What is the Graduate Program in Acoustics?

• The Graduate Program in Acoustics is:
  - Intercollege graduate degree program (IGDP), based in the College of Engineering
  - Administratively aligned with Dept. of Aerospace Engineering
  - Associated with the Applied Research Laboratory (ARL)

• History
  
  1965 Graduate Program established to provide the US Navy with an academic program in acoustics and its applications.
  1987 Distance Education established in partnership with ARL to further extend educational opportunities to students unable to pursue graduate school at University Park.
Philosophy

• Provide a broad education in acoustics fundamentals that will last a lifetime

• Provide this education for
  – residence students
  – working professionals

• Blend residence and distance students when possible
Educational Opportunities in Acoustics

Residence Education
– Master of Engineering in Acoustics
– Master of Science in Acoustics
– Ph.D. in Acoustics

Distance Education
– Master of Engineering in Acoustics
– Take individual courses a la carte
Upcoming Offerings

Fall 2011 (classes begin August 22:

- Nonlinear Acoustics
- Acoustic Data Measurement and Analysis
- Fundamentals of Acoustics
- Digital Signal Processing

Spring 2012:

- Noise Control Engineering
- Transducers
- Acoustics of Fluids II
- Ocean Acoustics

Future:

- Flow-induced Noise
- Computational Acoustics
- Virtual Acoustics (3-D)
- Architectural Acoustics
Delivery via Distance Education

Current Status of DE Delivery (1)

- Students have opportunity to see lectures live with residence students (blended) or archived (on demand)

- Students participate in chat room or use microphone to ask questions during lectures

- Web board interactions of students and media download between classes

- Live office hours / recitation sections

Thanks to Acoustics Graduate Students Miguel Horta and Andrew Orr for providing the following screen shots:
Current Status of DE Delivery (2)

- Use Adobe Connect (Macromedia Breeze) software
  - Need high-speed internet (no dialup)

- Use Smartboards for writing on board/screen

- Use student video producers to ensure quality
Current Status of DE Delivery (3)

Signals and Transforms

- Continuous-Time Transform
  - Function: \( X_c(t) \)
  - Sample at \( f_s = 1/T \)

- Discrete-Time Transform
  - Sequence: \( x[n] = x(nT) \)

- Fourier Transform
  - Continuous function of frequency
    - \( X(j\Omega) = X(s)|_{s=j\Omega} \)

- Discrete-Time Fourier Transform
  - Continuous function of frequency
    - \( X(e^{j\omega}) = \sum_{n=-\infty}^{\infty} x[n]e^{-j\omega n} \)

- Z-Transform
  - Continuous function complex variable \( z \)
  - Defined for all \( z \in \text{ROC} \)

- Z-transform evaluated on unit circle
  - \( (e^{j\omega}) = X(z)|_{z=e^{j\omega}} \)

(instructor draws on notes with pen)
Current Status of DE Delivery (4)

(students asking questions in chat area)
ANC Requirements Depend On Sound Field

- Duct is essentially 1-dimensional; sound propagates as plane waves
  - ANC relatively simple to implement

- In Enclosures and rooms, sound field is dominated by normal modes
  - Amplitudes vary throughout the space
  - Excitation Frequencies may be shared by several different modes, especially at high-frequencies
  - ANC requires multiple sensors and sources, effective only at low-frequencies

- In free-field, sound radiates with spherical spreading
  - Amplitude change with distance from source makes near-field cancellation limited
  - In far-field, cancellation can be achieved, but very directionally dependent
  - Many sensors and sources required for extensive sound reduction
Information Contacts

• Victor Sparrow – Interim Head
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• Karen Thal – Graduate Records Assistant
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Thank You!
**Acoustics Curriculum at Penn State**

Required courses for Penn State graduate degrees:

- 501 - fundamentals I (vibrations and acoustics of solids)
- 502 - fundamentals II (acoustics of fluids)
- 505 - laboratory [Resident Ed., but not Dist. Ed.]
- 513 - digital signal processing
- 514 - transducers
- 515 – acoustics of fluids II
- 516 - data measurement and analysis
- 590 - colloquium
Specialty Courses

Taught approximately every other year:

- Architectural Acoustics
- Computational Acoustics
- Nonlinear Acoustics
- Ocean Acoustics
- Outdoor Sound Propagation
- Structural Acoustics
- Aerodynamically Induced Noise
  
  . . . and others
Opportunities in Acoustics

Acoustics

- Chemical Engineering
- Biomedical Engineering
- Speech and Hearing
- Environmental Engineering
- Architectural Engineering
- Mechanical Engineering
- Physics
- Materials
  - Micro- and Nanotechnology
  - Electrical and Computer Engineering
  - Aerospace Engineering
Some of the Research Capabilities

Acoustic Microscopy
Active Control of Sound and Vibration
Aeroacoustics
Computational Acoustics
Data Acquisition Systems
Data Fusion
Design of Quiet Structures
Flow-Induced Noise
Intelligent Sensor Systems
Machinery Diagnostics
Marine Bioacoustics
Materials Characterization
Medical Ultrasonics
Modal Analysis

Noise Control Engineering
Nondestructive Testing/Evaluation
Nonlinear Acoustics
Ocean Acoustics
Resonance Ultrasound Spectroscopy
Seismology
Signal Processing
Smart Materials
Sonar Systems Engineering
Sound Quality/Sound Metrics
Structural Acoustics
Thermoacoustics
Transduction
Ultrasonic Imaging
Distance Education Classes leading to M. Eng. Degree

1987 – began acoustics distance education via satellite links with Navy labs and industry

1992 – added PictureTel video conferencing delivery in addition to satellite

1994 – added videotape distribution for many students

1997 – satellite discontinued

2002 – added videostreaming delivery over internet to PictureTel

2003 – ended PictureTel

2006 – blended classes; videostreaming only; no VHS
Acknowledgements (1)

Anthony Atchley

- Previous Head of Graduate Program in Acoustics
- Associate Dean for Research and Administration, College of Engineering
Acknowledgements (2)

Students
(this is what its all about)
What is “Acoustics”?

If mechanical motion is involved, it’s acoustics.
Degree Student Distribution Fall 2008

- M.S. 9
- M. Eng. (Res. Ed.) 2
- M. Eng. (Dist. Ed.) 17
- Ph.D. 36
- Total 64

- M. Eng. (Distance Ed) 26%
- M. Eng. (Resident) 1%
- M.S. 14%
- Ph.D. 57%

+ 35 non-degree students

acoustics@psu.edu
Where Penn State Graduates Get Jobs

Apple
APL Johns Hopkins
ARL Penn State
BBN
Boeing
Bose Corporation
Corps of Engineer’s Research Lab
Eminance Loudspeakers
ENSCO, Inc.
FDA
IBM
Ingersol Rand
Jet Propulsion Lab
Motorola
NASA Langley Research Center
Naval Surface Warfare Center
Northrup Grumman
Panasonic
US DOT Volpe Center
Verizon

Brigham Young University
Central Washington University
Cheju National University (Korea)
Harvard Medical School
Illinois Institute of Technology
James Madison University
Kettering University
Lehigh University
McGill University
Silpakorn University (Thailand)
University of Arizona
University of Cincinnati
University of Hartford
University of Michigan
University of Nebraska
University of Rhode Island
University of Texas at Austin
Virginia Tech
Proud of Our Graduates

• Acoustics Education Nationwide!

Robert Celmer
Univ. of Hartford

Lily Wang
Univ. of Nebraska

Rendell Torres
Rensselaer Poly.

Tim Leishman, Kent Gee
Scott Sommerfeldt
Brigham Young Univ.

Dan Russell
Kettering Univ.

Penn State Acoustics Program
Who are the Faculty?

• Approximately 40 Members of the Graduate Faculty
  – Acoustics (3)
  – Aerospace Engineering (5)
  – Applied Research Laboratory (22)
  – Bioengineering (1)
  – Communication Disorders (1)
  – Geosciences (2)
  – Engineering Science and Mechanics (2)
  – Mechanical Engineering (3)
  – Physics (1)