<table>
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<tr>
<th>Time</th>
<th>Day 1 September 7th</th>
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<th>Day 2 September 8th</th>
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<tbody>
<tr>
<td>8:30-9:00</td>
<td>Registration &amp; Introductions</td>
<td>8:30-9:25</td>
<td>8. SHM Sensing Technologies I (Todd)</td>
</tr>
</tbody>
</table>
| 9:00-9:55  | 1. Introduction (Farrar)  
- Course overview  
- Definition of Damage and SHM  
- Motivation for SHM, (NDE vs SHM)  
- Statistical pattern recognition paradigm  
- Historical overview: aerospace /civil/mechanical application | 9:25-10:20 | 9. SHM Sensing Technologies II (Flynn)  
- Piezoelectric materials  
- Commercial transducers/actuators  
- Custom transducers/actuators  
- Design consideration  
- Instrumentation techniques |
| 9:55-10:20 | 2. Operational Evaluation (Farrar)  
- Economic/Life-safety justification for SHM  
- Defining the damage to be detected  
- Constraints on the SHM process  
- Case Study | 10:20-10:40 | Coffee Break |
| 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. Sensing & Data Acquisition (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. Introduction to SHM Features (Farrar)  
- Define ‘features’ in the context of SHM  
- Features in the context of detection theory  
- Sufficient statistic  
- Feature types  
- Examples (frequencies, mode shapes) |
| 12:45-13:30 | Lunch | 12:45-13:20 | Lunch |
| 13:45-14:45 | 5. Signal Processing (Flynn)  
- Conditioning signals  
- Analyzing Signals  
- Time, Frequency &Time-frequency Methods  
- Correlation methods  
- Input-output methods | 13:45-14:45 | 12. Ultrasonic Methods (Flynn)  
- Acoustic emissions  
- Impedance method  
- Sensor self-diagnostics  
- Guides waves  
- Nonlinear acoustics  
- Integration with other SHM technologies |
| 14:45-15:40 | 6. Basic Statistics (Farrar)  
- Statistical moments/distributions  
- Density estimation  
- Confidence limits  
- Central limit theorem  
- Principal component analysis | 14:45-15:40 | 13. Advanced Features (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  
- Data import  
- Statistical analysis  
- Signal processing | 16:00-17:00 | 14. SHMTools Demonstration (Flynn)  
- Feature extraction with time series models  
- Rotating machinery example  
- Guided wave example |
<table>
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<th>Time</th>
<th>Day 3 September 9th</th>
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- Motivation for statistical decision analysis  
- Define supervised and unsupervised learning methods in the context of SHM  
- Cluster analysis  
- Outlier (Novelty) detection  
- Statistical process control |
- 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 (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 System Design: Detection and Location (Todd)**  
- Bayesian risk framework  
- Classical detection theory  
- Detector design  
- Detection/location examples |
| 12:45-13:45| **Lunch** |
| 13:45-14:45| **19. Value of Information in SHM (Thöns)**  
- Scenario definition for value of information analyses  
- Structural system and structural health information modelling  
- Example for value of information analysis |
| 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. Fundamental Axioms & Closing Remarks (Farrar)**  
- Recap the statistical pattern recognition paradigm  
- Fundamental axioms of SHM  
- Other sources of information  
- Course survey |