



**The Hashemite University**  
**Faculty of Engineering**  
**Course Syllabus**

**Course Title:** Special Topics in ME                      **Course Number:** 110402571  
**Department:** Mechanical Engineering                      **Designation:** Elective/Online  
**Prerequisite(s):** -  
**Instructor:** Dr. Mohammad Gharaibeh                      **Instructor's Office:** E3101  
**Instructor's e-mail:** [mohammada\\_fa@hu.edu.jo](mailto:mohammada_fa@hu.edu.jo)  
**Office Hours:** See MS-Teams Group.

**Course description:** Review on SDOF and MDOF systems; Eigenvalue problem; Modal Analysis; Types of structural damping; Vibration of continuous systems like strings and beams; Vibrations measurements and diagnoses; Design of Vibration absorbers and isolators; Balancing of rotary machines; structural vibration analysis; Machine Condition Monitoring and Diagnosis.

**Textbook(s):**

1. Rao, S. S. (2007). "Vibration of continuous systems", John Wiley & Sons.
2. Rao, S. S. (2011). "Mechanical vibrations", 5th edition Addison Wesley.

**Referenece(s):** 1. Inman, D., "Engineering Vibration", 4<sup>th</sup> edition, PrenHall.

**Course Outcomes:** After completing the Special Topics in ME course, the students are expected to:

- Analyze single and multi-degrees-of- freedom system using direct and modal analysis methods. Learn about the various types of structural damping.
- Calculate and interpret natural frequencies and mode shapes of simple structures like strings and beams.
- Be familiar with balancing of rotary machines (single and two phase) methods. Also, vibration reduction methods.
- Design vibration absorbers and isolators (damped and undamped) for systems with both fixed and vibrating bases.
- Learn basics of signal processing and analysis.
- Understand various types of transducers, vibration pickups and frequency measuring instruments. Know different aspects of machine condition monitoring.
- Learn the basic principles of mechanical and electrodynamic shakers and excitors.
- Be familiar with experimental modal analysis for measuring natural frequencies and mode shapes as well as modal damping ratios.

**Class schedule:** Three class sessions each week; 50 minutes each

<b>Grading Plan:</b>	
Midterm Exam	(30 Points)
Quizzes	(15 Points)
Project	(15 Points)
Final exam	(40 Points)

**Course designation according to the professional component:**

Professional Component	Course Designation
General Education	-----
Basic Science and Mathematics	----
Engineering Science	√
Engineering Design	√

**Course relationship to program outcomes:**

	<b>ME Program Outcomes</b>
√	1. Apply knowledge of science, mathematics (including multivariate calculus, linear algebra, differential equations) and engineering fundamentals to mechanical engineering applications. <b>(a, ME1)</b>
	2. Design and conduct experiments, as well as analyze and present results in a professional manner. <b>(b)</b>
√	3. Design, model, analyze and realize a component, system (thermal or mechanical), or process to meet specific requirements and realistic constraints. <b>(c, ME2)</b>
	4. Communicate effectively, and function in multidisciplinary teams. <b>(d, g)</b>
√	5. Identify, formulate, and solve engineering problems. <b>(e)</b>
√	6. Understand professional and ethical issues and the responsibilities of the engineering practice. <b>(f)</b>
√	7. Recognize contemporary issues and environmental, cultural, and economical consideration of the engineering profession. <b>(j, h)</b>
	8. Identify the need for professional development and engage in life-long learning. <b>(i)</b>
	9. Use the techniques, skills, and modern engineering and computing tools necessary for engineering practice. <b>(k)</b>
√	10. Apply the basics of statistics and probability. <b>(ME3)</b>
	11. Recognize the need and engage in solving national environmental issues.

**Course relationship to 2006/2007 ABET criteria for mechanical engineering programs:**

	Programs must demonstrate that graduates have:
√	A. Knowledge of chemistry and calculus-based physics with depth in at least one;
	B. The ability to apply advanced mathematics through multivariate calculus and differential equations;
√	C. Familiarity with statistics and linear algebra;
√	D. The ability to work professionally in both thermal and mechanical systems areas including the design and realization of such systems.

**Prepared by:**

Dr. Mohammad Gharaibeh

**Date:**

25/Feb/2025

## Course Contents and Approximate Timeline

<b>Chapter 2</b>	<b>Vibration of Discrete Systems: Brief Review [Textbook 1]</b>	
2.1	Vibration of Single-degree-of-freedom system	
2.1.1	Free Vibration	3
2.1.2	Forced Vibration Under Harmonic Force	
2.1.3	Forced Vibration Under General Force	
2.2	Vibration of Multidegree-of-freedom systems	
2.2.1	Eigenvalue Problem	
2.2.2	Orthogonality of Modal Vectors	
2.2.3	Free Vibration Analysis of an Undamped System using Modal Analysis	
2.2.4	Forced Vibration Analysis of an Undamped System using Modal Analysis	5
2.2.5	Forced Vibration Analysis of a System with Proportional Damping	
2.2.6	Forced Vibration Analysis of a System with General Viscous Damping	
<b>Chapter 4</b>	<b>Derivation of Equations: Variational Approach [Textbook 1]</b>	
4.1	Introduction	
4.2	Calculus of Single Variable	
4.3	Calculus of Variation	2
4.4	Variation Operator	
4.9	Boundary Conditions	
4.10	Variational Methods in Solid Mechanics: Hamilton's Principle	
<b>Chapter 8</b>	<b>Transverse Vibration of Strings [Textbook 1]</b>	
8.1	Introduction	
8.2	Equation of Motion: Variational Approach	3
8.3	Initial and Boundary Conditions	
8.5	Free Vibration of a String of Finite Length	
8.6	Forced Vibration of a String of Finite Length	
<b>Chapter 11</b>	<b>Transverse Vibration of Beams [Textbook 1]</b>	
11.1	Introduction	
11.2	Equation of Motion: Euler-Bernoulli Theory	2
11.3	Free Vibration Equations	
11.4	Free Vibration Solution	
11.5	Frequencies and Mode Shapes of Uniform Beams	
11.6	Orthogonality of Normal Modes	
11.7	Free Vibration Response due to Initial Conditions	5
11.8	Forced Vibration	
11.13	Beams on Elastic Foundation	
<b>Mid-Term Exam</b>		
<b>Chapter 9</b>	<b>Vibration Control [Textbook 2]</b>	
9.1	Introduction	
9.2	Vibration Nomograph and Vibration Criteria	3
9.3	Reduction of Vibration at the Source	
9.4	Balancing of Rotating Machines	
9.5	Whirling of Rotating Shafts	
9.6	Balancing of Reciprocating Engines	
9.7	Control of Vibrations	4
9.8	Control of Natural Frequencies	
9.9	Introduction to Damping	

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	9.10	Vibration Isolation	<b>3</b>
	9.11	Vibration Absorbers	
<b>Chapter</b>	<b>10</b>	<b>Vibrations Measurement and Applications [Textbook 2]</b>	
	10.1	Introduction	
	10.2	Transducers	<b>4</b>
	10.3	Vibration Pickups	
	10.4	Frequency Measuring Instruments	
	10.5	Vibration Exciters	
	10.6	Signal Analysis	<b>1</b>
	10.7	Dynamic Testing of Machines and Structures	
	10.8	Experimental Modal Analysis	
	10.9	Machine Condition Monitoring and Diagnosis	<b>6</b>
		<b>Case Studies from Real-Life Applications</b>	
		<b>Final Exam</b>	

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