

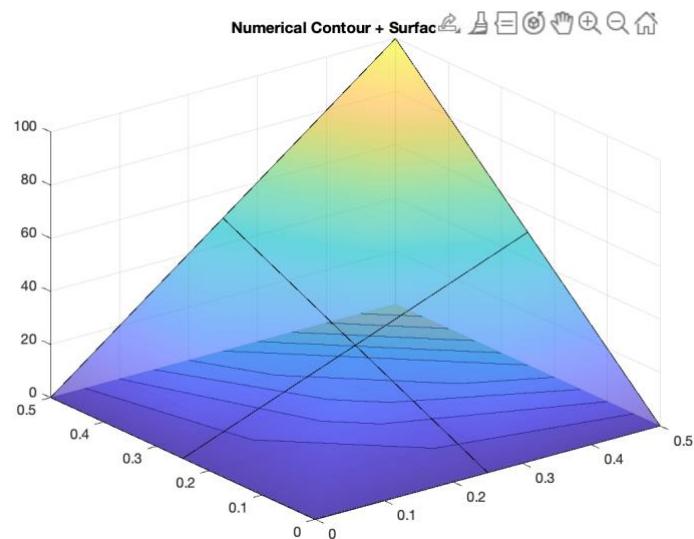
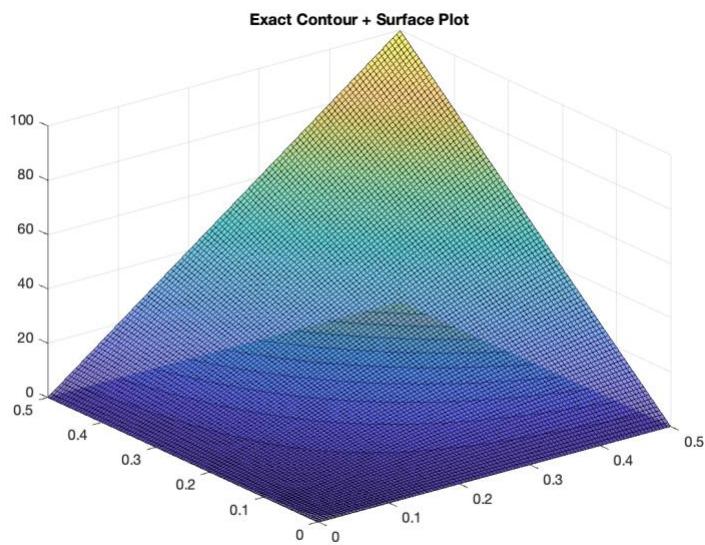
Lab 08

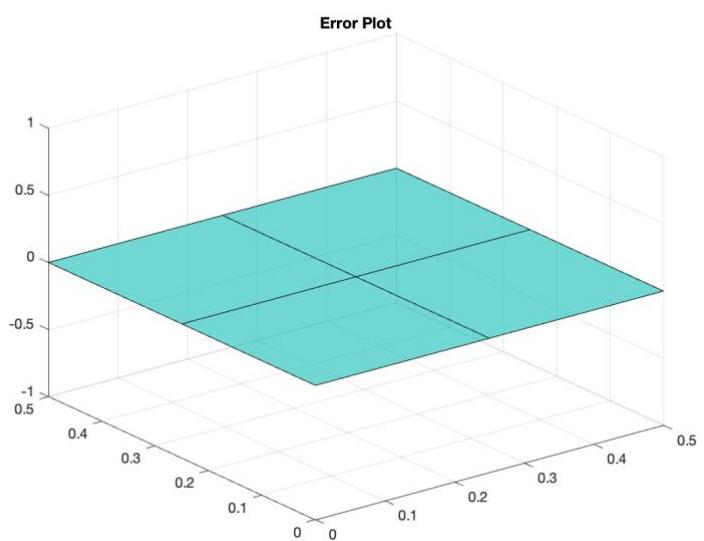
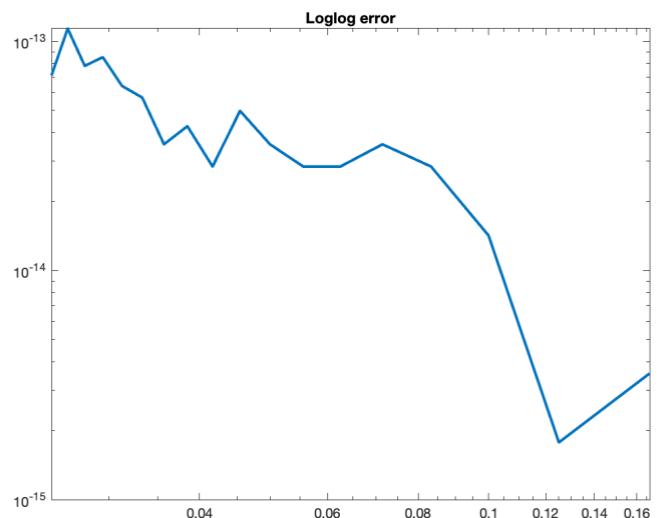
Naveen Kumar A G

210123075

Q1(a) Five Point Stencil:

$$\begin{matrix} 0 & 50 & 100 \\ 0 & 25 & 50 \\ 0 & 0 & 0 \end{matrix}$$

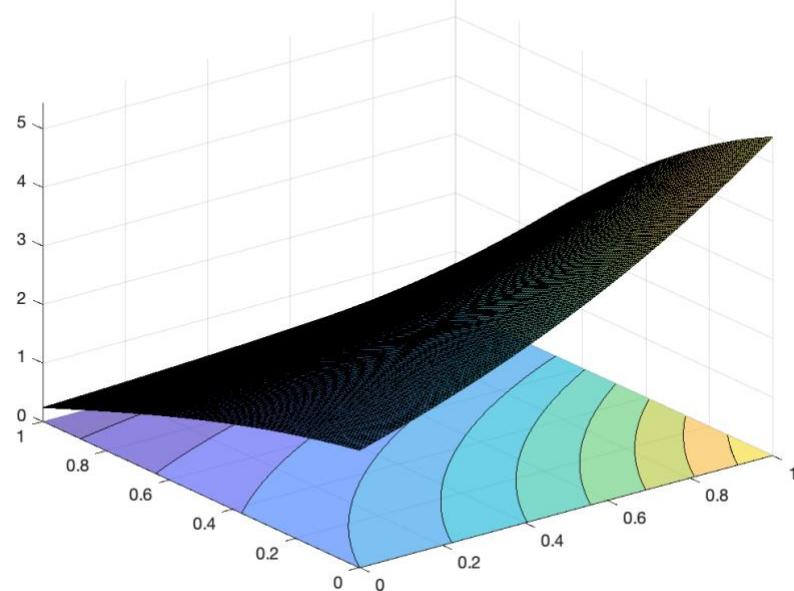




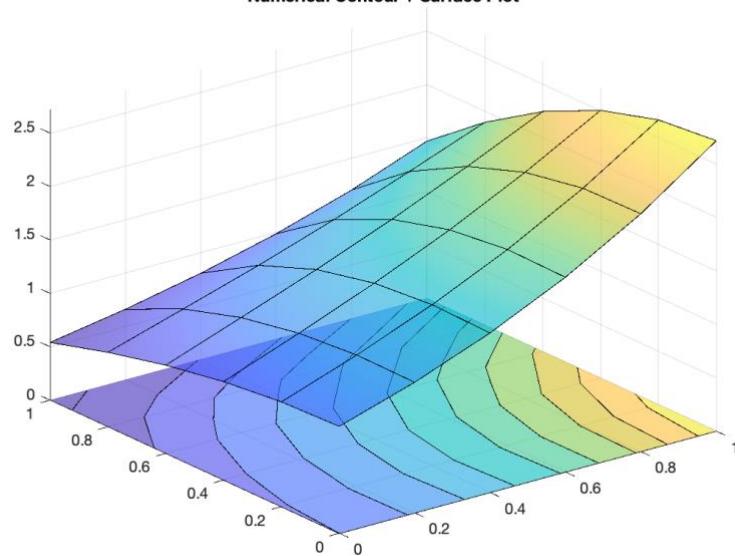
Q1(b) Five Point Stencil:

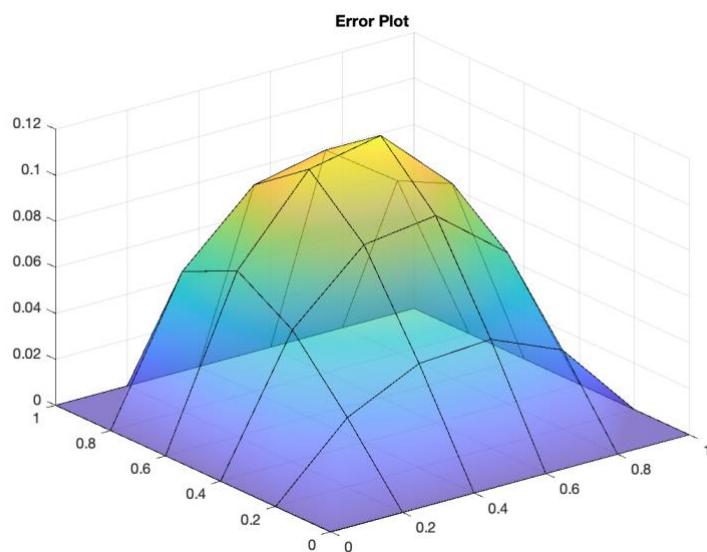
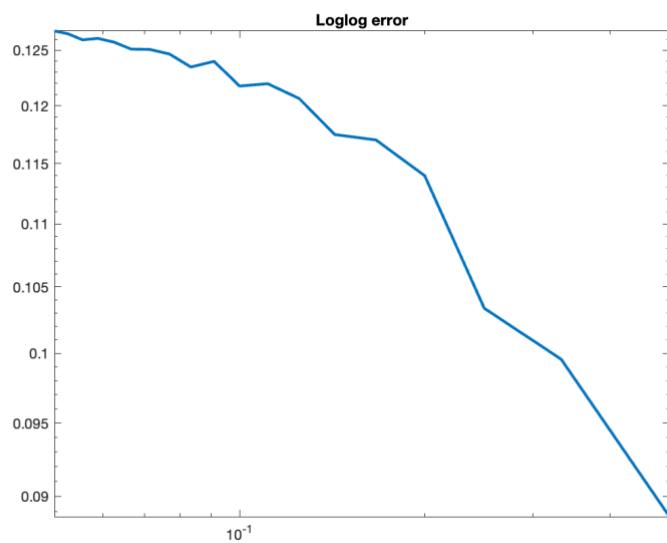
0.5403	0.6599	0.8060	0.9845	1.2025	1.4687
0.6967	0.9117	1.1292	1.3661	1.6254	1.8938
0.8253	1.0802	1.3390	1.6178	1.9214	2.2435
0.9211	1.1823	1.4600	1.7684	2.1155	2.5037
0.9801	1.2273	1.5074	1.8331	2.2155	2.6641
1.0000	1.2214	1.4918	1.8221	2.2255	2.7183

Exact Contour + Surface Plot



Numerical Contour + Surface Plot





Q2(a) Gauss Seidel:

Format: x-axis horizontal increasing from left to right

Format: y-axis vertical increasing from top to bottom

Estimated values:

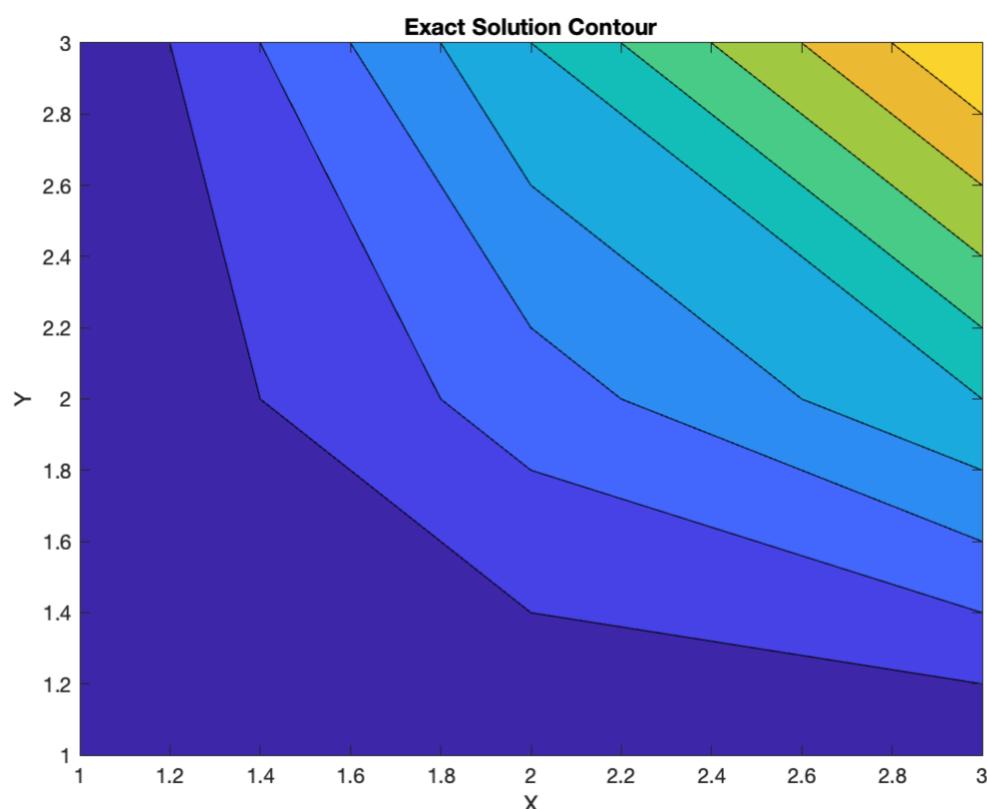
0	0	0
0	25	50
0	50	100

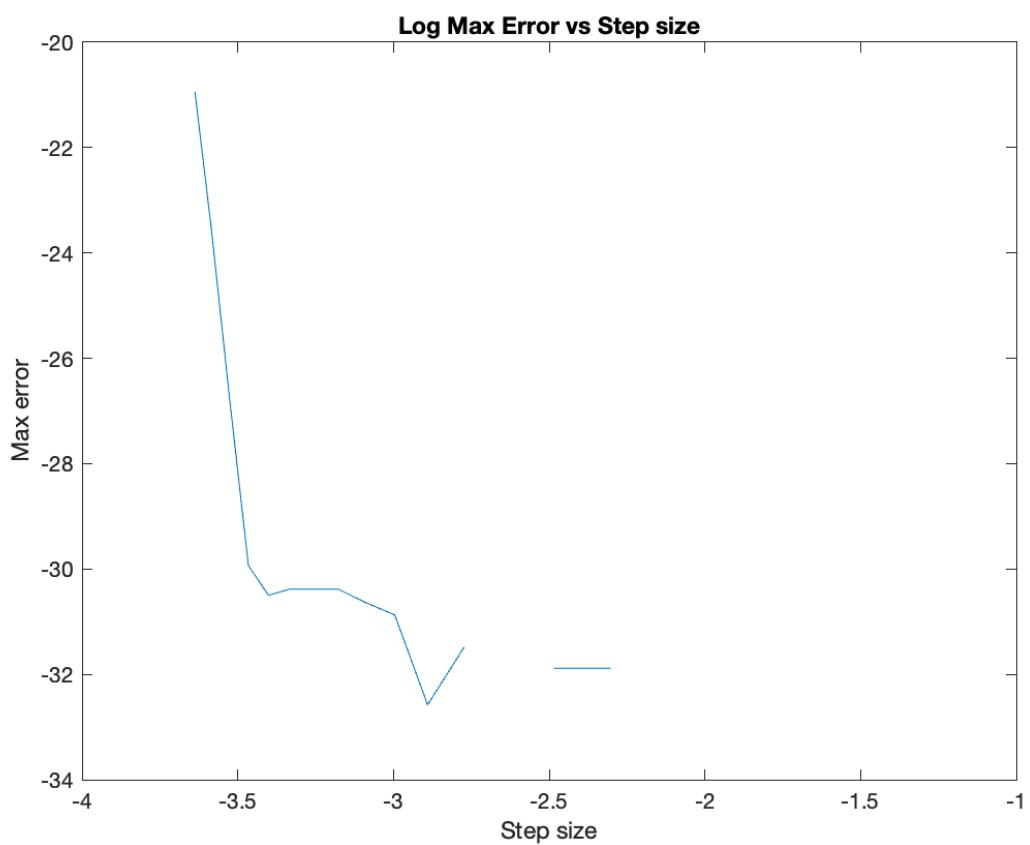
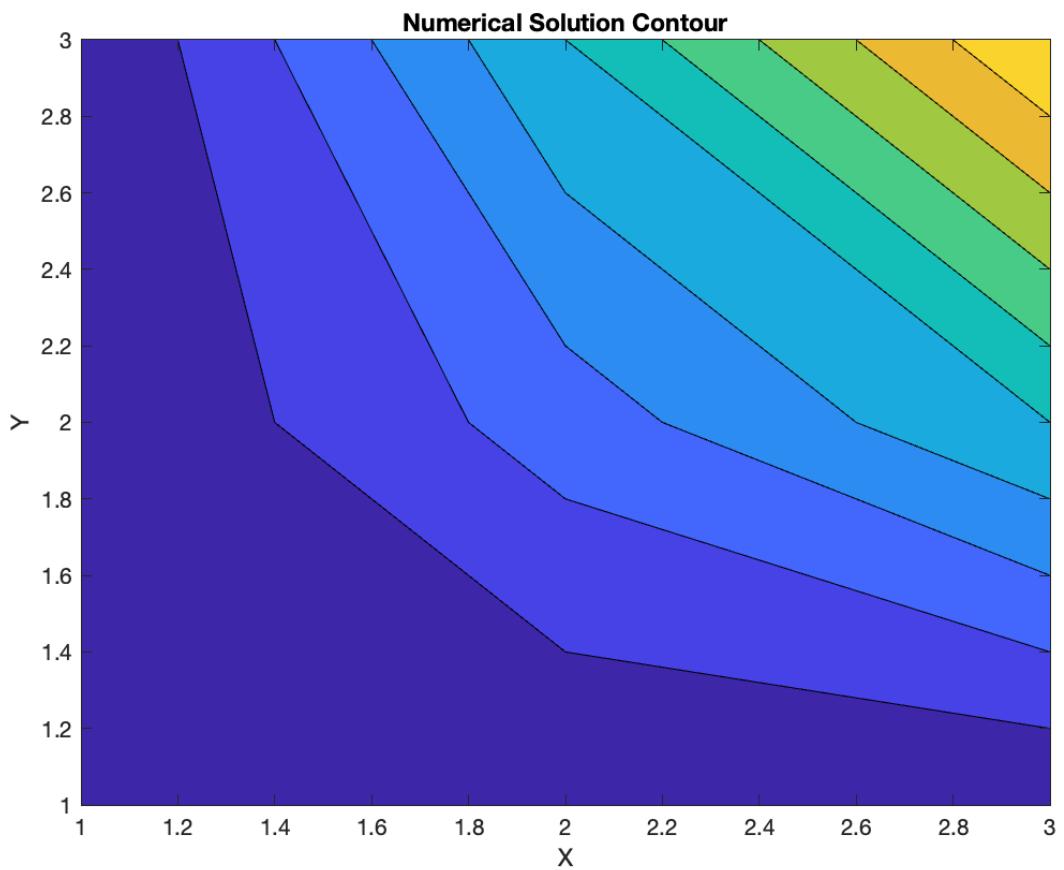
Actual values:

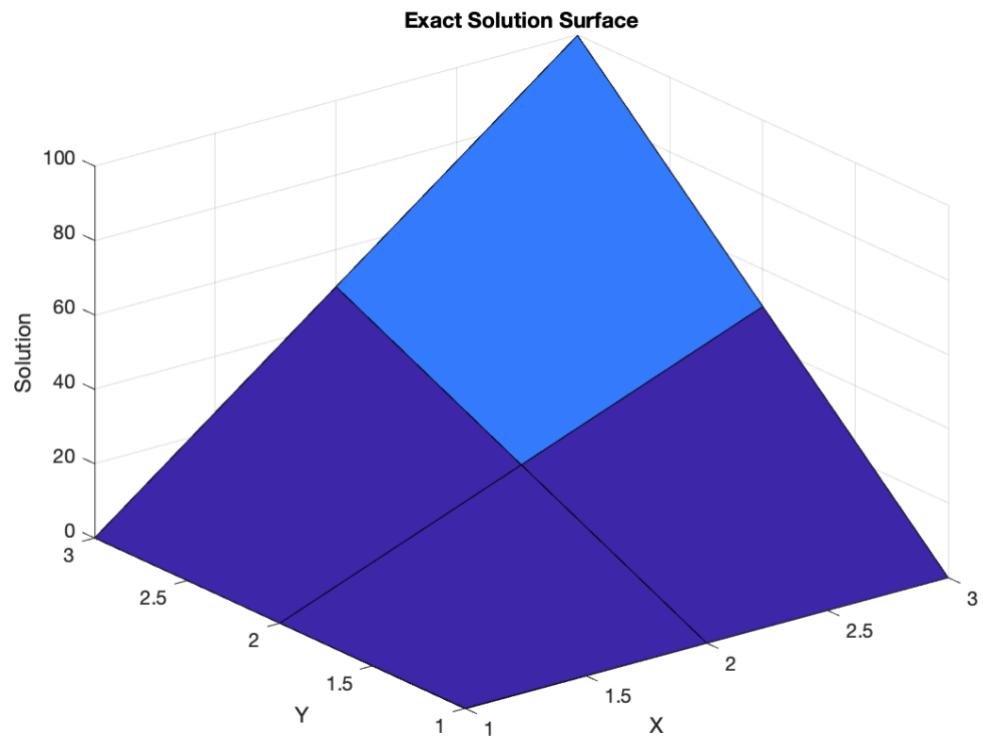
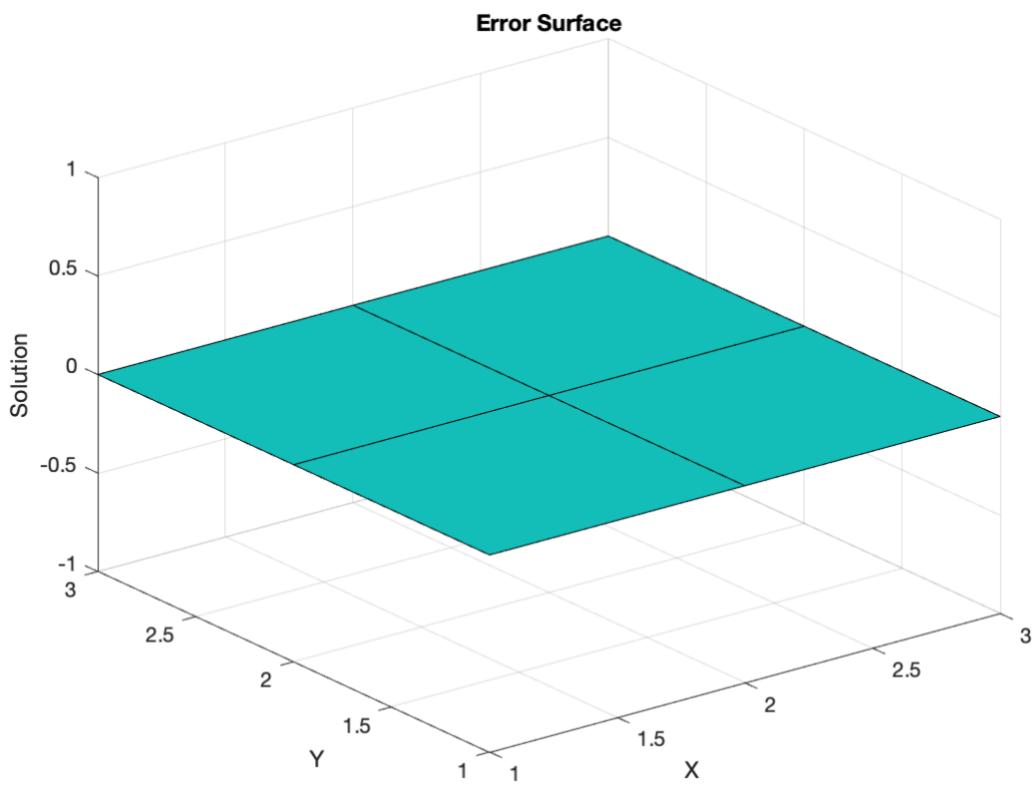
0	0	0
0	25	50
0	50	100

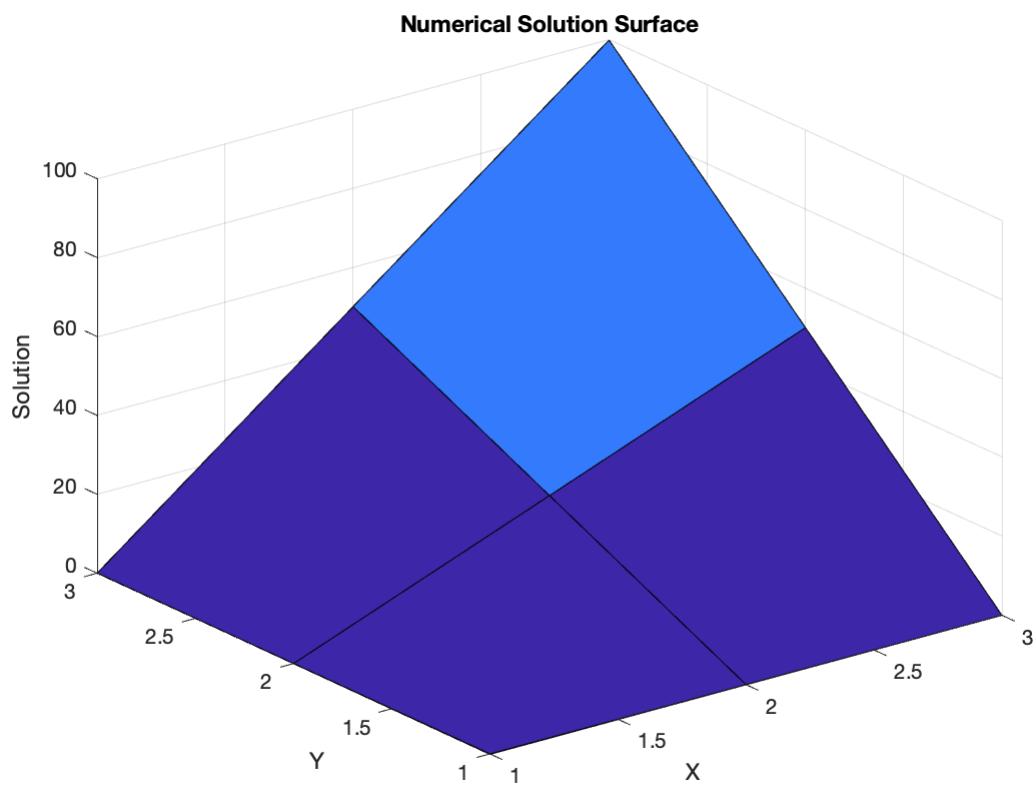
Errors:

0	0	0
0	0	0
0	0	0









Q2(b) Gauss Seidel:

Format: x-axis horizontal increasing from left to right

Format: y-axis vertical increasing from top to bottom

Estimated values:

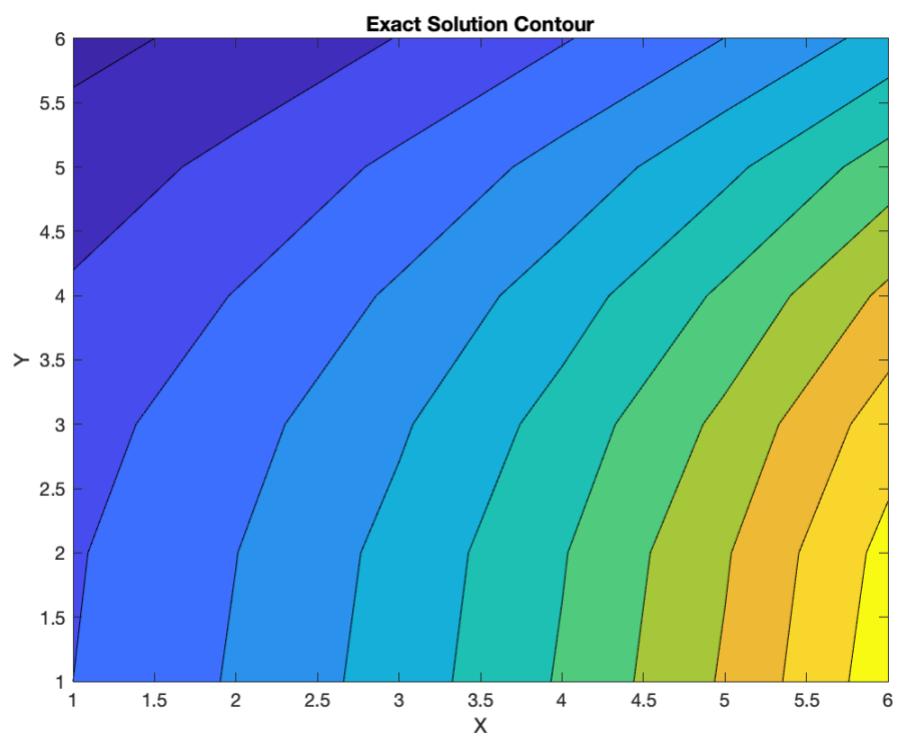
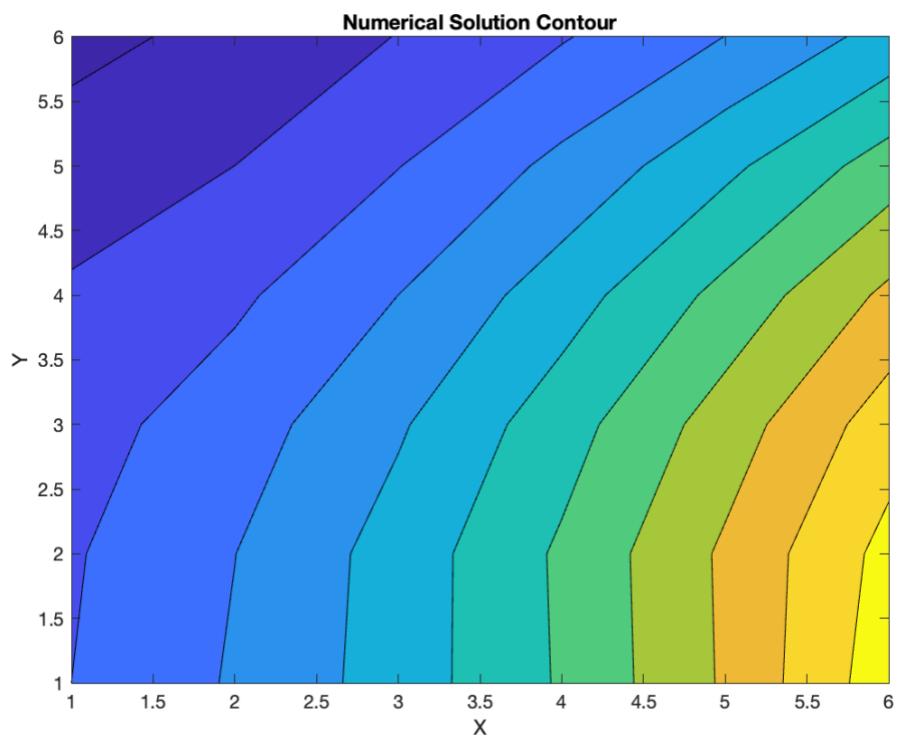
1.0000	1.2214	1.4918	1.8221	2.2255	2.7183
0.9801	1.1978	1.4834	1.8319	2.2333	2.6641
0.9211	1.1059	1.3757	1.7122	2.0965	2.5037
0.8253	0.9643	1.2006	1.5055	1.8593	2.2435
0.6967	0.8005	0.9950	1.2493	1.5514	1.8938
0.5403	0.6599	0.8060	0.9845	1.2025	1.4687

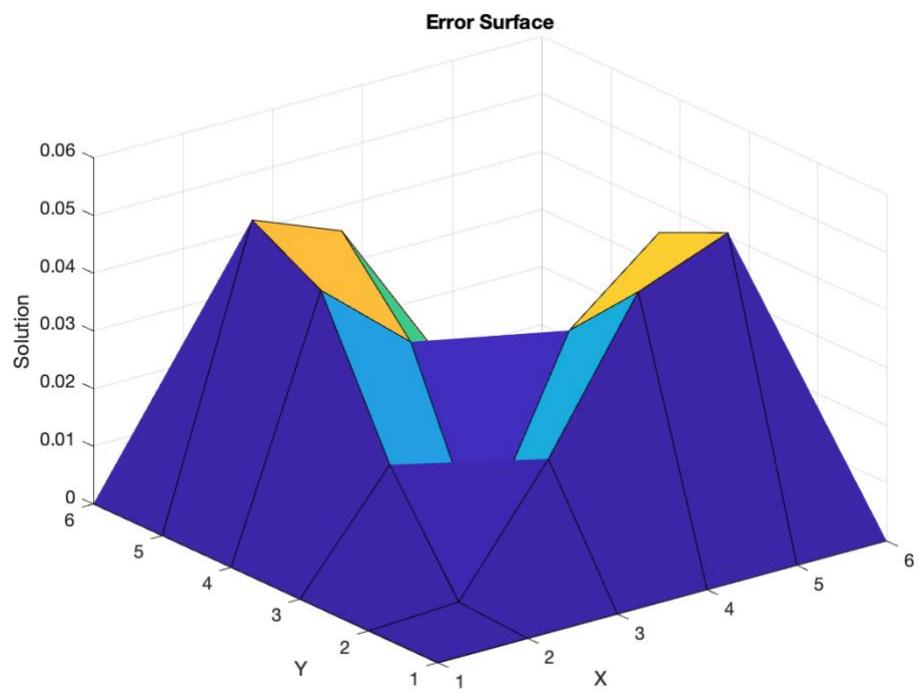
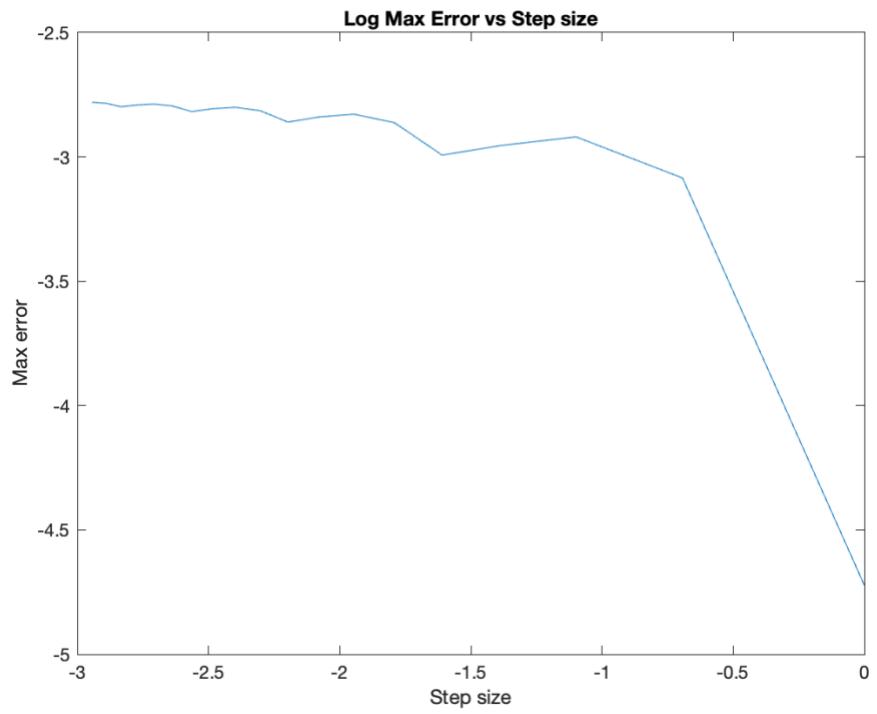
Actual values:

1.0000	1.2214	1.4918	1.8221	2.2255	2.7183
0.9801	1.1971	1.4621	1.7858	2.1812	2.6641
0.9211	1.1250	1.3741	1.6783	2.0499	2.5037
0.8253	1.0081	1.2313	1.5039	1.8368	2.2435
0.6967	0.8510	1.0394	1.2695	1.5505	1.8938
0.5403	0.6599	0.8060	0.9845	1.2025	1.4687

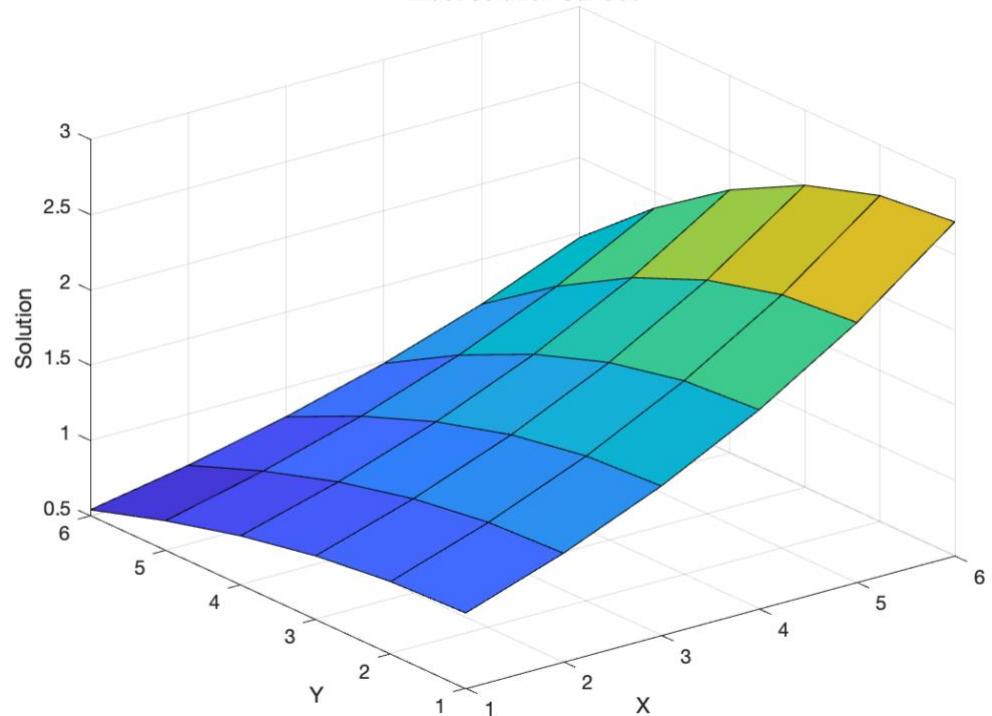
Errors:

0	0	0	0	0	0
0	0.0008	0.0214	0.0461	0.0521	0
0	0.0191	0.0016	0.0339	0.0466	0
0	0.0438	0.0307	0.0016	0.0225	0
0	0.0505	0.0444	0.0202	0.0008	0
0	0	0	0	0	0

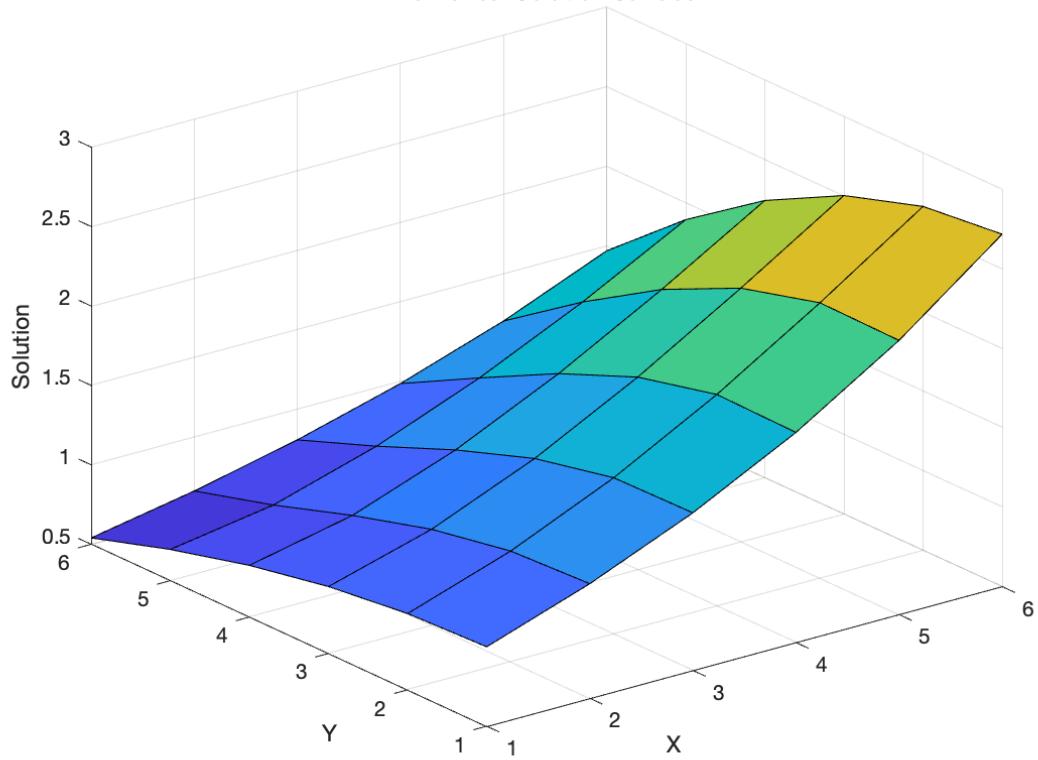




Exact Solution Surface



Numerical Solution Surface



Q3(a) Jacobi Iterative Method:

Format: x-axis horizontal increasing from left to right

Format: y-axis vertical increasing from top to bottom

Estimated values:

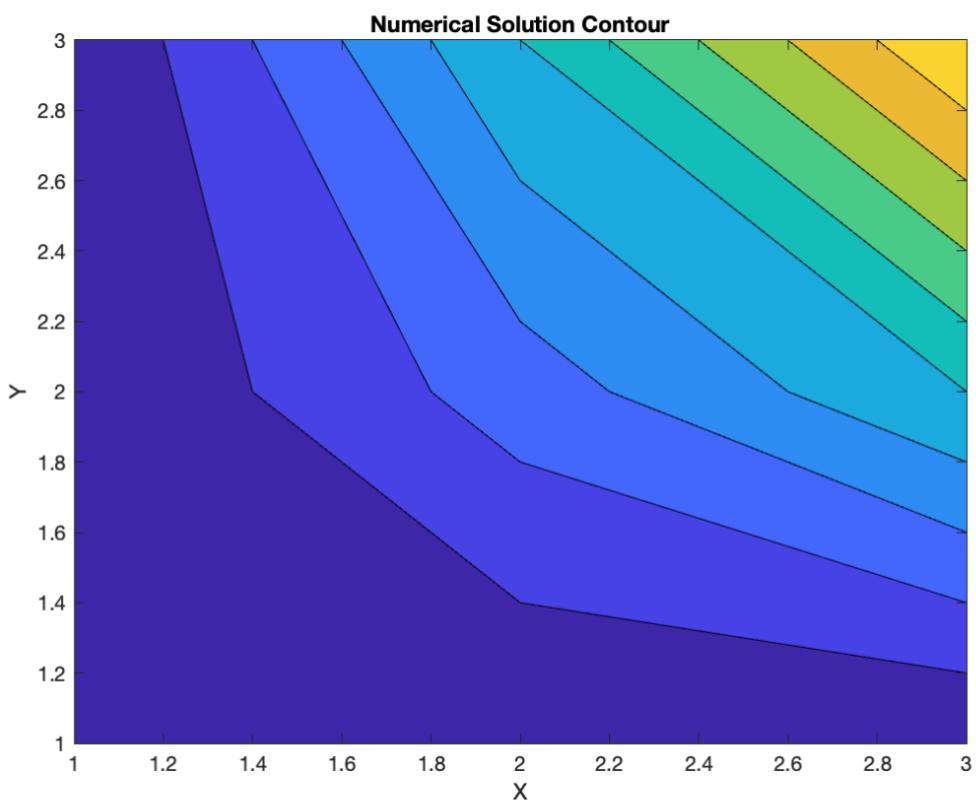
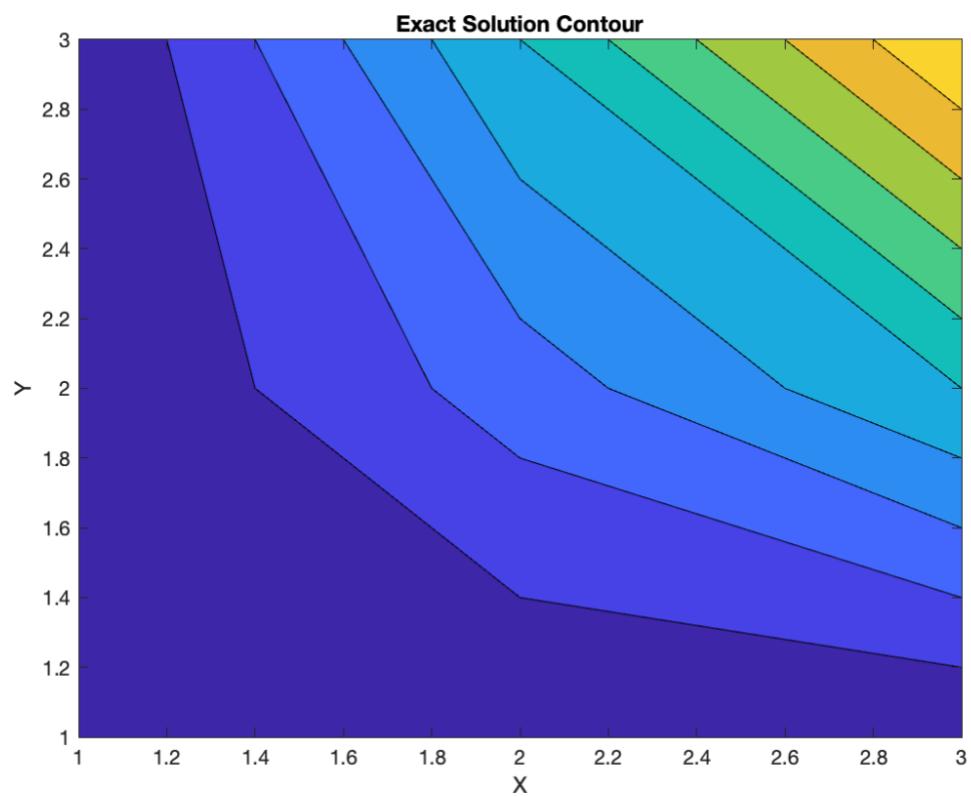
0	0	0
0	25	50
0	50	100

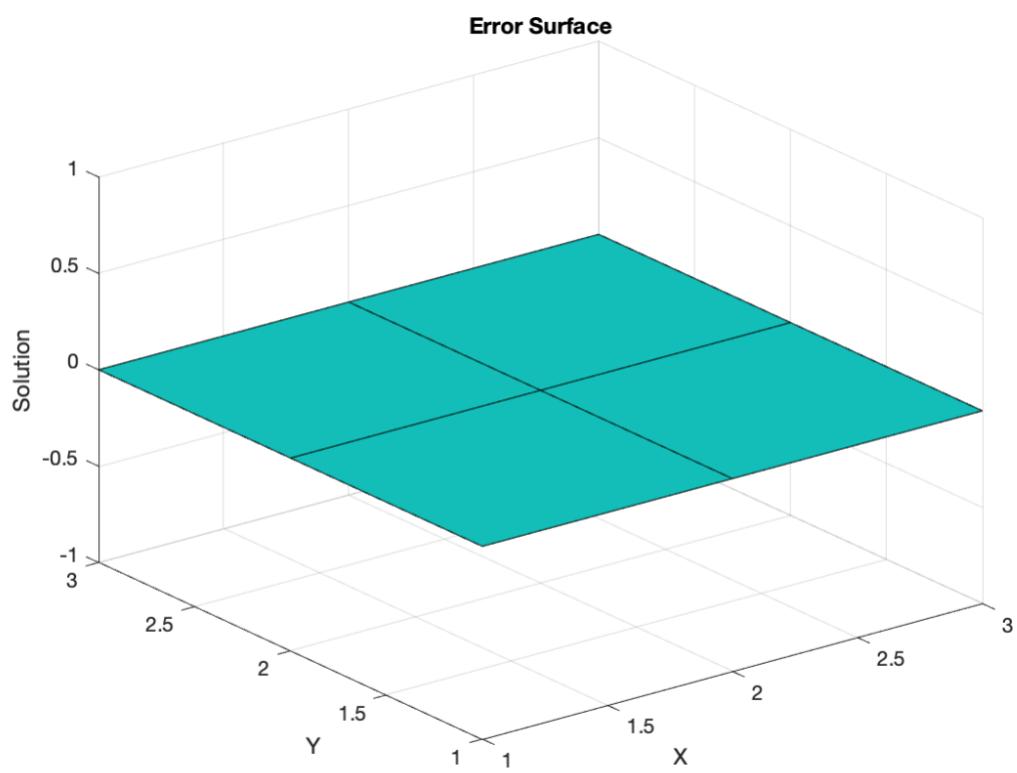
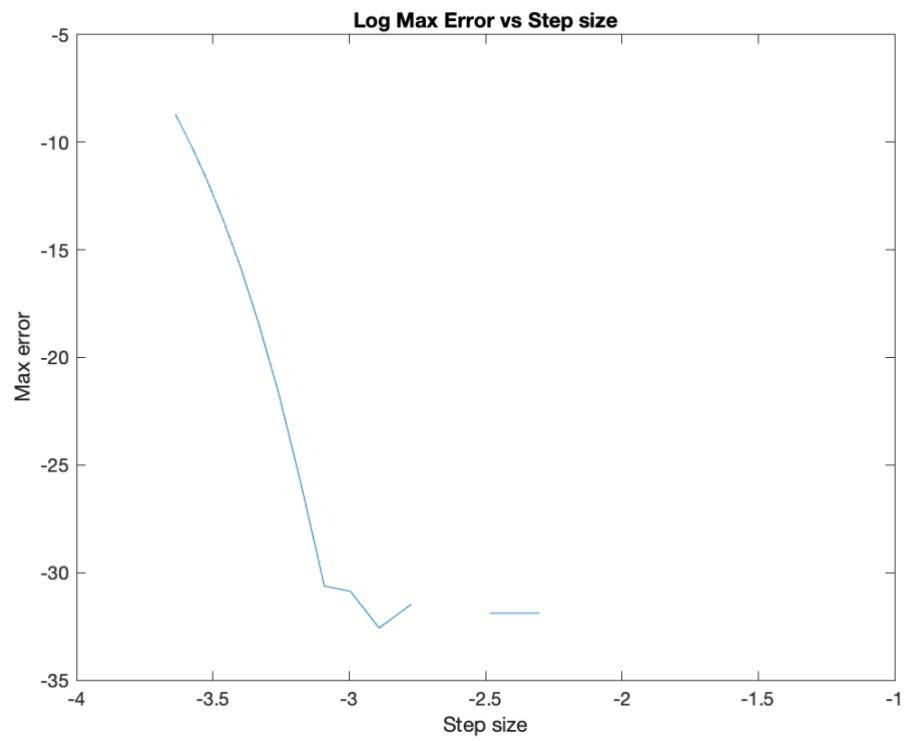
Actual values:

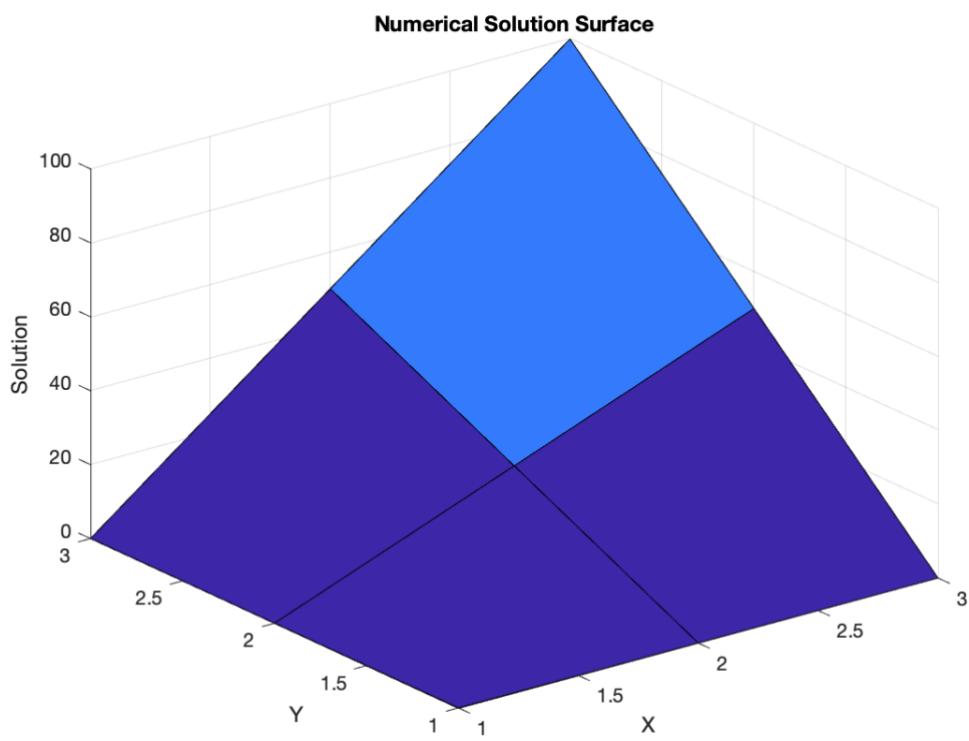
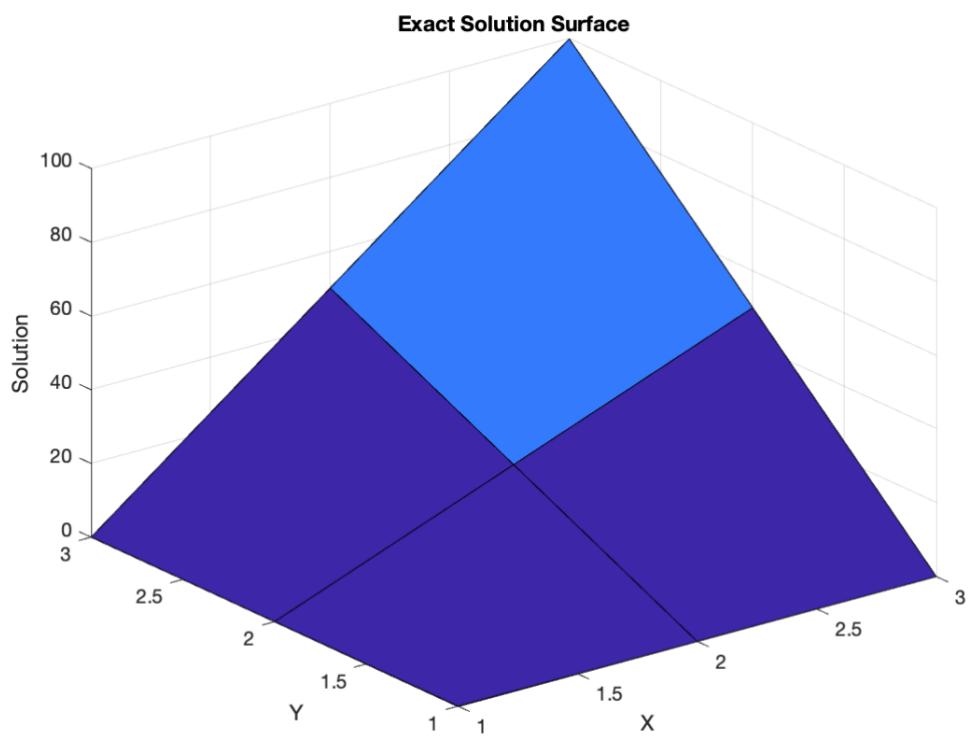
0	0	0
0	25	50
0	50	100

Errors:

0	0	0
0	0	0
0	0	0







Q3(b) Jacobi Iterative Method:

Format: x-axis horizontal increasing from left to right

Format: y-axis vertical increasing from top to bottom

Estimated values:

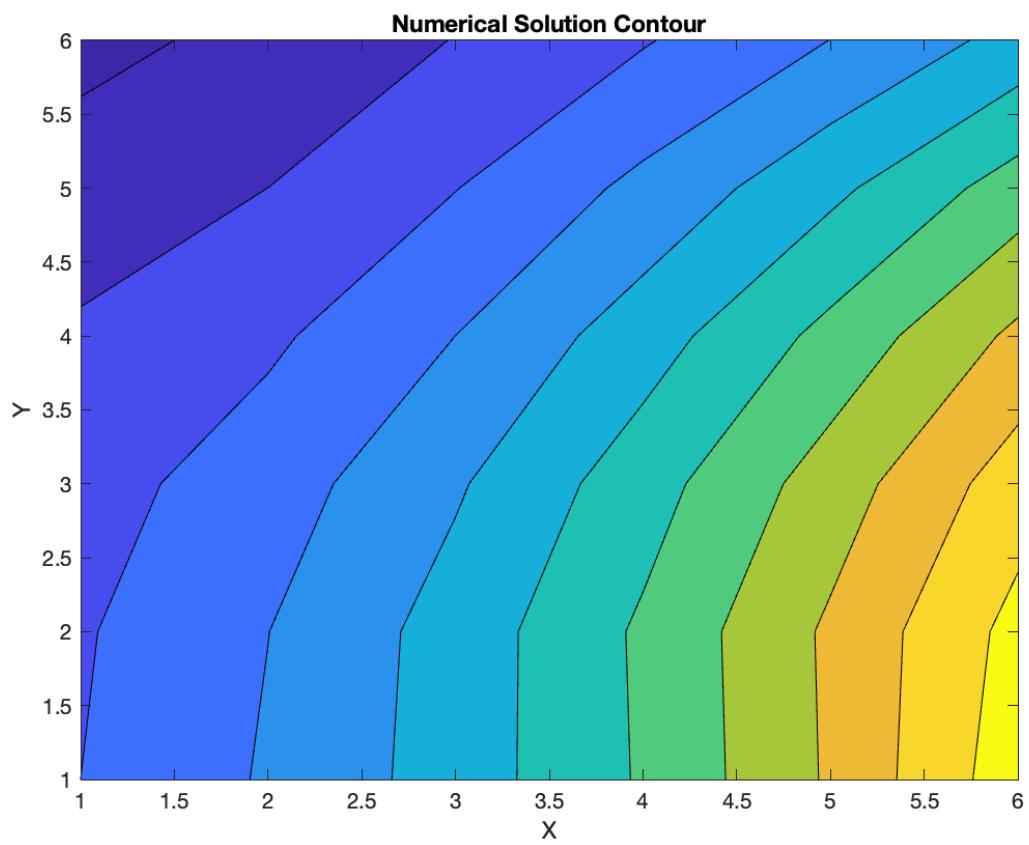
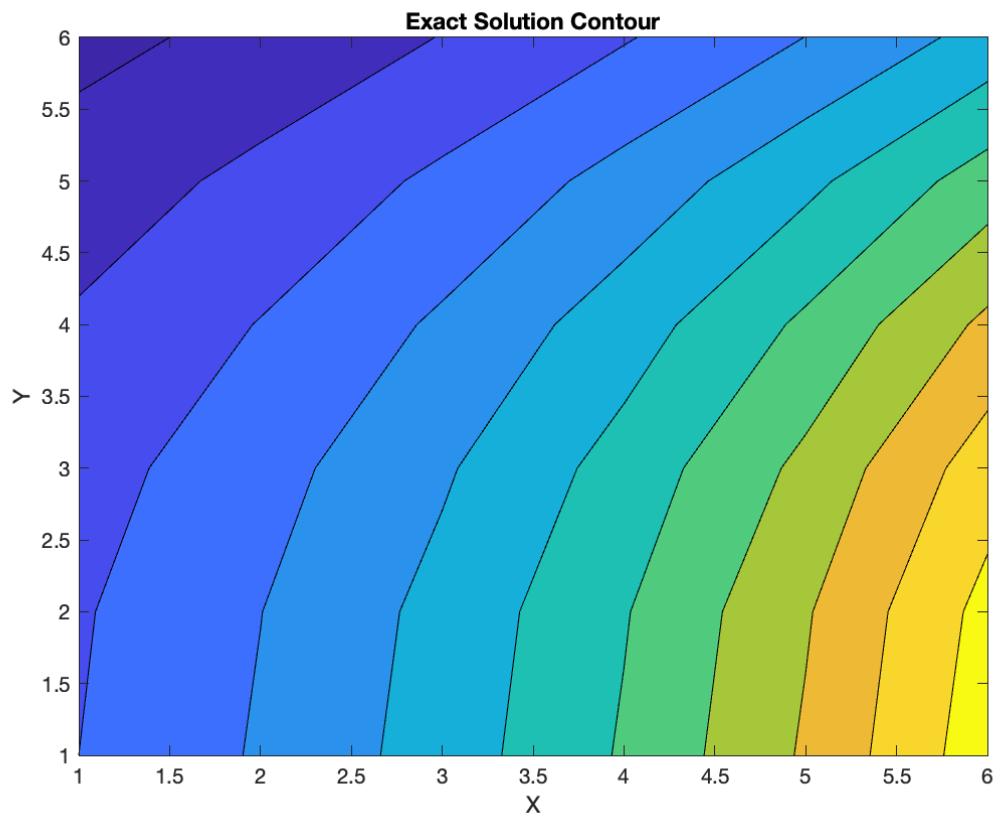
1.0000	1.2214	1.4918	1.8221	2.2255	2.7183
0.9801	1.1978	1.4834	1.8319	2.2333	2.6641
0.9211	1.1059	1.3757	1.7122	2.0965	2.5037
0.8253	0.9643	1.2006	1.5055	1.8593	2.2435
0.6967	0.8005	0.9950	1.2493	1.5514	1.8938
0.5403	0.6599	0.8060	0.9845	1.2025	1.4687

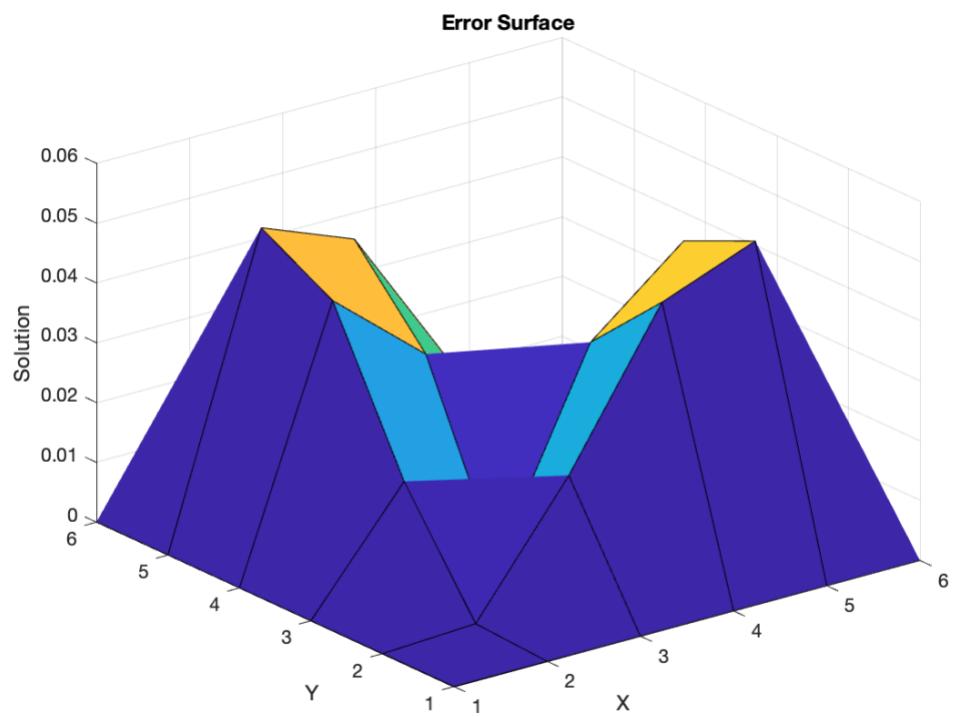
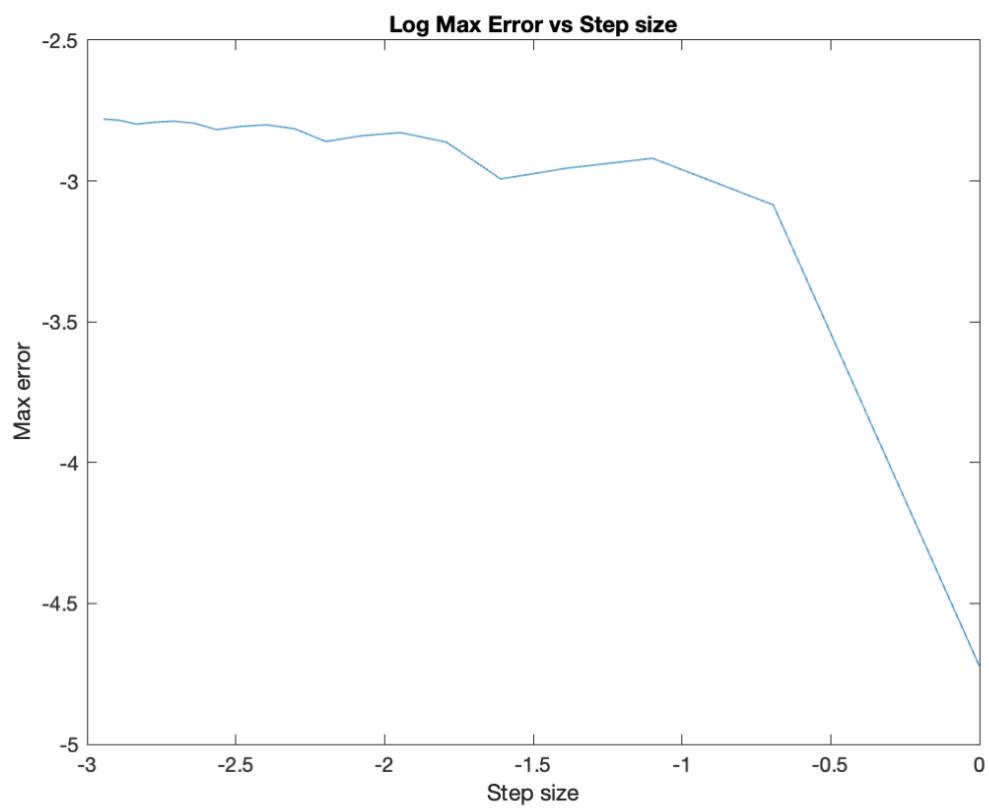
Actual values:

1.0000	1.2214	1.4918	1.8221	2.2255	2.7183
0.9801	1.1971	1.4621	1.7858	2.1812	2.6641
0.9211	1.1250	1.3741	1.6783	2.0499	2.5037
0.8253	1.0081	1.2313	1.5039	1.8368	2.2435
0.6967	0.8510	1.0394	1.2695	1.5505	1.8938
0.5403	0.6599	0.8060	0.9845	1.2025	1.4687

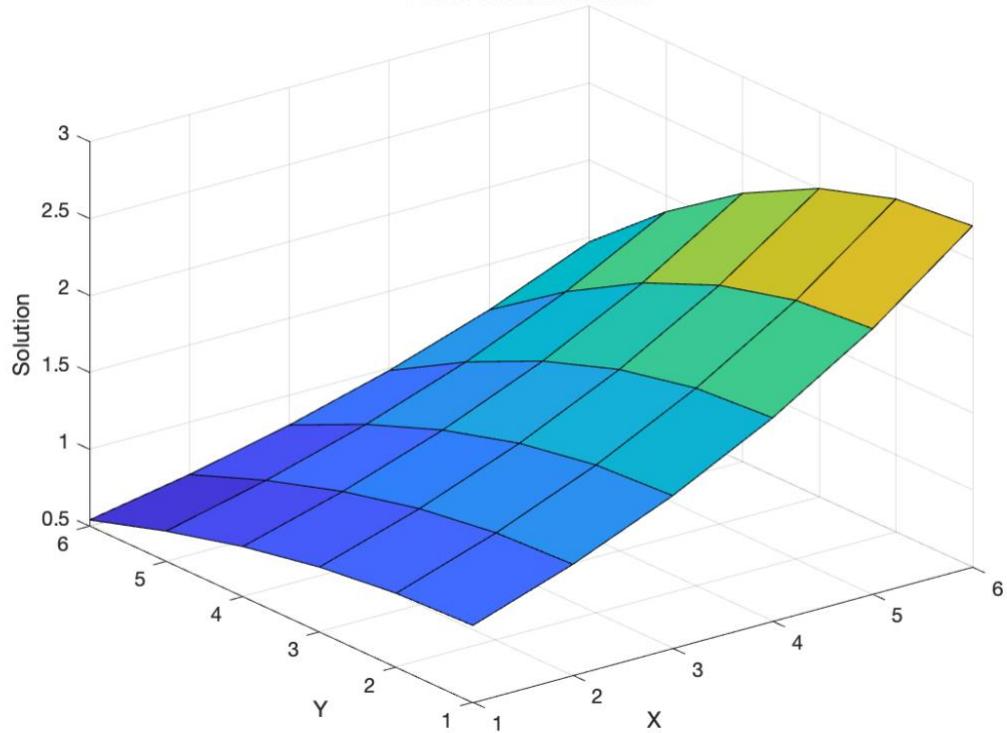
Errors:

0	0	0	0	0	0
0	0.0008	0.0214	0.0461	0.0521	0
0	0.0191	0.0016	0.0339	0.0466	0
0	0.0438	0.0307	0.0016	0.0225	0
0	0.0505	0.0444	0.0202	0.0008	0
0	0	0	0	0	0

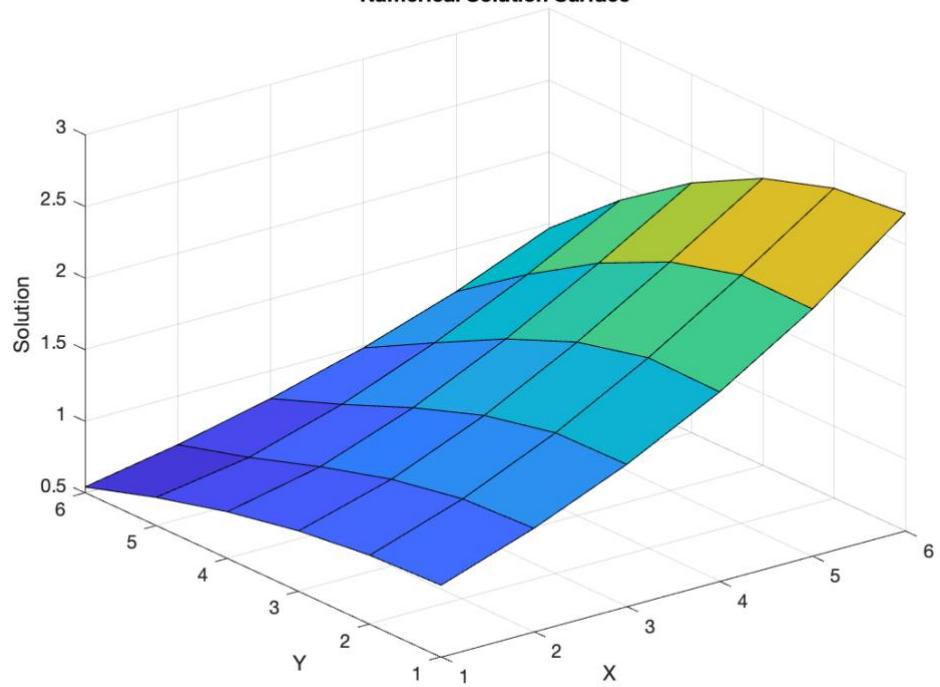




Exact Solution Surface



Numerical Solution Surface



Q4(a) FTCS Method:

Format: x-axis horizontal increasing from left to right

Format: y-axis vertical time increasing from top to bottom

Estimated values:

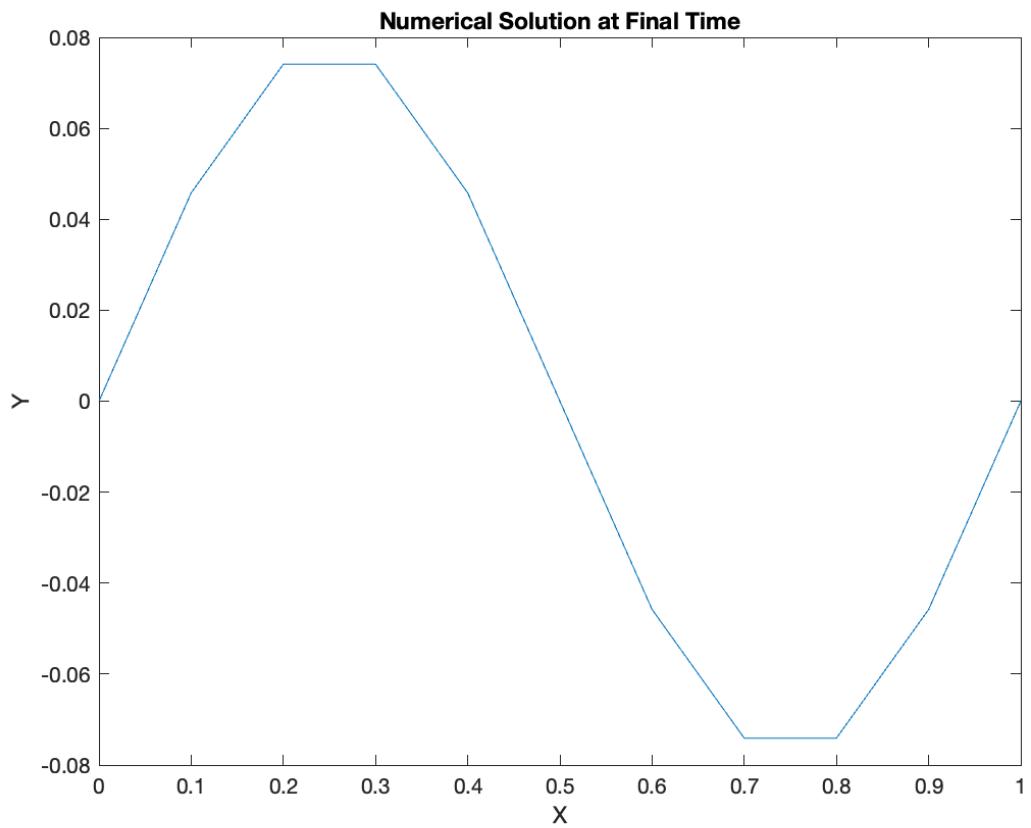
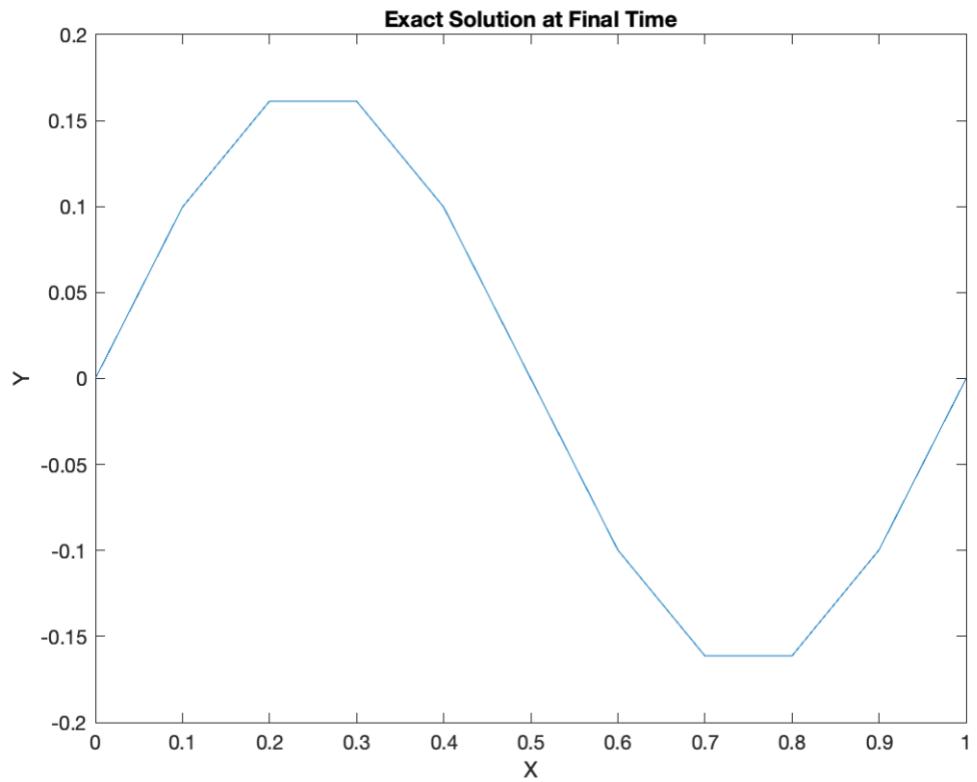
0	1.1756	1.9021	1.9021	1.1756	0.0000	-1.1756	-1.9021	-1.9021	-1.1756	-0.0000
0	0.6143	0.9939	0.9939	0.6143	0.0000	-0.6143	-0.9939	-0.9939	-0.6143	0
0	0.3210	0.5194	0.5194	0.3210	-0.0000	-0.3210	-0.5194	-0.5194	-0.3210	0
0	0.1677	0.2714	0.2714	0.1677	0.0000	-0.1677	-0.2714	-0.2714	-0.1677	0
0	0.0876	0.1418	0.1418	0.0876	-0.0000	-0.0876	-0.1418	-0.1418	-0.0876	0
0	0.0458	0.0741	0.0741	0.0458	0.0000	-0.0458	-0.0741	-0.0741	-0.0458	0

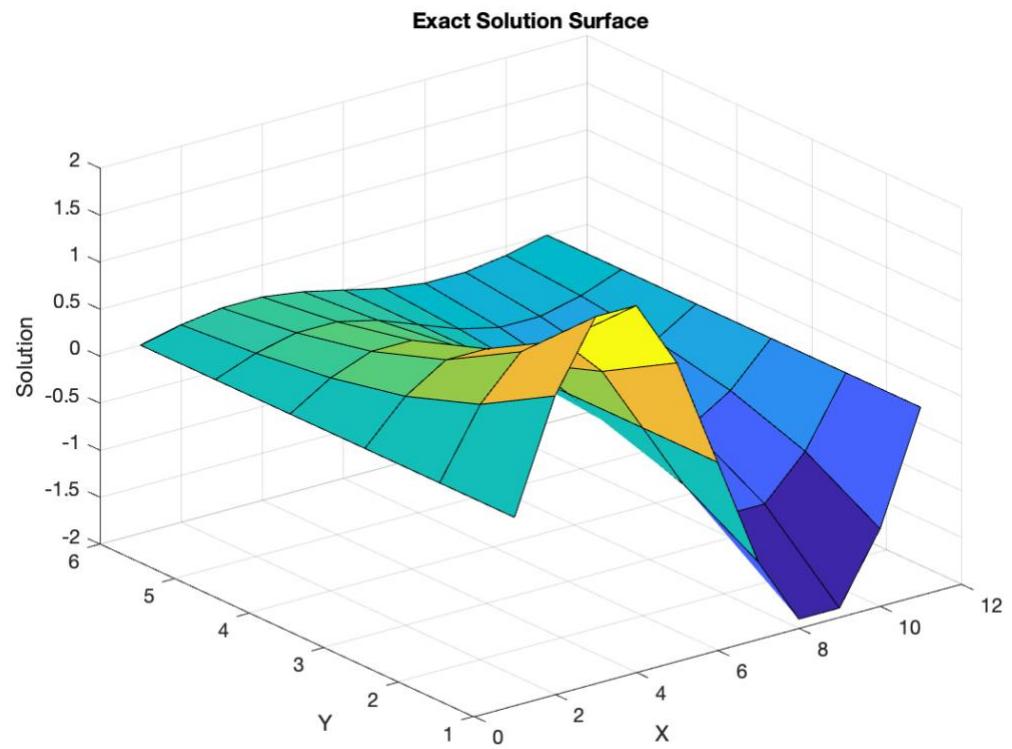
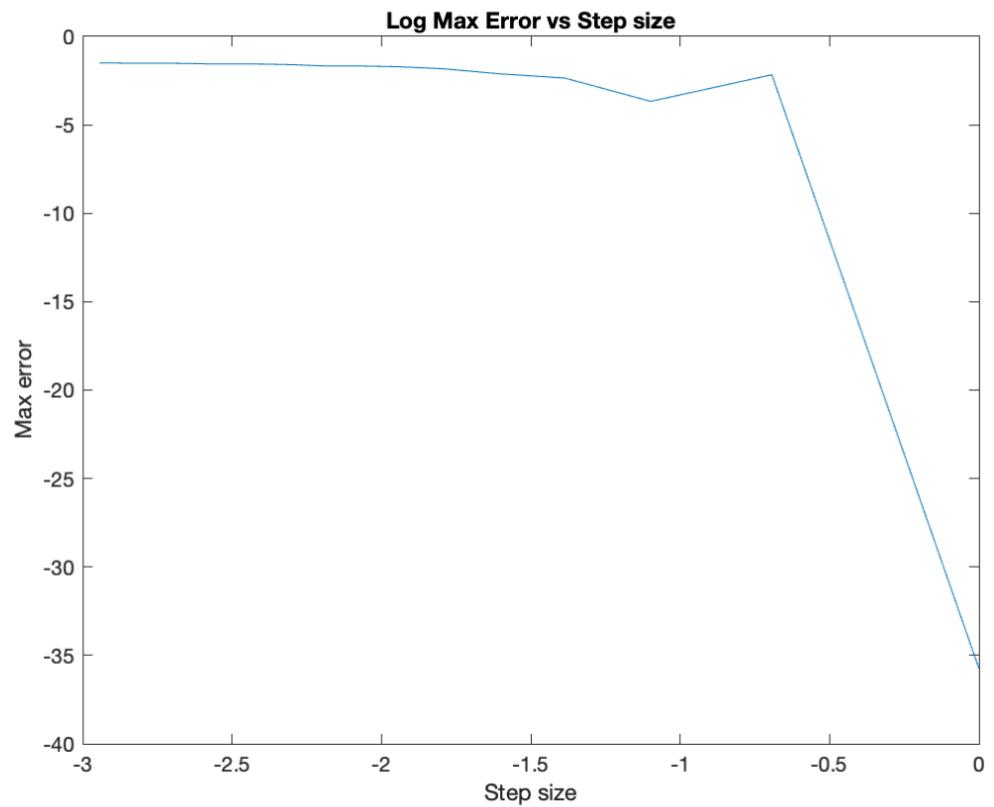
Actual values:

0	1.1756	1.9021	1.9021	1.1756	0.0000	-1.1756	-1.9021	-1.9021	-1.1756	-0.0000
0	0.7177	1.1612	1.1612	0.7177	0.0000	-0.7177	-1.1612	-1.1612	-0.7177	-0.0000
0	0.4381	0.7089	0.7089	0.4381	0.0000	-0.4381	-0.7089	-0.7089	-0.4381	-0.0000
0	0.2675	0.4328	0.4328	0.2675	0.0000	-0.2675	-0.4328	-0.4328	-0.2675	-0.0000
0	0.1633	0.2642	0.2642	0.1633	0.0000	-0.1633	-0.2642	-0.2642	-0.1633	-0.0000
0	0.0997	0.1613	0.1613	0.0997	0.0000	-0.0997	-0.1613	-0.1613	-0.0997	-0.0000

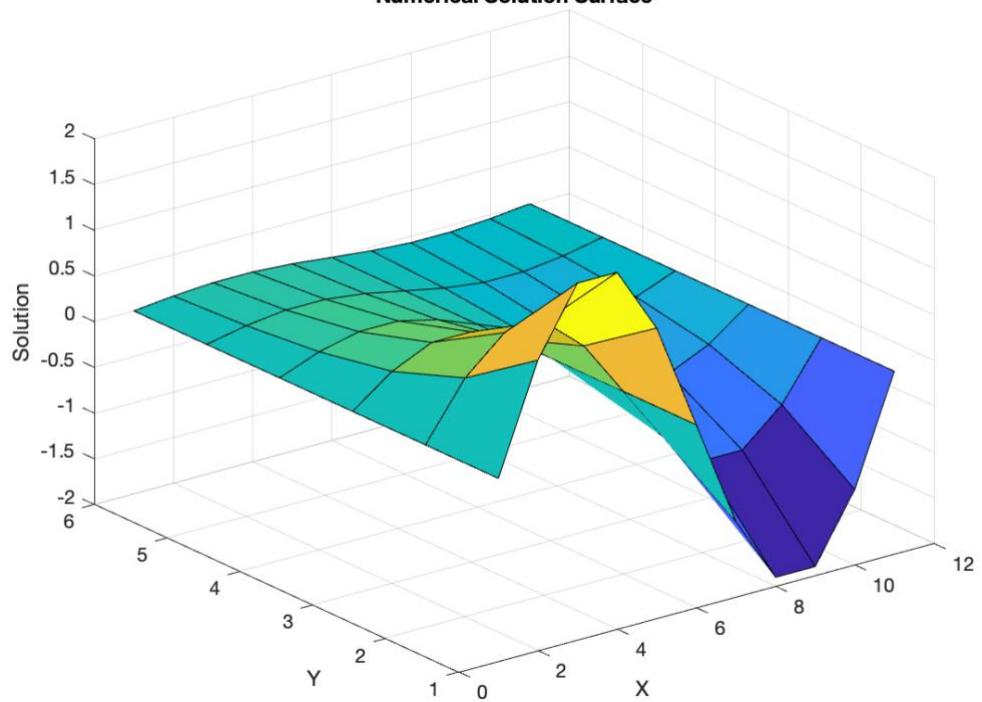
Errors:

0	0	0	0	0	0	0	0	0	0	0
0	0.1034	0.1673	0.1673	0.1034	0.0000	0.1034	0.1673	0.1673	0.1034	0.0000
0	0.1172	0.1896	0.1896	0.1172	0.0000	0.1172	0.1896	0.1896	0.1172	0.0000
0	0.0998	0.1614	0.1614	0.0998	0.0000	0.0998	0.1614	0.1614	0.0998	0.0000
0	0.0757	0.1224	0.1224	0.0757	0.0000	0.0757	0.1224	0.1224	0.0757	0.0000
0	0.0539	0.0872	0.0872	0.0539	0.0000	0.0539	0.0872	0.0872	0.0539	0.0000





Numerical Solution Surface



Q4(a) BTCS Method:

Format: x-axis horizontal increasing from left to right

Format: y-axis vertical time increasing from top to bottom

Estimated values:

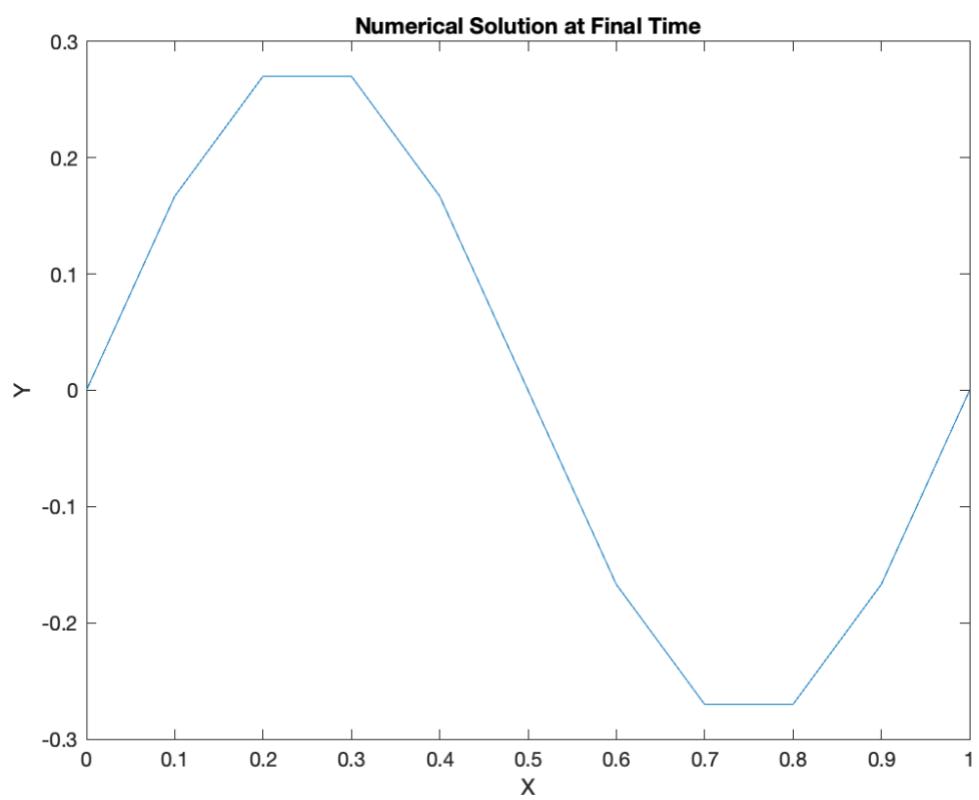
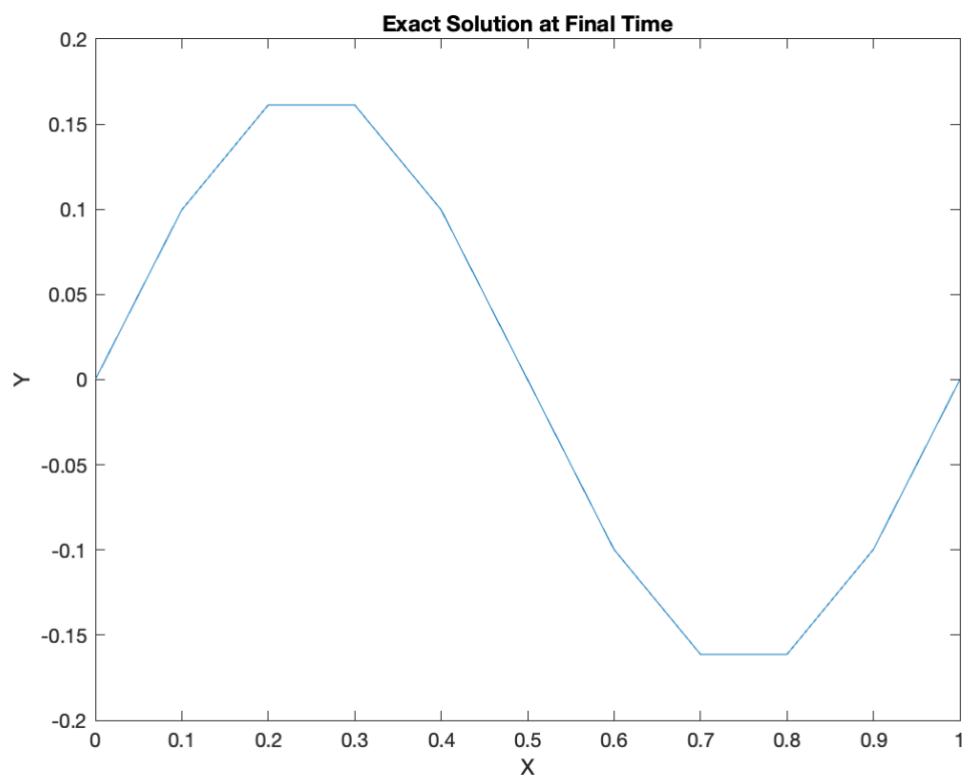
0	1.1756	1.9021	1.9021	1.1756	0.0000	-1.1756	-1.9021	-1.9021	-1.1756	-0.0000
0	0.7957	1.2874	1.2874	0.7957	0.0000	-0.7957	-1.2874	-1.2874	-0.7957	0
0	0.5385	0.8714	0.8714	0.5385	0.0000	-0.5385	-0.8714	-0.8714	-0.5385	0
0	0.3645	0.5898	0.5898	0.3645	0	-0.3645	-0.5898	-0.5898	-0.3645	0
0	0.2467	0.3992	0.3992	0.2467	-0.0000	-0.2467	-0.3992	-0.3992	-0.2467	0
0	0.1670	0.2702	0.2702	0.1670	0	-0.1670	-0.2702	-0.2702	-0.1670	0

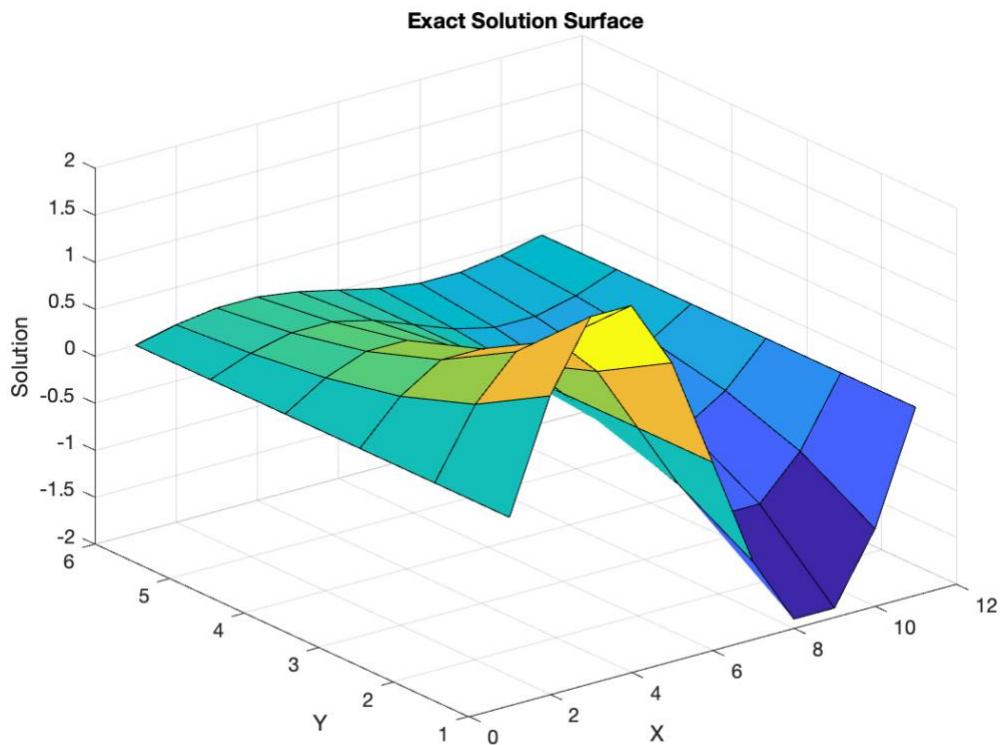
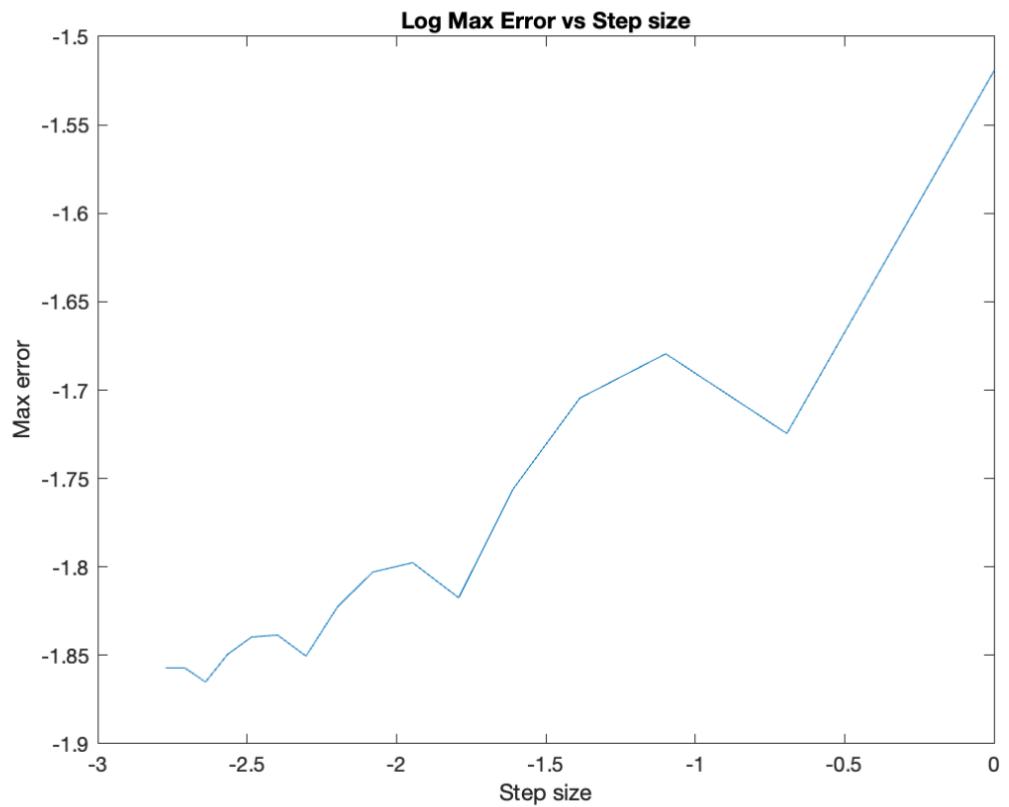
Actual values:

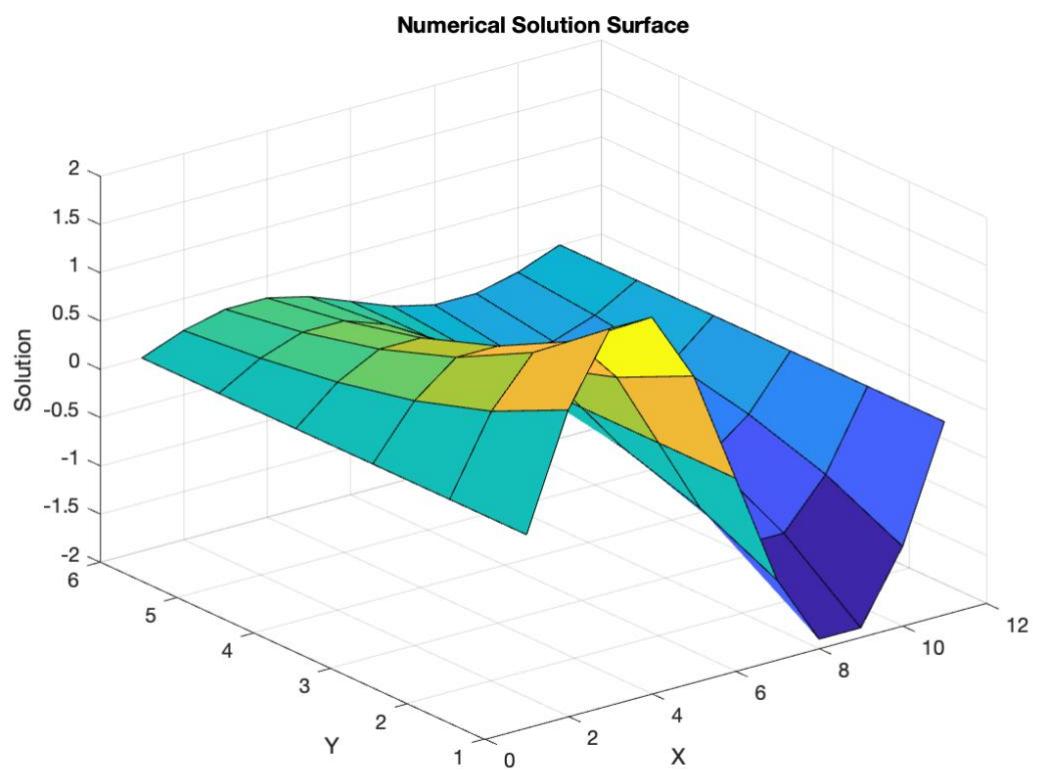
0	1.1756	1.9021	1.9021	1.1756	0.0000	-1.1756	-1.9021	-1.9021	-1.1756	-0.0000
0	0.7177	1.1612	1.1612	0.7177	0.0000	-0.7177	-1.1612	-1.1612	-0.7177	-0.0000
0	0.4381	0.7089	0.7089	0.4381	0.0000	-0.4381	-0.7089	-0.7089	-0.4381	-0.0000
0	0.2675	0.4328	0.4328	0.2675	0.0000	-0.2675	-0.4328	-0.4328	-0.2675	-0.0000
0	0.1633	0.2642	0.2642	0.1633	0.0000	-0.1633	-0.2642	-0.2642	-0.1633	-0.0000
0	0.0997	0.1613	0.1613	0.0997	0.0000	-0.0997	-0.1613	-0.1613	-0.0997	-0.0000

Errors:

0	0	0	0	0	0	0	0	0	0	0
0	0.0780	0.1262	0.1262	0.0780	0.0000	0.0780	0.1262	0.1262	0.0780	0.0000
0	0.1004	0.1624	0.1624	0.1004	0.0000	0.1004	0.1624	0.1624	0.1004	0.0000
0	0.0970	0.1570	0.1570	0.0970	0.0000	0.0970	0.1570	0.1570	0.0970	0.0000
0	0.0834	0.1350	0.1350	0.0834	0.0000	0.0834	0.1350	0.1350	0.0834	0.0000
0	0.0673	0.1089	0.1089	0.0673	0.0000	0.0673	0.1089	0.1089	0.0673	0.0000







Q4(a) Crank Nicolson Method:

Format: x-axis horizontal increasing from left to right

Format: y-axis vertical time increasing from top to bottom

Estimated values:

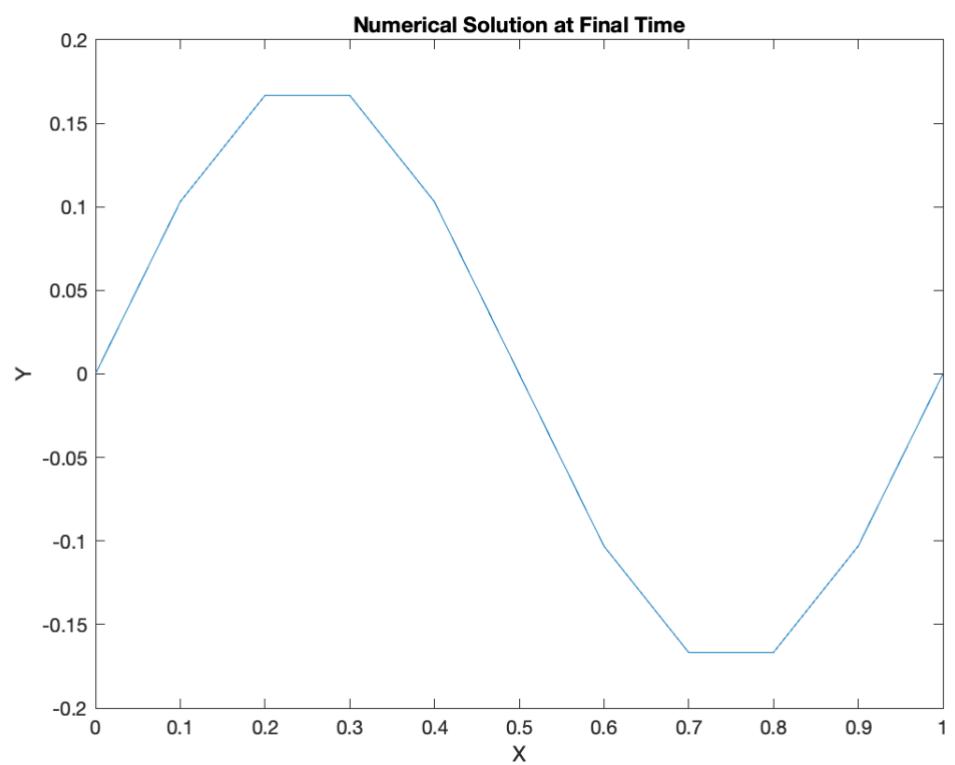
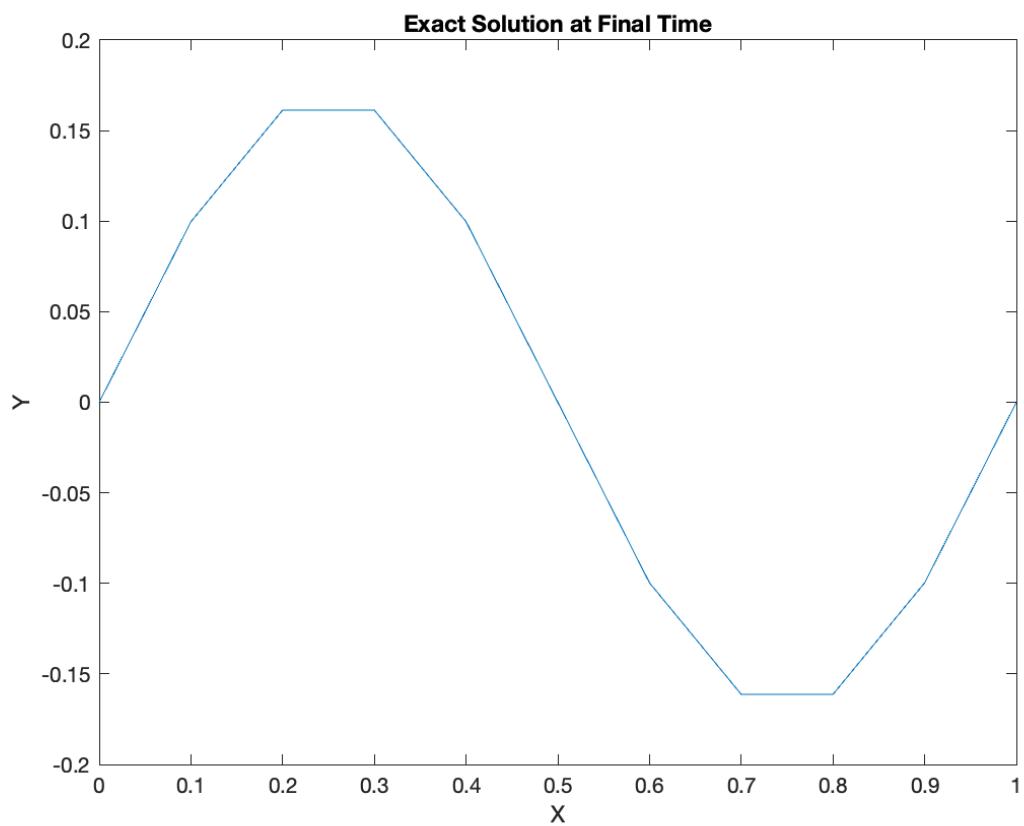
0	1.1756	1.9021	1.9021	1.1756	0.0000	-1.1756	-1.9021	-1.9021	-1.1756	-0.0000
0	0.7225	1.1690	1.1690	0.7225	0.0000	-0.7225	-1.1690	-1.1690	-0.7225	0
0	0.4440	0.7184	0.7184	0.4440	0.0000	-0.4440	-0.7184	-0.7184	-0.4440	0
0	0.2729	0.4415	0.4415	0.2729	0.0000	-0.2729	-0.4415	-0.4415	-0.2729	0
0	0.1677	0.2713	0.2713	0.1677	0.0000	-0.1677	-0.2713	-0.2713	-0.1677	0
0	0.1031	0.1667	0.1667	0.1031	0.0000	-0.1031	-0.1667	-0.1667	-0.1031	0

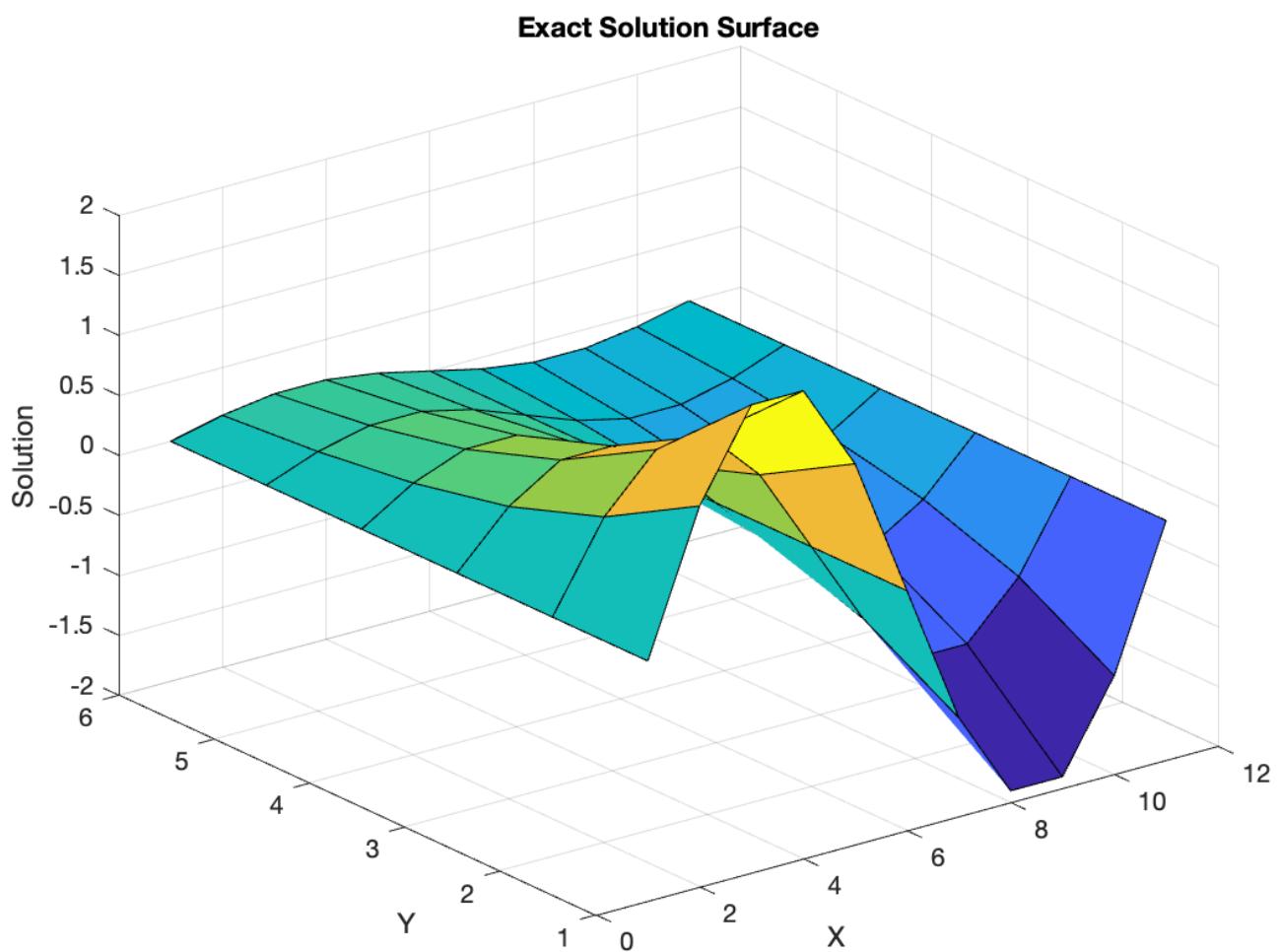
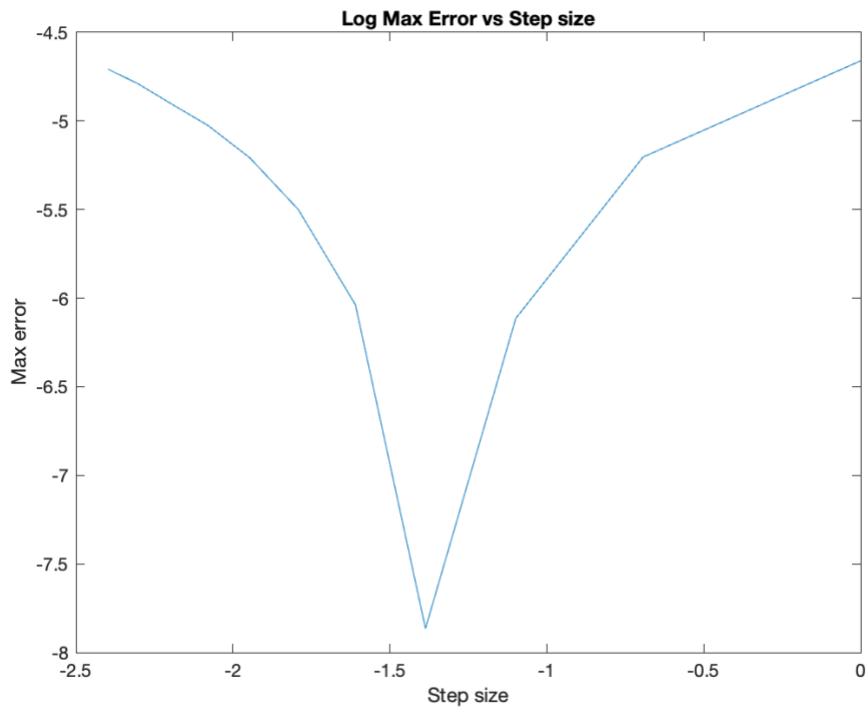
Actual values:

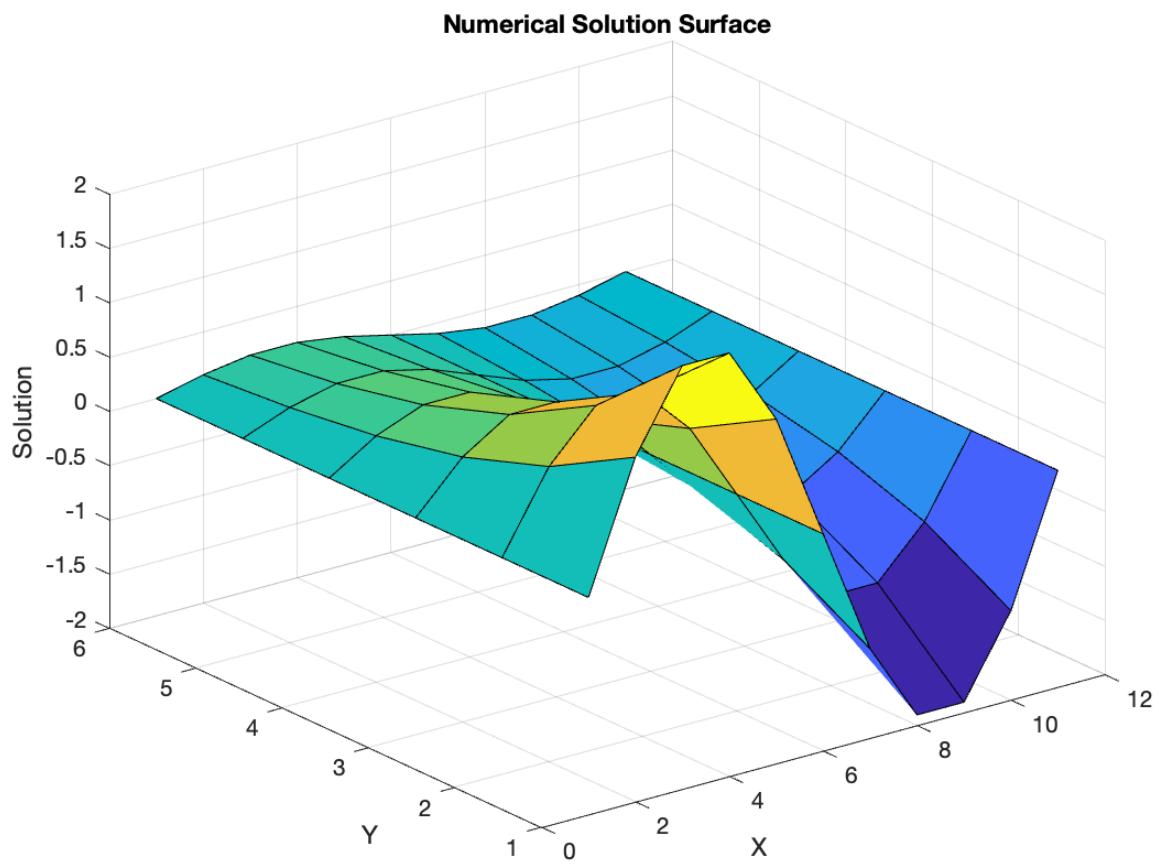
0	1.1756	1.9021	1.9021	1.1756	0.0000	-1.1756	-1.9021	-1.9021	-1.1756	-0.0000
0	0.7177	1.1612	1.1612	0.7177	0.0000	-0.7177	-1.1612	-1.1612	-0.7177	-0.0000
0	0.4381	0.7089	0.7089	0.4381	0.0000	-0.4381	-0.7089	-0.7089	-0.4381	-0.0000
0	0.2675	0.4328	0.4328	0.2675	0.0000	-0.2675	-0.4328	-0.4328	-0.2675	-0.0000
0	0.1633	0.2642	0.2642	0.1633	0.0000	-0.1633	-0.2642	-0.2642	-0.1633	-0.0000
0	0.0997	0.1613	0.1613	0.0997	0.0000	-0.0997	-0.1613	-0.1613	-0.0997	-0.0000

Errors:

0	0	0	0	0	0	0	0	0	0	0
0	0.0048	0.0077	0.0077	0.0048	0.0000	0.0048	0.0077	0.0077	0.0048	0.0000
0	0.0058	0.0095	0.0095	0.0058	0.0000	0.0058	0.0095	0.0095	0.0058	0.0000
0	0.0054	0.0087	0.0087	0.0054	0.0000	0.0054	0.0087	0.0087	0.0054	0.0000
0	0.0044	0.0071	0.0071	0.0044	0.0000	0.0044	0.0071	0.0071	0.0044	0.0000
0	0.0034	0.0054	0.0054	0.0034	0.0000	0.0034	0.0054	0.0054	0.0034	0.0000







Q4(b) FTCS Method:

Format: x-axis horizontal increasing from left to right

Format: y-axis vertical time increasing from top to bottom

Estimated values:

1.0e+05 *

0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0	-0.0000	-0.0000	-0.0000	-0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0	0.0001	0.0002	0.0002	0.0001	0.0000	-0.0001	-0.0002	-0.0002	-0.0001	0.0000
0	-0.0009	-0.0014	-0.0014	-0.0009	0.0000	0.0009	0.0014	0.0018	0.0001	0.0000
0	0.0057	0.0092	0.0092	0.0057	0.0000	-0.0057	-0.0010	-0.0409	0.0330	0.0000
0	-0.0379	-0.0613	-0.0613	-0.0379	0.0000	0.2027	-0.8932	2.2346	-2.1039	0.0000

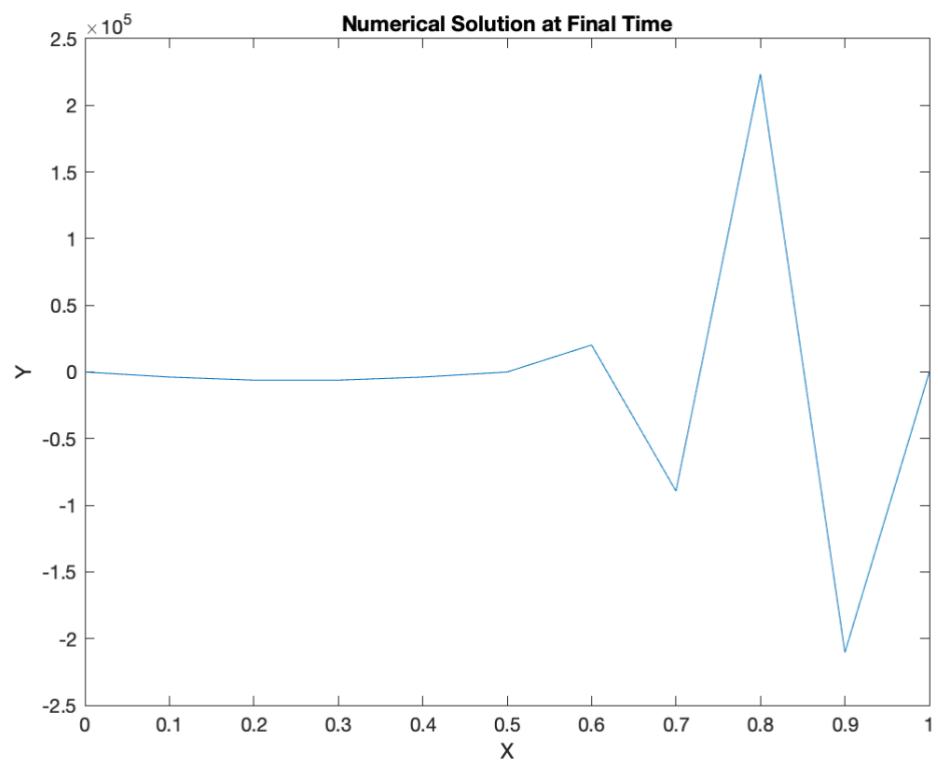
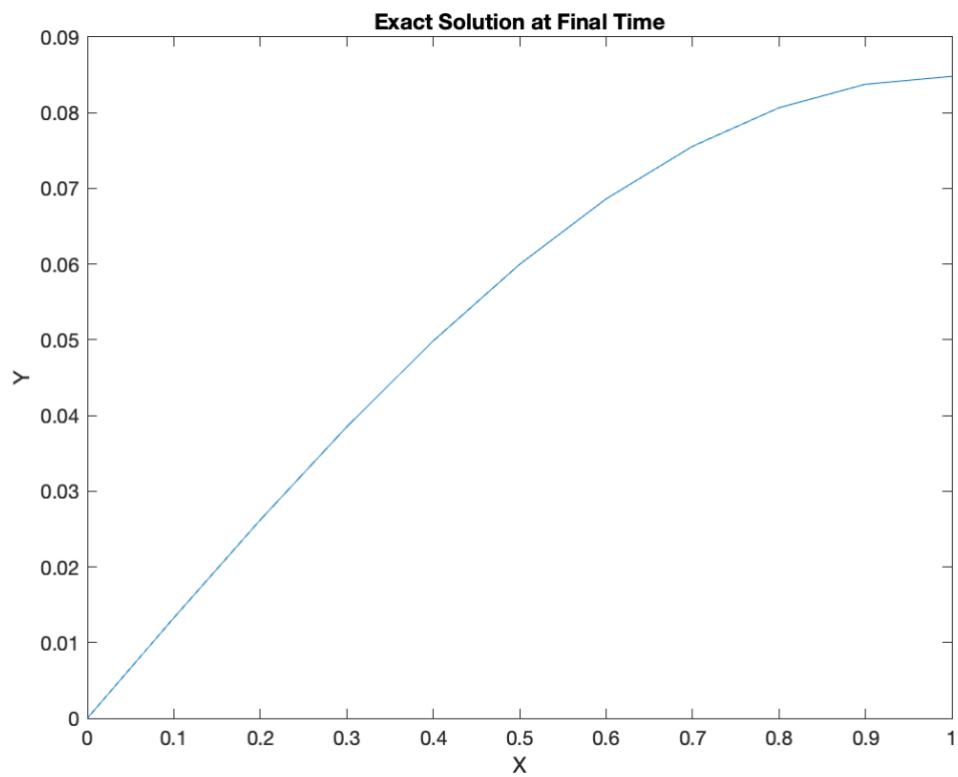
Actual values:

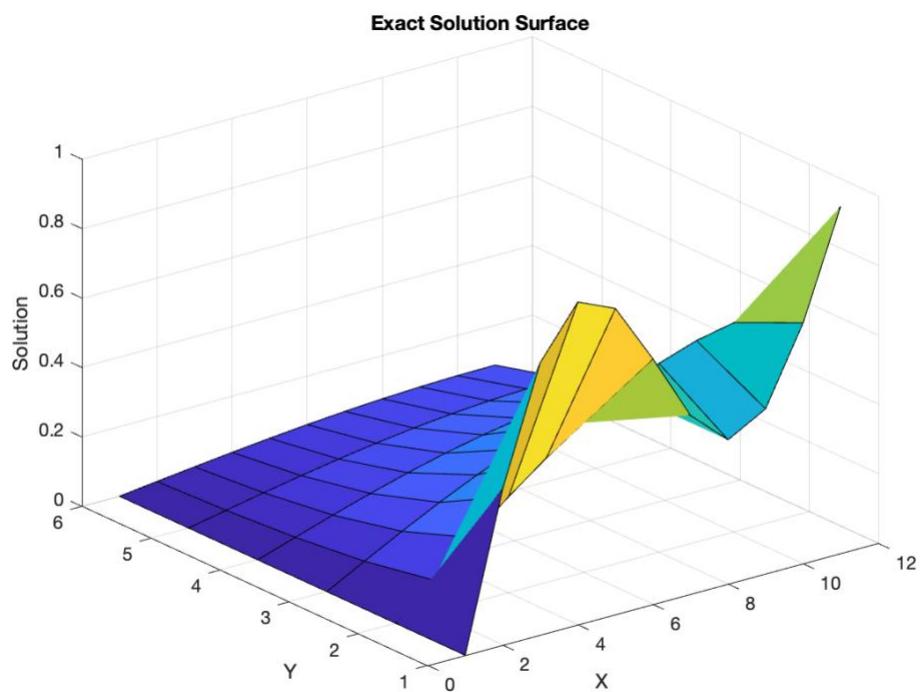
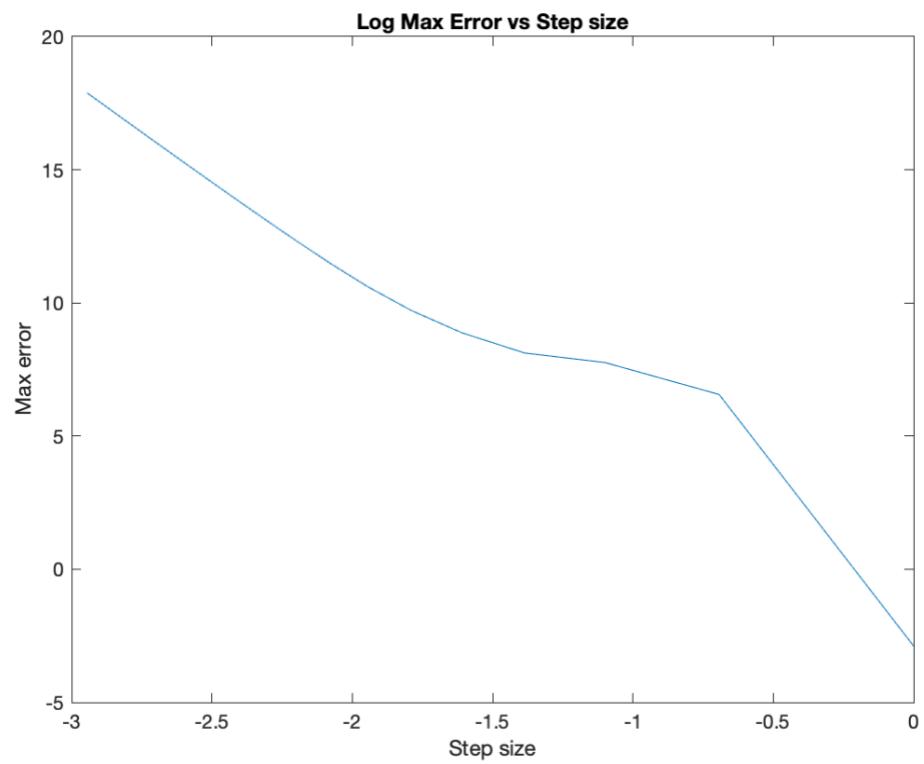
0	0.4503	0.7845	0.9295	0.8817	0.7071	0.5151	0.4155	0.4755	0.6938	1.0000
0	0.0956	0.1888	0.2773	0.3590	0.4317	0.4938	0.5438	0.5804	0.6029	0.6105
0	0.0583	0.1152	0.1692	0.2191	0.2635	0.3015	0.3321	0.3545	0.3681	0.3727
0	0.0356	0.0703	0.1033	0.1337	0.1609	0.1841	0.2027	0.2164	0.2247	0.2275
0	0.0217	0.0429	0.0631	0.0816	0.0982	0.1124	0.1238	0.1321	0.1372	0.1389
0	0.0133	0.0262	0.0385	0.0498	0.0600	0.0686	0.0756	0.0807	0.0838	0.0848

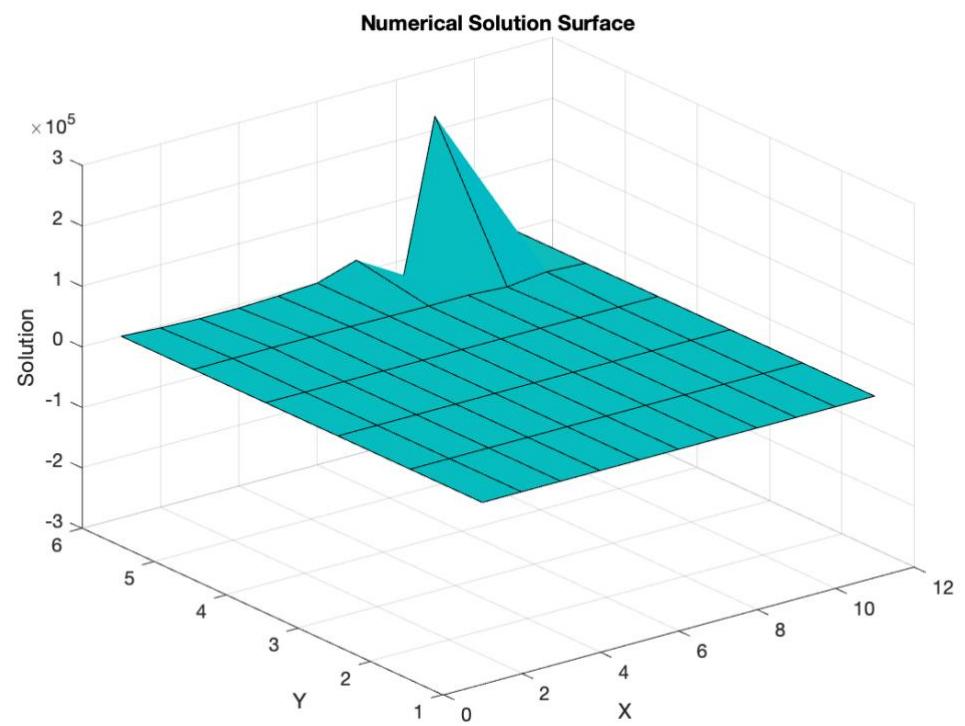
Errors:

1.0e+05 *

0	0	0	0	0	0	0	0	0	0	0
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0
0	0.0001	0.0002	0.0002	0.0001	0.0000	0.0001	0.0002	0.0002	0.0001	0
0	0.0009	0.0014	0.0014	0.0009	0.0000	0.0009	0.0014	0.0018	0.0001	0
0	0.0057	0.0092	0.0092	0.0057	0.0000	0.0057	0.0010	0.0409	0.0330	0
0	0.0379	0.0613	0.0613	0.0379	0.0000	0.2027	0.8932	2.2346	2.1039	0







Q4(b) BTCS Method:

Format: x-axis horizontal increasing from left to right

Format: y-axis vertical time increasing from top to bottom

Estimated values:

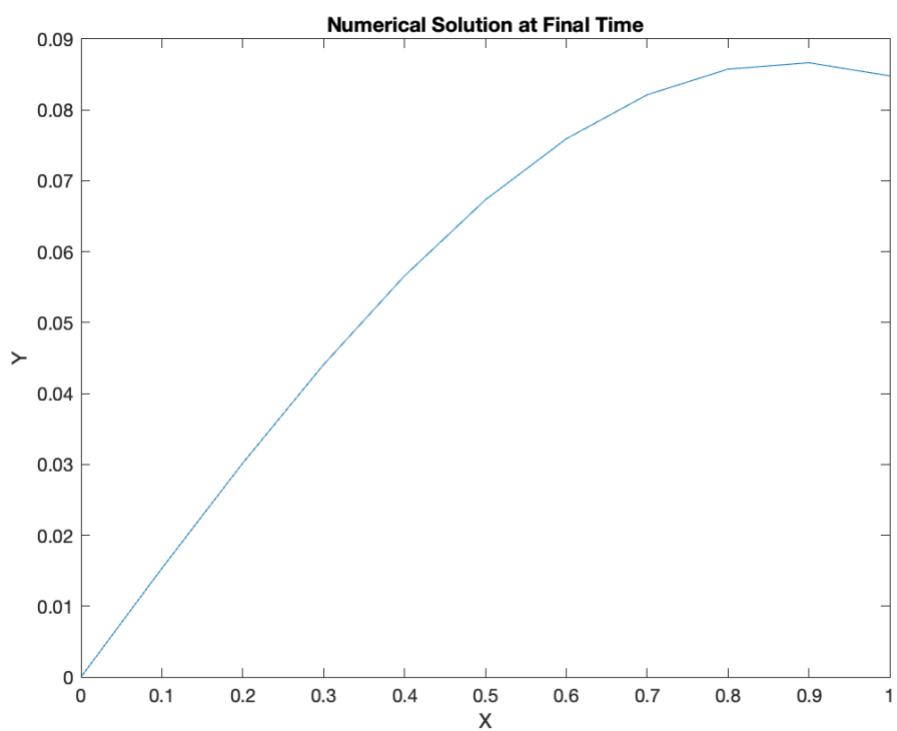
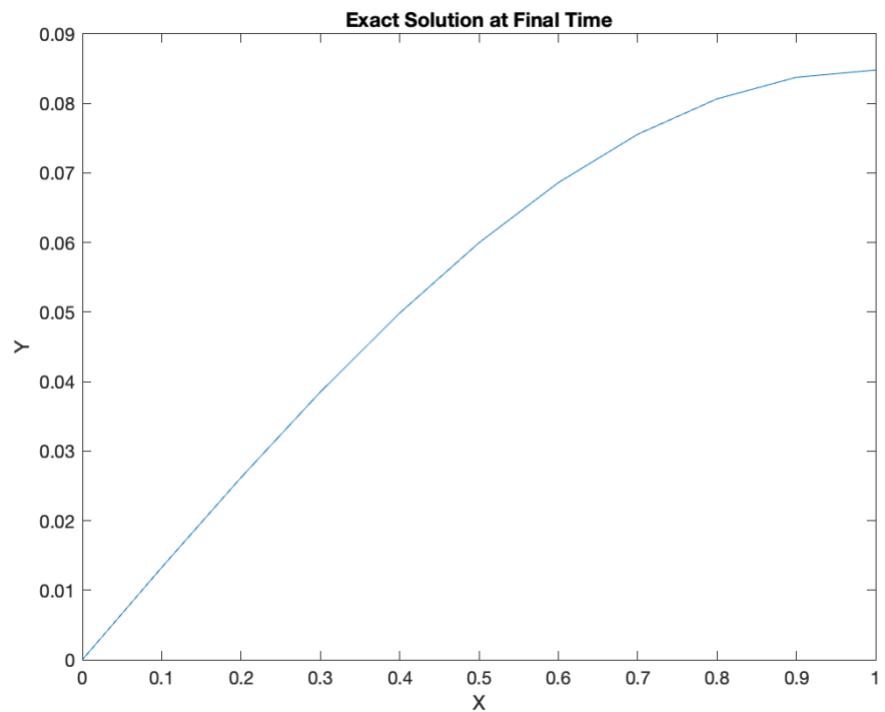
0	0.4503	0.7845	0.9295	0.8817	0.7071	0.5151	0.4155	0.4755	0.6938	1.0000
0	0.1359	0.2561	0.3499	0.4147	0.4562	0.4851	0.5125	0.5447	0.5805	0.6105
0	0.0686	0.1338	0.1930	0.2442	0.2870	0.3213	0.3474	0.3653	0.3741	0.3727
0	0.0408	0.0802	0.1170	0.1499	0.1781	0.2009	0.2176	0.2279	0.2313	0.2275
0	0.0250	0.0492	0.0718	0.0922	0.1097	0.1238	0.1340	0.1401	0.1417	0.1389
0	0.0153	0.0302	0.0441	0.0566	0.0673	0.0759	0.0821	0.0858	0.0867	0.0848

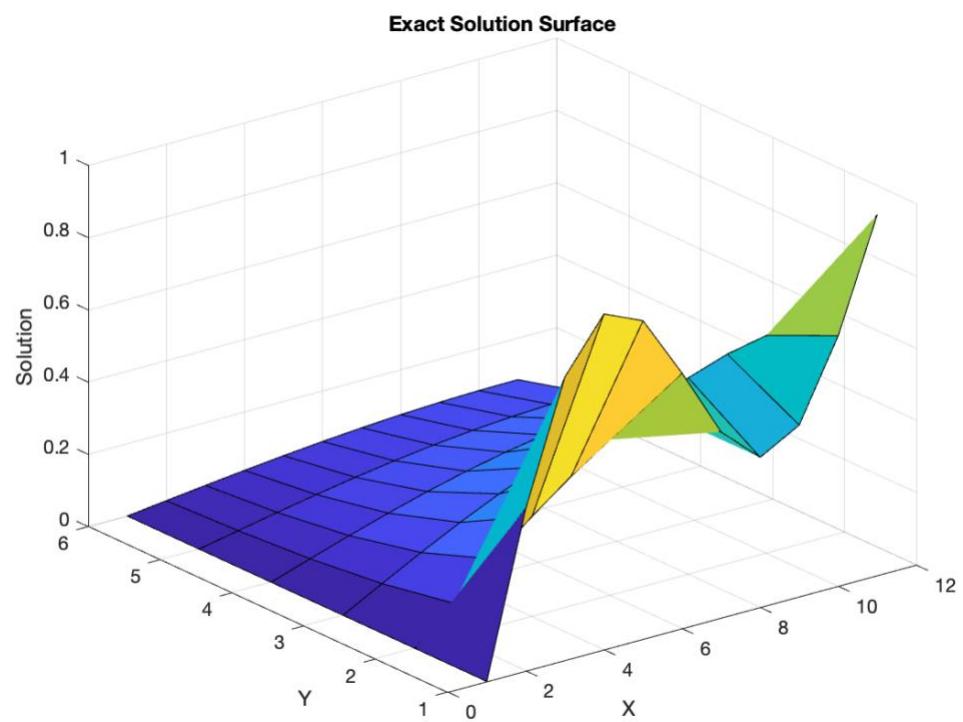
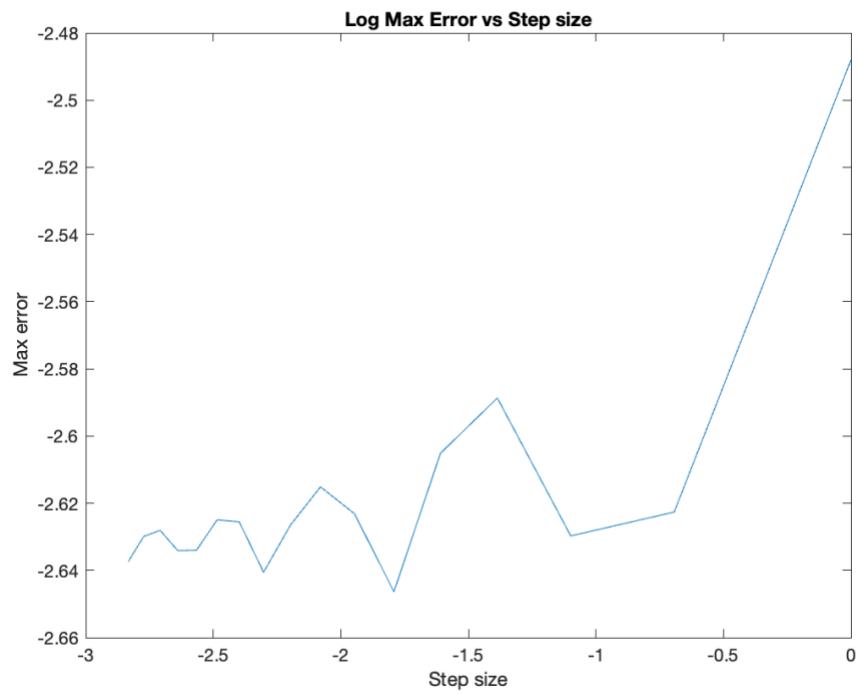
Actual values:

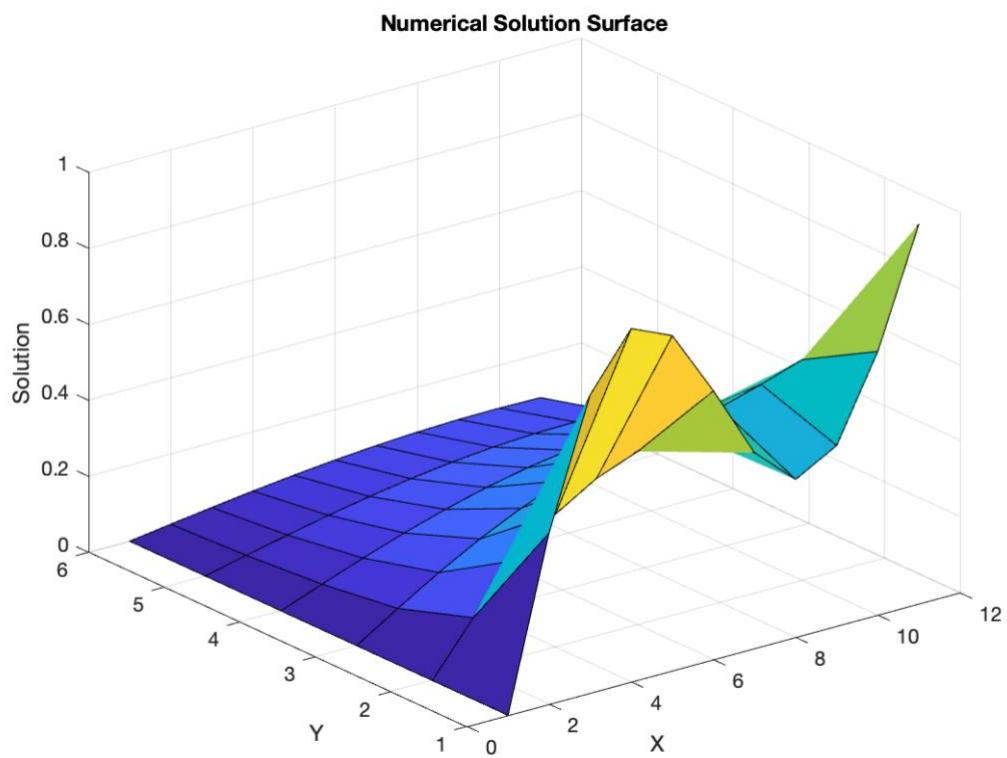
0	0.4503	0.7845	0.9295	0.8817	0.7071	0.5151	0.4155	0.4755	0.6938	1.0000
0	0.0956	0.1888	0.2773	0.3590	0.4317	0.4938	0.5438	0.5804	0.6029	0.6105
0	0.0583	0.1152	0.1692	0.2191	0.2635	0.3015	0.3321	0.3545	0.3681	0.3727
0	0.0356	0.0703	0.1033	0.1337	0.1609	0.1841	0.2027	0.2164	0.2247	0.2275
0	0.0217	0.0429	0.0631	0.0816	0.0982	0.1124	0.1238	0.1321	0.1372	0.1389
0	0.0133	0.0262	0.0385	0.0498	0.0600	0.0686	0.0756	0.0807	0.0838	0.0848

Errors:

0	0	0	0	0	0	0	0	0	0	0
0	0.0403	0.0673	0.0726	0.0558	0.0245	0.0087	0.0313	0.0357	0.0224	0
0	0.0103	0.0187	0.0238	0.0252	0.0235	0.0198	0.0153	0.0108	0.0060	0
0	0.0052	0.0099	0.0137	0.0161	0.0172	0.0168	0.0149	0.0115	0.0066	0
0	0.0033	0.0063	0.0088	0.0106	0.0115	0.0114	0.0103	0.0080	0.0045	0
0	0.0021	0.0040	0.0056	0.0067	0.0073	0.0073	0.0066	0.0051	0.0029	0







Q4(b) Crank Nicolson Method:

Format: x-axis horizontal increasing from left to right

Format: y-axis vertical time increasing from top to bottom

Estimated values:

0	0.4503	0.7845	0.9295	0.8817	0.7071	0.5151	0.4155	0.4755	0.6938	1.0000
0	-0.0772	-0.0910	-0.0031	0.1844	0.4288	0.6628	0.8193	0.8564	0.7735	0.6105
0	0.1583	0.2769	0.3305	0.3179	0.2617	0.1991	0.1678	0.1906	0.2670	0.3727
0	-0.0235	-0.0255	0.0073	0.0739	0.1598	0.2418	0.2969	0.3107	0.2830	0.2275
0	0.0560	0.0982	0.1182	0.1154	0.0975	0.0773	0.0675	0.0760	0.1026	0.1389
0	-0.0070	-0.0066	0.0056	0.0293	0.0596	0.0883	0.1078	0.1129	0.1036	0.0848

Actual values:

0	0.4503	0.7845	0.9295	0.8817	0.7071	0.5151	0.4155	0.4755	0.6938	1.0000
0	0.0956	0.1888	0.2773	0.3590	0.4317	0.4938	0.5438	0.5804	0.6029	0.6105
0	0.0583	0.1152	0.1692	0.2191	0.2635	0.3015	0.3321	0.3545	0.3681	0.3727
0	0.0356	0.0703	0.1033	0.1337	0.1609	0.1841	0.2027	0.2164	0.2247	0.2275
0	0.0217	0.0429	0.0631	0.0816	0.0982	0.1124	0.1238	0.1321	0.1372	0.1389
0	0.0133	0.0262	0.0385	0.0498	0.0600	0.0686	0.0756	0.0807	0.0838	0.0848

Errors:

0	0	0	0	0	0	0	0	0	0	0
0	0.1728	0.2798	0.2804	0.1746	0.0029	0.1690	0.2755	0.2760	0.1706	0
0	0.1000	0.1617	0.1613	0.0988	0.0019	0.1024	0.1643	0.1638	0.1011	0
0	0.0591	0.0958	0.0960	0.0598	0.0011	0.0577	0.0942	0.0943	0.0582	0
0	0.0342	0.0553	0.0552	0.0338	0.0007	0.0351	0.0563	0.0561	0.0346	0
0	0.0203	0.0328	0.0329	0.0205	0.0004	0.0197	0.0322	0.0322	0.0199	0

