Simulation of Tuning Fork

Designer: Wiseman Siriro
Study name: Tuning Fork
Analysis type: Frequency

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Description

This project performs a modal analysis, or natural frequency study, on a tuning fork geometry created in SOLIDWORKS to investigate its dynamic vibration behavior. The simulation computes the first ten natural frequencies along with their corresponding mode shapes and mass participation factors, providing insight into how the tuning fork responds to vibrational excitation. The model represents a classic tuning fork design featuring a spherical handle and two prongs, a configuration widely used in acoustics, physics education, and medical diagnostics, making the analysis relevant to both practical and instructional applications.

Assumptions

Model Information

Model name: Tuning Fork
Current Configuration: Default

Solid Bodies

Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified
Fillet1	Solid Body	**Mass:44.643 kg** **Volume:0.00572346 m^3** **Density:7,800 kg/m^3** **Weight:437.501 N**	**C:\Users\chuan\Downloads\Some Solidworks\Tuning Fork.SLDPRT** Feb 9 20:15:17 2026

Study Properties

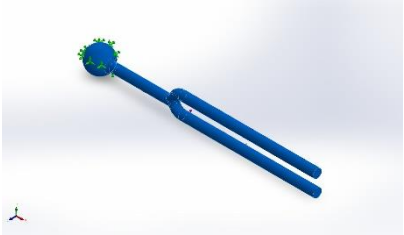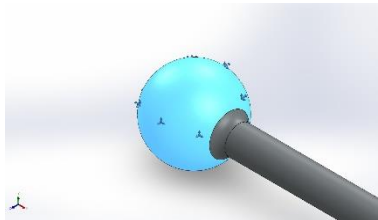|	
Study name	Tuning Fork
Analysis type	Frequency
Mesh type	Solid Mesh
Number of frequencies	10
Decouple the mixed free body modes	Off
Solver type	FFEPlus
Soft Spring:	Off
Incompatible bonding options	Automatic
Thermal option	Include temperature loads
Zero strain temperature	298 Kelvin
Include fluid pressure effects from SOLIDWORKS Flow Simulation	Off
Result folder	SOLIDWORKS document

Units

Unit system:	SI (MKS)
Length/Displacement	mm
Temperature	Kelvin
Angular velocity	Rad/sec
Pressure/Stress	N/m^2

Material Properties

Model Reference	Properties	Components
	Name: Chrome Stainless Steel **Model type:** Linear Elastic Isotropic **Default failure criterion:** Max von Mises Stress **Yield strength:** 1.72339e+08 N/m^2 **Tensile strength:** 4.13613e+08 N/m^2 **Mass density:** 7,800 kg/m^3 **Elastic modulus:** 2e+11 N/m^2 **Poisson's ratio:** 0.28 **Thermal expansion coefficient:** 1.1e-05 /Kelvin	SolidBody 1(Fillet1)(Tuning Fork)
Curve Data:N/A		

Loads and Fixtures

Fixture name	Fixture Image	Fixture Details
Fixed-1		**Entities:** 1 face(s) **Type:** Fixed Geometry

Connector Definitions
No Data

Interaction Information

No Data

Mesh information

Mesh type	Solid Mesh
Mesher Used:	Blended curvature-based mesh
Jacobian points for High quality mesh	16 Points
Maximum element size	0.894536 cm
Minimum element size	0.298176 cm
Mesh Quality	High

Mesh information - Details

Total Nodes	23344
Total Elements	14258
Maximum Aspect Ratio	5.1756
% of elements with Aspect Ratio < 3	100
Percentage of elements with Aspect Ratio > 10	0
Percentage of distorted elements	0
Time to complete mesh(hh;mm;ss):	00:00:13
Computer name:	RYAN

Mesh Control Information:

Mesh Control Name	Mesh Control Image	Mesh Control Details
Control-1		**Entities:** 1 Solid Body (s) **Units:** cm **Size:** 1.5 **Ratio:** 1.5

Mesh Quality Plots

Name	Type	Min	Max
Quality1	Mesh	-	-

Model name: Tuning Fork
Study name: Tuning Fork(-Default-)
Plot type: Mesh Quality1
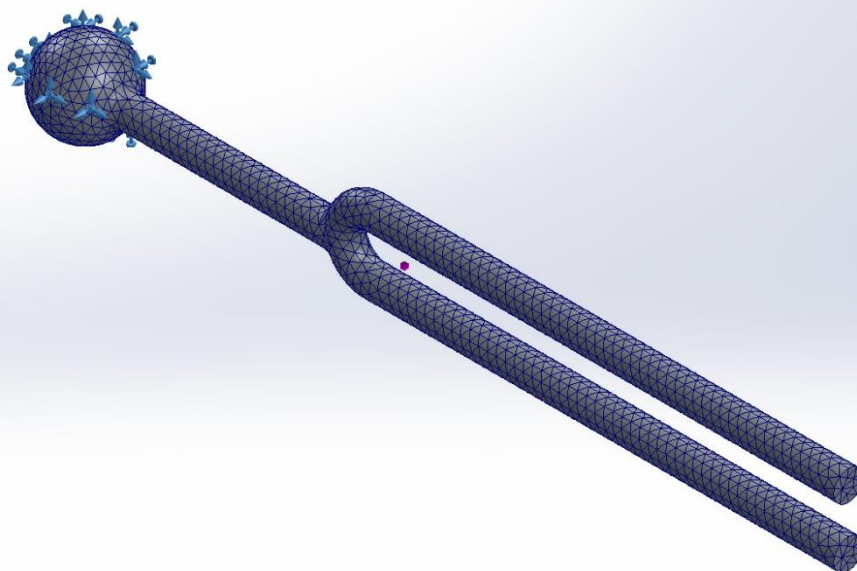
Tuning Fork-Tuning Fork-Quality-Quality1

Sensor Details

No Data

Study Results

Name	Type	Min	Max
Amplitude1	AMPRES: Resultant Amplitude Plot for Mode Shape: 1(Value = 17.5405 Hz)	0.000e+00 Node: 1	3.195e-01 Node: 565

Tuning Fork-Tuning Fork-Amplitude-Amplitude1
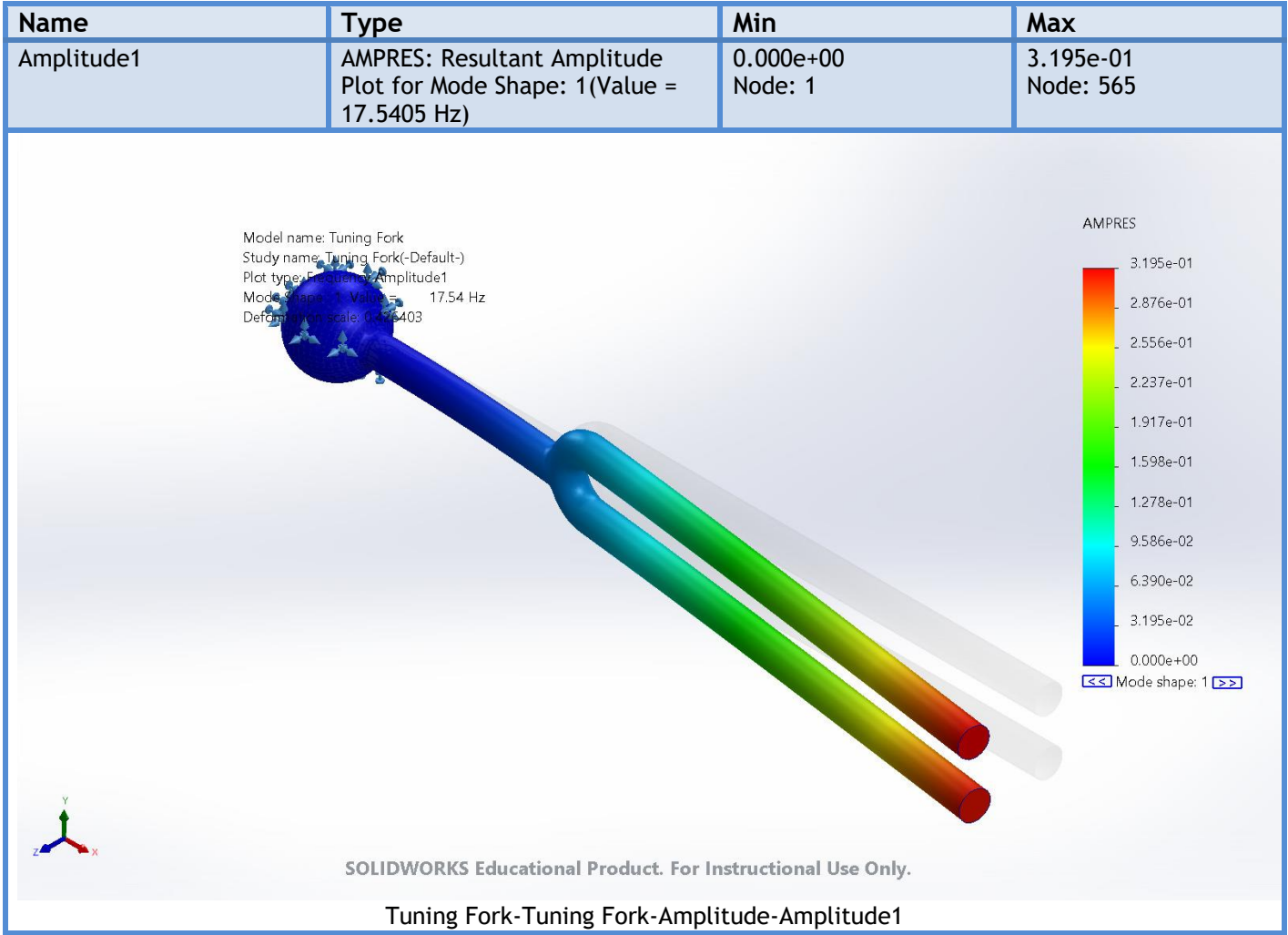
Name	Type	Min	Max
Amplitude2	AMPRES: Resultant Amplitude Plot for Mode Shape: 2(Value = 17.6129 Hz)	0.000e+00 Node: 1	3.185e-01 Node: 13

Model name: Tuning Fork
Study name: Tuning Fork(-Default-)
Plot type: Frequency Amplitude2
Mode Shape : 2 Value =   17.613 Hz
Deformation scale: 0.428905
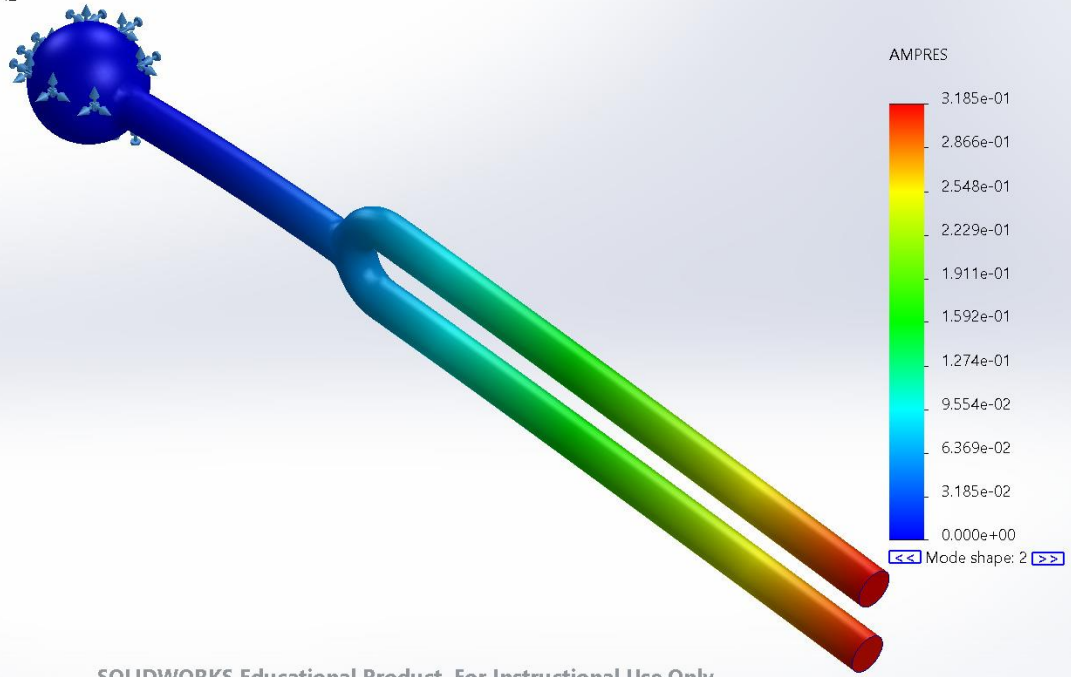
AMPRES

3.185e-01
2.866e-01
2.548e-01
2.229e-01
1.911e-01
1.592e-01
1.274e-01
9.554e-02
6.369e-02
3.185e-02
0.000e+00

Mode shape: 2

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Tuning Fork-Tuning Fork-Amplitude-Amplitude2

Name	Type	Min	Max
Amplitude3	AMPRES: Resultant Amplitude Plot for Mode Shape: 3(Value = 45.0788 Hz)	0.000e+00 Node: 1	3.868e-01 Node: 10

Model name: Tuning Fork
Study name: Tuning Fork(-Default-)
Plot type: Frequency Amplitude3
Mode Shape : 3 Value =   45.079 Hz
Deformation scale: 0.352186

AMPRES

3.868e-01
3.481e-01
3.094e-01
2.707e-01
2.321e-01
1.934e-01
1.547e-01
1.160e-01
7.736e-02
3.868e-02
0.000e+00

Mode shape: 3

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Tuning Fork-Tuning Fork-Amplitude-Amplitude3

Name	Type	Min	Max
Amplitude4	AMPRES: Resultant Amplitude Plot for Mode Shape: 4(Value = 46.6258 Hz)	0.000e+00 Node: 1	3.883e-01 Node: 10

Model name: Tuning Fork
Study name: Tuning Fork(-Default-)
Plot type: Frequency Amplitude4
Mode Shape : 4 Value =   46.626 Hz
Deformation scale: 0.351184

AMPRES

3.883e-01
3.494e-01
3.106e-01
2.718e-01
2.330e-01
1.941e-01
1.553e-01
1.165e-01
7.765e-02
3.883e-02
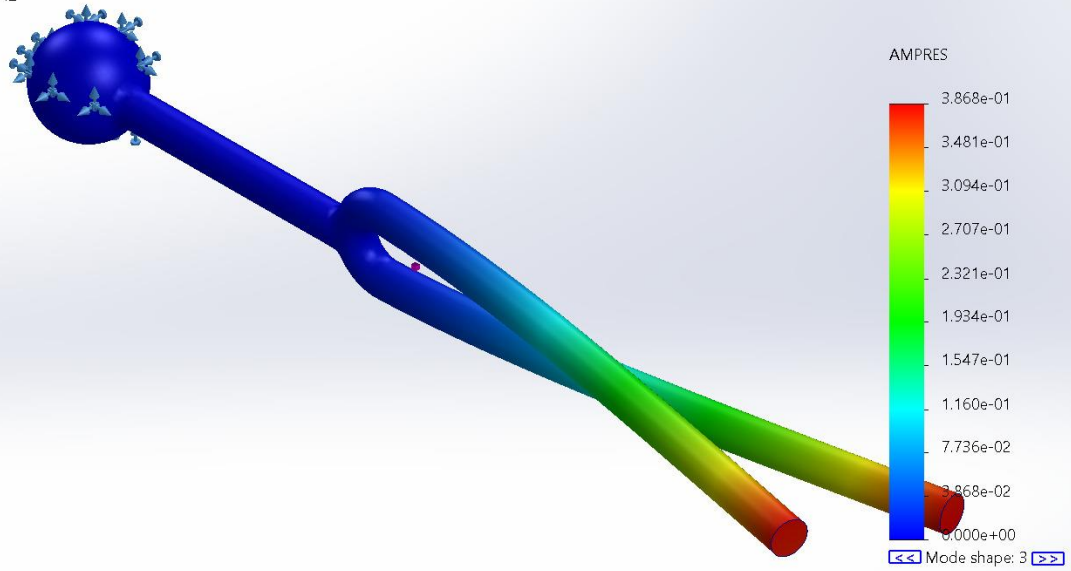0.000e+00

<< Mode shape: 4 >>

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Tuning Fork-Tuning Fork-Amplitude-Amplitude4

Name	Type	Min	Max
Amplitude5	AMPRES: Resultant Amplitude Plot for Mode Shape: 5(Value = 133.627 Hz)	0.000e+00 Node: 1	3.283e-01 Node: 12

Model name: Tuning Fork
Study name: Tuning Fork(-Default-)
Plot type: Frequency Amplitude5
Mode Shape : 5 Value =   133.63 Hz
Deformation scale: 0.414888

AMPRES

3.283e-01
2.955e-01
2.627e-01
2.298e-01
1.970e-01
1.642e-01
1.313e-01
9.850e-02
6.567e-02
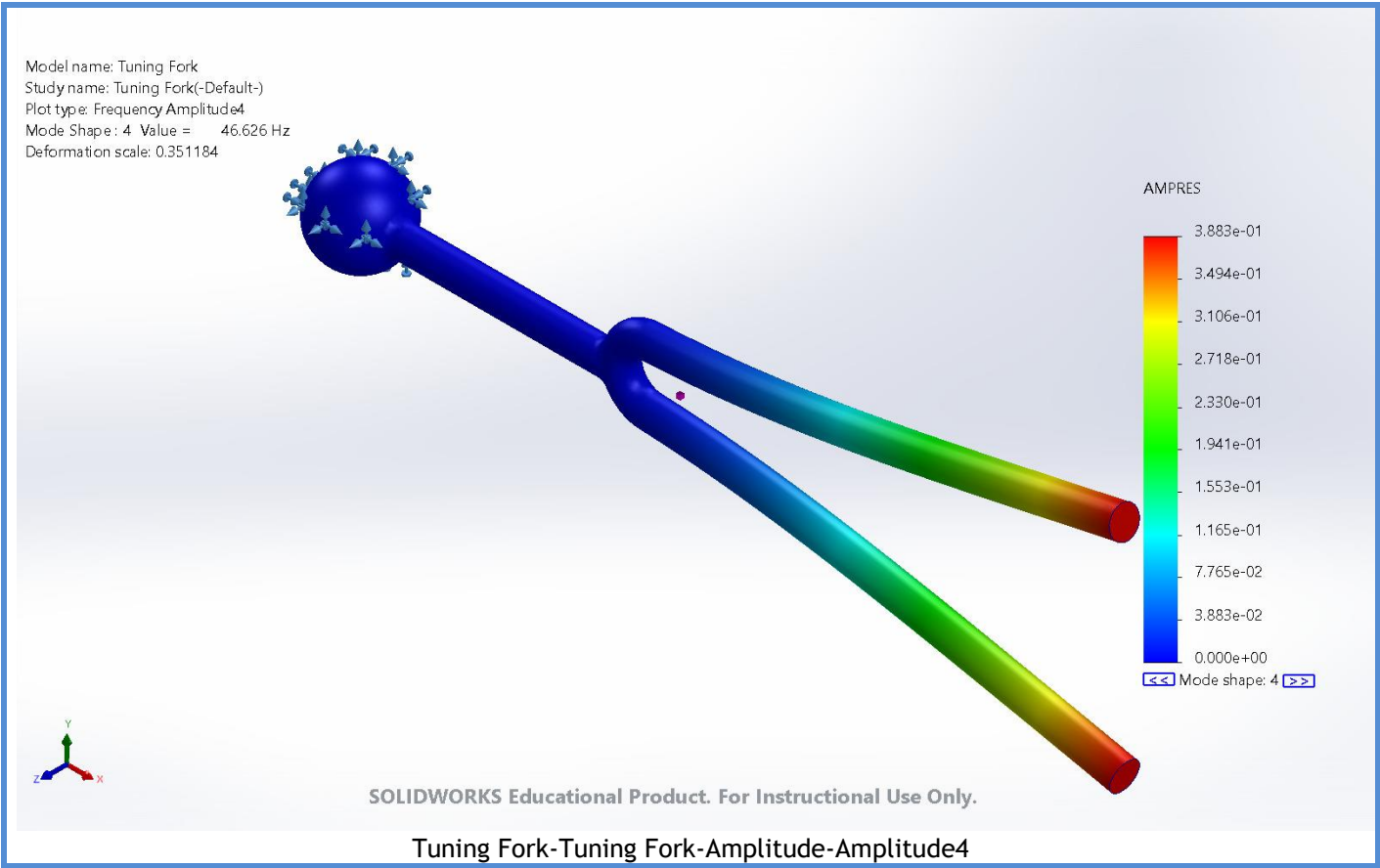3.283e-02
0.000e+00
◁◁ Mode shape: 5 ▷▷

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Tuning Fork-Tuning Fork-Amplitude-Amplitude5
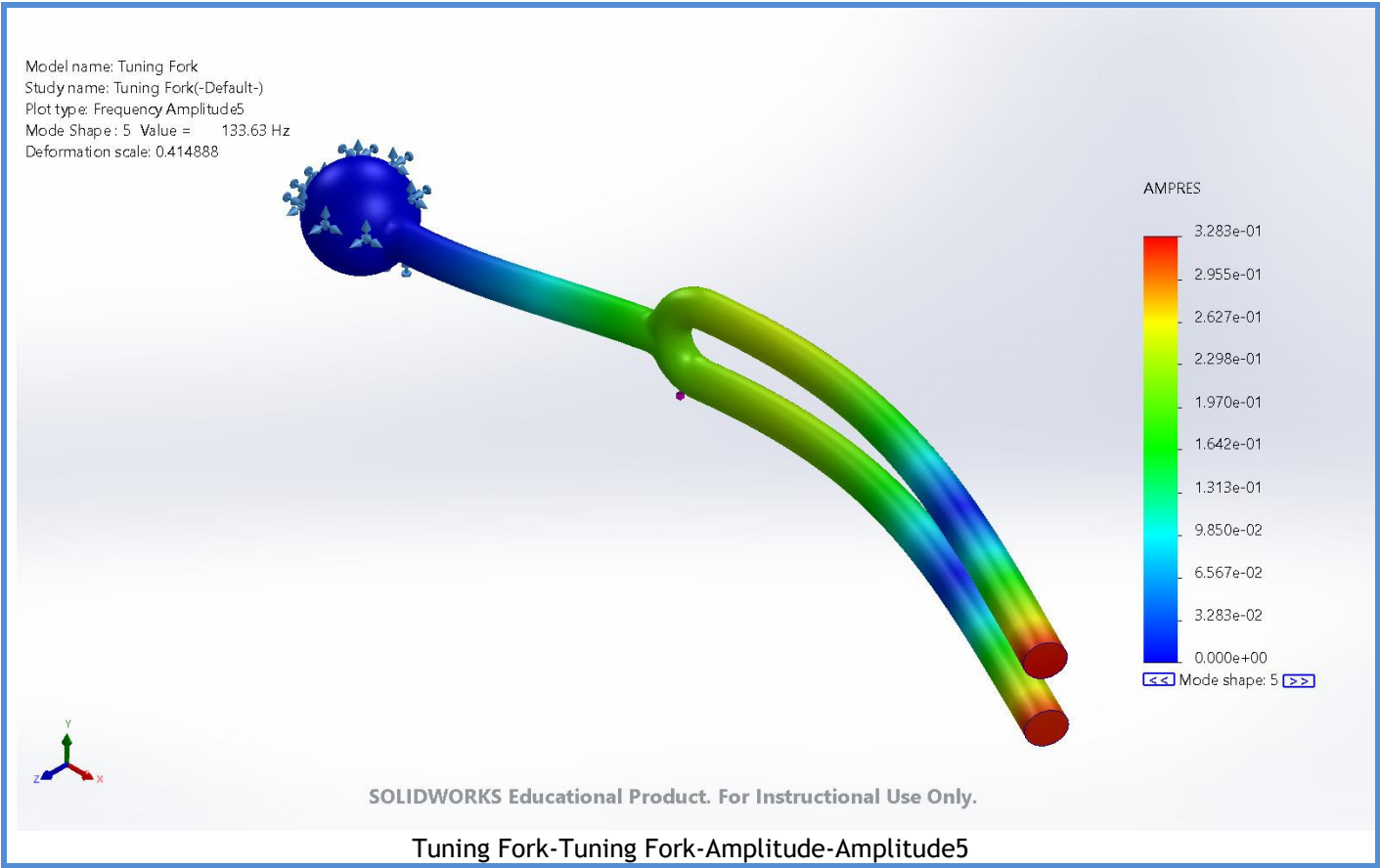
Name	Type	Min	Max
Amplitude6	AMPRES: Resultant Amplitude Plot for Mode Shape: 6(Value = 133.933 Hz)	0.000e+00 Node: 1	3.305e-01 Node: 11

Model name: Tuning Fork
Study name: Tuning Fork(-Default-)
Plot type: Frequency Amplitude6
Mode Shape : 6 Value =   133.93 Hz
Deformation scale: 0.416418

AMPRES

3.305e-01
2.974e-01
2.644e-01
2.313e-01
1.983e-01
1.652e-01
1.322e-01
9.914e-02
6.610e-02
3.305e-02
0.000e+00
Mode shape: 6

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Tuning Fork-Tuning Fork-Amplitude-Amplitude6

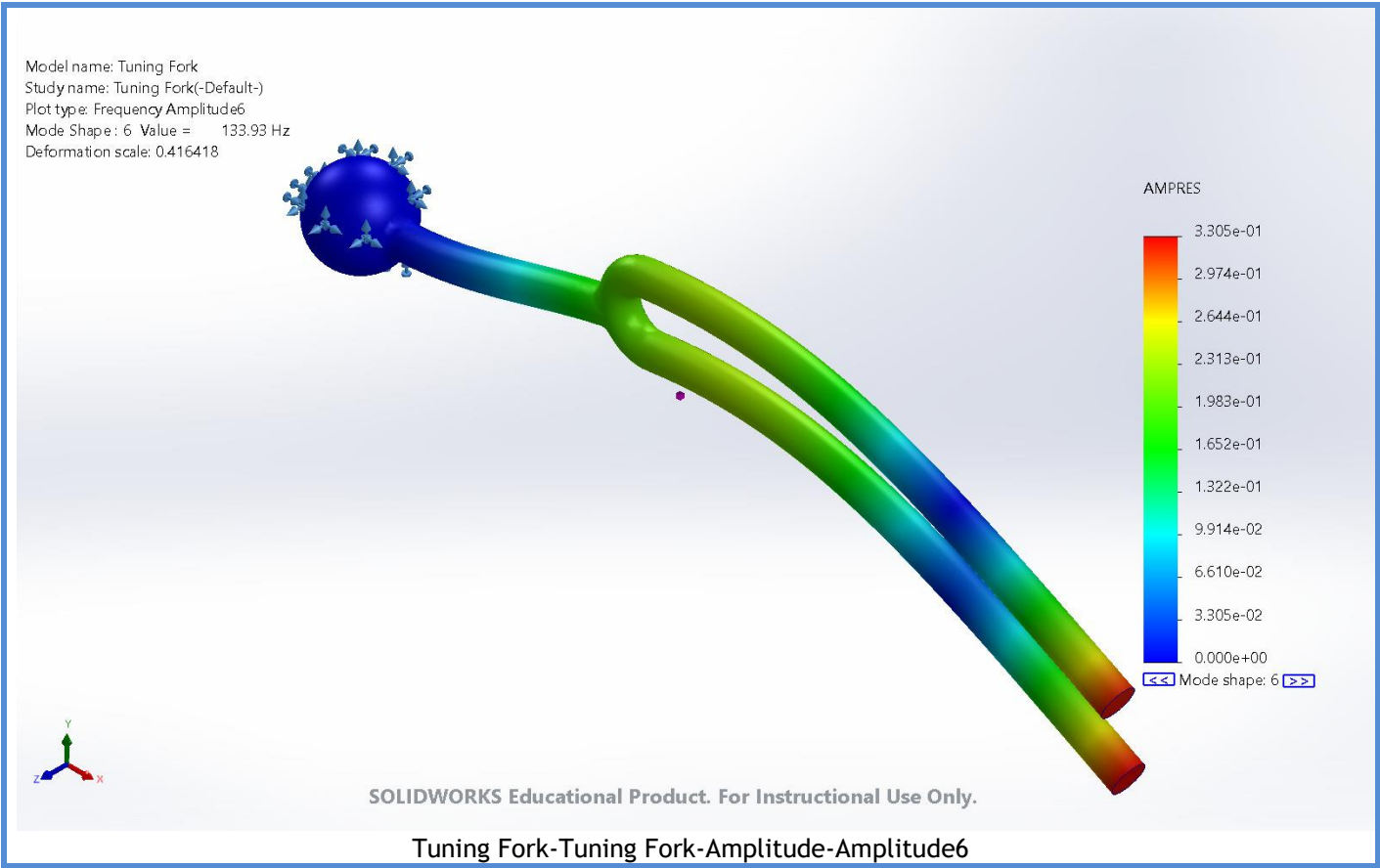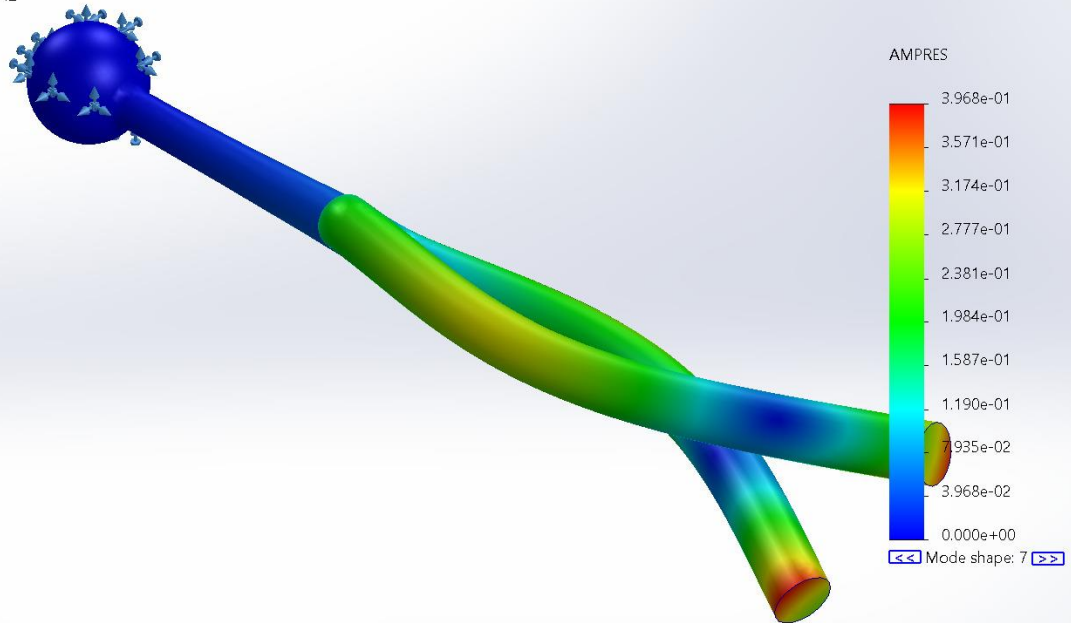| Name	Type	Min	Max
Amplitude7	AMPRES: Resultant Amplitude Plot for Mode Shape: 7(Value = 236.135 Hz)	0.000e+00 Node: 1	3.968e-01 Node: 11

Model name: Tuning Fork
Study name: Tuning Fork(-Default-)
Plot type: Frequency Amplitude7
Mode Shape : 7 Value = 236.13 Hz
Deformation scale: 0.343333

AMPRES

3.968e-01
3.571e-01
3.174e-01
2.777e-01
2.381e-01
1.984e-01
1.587e-01
1.190e-01
7.935e-02
3.968e-02
0.000e+00

<< Mode shape: 7 >>

Tuning Fork-Tuning Fork-Amplitude-Amplitude7

Name	Type	Min	Max
Amplitude8	AMPRES: Resultant Amplitude Plot for Mode Shape: 8(Value = 291.14 Hz)	0.000e+00 Node: 1	3.991e-01 Node: 12

Model name: Tuning Fork
Study name: Tuning Fork(-Default-)
Plot type: Frequency Amplitude8
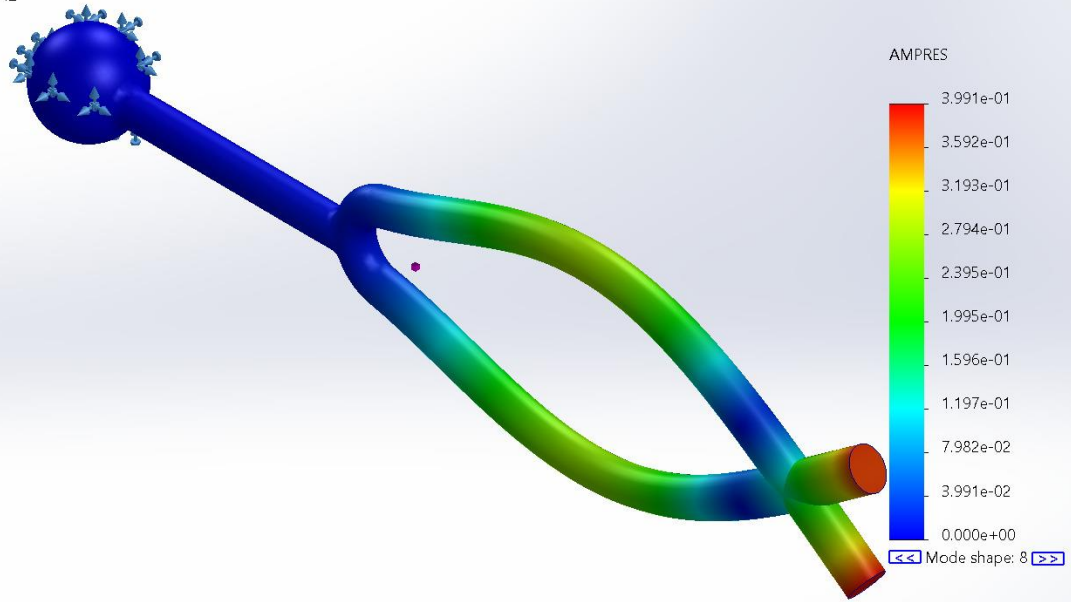Mode Shape : 8 Value = 291.14 Hz
Deformation scale: 0.346625

AMPRES

3.991e-01
3.592e-01
3.193e-01
2.794e-01
2.395e-01
1.995e-01
1.596e-01
1.197e-01
7.982e-02
3.991e-02
0.000e+00

<< Mode shape: 8 >>

Tuning Fork-Tuning Fork-Amplitude-Amplitude8

Name	Type	Min	Max
Amplitude9	AMPRES: Resultant Amplitude Plot for Mode Shape: 9(Value = 383.783 Hz)	0.000e+00 Node: 1	3.320e-01 Node: 11

Model name: Tuning Fork
Study name: Tuning Fork(-Default-)
Plot type: Frequency Amplitude9
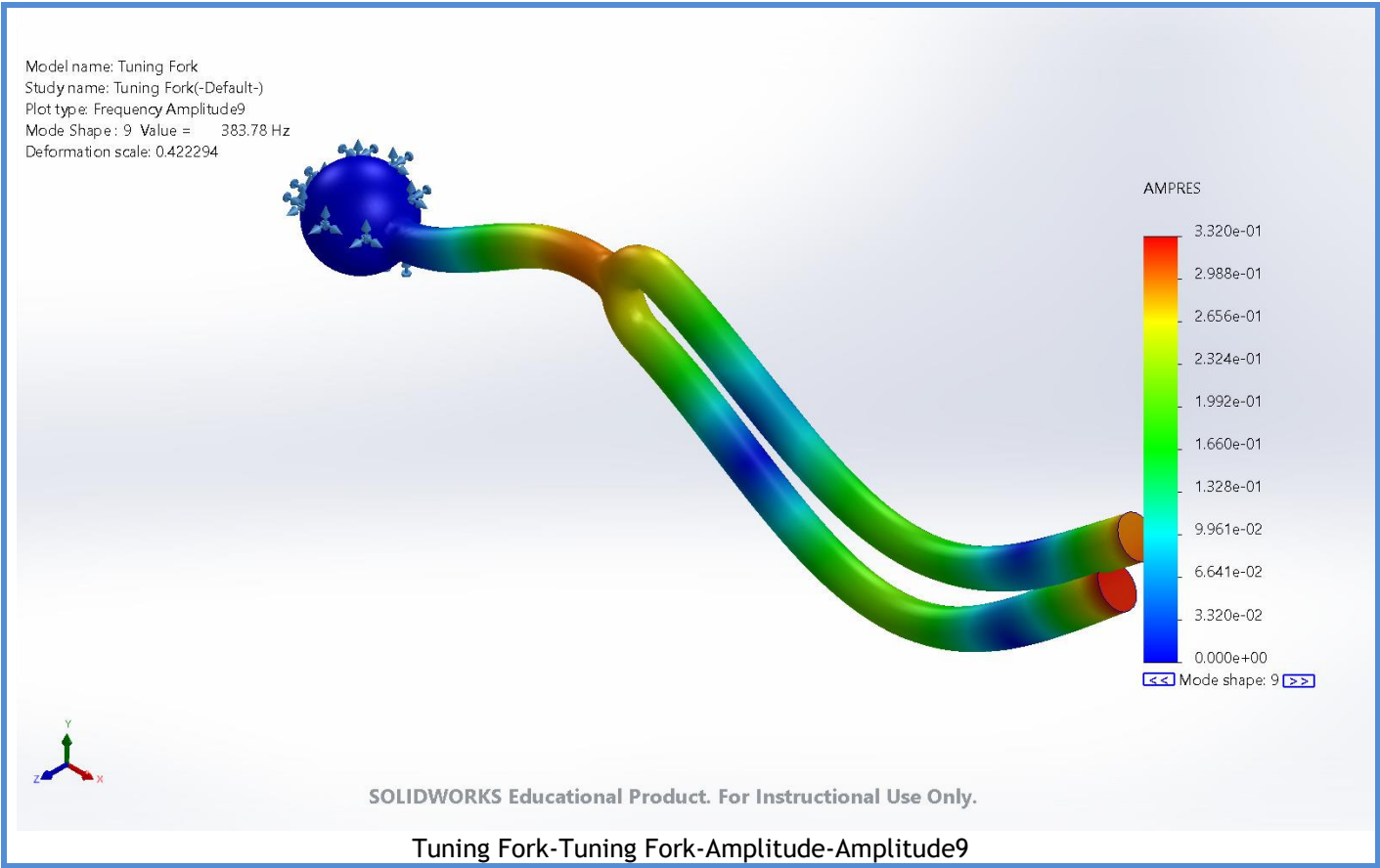Mode Shape : 9 Value =   383.78 Hz
Deformation scale: 0.422294

AMPRES

3.320e-01
2.988e-01
2.656e-01
2.324e-01
1.992e-01
1.660e-01
1.328e-01
9.961e-02
6.641e-02
3.320e-02
0.000e+00

Mode shape: 9

Tuning Fork-Tuning Fork-Amplitude-Amplitude9

Name	Type	Min	Max
Amplitude10	AMPRES: Resultant Amplitude Plot for Mode Shape: 10(Value = 385.254 Hz)	0.000e+00 Node: 1	3.543e-01 Node: 13

Model name: Tuning Fork
Study name: Tuning Fork(-Default-)
Plot type: Frequency Amplitude10
Mode Shape : 10 Value =   385.25 Hz
Deformation scale: 0.384512

AMPRES

3.543e-01
3.188e-01
2.834e-01
2.480e-01
2.126e-01
1.771e-01
1.417e-01
1.063e-01
7.085e-02
3.543e-02
0.000e+00

Mode shape: 10

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Tuning Fork-Tuning Fork-Amplitude-Amplitude10

Mode List

Frequency Number	Rad/sec	Hertz	Seconds
1	110.21	17.54	0.057011
2	110.67	17.613	0.056777
3	283.24	45.079	0.022183
4	292.96	46.626	0.021447
5	839.6	133.63	0.0074835
6	841.53	133.93	0.0074664
7	1,483.7	236.13	0.0042349
8	1,829.3	291.14	0.0034348
9	2,411.4	383.78	0.0026056
10	2,420.6	385.25	0.0025957

Mass Participation (Normalized)

Mode Number	Frequency(Hertz)	X direction	Y direction	Z direction
1	17.54	4.8491e-10	2.2943e-06	0.51775

2	17.613	0.00011312	0.51655	2.2876e-06
3	45.079	1.233e-11	8.3848e-12	3.5865e-05
4	46.626	5.7537e-05	2.6209e-05	1.7509e-11
5	133.63	1.0504e-08	3.7393e-06	0.12476
6	133.93	0.00034713	0.11775	3.9482e-06
7	236.13	5.6127e-12	2.8724e-12	9.6348e-05
8	291.14	0.0025604	3.0312e-05	9.8854e-13
9	383.78	0.0013123	0.035581	4.5834e-07
10	385.25	1.7584e-08	5.5481e-07	0.027777
		Sum X = 0.0043904	Sum Y = 0.66995	Sum Z = 0.67043

Conclusion

The modal analysis correctly captures the characteristic, closely spaced bending modes of the tuning fork at approximately 17.5 Hz, which is consistent with classical vibration theory for symmetric fork structures. The agreement between the simulated results and theoretical expectations demonstrates the reliability of the simulation methodology. As a result, the same approach can be confidently reused for analyzing musical tuning forks operating at standard frequencies such as 440 Hz and 512 Hz, medical tuning forks commonly used at 128 Hz and 256 Hz, as well as custom resonator and vibration-sensitive designs. Overall, this project serves as a strong educational example of how modal analysis can be effectively performed and interpreted using SOLIDWORKS Simulation.