Penn State University | GRADUATE
COLLEGE OF ENGINEERING | PROGRAM

AEROSPACE

The Aerospace Engineering graduate program offers course work and research projects in the following general areas of specialization:analytical / computational fluid dynamics, aeroacoustics, experimental fluid dynamics, flight science and vehicle dynamics, dynamics and control, rotorcraft engineering, structural dynamics/structures and materials, space propulsion, and turbomachinery. Areas within these specializations include flow instabilities and turbulence, advanced airfoil design, rotorcraft dynamics, spacecraft dynamics, advanced composite structures, smart structures, advanced electric propulsion concepts, and unpiloted air vehicles.

PENNSTATE

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RESEARCH AREAS

Analytical/Computational Fluid Dynamics

Fast algorithms; hypersonic flow; rarefied gas dynamics; algorithms for parallel computers; turbulence; hydrodynamic stability; aeroacoustics; computations of various turbomachinery flowfields.

Aeroacoustics

Computational aeroacoustics (CAA) applied to jet noise, fan inlet noise, acoustic liners, broadband airfoil noise, cavity noise, acoustic scattering, and cavity noise; semi-analytic predictions of jet noise; experimental studies of supersonic jet noise and centrifugal fan noise.

Computer and Software Systems

Robotics; object oriented programming; embedded computers; parallel computers; virtual reality; unmanned air vehicles; autonomous flight; wireless networks.

Experimental Fluid Dynamics

Turbulence structure in supersonic shear layers and in swirling flows; development of turbulent vertical structures in boundary layers; hydrodynamic instabilities and turbulence; hydroacoustics of boundary layer transitions; aeroacoustics of subsonic and supersonic jets, 2D airfoil characterization.

Flight Science and Vehicle Dynamics

Analytical, computational and experimental programs in various areas including aircraft design, performance, stability and control; airfoil design and analysis; low Reynolds number aerodynamics; wing-body aerodynamics; subsonic/hypersonic aerodynamics; aircraft operation; advanced concepts in V/STOL rotor control; propeller/stator interactions; unmanned air vehicles, aerial robotics, rotorcraft aeromechanics.

Spacecraft Dynamics and Control

Spacecraft dynamics and control; astrodynamics; use of generalized perturbation methods for various problems of orbital motion, dynamics and control of multibody and flexible spacecraft; analysis of control maneuvers of flexible space vehicles; trajectory optimization; high accuracy orbit determination; space environments; spacecraft and mission design.

Rotorcraft Engineering

Active control of rotor and drivetrain vibration and stability; modeling and characterization of elastomeric materials for dampers and bearings; dynamics of aeroelastically tailored helicopter and tiltrotor blades; computational aeroacoustics and aeroelasticity of rotors using parallel computers; dissimilar rotor systems for reduced vibration and noise; bearingless rotor optimization; rotorcraft health and usage monitoring; fan-in-fin computations; rotorcraft CFD.

Structural Dynamics/Structures and Materials

Structural dynamics; aeroelasticity; fatigue; advanced composite structures; passive vibration control and damping; damped composite structures; dynamic characterization of materials and structures; material damping models; active and semi-active vibration control; adaptive structures; piezoelectric transducers; elastomeric components; tunable transducers; shunted piezoelectrics and energy harvesting; damage modeling; health monitoring; dynamics of aerospace vehicles and structures; system impacts of materials.

Space Propulsion

Rocket propulsion; instabilities in solid and liquid propellant combustion; microwave-heated advanced propulsion concepts; microwave plasma enhanced combustion.

Turbomachinery and Air Breathing Propulsion

Aerotheromodynamics of turbomachinery; convective heat transfer; short duration wind tunnel techniques and fast response instrumentation; turbulent flow; turbulence modeling; computations and measurements of three-dimensional turbulent flow in compressors and turbine rotors; aeroacoustics of turbomachinery.

FACILITIES

Computational

16-rack, by 40-node cluster computing facility. IBM RS6000 SP parallel computer with 301 processors; several large Beowulf PC clusters with more tha n 1000 high-speed processors in total; Linux and Unix workstations; variety of computer labs and software; and access to NSF, NASA, and AF supercomputers.
Several visualization and simulations facilities are also available, including a Fakespace Rave virtual reality facility and high definition plasma screen facilities. There are also flight simulators available for both rotorcraft and fixed-wing aircraft.

Wind Tunnels

- Low-turbulence subsonic wind tunnel with six-component strain gauge balance (3.25 x 5 foot test section)
- Low-turbulence instructional subsonic wind tunnel (3 x 2 foot test section)
- Supersonic wind tunnel (6 x 6 inch test section)
- Supersonic free shear layer facility (2 x 5 inch test section)
- Convective heat transfer tunnel with real-time color image processing
- Compressed air flow facility (300 psi reservoir)
- Several probe calibration jets

Water Channels

- Laminar flow water channel (1.5 x 25 foot test section)
- Garfield Thomas Water Tunnel (at ARL; 4 foot test section)

Aeroacoustics

- Small anechoic jet noise facility
- Anechoic chamber
- Reverberant room

Structures Research Lab

- High temperature bi-axial tension/torsion testing facility
- Laser vibrometer for modal vibration tests
- Ultrasonic inspection system
- Hydraulic material testing machine

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Composite Materials Lab

- Autoclave (3 foot diameter x 7 foot length)
- Computer-controlled filament winding machine
- Pultrusion machine
- Braiding machine for composite materials manufacturing
- Hot Presses
- Axial Flow turbine
- Multi-stage compressor facility
- Linear turbine cascade facility

Space Propulsion

- High vacuum tank facility for low-density flow

Other Experimental Facilities

- Several laser Doppler anemometers including a subminiature semiconductor model
- Particle image velocimeter system (planar and stereoscopic)
- ATC/510G flight simulator
- Thermal analysis system
- Acoustic emission system
- Reflection polariscope used in material fabrication and characterization
- Helicopter rotor test system for aeromechanics research

DEGREES OFFERED

M.Eng., M.S., and Ph.D. in Aerospace Engineering

The M.Eng. degree (30 credits, no thesis) emphasizes breadth of knowledge in aerospace engineering at the graduate level and requires 27 credits of course work, a 2-credit project (including a literature review and some engineering analysis or experiment) reported in a scholarly paper, and a 1-credit graduate seminar. With an emphasis on research, the M.S. degree (30 credits, including thesis) requires 24 credits of course work and 6 credits of original research leading to the completion of a thesis.

STATISTICS

Number of Regular Faculty: 14
Graduates 2007-08: M.Eng., 2; M.S., 20; Ph.D., 5

THE FACULTY AND THEIR RESEARCH

Kenneth S. Brentner, professor, Ph.D. (Cambridge). Helicopter acoustics, rotor source noise prediction, computational aeroacoustics, computational fluid dynamics, aerodynamics, airframe noise, wind turbine noise prediction. (ksbrentner@psu.edu).

Cengiz Camci, professor, Ph.D. (Von Karman Institute, Belgium). Aerothermodynamics of turbomachinery, convective heat transfer; short duration wind tunnel techniques, finite element techniques for flow and heat transfer calculations, L.D.A., liquid crystal imaging for heat transfer studies. (c-camci@psu.edu).

Stephen C. Conlon, assistant professor, Ph.D. (Penn State). Structural qualification for vibro-acoustic environments, statistical energy analysis (SEA), power flow in structures, and health monitoring. (scc135@psu.edu).

Farhan Gandhi, professor, Ph.D. (Maryland). Computational structural mechanics, structural dynamics, viscoelasticity and damping, smart structures, helicopter dynamics and aeroelasticity, advanced bearingless rotor systems. (fgandhi@psu.edu).

Joseph F. Horn, associate professor, Ph.D. (Georgia Tech). Aircraft flight dynamics and control, automatic flight control system design for rotorcraft, simulation and modeling of rotorcraft, rotorcraft handling qualities, nonlinear adaptive control, control system design for envelope limit avoidance. (joehorn@psu.edu).

Robert F. Kunz, affiliate associate professor, Ph.D. (Penn State). Computational fluid dynamics, multiphase flows, turbomachinery. (rfk102@psu.edu).

Jacob Langelaan, assistant professor, Ph.D. (Stanford). Sensor fusion and estimation, control and path planning for autonomous vehicles and robots. Autonomous mobility in cluttered terrain. Cooperative estimation by teams of autonomous robots or distributed sensor networks. (jlangelaan@psu.edu).

George A. Lesieutre, professor and department head; associate director, Center for Acoustics and Vibration, Ph.D. (California, Los Angeles). Structural dynamics and vibration damping; composite structures, piezoceramic actuation, structural control, health monitoring. (g-lesieutre@psu.edu).

Deborah A. Levin, professor, Ph.D. (Caltech). Modeling of chemically reacting flows, hypersonic and supersonic flows, thermochemical nonequilibrium effects, direct simulation Monte Carlo omputer modeling, modeling of optical radiation and comparison with space flight experiments. (dalevin@psu.edu).

Lyle N. Long, distinguished professor; director, Institute for High Performance Computing Applications; co-director, Rotorcraft Center of Excellence, D.Sc. (George Washington). Computational fluid dynamics and hypersonics, massively parallel processing, computational aeroacoustics, and molecular dynamics (lnl@psu.edu).

Mark D. Maughmer, professor, Ph.D. (Illinois). Analytical, computational and experimental aerodynamics, aircraft design, performance, stability and control, airfoil design and analysis, low Reynolds number aerodynamics. (mdm@psu.edu).

Barnes W. McCormick, Boeing Professor Emeritus, Ph.D., P.E. (Penn State). Subsonic aerodynamics; advanced concepts in V/STOL, flight mechanics, and wake turbulence. (bwmaer@engr.psu.edu).

Dennis K. McLaughlin, professor, Ph.D. (MIT). Experimental fluid dynamics and aeroacoustics, turbulent structure in supersonic shear layers, aerodynamics and aeroacoustics of supersonic free jets and centrifugal turbomachinery. (dkmaer@engr.psu.edu).

Robert G. Melton, professor and director of undergraduate studies, Ph.D. (Virginia). Astrodynamics, spacecraft dynamics and control; trajectory optimization, perturbation analysis of low-thrust orbital motion, orbit determination, dynamics and control of multi-body spacecraft. (rgmelton@psu.edu).

Michael M. Micci, professor and graduate officer, Ph.D. (Princeton). Experimental and analytical rocket propulsion, rocket motor instabilities, advanced propulsion concepts, optical diagnostics of nozzle flows. (micci@psu.edu).

Philip J. Morris, Boeing/A.D. Welliver Professor of Aerospace Engineering, Ph.D. (Southampton). Computational and analytical fluid dynamics, hydrodynamic stability, computational aeroacoustics, turbulence modeling, aerodynamics and acoustics of jets, boundary layer stability. (pjm@psu.edu).

Edward C. Smith, professor; director, Rotorcraft Center of Excellence, Ph.D. (Maryland). Composite structures, rotorcraft dynamics; aeroelastic and aeromechanical tailoring of composite rotor blades, composite beam modeling, elastomeric materials, shipboard helicopter dynamics, rotor system health monitoring. (ecs@rcoe.psu.edu).

David B. Spencer, associate professor and director of graduate programs, College of Engineering. Ph.D. (Colorado). Astrodynamics, high accuracy orbit determination, space debris research, spacecraft trajectory optimization, spacecraft dynamics and control, space systems engineering. (dbs9@psu.edu)