STRUCTURAL HEALTH MONITORING USING STATISTICAL PATTERN RECOGNITION
Palermo, Sicily, July 2 - 4, 2020

Time	Day 1	Time	Day 2
8:30-9:00	**Registration & Introductions**		
9:00-9:55	**1. Introduction to Structural Health Monitoring (Farrar)** - Course overview - Definition of Damage and SHM - Motivation for SHM, (NDE vs SHM) - Statistical pattern recognition paradigm - Historical overview: aerospace /civil/mechanical application	8:30-9:25	**8. SHM Sensing Technologies I (Todd)** - Excitation methods - Conventional force/pressure sensing - Conventional strain sensing - Conventional acceleration sensing - Acoustic emission sensing - Fiber optic sensing
9:55-10:20	**2. Operational Evaluation for SHM (Farrar)** - Economic/Life-safety justification for SHM - Defining the damage to be detected - Constraints on the SHM process - Case Study	9:25-10:20	**9. SHM Sensing Technologies II (Flynn)** - Piezoelectric materials - Commercial transducers/actuators - Custom transducers/actuators - Design consideration - Instrumentation techniques
10:20-10:40	**Coffee Break**	**10:20-10:40**	**Coffee Break**
10:40-11:45	**3. Review of NDE Methods (Todd)** - Ultrasound - Thermography - Eddy Current - Radiography - Limitations	10:40-11:45	**10. SHM Sensing Technologies III (Todd)** - Laser-based non-contact measurements - Video-based non-contact measurements - Robotic devices used for SHM sensing - Specialty sensors developed for SHM (comparative vacuum monitoring, pressurized aircraft tubing, HERT, Underwater system) - Emerging sensing and data visualization hardware
11:45-12:45	**4. SHM Sensing & Data Acquisition Overview (Todd)** - Sensor and sensor system overview - Sensor performance metrics - Signal conditioning issues - Telemetry and power - Embedded systems - Sensor network paradigms	11:45-12:45	**11. Damage-Sensitive Features I (Farrar)** - Define “features’ in the context of SHM - Features in the context of detection theory - Feature types - Examples (frequencies, mode shapes)
12:45-13:45	**Lunch**	**12:45-13:20**	**Lunch**
13:45-14:45	**5. Signal Processing for SHM (Flynn)** - Conditioning signals - Analyzing Signals - Time, Frequency &Time-frequency Methods - Correlation methods - Input-output methods	13:45-14:45	**12. Ultrasonic Methods for SHM (Flynn)** - Acoustic emissions - Impedance method - Sensor self-diagnostics - Guides waves - Nonlinear acoustics -Integration with other SHM technologies
14:45-15:40	**6. Basic Statistics for SHM (Farrar)** - Statistical moments/distributions - Density estimation - Confidence limits - Central limit theorem - Principal component analysis	14:45-15:40	**13. Damage-Sensitive Features II (Todd)** - Nonlinear response concepts - Waveform comparisons (nonlinear) - Nonlinear time series modeling - Residual errors - Chaotic interrogation methods
15:40-16:00	**Coffee Break**	**15:40-16:00**	**Coffee Break**
16:00-17:00	**7. SHMTools Demonstration: Signal Analysis (Flynn)** - Using SHMTools & mFUSE - Function & process assembly	16:00-17:00	**14. SHMTools Demonstration (Flynn)** - Feature extraction with time series models - Rotating machinery example - Guided wave example

	- Data import - Statistical analysis - Signal processing		

Time	Day 3
8:30-9:25	**15. Unsupervised Learning for SHM (Farrar)** - Motivation for statistical decision analysis - Define supervised and unsupervised learning methods in the context of SHM - Cluster analysis - Outlier (Novelty) detection - Statistical process control
9:25-10:20	**16. Supervised Learning for SHM (Todd)** - Group classification & regression - Neural networks - Radial basis function - Support vector machines - Automated feature selection
10:20-10:40	**Coffee Break**
10:40-11:45	**17. Data Normalization for SHM (Farrar)** -Environmental/operational effects on SHM -Parametric modeling environmental effects -Look-up table technique -Machine learning techniques -SHM system design for normalization
11:45-12:45	**18. SHM Design I: Detection and Localization** - Bayesian risk framework - Classical detection theory - Detector design - Detection/location examples
12:45-13:45	**Lunch**
13:45-14:45	**19. SHM Design II: Optimization and Robustness** - SHM system design: Bayes Risk - SHM system design - Information Gap analysis for SHM robustness
14:45-15:40	**20. SHMTools Demonstration Detection & Classification (Flynn)** - Outlier detection - Data normalization - Supervised learning example
15:40-16:00	**Break**
16:00-17:00	**21. SHM Fundamental Axioms & Closing Remarks (Farrar)** - Recap the statistical pattern recognition paradigm - Fundamental axioms of SHM - Other sources of information - Course survey