Who Are We?

- **Ken Loh, Ph.D.**
  - TaylorMade Golf Chancellor’s Endowed Professor, Structural Engineering
  - B.S. in Civil Engineering, Johns Hopkins University
  - Director, ARMOR Lab
  - Instructor, SE 164 – Sensors and Data Acquisition
  - Interesting facts:
    - Went to GK-12 (Taipei American School) in Taipei, Taiwan
    - Engineering Duty Officer, U.S. Navy Reserve
    - Co-founder of JAK Labs

- **Chin-Hsiung (CH) Loh, Ph.D.**
  - Adjunct Professor, Structural Engineering
  - Distinguished Professor Emeritus, Civil Engineering, National Taiwan University
  - B.S., M.S., and Ph.D. in Civil Engineering, National Taiwan University (!@#$)
  - Former Director, National Center for Research on Earthquake Engineering
  - Instructor, SE 167 – Signal Processing & Spectral Analysis
  - Interesting facts:
    - Born and raised in Taipei, Taiwan
    - Three amazing grand children (Jacob 10, Peter 9, Olive 7)
    - Father of Prof. Ken Loh
Taiwan?
Just the basics…
Why Teach in Taiwan?

Its history…and our history…is perfect for this two-course sequence
Multi-hazard Vulnerability in the U.S.

- 1989 Loma Prieta Earthquake
- 1994 Northridge Earthquake
- 2011 Tohoku Tsunami
- 2004 Indian Ocean Tsunami
- 2005 Hurricane Katrina
- 2012 Hurricane Sandy
- 2014 & 2015 Polar vortex winters

- Infrastructure and property damage
- Jeopardize public safety
- Loss of lives
- Socioeconomic losses
They Learned – And Advanced

- National Center for Research on Earthquake Engineering (NCREE) in Taiwan
  - Most advanced testing facilities and engineering capabilities, capable of full-scale testing
What are we teaching?

Background and Course Information
Structures

Structure:
Materials + Geometry + Function

Civil
Geotechnical
Automotive
Aerospace
Marine
Biological
Damage and Degradation

- Environment
- Repeated loading
- Impulse-type events
- Natural disasters
- Extreme events
- Manmade
Need

Timely Intervention

Structural Damage

Undetected damage

Fiber-matrix cracking

Propagation

Structural Failure

Composite rudder failure in-flight

March 2005

Delamination

Structural Damage

Timely Intervention
Grand Challenge

- How can we generate, in a **scalable** manner, **appropriate data streams** that contain rich information about **spatially distributed structural properties** and **damage characteristics** suitable for **structural health diagnostics** and **decision-making**?

1. **SENSING**
   F. Lanza di Scalea & K. Loh

2. **DETECTION**
   C. Farrar, F. Lanza di Scalea, C-H. Loh, K. Loh & M. Todd

3. **DIAGNOSIS**
   C. Farrar, C-H. Loh & M. Todd
What are current and emerging sensors that we can use to understand how our built environment is interacting with the natural environment?

Topics:

- Sensor classification and characteristics
- Fundamentals of electric circuits
- Resistive, capacitive, and inductive sensing mechanisms
- Piezoelectricity and thermoelectricity
- Analog sensor interfaces
- Analog-to-digital converters (ADC), aliasing, and signal conditioning
- Data transmission and wireless sensor networks
- Radio frequency identification (RFID) and emerging technologies
How do we use real-world data, process them to reveal relevant features, and extract knowledge about our structures and potential damage?

Topics:
- Random data and Fourier Transforms
- Signal convolution and correlation, and sampling theorem
- Discrete-, Fast-, and Short-Time Fourier Transforms
- Power spectral density and input-output relationships in the frequency domain
- Low-pass filter and time-domain analysis
- Time-domain signal decomposition
- Hilbert Transform
- Time-frequency analysis
- Digital filters
- Online structural system identification
Specialization in SHM/NDE equips you with interdisciplinary knowledge in sensing technologies, data interrogation, and modeling and analysis.

- Encompasses structural, civil, mechanical, aerospace, and marine engineering
- Supports “design-to-retirement” life cycle management of systems

One-year M.S. program (36 units):

<table>
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<tr>
<th>Requirement</th>
<th>Thesis option</th>
<th>Comprehensive option</th>
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<tr>
<td>Core courses:</td>
<td>SE 263 – NDE (4)</td>
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<td>SE 265 – SHM Principles (4)</td>
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<td>Capstone experience:</td>
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<td>SE 296 – Independent Study (4)</td>
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<td>Thesis research:</td>
<td>SE 299 – Graduate Research (8)</td>
<td>No requirement</td>
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<td>Sensing Technology focus area</td>
<td>One course (4)</td>
<td>One course (4)</td>
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<tr>
<td>Data Interrogation focus area</td>
<td>Two courses (8)</td>
<td>Two courses (8)</td>
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<tr>
<td>Modeling &amp; Analysis focus area</td>
<td>Two courses (8)</td>
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<td>Technical elective:</td>
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<td>Total Units:</td>
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<tr>
<td>Graduate seminar:</td>
<td>Three quarters of SE 290 (3)</td>
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Complementing Classroom Education

- **Technical tours and museums**
  - NTU Civil Engineering building adjacent to NCREE
  - Taipei 101 and tuned mass damper
  - The 921 Earthquake Museum of Taiwan
  - 921 Chi-Chi Earthquake Museum
  - Taiwan Semiconductor Manufacturing Company (tsmc)
Beyond Studying

Living, experiencing, socializing, eating, and having fun
Interested?

- **Application details:**
  - Application Period: Opens on **November 1, 2023**
  - Application Deadline: Closes on **March 1, 2024 or until full**
  - Space is limited – program is capped at 28 students

- **Financial aid and scholarships:**
  - Funding options: [https://studyabroad.ucsd.edu/students/programs/global-seminars/funding.html](https://studyabroad.ucsd.edu/students/programs/global-seminars/funding.html)
Questions?