ME352 Machine Dynamics and Vibrations

A09 SDOF Vibration Calculator Report

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181ME160 M1

Problem Statement:

To program a Single Degree of Freedom (SDOF) Vibration Calculator to calculate mass-spring-damper natural frequency, circular frequency, damping factor, Q factor, critical damping, damped natural frequency and transmissibility for a harmonic input.

Parameters to be inputted are mass, soring rate(stiffness k), Damping ratio (coefficient) , whether it's free or forced vibration(radio button) Harmonic input frequency if it's forced vibration.

Single Degree of Freedom Vibration Equations:

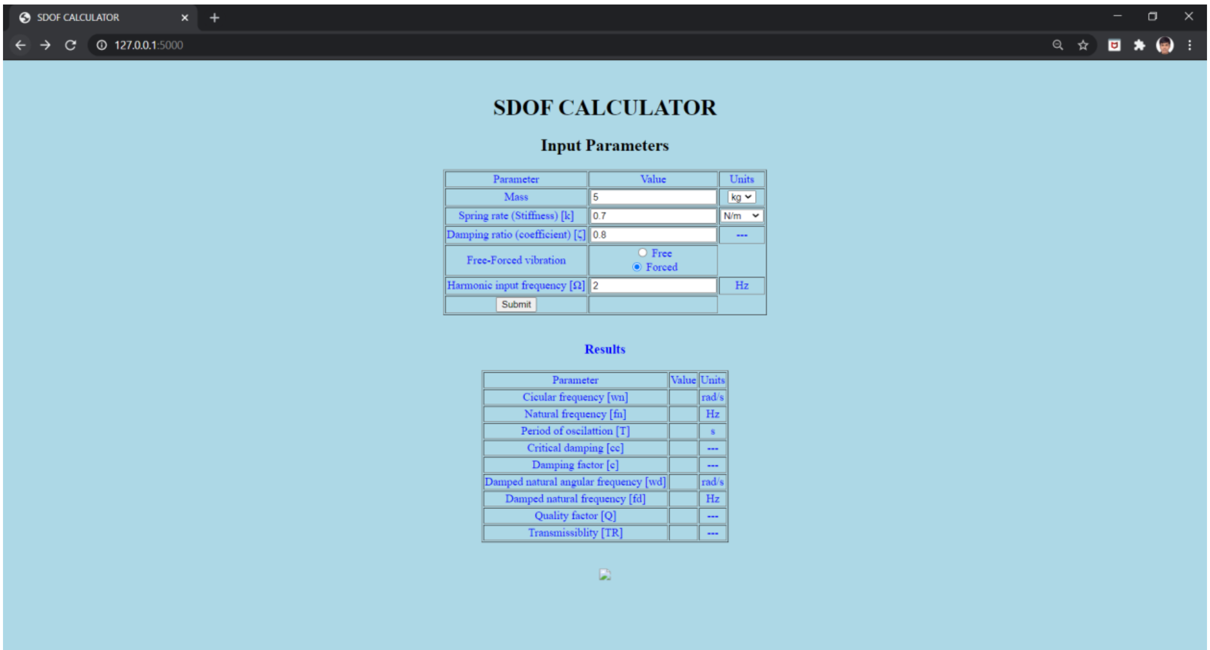
Parameter	Equation
Natural angular frequency (w_n)[rad/s]	$w_n = \sqrt{\frac{k}{m}}$
Natural frequency (f_n) [Hz]	$f_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$
Period of oscillations (T) [s]	$T = \frac{1}{f_n}$
Critical damping (c_c)	$c_c = 2mw_n$
Damping factor (c)	$c = \zeta c_c$
Damped natural frequency (w_d)	$w_d = w_n\sqrt{1-\zeta^2}$
Quality factor (Q)	$Q = \frac{1}{2\zeta}$
Transmissibility (TR)	$TR = \sqrt{\frac{1+(\frac{2\zeta\Omega}{w_n})^2}{[1-(\frac{\Omega}{w_n})^2]^2+(\frac{2\zeta\Omega}{w_n})^2}}$

k - Spring rate (stiffness), m - Mass of the object, ζ - Damping ratio, Ω - Forcing frequency

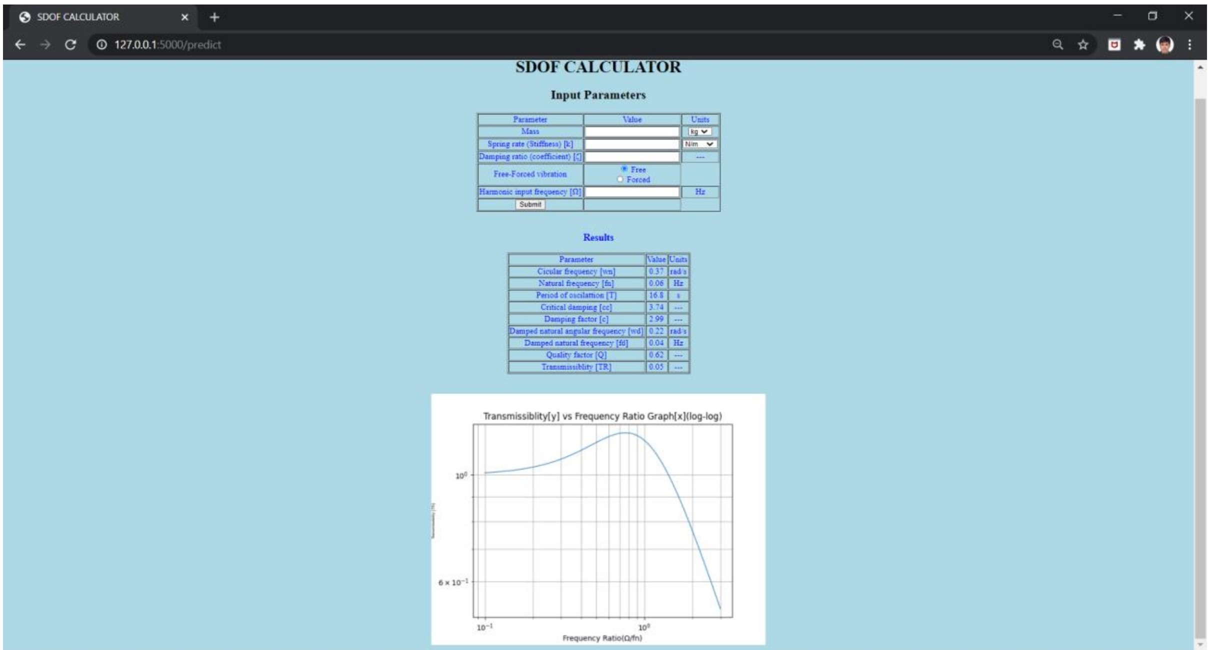
Results:

Website/UI:

During Input:



During Output:

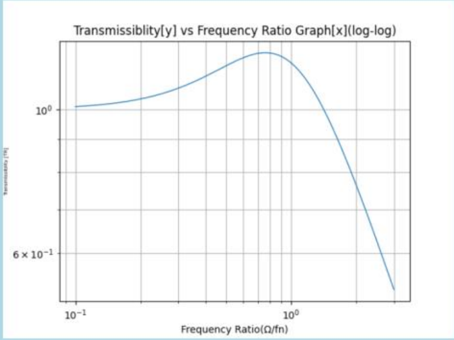


SDOF CALCULATOR

127.0.0.1:5000/predict

Results

Parameter	Value	Units
Cicular frequency [wn]	0.37	rad/s
Natural frequency [fn]	0.06	Hz
Period of oscilattion [T]	16.8	s
Critical damping [cc]	3.74	---
Damping factor [c]	2.99	---
Damped natural angular frequency [wd]	0.22	rad/s
Damped natural frequency [fd]	0.04	Hz
Quality factor [Q]	0.62	---
Transmissiblity [TR]	0.05	---



Detailed Input:

SDOF CALCULATOR

Input Parameters

Parameter	Value	Units
Mass	5	kg
Spring rate (Stiffness) [k]	0.7	N/m
Damping ratio (coefficient) [ζ]	0.8	---
Free-Forced vibration	○ Free ◉ Forced	
Harmonic input frequency [Ω]	2	Hz
Submit		

Detailed Output & Graph:

Results

Parameter	Value	Units
Cicular frequency [wn]	0.37	rad/s
Natural frequency [fn]	0.06	Hz
Period of oscillattion [T]	16.8	s
Critical damping [cc]	3.74	---
Damping factor [c]	2.99	---
Damped natural angular frequency [wd]	0.22	rad/s
Damped natural frequency [fd]	0.04	Hz
Quality factor [Q]	0.62	---
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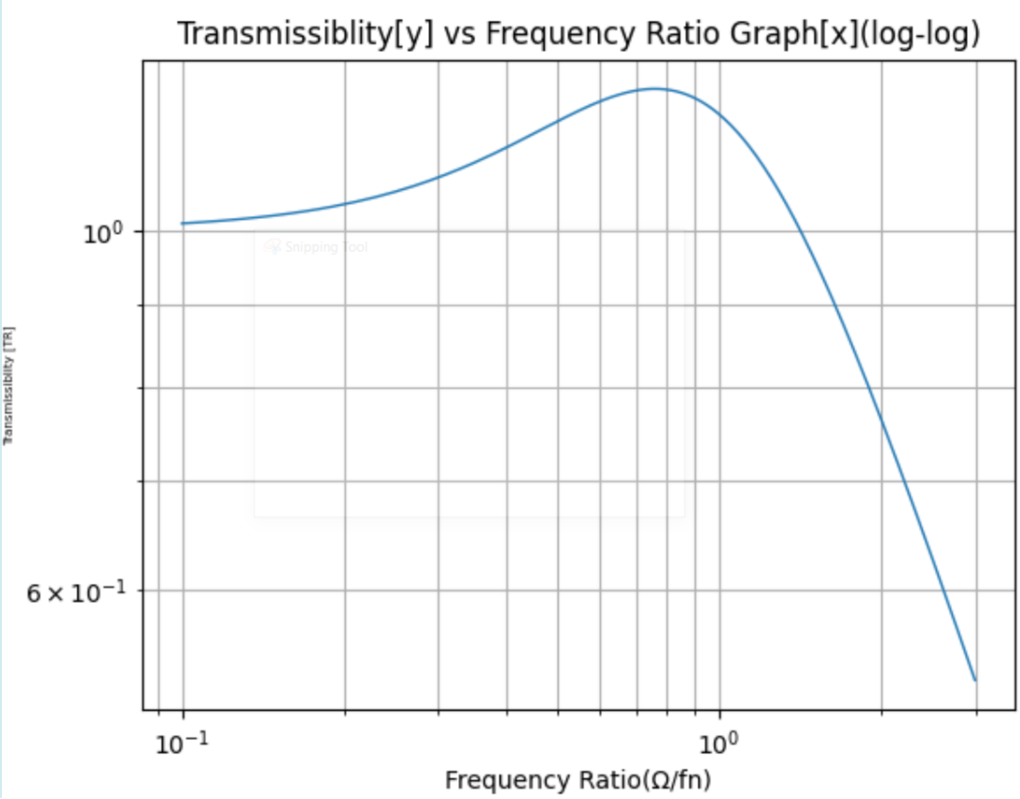

Work Done:

I have used Python for the calculations and the plotting part and website interface was made using html (frontend website/UI) . Python Flask helps us in designing webpages along with html. User has to input the parameters in the input parameters table selecting appropriate units required on the html window while the result(calculated parameters) and the graph is displayed on the same webpage after submitting the input parameters. The code has been attached in the folder. To execute the libraries imported have to be installed.

Further scope: This website can be deployed on Heroku app, enabling anyone online to use this with the link.

Inference:

I plotted the graph using matplotlib library in python.

I noticed from the log-log graph of Transmissibility vs frequency ratio that with higher values of frequency ratio (greater than 3) the value of transmissibility shoots up which does not occur on an experimentally derived graph. Besides the maximum Transmissibility occurs at frequency ratio =1 and transmissibility starts at 1 for frequency ratio 0.