United States Naval Academy

Mechanical Engineering Department

Catalog Description: EM496A Sound and Vibration Credit: 3 (3-0-3)
Designation: Major Elective

Sound and vibration are a part of everyday life. Whether constructive or destructive their understanding is central to the engineering of mechanical systems. From ships and submarines to aircraft and space craft, the prediction and control of sound and vibration are fundamental elements of mechanical design. With a focus on simple mechanical systems and basic acoustic propagation, this class provides an introduction to these topics and their application to such areas as the prediction and control of structural vibration and noise, and underwater acoustics. Reinforced by applied laboratory and project exercises, this course provides students with a fundamental understanding of the foundations of sound and vibration as well as its related testing and measurement principles.

Prerequisites: EM232, SM212, SP212
Co-requisites: None

Textbooks: Fundamentals Sound and Vibration, 2nd Edition, by Fahy and Thompson; CRC Press (2016).

Course Director: Associate Professor John Burkhardt

Course Content:

No.	Topic or Subtopic	hrs.
1.	Fundaments of Acoustics	8
2.	Fundamentals of Vibration	8
3.	Fundamentals of Signal Processing	7
4.	Noise Control	7
5.	Experimental Acoustics	7
6.	Experimental Vibrations	7

Assessment Methods:		YES	NO
A	Quizzes	X	
B	Homework	X	
C	Exams	X	
D	Laboratory Reports	X	
E	Oral Presentations		X
F	Design Reports/Notebooks		X
G	Prototypes/Demonstrations		X
H	Projects	X	
I	Other		X

Course Outcomes:

1. Students will be able to use analytical and computational tools for the interpretation, analysis, characterization and computation of acoustic and vibration signals including the use of complex, exponential notation and the decibel scale. (A, B, C, D, H)
2. Students will be able to interpret and compute free-field solutions to the acoustic wave equation and their properties for monopole and multipole acoustic sources including source power and intensity. (A, B, C, D, H)
3. Students will be able to interpret and compute acoustic sound fields and their properties in tubes and enclosures. (A, B, C, D, H)
4. Students will be able to interpret and compute the behavior of singe-degree-of-freedom and multiple-degree-of-freedom undamped and damped systems in free vibration and excited with time-harmonic and generally forced signals including the use of convolution integrals. (A, B, C, D, H)
5. Students will be able to interpret and compute the frequency composition of continuous and digitally sampled time signals including frequency response functions, frequency spectra, DFTs, FFTs and aliasing effects. (A, B, C, D, H)
6. Students will demonstrate an understanding of basic noise control concepts and principles including weighted spectra, spectrograms, sound source categories, acoustic efficiency, noise-path models, noise-generating mechanisms and the effect of sound absorption treatments, boundaries, barriers, partitions, and noise control enclosures on sound fields and acoustic noise. (A, B, C, D, H)
7. Students will be able to analyze and interpret the sound fields generated by vibrating structures and the effect of vibration control on acoustic noise. (A, B, C, D, H)
8. Students will demonstrate and understanding of acoustic measurement systems, their components and calibration. (A, B, C, D, H)
9. Students will demonstrate and understanding of vibration measurement systems, their components and calibration as well as signal types and their use in vibration testing. (A, B, C, D, H)

Letters in parenthesis refer to the assessment methods listed in previous section.

	Course Outcomes								
Program outcomes	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(a)	X	X	X	X	X	X	X	X	X
(b)								X	X
(c)						X			
(d)								X	X
(e)	X	X	X	X	X	X	X	X	X
(f)									
(g)								X	X
(h)									
(i)									
(j)									
(k)	X							X	X

Date of Latest Revision: October 2017, Associate Professor John Burkhardt