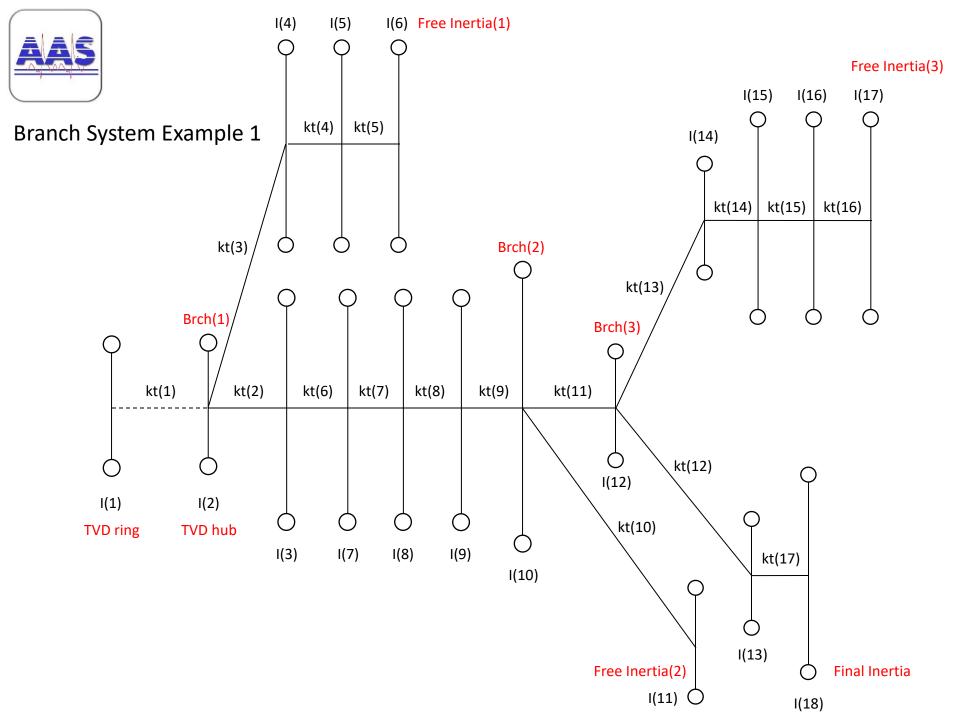# Using Navitorq

```
Editor - C:\Schalch\Matlab\Navitorq_TVA_v2.6\Start.m

File  Edit  Text  Go  Cell  Tools  Debug  Desktop  Window  Help

1 -    clc
2 -    clear all
3 -    close all
4
5      %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
6      % Torsional Vibration Analysis in Internal Combustion Engines      %
7      %                                                                  %
8      % NAVITORQ v2.6                                                    %
9      % Alexandre Schalch Mendes - 2011                                  %
10     %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
11
12     %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
13     %Specification of the output results file:
14 -   Results='Navitorq_V8';
15
16     %Input data
17 -   ma=1.72416;                    %Reciprocating masses [kg]
18 -   L=176;                         %Con rod length [mm]
19 -   s=105;                         %Piston stroke [mm]
20 -   d=98.2;                        %Piston diameter [mm]
21 -   ord_ign=[1 2 7 3 4 5 6 8];     %Firing order, starting from flywheel side
22 -   rpm_min=700;                   %Minimum engine speed to be considered [rpm]
23 -   rpm_max=2950;                  %Maximum engine speed to be considered [rpm]
24 -   int_rpm=50;                    %Engine speed step [rpm]
25 -   T_front=0;                     %Engagement torque in front end of the crankshaft [N.m]
26 -   T_rear=0;                      %Engagement torque in front end of the crankshaft [N.m]
27 -   Tcap_polia=2012;               %Permissible torque in front end bolted connection [N.m]
28 -   Tcap_volante=5413;             %Permissible torque in rear end bolted connection [N.m]
29 -   Tipo_damper=2;                 %Without damper(1); One mass rubber damper(2); Double mass rubb
30 -   Fn_damper1=120;                %Rubber damper natural frequency in working temperature [Hz] -
31 -   Fn_damper2=240;                %Rubber damper natural frequency in working temperature [Hz] -
32
33     %Inertias [kg.m²]
34 -   Ialt=0;%(ma*(s/2)^2*(0.5+((s/2)/L)^2/8))/1000000; %Reciprocating mass inertia
35 -   I(1)=0.0391;        %TVD ring
36 -   I(2)=0.01029;       %TVD hub
37 -   I(3)=0.000789;
38 -   I(4)=0.011140;
39 -   I(5)=0.017980+Ialt; %Cylinder 1
40 -   I(6)=0.013000+Ialt; %Cylinder 2
41 -   I(7)=0.01108;
```
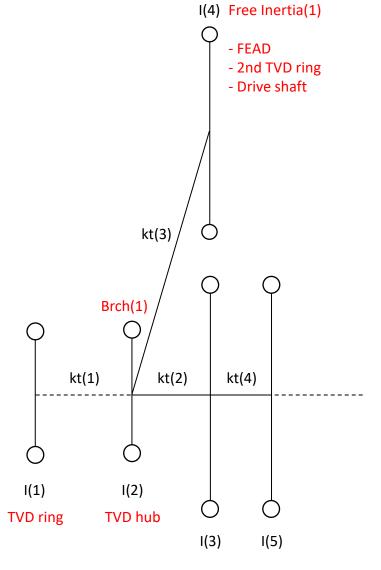
All input data is defined in file Start.m

Branch System Example 1

Stiffness Matrix for the Branch System Example 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	kt1	-kt1																
2	-kt1	kt1+kt2+kt3	-kt2	-kt3														
3		-kt2	kt2+kt6	0			-kt6											
4		-kt3	0	kt3+kt4	-kt4													
5				-kt4	kt4+kt5	-kt5												
6					-kt5	kt5	0											
7			-kt6			0	kt6+kt7	-kt7										
8							-kt7	kt7+kt8	-kt8									
9								-kt8	kt8+kt9	-kt9								
10									-kt9	kt9+kt10+kt11	-kt10	-kt11						
11										-kt10	kt10	0						
12										-kt11	0	kt11+kt12+kt13	-kt12	-kt13				
13												-kt12	kt12+kt17	0				-kt17
14												-kt13	0	kt13+kt14	-kt14			
15														-kt14	kt14+kt15	-kt15		
16															-kt15	kt15+kt16	-kt16	
17																-kt16	kt16	0
18													-kt17				0	kt17

Branch System Example 2

I(4) Free Inertia(1)

- FEAD
- 2nd TVD ring
- Drive shaft

kt(3)

Brch(1)

kt(1)   kt(2)   kt(4)

I(1)   I(2)

TVD ring   TVD hub

I(3)   I(5)

Cylinder Pressure Trace Input

Structure of the Output Results

Results file name must be defined at the begining of Start.m file

Structure of the Output Results

Variable Editor - DATA_OUTPUT_FREQ

File Edit View Graphics Debug Desktop Window Help

Stack: Base   Select data to plot

DATA_OUTPUT_FREQ <1x1 struct>

Field ▲	Value	Min	Max
Engine_Speed	<1x91 double>	700	2950
Maximum_Torque	<18x91 double>	20.0556	4.0230...
Hub_Displacement_Synthesis			).3708
Flywheel_Displacement_Synthesis			).3042

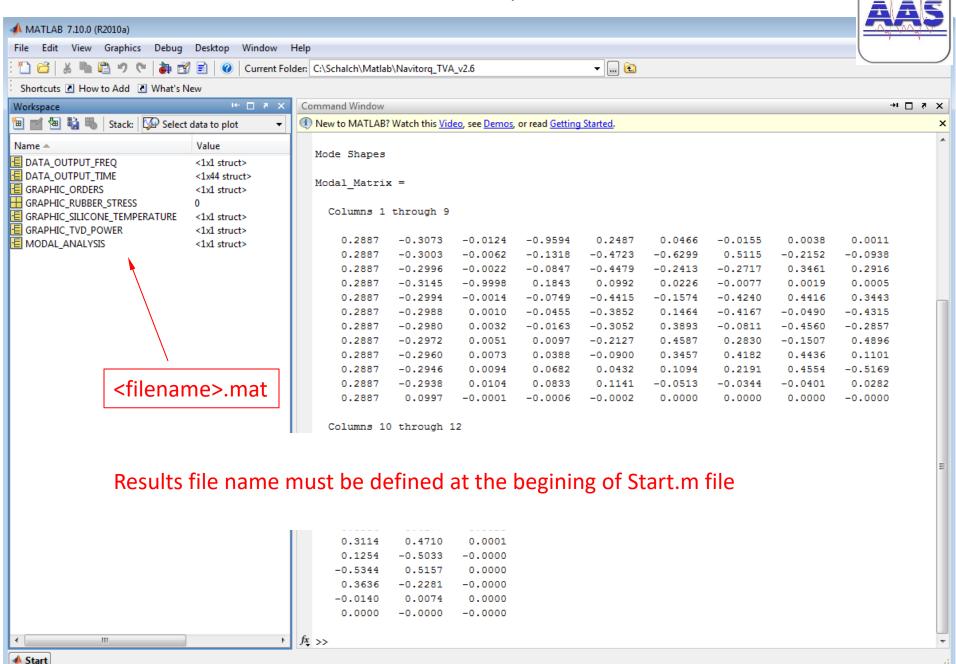Vector of the calculated engine speeds

Matrix of the maximum torque for each inertia of the elastic systems. Calculated for every rpm of the vector Engine_Speed
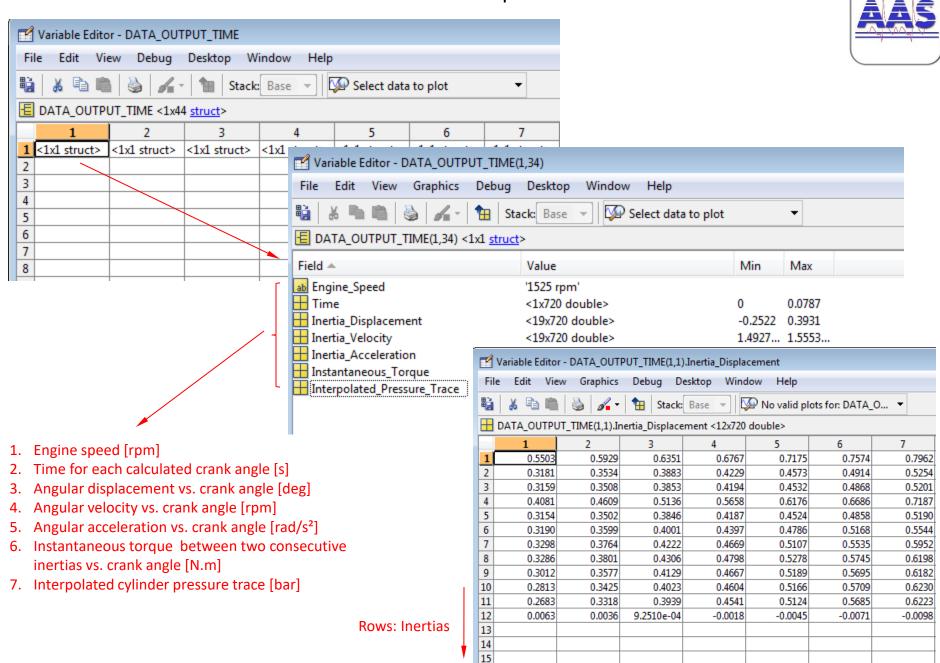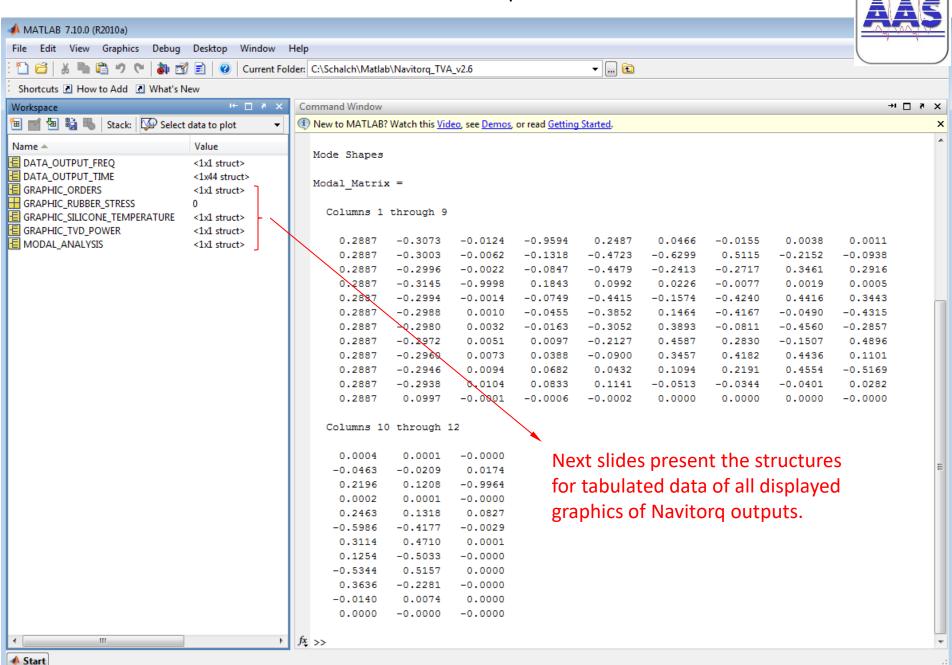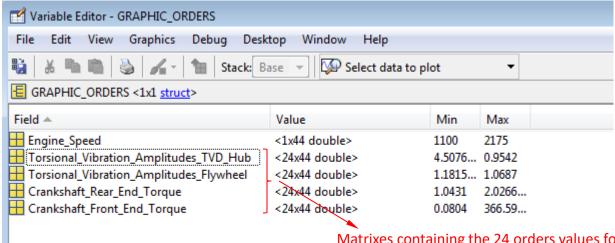
Rows: Inertias of the system

Columns: Steps of the engine speed

Variable Editor - DATA_OUTPUT_FREQ.Maximum_Torque

File Edit View Graphics Debug Desktop Window Help

Stack: Base   No valid plots for: DATA_O...

DATA_OUTPUT_FREQ.Maximum_Torque <11x44 double>

	1	2	3	4	5	6	7	8	9	10	11	12
1	393.9952	392.4889	390.7484	392.3318	395.3137	397.9376	400.0935	402.1383	404.4420	405.7544	406.5874	406.4464
2	556.2378	557.3658	561.1022	566.7115	570.4816	573.3134	573.3606	572.2017	569.0065	563.7367	557.3847	549.8727
3	57.2835	56.9504	56.8693	57.1182	57.6844	58.4616	59.4362	60.4580	61.3689	62.0521	62.4129	62.4078
4	7.8108e+04	7.7637e+04	7.7525e+04	7.7843e+04	7.8614e+04	7.9653e+04	8.0984e+04	8.2357e+04	8.3579e+04	8.4518e+04	8.4994e+04	8.4973e+04
5	6.4707e+03	6.4840e+03	6.4895e+03	6.4884e+03	6.4862e+03	6.4884e+03	6.4968e+03	6.5098e+03	6.5248e+03	6.5399e+03	6.5559e+03	6.5740e+03
6	6.5057e+03	6.5297e+03	6.5443e+03	6.5508e+03	6.5550e+03	6.5614e+03	6.5702e+03	6.5790e+03	6.5865e+03	6.5911e+03	6.5959e+03	6.6052e+03
7	6.1156e+03	6.1407e+03	6.1514e+03	6.1544e+03	6.1502e+03	6.1490e+03	6.1570e+03	6.1740e+03	6.1961e+03	6.2198e+03	6.2461e+03	6.2782e+03
8	6.3494e+03	6.3831e+03	6.4002e+03	6.4015e+03	6.3989e+03	6.4010e+03	6.4150e+03	6.4407e+03	6.4720e+03	6.5052e+03	6.5411e+03	6.5828e+03
9	5.9066e+03	5.9158e+03	5.9103e+03	5.8976e+03	5.8829e+03	5.8763e+03	5.8811e+03	5.8916e+03	5.9003e+03	5.9064e+03	5.9131e+03	5.9248e+03
10	5.2143e+03	5.2311e+03	5.2372e+03	5.2268e+03	5.2101e+03	5.1992e+03	5.2003e+03	5.2118e+03	5.2285e+03	5.2469e+03	5.2678e+03	5.2940e+03
11	2.6042e+03	2.5814e+03	2.5602e+03	2.5405e+03	2.5221e+03	2.5049e+03	2.4887e+03	2.4733e+03	2.4585e+03	2.4445e+03	2.4312e+03	2.4188e+03
12												
13												
14												
15												
16												

Structure of the Output Results

1. Engine speed [rpm]
2. Time for each calculated crank angle [s]
3. Angular displacement vs. crank angle [deg]
4. Angular velocity vs. crank angle [rpm]
5. Angular acceleration vs. crank angle [rad/s²]
6. Instantaneous torque between two consecutive inertias vs. crank angle [N.m]
7. Interpolated cylinder pressure trace [bar]

Rows: Inertias

Structure of the Output Results

Next slides present the structures for tabulated data of all displayed graphics of Navitorq outputs.

Structure of the Output Results

Variable Editor - GRAPHIC_ORDERS

File   Edit   View   Graphics   Debug   Desktop   Window   Help

Stack: Base ▼   Select data to plot ▼

GRAPHIC_ORDERS <1x1 struct>

Field ▲	Value	Min	Max
Engine_Speed	<1x44 double>	1100	2175
Torsional_Vibration_Amplitudes_TVD_Hub	<24x44 double>	4.5076...	0.9542
Torsional_Vibration_Amplitudes_Flywheel	<24x44 double>	1.1815...	1.0687
Crankshaft_Rear_End_Torque	<24x44 double>	1.0431	2.0266...
Crankshaft_Front_End_Torque	<24x44 double>	0.0804	366.59...

Matrixes containing the 24 orders values for every [rpm] of vector Engine_Speed

Columns: Engine speed steps

Rows: Orders

Variable Editor - GRAPHIC_ORDERS.Torsional_Vibration_Amplitudes_TVD_Hub

File   Edit   View   Graphics   Debug   Desktop   Window   Help

Stack: Base ▼   No valid plots for: GRAPHI... ▼

GRAPHIC_ORDERS.Torsional_Vibration_Amplitudes_TVD_Hub <24x44 double>

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.0691	0.0692	0.0693	0.0695	0.0696	0.0698	0.0699	0.0701	0.0702	0.0704	0.0705	0.0707
2	0.0096	0.0106	0.0116	0.0126	0.0136	0.0146	0.0154	0.0162	0.0167	0.0172	0.0174	0.0175
3	0.1272	0.1281	0.1293	0.1307	0.1321	0.1336	0.1350	0.1364	0.1378	0.1391	0.1404	0.1416
4	0.0064	0.0062	0.0060	0.0059	0.0057	0.0056	0.0055	0.0053	0.0052	0.0051	0.0050	0.0048
5	0.0505	0.0508	0.0511	0.0514	0.0517	0.0520	0.0523	0.0526	0.0529	0.0532	0.0535	0.0538
6	0.9542	0.8965	0.8433	0.7939	0.7480	0.7053	0.6655	0.6283	0.5935	0.5609	0.5303	0.5015
7	0.0396	0.0399	0.0403	0.0406	0.0409	0.0413	0.0416	0.0420	0.0423	0.0427	0.0431	0.0435
8	0.0024	0.0024	0.0024	0.0023	0.0023	0.0022	0.0022	0.0022	0.0021	0.0021	0.0020	0.0020
9	0.0699	0.0708	0.0717	0.0726	0.0736	0.0746	0.0755	0.0765	0.0774	0.0782	0.0791	0.0799
10	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	9.4862e-04	8.9338e-04	8.3628e-04	7.7652e-04	7.1441e-04	6.4978e-04
11	0.0191	0.0193	0.0196	0.0198	0.0201	0.0204	0.0207	0.0210	0.0213	0.0216	0.0219	0.0222
12	0.0255	0.0216	0.0179	0.0144	0.0110	0.0080	0.0053	0.0039	0.0048	0.0070	0.0096	0.0123
13	0.0114	0.0116	0.0118	0.0120	0.0122	0.0124	0.0126	0.0128	0.0130	0.0132	0.0135	0.0137
14	5.3552e-05	4.5076e-05	6.8095e-05	1.0640e-04	1.5135e-04	2.0063e-04	2.5369e-04	3.1043e-04	3.7100e-04	4.3568e-04	5.0366e-04	5.7799e-04
15	0.0155	0.0158	0.0161	0.0164	0.0168	0.0171	0.0174	0.0178	0.0183	0.0187	0.0192	0.0198
16	1.2864e-04	1.6018e-04	1.9418e-04	2.3027e-04	2.7006e-04	3.1324e-04	3.5989e-04	4.1128e-04	4.6771e-04	5.2880e-04	5.9803e-04	6.7505e-04
17	0.0028	0.0028	0.0029	0.0030	0.0031	0.0032	0.0033	0.0034	0.0036	0.0037	0.0039	0.0041

Structure of the Output Results

Structure of the Output Results