Course Specifications

Program(s) on which this course is given:	Aerospace Engineering
Department offering the program:	Aerospace Engineering Department
Department offering the course:	Aerospace Engineering Department
Academic Level:	Master of Science
Date	February 2015 to June 2015
Semester (based on final exam timing)	☐ Fall ☒ Spring

A- Basic Information

1. Title:	Experimental methods in structural analysis			**Code:**	AER 644			
2. Units/Credit hours per week:	Lectures	2	Tutorial	0	Practical	0	Total	2

B- Professional Information

1. Course description:	This course is the third of a series of courses aiming to setup the theoretical and technical background behind experimental modal analysis. These courses are AER 602 and AER 631 courses. Specifically, this course aims at dynamic system identification by experimentally measuring its Frequency Response Function (FRF). This course begins by reviewing uni-variate random processes, and then extends to bi-variate random processes. These theories are extended for stochastic random processes, and subsequently simplified for stationary and ergodic random processes. Bi-variate correlation along with its Fourier spectrum are then analyzed in details. System identification in order to measure FRF's of dynamic models. Experimental implementation and statistical considerations for system identification are then introduced and analyzed. Finally, all the concepts are generalized for realistic MDOF dynamic structures.
2. Intended Learning Outcomes of Course (ILOs):	**a) Knowledge and Understanding**
	1) Know the advanced structures of Aerospace vehicles
	2) Know random processes
	3) Understand basic probability theory concepts for random processes
	4) Understand theoretical expectation
	5) Know the moments of random processes
	6) Understand stochastic random processes
	7) Understand stationary and ergodic random processes and their importance
	8) Understand correlation, both in time and frequency domains, and its importance
	9) Understand the effect of noise on measurements
	b) Intellectual Skills
	10) Summarize and select the appropriate solution Methodology
	11) Experimentally estimate probability parameters
	12) Experimentally estimate the moments of random processes
	13) Calculate the correlation
	14) Experimentally estimate the moments of stationary and ergodic stochastic processes
	15) Experimentally estimate the FRF
	16) Estimate the quality of the estimated FRF's
	17) Estimate the FRF for MIMO systems
	18) Estimate the quality of the estimated MIMO FRF's
	c) Professional and Practical Skills

	19) Structural synthesize and/or design of a complete aerospace vehicle
	20) Practice several experimental modal analysis techniques and skills
	21) Gain serious programming and visualization skills using Matlab
	d) General and Transferable Skills
	22) Work in a team
	23) Write reports
	24) Analyze results and reach conclusion
	25) Understand the spectral density spectrum and extract useful information from it
	26) Ability to design experiments in noisy environments

3. Contents

Topic	**Total hours**	**Lectures hours**	**Tutorial/ Practical hours**
Introduction	1	1	
Random Processes	4.5	4	0.5
Stochastic Processes	5	4	1
Correlation and its Spectra	5	4	1
Statistical Estimation	4.5	4	0.5
Effect of measurement noise	2	2	
Multi Input Multi Output Systems	2	2	

4. Teaching and Learning Methods	Lectures (√)	Practical Training/ Laboratory (√)	Seminar/Workshop ( )
	Class Activity (√)	Case Study (√)	Projects ( )
	E-learning ( )	Assignments /Homework (√)	Other:

5. Student Assessment Methods

• **Assessment Schedule**	**Week**
-Assessment 1; Class Activity	2
-Assessment 2; Class Activity	3
-Assessment 3; Class Activity	4
-Assessment 4; Class Activity	5
-Assessment 5; Class Activity	7
-Assessment 6; Class Activity	8
-Assessment 7; Midterm Exam	10
-Assessment 8; Class Activity	12
-Assessment 9; Final Exam	15
• **Weighting of Assessments**	
-Mid-Term Examination	7
-Final-term Examination	70
-Class Activity	20
-Class Attendance	3
-Total	100

6. List of References

1) K. Shin and J. K. Hammond, Fundamentals of Signal Processing for Sound and Vibration Engineers, John Wiley & Sons, 2008.
2) J. S. Bendat and A. G. Piersol, Random Data: Analysis and Measurement Procedures, John Wiley & Sons, 1st ed., 1971.
7. Facilities Required for Teaching and Learning
Projector, white board, Modal analysis laboratory (Signal analyzer, multichannel dynamic data acquisition, vibration sensors (accelerometers), force transducers, programmable function generators, shakers, impact hummer, test structure, data acquisition/analysis software, experimental modal analysis software)

Course Coordinator:	**Dr. Ahmed Mohamed Rashed Desoki**
Head of Department:	**Prof. Ayman Hamdy Kassem**