Course Design Matrix

Course Name: Structural System Testing and Model Correlation	
Instructor Name: Dr. James Gardner	**Date:**
Program Outcomes Addressed: [Optional]	

Course Learning Outcomes

I. Ability to apply the scientific method to execute systematic approaches to problem solving, including problem definition, constraints, solution strategies, and results comparison/assessment.
II. Knowledge of structural dynamics theory, test design/execution, and signal processing.
III. Experience in test set-up, instrumentation, and data acquisition, with exposure to commercial DAQ and/or DAQ processing software (e.g., LabVIEW, Matlab, etc.)
IV. Ability to critically evaluate modeling assumptions and theory and determining their estimated error and uncertainty on the solution, including formal validation and verification procedures (SE 268, SE 207 “Val. and Ver. Of Comp. Models”)

Module # and Title	Course Learning Outcomes (CLOs)	Module Learning Outcomes (MLOs)	Assessments and Rubrics	Instructional Materials	Activities: Learner Interaction & Engagement
Module 1: Modeling and Analysis for Vibration Test (Weeks 1, 2, 3)	**II, III**	**After completing this module, students will be able to:** 1.1 Develop linear dynamic system models in spatial, modal, and frequency response domains. **(CLO II)** 1.2 Perform eigenanalysis on linear dynamic system models to find modal properties. **(CLOs II & III)** 1.3 Apply modal effective mass fraction, modal assurance criteria, and model reduction techniques to select vibration test target modes and degrees of freedom. **(CLOs II & III)**	**Lab 0** Ungraded pre-assessment **Lab 1** • Lab Rubric • **MLOs 1.1 & 1.2** **Lab 2** • Lab Rubric • **MLOs 1.2 & 1.3** **Exam 1:** vibrations and modal analysis • Exam 1 Rubric • **MLOs 1.1, 1.2, & 1.3**	**Lecture Week 1** multi DOF linear vibrations review; mass, stiffness, and damping matrices; time domain solution for multi DOF discrete linear systems **(MLO 1.1)** **Lecture Week 2** modal solution for multi-DOF discrete linear systems, Fourier analysis, frequency response function, comparison of spatial, modal, and response models **(MLOs 1.1 & 1.2)** **Lecture Week 3** finite element method review, MATLAB modeling of test system including boundary conditions, DOF selection, model reduction techniques (dealing with unmeasured DOFs) **(MLOs 1.1 & 1.3)**	**Lab Week 1** MATLAB software review: assessing basic MATLAB coding knowledge **(Review/Not Graded)** **Lab Week 2** Test structure modeling **(MLOs 1.1 & 1.2)** **Lab Week 3** Test structure modeling, DOF selection, model reduction **(MLOs 1.2 & 1.3)**
Module 2: Vibration Test Data Acquisition, Signal Processing, and Data Quality (Weeks 4-8)	**I, III**	**After completing this module, students will be able to:** 2.1 Execute a basic modal vibration test. **(CLOs I & III)** 2.2 Apply basic signal processing techniques for assessing vibration test data quality. **(CLO III)** 2.3 Estimate the frequency response function from measured vibration test data.	**Lab 3** • Lab Rubric • **MLOs 1.3 & 2.1** **Lab 4** • Lab Rubric • **MLOs 2.1 & 2.2** **Lab 5** • Lab Rubric • **MLOs 2.2 & 2.3** **Lab 6 (2-week lab)**	**Lecture Week 4** basic DSP (discrete data, averaging, windowing, FFT), introduction to test hardware, piezoelectric accelerometers **(MLOs 1.3 & 2.1)** **Lecture Week 5** data acquisition basics, data quality, advanced DSP (FRF, spectra) **(MLOs 2.1, 2.2, & 2.3)** **Lecture Week 6** advanced DSP (FRF, spectra), data quality **(MLOs 2.1, 2.2, & 2.3)**	**Lab Week 4** Introduction to experiments, introduce equipment, select instrumentation DOFs **(MLOs 1.3 & 2.1)** **Lab Week 5** Initial experimental test to verify boundary conditions **(MLOs 2.1 & 2.2)** **Lab Week 6** DSP exercises **(MLOs 2.2 & 2.3)** **Lab Week 7 & 8**

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		(CLOs I & III) 2.4 Apply basic frequency domain modal parameter estimation using rational fractional polynomial expansion technique. **(CLO III)**	• Lab Rubric • **MLO 2.4** **EXAM 2** DSP / Testing • Exam 2 Rubric • **MLOs 2.2, 2.3, & 2.4**	**Lecture Week 7 & 8** experimental modal testing: excitation methods; data quality checks; modal parameter extraction **(MLOs 2.3 & 2.4)**	Experimental modal testing: excitation methods; data quality checks; modal parameter Extraction **(MLO 2.4)**
Module 3: Model Updating and Optimization (Week 9-10)	**I, III, IV**	**After completing this module, students will be able to:** 3.1 Define and MATLAB-code a constrained optimization problem for model updating based on modal parameters. **(CLOs III & IV)** 3.2 Perform basic sensitivity analysis on tunable model updating parameters. **(CLOs I & III)** 3.3. Report comprehensive strategy for vibration plan, execution, and updating. **(CLOs I, III, & IV)**	**Lab 7** ● Lab Rubric ● **MLOs 3.1 & 3.2** **Final Project ("Lab 8")** ● Final Project Rubric ● **MLOs 3.3**	**Lecture Week 9 & 10** model / test correlation and updating principles **(MLOs 3.1 & 3.2)**	**Lab Week 9 & 10** Model correlation; CLO function formulation; updating/optimization **(MLOs 3.1 & 3.2)**