STRUCTURAL HEALTH MONITORING USING STATISTICAL PATTERN RECOGNITION

Virtual Course (offered over 5 days) Times Shown are Central European Time

Time	June 27	Time	June 28	Time	June 29
14:00-14:30	**Instructor and Participant Introductions**				
14:30-15:30	**1. Introduction** - Motivation for SHM, (NDE vs SHM) - Statistical pattern recognition paradigm - Historical overview: aerospace /civil/mechanical applications	14:00-15:00	**5. Signal Processing** - Conditioning signals - Analyzing Signals - Time, Frequency &Time-frequency Methods - Correlation methods - Input-output methods	14:00-15:00	**9. SHM Sensing Technologies II** - Piezoelectric materials - Commercial transducers/actuators - Custom transducers/actuators - Design consideration - Instrumentation techniques
15:30-16:30	**2. Review of NDE Methods** - Ultrasound - Acoustic Emission - Thermography - Eddy Current - Radiography - Limitations	15:00-16:00	**6. Basic Statistics** - Statistical moments/distributions - Density estimation - Confidence limits - Central limit theorem - Principal component analysis	15:00-16:00	**10. SHM Sensing Technologies III** - Laser-based measurements - Video-based measurements - Robotic devices for SHM sensing - Specialty sensors developed for SHM (comparative vacuum monitoring, pressurized aircraft tubing, HERT, Underwater system) - Emerging sensing and data visualization hardware
16:30-16:45	**Break**	**16:00-16:15**	**Break**	**16:00-16:15**	**Break**
16:45-17:15	**3. Operation Evaluation** - Economic/Life safety Justification - Definition of Damage - Constraints - Case studies	16:15-17:15	**7. SHMTools Demonstration: Signal Analysis** - Using SHMTools & mFUSE - Function & process assembly - Data import - Statistical analysis - Signal processing	16:15-17:15	**11. Damage Sensitive Features I** - Define “features’ in the context of SHM - Features in the context of detection theory - Feature types - Examples (frequencies, mode shapes)
17:15-18:15	**4. SHM Sensing & Data Acquisition Overview** - Sensor network components - Sensor performance metrics - Signal conditioning issues - Sensor network paradigms - Excitation	17:15-18:15	**8. SHM Sensing Technologies I** - Excitation methods - Conventional force/pressure sensing - Conventional strain sensing - Conventional acceleration sensing - Acoustic emission sensing - Fiber optic sensing	17:15-18:15	**12. Ultrasonic Methods** - Acoustic emissions - Impedance method - Sensor self-diagnostics - Guides waves - Nonlinear acoustics -Integration with other technologies

STRUCTURAL HEALTH MONITORING USING STATISTICAL PATTERN RECOGNITION

Virtual Course (offered over 5 days), Times Shown are Central European Time

Time	June 30	Time	July 1
14:00-15:00	**13. Damage-Sensitive Features II** - Nonlinear response concepts - Waveform comparisons (nonlinear) - Nonlinear time series modeling - Residual errors - Chaotic interrogation methods	14:00-15:00	**17. Data Normalization** -Environmental/operational effects on SHM -Parametric modeling environmental effects -Look-up table technique -Machine learning techniques -SHM system design for normalization
15:00-16:00	**14. SHMTools Demonstration** - Feature extraction with time series models - Rotating machinery example - Guided wave example	15:00-16:00	**18. SHM System Design I** - Bayesian risk framework - Classical detection theory - Detector design - Detection/location examples
16:00-16:15	**Break**	**16:00-16:15**	**Break**
16:15-17:15	**15. Statistical Inference and Unsupervised Learning** - Motivation for statistical decision analysis - Define supervised and unsupervised learning methods in the context of SHM - Cluster analysis - Outlier (Novelty) detection - Statistical process control	16:15-17:15	**19. SHM System Design II** - Probability of detection - Design examples - Robustness assessment - Comparative study
17:15-18:15	**16. Supervised Learning** - Group classification & regression - Neural networks - Radial basis function - Support vector machines - Automated feature selection	17:15-18:15	**20. SHMTools Demonstration Detection & Classification** - Outlier detection - Data normalization - Supervised learning example
		18:15-18:30	**21. Closing Remarks** - Recap the pattern recognition paradigm - Fundamental axioms of SHM - Other sources of information - Course survey