ENME 711 – Vibration Damping

Prerequisite: Advanced Vibration (ENME662); or equivalent.

Course Summary: This course aims at introducing the different damping models that describe the behavior of viscoelastic materials. Emphasis will be placed on modeling the dynamics of simple structures (rods and beams) with Passive Constrained Layer Damping (*PCLD*). Considerations will also be given to other types of surface treatments such as Shunted Network Constrained Layer Damping (*SNCLD*) and Active Constrained Layer Damping (*ACLD*). Energy dissipation characteristics of the damping treatments will be presented analytically and by using the modal strain energy approach as applied to finite element models of vibrating structures.

Topics Covered (*Active & Passive Vibration Damping*, A. Baz, J. Wiley, 2019)

1. Vibration Damping

1.1 Overview

1.2 Passive, Active and Hybrid Vibration Control

1.2.1 Passive Damping

1.2.2 Active Damping

1.2.3 Hybrid Damping

1.3 Summary

2. Viscoelastic Damping Models

2.1 Introduction

2.2 Classical Models of Viscoelastic Materials

2.3 Creep Compliance and Relaxation Modulus

2.4 Characteristics of the VEM in the Frequency Domain

2.5 Hysteresis and Energy Dissipation Characteristics of Viscoelastic Materials

2.7 Viscoelastic Versus Other Types of Damping Mechanisms

2.8 Summary

3. Characterization of the Properties of Viscoelastic Materials

3.1 Introduction

3.2 Typical Behavior of Viscoelastic Materials

3.3 Frequency Domain Measurement Techniques

3.4 Master Curves of Viscoelastic Materials

3.5 Time Domain Measurement Techniques

a. Split Hopkinson Pressure Bar Method

Detailed Timetable

Lect.	Date	Reading	Topics	Homework	Due Date
1	M, 1/28	**1.1-1.3**	**Introduction to Vibration Damping**	HW 1	W, 2/6
2	W, 1/30	**2.1-2.2**	**Classical Viscoelastic Models**		
3	M, 2/4	2.3	Creep and relaxation	HW 2	W, 2/13
4	W, 2/6	2.4	Performance in Frequency Domain		
5	M, 2/11	2.5	Hysteresis and Energy Dissipation	HW 3	W, 2/20
6	W, 2/13	**3.1-3.2**	**Characterization of Viscoelastic Materials**		
7	M, 2/18	3.3	Frequency Domain Measurements	HW4	W, 2/27
8	W, 2/20	3.4	Master Curves of Viscoelastic Materials		
9	M, 2/25	3.5	Time Domain Measurements (*SHPB*)	HW 5	W, 3/6
10	W, 2/26	3.5	Time Domain Measurements (Wave Methods)		
11	**M, 3/4**		**Review for Exam#1**		
12	**W, 3/6**		**Exam #1**		
13	M, 3/11	**4.1-4.2**	**Advanced Models Viscoelastic materials**		
14	W, 3/13		*GHM* – Optimization of Model Parameters		
15	**M, 3/18**		***Spring Break***		
16	**W, 3/20**		***Spring Break***		
17	M, 3/25	4.3	*FEM* of Beams Treated with *VEM*	HW 6	W, 4/3
18	W, 3/27	4.4	Generalized Maxwell Model (*GMM*)		
19	M, 4/1	4.5	Augmenting Thermodynamic Field (*ATF*) Model	HW 7	W, 4/10
20	W, 4/3	**5.1-5.2**	**Modal Strain Energy (*MSE*) Method**		
21	M, 4/8	5.3	Modified Modal Strain Energy Methods	HW 8	W, 4/17
22	W, 4/10	5.4	Summary of Strain Energy Methods		
23	**M, 4/15**		**Review for Exam#2**		
24	**W, 4/17**		**Exam #2**		
25	M, 4/22	5.5	Modal Strain Energy as a Design Metric for *VEM*	HW 9	W, 5/1
26	W, 4/24	**6.1**	**Energy Dissipation in Damping Treatments**		
27	M, 4/29	6.2	Passive Damping Treatments of Rods	HW 10	W, 5/8
28	W, 5/1	6.3	Active Damping Treatments of Rods		
29	M, 5/6	**7.1-7.2**	**Shunted Piezoelectric Patches**		
10	W, 5/8	7.3	*FEM* of Structures with Shunted Piezo-Networks		
11	**M, 5/13**		**Review for Final Exam**		
12	**W, 5/20**		**Final Exam**		