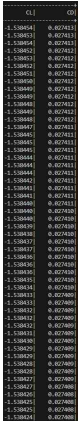
전산유체해석실습 과제 (4차)

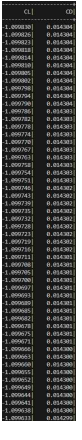
과목명 : 전산유체해석실습
담당교수 : 임동균 교수님
학과 : 항공기계공학과
학번 : 2021010530
이름 : 박진우
제출일 : 25-10-16

NACA0012

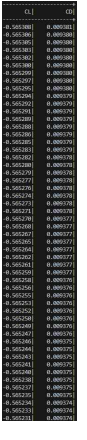
- Cl, CD


deg_-15

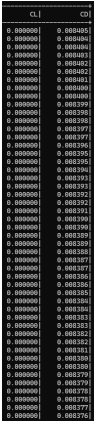
Cl	CD
-1.538454	0.027413
-1.538453	0.027413
-1.538454	0.027413
-1.538452	0.027413
-1.538453	0.027412
-1.538452	0.027412
-1.538451	0.027412
-1.538450	0.027412
-1.538449	0.027412
-1.538449	0.027412
-1.538448	0.027412
-1.538448	0.027412
-1.538448	0.027412
-1.538447	0.027413
-1.538446	0.027413
-1.538445	0.027413
-1.538444	0.027413
-1.538444	0.027413
-1.538444	0.027413
-1.538442	0.027413
-1.538441	0.027413
-1.538441	0.027413
-1.538440	0.027413
-1.538440	0.027410
-1.538439	0.027410
-1.538438	0.027410
-1.538437	0.027410
-1.538437	0.027410
-1.538436	0.027410
-1.538435	0.027410
-1.538435	0.027410
-1.538434	0.027410
-1.538433	0.027409
-1.538433	0.027409
-1.538432	0.027409
-1.538432	0.027409
-1.538432	0.027409
-1.538431	0.027409
-1.538430	0.027409
-1.538429	0.027409
-1.538429	0.027409
-1.538428	0.027408
-1.538427	0.027408
-1.538427	0.027408
-1.538426	0.027408
-1.538425	0.027408
-1.538425	0.027408
-1.538424	0.027408


deg_-10

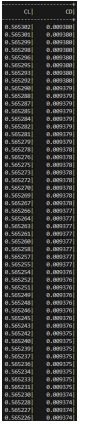
Cl	CD
-1.0998380	0.0143844
-1.0998226	0.0143844
-1.0998213	0.0143844
-1.0998038	0.0143844
-1.0998014	0.0143844
-1.0998010	0.0143844
-1.0998005	0.0143844
-1.0998002	0.0143844
-1.0997998	0.0143844
-1.0997994	0.0143844
-1.0997994	0.0143844
-1.0997990	0.0143844
-1.0997861	0.0143843
-1.0997822	0.0143843
-1.0997778	0.0143843
-1.0997774	0.0143843
-1.0997770	0.0143843
-1.0997767	0.0143843
-1.0997671	0.0143843
-1.0997587	0.0143843
-1.0997554	0.0143843
-1.0997551	0.0143843
-1.0997546	0.0143842
-1.0997417	0.0143842
-1.0997399	0.0143842
-1.0997335	0.0143842
-1.0997327	0.0143842
-1.0997228	0.0143842
-1.0997231	0.0143842
-1.0997210	0.0143842
-1.0997207	0.0143842
-1.0997111	0.0143841
-1.0997063	0.0143841
-1.0997055	0.0143841
-1.0997051	0.0143841
-1.0996997	0.0143841
-1.0996933	0.0143841
-1.0996885	0.0143841
-1.0996881	0.0143841
-1.0996852	0.0143841
-1.0996778	0.0143841
-1.0996771	0.0143841
-1.0996767	0.0143841
-1.0996663	0.0143840
-1.0996660	0.0143840
-1.0996655	0.0143840
-1.0996521	0.0143840
-1.0996489	0.0143840
-1.0996484	0.0143840
-1.0996341	0.0143840
-1.0996338	0.0143840
-1.0996331	0.0143840


deg_-5

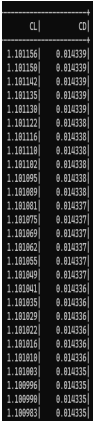
Cl	CD
-0.5653881	0.0093883
-0.5653896	0.0093880
-0.5653851	0.0093880
-0.5653849	0.0093880
-0.5653847	0.0093880
-0.5653842	0.0093880
-0.5653840	0.0093880
-0.5653839	0.0093880
-0.5653838	0.0093880
-0.5653837	0.0093880
-0.5653836	0.0093880
-0.5653835	0.0093880
-0.5653834	0.0093880
-0.5653833	0.0093880
-0.5653832	0.0093880
-0.5653831	0.0093880
-0.5653830	0.0093880
-0.5653829	0.0093880
-0.5653828	0.0093880
-0.5653827	0.0093880
-0.5653826	0.0093880
-0.5653825	0.0093880
-0.5653824	0.0093880
-0.5653823	0.0093880
-0.5653822	0.0093880
-0.5653821	0.0093880
-0.5653820	0.0093880
-0.5653819	0.0093880
-0.5653818	0.0093880
-0.5653817	0.0093880
-0.5653816	0.0093880
-0.5653815	0.0093880
-0.5653814	0.0093880
-0.5653813	0.0093880
-0.5653812	0.0093880
-0.5653811	0.0093880
-0.5653810	0.0093880
-0.5653809	0.0093880
-0.5653808	0.0093880
-0.5653807	0.0093880
-0.5653806	0.0093880
-0.5653805	0.0093880
-0.5653804	0.0093880
-0.5653803	0.0093880
-0.5653802	0.0093880
-0.5653801	0.0093880
-0.5653800	0.0093880
-0.5653799	0.0093880
-0.5653798	0.0093880
-0.5653797	0.0093880
-0.5653796	0.0093880
-0.5653795	0.0093880
-0.5653794	0.0093880
-0.5653793	0.0093880
-0.5653792	0.0093880
-0.5653791	0.0093880
-0.5653790	0.0093880
-0.5653789	0.0093880
-0.5653788	0.0093880
-0.5653787	0.0093880
-0.5653786	0.0093880
-0.5653785	0.0093880
-0.5653784	0.0093880
-0.5653783	0.0093880
-0.5653782	0.0093880
-0.5653781	0.0093880
-0.5653780	0.0093880
-0.5653779	0.0093880
-0.5653778	0.0093880
-0.5653777	0.0093880
-0.5653776	0.0093880
-0.5653775	0.0093880
-0.5653774	0.0093880


deg_0

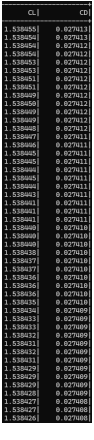
Cl	CD
0.0000000	0.0088485
0.0000000	0.0088484
0.0000000	0.0088484
0.0000000	0.0088483
0.0000000	0.0088483
0.0000000	0.0088482
0.0000000	0.0088482
0.0000000	0.0088481
0.0000000	0.0088480
0.0000000	0.0088480
0.0000000	0.0088399
0.0000000	0.0088398
0.0000000	0.0088398
0.0000000	0.0088397
0.0000000	0.0088397
0.0000000	0.0088396
0.0000000	0.0088395
0.0000000	0.0088395
0.0000000	0.0088394
0.0000000	0.0088393
0.0000000	0.0088393
0.0000000	0.0088392
0.0000000	0.0088392
0.0000000	0.0088391
0.0000000	0.0088390
0.0000000	0.0088390
0.0000000	0.0088389
0.0000000	0.0088388
0.0000000	0.0088387
0.0000000	0.0088387
0.0000000	0.0088386
0.0000000	0.0088386
0.0000000	0.0088385
0.0000000	0.0088384
0.0000000	0.0088384
0.0000000	0.0088383
0.0000000	0.0088383
0.0000000	0.0088382
0.0000000	0.0088382
0.0000000	0.0088381
0.0000000	0.0088381
0.0000000	0.0088380
0.0000000	0.0088379
0.0000000	0.0088379
0.0000000	0.0088378
0.0000000	0.0088378
0.0000000	0.0088377
0.0000000	0.0088376


deg_5

Cl	CD
0.5653922	0.0093880
0.5653857	0.0093880
0.5652999	0.0093880
0.5652981	0.0093880
0.5652966	0.0093880
0.5652953	0.0093880
0.5652933	0.0093880
0.5652922	0.0093880
0.5652900	0.0093879
0.5652887	0.0093879
0.5652881	0.0093879
0.5652847	0.0093879
0.5652832	0.0093879
0.5652821	0.0093879
0.5652797	0.0093879
0.5652790	0.0093878
0.5652786	0.0093878
0.5652751	0.0093878
0.5652723	0.0093878
0.5652700	0.0093878
0.5652699	0.0093878
0.5652697	0.0093878
0.5652666	0.0093877
0.5652644	0.0093877
0.5652633	0.0093877
0.5652602	0.0093877
0.5652600	0.0093877
0.5652588	0.0093877
0.5652577	0.0093877
0.5652551	0.0093877
0.5652548	0.0093876
0.5652522	0.0093876
0.5652515	0.0093876
0.5652490	0.0093876
0.5652483	0.0093876
0.5652460	0.0093876
0.5652455	0.0093876
0.5652451	0.0093875
0.5652433	0.0093875
0.5652427	0.0093875
0.5652408	0.0093875
0.5652403	0.0093875
0.5652399	0.0093875
0.5652384	0.0093875
0.5652375	0.0093875
0.5652370	0.0093875
0.5652367	0.0093874
0.5652359	0.0093874
0.5652356	0.0093874
0.5652354	0.0093874
0.5652351	0.0093874
0.5652349	0.0093874
0.5652347	0.0093874
0.5652346	0.0093874


deg_10

Cl	CD
1.101156	0.0143397
1.101150	0.0143397
1.101142	0.0143397
1.101135	0.0143397
1.101130	0.0143397
1.101122	0.0143398
1.101116	0.0143398
1.101110	0.0143398
1.101102	0.0143398
1.101095	0.0143398
1.101089	0.0143398
1.101081	0.0143377
1.101075	0.0143377
1.101069	0.0143377
1.101062	0.0143377
1.101055	0.0143377
1.101049	0.0143377
1.101041	0.0143376
1.101035	0.0143376
1.101029	0.0143376
1.101022	0.0143376
1.101016	0.0143376
1.101010	0.0143376
1.101003	0.0143375
1.100996	0.0143375
1.100990	0.0143375
1.100983	0.0143375

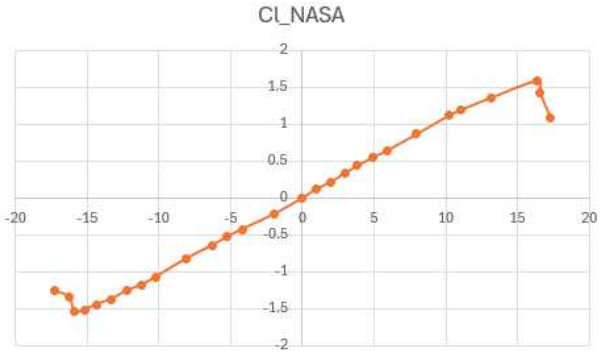

deg_15

Cl	CD
1.538455	0.027413
1.538454	0.027413
1.538454	0.027412
1.538454	0.027412
1.538453	0.027412
1.538453	0.027412
1.538451	0.027412
1.538451	0.027412
1.538449	0.027412
1.538450	0.027412
1.538449	0.027412
1.538449	0.027412
1.538448	0.027412
1.538447	0.027412
1.538446	0.027411
1.538445	0.027411
1.538445	0.027411
1.538444	0.027411
1.538445	0.027411
1.538443	0.027412
1.538441	0.027411
1.538441	0.027411
1.538441	0.027411
1.538440	0.027410
1.538440	0.027410
1.538439	0.027410
1.538439	0.027410
1.538437	0.027410
1.538437	0.027410
1.538436	0.027410
1.538436	0.027410
1.538435	0.027410
1.538435	0.027410
1.538434	0.027409
1.538434	0.027409
1.538433	0.027409
1.538433	0.027409
1.538432	0.027409
1.538431	0.027409
1.538431	0.027409
1.538432	0.027409
1.538431	0.027409
1.538429	0.027409
1.538429	0.027409
1.538429	0.027409
1.538428	0.027409
1.538428	0.027408
1.538427	0.027408
1.538426	0.027408

NACA0012

- deg, Cl_NASA

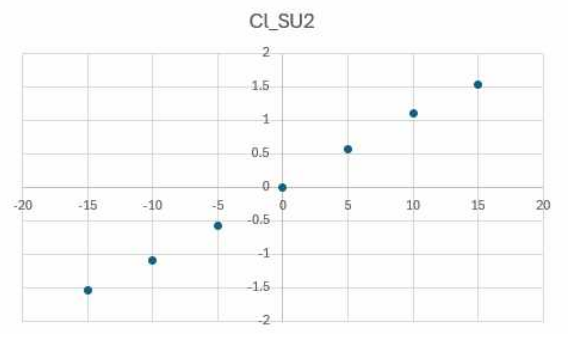
deg	Cl_NASA
-17.2794	-1.25323
-16.2296	-1.34704
-15.8616	-1.54416
-15.1713	-1.51805
-14.3133	-1.44038
-13.2811	-1.3712
-12.2535	-1.25912
-11.2222	-1.18135
-10.1947	-1.06927
-8.14138	-0.82796
-6.25579	-0.63821
-5.22822	-0.52613
-4.19972	-0.42263
-1.96944	-0.21553
0	0
0.940006	0.120611
1.96944	0.215533
2.99515	0.34477
3.85131	0.439599
4.87888	0.551678
5.90831	0.6466
7.96346	0.870758
10.1891	1.12074
11.0471	1.19842
13.1088	1.36252
16.3759	1.59591
16.5678	1.42443
17.2971	1.09024



NACA0012

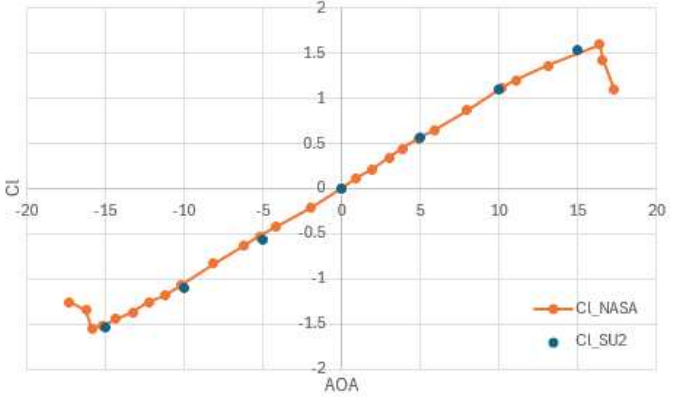
- deg,Cl_SU2

deg	Cl_SU2
-15	-1.53842
-10	-1.09963
-5	-0.56523
0	0
5	0.565226
10	1.100983
15	1.538426



NACA0012

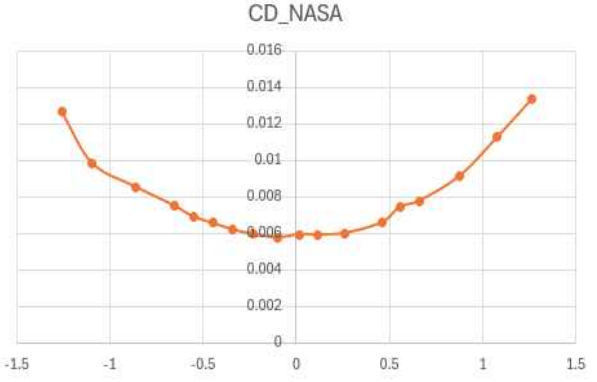
- deg,Cl_비교



NACA0012

- Cl, CD_NASA

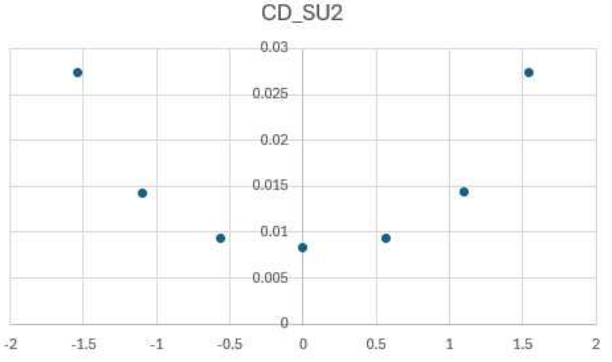
Cl	CD_NASA
-1.25583	0.012713
-1.09305	0.009865
-0.860237	0.008562
-0.653233	0.007519
-0.549778	0.006911
-0.446183	0.006562
-0.342588	0.006212
-0.230298	0.005948
-0.100665	0.005769
0.0205051	0.005934
0.115637	0.005929
0.262707	0.006007
0.461945	0.006599
0.557543	0.007454
0.661509	0.007792
0.878463	0.009157
1.07854	0.011297
1.26127	0.013352



NACA0012

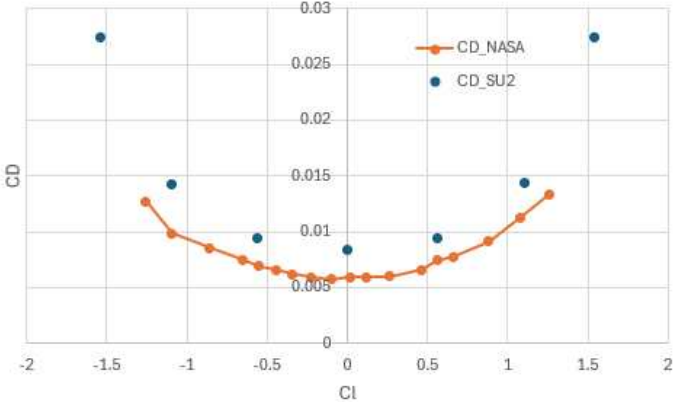
- Cl, CD_SU2

Cl	CD_SU2
-1.53842	0.027408
-1.09963	0.014299
-0.56523	0.009374
0	0.008376
0.565226	0.009374
1.100983	0.014335
1.538426	0.027408



NACA0012

- Cl, CD_비교



AOA_0deg

- 조건

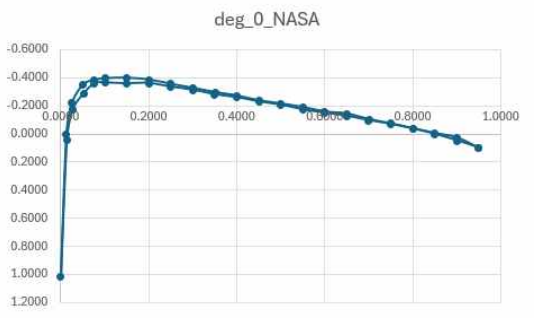
```
% ------------------- COMPRESSIBLE FREE-STREAM DEFINITION -------------------%
%
% Mach number (non-dimensional, based on the free-stream values)
MACH_NUMBER= 0.15
%
% Angle of attack (degrees, only for compressible flows)
AOA= 0.0
%
% Side-slip angle (degrees, only for compressible flows)
SIDESLIP_ANGLE= 0.0
%
% Init option to choose between Reynolds (default) or thermodynamics quantities
% for initializing the solution (REYNOLDS, TD_CONDITIONS)
INIT_OPTION= REYNOLDS
%
% Free-stream option to choose between density and temperature (default) for
% initializing the solution (TEMPERATURE_FS, DENSITY_FS)
FREESTREAM_OPTION= TEMPERATURE_FS
%
% Free-stream temperature (288.15 K by default)
FREESTREAM_TEMPERATURE= 288.15
%
% Reynolds number (non-dimensional, based on the free-stream values)
REYNOLDS_NUMBER= 6.0E6
%
% Reynolds length (1 m by default)
REYNOLDS_LENGTH= 1.0
```

```
% ------------------- BOUNDARY CONDITION DEFINITION -------------------------%
%
% Navier-Stokes wall boundary marker(s) (NONE = no marker)
MARKER_HEATFLUX= ( airfoil, 0.0 )
%
% Far-field boundary marker(s) (NONE = no marker)
MARKER_FAR= ( farfield )
%
% Symmetry boundary marker(s) (NONE = no marker)
%MARKER_SYM= ( SYMMETRY )
%
% Marker(s) of the surface to be plotted or designed
MARKER_PLOTTING= ( airfoil )
%
% Marker(s) of the surface where the functional (Cd, Cl, etc.) will be evaluated
MARKER_MONITORING= ( airfoil )
```

AOA_0deg

- point data_NASA

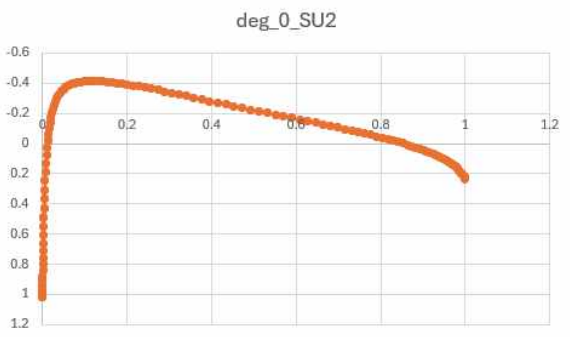
x/c	deg_0_NASA
0.9483	0.1008
0.9000	0.0279
0.8503	-0.0038
0.7998	-0.0378
0.7497	-0.0731
0.7003	-0.1027
0.6502	-0.1428
0.5997	-0.1585
0.5506	-0.1887
0.5000	-0.2152
0.4503	-0.2371
0.4000	-0.2716
0.3507	-0.2958
0.3002	-0.3257
0.2501	-0.3550
0.2004	-0.3854
0.1504	-0.3986
0.1000	-0.3949
0.0755	-0.3815
0.0510	-0.3522
0.0251	-0.2208
0.0122	0.0070
0.0000	1.0184
0.0135	0.0407
0.0271	-0.1745
0.0515	-0.2864
0.0763	-0.3605
0.1012	-0.3644
0.1503	-0.3592
0.1994	-0.3618
0.2501	-0.3346
0.2999	-0.3139



AOA_0deg

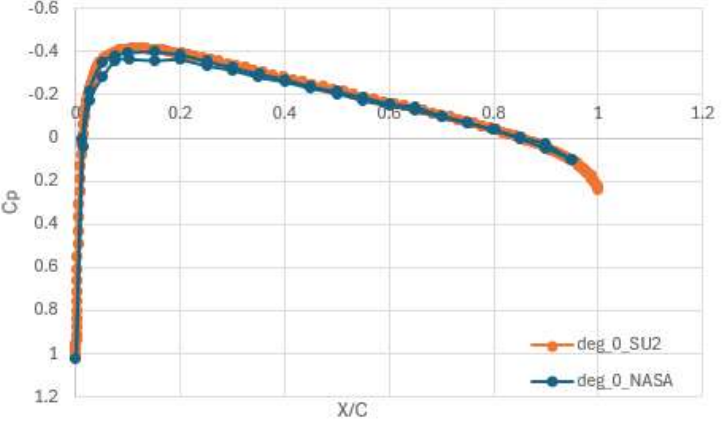
- point data_SU2

Points_0	deg_0_SU2
1	0.237729
0.997966	0.222476
0.995782	0.214159
0.993438	0.204886
0.990924	0.195198
0.988228	0.185737
0.985337	0.176677
0.982239	0.167937
0.978921	0.159393
0.975369	0.150958
0.971568	0.142593
0.967502	0.134293
0.963157	0.126068
0.958515	0.117832
0.95356	0.10966
0.948275	0.101539
0.942641	0.0934196
0.93664	0.0852783
0.930255	0.0770796
0.923466	0.0687968
0.916256	0.0604111
0.908605	0.0519186
0.900496	0.043317
0.891912	0.0346103
0.882836	0.025806
0.873252	0.0169096
0.863146	0.0079285
0.852504	-0.0011335
0.841316	-0.0102726
0.829572	-0.0194875
0.817266	-0.0287797
0.804393	-0.0381498



AOA_0deg

- 비교



AOA_10deg

- 조건

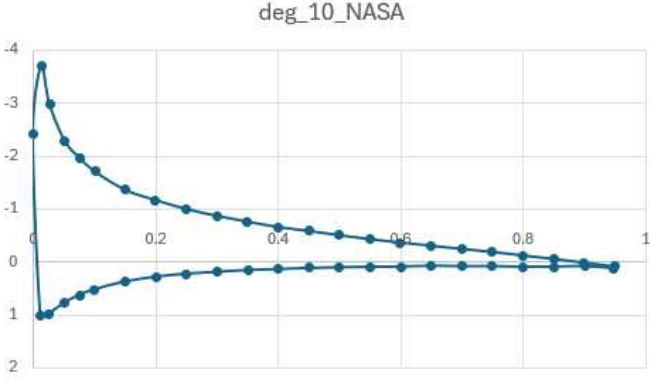
```
% ------------------- COMPRESSIBLE FREE-STREAM DEFINITION -------------------%
%
% Mach number (non-dimensional, based on the free-stream values)
MACH_NUMBER= 0.15
%
% Angle of attack (degrees, only for compressible flows)
AOA= 10.0
%
% Side-slip angle (degrees, only for compressible flows)
SIDESLIP_ANGLE= 0.0
%
% Init option to choose between Reynolds (default) or thermodynamics quantities
% for initializing the solution (REYNOLDS, TD_CONDITIONS)
INIT_OPTION= REYNOLDS
%
% Free-stream option to choose between density and temperature (default) for
% initializing the solution (TEMPERATURE_FS, DENSITY_FS)
FREESTREAM_OPTION= TEMPERATURE_FS
%
% Free-stream temperature (288.15 K by default)
FREESTREAM_TEMPERATURE= 288.15
%
% Reynolds number (non-dimensional, based on the free-stream values)
REYNOLDS_NUMBER= 6.0E6
%
% Reynolds length (1 m by default)
REYNOLDS_LENGTH= 1.0
```

```
% ------------------- BOUNDARY CONDITION DEFINITION -------------------------%
%
% Navier-Stokes wall boundary marker(s) (NONE = no marker)
MARKER_HEATFLUX= ( airfoil, 0.0 )
%
% Far-field boundary marker(s) (NONE = no marker)
MARKER_FAR= ( farfield )
%
% Symmetry boundary marker(s) (NONE = no marker)
%MARKER_SYM= ( SYMMETRY )
%
% Marker(s) of the surface to be plotted or designed
MARKER_PLOTTING= ( airfoil )
%
% Marker(s) of the surface where the functional (Cd, Cl, etc.) will be evaluated
MARKER_MONITORING= ( airfoil )
```

AOA_10deg

- point data_NASA

x/c	deg_10_NASA
0.9483	0.1172
0.9000	0.0783
0.8503	0.0888
0.7998	0.0911
0.7497	0.0790
0.7003	0.0809
0.6502	0.0726
0.5997	0.0885
0.5506	0.0932
0.5000	0.1022
0.4503	0.1147
0.4000	0.1366
0.3507	0.1531
0.3002	0.1866
0.2501	0.2245
0.2004	0.2807
0.1504	0.3703
0.1000	0.5194
0.0755	0.6255
0.0510	0.7709
0.0251	0.9798
0.0122	1.0067
0.0000	-2.4197
0.0135	-3.6981
0.0271	-2.9842
0.0515	-2.2957
0.0763	-1.9649
0.1012	-1.7081
0.1503	-1.3616
0.1994	-1.1692
0.2501	-0.9990
0.2999	-0.8691



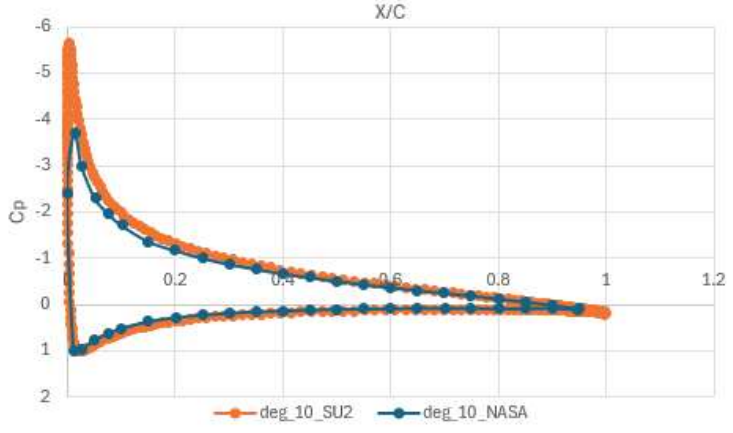
AOA_10deg

- point data_SU2

Points_0	deg_10_SU2
1	0.201881
0.997966	0.208088
0.995782	0.20166
0.993438	0.192885
0.990924	0.185239
0.988228	0.178741
0.985337	0.173277
0.982239	0.168549
0.978921	0.164336
0.975369	0.16051
0.971568	0.157005
0.967502	0.153785
0.963157	0.150811
0.958515	0.147925
0.95356	0.145164
0.948275	0.142548
0.942641	0.140005
0.93664	0.137526
0.930255	0.135106
0.923466	0.132745
0.916256	0.130454
0.908605	0.128241
0.900496	0.12612
0.891912	0.124105
0.882836	0.122208
0.873252	0.120443
0.863146	0.11882
0.852504	0.117355
0.841316	0.116056
0.829572	0.114937
0.817266	0.114007
0.804393	0.113276

AOA_10deg

- 비교



AOA_15deg

- 조건

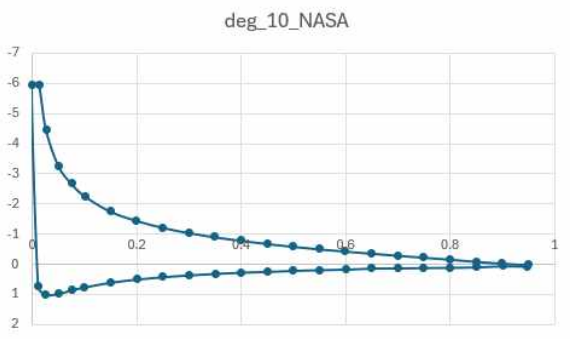
```
% ------------------- COMPRESSIBLE FREE-STREAM DEFINITION -------------------%
%
% Mach number (non-dimensional, based on the free-stream values)
MACH_NUMBER= 0.15
%
% Angle of attack (degrees, only for compressible flows)
AOA= 15.0
%
% Side-slip angle (degrees, only for compressible flows)
SIDESLIP_ANGLE= 0.0
%
% Init option to choose between Reynolds (default) or thermodynamics quantities
% for initializing the solution (REYNOLDS, TD_CONDITIONS)
INIT_OPTION= REYNOLDS
%
% Free-stream option to choose between density and temperature (default) for
% initializing the solution (TEMPERATURE_FS, DENSITY_FS)
FREESTREAM_OPTION= TEMPERATURE_FS
%
% Free-stream temperature (288.15 K by default)
FREESTREAM_TEMPERATURE= 288.15
%
% Reynolds number (non-dimensional, based on the free-stream values)
REYNOLDS_NUMBER= 6.0E6
%
% Reynolds length (1 m by default)
REYNOLDS_LENGTH= 1.0
```

```
% ------------------- BOUNDARY CONDITION DEFINITION -------------------------%
%
% Navier-Stokes wall boundary marker(s) (NONE = no marker)
MARKER_HEATFLUX= ( airfoil, 0.0 )
%
% Far-field boundary marker(s) (NONE = no marker)
MARKER_FAR= ( farfield )
%
% Symmetry boundary marker(s) (NONE = no marker)
%MARKER_SYM= ( SYMMETRY )
%
% Marker(s) of the surface to be plotted or designed
MARKER_PLOTTING= ( airfoil )
%
% Marker(s) of the surface where the functional (Cd, Cl, etc.) will be evaluated
MARKER_MONITORING= ( airfoil )
```

AOA_15deg

- point data_NASA

x/c	deg_10_NASA
0.9483	0.0617
0.9000	0.0513
0.8503	0.0877
0.7998	0.1017
0.7497	0.1074
0.7003	0.1208
0.6502	0.1275
0.5997	0.1627
0.5506	0.1787
0.5000	0.2027
0.4503	0.2369
0.4000	0.2621
0.3507	0.3031
0.3002	0.3522
0.2501	0.4122
0.2004	0.4922
0.1504	0.5984
0.1000	0.7577
0.0755	0.8538
0.0510	0.9678
0.0251	1.0003
0.0122	0.7025
0.0000	-5.9494
0.0135	-5.9727
0.0271	-4.4770
0.0515	-3.2561
0.0763	-2.6775
0.1012	-2.2702
0.1503	-1.7605
0.1994	-1.4603
0.2501	-1.2253
0.2999	-1.0511



AOA_15deg

- point data_SU2

Points_0	deg_15_SU2
1	0.0892742
0.997966	0.121933
0.995782	0.120259
0.993438	0.115889
0.990924	0.113695
0.988228	0.112958
0.985337	0.113281
0.982239	0.11422
0.978921	0.115505
0.975369	0.117007
0.971568	0.11867
0.967502	0.120462
0.963157	0.122349
0.958515	0.124184
0.95356	0.125993
0.948275	0.127856
0.942641	0.129723
0.93664	0.131605
0.930255	0.13352
0.923466	0.135484
0.916256	0.137512
0.908605	0.139622
0.900496	0.141831
0.891912	0.144159
0.882836	0.146621
0.873252	0.149238
0.863146	0.152025
0.852504	0.155
0.841316	0.158177
0.829572	0.161574
0.817266	0.165205
0.804393	0.169087

AOA_15deg

- 비교