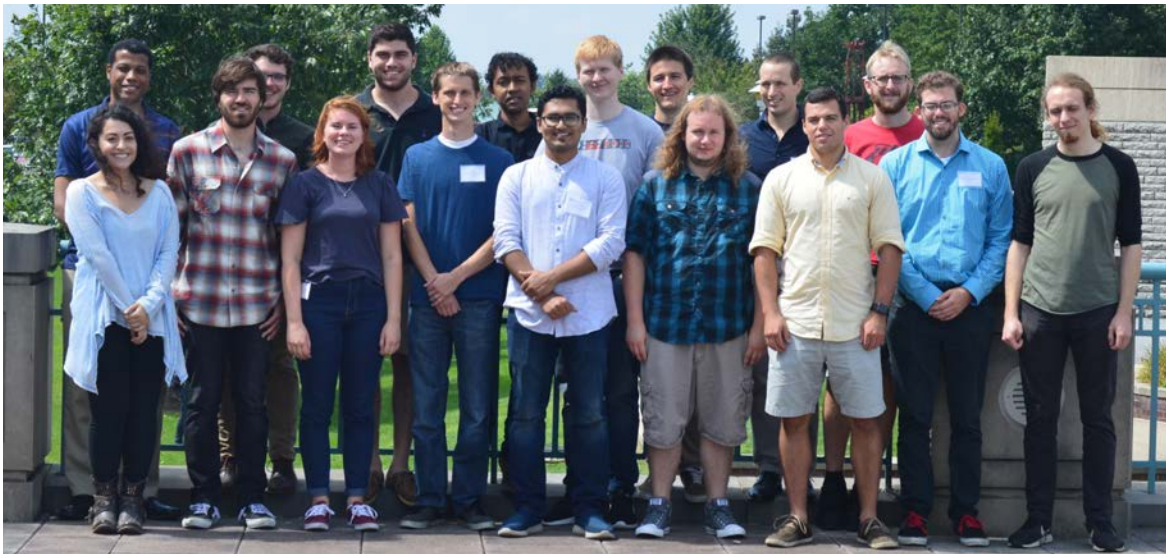
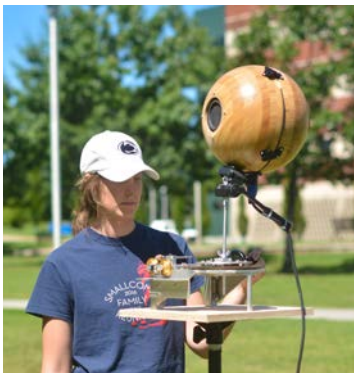
Student Handbook
Graduate Program in Acoustics
Pennsylvania State University








2019-2020
(Draft Version 1.1)

PennState
College of Engineering

Graduate Program in Acoustics
201 Applied Science Building
University Park, PA 16802

Ph: +1 814-865-6364
E-mail: vws1@psu.edu

August 23, 2019

Students in Acoustics,

It is a great pleasure to welcome you to the Graduate Program in Acoustics and to this handbook. It is intended to be a helpful reference to aid you in finding your way through your degree program.

The Graduate Program in Acoustics is over 50 years old, beginning in 1965. Since that time, we have had over 700 graduates. Now we want to make sure we do all we can to ensure that you also successfully complete all of the program requirements so that you can participate in Penn State's commencement ceremonies.

There are three other resources that you should be aware of in addition to this handbook. First and foremost, your academic advisor will help you. They are there particularly to support you throughout your time at Penn State. Secondly, the Acoustics Program office will be pleased to answer questions, particularly if there are discrepancies between what you see in this handbook and information you may receive other ways. And thirdly, you may also need to refer to online resources such as the Acoustics Program web page (www.acs.psu.edu) and other resources available at the Penn State Graduate School (www.gradsch.psu.edu).

I would very much like to thank Dr. Dan Russell and Melissa Wandrisco for being the primary authors of this handbook. They, and I, intend for this to be a go-to resource when charting your way to achieve an academic degree in the Graduate Program in Acoustics.

Again, welcome!

Victor W. Sparrow

Victor W. Sparrow, Ph.D.
United Technologies Corporation Professor
Of Acoustics
Director of the Graduate Program in Acoustics

Section 1
Overview of the Graduate Program in Acoustics

- About the Graduate Program in Acoustics
- Our Corner of Campus (maps and floor plans)
- Acoustics Faculty and Staff
  - Core Acoustics Faculty
  - Acoustics Program Staff
  - ARL Research Faculty
  - Acoustics Faculty from Other Departments
- Laboratory and Research Facilities
- Professional Societies and Clubs
- Acoustics Program Social Events

A PDF version of the 2019-2020 draft version of this handbook (with working active links) is available at
www.acs.psu.edu/drussell/ACS-handbook-2019-v1.pdf

About the Graduate Program in Acoustics

The Graduate Program in Acoustics at Penn State is a unique interdisciplinary program that offers a broad educational background applicable to a variety of scientific and technological fields, providing life-long flexibility for continued professional growth.

Our course selection includes a wide array of courses covering topics in, fundamental theoretical acoustics, physical acoustics, underwater acoustics, signal processing and analysis, electroacoustic transducers, biomedical ultrasonics, aeroacoustics, flow noise, structural vibration, computational acoustics, nonlinear acoustics, noise control engineering, outdoor sound propagation, architectural acoustics, psychoacoustics, musical instruments, and more.

Our faculty hail from a broad range of acoustics related sub-fields combining many related disciplines, and they conduct research in areas including:

- Acoustic Metamaterials
- Acoustical Oceanography
- Acoustic Remote Sensing
- Active Control
- Adaptive Signal Processing
- Aero-acoustics
- Architectural Acoustics
- Atmospheric Acoustics
- Biomedical Ultrasound
- Education in Acoustics
- Electroacoustic Transducers
- Energy Harvesting
- Flow Induced Noise
- Fluid-Structure Interaction
- Gear System Noise
- Infrasound
- Machine Condition Monitoring
- Musical Acoustics
- Noise Control
- Nondestructive Evaluation
- Nonlinear Acoustics
- Numerical Modeling
- Ocean Acoustics
- Outdoor Sound Propagation
- Physical Acoustics
- Psychological Acoustics
- Physiological Acoustics
- Seafloor Acoustics
- Seismic Surveillance
- Signal Processing
- Sonar Engineering
- Sonic Booms
- Modal Analysis
- Musical Acoustics
- Structural Acoustics
- Structural Health Monitoring
- Ultrasonic Imaging
- Underwater Acoustics
- Vibration Control

Since 1965, the Graduate Program in Acoustics has been offering several options leading to graduate degrees in acoustics. Penn State is the only school in the U.S. that currently offers the Ph.D. in Acoustics. As of August 2019, we have awarded:

245 M.Eng. in Acoustics (190 through distance education)
308 M.S. in Acoustics
226 Ph.D. in Acoustics

The Graduate Program in Acoustics at Penn State routinely receives far more job posting announcements than we have students graduating to fill those job postings. Most students receive multiple job offers upon graduation. **Companies where our graduates currently work** include: *Apple, Bose, Boeing, NASA, General Dynamics Electric Boat, Naval Undersea Warfare Center, Shure, Knowles Electronics, Harmon, BBN, Raythoen, Motorola,* as well as several government laboratories and a large number of acoustical consulting firms.

We also have several Ph.D. graduates who hold academic positions at *Brigham Young University, Georgia Institute of Technology, University of Texas-Austin, University of Nebraska, Central Washington University, Michigan Technological University, University of Hartford, Purdue University, Rollins College, Southern Polytechnic University, Cooper Union*.

And many of our graduates hold prominent positions of leadership within professional societies such as the Acoustical Society of America (ASA) and the Institute for Noise Control Engineering (INCE).

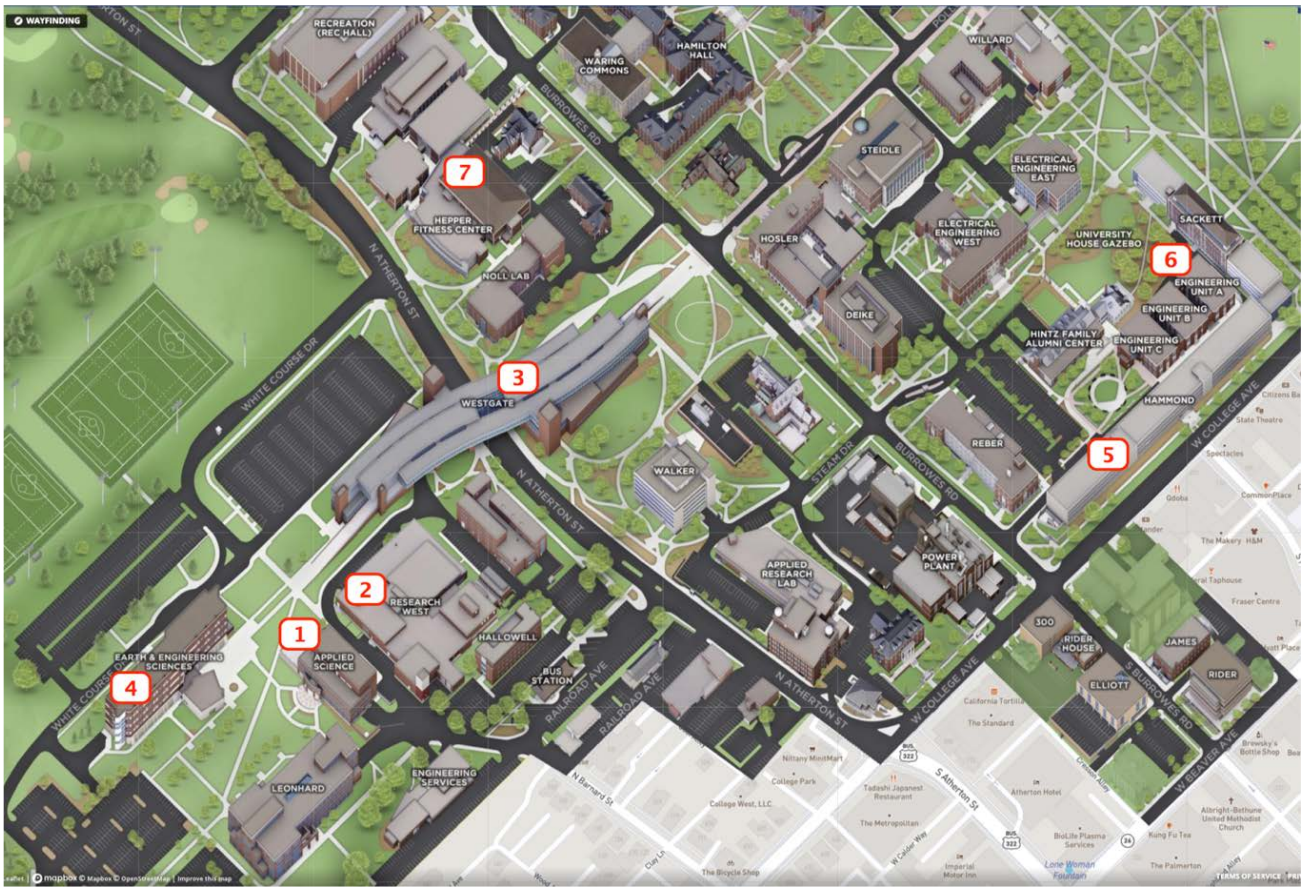
For information about the history of the Acoustics Program and its impact on the acoustics community, check out:

- Video celebrating out 50th Anniversary: https://www.youtube.com/watch?v=4oPCjHDwhTA
- Article about the History of the Graduate Program in Acoustics published in *Acoustics Today*: https://acousticstoday.org/wp-content/uploads/2015/11/Penn-State.pdf

Our Corner of the Penn State Campus

⇨ The most useful online map for the Penn State Campus is http://map.psu.edu
Some buildings that you may find yourself frequently visiting:

1. **Applied Science Building** → Graduate Program in Acoustics (2nd floor) -- classroom, student area, faculty offices, computer lab (*enter from the alley across from Research West [2]*)
2. **Research Building West** → Acoustics Teaching lab, faculty research labs (BASiL, Batcave), student area (*enter from the alley across from the Applied Science Building [1]*)
3. **Westgate** (IST Bridge) → Panera Café, IT Help Desk
4. **Earth and Engineering Science Bldg** → faculty offices and labs (ultrasound in solids)
5. **Hammond Building** → SPRAL Anechoic Chamber (basement), Aerospace Engineering Dept. (2nd floor), Dean's Office (1st floor), Engineering Library (3rd floor)
6. **Engineering Unit A** → Engineering Printing Services
7. **Rec Hall** – Fitness Center, Racquetball courts



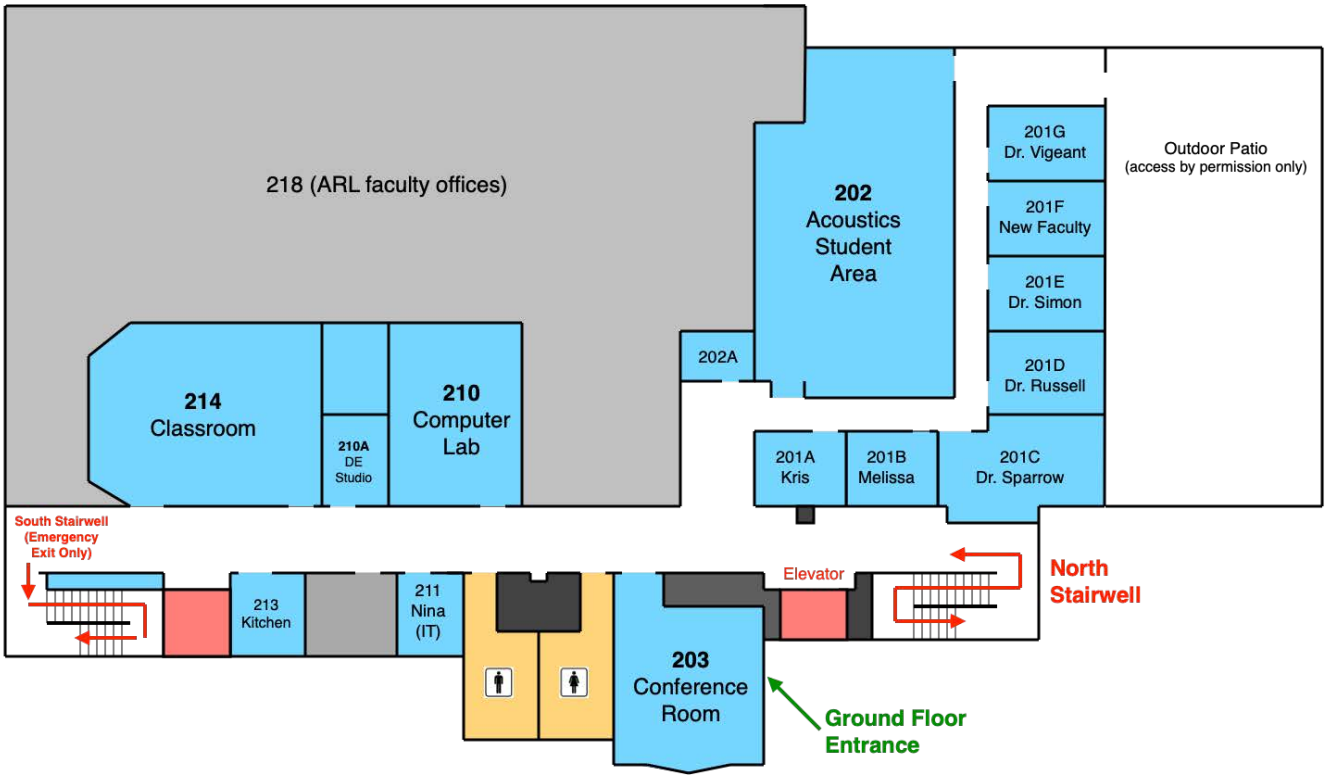
Other buildings that you may find yourself frequently visiting – not shown on the map above, but easily located at http://map.psu.edu/ include:

8. **HUB** (Hetzel Union Building) – student center, food court restaurants, Penn State Bookstore, and where you go to get your PSU ID
9. **Millennium Science Complex** – lots of really cool labs for materials science
10. **Pattee-Paterno Library** – books (lots of books), a large DVD & blu-ray collections, along with computers, and many study areas. Lots of online resources and inter-library loans. And a big Starbucks!
11. **Intramural Building** – lots of intramural sports opportunities

Acoustics Space in the Applied Science Building

The Graduate Program in Acoustics occupies space on the 2nd floor of the Applied Science Building. The entry to the Applied Science Building is off of the Barnard St. alley across from Research Building West. Once in the building, enter the door in the right side, and follow the hallway around to the elevator or the stairwell to the 2nd floor. The Applied Science Building is a controlled access building, operated by the Applied Research Laboratory (ARL) and requires an ARL badge for access in evenings and on weekends. Students in the Acoustics Program will receive ARL badges at New Student Orientation.

Applied Science Building -- 2nd Floor



Rooms that you will use on daily basis:

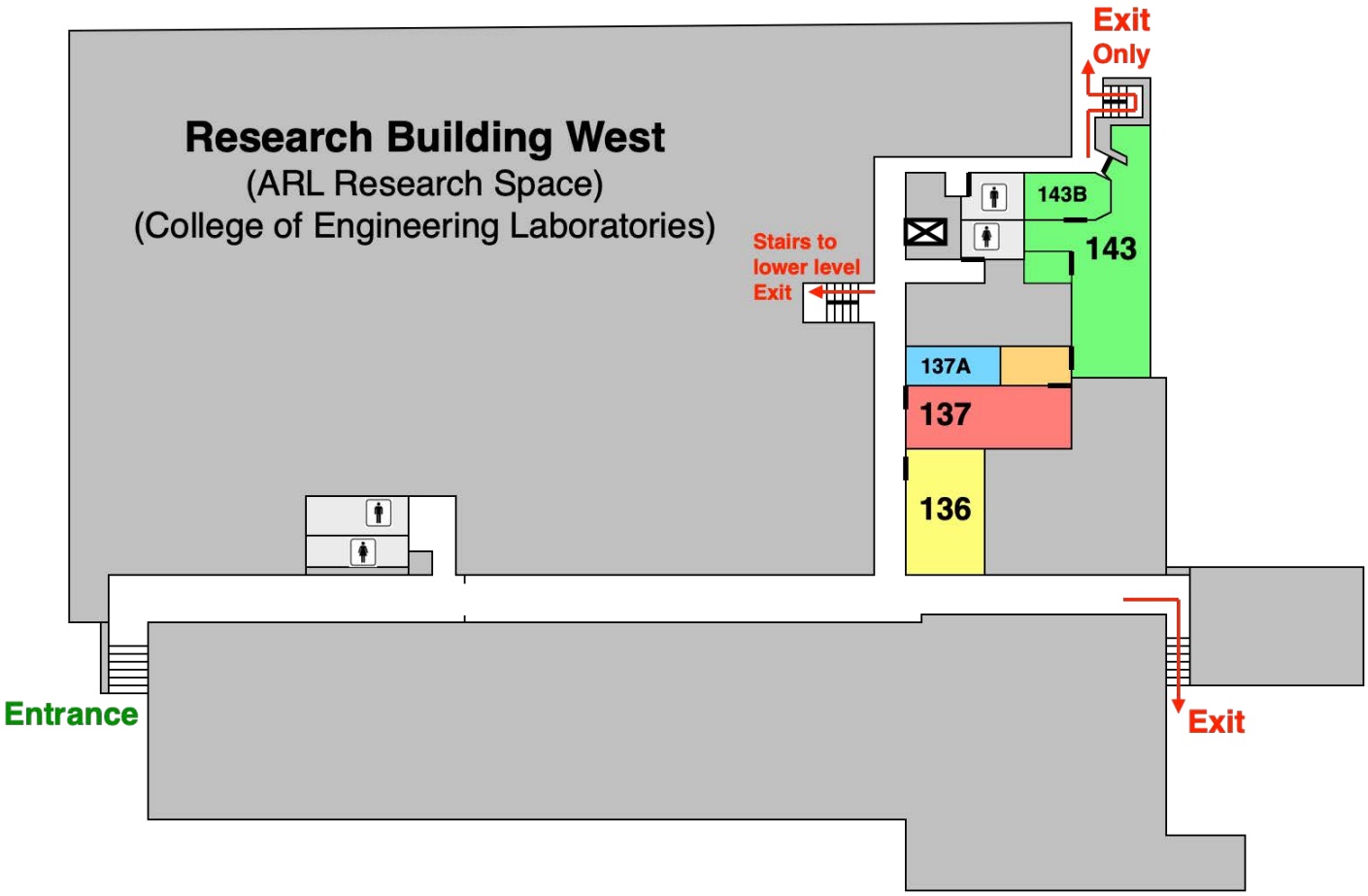
- **202** – the student area, with lockers for you to store your books and belonging, large tables for studying, lots of white board space for writing, and a small lounge area.
- **214** – the acoustics classroom. Almost all of your acoustics classes will take place in this classroom. This is also where we host most of our seminars.
- **210** – the computer lab and acoustics library
- **203** – the acoustics conference room contains our acoustics thesis collection

Faculty and Staff Offices:

- **201A** – Kris Popovich – Distance Education Operations Manager
- **201B** – Melissa Wandrisco – Graduate Student Records Coordinator
- **201C** – Dr. Vic Sparrow – Director of the Graduate Program in Acoustics, United Technologies Corporation Professor of Acoustics
- **201D** – Dr. Dan Russell – Teaching Professor of Acoustics and Distance Education Coordinator
- **201E** – Dr. Julianna Simon – Assistant Professor of Acoustics and Biomedical Engineering
- **201G** – Dr. Michelle Vigeant – Associate Professor of Acoustics and Architectural Engineering
- **202A** – Dr. Steve Thompson – Research Professor of Acoustics
- **211** – Nina Barr – Information Technology Support

Acoustics Space in Research Building West

The Graduate Program in Acoustics has some laboratory space on the 1st floor of Research Building West. Most of the rest of this building is occupied by laboratories for Applied Research Laboratory (ARL) research faculty and by faculty and graduate students in other degree programs within the College of Engineering.



Acoustics Laboratories and Areas in Research Building West:

- **136** – Dr. Simon's Research Lab -- Biomedical Acoustics Simon Laboratory (BASiL)
- **137** – Acoustics Teaching Laboratory.
- **137A** – Dr. Russell's Research Space (The Batcave)
- **137A** – Dr. Steve Thompson's Research Space (the Speaker Corner)
- **143** – Graduate Student desks for Dr. Vigeant's and Dr. Sparrow's and Dr. Thompson's students.
- **143B** – the conference room in Research West contains our paper copies of the entire collection of issues of the Journal of the Acoustical Society of America.

The Acoustics Program also has Laboratory space in Hammond Building:

- Dr. Vigeant's Research Lab – Sound Perception and Room Acoustics Laboratory (SPRAL) is located in room 42 in the basement of Hammond.
- The Center for Acoustics and Vibration (CAV) anechoic and reverberation chamber suite is also accessed from room 42 in the basement of Hammond.
- Dr. Thompson has some additional research space in room 22 in the basement of Hammond.

Acoustics Faculty and Staff

Acoustics is a very interdisciplinary subject, and our faculty reflect that topical diversity. There are several core acoustics faculty members with whom you will interact with on a regular basis, but there are also many additional affiliated acoustics faculty members from other departments with whom you might end up doing research or having as a professor in a class.

Core Acoustics Faculty

These are graduate faculty members with a primary (or sole) appointment in the Graduate Program in Acoustics through the College of Engineering. These faculty have offices in the Applied Science Building, and they teach many of the courses you will take.

Victor Sparrow

Director of the Graduate Program in Acoustics, and United Technologies Corporation Professor of Acoustics

Ph.D. in Electrical Engineering, University of Illinois, 1990

201C Applied Science Buidling
814-865-6364 / vws1@psu.edu

In addition to directing the Acoustics Program, Dr. Sparrow teaches several core and elective courses, including ACS 533, Outdoor Sound Propagation; ACS 540, Nonlinear Acoustics; ACS 544, Computational Acoustics; and ACS 551, Spatial Sound and 3D Audio. He advises several M.S. and Ph.D. students on projects involving noise from supersonic aircraft, computational models of sound propagation through the atmosphere, and nonlinear acoustics. During the 2019-2020 academic year, Dr. Sparrow is the president of the Acoustical Society of America.

Michelle Vigeant

Associate Professor of Acoustics and Architectural Engineering

Ph.D. in Architectural Engineering, University of Nebraska 2008

201G Applied Science Buidling
814-865-7145 / mcv3@psu.edu

Dr. Vigeant oversees the Sound Perception and Room Acoustics Laboratory (SPRAL). She primarily teaches undergraduate courses in architectural acoustics and noise control including AE 458, Advanced Architectural Acoustics and Noise Control. She advises several M.S. and Ph.D. students on projects involving the experimental assessment of concert halls and metrics for quantifying the human perception of sound in acoustic spaces. Dr. Vigeant is currently on sabbatical during the 2019-2020 academic year.

Julianna Simon

Assistant Professor of Acoustics and Biomedical Engineering

Ph.D. in Bioengineering, University of Washington, 2013

201E Applied Science Buidling
814-865-4417 / jcs516@psu.edu

Dr. Simon teaches ACS 502, Elements of Waves in Fluids and ACS 542, Physical Principles in Biomedical Ultrasonics. Her research group (Biomedical Acoustics Simon Laboratory (BASiL)) collaborates with researchers from Biomedical Engineering and Hershey Medical Center on projects involving diagnostic and therapeutic applications of ultrasound. She advises several M.S. and Ph.D. students exploring ultrasound to treat musculoskeletal injuries and ultrasound twinkling to detect kidney stones and other forms of pathological mineralization. Other projects use ultrasound to monitor blood clot formation and to guide and release drugs locally.

Daniel Russell

Teaching Professor of Acoustics and Distance Education Coordinator

Ph.D. in Acoustics, Penn State, 1995

201D Applied Science Buidling
814-865-6365 / dar119@psu.edu

Dr. Russell teaches several required and elective courses including ACS 501, Elements of Acoustics and Vibration; ACS 502, Elements of Sound Waves in Fluids; ACS 515, Acoustics in Fluid Media; ACS 537 Noise Control Engineering; ACS 555, Acoustics of Musical Instruments. He also oversees the Distance Education side of the Acoustics Program. His research interests include acoustics education (animations and demonstrations), the structural vibration of hand-held sports equipment. He primarily advises distance education students, but occasionally supervises M.S. and Ph.D. students on projects involving the acoustics and vibration of sports equipment and musical instruments.

Stephen Thompson
Research Professor of Acoustics
Ph.D. in Physics, Case Western Reserve University, 1978
202 Applied Science Buidling
814-865-0190 / stc12@psu.edu

Dr. Thompson teaches ACS 524, Advanced Transducers & Acoustic System Modeling. His research focuses on the design and testing of magnetic induction loudspeakers including moving coil and balanced armature transducers. He conducts research and advises students on several industrial sponsors involving the design of loudspeaker elements and arrays with applications for audio as well as active noise control.

Acoustics Program Staff

These staff members are some of the most important people you will interact with during your time as a graduate student at Penn State. Their offices are on the 2nd floor of the Applied Science Building in the main Acoustics Program area.

Melissa Wandrisco
Graduate Student Records Coordinator
201B Applied Science Buidling
814-865-6364 / myw5290@psu.edu

Melissa is the head administrative assistant for the Acoustics program. As the Resident Student Coordinator, she maintains contact with resident students from the application process through to graduation. She will be tracking your progress and sending you email reminders along the way, and she will be your primary contact regarding all of the milestones including paperwork for assistantships, wages, comprehensive and oral exams, SARI, and final dissertations. She is your liaison to the Graduate School, and she can also help you with access to buildings and labs. Please see Melissa with any questions you have or any assistance you need throughout your academic career.

Christine (Kris) Popovich –
Distance Education Operations Manager
201A Applied Science Buidling
814-863-6078 / cxp23@psu.edu

Kris primarily works with our Distance Education students, tracking their progress from application through graduation, though she also helps out with many resident student tasks. She also checks formatting for all M.Eng. papers.

Nina Barr
IT support
211 Applied Science Buidling
814-865-0190 / nxb300@psu.edu

Nina maintains all of our computers (classroom, computer lab, faculty and student computers, research lab computers and upgrades) as well as handling general IT issues. She is your go-to person if you need help with your computer accounts, WiFi access, software and hardware needs, and any other IT computer issues.

New Person (TBA)
Staff Assistant
201 Applied Science Buidling

During the Fall 2019 semester we will be hiring an additional office staff person.

Affiliated Faculty from the Applied Research Laboratory

The Applied Research Laboratory (ARL) at Penn State is a Department of Defense designated University-Affiliated Research Center (UARC). Approximately 1400 research scientists, technicians and staff conduct research on a wide variety of problems of interest to the U.S. Navy. Several of those research faculty, whose primary affiliation is with the Applied Research Laboratory, have a strong collaboration with the Graduate Program in Acoustics. The faculty listed below teach some of our graduate acoustics courses, conduct research in acoustics and related areas, and support graduate students in funded projects involving acoustics.

Daniel Brown
Assistant Research Professor
Ph.D. in Acoustics, Penn State, 2017
9720A ARL Building
814-865-1193 / dcb19@psu.edu
Research interests: underwater acoustics, sonar performance modeling, sonar hardware design, acoustic propagation underwater, sea-floor scattering, near-field acoustics, array signal processing.

Timothy Brungart
Research Professor
Ph.D. in Acoustics, Penn State, 1997
3210B Garfield Thomas Water Tunnel
814-653-3034 / tab7@psu.edu
Research interests: Aeroacoustics, atmospheric sound propagation, flow noise, noise control.

Russell Burkhardt
Assistant Research Professor
Ph.D. in Acoustics, Penn State, 1992
9000L ARL Science Park Building
814-653-4139 / rcb6@psu.edu
Research interests: adaptive and robot signal processing, array processing, underwater acoustics, detection and estimation theory, sonar engineering.

Robert Campbell
Associate Research Professor
Ph.D. in Mechanical Engineering, Penn State
322B Garfield Thomas Water Tunnel
814-655-8959 / rlc138@psu.edu
Research interests: fluid-structure interaction, computational structural mechanics, structural finite element modeling, experimental modal analysis.

Dean Capone
Associate Research Professor
Ph.D. in Acoustics, Penn State, 1999
3000B Garfield Thomas Water Tunnel
814-653-3207 / dec5@psu.edu
Research interests: flow induced noise, structural acoustics, noise control.

Stephen Conlon
Research Professor
Ph.D. in Acoustics, Penn State, 2003
3220B Garfield Thomas Water Tunnel
814-653-9894 / scc135@psu.edu
Research interests: metamaterials.

Tyler Dare
Assistant Research Professor
Ph.D. in Mechanical Engineering, Purdue University, 2012
3001 Garfield Thomas Water Tunnel
814-865-4464 / tpd10@psu.edu
ACS 505 Experimental Techniques.
Research interests: structural acoustics, noise control, modal analysis, video-based vibration measurement, and analysis of large data sets.

John Fahnline
Assistant Research Professor
Ph.D. in Acoustics, Penn State, 1993
3220B Garfield Thomas Water Tunnel
814-863-0574 / jbf103@psu.edu
Research interests: numerical modeling, noise control, structural acoustics, and transducer design.

Thomas Gabrielson
Research Professor
Ph.D. in Acoustics, Penn State, 1985
218 Applied Science Buidling (ARL)
814-865-1370 / tbg3@psu.edu
ACS 514, Electro-acoustic Transducers and ACS 504, Signal Analysis for Acoustics and Vibration
Research interests: underwater and atmospheric acoustics, low-noise sensor design, power transducer design, precision calibration, analog electronics, embedded microcontrollers, remote and autonomous sensing, field instrumentation

Stephen Hambric
Research Professor
D.Sc. in Mechanical Engineering, George Washington University, 1995
322B Garfield Thomas Water Tunnel
814-653-3030 / sah19@psu.edu
ACS 519, Sound Structure Interaction. Director of the Center for Acoustics and Vibration (CAV), and leader of the CAV Structural Acoustics and Vibration technical group. Research interests: structural acoustics and vibration topics, flow noise, noise control, modal analysis, and design optimization.

Amanda Hanford
Assistant Research Professor
Ph.D. in Acoustics, Penn State, 2008
3220B Garfield Thomas Water Tunnel
814-655-4528 / ald227@psu.edu
ACS 598, Engineering Mathematics (Distance Education). CAV Acoustics Materials and Metamaterials technical group leader. Research interests: flow induced noise, acoustic metamaterials, computational acoustics.

Charles Holland
Research Professor
Ph.D. in Acoustics, Penn State, 1991
218 Applied Science Building (ARL)
814-655-1724 / cwh10@psu.edu
Research interests: Ocean acoustics, underwater propagation and reverberation, reflection and scattering from marine sediments, inverse problems, acoustic remote sensing.

Michael Krane
Associate Research Professor
3210B Garfield Thomas Water Tunnel
814-653-0021 / mhk5@psu.edu
Research interests: experimental fluid mechanics, fluid-structure interaction, aeroacoustics, signal processing, speech and sound production.

Sheri Martinelli
Assistant Research Professor
Ph.D. in Applied Mathematics, Brown University
218T Applied Science Building (ARL)
814-655-2118 / slm77@psu.edu
ACS 560, Ocean Acoustics.
Research interests: Underwater acoustics, active sonar, underwater acoustic propagation and scattering, computational high-frequency acoustics, structural acoustics.

Karl Reichard
Associate Research Professor
4530E ARL West (Swan)
814-653-7681 / kmr5@psu.edu
ACS 523, Advanced Signal Analysis for Acoustics and Vibration. Head of the ARL Embedded Monitoring and Control Systems Dept. Co-leader of the CAV technical group on Systems and Structures Health Management. Research interests: active noise control, signal processing, passive acoustic sensor systems, machine learning, and applications of acoustics and vibration for machinery health monitoring and remote sensing.

Micah Shepherd
Assistant Research Professor
Ph.D. in Acoustics, Penn State, 2008
3220B Garfield Thomas Water Tunnel
814-63-3003 / mrs30@psu.edu
ACS 505 Experimental Techniques.
Research interests: Optimization, structural acoustics and vibration, experimental modal analysis.

Robert Smith
Assistant Research Professor
Ph.D. in Acoustics, Penn State, 2008
218-B Applied Science Building (ARL)
814-655-5883 / rws100@psu.edu
Research interests: parametric stabilization, thermoacoustics, transducers, bubbles, physical acoustics, finite element analysis, optics, mechanical design.

David Swanson
Associate Research Professor
Ph.D. in Acoustics, Penn State, 1986
5800A ARL Building
814-655-2448 / dcs5@psu.edu
ACS 553, Signal Processing for Audio Applications.
Research interests: active noise control, intelligent sensor networks, structural acoustics, sound propagation, acoustic pattern recognition, machinery health monitoring and prognostics, chemical and biological sensing.

Affiliated Faculty from Other Departments

These are faculty members with a primary (or sole) appointment in another department at Penn State, but who teach acoustics related courses, conduct research in acoustics topics, and support students on projects related to acoustics and vibration.

Sridhar Anandakrishnan
Professor of Geosciences
Ph.D. in Geophysics, University of Wisconsin-Madison, 1990

442 Deike Building
814-863-6742 / sxa17@psu.edu
Research interests: reflection seismology, glaciology, geophysics.

Andrea Arguelles
Assistant Professor of Engineering Science and Mechanics
Ph.D. in Mechanical Engineering and Applied Mechanics, University of Nebraska-Lincoln, 2016

409C Earth and Engineering Sciences
814-865-3440 / aza821@psu.edu

Research interests: experimental, computational, and theoretical analysis of stress wave propagation in heterogeneous materials; biomedical ultrasound; energy infrastructure, storage and devices, structural and human health monitoring.

Kenneth Brentner
Professor of Aerospace Engineering
Ph.D. in Acoustics, University of Cambridge, 1991

233D Hammond Building
814-865-6433 / ksb16@psu.edu

Research interests: aeroacoustics, computational and experimental fluid dynamics, rotorcraft engineering.

Eric Greenwood
Assistant Professor of Aerospace Engineering
Ph.D. in Aerospace Engineering, University of Maryland, 2011

229E Hammond Building
814-863-9712 / evg5332@psu.edu

Research interests: ultra-low-noise operations of vertical lift aircraft in and around communities, helicopter noise modeling methods and codes, physics of rotor noise generation and radiation.

Sri-Rajasekhar (Raj) Kothapalli
Associate Professor of Engineering Science and Mechanics
Ph.D. in Civil Engineering, Rutgers, The State University of New Jersey, 2006

325 Chemical & Biomedical Engineering Building
814-865-0459 / szk416@psu.edu

Research interests: Biomedical Ultrasound, photoacoustic imaging, biophotonics

Christopher Kube
Assistant Professor of Engineering Science and Mechanics
Ph.D. in Mechanical Engineering and Applied Mechanics, University of Nebraska-Lincoln, 2014

407D Earth & Engineering Science Bldg.
814-863-0570 / cmk6284@psu.edu

Research interests: ultrasound propagation and scattering in heterogenous and micro-structured materials; emerging manufacturing processes for materials, tissues, and devices; multiscale and Multiphysics modeling, computational analysis; structural and human health monitoring.

Clifford Lissenden
Professor of Engineering Science and Mechanics
Ph.D. in Civil Engineering and Applied Mechanics, University of Virginia, 1993

411D Earth and Engineering Sciences
814-863-5754 / clj9@psu.edu

Research interests: nondestructive characterization of materials (metals, composites, concrete, rock, bone), ultrasonic guided waves, structural health monitoring, cloaking structures from earthquakes.

Andrew Nyblade
Professor of Geosciences
Ph.D. in Geology, Wittenberg University, 1982

441 Deike Building
814-863-8341 / aan2@psu.edu

Research interests: geophysics, tectonics, applied seismology, Africa array.

Philip Morris
Boeing / A.D. Welliver Professor of Aerospace Engineering
Ph.D. in Aeronautics, University of Southampton, 1971

233C Hammond Building
814-863-0157 / pmj@psu.edu

Research interests: aeroacoustics, computational and experimental fluid dynamics, hydrodynamic stability, turbulence modeling.

Peter Newman
Department Head and Professor of Recreation, Park and Tourism Management
Ph.D. in Natural Resources, University of Vermont

801 Donald H. Ford Building
814-863-7849 / pbn3@psu.edu

Research interests: soundscape/acoustic management in parks, visitor management to protected areas, transportational management and planning, efficacy and communication of "leave no trace" principles.

Jacques Rivière
Assistant Professor of Engineering Science and Mechanics
Ph.D. in Acoustics, Universitè Pierre et Marie Curie, Paris, 2011.

408 Earth & Engineering Science Bldg.
814-865-9654 / jvr5626@psu.edu

Research interests: ultrasonics, geophysics, nonlinear acoustics, vibrations, nondestructive testing of materials, structural health monitoring, material characterization and damage assessment, friction.

Parisa Shokouhi
Associate Professor of Engineering Science and Mechanics
Ph.D. in Civil Engineering, Rutgers, The State University of New Jersey, 2006

411D Earth & Engineering Science Bldg.
814-863-0678 / pxs990@psu.edu

Research interests: stress wave propagation in fractured media, nondestructive evaluation (linear and nonlinear testing), structural health monitoring (acoustic emission), machine learning and data analytics, seismic metamaterials.

Navin Viswanathan
Associate Professor of Communication Sciences and Disorders
Ph.D. in Cognitive Psychology and Psycholinguistics, University of Connecticut, 2009

401E Ford Building
814-867-4340 / nxv175@psu.edu

Research interests: speech perception and production; factors affecting speech perception (language of speaker and listener, speech rate, room acoustics), speech to text recognition.

Affiliated Faculty in Administrative Positions

These are several administrators within the College of Engineering and the University whose academic affiliation is with the Graduate Program in Acoustics.

Anthony Atchley
Senior Associate Dean, College of Engineering (Professor of Acoustics)
Ph.D. in physics, University of Missisippi, 1984

101 Hammond Building
814-865-2151 / atchley@psu.edu

Research interests: shock formation in very high amplitude noise, measurements of noise from commercial aircraft and sub- and super-sonic military jets, acoustic propagation modeling, optical imaging of sound fields, ultrasonics, oscillatory boundary layer processes, and acoustic heat transport

George Lesieutre
Associate Dean, for Research and Graduate Programs, College of Engineering (Professor of Aerospace Engineering)
Ph.D., University of Connecticut, 2009

101 Hammond Building
814-865-2151 / atchley@psu.edu

Research interests: shock formation in very high amplitude noise, measurements of noise from commercial aircraft and sub- and super-sonic military jets, acoustic propagation modeling, optical imaging of sound fields, ultrasonics, oscillatory boundary layer processes, and acoustic heat transport

Lora Weiss
Senior Vice President for Research (Research Professor of Acoustics)
Ph.D. in Acoustics, Penn State, 1993

Old Main
814-865-##### / lgw1@psu.edu

Research interests: implementation of robotics and unmanned systems, autonomous control systems, and digital and acoustic signal processing technologies, advancing the capabilities of unmanned air, ground, sea surface and undersea systems.

Emeritus Faculty

These are professors who have officially retired in good standing, but who are still involved with the acoustics program. Some may occasionally teach courses or conduct research involving students.

Ingrid Blood
Professor Emeritus of Communication Disorders
308 Ford Building
814-863-6131 / i2b@psu.edu

David Bradley
Professor Emeritus of Acoustics
dlb25@psu.edu

Sabih Hayek
Professor Emeritus of Engineering Science and Mechanics
ic8@psu.edu

Robert Keolian
Professor Emeritus of Acoustics
rmk10@psu.edu

Gary Koopman
Professor Emeritus of Mechanical Engineering
ghk1@psu.edu

Gerald Lauchle
Professor Emeritus of Acoustics
ghk1@psu.edu

William Mark
Professor Emeritus
wdm6@psu.edu

Dennis McLaughlin
Professor Emeritus of Aerospace Engineering
230B Hammond Building
D814-865-2560 / km2@psu.edu

Joseph Rose
Paul Morrow Professor Emeritus in Engineering Design and Manufacturing
411E Earth and Engineering Sciences Bldg.
814-863-8026 / jlr9@psu.edu

Dennis Thompson
Professor Emeritus of Meteorology
dwt2@psu.edu

Bernhard Tittmann
Schell Professor Emeritus
309E Earth and Engineering Sciences Bldg.
814-865-7827 / brt4@psu.edu

Richard Tutwiler
Professor Emeritus of Meteorology
rlt1@psu.edu

Acoustics Laboratory and Research Facilities

Acoustics Teaching Lab

The acoustics teaching laboratory is located in **137 Research Building West**. Our laboratory course ACS 505, Experimental Techniques uses this space for lab experiments and projects. Most of the equipment in this lab space (sources, sensors, analyzers, etc.) may be checked out and used by students for use on projects and research. Access to this lab space requires card-swipe permission (request access from Melissa Wandrisco).

Laboratory Manager TA for 2019-2020: Gary Rhoades – *glr31@psu.edu*

Acoustics Computer Lab

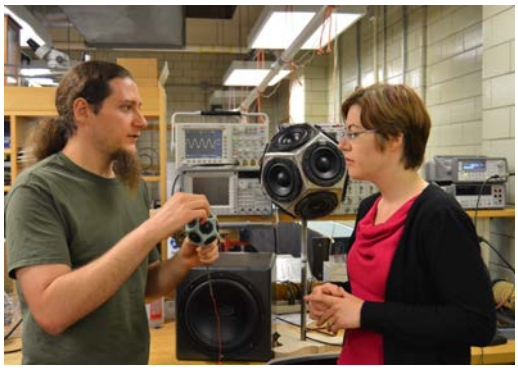
The Acoustics Computer Lab, located in **210 Applied Science Building**, has several desktop Windows computers available for student use. These computers have specialized software that is frequently used for various acoustics classes, including *MATLAB, Mathematica,* ODEON (USB dongles available), Actran (for solving acoustics, vibro-acoustics, and aero-acoustics problems), and other software packages as needed for our acoustics courses. The Acoustics Computer Lab also houses a sizeable acoustics library of textbooks and reference materials.

Anechoic and Reverberation Chamber Suite

This facility, located in the in the basement of **Hammond Building Room 30**, has a reverberation chamber and a fully anechoic chamber. The two chambers are connected by a door and window which provides the capability of measuring transmission loss through panels. The anechoic and reverberation chamber suite is primarily used and operated by the **Sound Perception & Room Acoustics Laboratory (SPRAL)** with occasional use by members of the **Center for Acoustics and Vibration (CAV)**, as well as for other acoustics faculty and student projects.

Sound Perception & Room Acoustics Laboratory (SPRAL)

Dr. Vigeant's Sound Perception and Room Acoustics Laboratory (SPRAL) research group is the primary user of the anechoic chamber (Hammond Building Room 30). Fixtures in the anechoic chamber support the **AU**ralization and **R**eproduction of **A**coustic **S**ound-fields facility (**AURAS**), which consists of a nearly spherical array of 32 loudspeakers controlled by a 32-channel digital to analog converter powered by three 12-channel amplifiers. The



AURAS facility is used to reproduce the 3-D sound fields measured in concert halls and other acoustic spaces in order to conduct listening tests and subjective studies of human auditory perception. Other equipment used by the SPRAL group includes a 32-element spherical microphone array (Eigenmike, em32), several dodecahedron loudspeakers of varying size, and a B&K HATS (Head And Torso Simulator) binaural head measurement system.

Research undertaken using the AURAS facility focuses on topics related to room acoustic measurement techniques, virtual acoustics, spherical array processing, the subjective impression of room acoustics, neuroimaging, emotional processing of speech and music, and impact of noise upon learning and performance, and aircraft noise and annoyance.

Key Faculty: Michelle Vigeant

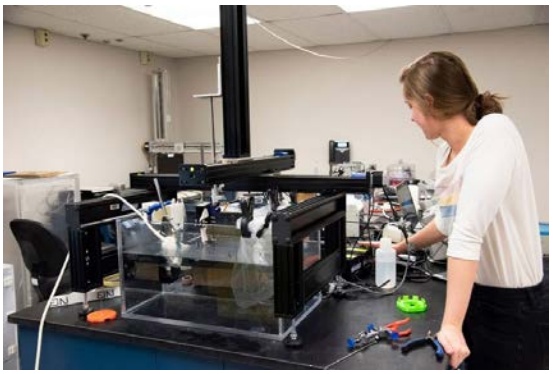
Lab Website: sites.psu.edu/spral/

Current Projects:

- Predicting the Subjective Quality of Concert Halls using Spherical Microphone Array Measurements and 3D Auralization
- Measuring Head-related Transfer Functions Using a Sparsely-sampled Source Space Perception of Sonic Boom Noise
- Measuring Emotional Responses of the Brain to Concert Hall Acoustic Stimuli
- Subjective Impression of Mach Cutoff (from aircraft) Signatures

Biomedical Acoustics Simon Lab (BASiL)

The **B**iomedical **A**coustics **Si**mon **L**ab (**BASiL**) is located in **136 Research Building West**, and primarily focuses on diagnostic and therapeutic applications of ultrasound with an emphasis on technologies that can benefit human spaceflight. Equipment includes a 128 channel Verasonics® Research Ultrasound System, several high-intensity focused ultrasound (HIFU) transducers, hydrophones and data acquisition systems.



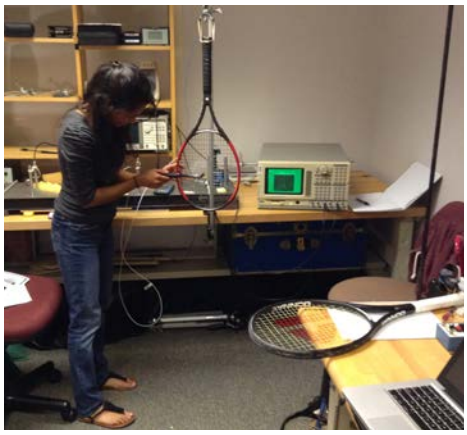
Key Faculty: Julianna Simon

Lab Website: sites.psu.edu/basil/

Current Projects:

- Ultrasound Twinkling of Kidney Stones
- Focused Ultrasound for Tendon Injuries
- Ultrasound for the Diagnosis and Treatment of Pathological Biomineralization
- Ultrasound-Guided, Focused-Ultrasound-Mediated Drug Delivery

The Batcave (Structural Acoustics Lab)



The Batcave (hallway **137A Research Building West**) is a small research space used by Dr. Russell to explore the acoustics and vibration of hand-held sports equipment (baseball and softball bats, golf clubs, tennis rackets, hockey sticks, etc.) as well as musical instruments. This small lab space has equipment for structural vibration analysis, including impact hammers, accelerometers, FFT analyzers, and software for experimental modal analysis; mechanical shaker and impedance head; a Microflown p-u system; and will soon have a high speed camera and an electronic speckle pattern interferometry (ESPI) system for analyzing vibrating objects.

Key Faculty: Dan Russell

Current Projects:

- Dependence of barrel properties on perception of feel for composite and aluminum baseball bats.
- Effect of material properties and structural design in the vibration of composite field hockey sticks.
- Acoustic radiation from the golf putter-ball impact and its dependence on ball properties.
- Assessment of the effect of violin mutes on the input impedance at the bridge.

The SPEAKER Corner & Transducer Development Lab

The SPEAKER Corner (hallway **137A Research Building West**) and the Transducer Development Lab (**Hammond Building room 22**) are the research spaces where Dr. Stephen Thompson and his students to design, build, and test loudspeakers, microphones, arrays, and other acoustic transducers for various applications of interest to industry.

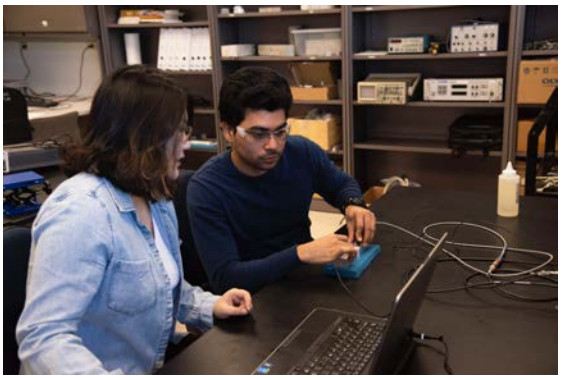
Key Faculty: Steve Thompson

Current Projects:

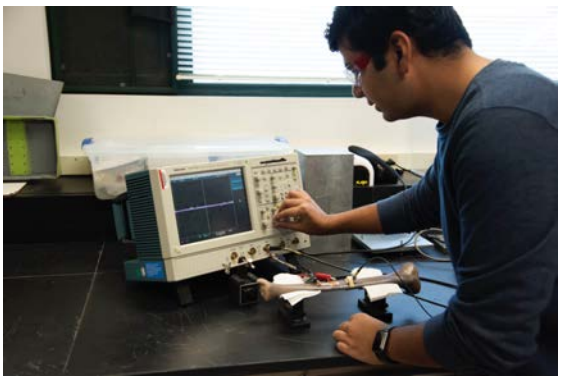
- Loudspeaker design and testing for noise control applications
- Active Control of Noise using a Sparse Array
- Analysis for improved MEMS microphones

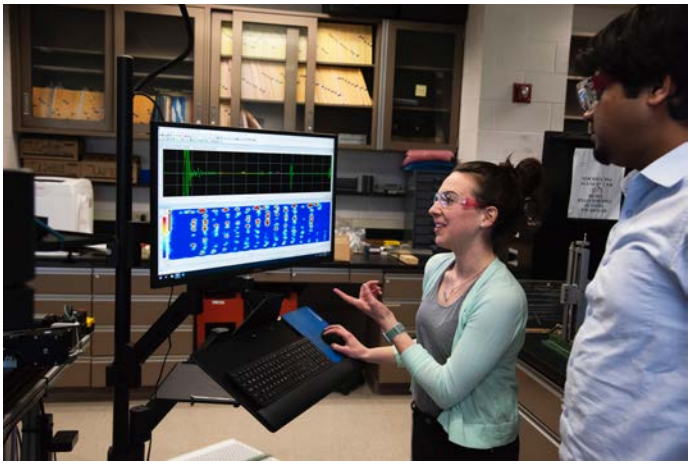
Other Laboratory Facilities Related to Acoustics

Penn State Ultrasonics Laboratory (PennSUL)



This suite of laboratory facilities (house in the **Earth and Engineering Science Building**), is operated by Engineering Science and Mechanics faculty. Research in this lab facility focuses on nondestructive evaluation, structural health monitoring, materials characterization, acoustic metamaterials, and ultrasonic data analysis. Faculty and graduate students develop experimental, numerical, analytical approaches for ultrasonic guided waves, nonlinear ultrasonic testing, multiple scattering, and acoustic emission.





Equipment includes:

EES 406 – Laser ultrasonics testbed

EES 408 – Two NI generation and acquisition systems for linear and nonlinear ultrasound; 128 channel phased-array and acoustic emission system; A range of contact transducers from 20kHz to 10MHz; MIRA ultrasonic tomographer for field inspection; Laser Doppler Vibrometer; Stand-alone Resonance Ultrasound Spectroscopy (RUS) station; Environmental chamber

EES 410 – Ultrasonic immersion system/acoustic microscope, range of immersion transducers from 500 kHz to 50 MHz, polymer SLA and FFF 3D printers, portable high frequency ultrasonic system, Ritec SNAP system to study nonlinear phenomenon

EES 412 – General purpose lab and ultrasonic demonstration space

Key Faculty: Andrea Arguelles, Christopher Kube, Clifford Lissenden, Jacques Reviere, Parisa Shokouhi

Lab Website: www.pennsul.org

Current Projects:

- Research in PennSUL focuses on nondestructive evaluation, structural health monitoring, materials characterization, acoustic metamaterials, and ultrasonic data analysis
- Development of experimental, numerical, analytical approaches for ultrasonic guided waves, nonlinear ultrasonic testing, multiple scattering, and acoustic emission.

Aerospace Jet Flow-Through Anechoic Chamber

Located in the basement of **Hammond Building**, this facility is a 5.0m x 6.0m x 2.8m anechoic chamber anechoic room with inlet and exhaust ducts to allow air to be blown into and sucked out of the facility. This capability is used to examine the effect of forward flight on the noise generated by jet flows or the effect of wind on the noise produced by the jets on a STOVL (Short takeoff and vertical landing) vehicle.

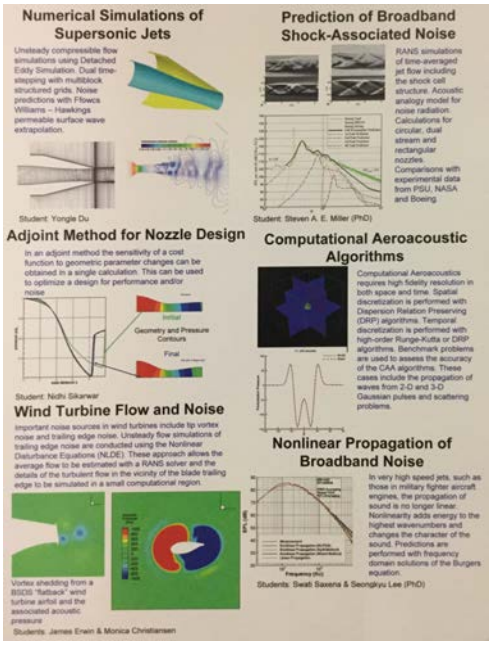
Key Faculty: Kenneth Brentner, Dennis McLaughlin, Philip Morris

Lab Website: https://www.aero.psu.edu/research/research-areas/aeroacoustics.aspx

Current Projects:

Previous and ongoing measurements to investigate the flow field and acoustics of jets have included: near and far field pressure measurements of the flow field and acoustics of jets using microphones, surface pressure measurements with Kulite and Endevco transducers, high-speed schlieren and shadowgraph flow visualization videography, Optical Deflectometry, Laser Doppler Anemometry, and Particle Image Velocimetry.

Computational Aero- and Thermo-Acoustics Laboratory



Computational aeroacoustics involves the numerical simulation of the unsteady flow and the noise it produces. Predictions can be based on steady or unsteady flow calculations. In the former case, knowledge of the average flow allows the radiated noise to be estimated using analytical methods. The unsteady turbulent flow field can also be simulated with numerical solutions of the full equations of motion. These calculations are very computationally intensive but can be performed on the computer clusters available in the department. This computational lab is located on the ground floor of **Engineering Unit B.**

Key Faculty: Philip Morris

Lab Website: https://www.aero.psu.edu/research/research-areas/aeroacoustics.aspx

Current Projects:

Previous and ongoing measurements to investigate the flow field and acoustics of jets have included: near and far field pressure measurements using microphones, surface pressure measurements with Kulite and Endevco transducers, high-speed schlieren and shadowgraph flow visualization videography, Optical Deflectometry, Laser Doppler Anemometry, and Particle Image Velocimetry.

Applied Research Laboratory Facilities

The Applied Research Laboratory houses a large number of experimental research facilities, both on the Penn State campus and at other locations off-campus. Most of these laboratory spaces and facilities are located in controlled access buildings requiring an ARL badge for entry, and so access is usually limited to students working on projects funded by ARL. Acoustics-related laboratory facilities on the University Park Penn State campus include

- Several sizes of Closed Loop Water Tunnels with varying flow rates
- Large Flow-Through Anechoic Chamber
- Reverberant Water Tank
- Various experimental and computational facilities for structural vibration and acoustics

Key Faculty: various acoustics-affiliated faculty from the Applied Research Laboratory

Lab Website: www.arl.psu.edu

Acoustics Professional Societies and Clubs

Professional Societies for Acoustics Graduate Students

Acoustical Society of America (ASA)

The Acoustical Society of America is the most important professional society to which a student in the Graduate Program in Acoustics should belong. The ASA was founded in 1929 and currently has approximately 7000 volunteer members from a wide range of subdisciplines including: acoustical oceanography, animal bioacoustics, architectural acoustics, biomedical acoustics, computational acoustics, acoustical engineering, musical acoustics, noise, physical acoustics, psychoacoustics, audio signal processing, speech communication, structural acoustics and vibration, and underwater acoustics. The ASA produces four publications:

- *The Journal of the Acoustical Society of America (JASA)*
- *JASA Express Letters (JASA-EL)*
- *Proceedings of Meetings on Acoustics (POMA)*
- *Acoustics Today*

There are two international conferences each year (typically May/June and Nov/Dec) where many of our acoustics faculty and students present papers, serve on committees, and interact with colleagues.

ASA Website: acousticalsociety.org

Institute for Noise Control Engineering (INCE)

INCE-USA is a non-profit professional organization whose primary purpose is to promote, through its members, noise control solutions to environmental, product, machinery, industrial and other noise problems. INCE-USA is a Member Society of the International Institute of Noise Control Engineering, an international consortium of organizations with interests in acoustics and noise control. INCE sponsors two conferences every year – Inter-Noise and NOISE-CON – and publishes the *Noise Control Engineering Journal*.

INCE Website: www.inceusa.org

Audio Engineering Society (AES)

(*from the AES website*) The Audio Engineering Society is the only professional society devoted exclusively to audio technology. Founded in the United States in 1948, the AES has grown to become an international organization that unites audio engineers, creative artists, scientists and students worldwide by promoting advances in audio and disseminating new knowledge and research.
Currently, over 12,000 members are affiliated with more than 75 AES professional sections and more than 95 AES student sections around the world. Section activities may include guest speakers, technical tours, demonstrations and social functions. Through local AES section events, members experience valuable opportunities for professional networking and personal growth.

AES Website: www.aes.org

Audio & Loudspeaker Technologies International (ALTI)

(*from the ALTI website*) Audio & Loudspeaker Technologies International is a not for profit association that serves Professionals in the Audio, Loudspeaker, and Technologies industry. Founded in 1964, ALTI's focus is in providing education, networking, and a productive environment in which to do business. Our global Membership includes engineering and product development professionals as well as management, sales, and marketing professionals. ALTI is the owner and producer of ALTI-EXPO (formerly AISE) The two-day event is held annually and focuses upon building knowledge, relationships and getting business done for our exhibitors and attendees.

ALTI Website: almaint.org

Penn State Acoustics Groups

Center for Acoustics and Vibration

The Center for Acoustics and Vibration is a consortium consisting of faculty, graduate students, and staff in eleven research groups throughout the College of Engineering as well as industrial sponsors, government research labs, and international laboratories. These research groups perform both disciplinary and cross-disciplinary research in areas related to acoustics and vibration. Areas of research activity include: active control, adaptive structures, flow-induced noise and vibration, structural health monitoring, propagation and radiation, rotorcraft acoustics and dynamics, structural vibration and acoustics, and underwater acoustics and instrumentation.

Every semester, various technical groups within the CAV sponsor seminars with invited speakers. In addition, each fall there is a 2-day workshop with presentations by the various Penn State CAV research groups, as well as by government and international liaisons; the workshop includes a research poster contest (with cash prizes) for graduate students to present their research.

Student membership is free, and provides students with free registration to the Annual CAV Workshop.

CAV Website: www.cav.psu.edu/

Student Clubs and Societies

PSU ASA – Penn State Student Chapter of the Acoustical Society of America

Penn State has an active student chapter of the ASA. Student members participate in local area STEM outreach events both on and off campus. The PSU ASA chapter hosts several events for first year students – a MATLAB bootcamp, and several social activities. And, the PSU ASA chapter coordinates student travel to ASA meetings.

Contact: Connor McCluskey – *cxm1198@psu.edu*

PSU AES – Penn State Student Chapter of the Audio Engineering Society

Penn State has an active student chapter of the AES, which involves both graduate and undergraduate students. The student chapter of AES has weekly meetings to discuss loudspeakers and microphone design and usage, as well as recording techniques. The PSU AES group often participates in the large AES convention held each fall.

Contact: Noah Wood – *npw5098@psu.edu*

Annual Social Functions for the Acoustics Program

Acoustics Program Facebook Page

The Acoustics program maintains a Facebook page (https://www.facebook.com/psu.acoustics/) where we post news stories, photo albums of acoustics program events, announcements of student defenses, and other information interest to acoustics students and faculty. Photographs and summaries from previous years for the three main events listed below are posted to our Facebook page.

Fall Picnic

During the 1st or 2nd week of the fall semester, the Acoustics program hosts a meet-n-greet cookout and picnic at Sunset Park, just north of campus. The program provides meat and beverages, and our faculty and older students bring pot-luck dishes to share. This picnic is traditionally co-sponsored by the Penn State student chapter of the ASA.

Winter Party

On the Friday evening before the Super Bowl, the Acoustics Program has a Winter Party at the Ferguson Township Lions Club, in Pine Grove Mills, PA. First Year students select a theme for the party, and they organize and plan a schedule of events to support the theme; many years we have a talent show which highlights the musical talents of our students. The meal is potluck, and all students and faculty (and their families) are invited.

Spring Awards Banquet

Every spring, usually in April, the faculty, students, staff, and friends of the Acoustics program gather to formally honor and recognize the accomplishments of our students. This is a more formal sit-down catered meal (often held in the Nittany Lion Inn or the Atherton Hotel). In addition to highlighting general accomplishments (scholarships, best paper awards from conferences, etc.) the program awards for students who publish their work, and a citation for students who present work at professional conferences.

The **Simowitz Citation** and the **Simowitz Award** were established as a memorial by the family of Kenneth T. Simowitz, a student in the Acoustics Program who tragically passed away just before defending his Ph.D. thesis. These awards are given to encourage students to publish and present their research.

> The **Simowitz Citation** is awarded to students whose work appears in written proceedings of major conferences, who participate in special exhibits or poster sessions, who present "invited" papers at technical meetings, or other such activity as may be approved by the Awards Committee. The citation consists of a cash prize and a certificate.
>
> The **Simowitz Award** is given in recognition of superior work in one of the following areas: a written article published in a refereed journal; other scholarly work such as a film, patent, editorial or creative work; such other professional activity as may be approved by the Awards Committee. The award consists of a cash prize and a plaque or certificate.

The **Skudrzyk Award** was established in January 1991 to honor the memory of Dr. Eugen Skudrzyk, a former member of the Acoustics Program faculty. The Award is given to recognize "outstanding achievements by graduate students at Penn State who conduct research and publish on the relationship between complex vibratory structures and the surrounding acoustic environment." The award consists of a cash prize and a plaque or certificate.

Section 2
Acoustics Courses

- Overview of Acoustics Courses
- Acoustics Course Descriptions
  - Required ACS Courses
  - Elective ACS Courses
  - Specialty Courses
- Related Courses from Other Departments

Overview of Acoustics Courses

The following courses are offered directly through the Graduate Program in Acoustics and are usually taught from the Acoustics Classroom so we can broadcast a livestream of the course to our distance education students. Courses marked with "⇨" are required for all resident acoustics graduate students (M.Eng., M.S., and Ph.D.). Courses marked with "➨" are also required for Ph.D. students. The rest of the courses marked with "•" are electives. Required courses are offered every year (Fall or Spring); elective courses are offered on a rotating basis, usually every 2-3 years. Many of the ACS 597 "Special Topics" courses are in the process of being assigned new numbers, as indicated below.

⇨ ACS 501, Elements of Acoustics and Vibration
⇨ ACS 502, Elements of Sound Waves in Fluids
⇨ ACS 597, Signal Analysis for Acoustics and Vibration (new number will be ACS 503)
⇨ ACS 505, Experimental Techniques in Acoustics
⇨ ACS 514, Electroacoustic Transducers
⇨ ACS 515, Acoustics in Fluid Media
➨ ACS 597, Advanced Signal Analysis for Acoustics and Vibration (new number will be ACS 523)
⇨ ACS 590, Colloquium

- ACS 519, Sound and Structure Interaction
- ACS 521, Stress Waves in Solids
- ACS 530, Flow Induced Noise
- ACS 537, Noise Control Engineering
- ACS 597, Advanced Transducers & Acoustic System Modeling (new number will be ACS 524)
- ACS 597, Outdoor Sound Propagation (new number will be ACS 533)
- ACS 597, Nonlinear Acoustics (new number will be ACS 540)
- ACS 542, Physical Principles in Biomedical Ultrasonics
- ACS 597, Computational Acoustics (new number will be ACS 544)
- ACS 597, Spatial Sound and 3D Audio (new number will be ACS 551)
- ACS 597, Architectural Acoustics Theory and Research (new number will be ACS 552)
- ACS 597, Signal Processing for Audio Applications (new number will be ACS 553)
- ACS 597, Applications of Aero- and Vibro-Acoustics (new number will be ACS 555)
- ACS 597, Ocean Acoustics (new number will be ACS 560)
- ACS 598E, Advanced Engineering Mathematics (new number will be ACS 504)

- ACS 594, Research Topics
- ACS 596, Individual Studies

- ACS 600, Thesis Research – full-time M.S. and Ph.D. (pre Comprehensive Exam)
- ACS 601, Dissertation – full-time Ph.D. students (post Comprehensive Exam)
- ACS 610, Thesis Research – for students conducting off-campus research
- ACS 611, Dissertation – part-time Ph.D. students post Comprehensive Exam

- AE 458, Advanced Architectural Acoustics and Noise Control
- AERSP 511, Aerodynamic Noise

Descriptions of Acoustics Courses

Required Core Courses

ACS 501, Elements of Acoustics and Vibration

This course introduces the fundamentals of acoustics and vibration, focusing on structural vibration and sound waves in simple objects such as mass-spring systems, strings, rods, and plates. The fundamental concepts of vibration are presented along with applications to engineering and industrial problems. Topics covered: simple harmonic oscillator; mechanical resonance and damping; forced vibration and normal modes; transverse waves on strings; boundary conditions and standing waves; elasticity; longitudinal, torsional, and transverse vibration of bars; transverse vibrations of membranes; and flexural vibrations of thin plates. *[Fall semester]*

ACS 502, Elements of Sound Waves in Fluids

This course lays the fundamental groundwork for the propagation of acoustic waves in fluids. Topics include: basic equations of fluid dynamics, acoustic lumped elements, speed of sound, linear acoustic wave propagation, plane and spherical waves, radiation of sound from sources and arrays, sound intensity and power, reflection and transmission of sound at boundaries, absorption of sound, normal modes in rooms, probation of sound in pipes and acoustic filters. [*Fall semester*]

ACS 597, Signal Analysis for Acoustics and Vibration (new number will be ACS 503)

Time- and frequency-domain analyses for sampled, discrete-time acoustic and vibration measurements. Development, application, and consequences of filtering, spectral analysis, and correlation for single- and multi-channel data. *[Fall semester]*

ACS 505, Experimental Techniques in Acoustics (2 credits)

This is a hands-on laboratory course in which students will gain experience with data acquisition and data management while making measurements of acoustic and vibration quantities and phenomena. *[Spring semester]*

ACS 514, Electroacoustic Transducers

This course covers derivation and discussion of the fundamental operating characteristics of transducers for acoustics and for vibration. Acoustic transducers will include microphones, loudspeakers, and underwater hydrophones and projectors. Student must have a working knowledge of MATLAB prior to taking this course. *[Spring semester]*

ACS 515, Acoustics in Fluid Media

This course covers theoretical aspects of sound radiation and propagation. Topics incude: wave propagation, superposition of simple courses, free space Green's functions, dipoles and quadrupoles, multipole expansion, radiation of sound, Kirchhoff-Helmholtz integral theorem, Rayleigh integral, radiation from cylinders and spheres, scattering from cylinders and spheres, diffraction, sound sources in ducts, cavities, and rooms, wave propagation in cavities. *[Spring semester]*

ACS 597, Advanced Signal Analysis for Acoustics and Vibration (new number will be ACS 523)

*[*This course is required for Ph.D. students but is elective for M.S. and M.Eng. students.]*

This course is concerned with the time and frequency-domain analysis of discrete-time signals and discrete-time linear systems, with an emphasis on developing and applying analysis techniques with applications in acoustics and vibrations. Topics covered include: a review of time and frequency-domain representations of systems; the analysis and design of IIR and FIR digital filters; time-frequency analysis; signal detection and classification; and signal modulation. Possible application topics include vibration and modal analysis, machinery and structural health and condition monitoring, source localization and classification, and outdoor sound propagation. **(Prerequisite ACS 503, Signal Analysis for Acoustics and Vibration)** *[Spring semester]*

ACS 590, Colloquium (1 credit)

This course provides students the opportunity to develop the important skills for effective oral scientific presentations. Additional topics will include intellectual property, patents, acoustical consulting, and professional development. *[Spring semester]*

Elective Courses in Acoustics

Elective courses are offered on a rotating basis, depending on faculty availability and student interest. We usually offer at least two elective courses every Fall and Spring semester.

ACS 519, Sound and Structure Interaction

Topics covered: structural vibrations of beams, plates, and cylindrical shells; structural damping; coupling of structural vibrations with acoustic pressure fields; analytical and numerical techniques (finite element and boundary element methods) for solving structural-acoustic problems; statistical energy analysis; transmission loss of plates; survey of practical applications for aerospace, automotive, and naval structural-acoustic systems.

ACS 597, Advanced Transducers & Acoustic System Modeling (new number will be ACS 524)

Topics for this course include: condenser, electret, piezoelectric, magnetic coil, and balanced-arm transducers, mechanical mounting; interaction of closely-spaced transducers and nonlinear response. Computational modeling for analog circuits using SPICE, and Modelica and Simscape for FEA and DAE models. **(Prerequisite ACS 503, Signal Analysis for Acoustics and Vibration)**

ACS 530, Flow Induced Noise

The objective of this course is to provide the basic and applied aspects of noise created by subsonic fluid flows including prediction and reduction techniques. The concepts of noise and non-radiating pressure fluctuations created by unsteady flows are discussed from both a theoretical and experimental perspective. For a given class of flow, mechanisms for the creation of unsteady wall pressures, forces and sound, radiated directly and re-radiated by the vibration of the structure, are presented. The course will place a heavy emphasis on real world applications with material discussing both current research thrusts and past work in the field including the review and discussion of relevant journal articles.

ACS 597, Outdoor Sound Propagation (new number will be ACS 533)

This course will cover a variety of outdoor sound scenarios, but a majority will focus on propagation near the ground. Topics include: effects of realistic ground surfaces; temperature gradients; atmospheric turbulence; propagation over barriers and terrain, and computational methods for outdoor sound.

ACS 537, Noise Control Engineering

Topics covered: source-path-receiver model, human hearing and psychoacoustics, human response to noise and vibration, sound quality metrics and criteria for quantifying noise, acoustic standards related to noise and vibration control, instrumentation for measuring and analyzing noise and vibration, noise sources (distributed sources, impact sources, flow noise), absorption (materials, measurement, placement), control of sound in large and small rooms, partitions and barriers, mufflers, and vibration control techniques.

ACS 597, Nonlinear Acoustics (new number will be ACS 540)

The topics covered for this are: review of thermoviscous linear sound; nonlinear equations of acoustics; steepening/harmonic generation; weak shocks/N-waves; Burgers' equation; sonic booms; acoustic saturation; radiation pressure; acoustic levitation; nonlinear reflections and standing waves; biomedical harmonic imaging; streaming; cavitation and sonoluminescence; parametric arrays and the "audio spotlight"; scattering of sound by sound; and computational nonlinear acoustics.

ACS 542, Physical Principles in Biomedical Ultrasonics

This course focuses on the phenomenon of ultrasound in the context of medical and biological applications, systematically discussing physical principles and concepts. Concepts of wave acoustics are examined, and practical implications are explored - first, the generation and nature of acoustic fields and then their formal descriptions and measurement. Real tissues attenuate and scatter ultrasound in ways that have interesting relationships to their physical chemistry, and the course includes coverage of these topics. This course also includes critical accounts and discussions of the wide variety of diagnostic and investigative applications of ultrasound that are available in medicine and biology. The course encompasses the biophysics of ultrasound and its practical applications to therapeutic and surgical objectives. The course utilizes finite element methods for simulation. **[Cross-listed as EMCH 542]**

ACS 597, Computational Acoustics (new number will be ACS 544)

This course provides a background to the field of computational acoustics with exposure to several important computational tools including symbolic mathematics software (like Mathematica), finite differences, finite elements, boundary elements, scientific visualization, sound propagation algorithms. When possible, emphasis will be placed on commercially available software for solving noise and vibration problems. Guidelines are given for choosing the right numerical approach, generating meshes, and solving problems in areas such as product noise,

audio and telephony, structural acoustics, and automobile and aircraft interior noise. Time domain, frequency domain, and fluid-structure interaction problems are all addressed.

ACS 597, Spatial Sound and 3D Audio (new number will be ACS 551)
This course is an overview of recent developments in virtual acoustics (also known as 3-D sound, 3-D audio, binaural audio, or spatialized sound). The course pulls from many subdisciplines of acoustics including psychoacoustics, physical acoustics, signal processing, active acoustic control, architectural acoustics, audio engineering and computational acoustics. Topics to be covered include: Head related transfer functions (HRTFs); elements of psychoacoustics for 3-D sound; the "stereo dipole"; auralization (including reverberation effects); virtual acoustic systems; cross talk cancellation; ambisonics; wave field synthesis; multi-channel audio; virtual reality modeling language (VRML) and applications.

ACS 597, Architectural Acoustics Theory and Research (new number will be ACS 552)
This 3-credit graduate course will cover underlying theory and commonly used research methods in architectural acoustics. The theory topics will include reflections from infinite surfaces and finite objects, absorption mechanisms, and psychoacoustics concepts specific to architectural acoustics. The research methods that will be discussed include room acoustics impulse response measurements, modeling of room acoustics using commercially- available software, and experimental design of subjective listening tests. A set of recently published research articles related to these topics will also be examined in detail.

ACS 597, Signal Processing for Audio Applications (new number will be ACS 553)
This course will present the essential signal processing and acoustical modeling associated with audio systems used in broadcasting, communications, music recording, and video foley production. Topics covered: details of digital waveform compression processes and formats; digital signal processing for audio filters, modulation, filters, compressors, harmonizers, and reverberation special effects; digital audio workstations; the history and types of microphones and guitar pickups; amplifier design types, including digital, transistor, and vacuum tube amplifier designs; and loudspeaker system design including measurements and cross-over design for vented and sealed cabinets. This course will prepare students for working in the audio industry by supporting practical applications of acoustics theory to audio-related applications, but it will not address electrical design of devices such as amplifiers or transducers. However, it will explain the differences and common uses of devices and processes in audio engineering.

ACS 555, Applications of Aero- and Vibro-Acoustics (new number will be ACS 555)
[*Alternate title*: ***Acoustics of Musical Instruments***] This course will provide an in-depth exploration of the physics and acoustics of classical musical instruments. Topics will focus on the mechanisms of sound production by stringed instruments (plucked, struck and bowed), percussion (drums, marimba) brass winds (lip reed, cylindrical bore, conical bore), woodwinds (flutes, single-reed, double reed). Related topics will include radiation properties, damping mechanisms, impedance measurements, and the coupling between acoustics and structural components. As time allows, ethnic variations on classical instruments may be discussed. An understanding of the fundamentals of acoustics and vibration will be assumed as prerequisite for this course.

ACS 597, Ocean Acoustics (new number will be ACS 560)
This course covers a broad, but comprehensive, introduction to many important topics in underwater acoustics. The major goal is to give participants a practical understanding of fundamental concepts, along with an appreciation of current research and development activities. It serves as a foundation for more advanced study of current literature or for other specialized courses. Topics covered: ocean dynamics: e.g., derivation of the Navier-Stokes equation; derivation and solution of the wave equation: Green's functions, wavenumber integration, normal modes, PE, ray theory, energy flux; boundary reflection: layered fluid and elastic media, plane and spherical wave reflection; and boundary and volume scattering.

ACS 598E, Advanced Engineering Mathematics (new number will be 504)
[*This course is currently only offered for distance education students.*] This course will provide basic tools for solution of differential equation of acoustics and vibration. Topics include: first, second, and higher order ODEs, boundary and initial value problems; special functions and series solutions; Laplace and Fourier transforms; and numerical integration techniques. *[Spring semester]*

Special Courses (Special Topics and Research Credits)

Graduate students registering for the special courses below should consult with their advisor to insure they are registering for the correct course. Failure to select the correct course may require the student to pay "retroactive fees" and perhaps additional course-credit fees.

ACS 580, Research Topics (1 credit)

[This course is only for students enrolled in the 1-year M.S. program.] This course provides a survey of contemporary research activities in acoustics, major research thrusts, including current research methodologies and their imitations.

ACS 594, Research Topics (1-credit)

[This course is only for students enrolled in the 1-year M.S. program.] This course is part of the 1-year M.S. program and will enable students to participate in supervised research projects on an individual or small-group basis.

ACS 596, Individual Studies (1-6 credits)

Individual courses are creative projects, including non-thesis research, that are supervised by an Acoustics Program faculty member on an individual basis, and which fall outside of the scope of formal courses. Individual study courses need to be arranged with an Acoustics Program faculty member and may range from 1 to 6 credits – the credit load is determined by the content and expected student effort, and in negotiation between, student, instructor, and the Acoustics Program. Individual study courses require a constant interaction between the student and instructor and active engagement of both with the content. Individual Studies credits should not be used for M.S. or Ph.D. Thesis research.

ACS 597 Special Topics

This course number is reserved for formal courses on a topical or special interest topics and is used for courses that are offered on temporary trial basis before being assigned a permanent number. A large number of the Acoustics Elective courses (see above) are in the process of being transitioned from 597 to permanent numbers.

ACS 600 (610 off-campus) Thesis Research

This course should be used to register for M.S. and Ph.D. thesis research. Instructors usually award a grade of R (for research, which assumes adequate effort) for this course, but may award a grade of A, B, C, D, or F for up to 6 credits for M.S. students and 12 credits for Ph.D. students. An R need not be changed later to a quality grade. A quality grade must be reported no later than the end of the following semester.

ACS 601 (611 off-campus) Ph.D. Thesis Preparation

ONLY Ph.D. STUDENTS CAN REGISTER FOR ACS 601 AND ONLY AFTER THEY HAVE PASSED THEIR COMPREHENSIVE EXAM AND MET THE TWO-SEMESTER RESIDENCY REQUIREMENT. Ph.D. students may register for one additional course when they register for ACS 601. If this course is for credit (not simply a course audit), an additional fee is required. Prior to graduation, the Graduate School reviews students' transcripts. Students registering for ACS 601 when they have not satisfied the above requirements will be asked to retroactively change their registration, pay retroactive fees and possible additional course-credit costs before they will be permitted to graduate. It is vital that graduate students consult their advisors prior to each semester's registration to insure they are registering for the correct course.

Related Courses Offered by Other Departments

Departmental Abbreviations:

AE	Architectural Engineering	ESC	Engineering Science
AERSP	Aerospace Engineering	GEOSC	Geosciences
BIOE	Bioengineering	ME	Mechanical Engineering
CSD	Communication Sciences & Disorders	METEO	Meteorology
EE	Electrical Engineering	PHYS	Physics
EMCH	Engineering Mechanics	STAT	Statistics

Architectural Acoustics and Noise

AE 458, Advanced Architectural Acoustics and Noise Control
This course covers advanced consideration of noise control in buildings; ventilating system noise and vibration; acoustic design variables. The course will begin with a brief review of acoustics fundamentals and will include the following topics: (1) sound isolation in buildings, (2) heating, ventilation and air conditioning (HVAC) noise control and (3) an introduction to architectural acoustics principles for the design of venues for speech and/or music. *[Fall Semester]*

Structures and Vibration

EMCH 470, Analysis and Design in Vibration Engineering
Application of Lagrange's equations to mechanical system modeling, multiple- degree-of-freedom systems, experimental and computer methods; some emphasis on design applications.

EMCH 507, Theory of Elasticity and Applications
Equations of equilibrium and compatibility; stresses and strains in beams, curved members, rotating discs, thick cylinders, torsion and structural members.

EMCH 520, Advanced Dynamics
Dynamics of a particle and of rigid bodies; Newtonian equations in moving coordinate systems; Lagrange's and Hamilton's equations of motion; special problems in vibrations and dynamics.

EMCH 521, Stress Waves in Solids
This course will cover recent advances in ultrasonic nondestructive evaluation; the propagation of elastic stress waves in solids; reflection and refraction of waves; horizontal shear; multilayer structures; viscoelastic media; testing principles. **[often cross-listed as ACS 521]**

EMCH 527, Structural Dynamics
Dynamic behavior of structural systems, normal modes; input spectra; finite element representation of frameworks, plates, and shells; elastic-, plastic response.

EMCH 528, Experimental Methods in Vibrations
Investigation of one or more degrees of freedom, free and forced mechanical vibrations, vibrational properties of materials, nondestructive testing.

ESC 536, Wave Propagation and Scattering
Survey of analytical and numerical methods for solving acoustic, electro- magnetic and elastic wave propagation and scattering problems. **[pre-req: EMCH 524A or EMCH 524B]**

EMCH 541, Structural Health Monitoring
Technology development to address maintenance and safety concerns related to the aging aerospace/mechanical/civil infrastructure.

EMCH 571, Foundations of Structural Dynamics and Vibration
Modeling approaches and analysis methods of structural dynamics and vibration **[cross-listed as AERSP 571 and ME 571]**

ME 560, Solid Mechanics
Introduction to continuum mechanics, variational methods, and finite element formulations; application to bars, beams, cylinders, disks, and plates

ME 563, Nonlinear Finite Elements
Advanced theory of semidiscrete formulations for continua and structures; emphasizes dynamic and nonlinear problems.

ME 571, Foundations of Structural Dynamics and Vibration
Modeling approaches and analysis methods of structural dynamics and vibration **[cross-listed as AERSP 571 and EMCH 571]**

ME 572, Experimental Modal Analysis
The development of structural dynamic models from experimental data, analytical and experimental vibration, analysis methods, laboratory techniques

Fluids and Flow Noise

AERSP 511, Aerodynamically Induced Noise
This course covers all aspects of sound generation by unsteady flow. The material includes methods based on classical acoustics as well as noise modeling and prediction based on computational fluid dynamics (CFD) simulations. Topics covered: Human response to noise; noise metrics; fundamental solutions of the wave equation; Green's functions; sound generated by flow; Lighthill's acoustic analogy; application of Lighthill's analogy to turbulent flows; physics of jet noise; modern theories of aerodynamic noise generation; sound generation by solid boundaries; propeller noise helicopter rotor noise; and duct acoustics.

AERSP 508, Foundations of Fluid Mechanics
Mathematical review, fluid properties, kinematics, conservation laws, constitutive relations, similarity principles, the boundary layer, inviscid flow, vorticity dynamics, wave motion

AERSP 524, Turbulence and Applications to CFD: DNS and LES
First of two courses: Scalings, decompositions, turbulence equations; scale representations, Direct and Large-Eddy Simulation modeling; pseudo-spectral methods; 3 computer projects. **[pre-req: AERSP 508]**

AERSP 525, Turbulence and Applications to CFD: RANS
Second in two courses: Scalings, decomposition, turbulence equations; Reynolds Averaged Navier Stokes (RANS) modeling; phenomenological models; 3 computer projects. **[pre-req: AERSP 508]**

BIOE 503, Fluid Mechanics of Bioengineering Systems
Cardiovascular system and blood flow, non-Newtonian fluid description, vessel flows, unsteady flows and wave motion, wind kessel theory, transmission line theory.

ME 521, Foundations of Fluid Mechanics I
First semester of core sequence in fluid mechanics; Navier-Stokes equations, potential flow, low Re flow, laminar boundary layers.

ME 522, Foundations of Fluid Mechanics II
Second semester of core sequence in fluid mechanics; continuation of boundary layers, stability, transition, turbulence, turbulent boundary layers, turbulence models.

Mathematics and Statistics

EMCH 524A, Mathematical Methods in Engineering
Special functions, boundary value problems, eigenfunctions and eigenvalue problems; applications to engineering systems in mechanics, vibrations, and other fields.

EMCH 524B, Mathematical Methods in Engineering
Boundary-value problems in curvilinear coordinates, integral transforms; application to diffusion, vibration, Laplace and Helmholtz equations in engineering systems. **[pre-req: EMCH 524A]**

EMCH 524C, Mathematical Methods in Engineering
Green's functions applied to problems in potentials, vibration, wave propagation and diffusion with special emphasis on asymptotic methods. **[pre-req: EMCH 524A]**

IE 511: Experimental Design in Engineering
Statistical design and analysis of experiments in engineering; experimental models and experimental designs using the analysis of variance.

STAT 500, Applied Statistics
Descriptive statistics, hypothesis testing, power, estimation, confidence intervals, regression, one- and 2-way ANOVA, Chi-square tests, diagnostics.

STAT 501, Regression Methods
Analysis of research data through simple and multiple regression and correlation; polynomial models; indicator variables; step-wise, piece-wise, and logistic regression.

STAT 502, Analysis of Variance and Design of Experiments
Analysis of variance and design concepts; factorial, nested, and unbalanced data; ANCOVA; blocked, Latin square, split-plot, repeated measures designs.

STAT 509, Design and Analysis of Clinical Trials
An introduction to the design and statistical analysis of randomized and observational studies in biomedical research. The objective of the course is to introduce students to the various design and statistical analysis issues in biomedical research. This is intended as a survey course covering a wide variety of topics in clinical trials, bioequivalence trials, toxicological experiments, and epidemiological studies. **[pre-req: STAT 500]**

Atmospheric, Seismic, and Ocean Topics

GEOSC 488H, An Introduction to Seismology
An overview of the observations, methods, and frameworks used in seismogram analysis for earthquake and earth-structure investigations (includes laboratory).

GEOSC 507, Seismology
Introduces the basic equations and techniques necessary to do modern earthquake and lithospheric seismological studies.

GEOSC 559, Seismology II
Rigorously covers the methods of computing wave fields for point and distributed seismic sources in vertically inhomogeneous elastic media.

METEO 520, Geophysical Fluid Dynamics
Fundamentals of fluid dynamics with an emphasis on basic concepts that are important for atmospheric and oceanic flows. This is a course in the fundamentals of fluid dynamics with an emphasis on basic concepts that are important for geophysical flows, such as those in the atmosphere and ocean.

METEO 551, Physical Oceanography
This course provides graduate and advanced undergraduate students in the sciences and engineering an overview of the circulation of the ocean and the theories used to explain it. The focus is on the large-scale circulation driven by winds, buoyancy, and tidal forces. The course will also cover the distributions of temperature and salinity in the ocean, the surface ocean mixed layer, mesoscale eddies, and internal waves.

METEO 554, Atmospheric Turbulence
An introduction to the physics, structure, modeling, representation, and measurement of atmospheric turbulence.

Ultrasound in Fluids and Solids

BIOE 506, Medical Imaging
Medical diagnostic imaging techniques, including generation and detection of ultrasound, x-ray, and nuclear radiation; instrumentation and biological effects

EMCH 523, Ultrasonic Nondestructive Evaluation
This course will cover recent advances in ultrasonic nondestructive evaluation; the propagation of elastic stress waves in solids; reflection and refraction of waves; horizontal shear; multilayer structures; viscoelastic media; testing principles.

Section 3
Master's Degrees in Acoustics

- M.Eng. (resident)
- 1-year M.S. (no-thesis)
- M.S. (research thesis)

Master of Engineering (M.Eng.)

The Master of Engineering degree is a professional master's degree which is primarily based on graduate course work (10 courses = 30 credits). Students are also required to submit to the Acoustics Program Office a capstone paper written about an acoustics related topic of their choosing, under the supervision of an acoustics faculty member. Most students who pursue the M.Eng. degree from the Graduate Program in Acoustigcs are distance education students who take classes online through World Campus. But, the M.Eng. degree may be earned by resident students. However, M.Eng. students are not eligible for funding through a research assistantship.

Advisors for M.Eng. students

Dr. Vic Sparrow (the Acoustics Program Director) is the default academic advisor for all resident students pursuing the M.Eng. degree. When the students is at the stage of writing the capstone paper, another faculty member may be appointed (relevant to the topic of the paper) to read and sign approval of the paper.

M.Eng. Course Credit Requirements

The M.Eng. degree requires 30 credits of graduate level coursework. All Acoustics M.Eng. students are required to complete 18 credits of required core courses

- ACS 501, Elements of Acoustics and Vibration
- ACS 502, Elements of Sound Waves in Fluids
- ACS 597, Signal Analysis for Acoustics and Vibration (new number will be ACS 503)
- ACS 505, Experimental Techniques in Acoustics (2 credits)
- ACS 514, Electroacoustic Transducers
- ACS 515, Acoustics in Fluid Media
- ACS 590, Colloquium (1 credit)

The remaining 12 credits may be completed by taking elective courses from the list of ACS courses offered by the Acoustics program (see section 3 of this handbook for the complete list of courses), approved courses related to acoustics topics taught by other departments at Penn State, or Individual Studies (ACS 596). A maximum of 6 credits of ACS 596, Individual Studies may be applied toward the M.Eng. degree. No research credits (ACS 600) may be counted toward the 30 required course credits.

A minimum grade point average of 3.00 for work done at the University is required for graduation.

Typical Course Schedule for M.Eng. Students

First Year	
Fall Semester	Spring Semester
ACS 501, Elements of Acoustics and Vibration	ACS 514, Electroacoustic Transducers
ACS 502, Elements of Sound Waves in Fluids	ACS 515, Acoustics in Fluid Media
ACS 597, Signal Analysis for Acoustics and Vibration	ACS 505, Experimental Techniques
	ACS 590, Colloquium
Second Year	
Fall Semester	**Spring Semester**
ACS Elective	ACS Elective
ACS Elective	ACS Elective
Elective or ACS 596, Individual Studies	Elective or ACS 596, Individual Studies

M.Eng. Capstone Paper Requirements

The M.Eng. capstone paper is a paper involving at least one acoustics topic represented in the course work. Normally, such a paper represents a study of a particular topic that is more limited than that necessary for a thesis. Often this paper can be developed from some previous work of the student such as a term paper or a technical report. The report is free of any formal requirements of the Graduate School, but it is expected that the student will use the Thesis Guide as an example of the appropriate format. The paper must be approved for its technical content and style by the student's advisor and for its format by the Acoustics Program Office. The paper must also be signed by the Program Director (Dr. Sparrow).

Each student shall deliver to the Program Office one (1) bound copy of this paper for retention by the Program. Additional bound copies may be required by the advisor. The costs of thesis preparation, copying, and binding are the responsibilities of the student. The student should consult with the Acoustics Program Office before final preparation of the bound and unbound copies of the report.

Expected Time to Completion

The typical length of time to complete the Master of Engineering degree program as a resident student is two (2) calendar years.

Master of Science (M.S.) – One Year (no thesis)

This option allows students to complete the required coursework and a scholarly paper to earn the M.S. degree in Acoustics within one calendar year. Students admitted to the one-year M.S. option are **not eligible to receive funding** in the form of a graduate research assistantship. Students in the one-year M.S. track are expected to pay for tuition and living expenses.

Advisors for M.Eng. students

Dr. Stephen Thompson is the default academic advisor for all students pursuing the 1-year M.S. (no thesis) degree.

Course Requirements for the 1-year M.S. (no-thesis)

The 1-year M.S. degree (no-thesis option) requires 30 credits, of which 24 credits must be from graduate level coursework. Students in the 1-year M.S. program are required to complete 21 credits of required core courses:

- ACS 501, Elements of Acoustics and Vibration
- ACS 502, Elements of Sound Waves in Fluids
- ACS 597, Signal Analysis for Acoustics and Vibration (new number will be 503)
- ACS 505, Experimental Techniques in Acoustics (2 credits)
- ACS 514, Electroacoustic Transducers
- ACS 515, Acoustics in Fluid Media
- ACS 580, Contemporary Research Topics in Acoustics (1 credit)
- ACS 590, Colloquium (1 credit)
- ACS 594, Research Topics (1 credit taken twice)

Students in the 1-year M.S. program are required to enroll in 1 credit of ACS 594, Research Topics during each of the Fall and Spring semesters, along with 1 credit of ACS 580, Contemporary Research Topics in Acoustics during the Summer session.

The remaining 9 course credits may be completed by taking elective courses from the list of ACS courses offered by the Acoustics program (see section 2 of this handbook for the complete list of courses), approved courses related to acoustics topics taught by other departments at Penn State, or Individual Studies (ACS 596). Students in the 1-year M.S. may not count research credits (ACS 600) toward the degree.

A minimum grade point average of 3.00 for work done at the University is required for graduation.

Typical Course Schedule for 1-year M.S. (no-thesis)

Students in the 1-year M.S. program will carry a heavier course load than typical M.S. students. In order to complete the requirements for the M.S. degree within one calendar year, students will have to carry 13 credits during both fall and spring semesters. A typical class schedule is shown below.

Fall Semester (13 credits)	Spring Semester (13 credits)	Summer (4 credits)
ACS 501	ACS 514	ACS 580
ACS 502	ACS 515	Elective
ACS 597, Signal Analysis	ACS 505	
ACS 594	ACS 590	Write Scholarly Paper
ACS Elective	ACS 594	
	ACS Elective	

Scholarly Paper

All students earning the M.S. degree through the one-year option are required to write a scholarly paper. This scholarly paper will be developed in the ACS 594, Research Topics classes during the Fall and Spring semesters, and will normally be completed while the student is taking ACS 580, Contemporary Research Topics in Acoustics during the Summer Session. This paper will typically be a study of a particular acoustics topic and will involve research, but to a more limited extent than it necessary for a thesis. The paper is free of any formal requirements of the Graduate School but it is expected that the student will follow the formatting requirements in the Thesis Guide available from the Graduate School.

Time to Completion

The one-year M.S. option is expected to be completed within one (1) calendar year, from August to August.

Master of Science (M.S.) – Traditional (Thesis)

The traditional M.S. degree is based on a combination of graduate course work and research which is documented and culminates in a Master of Science thesis which the students writes and orally defends. Both the course selection and research are directed by an advisor. At least two other faculty members, upon the advisor's suggestion, will be appointed to form a thesis committee.

Course Requirements

The M.S. degree (thesis option) requires 30 credits, of which 24 credits must be from graduate level coursework. In addition, 20 of these credits must be completed at the University Park campus, and . All Acoustics M.S. students are required to complete 18 credits of required core courses:

- ACS 501, Elements of Acoustics and Vibration
- ACS 502, Elements of Sound Waves in Fluids
- ACS 597, Signal Analysis for Acoustics and Vibration (new number will be ACS 503)
- ACS 505, Experimental Techniques in Acoustics (2 credits)
- ACS 514, Electroacoustic Transducers
- ACS 515, Acoustics in Fluid Media
- ACS 590, Colloquium (1 credit)

The remaining 6 course credits may be completed by taking elective courses from the list of ACS courses offered by the Acoustics program (see section 2 of this handbook for the complete list of courses), approved courses related to acoustics topics taught by other departments at Penn State, or Individual Studies (ACS 596). A maximum of 6 credits of ACS 596, Individual Studies may be applied toward the M.S. degree.

The M.S. degree (thesis-option) requires 6 research credits (ACS 600). Students who are funded by an assistantship or fellowship must carry a minimum of 9 credits each semester and may need to add ACS 600 research credits to reach that total. However, any ACS 600 credits beyond 6 will be graded with an "R" and will not count toward the required 30 credits for the M.S. degree.

A minimum grade point average of 3.00 for work done at the University is required for graduation.

Typical Course Schedule for M.S. (with thesis option)

First Year	
Fall Semester	Spring Semester
ACS 501, Elements of Acoustics and Vibration	ACS 514, Electroacoustic Transducers
ACS 502, Elements of Sound Waves in Fluids	ACS 515, Acoustics in Fluid Media
ACS 597, Signal Analysis for Acoustics and Vibration	ACS 505, Experimental Techniques
	ACS 590, Colloquium
Second Year	
Fall Semester	**Spring Semester**
ACS Elective	ACS Elective
ACS Elective	ACS Elective or ACS 600 Thesis Research
ACS 600 Thesis Research	ACS 600 Thesis Research

Advisors and Thesis Research Projects

M.S. students are eligible to receive funding in the form of a half-time research assistantship, to the extent that funding is available and there is mutual agreement between the student and the faculty member providing the funding. Students who do not have a research assistantship in place prior to matriculation must confer with the Acoustics Program Director (Dr. Sparrow), who will assign a temporary

academic advisor to assist in planning a program of study. This temporary academic advisor will give final approval of the student's course selection prior to registration each semester until the student has obtained a permanent advisor.

During the first semester of study, it is the responsibility of each student, who has not already secured an assistantship or a thesis project, to determine what research is being conducted by the Acoustics Faculty, as well as which faculty members might be willing to serve as a thesis advisor. The Acoustics Program will schedule a Faculty Showcase during the Fall semester for faculty to highlight their research areas, and seminars through the semester may feature faculty research. However, it is the responsibility of the student to search out and make connections with faculty members. Before the end of the first year of graduate study, the student should select a thesis topic and obtain the agreement of a member of the graduate faculty to act as permanent advisor. The student should feel free to approach any member of the graduate faculty for advice and counsel in this connection. The selection of a topic and a research advisor may have a connection to funding and an assistantship. A student may subsequently change advisors; but it is imperative that the Acoustics Program be notified of any such change, since a change in thesis topic and advisor may mean the cancellation of an assistantship supported by that project.

Normally most students who are funded by a research assistantship do not enroll in courses during the summer and are placed on a stipend-only assistantship (no tuition) equivalent half-time assistantship. However, there are occasionally course offered during summer sessions which might be relevant to certain research topics. Students should consult their advisors to see if they should register for any summer courses and remain on a tuition-bearing assistantship during the summer.

M.S. Thesis Requirements

By writing an acceptable M.S. thesis, a student demonstrates that he or she is capable of completing a well-defined, directed study of a limited problem and is capable of writing a relatively brief, coherent report summarizing the major objectives and results of the study. Although in most cases the thesis work will be publishable, this is not a requirement for the degree.

Thesis Committee. The faculty committee for M.S. thesis students is comprised of the student's advisor and two or three additional acoustics faculty. All committee members must be approved by the Program Director. Although not required, it is sometimes helpful for the student to schedule a meeting with the committee prior to the defense in order to report progress or to obtain input and direction for the project.

Upon completion of the thesis research, and after editorial review by the advisor, the student will supply the members of his or her committee with a clean draft copy of the thesis at least 2 weeks prior to the thesis defense. The student must then defend the thesis before the committee. Under very special circumstances, exceptions to this procedure may be granted by the Program Director.

Thesis Defense. All master's thesis defenses are open to the public and students are urged to attend the defense presentations of their colleagues to gain an appreciation of the proceedings. **The Acoustics Program Office must be notified at least 2 weeks prior to the scheduled thesis defense** so that announcements of the defense can be circulated to faculty and students. A thesis presentation should emulate the presentation of a paper at a technical session of a professional society meeting. It should be presented in a definite time interval (typically 45 minutes). The talk should have been rehearsed to verify the time required and to refine the presentation.

Following general questions from the audience, the public is asked to leave the room and the student is expected to answer questions from the committee without undue reliance upon the advisor. The committee may request that changes be made to the written thesis before agreeing to sign the final copy.

Thesis Format. The thesis must be written according to the guidelines discussed in the Thesis Guide available from the Graduate School. Historically, the signatory page is the page most often rejected by the Graduate School because of some error in format or in the citing of the title of members of the committee. The student is urged to pay particular attention to this page and to consult the Acoustics Program Office to eliminate unnecessary problems. After the thesis has been approved by at least two-thirds of the members of the committee, the final amended thesis draft will be reviewed again by the thesis advisor to ensure that it conforms to the recommended and agreed upon changes requested by the committee.

Submitted Copies. An electronic PDF copy of the thesis is required by the Graduate School and is uploaded directly through the Graduate School website. The Acoustics Program Office requires one bound, paper copy; the binding must be a black cover with gold lettering. An additional bound copy may be required by the thesis advisor and/or committee members. The costs of thesis preparation, copying, and binding are the responsibilities of the student. The student should consult with the Acoustics Program Office before final preparation of the bound and unbound copies of the report

Time to Completion

The entire M.S. degree program, for a resident student on a half-time assistantship, should typically require no more than 2.5 years to complete. Because of this short time duration, it is paramount that a student should begin work on the thesis research as soon as possible, and certainly before the end of the first year of study. In the first semester of residence, it is the responsibility of each student to determine what research is being conducted in the Program as well as which of the faculty members might be willing to serve as a thesis advisor. One way of learning what work is being done in the Program is for the students to attend some of the various seminars conducted each semester.

Section 4
Doctoral Degree in Acoustics

Doctor of Philosophy (Ph.D.)

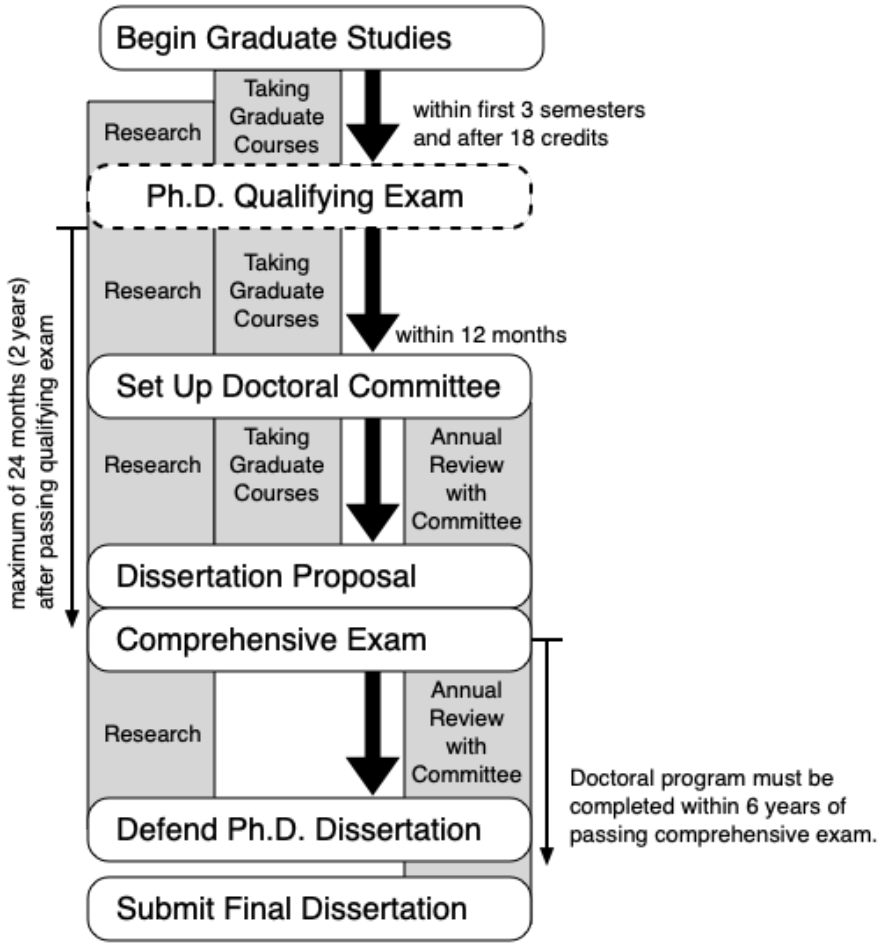
The Doctor of Philosophy Ph.D.) degree is conferred in recognition of high attainment and productive scholarship. Admission to the Ph.D. program is a two-step process. First, the candidate must be admitted to the Graduate Program in Acoustics as a Ph.D. student. Admission to the program will permit the student to begin taking classes and working toward a doctor's degree. However, the student is not fully admitted to the Ph.D. program until the Acoustics Ph.D. Qualifying Examination has been successfully passed.

Residency Requirements for the Ph.D.

All Ph.D. students must satisfy the University residency requirement. Between admission into the Ph.D. program and completion of the degree, the candidate must physically spend two consecutive semesters (Fall and Spring) as a registered full-time student engaged in academic work at the University Park campus. 600-level courses (thesis research) may not be used to meet the full-time residence requirement.

Flow Chart of Progress through the Ph.D. Program

The flowchart below summarizes the progress through the Ph.D. program toward completion of the degree. Each step will be explained in greater detail in the following sections



Course Requirements for the Ph.D.

All Acoustics Ph.D. students are required to complete 21 credits of required core courses

- ACS 501, Elements of Acoustics and Vibration
- ACS 502, Elements of Sound Waves in Fluids
- ACS 597, Signal Analysis for Acoustics and Vibration (new number will be ACS 503)
- ACS 505, Experimental Techniques in Acoustics (2 credits)
- ACS 514, Electroacoustic Transducers
- ACS 515, Acoustics in Fluid Media
- ACS 597, Advanced Signal Analysis for Acoustics and Vibration (new number will be ACS 523)
- ACS 590, Colloquium (1 credit)

The student's advisor and/or doctoral committee may require taking specific additional courses deemed relevant to the specific research topic. A maximum of 12 credits of 600-level research credits may be taken for a grade; all 600-level research credits beyond 12 will be assigned an "R".

A minimum grade point average of 3.00 for work done at the University is required for graduation.

The table below shows a typical course schedule for the first two years of a Ph.D. program.

First Year	
Fall Semester	**Spring Semester**
ACS 501, Elements of Acoustics and Vibration	ACS 514, Electroacoustic Transducers
ACS 502, Elements of Sound Waves in Fluids	ACS 515, Acoustics in Fluid Media
ACS 597, Signal Analysis for Acoustics and Vibration	ACS 597, Advanced Signal Analysis
Math Course (EMCH 524A or equivalent)	ACS 505, Experimental Techniques
	ACS 590, Colloquium
Summer (June) ⇨ Ph.D. Qualifying Exam	
Second Year	
Fall Semester	**Spring Semester**
ACS Elective	ACS Elective
ACS Elective	ACS Elective or ACS 600 Thesis Research
ACS 600 Thesis Research	ACS 600 Thesis Research

English Competency

The Graduate School at Penn State (policy GCAC-700E) requires that all Ph.D. students demonstrate high level competence in the use of the English language. For Ph.D. students in the Acoustics program, the level of English Competency (written and oral) will be assessed as part of the Acoustics Qualifying Exam. Students will demonstrate their ability to communicate through written English by writing 500-1000 word essay in response to a question or statement the day before the written acoustics problem portion of the qualifying exam. Students' oral English competence will be assessed during the oral inter-view portion of the qualifying exam.

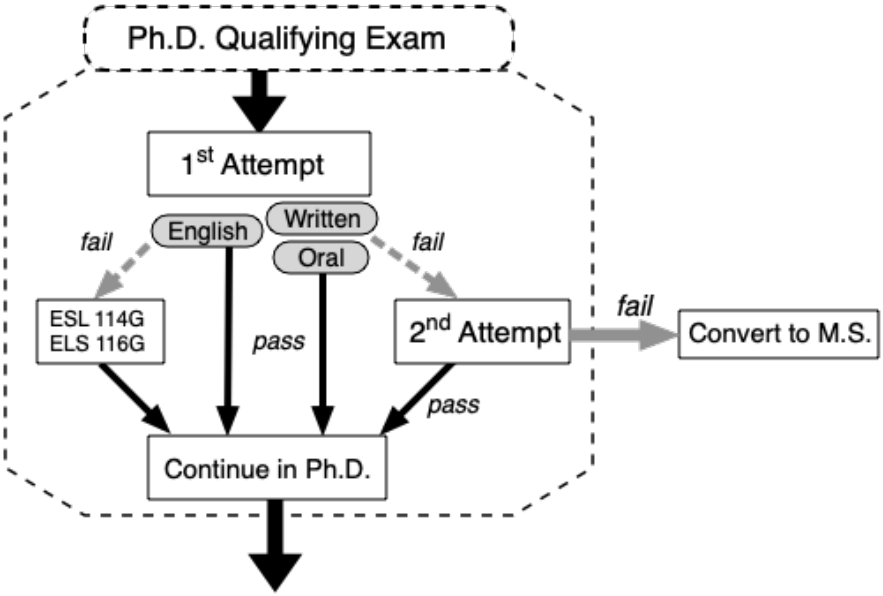
Students for whom English is not their first language and who fail to demonstrate satisfactory verbal competence will be required to take (and pass with a B or higher grade) ESL 114G, American Oral English for Academic Purposes. Students for whom English is not their first language and who fail the written part of the assessment will be required to take (and pass with a B or higher grade) ESL 116G, Composition for Academic Disciplines.

Students for whom English is their first language but who fail the verbal part of the assessment will be required to take (and pass with a B or higher grade) ENG 101G. Students for whom English is their first language but who fail the written part of the assessment will be required to take (and pass with a B or higher grade) ENG 102G.

Acoustics Ph.D. Qualifying Exam

All students wishing to pursue a doctoral degree at Penn State must pass a qualifying examination. The purpose of the qualifying examination is to assess whether or not the student is well grounded in the fundamental knowledge of acoustics, has demonstrated evidence of critical thinking skills necessary to be a successful doctoral researcher. The student is expected to demonstrate sufficient intellectual capacity and maturity to progress successfully through the course work and other organized aspects of the Ph.D. program.

This flow-chart and the following text explain the process for the Ph.D. Qualifying Exam.



The Acoustics Ph.D. Qualifying Exam is offered twice a year, usually during the summer (June) and again in winter (late January). **Students must make their first attempt to pass the Qualifying Exam within the first three semesters of entry into the doctoral program.**

In order to sit for the Acoustics Qualifying Exam, the student must . . .

- have been admitted to the Acoustics Program as a Ph.D. student.
- have completed at least 18 credits in courses eligible to be counted toward the graduate degree (these may be graduate credits earned previously at other recognized institutions from which transfer credits would be accepted) or the equivalent upon approval of the program.
- have maintained a grade-point average of 3.00 or greater for work done at Penn State while a graduate student
- have no incomplete or deferred grades

Students who do not pass the qualifying exam on their first attempt may be given a second opportunity to take the exam; the decision to offer a student a second opportunity to take the exam will be at the discretion of the faculty committee evaluating the exam. Any student taking the qualifying exam for the second time must take the exam the next time the exam is offered. A student will be allowed only two opportunities to pass the qualifying exam. A student who fails the qualifying exam on the second attempt will not be allowed to continue pursuing a Ph.D. in Acoustics at Penn State. The student may be allowed to complete a M.S. thesis, at the discretion of the student's advisor and available funding.

The Acoustics Ph.D. Qualifying Exam consists of three parts:

- **English Essay** A 500-1000-word essay in response to a given question or statement is used to assess students' competency at communicating through written English.
- **Written Exam:** A 4-hour hand-written exam (usually taken on a Saturday morning), consisting of 8 worked out problems. These 8 problems will be devised by the faculty members comprising the committee. Problems are based on subject material covered in ACS 501 and ACS 502; some problems may require applications of mathematics and may involve a mixture of both vibration and fluids topics. Students who inform the Acoustics Program office that they intend to sit for the written exam will be provided with a collection of problems taken from previous year's exams which they can use as studying aids. During the written exam, students may bring 5 handwritten pages (8.5x11, one side only) containing equations and other useful information.
- **Oral Interview:** A 1.5-hour oral interview in which students field questions from the faculty committee members (roughly 15 minutes for each of the four committee members). Passing the oral interview also satisfies the oral English Competency requirement.

The Qualifying examination is supervised by the Ph.D. Qualifying Exam committee, which is composed of four faculty members from the Acoustics Program. For the 2020-2021 cycle, the Qualifying Exam committee is comprised of Dr. Dan Russell (chair), Dr. Steve Thompson, Dr. Robert Smith, and Dr. Julianna Simon.

Upon completion of the written and oral portions of the exam, the committee will notify students in writing whether or not they have passed the exam; the outcome will also be reported to the Program Office and to the Graduate School.

Ph.D. Committee

A Ph.D. student's Doctoral Committee must be formed within 12 months of passing the Acoustics Ph.D. Qualifying Exam. The candidate and the candidate's research advisor should discuss possible committee members. The student's advisor must propose the committee make up to the Acoustics Program Director for approval, before inviting faculty members to serve. The committee must have a minimum of four members, one of whom must be from a department other than Acoustics (and preferably from a designated related area that the student will pursue). In special situations, a member of the Acoustics faculty who is also a member of the faculty in another department at the University, may be approved as the outside member. All members of the doctoral committee must be members of the Graduate Faculty. The specific rules for forming a doctoral committee are outlined in policy GCAC-602. A Graduate Student Committee Policies and Procedures and Committee Appointment Signature Form must be signed and dated by the student, the committee chair, members of the committee, and the Acoustics Program Director. After the Graduate School approves the committee, the committee assumes the function of providing guidance for the remainder of the student's program.

Policy GCAC-603 outlines the responsibilities of the doctoral committee. The chairperson of the doctoral committee is responsible for the administrative aspects of the doctoral program such as coordinating the committee's activities and convening meetings of the committee. In most cases, the chairperson is also the research adviser. The student's research advisor has the following specific responsibilities:

- Directs the research program.
- Serves (and possibly chairs) on the student's doctoral committee.
- Assists the student in selecting courses.
- Supervises preparation of documents such as research proposal, draft of thesis, and final copy of thesis submitted to the Graduate School.

Within one semester after the doctoral committee is formed, a planning meeting must be scheduled with these objectives:

- Review of student's academic record as well as work and educational experiences.
- Presentation of research proposal by the student.

- Identify courses relevant to the research program that the student should take, in addition to the core courses.
- Approve a tentative time schedule for the student's program and taking the comprehensive examination.

The doctoral committee chairperson will provide a written record of the planning meeting to the Acoustics Program Office for inclusion in the student's file, as required by GCAC-603.

The doctoral committee is required to meet regularly (at least once a year) to review the status of the student's program of study and research. The committee may meet at any other time the advisor feels the objective or character of the research has changed significantly. The results and recommendations of the meeting will be communicated in writing by the Committee Chairperson to the Acoustics Program Chair for review and inclusion in the student's file.

Comprehensive Examination

The purpose of the comprehensive examination is to evaluate the candidate's mastery of acoustics and assess a student's general preparedness to do research in their chosen research area. As such, this exam should be administered relatively early on in the student's program. The comprehensive exam consists of two parts which can be taken in any order as determined by the Doctoral Committee. However, while Part I and Part II may be completed in any sequence, both parts must be passed before notification of passage is communicated to the Graduate School.

The first part of the comprehensive examination (Part I) cannot be attempted until after the student has substantially completed all the courses required by the Doctoral Committee. **However, Part I must be passed no later than 24 months after the completion of the qualifying examination** unless a delay is approved by at least two-thirds of the Doctoral Committee because of special circumstances. The student must be registered as a full-time or part-time student for the semester in which the comprehensive examination is taken. A minimum grade point average of 3.00 for work done at the University is required for admission to the comprehensive examination and for graduation.

Part I: Written and Oral Examination. This part is is administered and evaluated by the student's Doctoral Committee. A favorable vote of at least two-thirds of the members of the Doctoral Committee is required for passing. In case of failure, the Doctoral Committee will determine whether the candidate will be permitted to take another comprehensive examination. The examination will consist of a written part to be administered first and then an oral interview to be administered within two weeks of the written part. The written part may be either open book or closed book, at the discretion of the Doctoral Committee. The written examination primarily covers material related to the thesis research area, and it is posed and evaluated by the Doctoral Committee members; at least one question from every Doctoral Committee member is included in the examination. The written examination will last no longer than two consecutive days. The Doctoral Committee chairperson requests the Program Office to contact the Graduate School to schedule the oral portion of Part I and to notify the Doctoral Committee members of the time and place of the examination. At least two-thirds of the Doctoral Committee must vote in favor of passing for the student to have passed the examination.

Part II: Dissertation Research Proposal. Instructions for the content of this Proposal (e.g., Title, Problem Statement, Justification and Significance, Methodology, Resource Requirements and Literature Search), and its oral defense, must be followed, including the 15-page limit.

- https://www.acs.psu.edu/assets/docs/Thesis_Proposal_Requirements_rev4.pdf

Once a student has passed both parts of the comprehensive examination, the doctoral program must be completed within six years or a second comprehensive examination is required. After passing the comprehensive examination, a student usually registers for the noncredit course ACS 601 (Thesis Preparation, full time) or ACS 611 (Thesis Preparation, part-time). Under University rules, students registered in ACS 601 may also take 3 credits (maximum) of course work for audit at no additional fee while students registered in ACS 601 may take 3 credits (maximum) of course work for credit by paying an additional flat fee.

Continuous Registration

All students who have passed their comprehensive exam and who have satisfied the two-semester full-time residence requirement must register each fall and spring semester until graduation, with one exception. Summer session registration is required if either the Comprehensive or Final Oral Exam is taken after the first six-week summer session has begun. However, summer session registration is not required if the Final Oral Exam is taken prior to the first day of classes for the first six-week summer session. Also, a student must be registered in the semester that the Candidacy Exam is taken.

If, for compelling reasons, a Ph.D. student will not be in residence for an extended period then the senior associate dean of the Graduate School will consider a petition for a waiver of the continuous registration requirement. This petition must come from the doctoral committee chairperson and must carry the endorsement of the Program Chair.

Written Dissertation and Final Oral Exam

All Ph.D. candidates must write a dissertation. The topic of the study must be original and must be developed in large part by the student. Thus, the purpose of writing the dissertation is for the student to demonstrate the ability to pose a new relevant problem, conduct the necessary research, and summarize the results in a well-organized written form. The dissertation should be completed within three to four years after a student has been admitted to Ph.D. candidacy. Further information on the required format of the dissertation can be obtained from the Thesis Guide published by the Graduate School.

Once completed in manuscript form and approved by the research advisor, the dissertation is given to the student's Doctoral Committee whose members read it and then administer a Final Oral Exam, or Defense. A clean draft copy of the thesis should be provided to the student's Doctoral Committee at least 2 weeks prior to the oral exam (defense). This final oral exam (defense) is scheduled by the Graduate School in the same way that the Comprehensive Exam was scheduled; as with the other exams, the student must be registered, and the current tuition bill must have been paid in order to take the exam. The Program Office should be notified at least **two weeks prior** to the scheduled dissertation defense so that announcements of the defense can be circulated to faculty and students.

The final oral examination consists of an oral presentation of the dissertation by the student and a period of question and responses. This phase of the final oral exam is open to the public. Following the presentation and question and response phase, the public is excused, and the student meets with his or her doctoral committee. The committee members may continue the questioning. Although the questions should relate in large part to the dissertation, they may cover the student's whole program of study, since one of the purposes of the examination is to assess the general scholarly attainments of the student. The committee decides whether a student passes the exam; as with the Comprehensive Exam, at least two-thirds of the committee must vote in favor of passing the student for the student to have passed the exam.

When the final oral examination has been passed and the dissertation accepted (after incorporating the changes made by the committee), it should be submitted in final form to the Graduate School (see the Thesis Guide, which can be obtained from the Graduate School Thesis Office). The unbound master copy of the thesis is required by the Graduate School and one (1) bound copy is to be presented to the Acoustics Program Office. An additional bound copy may be required by the thesis advisor. Traditionally, committee members are presented with bound copies as well. The costs of dissertation preparation, copying, and binding are the responsibilities of the student.

Time to Completion for Ph.D.

Penn State's Graduate School allows 8 years after successful completion of the qualifying exam for completion of a doctoral degree. The Acoustics Program anticipates a student will complete the doctoral degree in approximately 3 years beyond the completion of a master's degree, or 5 years without a master's degree.

Section 5
Resources for Graduate Students

IMPORTANT LINKS

Very important link to read thoroughly: http://gradschool.psu.edu/current-students/

Affirmative Action Office

This office is committed to ensuring the University maintains an environment free of harassment and discrimination. https://affirmativeaction.psu.edu/

Career Services

Their office is located in the MBNA Career Services Building, is fully equipped to assist graduate students in the preparation of resumes and curriculum vitae and in developing effective interviewing skills. Career Services hosts a career fair that is open to graduate as well as undergraduate students.

https://studentaffairs.psu.edu/career

Code of Conduct

Available at from The Office of Student Conduct https://studentaffairs.psu.edu/conduct/codeofconduct/

Counseling and Psychological Services (CAPS)

CAPS can help students resolve personal concerns that may interfere with their academic progress, social development, and satisfaction at Penn State. Some of the more common concerns include difficulty with friends, roommates, or family members; depression and anxiety; sexual identity; lack of motivation or difficulty relaxing, concentrating or studying; eating disorders; sexual assault and sexual abuse recovery; and uncertainties about personal values and beliefs.

https://studentaffairs.psu.edu/counseling

The Office for Disability Services

Provides information and assistance to students with disabilities.

http://equity.psu.edu/student-disability-resources/

Graduate & Professional Student Association (GPSA) "Guide to Graduate Life"

GPSA https://gpsa.psu.edu/ is the representative body for all graduate and professional students. The GPSA addresses issues of concern to graduate students and elect's members to sit on shared-governance bodies of the University. The GPSA also organizes social events for graduate students. In 2014, the organization that was then the Graduate Student Association, produced an extremely useful booklet titled "**The Guide to Graduate Life**". Although outdated, this booklet still contains a lot of extremely useful information. http://gpsa.psu.edu/wpcontent/uploads/sites/12283/2014/05/guide2gradlife.pdf

Graduate Degree Programs Bulletin

The Graduate Degree Programs Bulletin https://bulletins.psu.edu/graduate/ is Penn State's comprehensive source for graduate academic information and program requirements.

HUB- Robeson Center

The HUB- Robeson Student Center is the site for multiple student services including restaurants, a copy center, a bank (Penn State Federal Credit Union), STA Travel, a convenience store, the Penn State Bookstore, the Center for Arts and Crafts, art galleries, and the main information desk for the University.

Health Care for Graduate Students

Penn State students are eligible to purchase a student health insurance plan. All graduate students taking one or more credits are eligible to purchase the plan. Visit the **Student Affairs University Health Services** webpage to learn more.

The Office of Human Resources

Provides resource booklets on child care facilities in the State College area and summer programs and camps for school-age children.

https://hr.psu.edu/employee-and-family-resources/your-family/child-care-resources/

International Student Services

This office will answer questions and needs that are unique to international students. The office is located at 410 Boucke Building. https://global.psu.edu/

Lions Pantry

Provides sustenance to Penn State students experiencing food insecurity.

https://thelionspantry.psu.edu/

Living in State College

Helpful information for living in State College:

Downtown State College: https://www.visitpennstate.org/
Central PA Convention & Visitors Bureau: https://www.downtownstatecollege.com/

Penn State Police Escort Service

This service is operated under the auspices of Police Services and will provide an escort for students walking on campus after dark. The escort service may be reached at 814-865-WALK (9255).

https://police.psu.edu/safe-walk-service

Off Campus Housing

Housing opportunities are listed in 213 HUB-Robeson Center. https://studentaffairs.psu.edu/offcampus

The Office of Student Aid

This is a good place to begin the search for financial assistance. https://studentaid.psu.edu/

Office of Student Conduct

This office is responsible for dealing with violations of the Code of Conduct including sexual assault, harassing, stalking, and physical assault. https://studentaffairs.psu.edu/conduct

Pasquerilla Spiritual Center

Home to more than fifty spiritual organizations, the center is non-denominational and provides students with opportunities to explore ethical and spiritual issues. https://studentaffairs.psu.edu/spiritual

Problem Resolution

Graduate students occasionally have difficulties with their advisors, their programs or an academic matter associated with their programs. The first step in problem resolution is always to talk with your advisor and then with the program chair or department head and then the associate dean of your college. If satisfactory resolution remains elusive, the associate dean of the Graduate School is available to provide guidance and maintain neutrality. Issues discussed during meetings with the associate dean will remain confidential if requested by the student. Appointments may be made by calling 814-865-2516.

Research Protections

This office that oversees all research on human participants, animals, radioisotopes and biohazardous materials. You must have permission from this office prior to conducting research involving any of these subjects. Permission cannot be obtained after the work has begun. https://www.research.psu.edu/orp

Student Life/Resources

A comprehensive list of links provided by The Graduate School. Topics include general information for the current graduate student and the graduate assistant; professional development opportunities; research; and curriculum.

Thesis Information

The University guide for preparing your thesis, submission form, calendar for submission, and other pertinent information and forms can be found here.

http://gradschool.psu.edu/current-students/etd/

University Libraries

Search the University Libraries online for books, articles, databases, resources by subject, reference materials, etc. https://libraries.psu.edu/

The Graduate Writing Center

The center is sponsored by the Graduate School and provides assistance to graduate students who wish to enhance their writing skills. Graduate students are invited to schedule appointments for one-on-one discussions of their writing projects. https://gwc.psu.edu/

Section 6
General Graduate Student Policies

Graduate Student Policies

The following are up-to-date policies and procedures that affect students of the Penn State Graduate School. Additional policies are located in Graduate Education Policies.
Further information on all of the topics below may be found: http://gradschool.psu.edu/current-students/student/

Conduct and Integrity

- GCAC-801 Conduct
- General Standards of Professional Ethics (AD47)
- Academic Integrity Policy (49-20)
- Academic Integrity (G-9)
- Discrimination, Harassment, Sexual Harassment, and Related Inappropriate Conduct (AD85)
- Statement on Intolerance (AD29)
- Addressing Allegations of Research Misconduct (RP02)

Grading

- Basis for Grades (47-20)
- Grade Mediation and Adjudication (G-10)
- GCAC-803 Procedures for Termination of the Degree Program of a Graduate Student for Unsatisfactory Scholarship

Graduate Assistants

- Graduate Assistants (PR06)
- Guidelines for Graduate Assistant Paid Leaves
- GCAC-804 Procedures for Termination of Assistantships Due to Inadequate Performance
- GCAC-902 Student Instructional Assistants in Graduate (500- and 800-Level) Courses
- Graduate Student Instructional Assistant (GSIA) Conflict of Interest (COI) Disclosure Form (PDF)
- Graduate Assistantships for Students in Joint Degree Programs
- Summer Graduate Lecturer/Researcher

Intellectual Property

- Ownership and Management of Intellectual Property (IP01)
- Co-authorship of Scholarly Reports, Papers and Publications (IP02)

Privacy/Confidentiality

- University Policy on Confidentiality of Student Records (AD11)
- Privacy Statement (AD53)

Residency

- Residency Classification for Tuition Purposes
- GCAC-601 Residency Requirement - Research Doctorate
- GCAC-700-A Residency Requirement - Professional Doctoral Degrees

Other Topics

- Course Drop Policy (34-89)
- GSAD-920 Graduate Student Policy for International Travel
- Recommended Practices in Graduate Education
- GCAC-802 Procedures for Resolution of Problems
- World Campus Course Registration for Graduate Assistants, Graduate Fellows, and Graduate Trainees and STAP Recipients

Additional Policies May Be Found from The Following Sources

- Graduate Faculty Policies
- Graduate Education Policies
- Office of the Vice President for Research at Penn State
- University Policy Manual (GURU)
- University Faculty Senate Policies
- Academic Administrative Policies and Procedures

Academic Status

A graduate student is expected to maintain at least a 3.00 cumulative grade point average while pursuing a graduate degree. A student will be placed on departmental academic probation at the beginning of the first semester after his or her cumulative grade point average falls below 3.00 and will remain on probation until the cumulative grade point average rises above 3.00. If the student's semester grade average for any subsequent semester while the student is on probation is below 3.00, then the student will be dropped from the degree program. A student dropped from degree program status because of a deficient GPA can continue to complete graduate course work as a non-degree student. Upon earning a GPA of 3.0 or better, the student can apply for admission to the degree program.

Reappointment of a student as a research assistant when the student is on academic probation will be reviewed carefully by the student's advisor, the Graduate Program Officer, and the Program Chair.

If a student is on academic probation, he or she must see his or her advisor and the Graduate Program Officer for the Graduate Program in Acoustics at the beginning of the semester and reassess the choices of the courses that are to be taken that semester. The Graduate Program Officer is authorized by the Program to require the student to take various remedial courses in conjunction with or before enrolling in specified courses administered by the Program.

If a student should be dropped from the program, it may be possible for a student to enroll as a non-degree student and take selected courses to better prepare for graduate work and then to apply for admission.

Academic Advisors

The academic advisor, in conjunction with the thesis or doctoral committee, is the primary source of guidance for the student's progress through his or her course work, research, and writing of the thesis, paper, or dissertation.

Advisors to students in the Graduate Program in Acoustics are appointed by the Program Chair from among the Program's faculty. Faculty supervising incoming students working on sponsored research programs will normally serve as the academic advisor to such students. It is the responsibility of each student to provide the Acoustics Program with a statement of interests or areas in which the student desires to focus his or her academic work. The Program will in turn provide the students with a list of faculty whose interests or work coincide with that of the student. The student should then schedule a meeting with each faculty member to discuss the potential of establishing an advisor/advisee relationship. Once a student and a faculty member have agreed to work together, the Program Chair should be consulted, and the appointment made. The Graduate Program Officer will serve as a temporary advisor for incoming students who, by the first day of the semester, do not yet have an advisor.

From time to time, the student and advisor relationship may experience discord; however, such periods are to be expected and should be resolvable. In rare cases the advisor and student relationship is not mutually successful and the discord appears to be irresolvable. In such cases, the Program Chair should be consulted. The Program Chair will then decide whether a termination of the relationship is appropriate. It is the responsibility of the student to identify a new faculty member willing to assume the role of advisor. Once the student and the new faculty member have agreed to work together, the Program Chair should be consulted, and the appointment made.

Course Credit Load

Full-time students and students receiving fellowships should register for 12-15 credits per semester. All students (US and International) receiving assistantships should register as follows: Category Credits 1/4-time Assistantship 9-14 1/2-time Assistantship 9-12 3/4-time Assistantship 6-8 Students may apply to the Graduate School for one credit beyond this limit, provided they have the approval of their advisor, work supervisor and the Head of the Department. International students with student visas must maintain full-time academic status as determined by their type of assistantship or must be registered for at least 9 credits if not supported by an assistantship during both the Fall and the Spring semesters.

Full-Time Academic Status--Self-supported or fellowship students who register for at least 9 credits are considered to be engaged in full-time academic work for that semester. If such a student wishes to register for more than 15 credits, an exception to the normal maximum load must be granted through petition (with advisor's approval) to the Office of Graduate Enrollment Services. Students holding fellowships, traineeships, or other awards that require full-time summer registration should register for a minimum cumulative total of 9 credits (over all summer sessions), or SUBJ 601 (in the case of post-comprehensive doctoral candidates). A graduate assistant whose semester or summer session credit load meets or exceeds the minima in the above credit table and whose assistantship duties are directly related to his or her degree objectives is considered by the Graduate School to be engaged in full-time academic work for that semester or summer. A post-comprehensive doctoral candidate who is registered for SUBJ 601 also is so considered.

Part-Time Academic Status--A student who in any semester or summer session is registered for study but who does not meet the criteria for full-time status is considered to be engaged in parttime academic work for that semester. This includes students registered for SUBJ 611.

Credit Loads for International Students--The Department of Homeland Security requires that international students proceed in a timely fashion toward completion of their degrees, as established by the academic department and (usually) stated on their initial immigration document. Failure to maintain normal progress toward completion of the degree during this period will jeopardize the student's ability to continue academic study, adjust status, or seek future employment in the United States. Because of this, students should not be enrolled less than full-time during fall or spring semester without prior approval of the University Office of Global Programs Directorate of International Student & Scholar Advising (DISSA). The U.S. Department of Homeland Security requires the DISSA to report violations of status, including failure to maintain full-time enrollment. The following is intended to provide guidance for international graduate students and for DISSA in determining full-time status: A graduate student is considered full-time if registered for a minimum of 9 credits, excluding courses taken for audit, or if a Ph.D. candidate who has successfully completed the comprehensive examination and is registered for SUBJ 601. • On rare occasions, and under exceptional circumstances, international students in master's degree programs who have completed all required course work and, if applicable, research for their degree, may be granted an exception to the need to maintain full-time status as defined above, for a limited period (in no case to exceed two semesters), by special petition to DISSA in advance of the semester in which the exception is needed. This request must be initiated by the student using the DISSA eForm system. The academic advisor will be asked through this eForm system to justify the reduced course load. • Under all circumstances, international students must be enrolled--either full-time or approved by DISSA for a reduced course load.

Grades

A +/- grading system is used in both graduate and undergraduate level courses. Grades with plus and minus include, A 4.0; A-, 3.67; B+, 3.33; B, 3.0; B-, 2.67; C+, 2.33. A minimum grade-point average of 3.00 for work done at the University is required for all graduate degrees.

Scholarship and Research Integrity: SARI @ PSU

SARI @ PSU is a responsible conduct of research (RCR) education program for students, postdocs, and faculty at Penn State. SARI (Scholarship and Research Integrity) is designed to create an awareness of ethical principles and established professional norms in the performance of all activities related to scholarship and research. Ultimately, our goal is to further foster trust among scientists and to increase the public's support for research. Penn State requires RCR training for all graduate students, post-docs, and new faculty to ensure the ethical conduct of research at the University.

There are two parts to SARI @ PSU for graduate students: an online course offered through the Collaborative Institutional Training Initiative (CITI Program) and a minimum of five hours of discussion-based activities. Each graduate department or program has a specific SARI @ PSU plan.
Satisfying the Part 1 Requirement.

The CITI Program at Penn State website provides more information about the program, including instructions, FAQs, and access to the Responsible Conduct of Research (RCR) online training that is used to satisfy the Part 1 requirement.

In order to Satisfy the Part 2 Requirement, graduate students must also complete at least five hours of discussion-based activities. The Graduate Program in Acoustics offers 2 hours during Orientation, 2 Hours during ACS 590 Colloquium class, which is a requirement for every resident student. and 1 hour of individual studies. Students may also attend up to two (2) workshops sponsored by the Office for Research Protections (ORP), see the SARI Workshop Schedule for upcoming events.

Resources for Reporting Wrongdoing

A MESSAGE TO ALL FACULTY, STAFF AND STUDENTS ABOUT REPORTING WRONGDOING AND AVAILABLE RESOURCES (on behalf of the Office of the President 5/23/19)

All members of the Penn State community are asked to remain mindful of their individual commitment to Penn State's values by helping to keep the University a safe and ethical institution. In addition, as members of this community, everyone should be responsible stewards of University funds, whether generated from state, federal, student or other sources.

The University does not condone wrongful conduct by any member of the Penn State community, no matter what position he or she may hold.

Penn State University encourages the reporting of misconduct. **If you see something, say something.**

If you report misconduct, be assured that the University will protect you from retaliation.
See AD67 (https://policy.psu.edu/policies/ad67) or contact the Office of Ethics & Compliance(http://www.universityethics.psu.edu/) for more information.

The following resources are available for faculty, staff, students, and others:

TO MAKE A REPORT

See a summary of types of misconduct and how to report (http://reporting.psu.edu).

If at any point you are unsure where to report a non-emergency, you may contact:

- The Office of Ethics and Compliance, Monday-Friday, 8am-5pm ET: **814-867-5088**
- The Penn State Hotline, 24/7: **800-560-1637** or http://hotline.psu.edu

Crime or emergency situation

- Contact the campus police or security office
- In an emergency, dial **911**
- Penn State has established a Responsible Action Protocol, in response to the University Park Undergraduate Association's campaign for a medical amnesty policy. Effective January 2018, the Responsible Action Protocol was updated and now reflects the following:
- A student who acts responsibly by notifying the appropriate authorities (e.g. calling 911, alerting a resident assistant, contacting police) AND meets one or more of the following criteria typically will not face University conduct action for his or her own use or possession of alcohol or drugs. However, the student will be required to attend an approved alcohol or drug education program, such as BASICS or the Marijuana Intervention Program (MIP); the fee will be waived. When the student's behavior involves other Code of Conduct violations (e.g., vandalism, assault, furnishing to minors) the additional behavior may be subject to conduct action. If a student exhibits a pattern of problematic behavior with alcohol or drugs, that student may be subject to conduct action.
- The criteria which invoke the Protocol are:
- A student seeks medical assistance *for themselves* when experiencing an alcohol or drug overdose or related problems
- A student seeks medical assistance *for a peer* suffering from an alcohol or drug overdose or related problems and remains with the peer until appropriate authorities arrive

- A student suffering from an alcohol or drug overdose or related problems, *for whom another student seeks assistance* and remains with the peer until appropriate authorities arrive, will also not be subject to disciplinary action for alcohol violations.

Suspected ethical or policy violations
(including fraud, theft, conflict of interest, abusive or intimidating behavior, retaliation, athletics integrity or NCAA compliance)

- Report employee misconduct to your supervisor or HR Strategic Partner (http://ohr.psu.edu/content/hr-strategic-partner-and-consultant-directory)
- Report student misconduct to the Office of Student Conduct (http://studentaffairs.psu.edu/conduct) or **814-863-0342**
- Use Penn State Hotline (http://hotline.psu.edu) or **1-800-560-1637**. Both are anonymous and available 24/7

Child abuse, including child sexual abuse

- Contact the Pennsylvania Child Welfare Services "ChildLine" (https://www.compass.state.pa.us/cwis) – **800-932-0313**
- If the child is in immediate danger, dial **911** first
- You must also email AD72@psu.edu communicating that a report has been made. See more information on AD72 (Reporting Suspected Child Abuse) (https://policy.psu.edu/policies/ad72)
- Further details can be found in the Building a Safe Penn State: Reporting Child Abuse training available on the Learning Resource Network (http://lrn.psu.edu)

Behavioral threat

- Contact the Behavioral Threat Management Team (http://btmt.psu.edu/) – **855-863-BTMT (2868), or 814-863-BTMT (2868).**

Bias or discrimination

- To report behavior *by an employee*, Contact the Affirmative Action Office at **814-863-0471**
- To report behavior *by a student*, contact the Office of Student Conduct at **814-863-0342**
- Visit the Report Bias website (https://reportbias.psu.edu) (For student reporting only)

Hazing

- Contact the Office of Ethics and Compliance, Monday-Friday, 8 a.m.-5 p.m. ET: **814-867-5088** or email psoec@psu.edu
- Report online 24/7 via the Penn State Hotline: (http://hotline.psu.edu) or **800-560-1637**
- For concerns related to students and/or student organizations:
- Contact the Office of Student Conduct at **814-863-0342** or email StudentConduct@psu.edu
- Report online using the Incident Reporting Form(https://cm.maxient.com/reportingform.php?PennState&layout_id=0)
- For concerns related to employees:
- Contact Human Resources, Labor and Employee Relations at **814-867-0041**

Sexual harassment and other forms of sexual misconduct**

- **To make a report to the University:**
- Contact the University's Title IX Coordinator (titleix@psu.edu) or **814-867-0099**
- **To file an online report:** Visit the Office of Sexual Misconduct Prevention and Response's website (http://titleix.psu.edu/filing-a-report/) to file an online report
- **To file an anonymous report:** The Penn State Hotline (http://hotline.psu.edu) is available 24/7 – **800-560-1637**. Both are anonymous and available 24/7
- **To file a discrimination or harassment complaint outside of the University:**
- The Office for Civil Rights (Philadelphia Office) at **215-656-8541** or email OCR.Philadelphia@ed.gov
- The Equal Employment Opportunity Commission (Philadelphia District Office) at **800-669-4000**
- The Pennsylvania Human Relations Commission (Harrisburg Regional Office) at **717-787-9780**

**** Additional information regarding information and resources available in relation to incidents of sexual harassment and/or misconduct (including a campus-specific list of victim support services and confidential reporting options) can be found at the Office of Sexual Misconduct Prevention & Response (http://titleix.psu.edu/).**

Student Misconduct

- Contact The Office of Student Conduct (http://studentaffairs.psu.edu/conduct) – **814-863-0342** or report using the Incident Reporting Form(https://cm.maxient.com/reporting-form.php?PennState&layout_id=0)

Hazing by any student organization or individual is against Penn State's code of conduct, and also a violation of Pennsylvania law. To report instances of hazing within any student organization or group, including fraternities and sororities, contact the Office of Student Conduct(http://studentaffairs.psu.edu/conduct) – **814-863-0342**, or the Penn State Hotline (http://hotline.psu.edu) – **800-560-1637**.

Research-related

- Any research-related concerns should be directed to the Office for Research Protections (orp@psu.edu) –**814-865-1775**
- Research misconduct concerns should be directed to **814-865-1775** or researchconcerns@psu.edu

RESOURCES

- Policy AD88 – Code of Responsible Conduct (https://policy.psu.edu/policies/ad88)
- By-laws of The Pennsylvania State University (section 8.13)(http://news.psu.edu/story/143476/2013/01/04/employees-reminded-disclose-conflicts-interest)
- Policy HR91 – Conflict of Interest (https://policy.psu.edu/policies/hr91)
- Policy RP02 – Addressing Allegations of Research Misconduct (https://policy.psu.edu/policies/rp02)
- Policy RP06 – Disclosure and Management of Significant Financial Interests (https://policy.psu.edu/policies/rp06)

- Policy AD74 – Compliance With Clery Act (https://policy.psu.edu/policies/ad74)
- Policy AD77 – Engaging in Outside Professional Activities (Conflict of Commitment) (http://policy.psu.edu/policies/ad77)
- Policy AD85 – Sexual and/or Gender-Based Harassment and Misconduct (Including Sexual Harassment, Sexual Assault, Dating Violence, Domestic Violence, Stalking, and Related Inappropriate Conduct) (https://policy.psu.edu/policies/ad85)
- Policy AD86 – Acceptance of Gifts and Entertainment (https://policy.psu.edu/policies/ad86)
- Policy AD91 – Discrimination and Harassment and Related Inappropriate Conduct (https://policy.psu.edu/policies/ad91)
- Student Code of Conduct (https://studentaffairs.psu.edu/support-safety-conduct/student-conduct/code-conduct)

If it is not clear where to turn for assistance, any of these offices will guide you to someone who can help:

- Human Resources, Labor and Employee Relations at **814-867-0041**
- Office of Ethics and Compliance (http://www.universityethics.psu.edu/) at **814-867-5088**
- Office of Affirmative Action (http://www.psu.edu/dept/aaoffice/) – **814-863-0471**
- Title IX Coordinator (titleix@psu.edu) – **814-863-0471**
- Office of Student Conduct (http://studentaffairs.psu.edu/conduct) – **814-863-0342**
- Office of Internal Audit (http://www.internalaudit.psu.edu/) – **814-865-9596**
- Clery Act Compliance Manager (http://www.police.psu.edu/clery/) – **814-863-1273**
- Your campus, college, or unit's Human Resources Strategic Partner (http://ohr.psu.edu/content/hr-strategic-partner-and-consultant-directory)

TRAINING

Training for employees is available on many of the above topics through the Office of Human Resources' Learning Resource Network (http://lrn.psu.edu) and the Affirmative Action Office at **814-863-0471**.