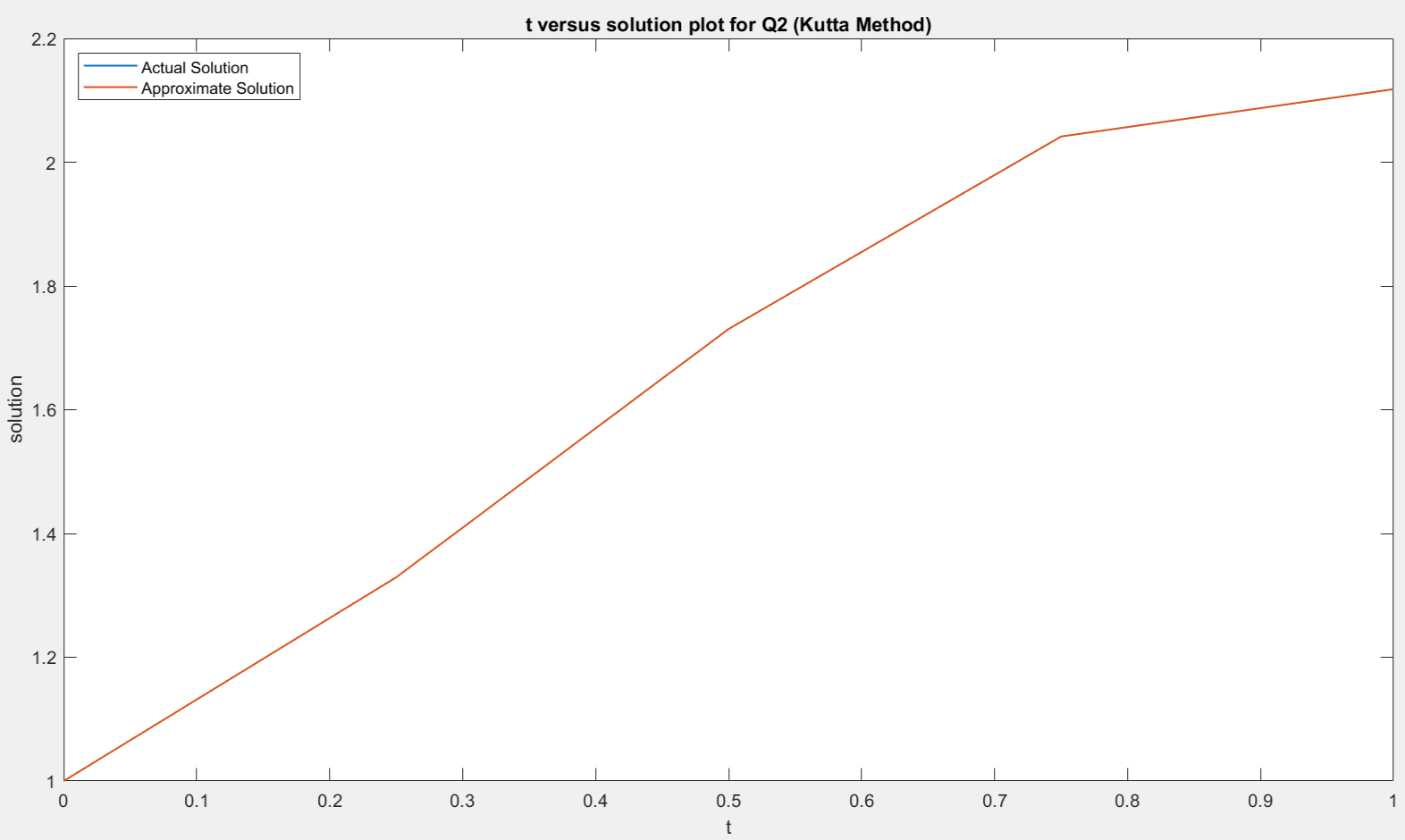


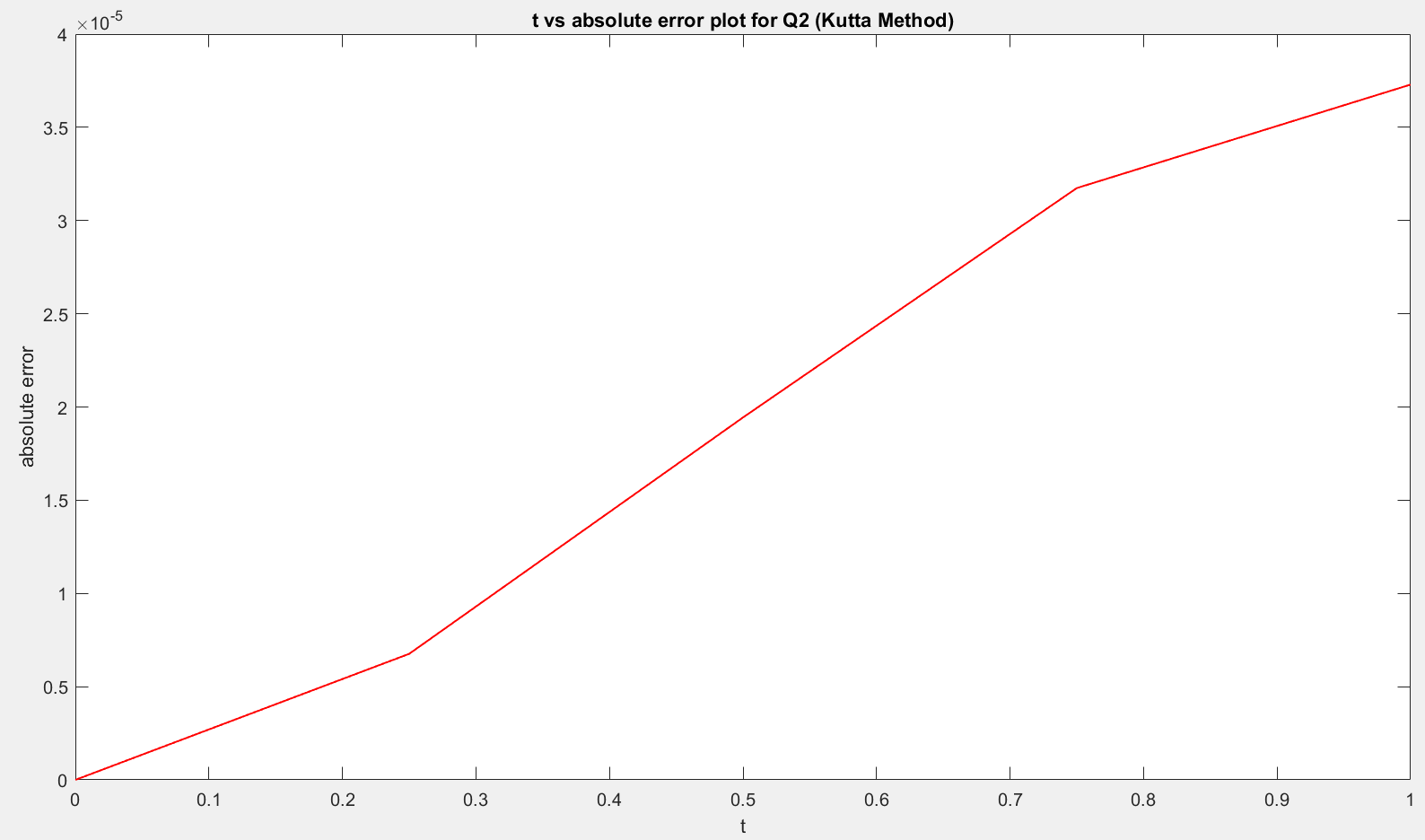


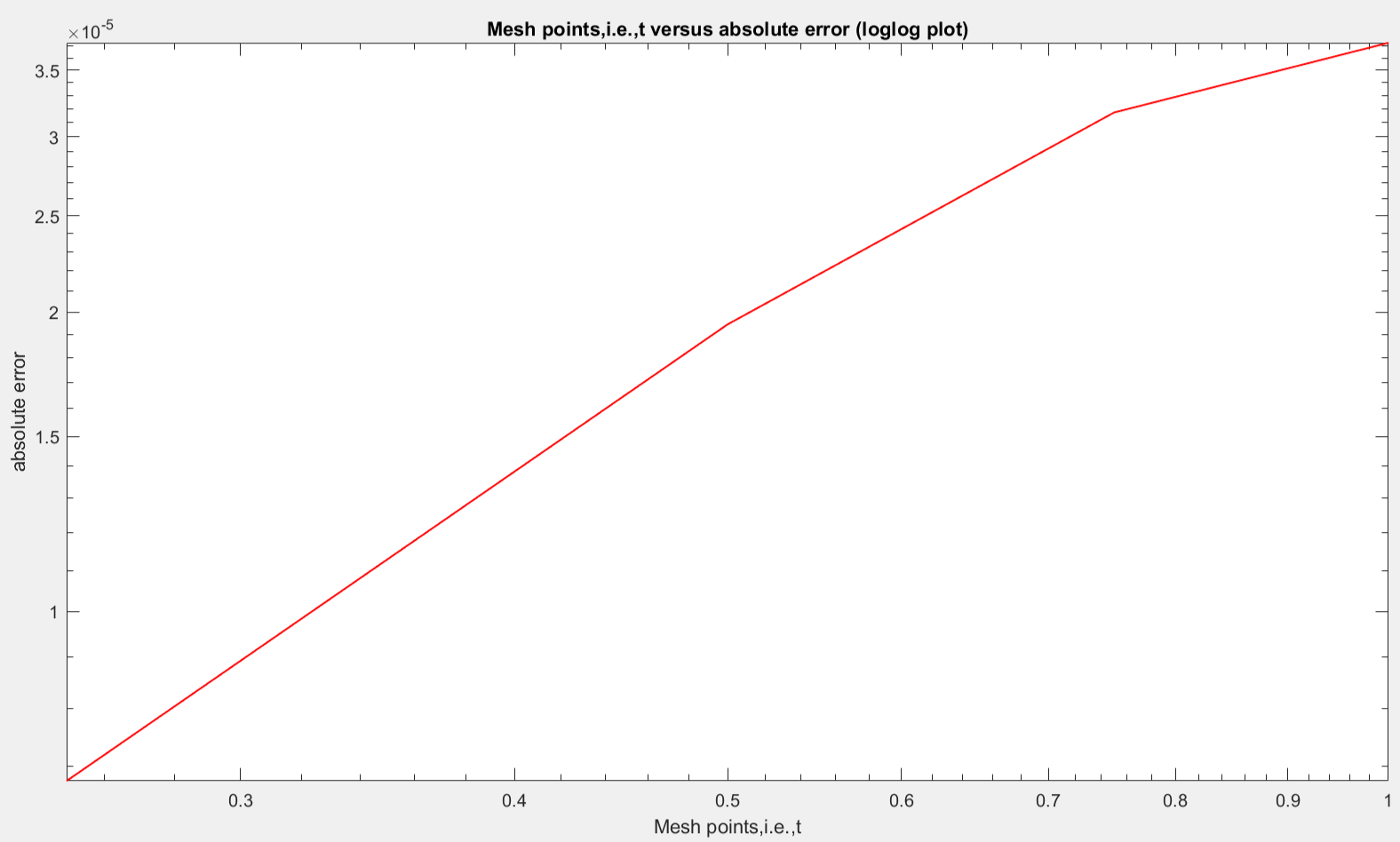


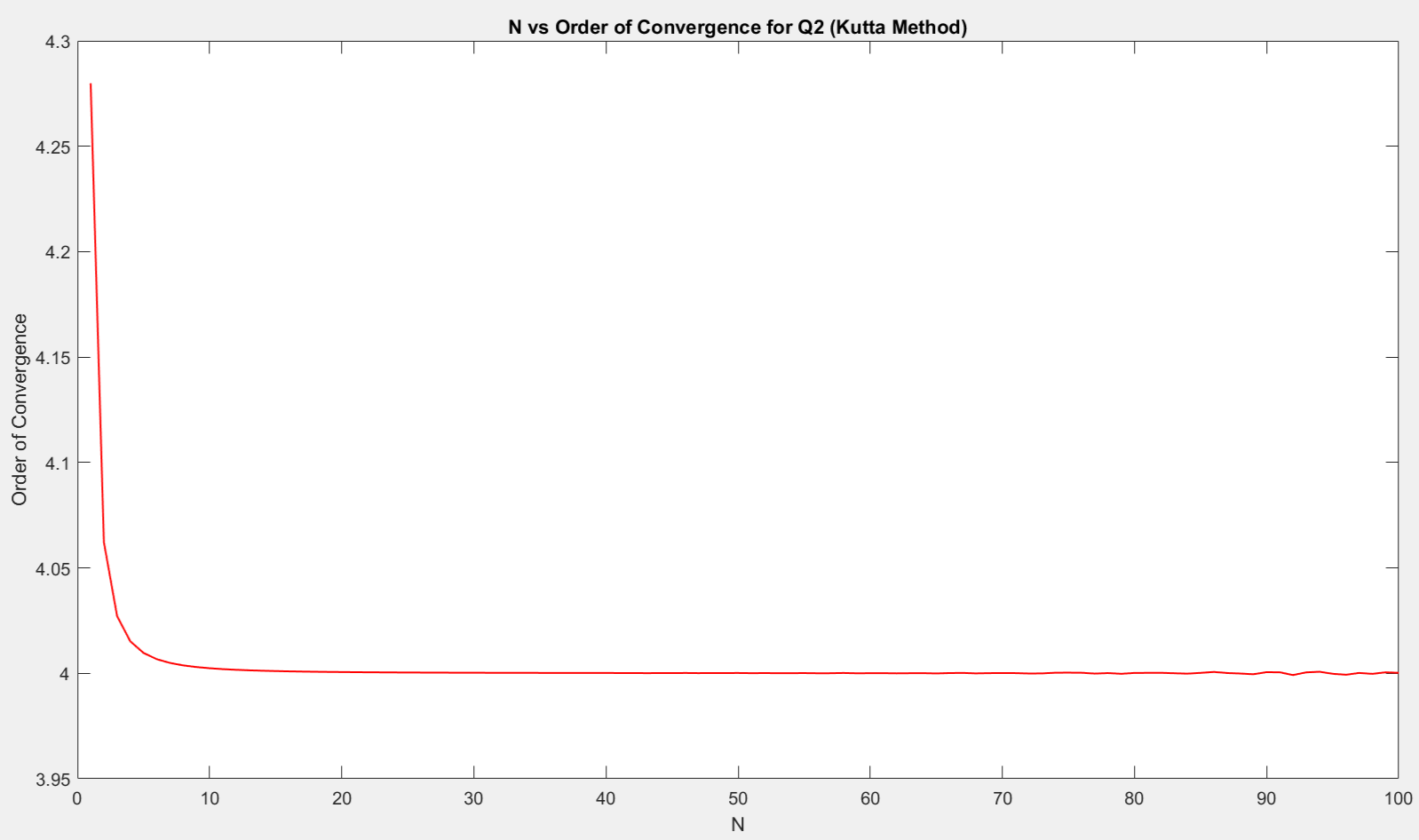


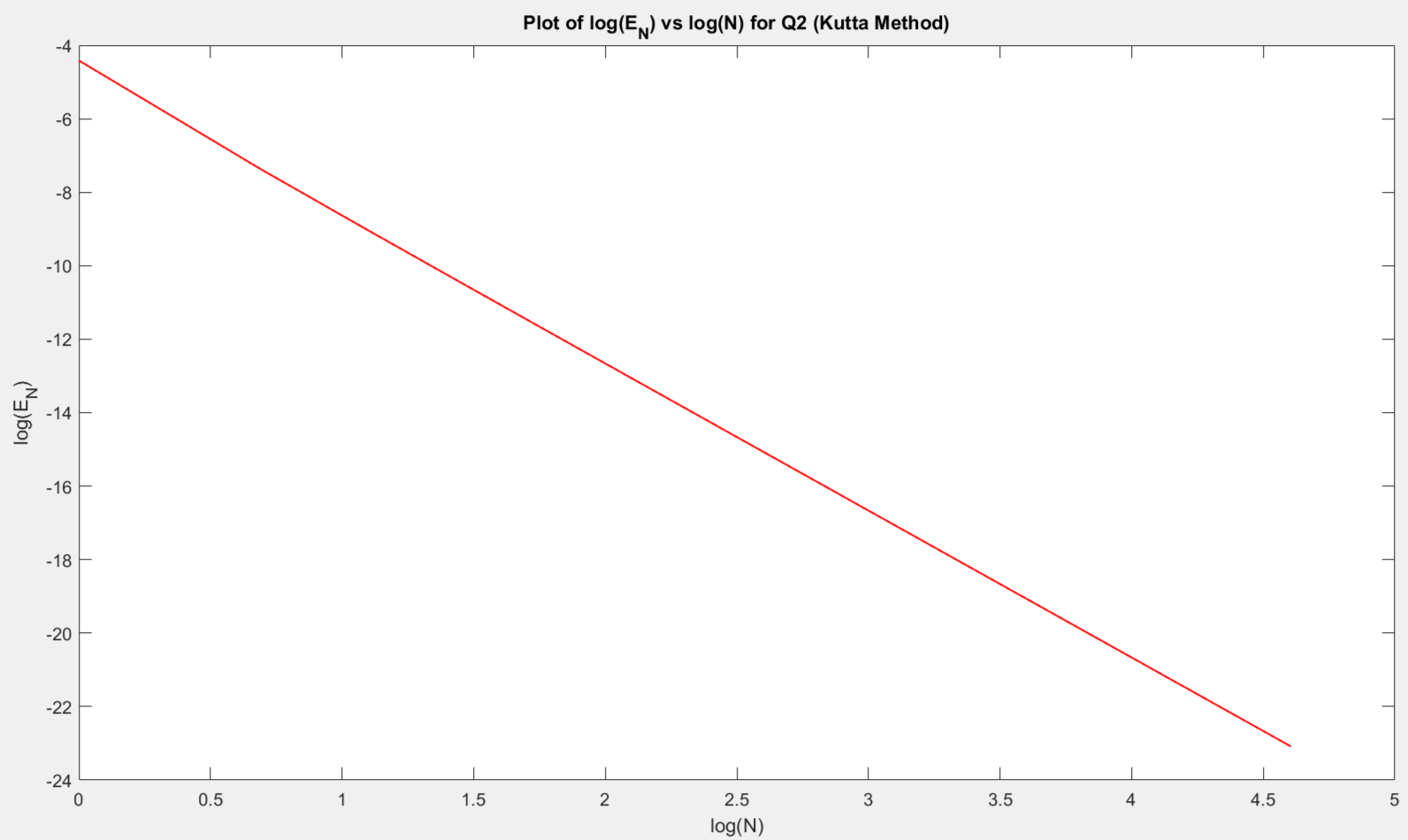












Both Classical and Kutta methods exhibit similar performance, with little discernible difference between them. Kutta method is giving slightly better estimates.