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:	Doctor of Philosophy
Date	
Semester (based on final exam timing)	☐ Fall ☐ Spring

A- Basic Information

1. Title:	Applied Signal Processing			**Code:**	AER 734			
2. Units/Credit hours per week:	Lectures	2	Tutorial	0	Practical	0	Total	2

B- Professional Information

1. Course description:	This course complements AER 730 course aiming to setup the theoretical and technical background behind experimental modal analysis. Doing so, the following topics is covered: Introduction to signal processing, signal types, deterministic signals, continuous Fourier analysis, discrete Fourier transform, short time Fourier Transform, random processes, correlation and spectra, stochastic estimation, system identification, experimental implementation and statistical considerations for system identification, MDOF dynamic structures, applications to vibration, acoustics and condition monitoring
2. Intended Learning Outcomes of Course (ILOs):	**a) Knowledge and Understanding**
	1) Understand the basics of Fourier analysis and signal processing
	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) Use principles and concepts in solving problems
	11) Calculate the continuous and discrete Fourier transform of signals
	12) Calculate short time continuous and discrete Fourier transform
	13) Experimentally estimate probability parameters
	14) Experimentally estimate the moments of random processes
	15) Calculate the correlation
	16) Experimentally estimate the moments of stationary and ergodic stochastic processes
	17) Experimentally estimate the FRF
	18) Estimate the quality of the estimated FRF's
	19) Estimate the FRF for MIMO systems
	20) Estimate the quality of the estimated MIMO FRF's
	c) Professional and Practical Skills
	21) Structural synthesize and/or design of a complete aerospace vehicle
	22) Practice several experimental modal analysis techniques and skills
	23) Gain serious programming and visualization skills using Matlab

	d) General and Transferable Skills
	24) Solve problems
	25) Analyze results and reach conclusion
	26) Understand the spectral density spectrum and extract useful information from it
	27) Ability to design experiments in noisy environments

3. Contents

Topic	**Total hours**	**Lectures hours**	**Tutorial/ Practical hours**
Signal Processing Basics	4	3	1
Random Processes	3	2	1
Stochastic Processes	5	4	1
Correlation and its Spectra	5	4	1
Statistical Estimation	3	2	1
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; Report Assignment	2
-Assessment 2; Report Assignment	3
-Assessment 3; Report Assignment	4
-Assessment 4; Report Assignment	5
-Assessment 5; Midterm Exam	7
-Assessment 6; Report Assignment	8
-Assessment 7; Report Assignment	10
-Assessment 8; Report Assignment	12
-Assessment 9; Final Exam	15
• **Weighting of Assessments**	
-Mid-Term Examination	6
-Final-term Examination	70
-Reports	18
-Class Attendance	6
-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**