Polymath를 이용한 Diffusion Equation 풀기

Diffusion Equation

$$\frac{du}{dt} = \alpha \frac{d^2u}{dx^2}$$

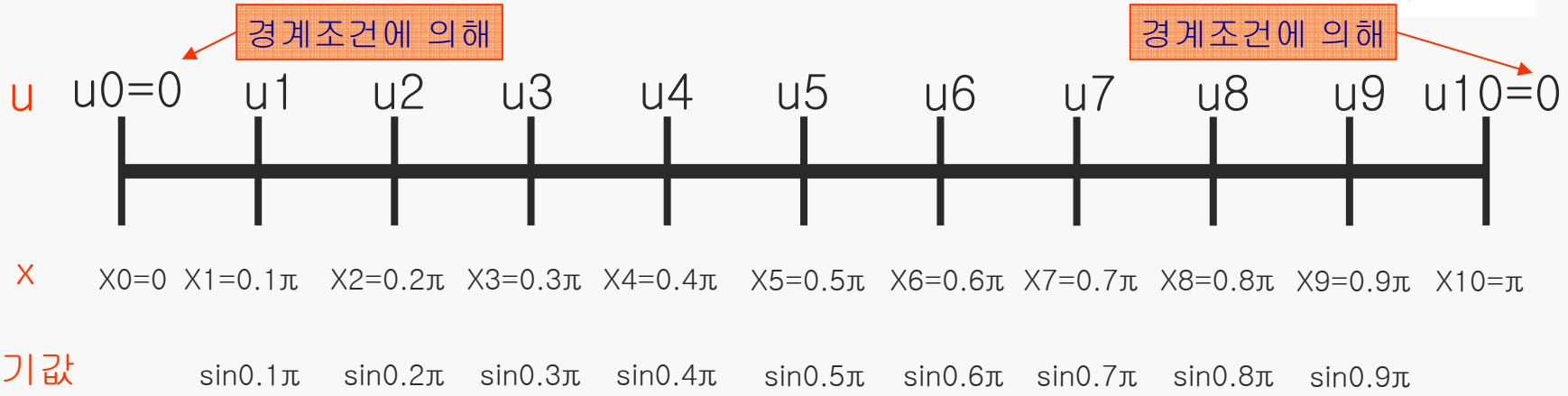
- 초기조건 $u(x,0) = \sin x \quad (0 \le x \le \pi)$
- 경계조건 $u(0,t) = u(\pi,t) = 0 \quad (0 \le t \le 1)$
- 정확해 $u(x,t) = \sin x e^{-0.5t}$

$$\Delta x = 0.1\pi \quad \alpha = 0.5 \quad \Delta t = 0.02$$

modeling

U값을 구하기 위한 모델링을 해준다

$$\Delta x = 0.1\pi$$

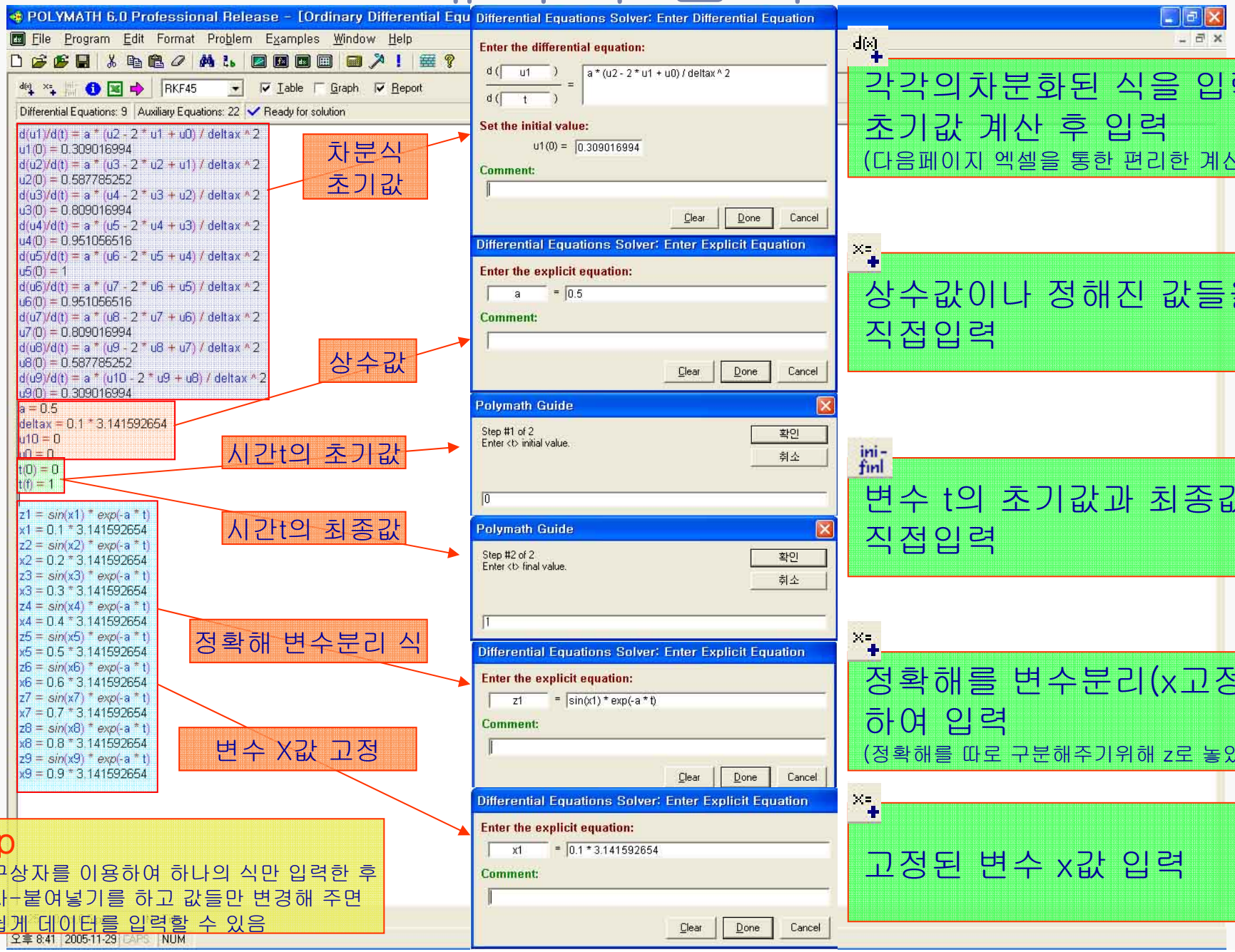


각각의 u에대한
식을 차분화 시켜줌

$$u_i = \frac{u_{i+1} - 2u_i + u_{i-1}}{(\Delta x)^2}$$

Diffusion equation을 차분화 해주고, 경계값과 초기값을 대입해준 후, 시간t에 대한 변화를 알아본다.

데이터 입력



Tip

도구상자를 이용하여 하나의 식만 입력한 후 복사-붙여넣기를 하고 값들만 변경해 주면 손쉽게 데이터를 입력할 수 있음

초기값 엑셀을 이용한 계산

Polymath에선 초기값을 방정식으로 넣지 못함
데이터를 입력할 때 초기값을 일일이 계산해서 넣어줘야 함
->엑셀을 통해 초기값을 쉽게 구할 수 있음

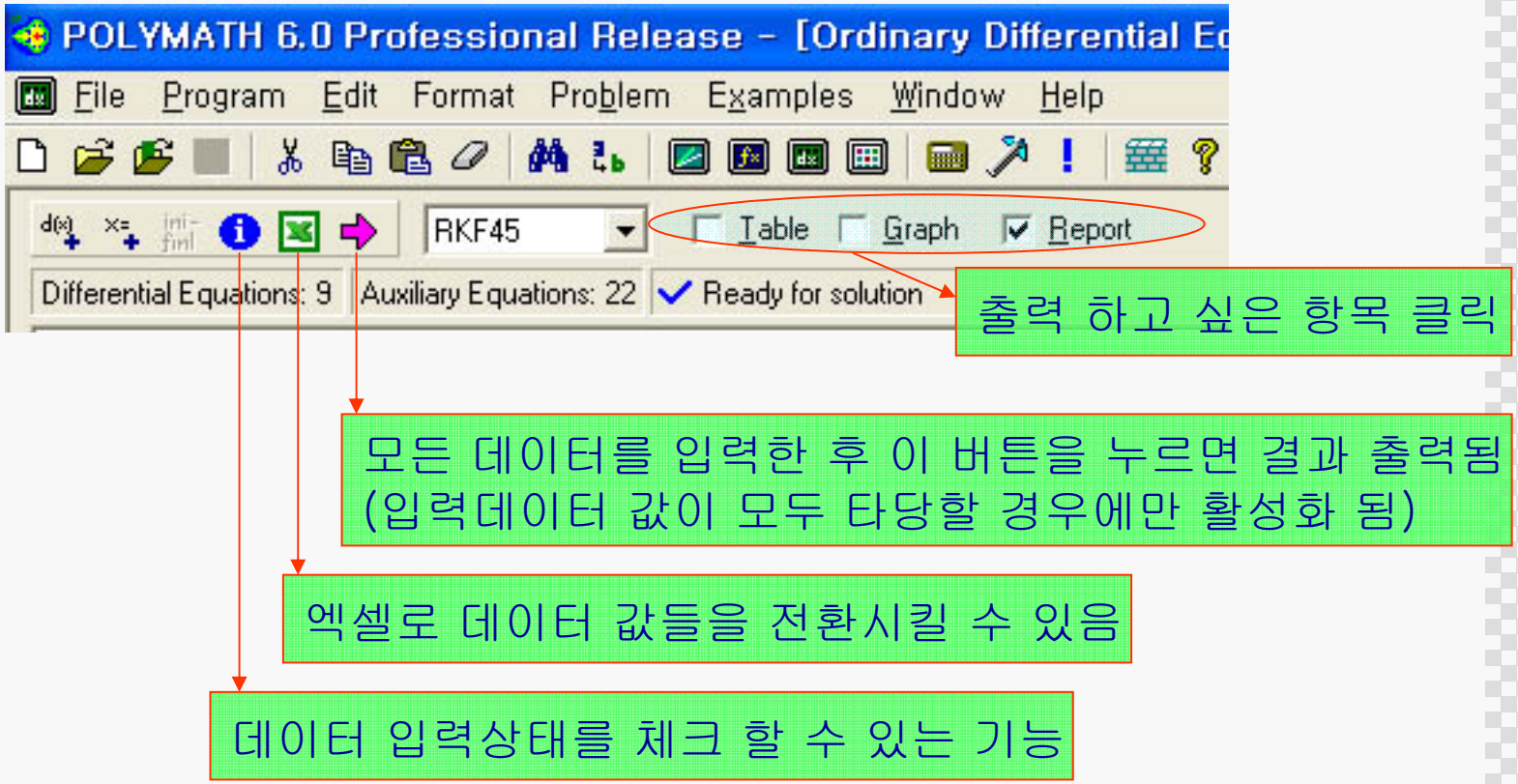
곱해줌

X

deltax=0.1*pi일 때				
	x값	x값	초기값	
	pi	3.141592654	sinx	
0.1	0.1*pi	0.314159265	sin 0.309016994	u1일때의 초기값
0.2	0.2*pi	0.628318531	0.587785252	u2일때의 초기값
0.3	0.3*pi	0.942477796	0.809016994	u3일때의 초기값
0.4	0.4*pi	1.256637061	0.951056516	u4일때의 초기값
0.5	0.5*pi	1.570796327	1	u5일때의 초기값
0.6	0.6*pi	1.884955592	0.951056516	u6일때의 초기값
0.7	0.7*pi	2.199114858	0.809016994	u7일때의 초기값
0.8	0.8*pi	2.513274123	0.587785252	u8일때의 초기값
0.9	0.9*pi	2.827433388	0.309016994	u9일때의 초기값

계산된 초기값을 데이터에 입력

데이터 입력(몇가지 Tip)



결과 출력(Report)

POLYMATH Report
Ordinary Differential Equations

Calculated values of DEQ variables

	Variable	Initial value	Minimal value	Maximal value	Final value
1	t	0	0	1.	1.
2	u1	0.309017	0.1881981	0.309017	0.1881981
3	u2	0.5877853	0.357974	0.5877853	0.357974
4	u3	0.809017	0.492709	0.809017	0.492709
5	u4	0.9510565	0.5792142	0.9510565	0.5792142
6	u5	1.	0.6090218	1.	0.6090218
7	u6	0.9510565	0.5792142	0.9510565	0.5792142
8	u7	0.809017	0.492709	0.809017	0.492709
9	u8	0.5877853	0.357974	0.5877853	0.357974
10	u9	0.309017	0.1881981	0.309017	0.1881981
11	a	0.5	0.5	0.5	0.5
12	deltax	0.3141593	0.3141593	0.3141593	0.3141593
13	u10	0	0	0	0
14	u0	0	0	0	0
15	x1	0.3141593	0.3141593	0.3141593	0.3141593
16	z1	0.309017	0.1874283	0.309017	0.1874283
17	x2	0.6283185	0.6283185	0.6283185	0.6283185
18	z2	0.5877853	0.3565098	0.5877853	0.3565098
19	x3	0.9424778	0.9424778	0.9424778	0.9424778
20	z3	0.809017	0.4906936	0.809017	0.4906936
21	x4	1.256637	1.256637	1.256637	1.256637
22	z4	0.9510565	0.5768449	0.9510565	0.5768449
23	x5	1.570796	1.570796	1.570796	1.570796
24	z5	1.	0.6065307	1.	0.6065307
25	x6	1.884956	1.884956	1.884956	1.884956
26	z6	0.9510565	0.5768449	0.9510565	0.5768449
27	x7	2.199115	2.199115	2.199115	2.199115
28	z7	0.809017	0.4906936	0.809017	0.4906936
29	x8	2.513274	2.513274	2.513274	2.513274
30	z8	0.5877853	0.3565098	0.5877853	0.3565098
31	x9	2.827433	2.827433	2.827433	2.827433
32	z9	0.309017	0.1874283	0.309017	0.1874283

Differential equations

1 d(u1)/d(t) = a * (u2 - 2 * u1 + u0) / deltax ^ 2
2 d(u2)/d(t) = a * (u3 - 2 * u2 + u1) / deltax ^ 2
3 d(u3)/d(t) = a * (u4 - 2 * u3 + u2) / deltax ^ 2
4 d(u4)/d(t) = a * (u5 - 2 * u4 + u3) / deltax ^ 2
5 d(u5)/d(t) = a * (u6 - 2 * u5 + u4) / deltax ^ 2
6 d(u6)/d(t) = a * (u7 - 2 * u6 + u5) / deltax ^ 2
7 d(u7)/d(t) = a * (u8 - 2 * u7 + u6) / deltax ^ 2
8 d(u8)/d(t) = a * (u9 - 2 * u8 + u7) / deltax ^ 2
9 d(u9)/d(t) = a * (u10 - 2 * u9 + u8) / deltax ^ 2

Explicit equations

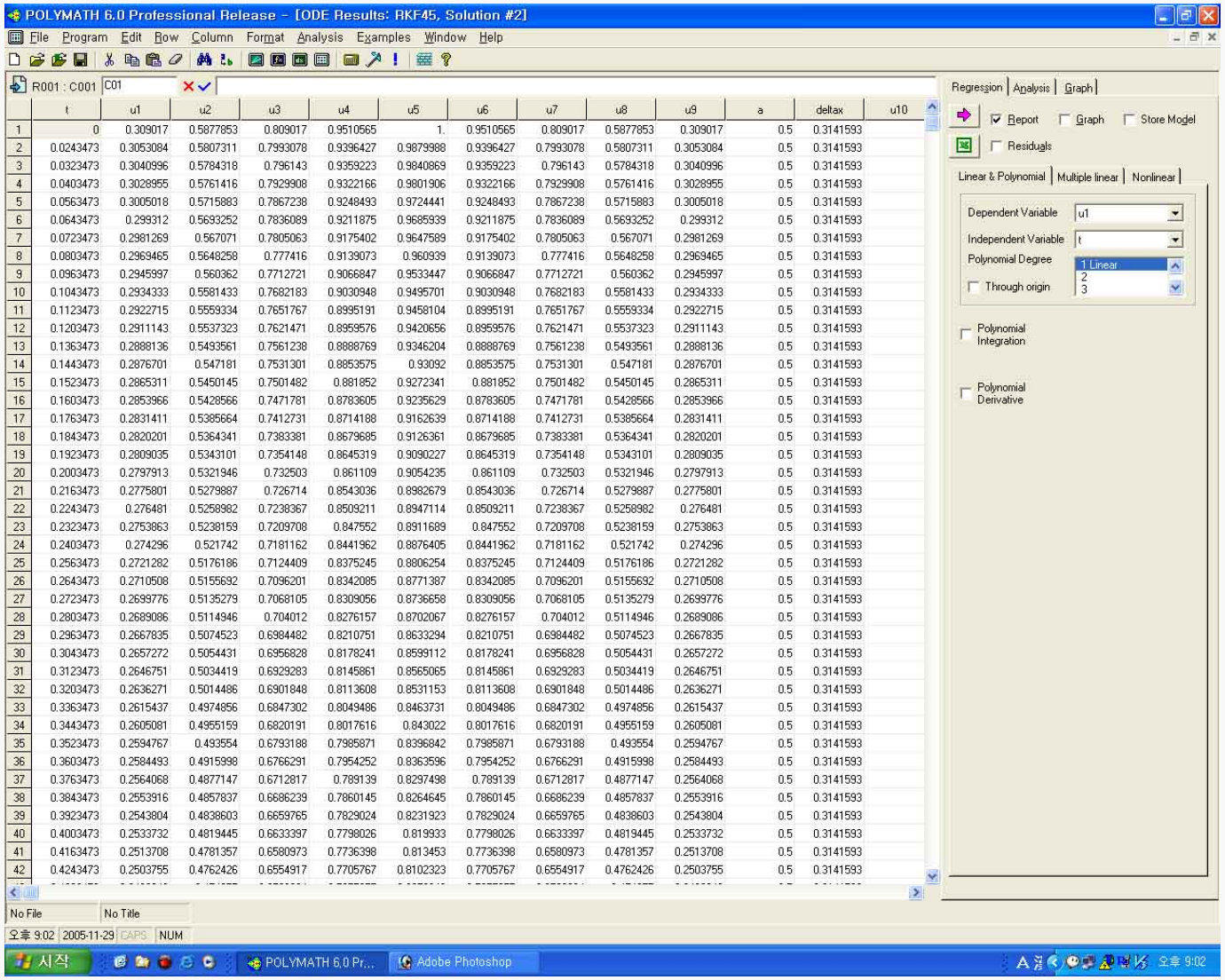
1 a = 0.5
2 deltax = 0.1 * 3.1415
3 u10 = 0
4 u0 = 0
5 x1 = 0.1 * 3.141592654
6 z1 = sin(x1) * exp(-a * t)
7 x2 = 0.2 * 3.141592654
8 z2 = sin(x2) * exp(-a * t)
9 x3 = 0.3 * 3.141592654
10 z3 = sin(x3) * exp(-a * t)
11 x4 = 0.4 * 3.141592654
12 z4 = sin(x4) * exp(-a * t)
13 x5 = 0.5 * 3.141592654
14 z5 = sin(x5) * exp(-a * t)
15 x6 = 0.6 * 3.141592654
16 z6 = sin(x6) * exp(-a * t)
17 x7 = 0.7 * 3.14159265
18 z7 = sin(x7) * exp(-a *
19 x8 = 0.8 * 3.14159265
20 z8 = sin(x8) * exp(-a *
21 x9 = 0.9 * 3.141592654
22 z9 = sin(x9) * exp(-a * t)

u1과 u9, u2와 u8, u3와 u7, u4와 u6의 값이 같음
u5를 중심으로 대칭된 값을 갖음(양쪽 경계값이 같고, 초기값이 sin함수를 따르기 때문)

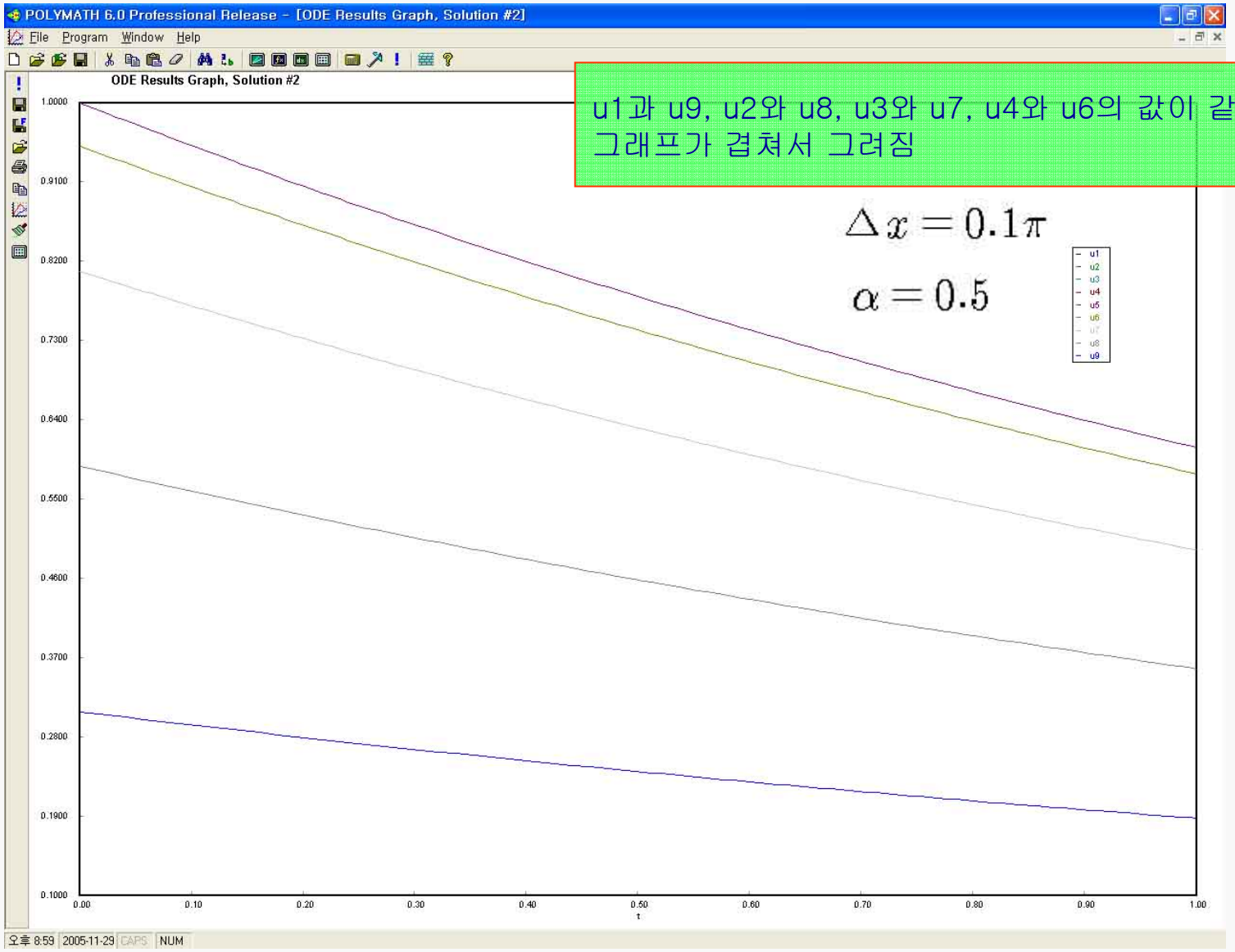
Numerical solution과 Analytical solution이 거의 비슷하게 나옴

z1과 z9, z2와 z8, z3와 z7, z4와 z6의 값이 같음
z5를 중심으로 대칭된 값을 갖음

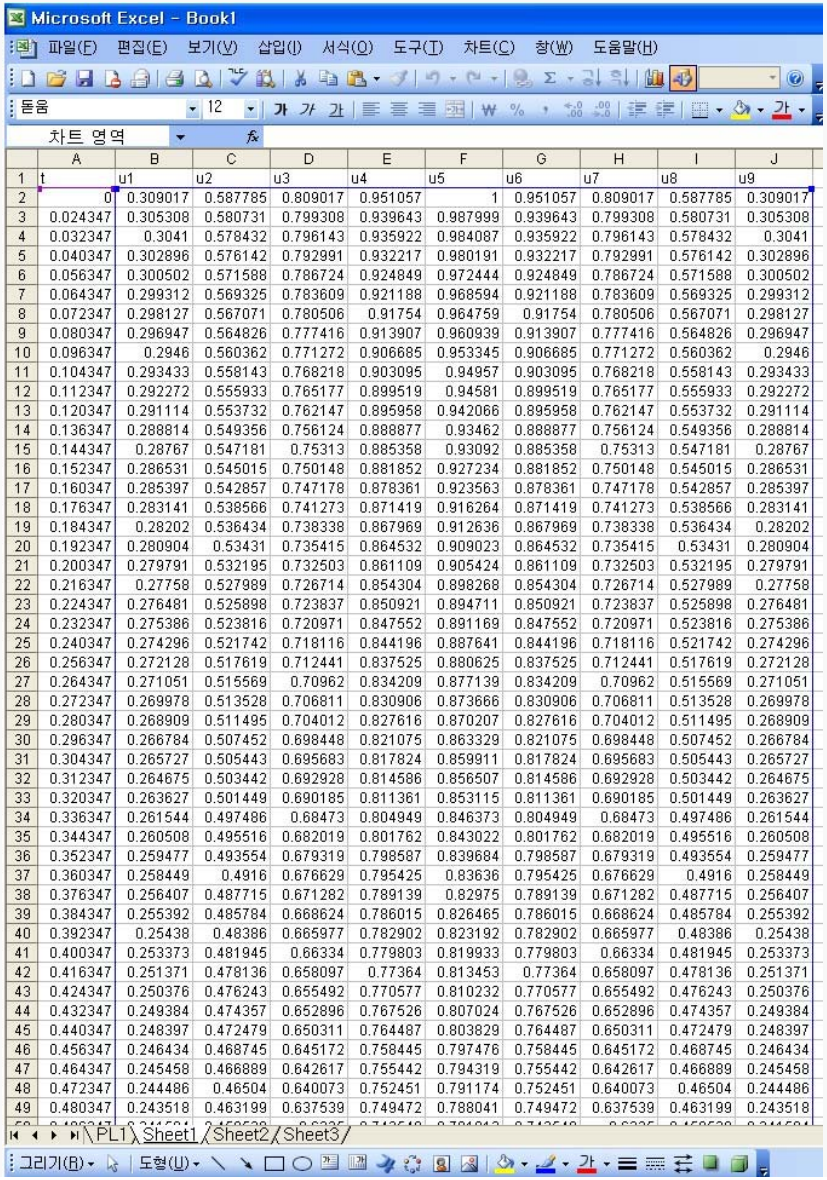
결과 출력(Table)


POLYMATH 6.0 Professional Release - [ODE Results: RKF45, Solution #2]
File Program Edit Row Column Format Analysis Examples Window Help
R001 : C001 C01
t u1 u2 u3 u4 u5 u6 u7 u8 u9 a deltax u10
0 0.309017 0.5877853 0.809017 0.9510565 1. 0.9510565 0.809017 0.5877853 0.309017 0.5 0.3141593
0.0243473 0.3053084 0.5807311 0.7993078 0.9396427 0.9879988 0.9396427 0.7993078 0.5807311 0.3053084 0.5 0.3141593
0.0323473 0.3040996 0.5784318 0.796143 0.9359223 0.9840869 0.9359223 0.796143 0.5784318 0.3040996 0.5 0.3141593
0.0403473 0.3028955 0.5761416 0.7929908 0.9322166 0.9801906 0.9322166 0.7929908 0.5761416 0.3028955 0.5 0.3141593
0.0563473 0.3005018 0.5715883 0.7867238 0.9248493 0.9724441 0.9248493 0.7867238 0.5715883 0.3005018 0.5 0.3141593
0.0643473 0.299312 0.5693252 0.7836089 0.9211875 0.9685939 0.9211875 0.7836089 0.5693252 0.299312 0.5 0.3141593
0.0723473 0.2981269 0.567071 0.7805063 0.9175402 0.9647589 0.9175402 0.7805063 0.567071 0.2981269 0.5 0.3141593
0.0803473 0.2969465 0.5648258 0.777416 0.9139073 0.960939 0.9139073 0.777416 0.5648258 0.2969465 0.5 0.3141593
0.0963473 0.2945997 0.560362 0.7712721 0.9066847 0.9533447 0.9066847 0.7712721 0.560362 0.2945997 0.5 0.3141593
0.1043473 0.2934333 0.5581433 0.7682183 0.9030948 0.9495701 0.9030948 0.7682183 0.5581433 0.2934333 0.5 0.3141593
0.1123473 0.2922715 0.5559334 0.7651767 0.8995191 0.9458104 0.8995191 0.7651767 0.5559334 0.2922715 0.5 0.3141593
0.1203473 0.2911143 0.5537323 0.7621471 0.8959576 0.9420656 0.8959576 0.7621471 0.5537323 0.2911143 0.5 0.3141593
0.1363473 0.2888136 0.5493561 0.7561238 0.8888769 0.9346204 0.8888769 0.7561238 0.5493561 0.2888136 0.5 0.3141593
0.1443473 0.2876701 0.547181 0.7531301 0.8853575 0.93092 0.8853575 0.7531301 0.547181 0.2876701 0.5 0.3141593
0.1523473 0.2865311 0.5450145 0.7501482 0.881852 0.9272341 0.881852 0.7501482 0.5450145 0.2865311 0.5 0.3141593
0.1603473 0.2853966 0.5428566 0.7471781 0.8783605 0.9235629 0.8783605 0.7471781 0.5428566 0.2853966 0.5 0.3141593
0.1763473 0.2831411 0.5385664 0.7412731 0.8714188 0.9162639 0.8714188 0.7412731 0.5385664 0.2831411 0.5 0.3141593
0.1843473 0.2820201 0.5364341 0.7383381 0.8679685 0.9126361 0.8679685 0.7383381 0.5364341 0.2820201 0.5 0.3141593
0.1923473 0.2809035 0.5343101 0.7354148 0.8645319 0.9090227 0.8645319 0.7354148 0.5343101 0.2809035 0.5 0.3141593
0.2003473 0.2797913 0.5321946 0.732503 0.861109 0.9054235 0.861109 0.732503 0.5321946 0.2797913 0.5 0.3141593
0.2163473 0.2775801 0.5279887 0.726714 0.8543036 0.8982679 0.8543036 0.726714 0.5279887 0.2775801 0.5 0.3141593
0.2243473 0.276481 0.5258982 0.7238367 0.8509211 0.8947114 0.8509211 0.7238367 0.5258982 0.276481 0.5 0.3141593
0.2323473 0.2753863 0.5238159 0.7209708 0.847552 0.8911689 0.847552 0.7209708 0.5238159 0.2753863 0.5 0.3141593
0.2403473 0.274296 0.521742 0.7181162 0.8441962 0.8876405 0.8441962 0.7181162 0.521742 0.274296 0.5 0.3141593
0.2563473 0.2721282 0.5176186 0.7124409 0.8375245 0.8806254 0.8375245 0.7124409 0.5176186 0.2721282 0.5 0.3141593
0.2643473 0.2710508 0.5155692 0.7096201 0.8342085 0.8771387 0.8342085 0.7096201 0.5155692 0.2710508 0.5 0.3141593
0.2723473 0.2699776 0.5135279 0.7068105 0.8309056 0.8736658 0.8309056 0.7068105 0.5135279 0.2699776 0.5 0.3141593
0.2803473 0.2689086 0.5114946 0.704012 0.8276157 0.8702067 0.8276157 0.704012 0.5114946 0.2689086 0.5 0.3141593
0.2963473 0.2667835 0.5074523 0.6984482 0.8210751 0.8633294 0.8210751 0.6984482 0.5074523 0.2667835 0.5 0.3141593
0.3043473 0.2657272 0.5054431 0.6956828 0.8178241 0.8599112 0.8178241 0.6956828 0.5054431 0.2657272 0.5 0.3141593
0.3123473 0.2646751 0.5034419 0.6929283 0.8145861 0.8565065 0.8145861 0.6929283 0.5034419 0.2646751 0.5 0.3141593
0.3203473 0.2636271 0.5014486 0.6901848 0.8113608 0.8531153 0.8113608 0.6901848 0.5014486 0.2636271 0.5 0.3141593
0.3363473 0.2615437 0.4974856 0.6847302 0.8049486 0.8463731 0.8049486 0.6847302 0.4974856 0.2615437 0.5 0.3141593
0.3443473 0.2605081 0.4955159 0.6820191 0.8017616 0.843022 0.8017616 0.6820191 0.4955159 0.2605081 0.5 0.3141593
0.3523473 0.2594767 0.493554 0.6793188 0.7985871 0.8396842 0.7985871 0.6793188 0.493554 0.2594767 0.5 0.3141593
0.3603473 0.2584493 0.4915998 0.6766291 0.7954252 0.8363596 0.7954252 0.6766291 0.4915998 0.2584493 0.5 0.3141593
0.3763473 0.2564068 0.4877147 0.6712817 0.789139 0.8297498 0.789139 0.6712817 0.4877147 0.2564068 0.5 0.3141593
0.3843473 0.2553916 0.4857837 0.6686239 0.7860145 0.8264645 0.7860145 0.6686239 0.4857837 0.2553916 0.5 0.3141593
0.3923473 0.2543804 0.4838603 0.6659765 0.7829024 0.8231923 0.7829024 0.6659765 0.4838603 0.2543804 0.5 0.3141593
0.4003473 0.2533732 0.4819445 0.6633397 0.7798026 0.819933 0.7798026 0.6633397 0.4819445 0.2533732 0.5 0.3141593
0.4163473 0.2513708 0.4781357 0.6580973 0.7736398 0.813453 0.7736398 0.6580973 0.4781357 0.2513708 0.5 0.3141593
0.4243473 0.2503755 0.4762426 0.6554917 0.7705767 0.8102323 0.7705767 0.6554917 0.4762426 0.2503755 0.5 0.3141593
Regression Analysis Graph
Report Graph Store Model
Residuals
Linear & Polynomial Multiple linear Nonlinear
Dependent Variable u1
Independent Variable t
Polynomial Degree
1 Linear
2
3
Through origin
Polynomial Integration
Polynomial Derivative
No File No Title
오후 9:02 2005-11-29 CAPS NUM
시작 POLYMATH 6.0 Pr... Adobe Photoshop 오후 9:02

결과 출력(Numerical solution Graph)



Excel로의 결과 출력(Numerical solution table)



Microsoft Excel - Book1

파일(F) 편집(E) 보기(V) 삽입(I) 서식(O) 도구(T) 차트(C) 창(W) 도움말(H)

돋움 12

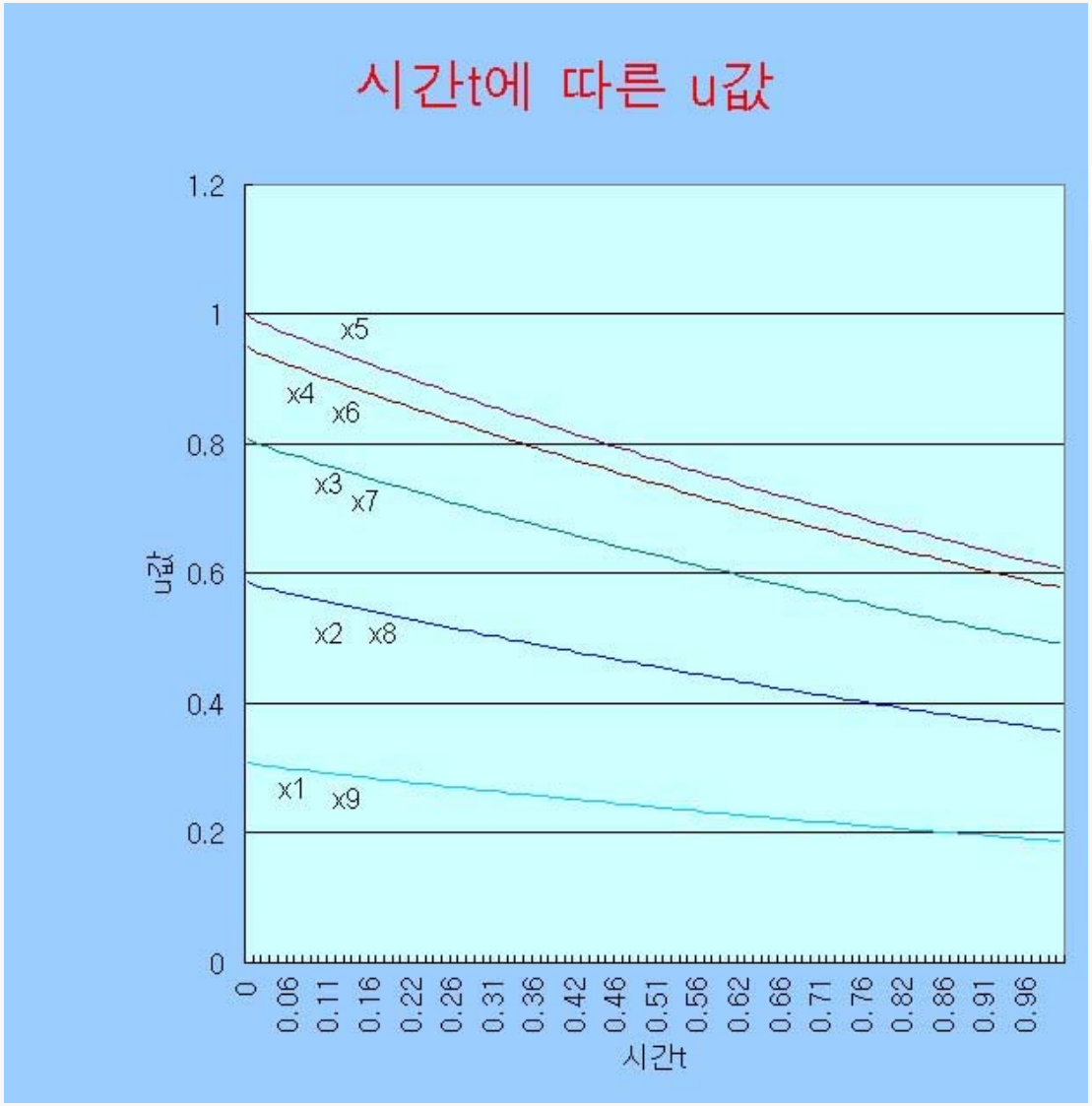
차트 영역

	A	B	C	D	E	F	G	H	I	J
1	t	u1	u2	u3	u4	u5	u6	u7	u8	u9
2	0	0.309017	0.587785	0.809017	0.951057	1	0.951057	0.809017	0.587785	0.309017
3	0.024347	0.305308	0.580731	0.799308	0.939643	0.987999	0.939643	0.799308	0.580731	0.305308
4	0.032347	0.3041	0.578432	0.796143	0.935922	0.984087	0.935922	0.796143	0.578432	0.3041
5	0.040347	0.302896	0.576142	0.792991	0.932217	0.980191	0.932217	0.792991	0.576142	0.302896
6	0.056347	0.300502	0.571588	0.786724	0.924849	0.972444	0.924849	0.786724	0.571588	0.300502
7	0.064347	0.299312	0.569325	0.783609	0.921188	0.968594	0.921188	0.783609	0.569325	0.299312
8	0.072347	0.298127	0.567071	0.780506	0.91754	0.964759	0.91754	0.780506	0.567071	0.298127
9	0.080347	0.296947	0.564826	0.777416	0.913907	0.960939	0.913907	0.777416	0.564826	0.296947
10	0.096347	0.2946	0.560362	0.771272	0.906685	0.953345	0.906685	0.771272	0.560362	0.2946
11	0.104347	0.293433	0.558143	0.768218	0.903095	0.94957	0.903095	0.768218	0.558143	0.293433
12	0.112347	0.292272	0.555933	0.765177	0.899519	0.94581	0.899519	0.765177	0.555933	0.292272
13	0.120347	0.291114	0.553732	0.762147	0.895958	0.942066	0.895958	0.762147	0.553732	0.291114
14	0.136347	0.288814	0.549356	0.756124	0.888877	0.93462	0.888877	0.756124	0.549356	0.288814
15	0.144347	0.28767	0.547181	0.75313	0.885358	0.93092	0.885358	0.75313	0.547181	0.28767
16	0.152347	0.286531	0.545015	0.750148	0.881852	0.927234	0.881852	0.750148	0.545015	0.286531
17	0.160347	0.285397	0.542857	0.747178	0.878361	0.923563	0.878361	0.747178	0.542857	0.285397
18	0.176347	0.283141	0.538566	0.741273	0.871419	0.916264	0.871419	0.741273	0.538566	0.283141
19	0.184347	0.28202	0.536434	0.738338	0.867969	0.912636	0.867969	0.738338	0.536434	0.28202
20	0.192347	0.280904	0.53431	0.735415	0.864532	0.909023	0.864532	0.735415	0.53431	0.280904
21	0.200347	0.279791	0.532195	0.732503	0.861109	0.905424	0.861109	0.732503	0.532195	0.279791
22	0.216347	0.27758	0.527989	0.726714	0.854304	0.898268	0.854304	0.726714	0.527989	0.27758
23	0.224347	0.276481	0.525898	0.723837	0.850921	0.894711	0.850921	0.723837	0.525898	0.276481
24	0.232347	0.275386	0.523816	0.720971	0.847552	0.891169	0.847552	0.720971	0.523816	0.275386
25	0.240347	0.274296	0.521742	0.718116	0.844196	0.887641	0.844196	0.718116	0.521742	0.274296
26	0.256347	0.272128	0.517619	0.712441	0.837525	0.880625	0.837525	0.712441	0.517619	0.272128
27	0.264347	0.271051	0.515569	0.70962	0.834209	0.877139	0.834209	0.70962	0.515569	0.271051
28	0.272347	0.269978	0.513528	0.706811	0.830906	0.873666	0.830906	0.706811	0.513528	0.269978
29	0.280347	0.268909	0.511495	0.704012	0.827616	0.870207	0.827616	0.704012	0.511495	0.268909
30	0.296347	0.266784	0.507452	0.698448	0.821075	0.863329	0.821075	0.698448	0.507452	0.266784
31	0.304347	0.265727	0.505443	0.695683	0.817824	0.859911	0.817824	0.695683	0.505443	0.265727
32	0.312347	0.264675	0.503442	0.692928	0.814586	0.856507	0.814586	0.692928	0.503442	0.264675
33	0.320347	0.263627	0.501449	0.690185	0.811361	0.853115	0.811361	0.690185	0.501449	0.263627
34	0.336347	0.261544	0.497486	0.68473	0.804949	0.846373	0.804949	0.68473	0.497486	0.261544
35	0.344347	0.260508	0.495516	0.682019	0.801762	0.843022	0.801762	0.682019	0.495516	0.260508
36	0.352347	0.259477	0.493554	0.679319	0.798587	0.839684	0.798587	0.679319	0.493554	0.259477
37	0.360347	0.258449	0.4916	0.676629	0.795425	0.83636	0.795425	0.676629	0.4916	0.258449
38	0.376347	0.256407	0.487715	0.671282	0.789139	0.82975	0.789139	0.671282	0.487715	0.256407
39	0.384347	0.255392	0.485784	0.668624	0.786015	0.826465	0.786015	0.668624	0.485784	0.255392
40	0.392347	0.25438	0.48386	0.665977	0.782902	0.823192	0.782902	0.665977	0.48386	0.25438
41	0.400347	0.253373	0.481945	0.66334	0.779803	0.819933	0.779803	0.66334	0.481945	0.253373
42	0.416347	0.251371	0.478136	0.658097	0.77364	0.813453	0.77364	0.658097	0.478136	0.251371
43	0.424347	0.250376	0.476243	0.655492	0.770577	0.810232	0.770577	0.655492	0.476243	0.250376
44	0.432347	0.249384	0.474357	0.652896	0.767526	0.807024	0.767526	0.652896	0.474357	0.249384
45	0.440347	0.248397	0.472479	0.650311	0.764487	0.803829	0.764487	0.650311	0.472479	0.248397
46	0.456347	0.246434	0.468745	0.645172	0.758445	0.797476	0.758445	0.645172	0.468745	0.246434
47	0.464347	0.245458	0.466889	0.642617	0.755442	0.794319	0.755442	0.642617	0.466889	0.245458
48	0.472347	0.244486	0.46504	0.640073	0.752451	0.791174	0.752451	0.640073	0.46504	0.244486
49	0.480347	0.243518	0.463199	0.637539	0.749472	0.788041	0.749472	0.637539	0.463199	0.243518

PL1 Sheet1 Sheet2 Sheet3

그리기(R) 도형(U)

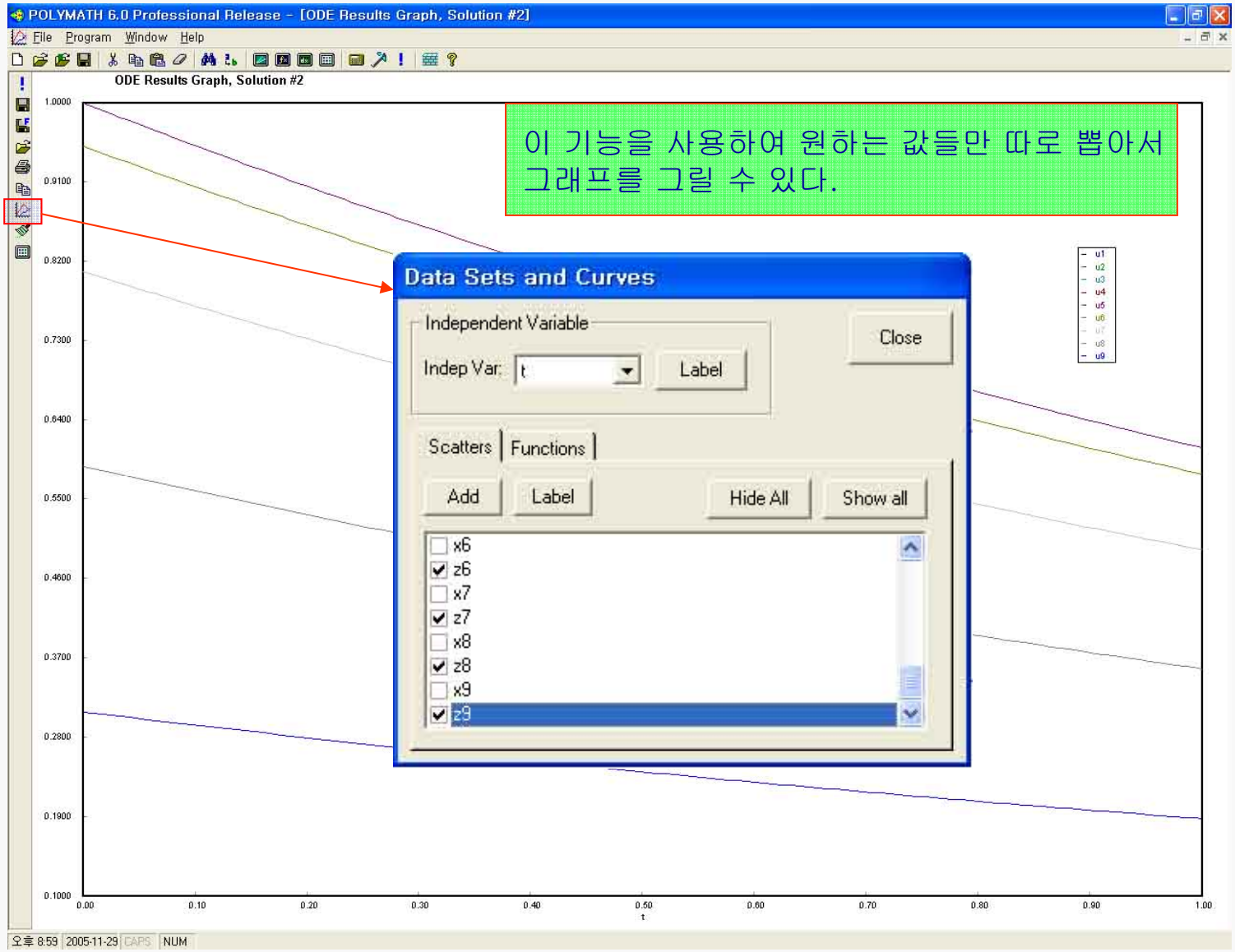
Excel로의 결과 출력(Numerical solution Graph)



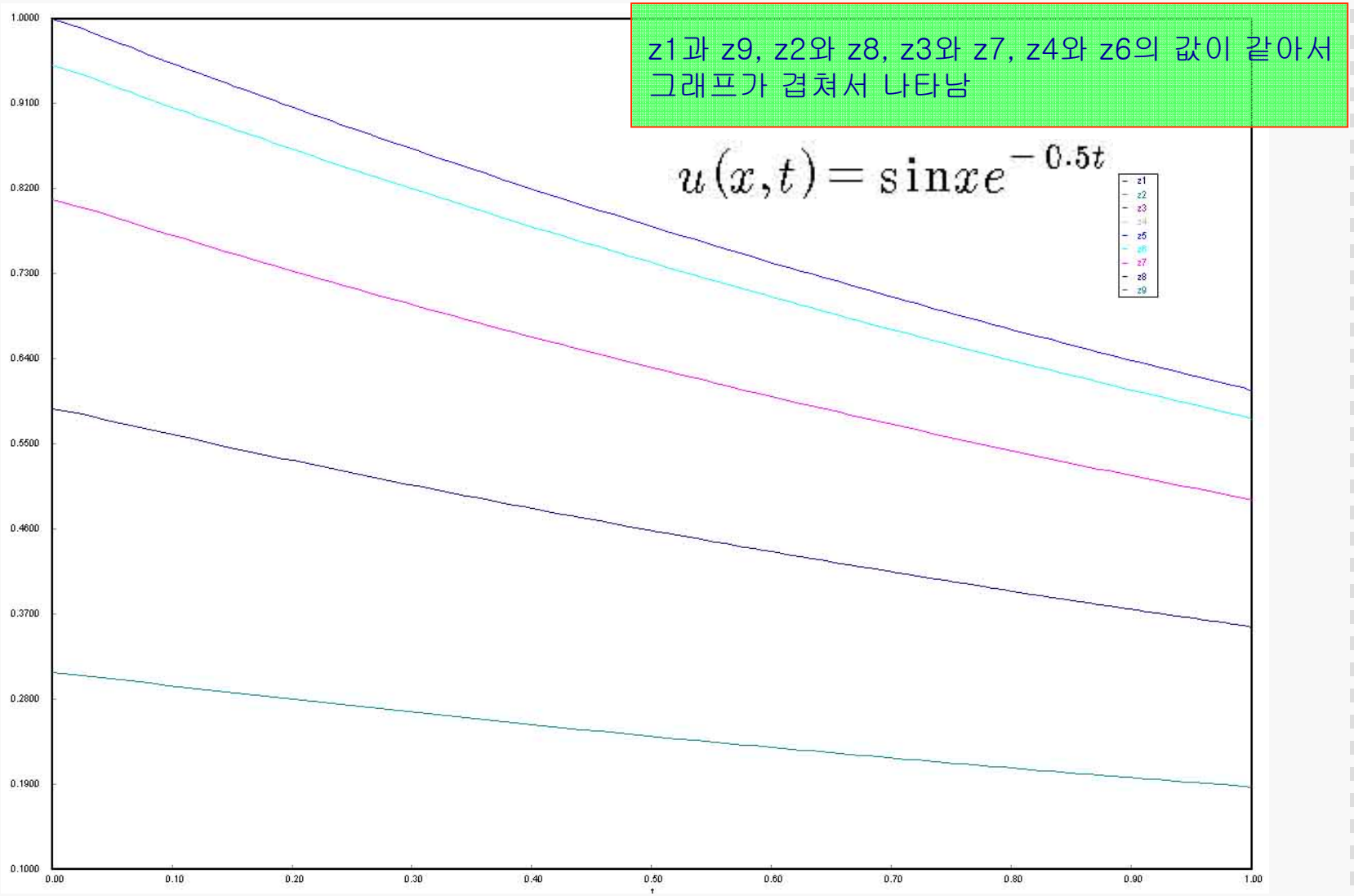
$\Delta x = 0.1\pi$

$\alpha = 0.5$

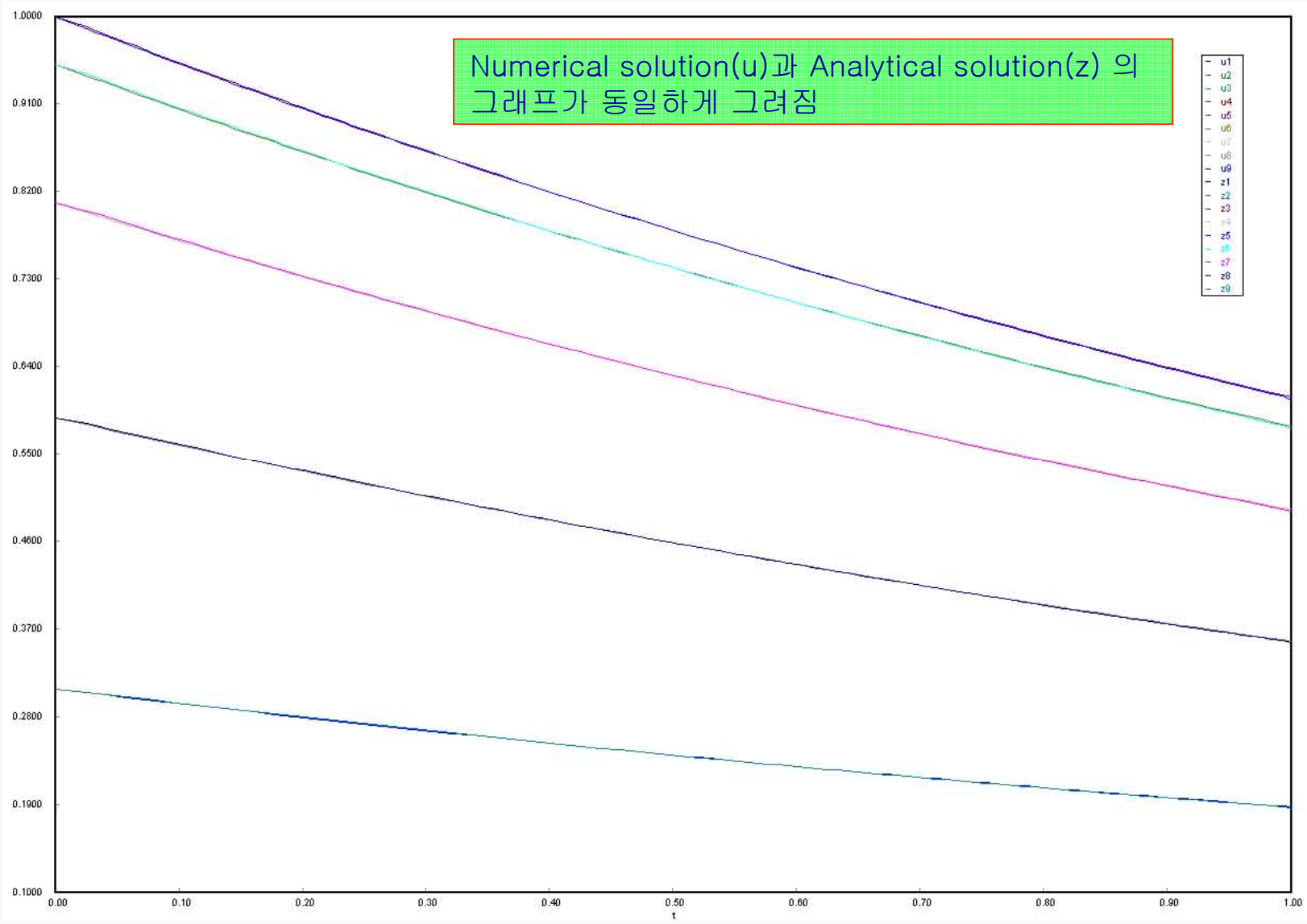
선택적 그래프 그리기


POLYMATH 6.0 Professional Release - [ODE Results Graph, Solution #2]
File Program Window Help
ODE Results Graph, Solution #2
이 기능을 사용하여 원하는 값들만 따로 뽑아서 그래프를 그릴 수 있다.
Data Sets and Curves
Independent Variable
Indep Var: t
Label
Close
Scatters
Functions
Add
Label
Hide All
Show all
x6
z6
x7
z7
x8
z8
x9
z9
u1
u2
u3
u4
u5
u6
u7
u8
u9
1.0000
0.9100
0.8200
0.7300
0.6400
0.5500
0.4600
0.3700
0.2800
0.1900
0.1000
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
t
오후 8:59
2005-11-29
CAPS
NUM

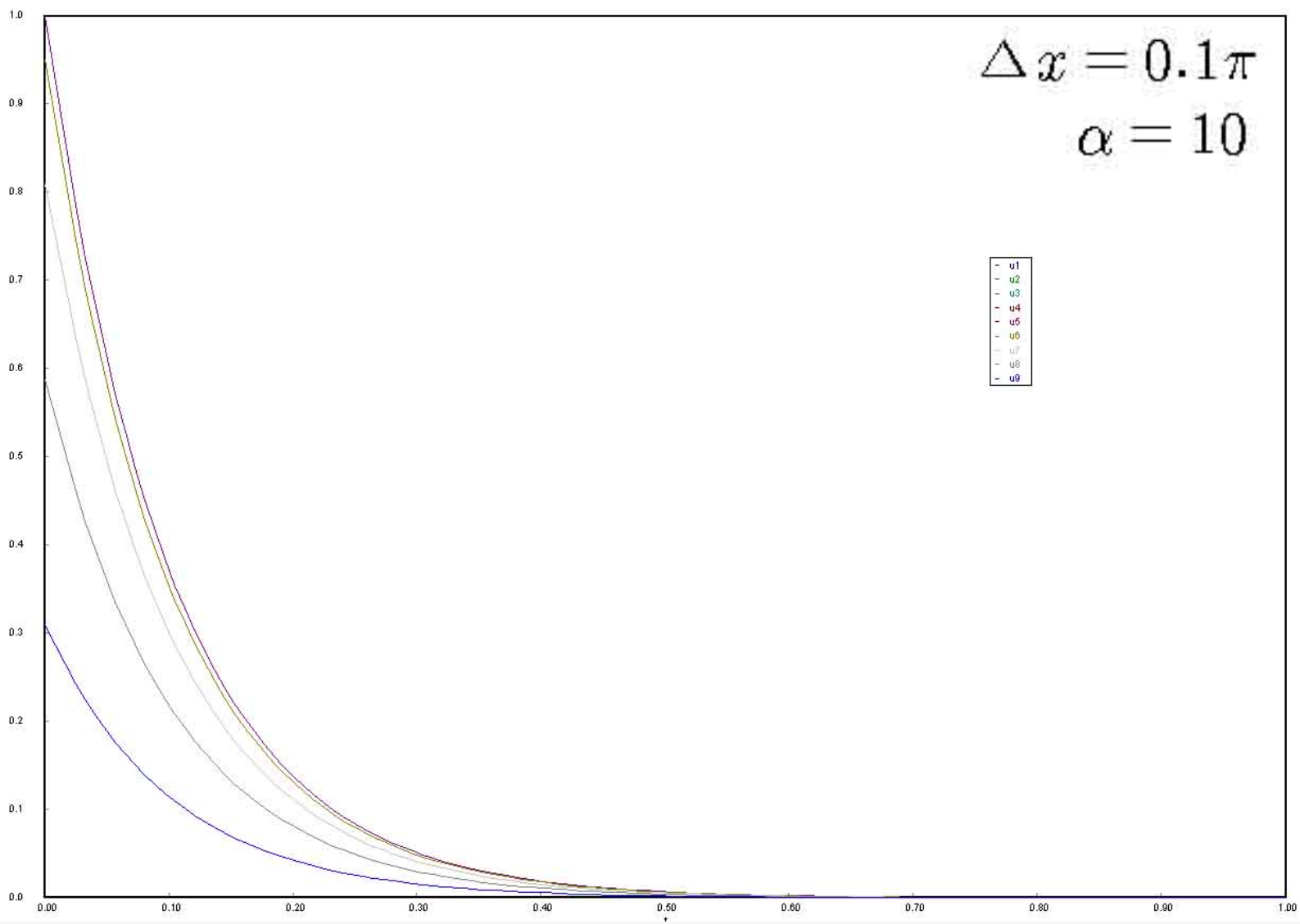
결과 출력(Analytical solution Graph)



Numerical solution(u)과 Analytical solution(z)의 비교



값 변화에 따른 그래프


$\Delta x = 0.1\pi$
$\alpha = 10$
u1
u2
u3
u4
u5
u6
u7
u8
u9
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

$\Delta x = 0.2\pi$ 일때의 입력데이터

```
d(u1)/d(t) = a * (u2 - 2 * u1 + u0) / deltax ^ 2
u1(0) = 0.587785252
d(u2)/d(t) = a * (u3 - 2 * u2 + u1) / deltax ^ 2
u2(0) = 0.951056516
d(u3)/d(t) = a * (u4 - 2 * u3 + u2) / deltax ^ 2
u3(0) = 0.951056516
d(u4)/d(t) = a * (u5 - 2 * u4 + u3) / deltax ^ 2
u4(0) = 0.587785252
a = 0.5
deltax = 0.2 * 3.141592654
u5 = 0
u0 = 0
t(0) = 0
t(f) = 1

z1 = sin(x1) * exp(-a * t)
x1 = 0.2 * 3.141592654
z2 = sin(x2) * exp(-a * t)
x2 = 0.4 * 3.141592654
z3 = sin(x3) * exp(-a * t)
x3 = 0.6 * 3.141592654
z4 = sin(x4) * exp(-a * t)
x4 = 0.8 * 3.141592654
```

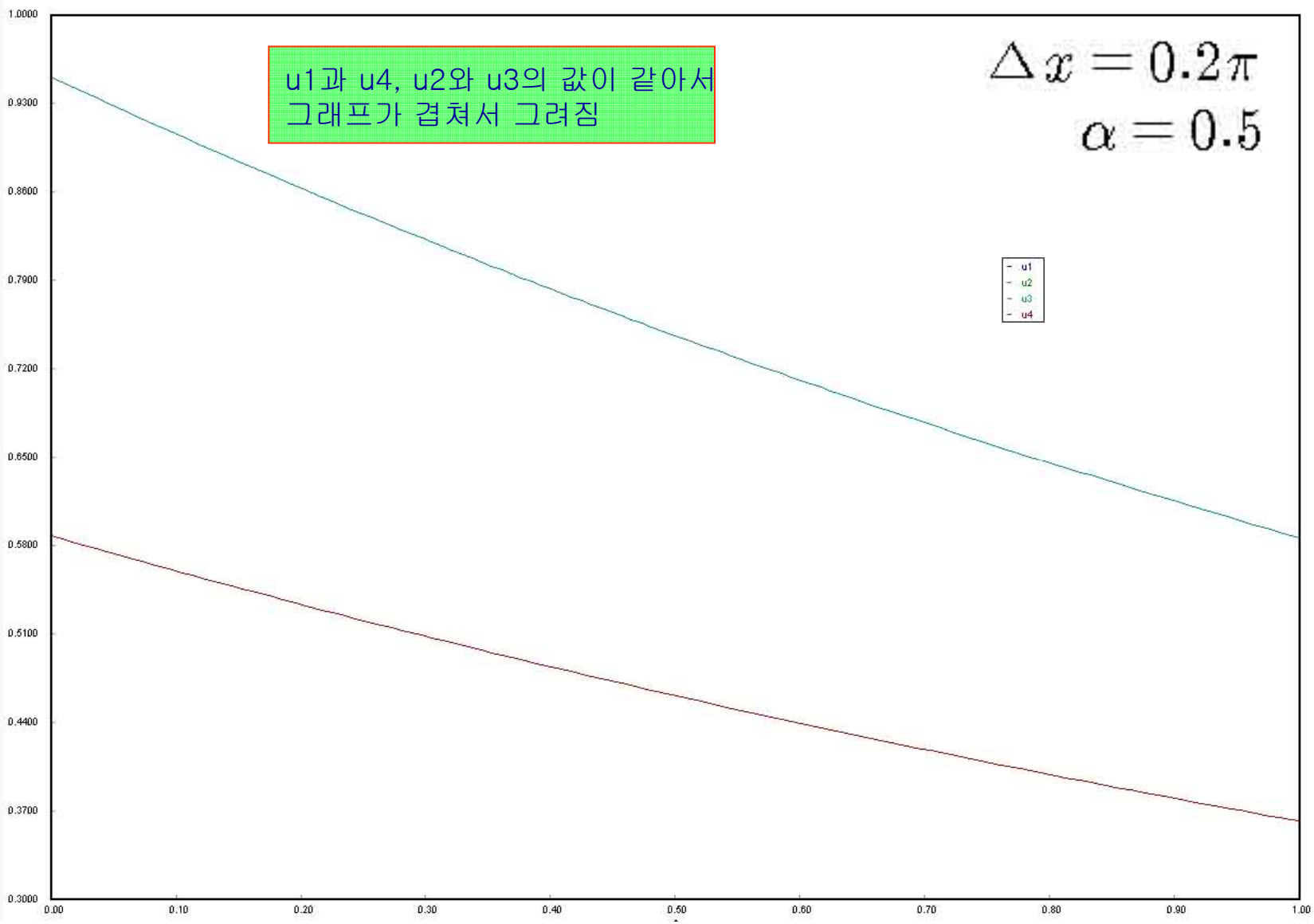
Δx의 변화에 따른 u1,u2,u3,u4값 새로 정리

엑셀을 통한 초기값 입력

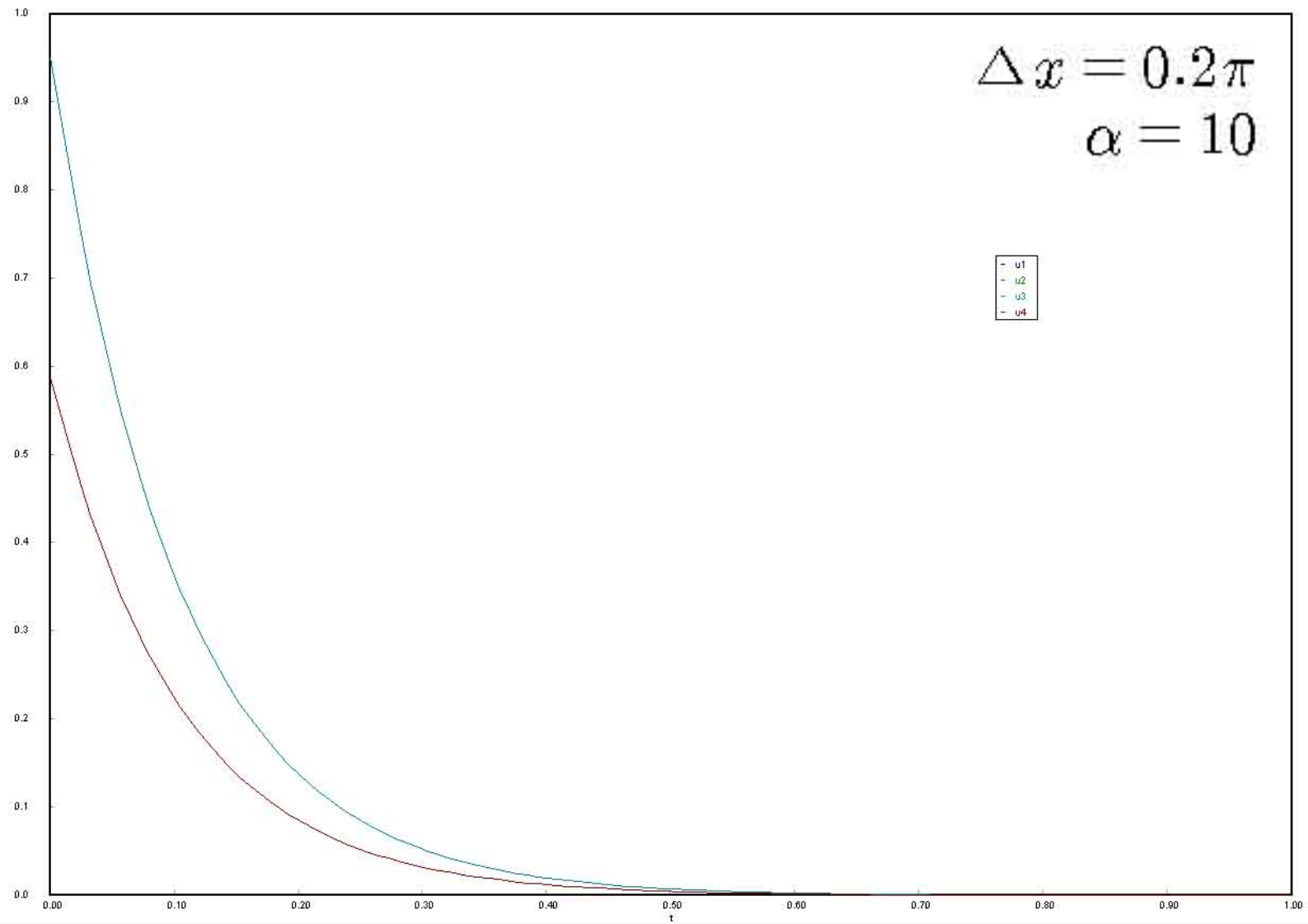
Δx의 변화에따른 x1,x2,x3,x4값 새로 지정해준 후 변수분리 된 정확해 입력

deltax=0.2*pi일 때				
	x값	x값	초기값	
	pi	3.141592654	sinx	
0.2	0.2*pi	0.628318531	0.587785252	u1일때의초기값
0.4	0.4*pi	1.256637061	0.951056516	u2일때의초기값
0.6	0.6*pi	1.884955592	0.951056516	u3일때의초기값
0.8	0.8*pi	2.513274123	0.587785252	u4일때의초기값

값 변화에 따른 그래프


u1과 u4, u2와 u3의 값이 같아서
그래프가 겹쳐서 그려짐
$\Delta x = 0.2\pi$
$\alpha = 0.5$
u1
u2
u3
u4
1.0000
0.9300
0.8600
0.7900
0.7200
0.6500
0.5800
0.5100
0.4400
0.3700
0.3000
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

값 변화에 따른 그래프


$\triangle x = 0.2\pi$
$\alpha = 10$
u1
u2
u3
u4
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
t

토론 및 검토

- Numerical solution과 Analytical solution의 값이 거의 동일하게 나옴.
- U값은 가운데를 중심으로 대칭됨.
- Δx값을 작게 해주면 더 조밀한 간격의 u값의 변화를 알 수 있음.
- α값의 변화에 따른 데이터 값은 α값이 클수록 u값이 급격히 감소하는 경향을 보임.