Scientific Computing (MA322)

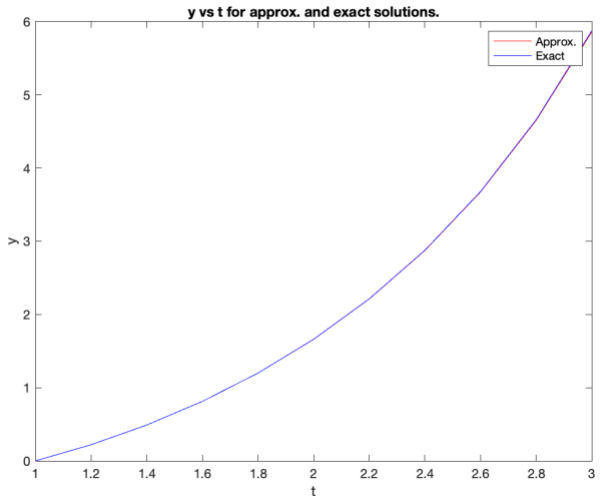
Lab 12

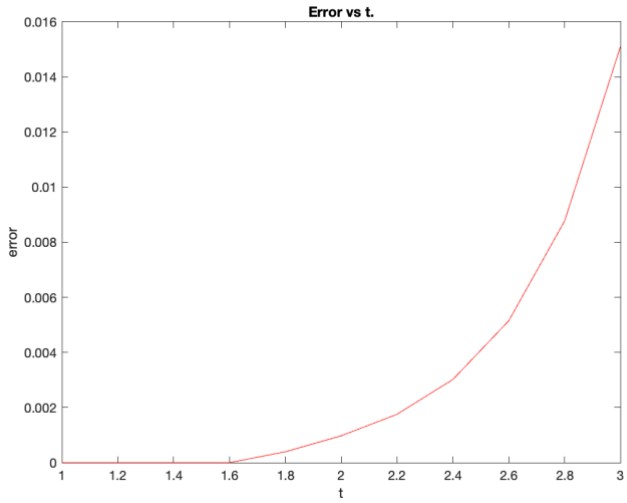
Naveen Kumar A G 210123075

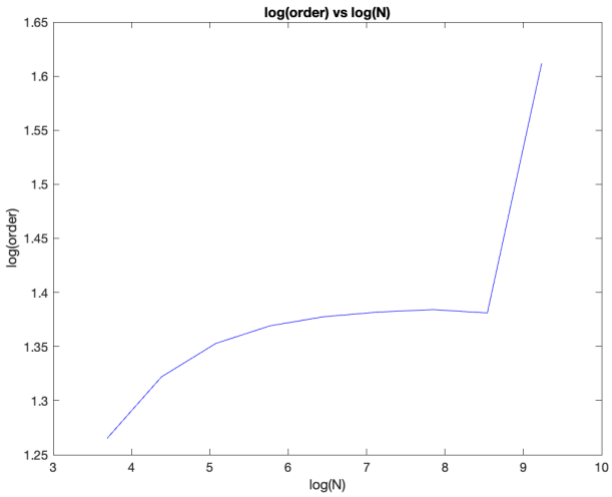
Q1 (a) Adams-Bashforth

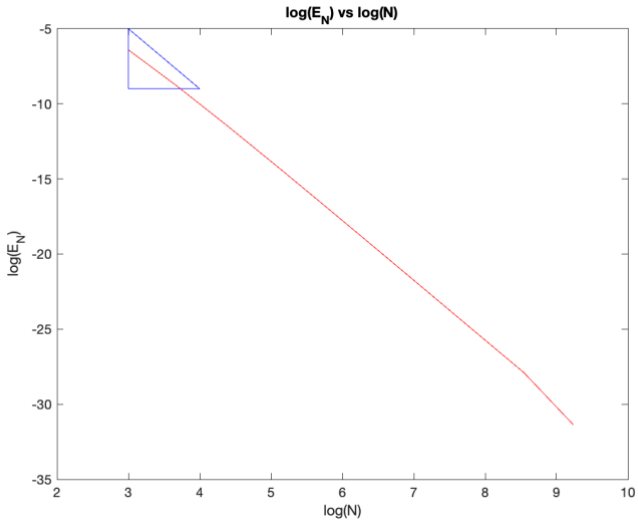
t_i	Approx.	Exact	Error
1	0	0	0
1.20000000000000	0.221242772757631	0.221242772757631	0
1.40000000000000	0.489681663750943	0.489681663750943	0
1.60000000000000	0.812752740561542	0.812752740561542	0
1.80000000000000	1.19904358747061	1.19943864032594	0.000395052855329148
2	1.66030714271453	1.66128175572157	0.000974613007039382
2.20000000000000	2.21174620699483	2.21350181348063	0.00175560648580175
2.40000000000000	2.87353403712935	2.87655141999484	0.00301738286549647
2.60000000000000	3.67332942263360	3.67847533085185	0.00514590821824656
2.80000000000000	4.64989739650218	4.65866505823951	0.00876766173733223
3	5.85899944353019	5.87409997818417	0.0151005346539774

N	E_N	Order
20	0.00167804029568508	0
40	0.000143881248472866	3.54382687223558
80	1.06868805049842e-05	3.75096588538949
160	7.31661573993847e-07	3.86852049013439
320	4.79264992137018e-08	3.93228102479201
640	3.06765635116335e-09	3.96561478067500
1280	1.94054550206602e-10	3.98260270944296
2560	1.22000187730009e-11	3.99150698907283
5120	7.73603403558809e-13	3.97914541540327
10240	2.39808173319034e-14	5.01164140643540


y vs t for approx. and exact solutions.
Approx.
Exact
y
t


Error vs t.
error
t

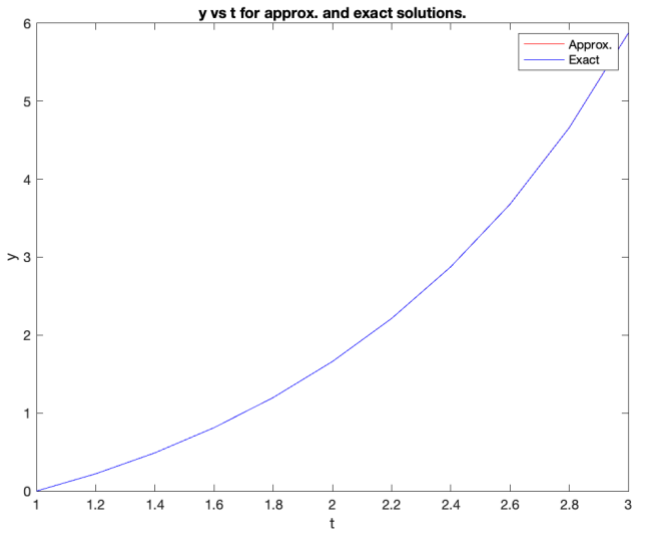

log(order) vs log(N)
log(order)
log(N)

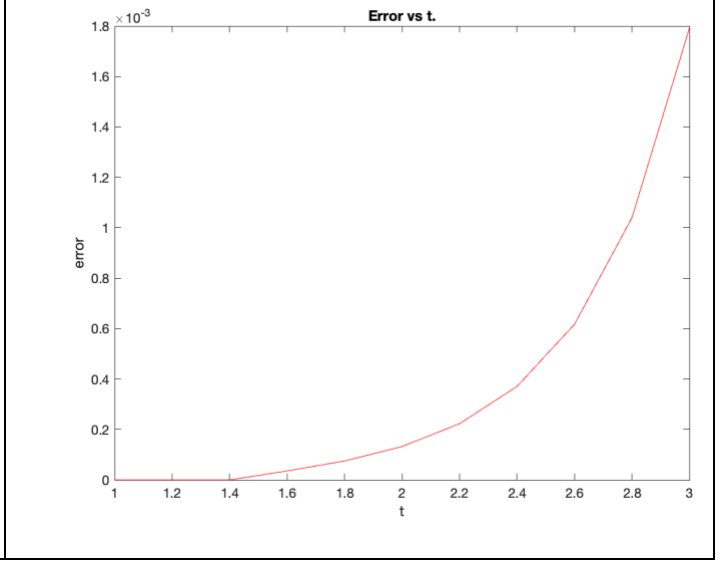

log(E_N) vs log(N)
log(E_N)
log(N)

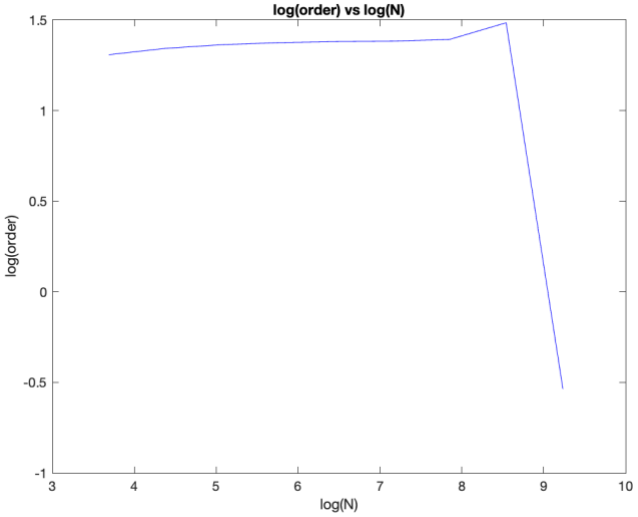
Adams-Moulton

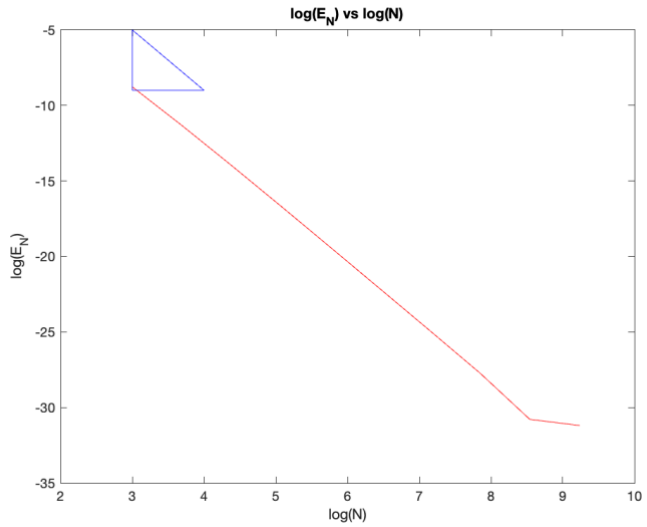
t_i	Approx.	Exact	Error
1	0	0	0
1.20000000000000	0.221242772757631	0.221242772757631	0
1.40000000000000	0.489681663750943	0.489681663750943	0
1.60000000000000	0.812788290773803	0.812752740561542	3.55502122604268e-05
1.80000000000000	1.19951376577940	1.19943864032594	7.51254534616663e-05
2	1.66141405525966	1.66128175572157	0.000132299538096126
2.20000000000000	2.21372469925242	2.21350181348063	0.000222885771781645
2.40000000000000	2.87692202858862	2.87655141999484	0.000370608593774247
2.60000000000000	3.67909237261725	3.67847533085185	0.000617041765407667
2.80000000000000	4.65970484127393	4.65866505823951	0.00103978303441821
3	5.87589210121138	5.87409997818417	0.00179212302721332

N	E_N	Order
20	0.000158216688408430	0
40	1.21840820854757e-05	3.69883230900938
80	8.56618574296419e-07	3.83020079641554
160	5.70133513733140e-08	3.90928124597907
320	3.68122776706059e-09	3.95304088796927
640	2.33915109504324e-10	3.97613005654295
1280	1.47526435512191e-11	3.98693965236937
2560	9.07718344933528e-13	4.02258497191212
5120	4.26325641456060e-14	4.41221698021647
10240	2.84217094304040e-14	0.584962500721156





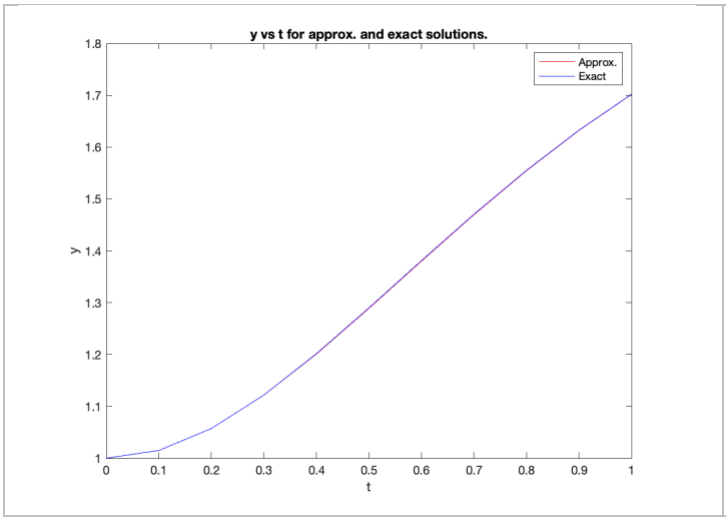

log(order) vs log(N)
log(order)
log(N)
1.5
1
0.5
0
-0.5
-1
3
4
5
6
7
8
9
10

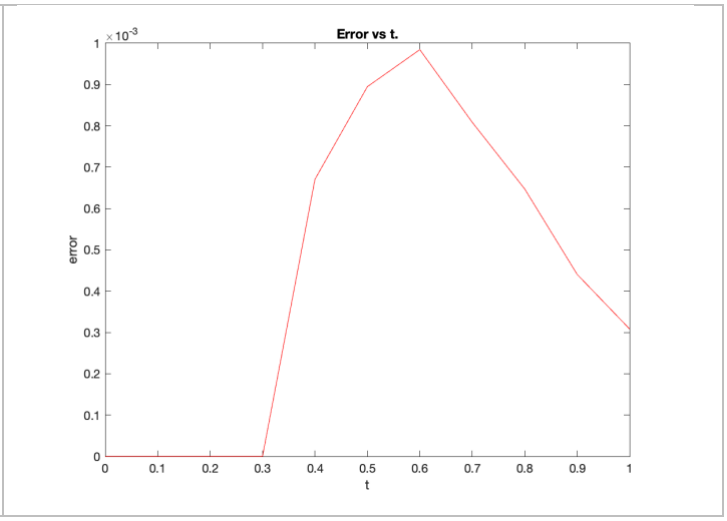

log(E_N) vs log(N)
log(E_N)
log(N)
-5
-10
-15
-20
-25
-30
-35
2
3
4
5
6
7
8
9
10

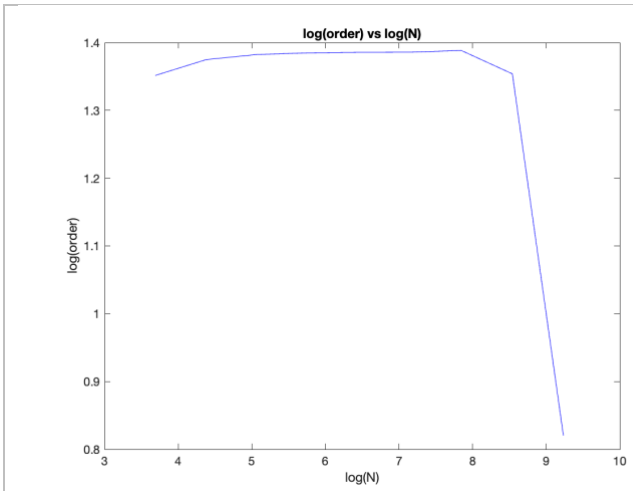
Q1 (b) Adams-Bashforth

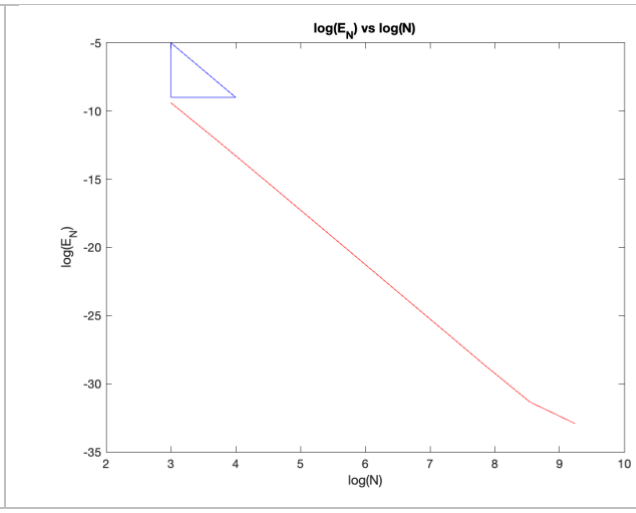
t_i	Approx.	Exact	Error
0	1	1	0
0.100000000000000	1.01481549985822	1.01481549985822	0
0.200000000000000	1.05718100746420	1.05718100746420	0
0.300000000000000	1.12169801826798	1.12169801826798	0
0.400000000000000	1.20081535729184	1.20148601036440	0.000670653072561089
0.500000000000000	1.28891038083867	1.28980527630561	0.000894895466940993
0.600000000000000	1.37994670816272	1.38093121544373	0.000984507281013514
0.700000000000000	1.46960661876357	1.47041518539722	0.000808566633653030
0.800000000000000	1.55438422133613	1.55503142343518	0.000647202099050892
0.900000000000000	1.63217271240349	1.63261318178287	0.000440469379380914
1	1.70156173265831	1.70187005276128	0.000308320102972326

N	E_N	Order
20	8.44583032855173e-05	0
40	5.80290313267895e-06	3.86339251315832
80	3.74177811623966e-07	3.95497893048698
160	2.36345492066192e-08	3.98475475787926
320	1.48312007119955e-09	3.99419004164448
640	9.28566112889939e-11	3.99748695862060
1280	5.81001913246837e-12	3.99838981256019
2560	3.61044527608101e-13	4.00829423372773
5120	2.46469511466785e-14	3.87269567572492
10240	5.10702591327572e-15	2.27085391029309





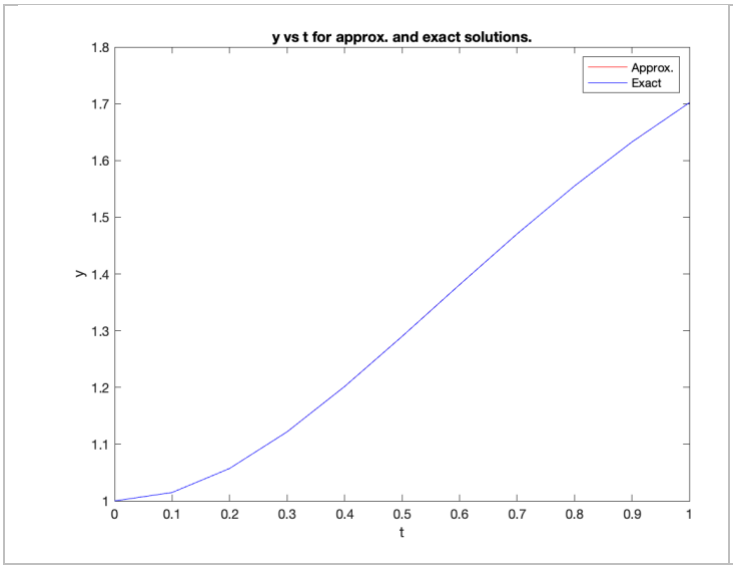

log(order) vs log(N)
log(order)
log(N)
1.4
1.3
1.2
1.1
1
0.9
0.8
3
4
5
6
7
8
9
10

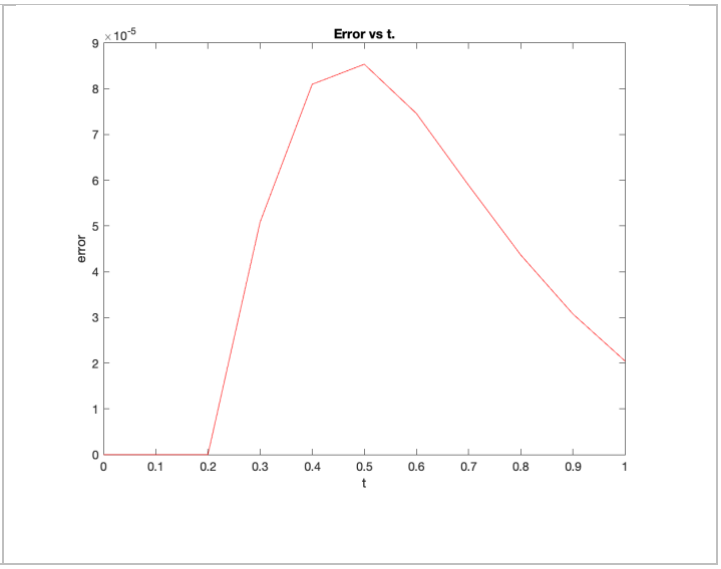

log(E_N) vs log(N)
log(E_N)
log(N)
-5
-10
-15
-20
-25
-30
-35
2
3
4
5
6
7
8
9
10

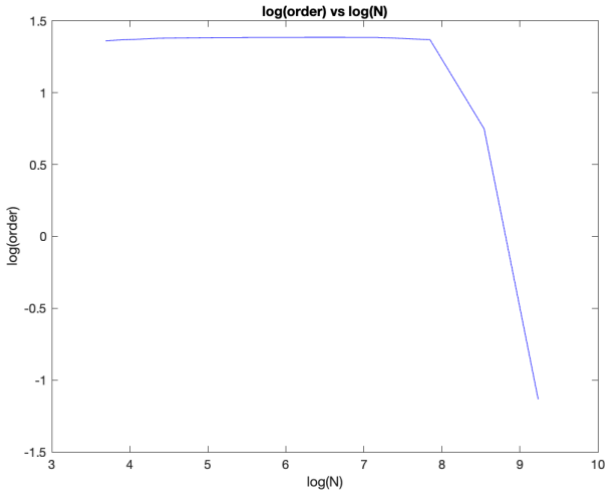
Adams-Moulton

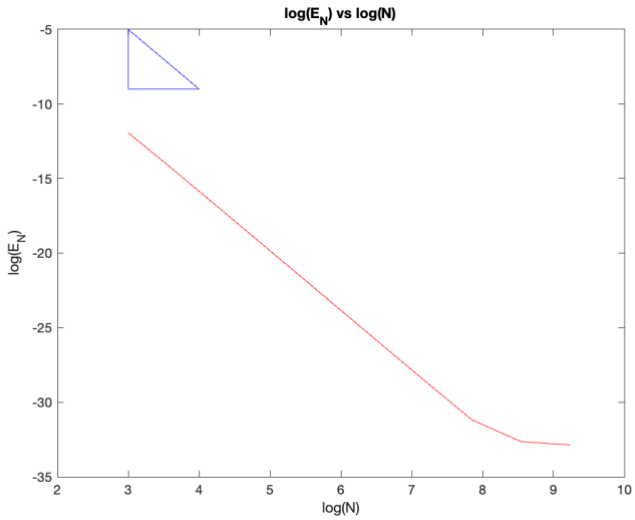
t_i	Approx.	Exact	Error
0	1	1	0
0.100000000000000	1.01481549985822	1.01481549985822	0
0.200000000000000	1.05718100746420	1.05718100746420	0
0.300000000000000	1.12174883921953	1.12169801826798	5.08209515479585e-05
0.400000000000000	1.20156700109546	1.20148601036440	8.09907310579394e-05
0.500000000000000	1.28989064739521	1.28980527630561	8.53710896053794e-05
0.600000000000000	1.38100580739898	1.38093121544373	7.45919552416208e-05
0.700000000000000	1.47047409279739	1.47041518539722	5.89074001691170e-05
0.800000000000000	1.55507509312925	1.55503142343518	4.36696940702142e-05
0.900000000000000	1.63264394511254	1.63261318178287	3.07633296703358e-05
1	1.70189052355621	1.70187005276128	2.04707949300609e-05

N	E_N	Order
20	6.70789613543832e-06	0
40	4.47680100768011e-07	3.90532025302994
80	2.85301005042982e-08	3.97191145806115
160	1.79489112461795e-09	3.99051658906186
320	1.12440945443382e-10	3.99665694031577
640	7.03437308402499e-12	3.99860182573331
1280	4.40536496171262e-13	3.99708840458010
2560	2.88657986402541e-14	3.93182849735842
5120	6.66133814775094e-15	2.11547721741994
10240	5.32907051820075e-15	0.321928094887362

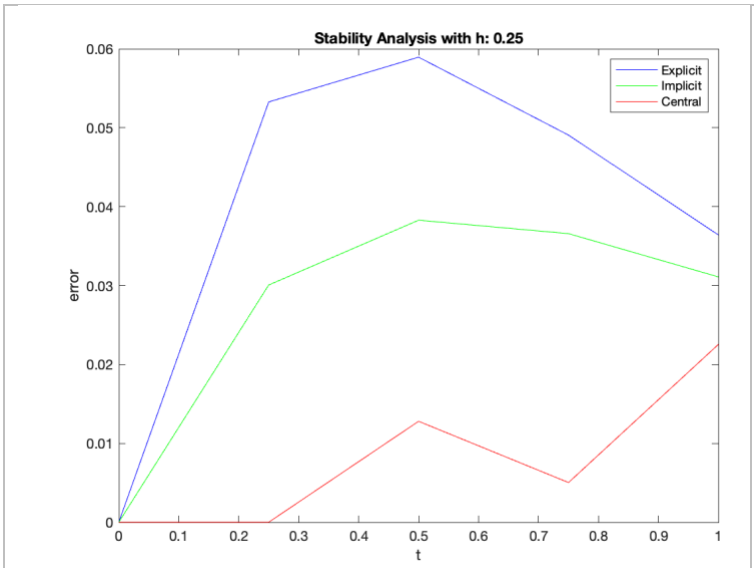


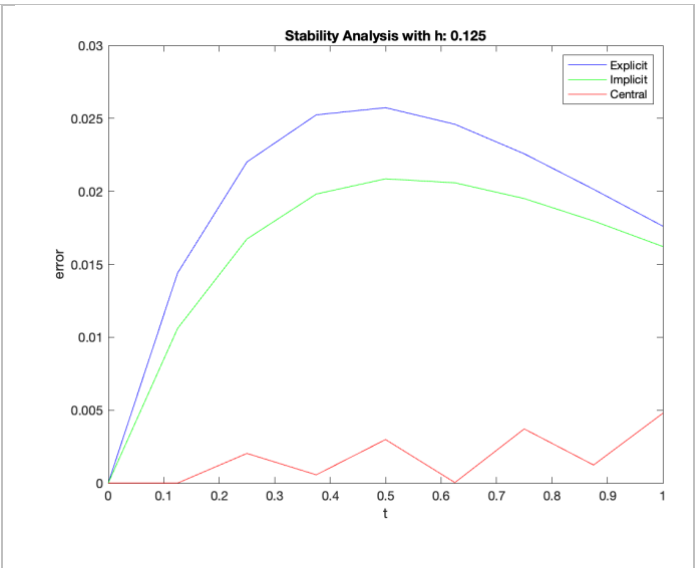


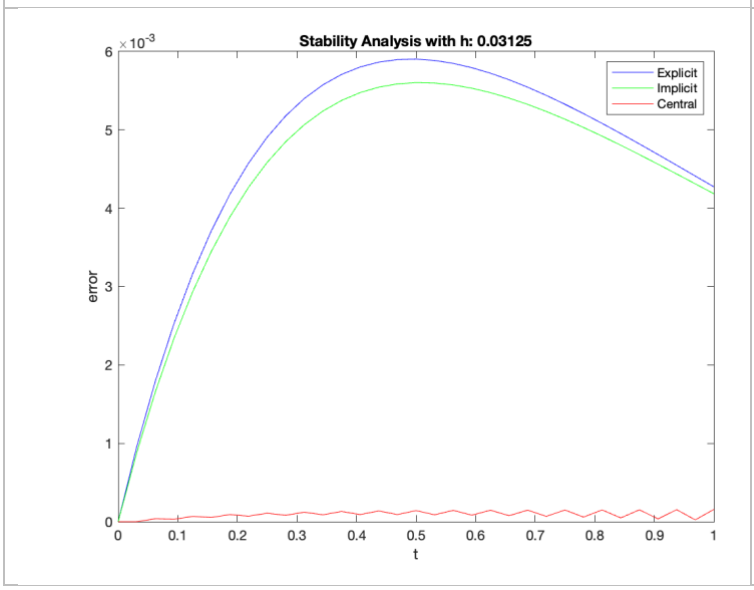

log(order) vs log(N)
log(order)
log(N)
1.5
1
0.5
0
-0.5
-1
-1.5
3
4
5
6
7
8
9
10

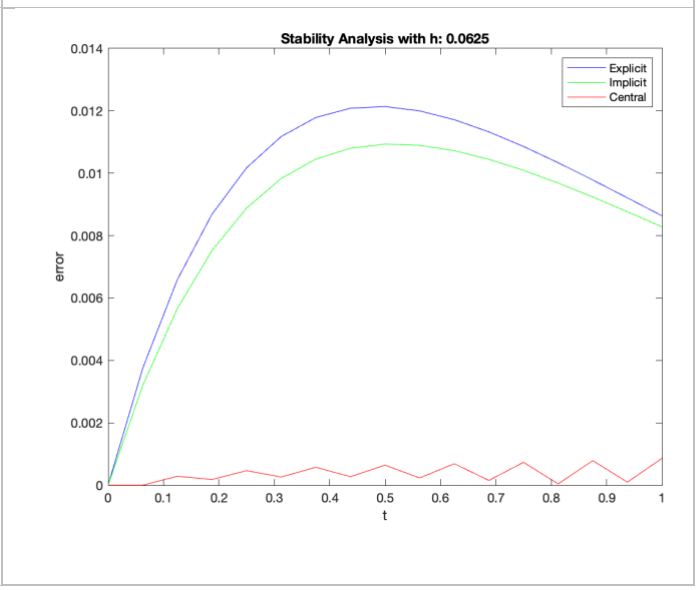

log(E_N) vs log(N)
log(E_N)
log(N)
-5
-10
-15
-20
-25
-30
-35
2
3
4
5
6
7
8
9
10

Q2 Stability analysis of Euler explicit and implicit and central difference.





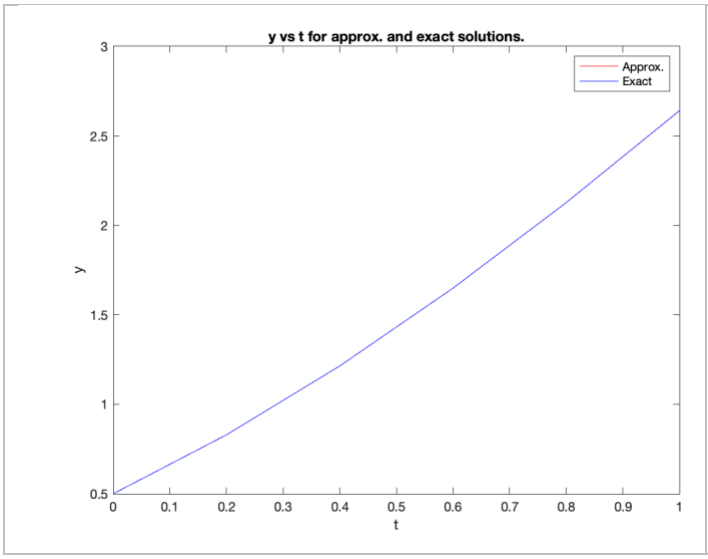


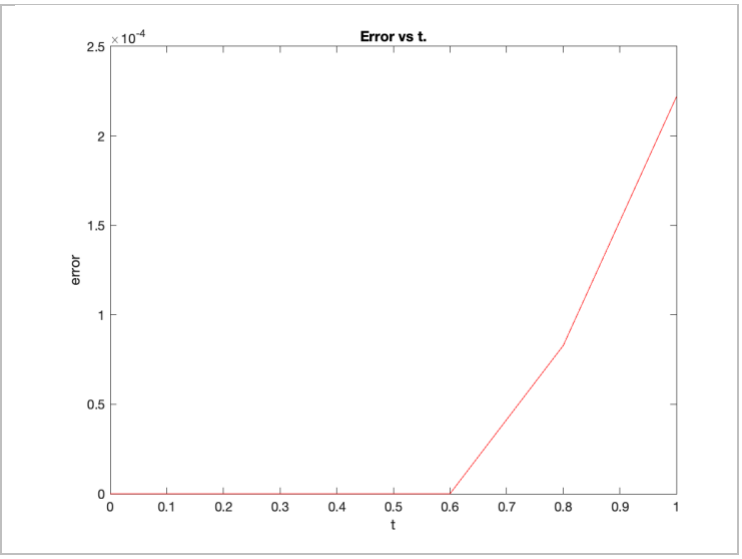


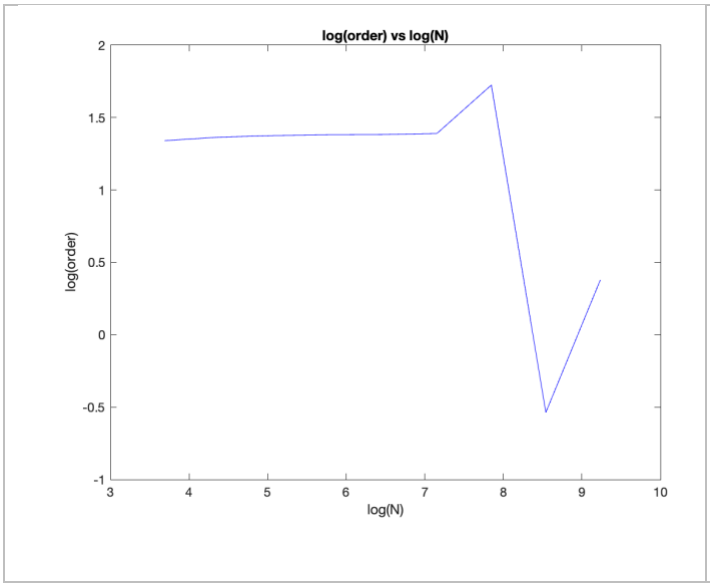
Q3 Adams-Bashforth 4-step

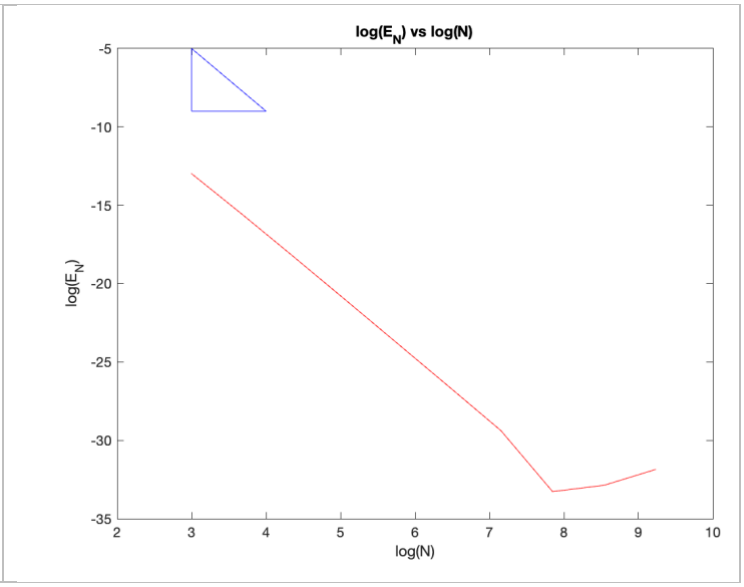
t_i	Approx.	Exact	Error
0	0.500000000000000	0.500000000000000	0
0.200000000000000	0.829298620919915	0.829298620919915	0
0.400000000000000	1.21408765117936	1.21408765117936	0
0.600000000000000	1.64894059980475	1.64894059980475	0
0.800000000000000	2.12731235433571	2.12722953575377	8.28185819408134e-05
1	2.64108101771355	2.64085908577048	0.000221931943072740

N	E_N	Order
20	2.32898847052354e-06	0
40	1.64680480363444e-07	3.82196203046810
80	1.09197588749055e-08	3.91465665724243
160	7.02570446264872e-10	3.95815429881037
320	4.45439241048007e-11	3.97934232733596
640	2.80842016309180e-12	3.98739796207735
1280	1.73638881051374e-13	4.01559685505102
2560	3.55271367880050e-15	5.61102479730735
5120	5.32907051820075e-15	-0.584962500721156
10240	1.46549439250521e-14	-1.45943161863730





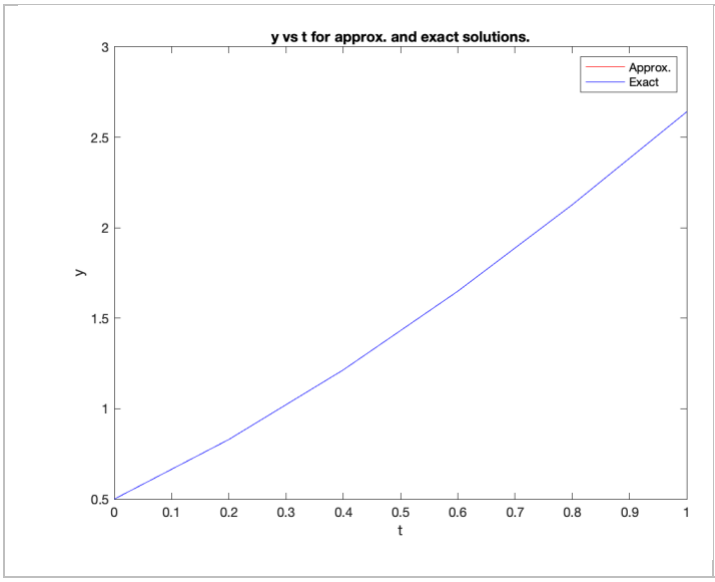

log(order) vs log(N)
log(order)
log(N)
2
1.5
1
0.5
0
-0.5
-1
3
4
5
6
7
8
9
10

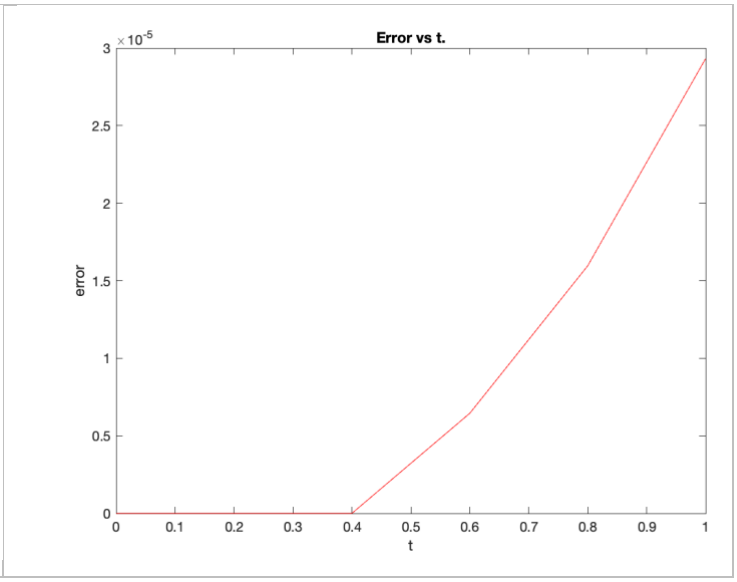

log(E_N) vs log(N)
log(E_N)
log(N)
-5
-10
-15
-20
-25
-30
-35
2
3
4
5
6
7
8
9
10

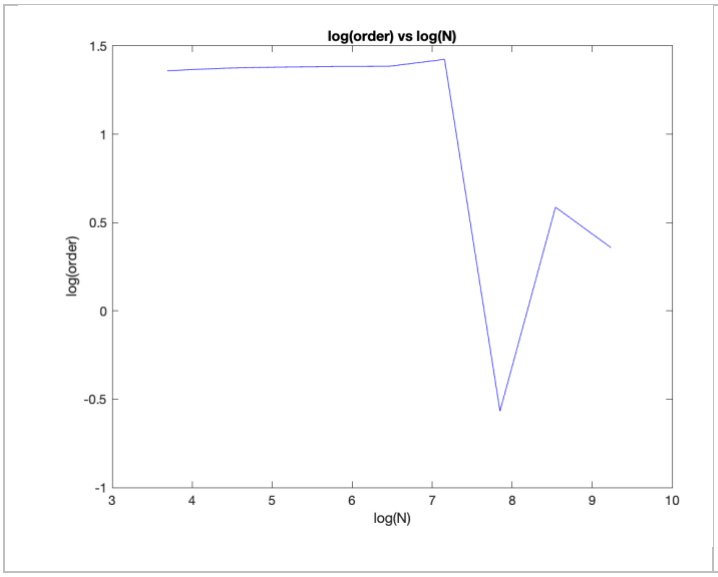
Adams-Moulton 3-step

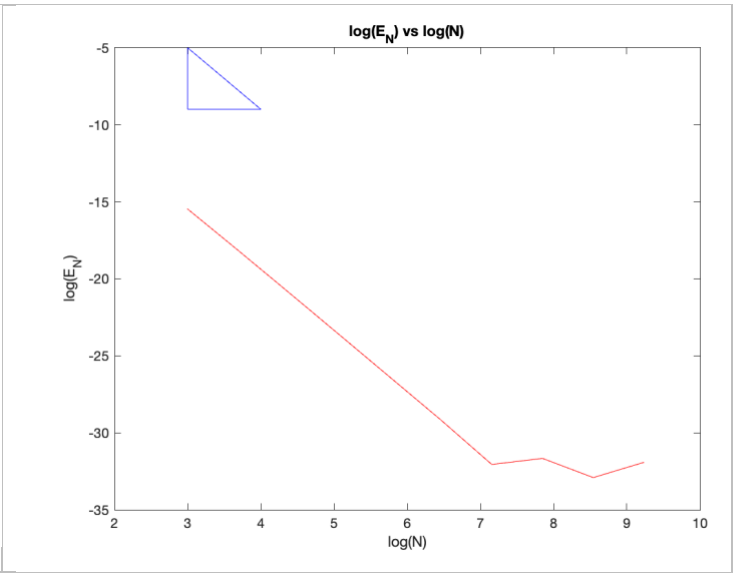
t_i	Approx.	Exact	Error
0	0.500000000000000	0.500000000000000	0
0.200000000000000	0.829298620919915	0.829298620919915	0
0.400000000000000	1.21408765117936	1.21408765117936	0
0.600000000000000	1.64893414783182	1.64894059980475	6.45197292525879e-06
0.800000000000000	2.12721357579861	2.12722953575377	1.59599551525780e-05
1	2.64082976529755	2.64085908577048	2.93204729318042e-05

N	E_N	Order
20	1.93922383484590e-07	0
40	1.30493726935299e-08	3.89342697541497
80	8.45361114443222e-10	3.94826889360693
160	5.37783151344229e-11	3.97447129008443
320	3.39150929562493e-12	3.98702520438340
640	2.13162820728030e-13	3.99189971277269
1280	1.19904086659517e-14	4.15200309344505
2560	1.77635683940025e-14	-0.567040592723894
5120	5.10702591327572e-15	1.79836613883035
10240	1.37667655053519e-14	-1.43063435432986





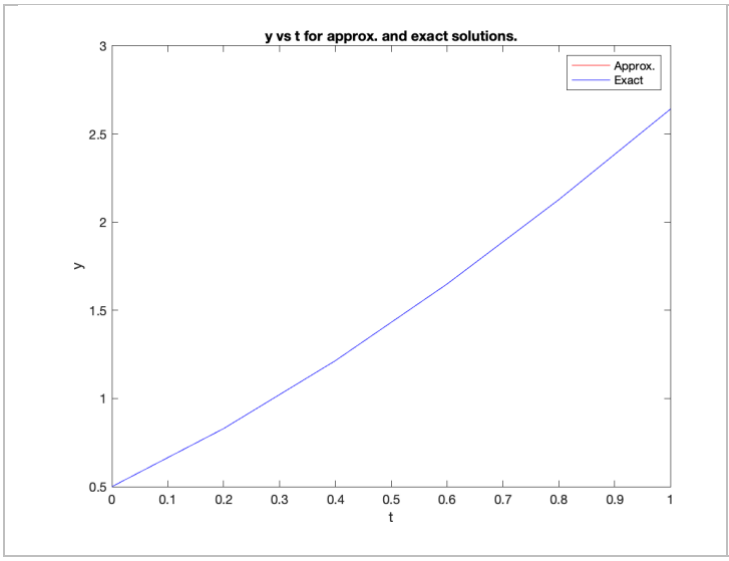

log(order) vs log(N)
log(order)
log(N)
1.5
1
0.5
0
-0.5
-1
3
4
5
6
7
8
9
10

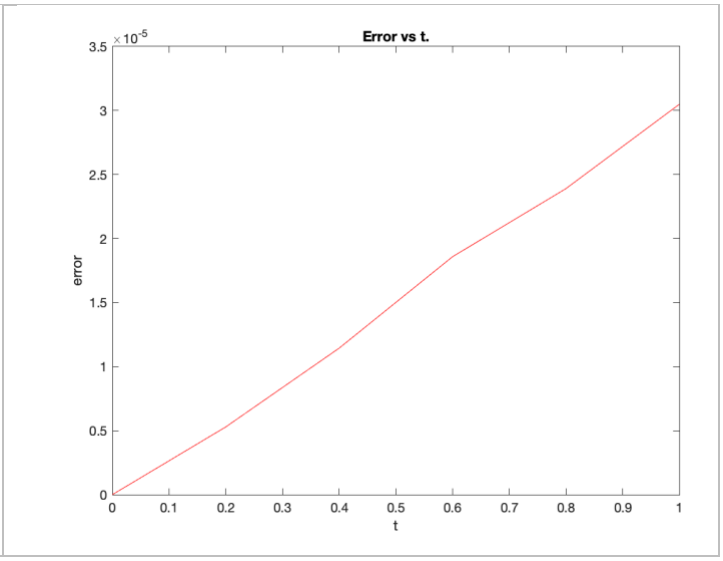

log(E_N) vs log(N)
log(E_N)
log(N)
-5
-10
-15
-20
-25
-30
-35
2
3
4
5
6
7
8
9
10

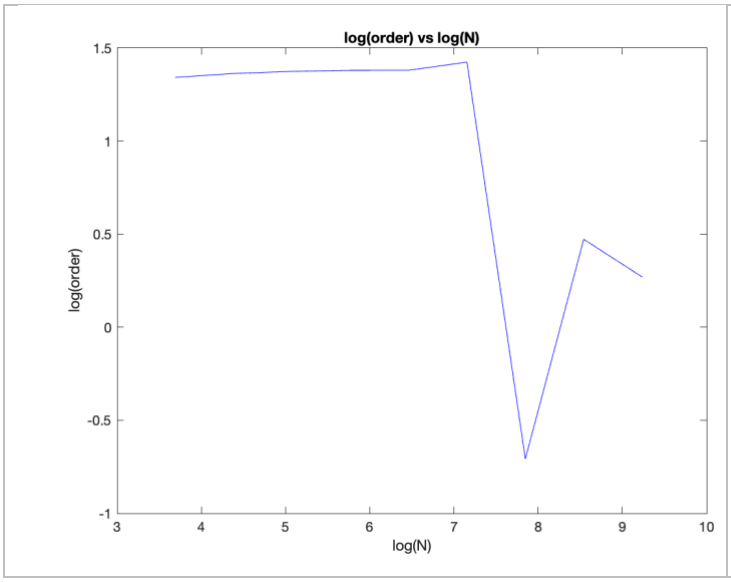
Q4 Predictor Corrector Method on the same problem in Q3.

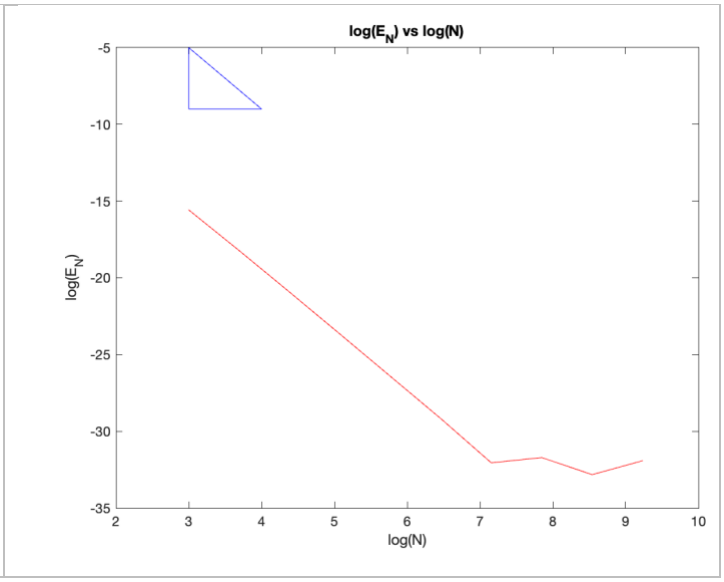
t_i	Approx.	Exact	Error
0	0.500000000000000	0.500000000000000	0
0.200000000000000	0.829293333333333	0.829298620919915	5.28758658158157e-06
0.400000000000000	1.21407621066667	1.21408765117936	1.14405126978578e-05
0.600000000000000	1.64892201704160	1.64894059980475	1.85827631460356e-05
0.800000000000000	2.12720563241878	2.12722953575377	2.39033349882511e-05
1	2.64082859596964	2.64085908577048	3.04898008423038e-05

N	E_N	Order
20	1.74851376932850e-07	0
40	1.23127610329732e-08	3.82790294169786
80	8.20004064649993e-10	3.90837943909467
160	5.29460919551639e-11	3.95303495561044
320	3.36397576461422e-12	3.97628498326222
640	2.13606909937880e-13	3.97713708947763
1280	1.19904086659517e-14	4.15500558160657
2560	1.68753899743024e-14	-0.493040011280117
5120	5.55111512312578e-15	1.60407132366886
10240	1.37667655053519e-14	-1.31034012061215






log(order) vs log(N)
log(order)
log(N)
1.5
1
0.5
0
-0.5
-1
3
4
5
6
7
8
9
10


log(E_N) vs log(N)
log(E_N)
log(N)
-5
-10
-15
-20
-25
-30
-35
2
3
4
5
6
7
8
9
10