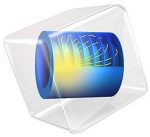

Optimization of a Tuning Fork

Introduction

This model extends the model *Tuning Fork* in the COMSOL Multiphysics Application Library by adding a second study, in which the Parametric Sweep is replaced by an Optimization study node. The prong length L is determined by minimizing the objective function $(f - 440\ \text{Hz})^2$, where f is the fundamental frequency of the fork. The result agrees with that found in the original model version. For a detailed description of the model geometry and setup, see *Tuning Fork* in the COMSOL Multiphysics Application Library.

Application Library path: `Optimization_Module/Design_Optimization/tuning_fork_optimization`

Modeling Instructions

ROOT

In this model version you determine the prong length by using an **Optimization** study node.

APPLICATION LIBRARIES

1. From the **File** menu, choose **Application Libraries**.
2. In the **Application Libraries** window, select **COMSOL Multiphysics>Structural Mechanics> tuning_fork** in the tree.
3. Click **Open**.

To keep the results of the parametric study, add a second study with an **Eigenfrequency** step set up the same way as before.

ADD STUDY

1. In the **Home** toolbar, click **Add Study** to open the **Add Study** window.
2. Go to the **Add Study** window.
3. Find the **Studies** subsection. In the **Select Study** tree, select **General Studies> Eigenfrequency**.
4. Click **Add Study** in the window toolbar.
5. In the **Home** toolbar, click **Add Study** to close the **Add Study** window.

STUDY 2

Step 1: Eigenfrequency

1 In the **Settings** window for **Eigenfrequency**, locate the **Study Settings** section.

2 Select the **Desired number of eigenfrequencies** check box. In the associated text field, type `1`.

3 In the **Search for eigenfrequencies around shift** text field, type `440`.

Now, add optimization. The **BOBYQA** solver is generally the fastest of the derivative-free solvers when the objective function is smooth.

Optimization

1 In the **Study** toolbar, click **Optimization** and choose **Optimization**.

2 In the **Settings** window for **Optimization**, locate the **Optimization Solver** section.

3 From the **Method** list, choose **BOBYQA**.

4 Locate the **Objective Function** section. In the table, enter the following settings:

Expression	Description	Evaluate for
`(freq-440[Hz])^2`		Eigenfrequency

Next, add the control parameter. You can choose between the global parameters defined in your model. In this case, use the prong length.

5 Locate the **Control Variables and Parameters** section. Click **Add**.

Specify a length scale and suitable bounds.

6 In the table, enter the following settings:

Parameter name	Initial value	Scale	Lower bound	Upper bound
L (Cylinder length)	`7.8[cm]`	`1[cm]`	`7[cm]`	`9[cm]`

The setup is now complete.

7 In the **Study** toolbar, click **Compute**.

RESULTS

Mode Shape (solid) 1

1 Click the **Zoom Extents** button in the **Graphics** toolbar.

The default plot shows the eigenmode that corresponds to the optimized value of the cylinder length `L`.

Objective Table 3

The optimized value of the cylinder length can be seen in the Objective Table:

The resulting cylinder length is close to 7.91 cm, which agrees with the value determined using a parametric sweep.

Mode Shape (solid) 1

Click the  **Zoom Extents** button in the **Graphics** toolbar.