NEW GRADUATE STUDENT ORIENTATION

Aerospace Engineering and Engineering Mechanics (ASE/EM)

Fall 2016
Prof. Shaaban Abdallah
Director of Graduate Studies
August 2016
Agenda

- People
- Procedures
- Financial Aid
- Registration
- MS Program Requirements
- PhD Requirements and Qualifying Exam
- Faculty
People

Department Head - Prof. Paul Orkwis

Director of Graduate Studies

Prof. Shaaban Abdallah
Director of Graduate Studies
721 Rhodes Hall
556-3321
Shaaban.Abdallah@uc.edu

Suggest stopping by his office rather than email.

CEAS

Ms. Julie Muenchen
Graduate Coordinator for Engineering
CEAS Office of Graduate Studies
665 Baldwin Hall
556-0635
Julie.Muenchen@uc.edu

ASE/EM

Ms. Shelly Tipton
ASE/EM Administrator
745 Baldwin Hall
556-3548
Shelly.tipton@uc.edu
Definitions

- **GA = Graduate Assistant**: Department support, Department teaching or grading assignment (expect e-mail on assignments by 2\textsuperscript{nd} week) and research assignment
- **RA = Research Assistant**: Grant-based support that involves a research assignment from a professor
- **GA and RA must** fill out and turn in (to Department) **report every semester** of their activities to maintain aid
  - Must be signed by both departmental supervisor and research supervisor (may be the same professor)
  - Ms. Tipton will send reminders near end of each semester
Notes for All Students

- **Grad student mailboxes** are in 745 Baldwin
- **Email/internet access** – Establish account at Office of College Computing (OCC), 636 ERC. Notify Ms. Muenchen and Ms. Tipton of your e-mail address and sign up on-line for listserv.
- **Desks** assigned to GA/RA only. Assignments will be e-mailed ASAP. Obtain office key via Ms. Tipton.
- **Program of Study** – Develop with advisor. Turn in first one by December 1 – Forms & degree requirements are on-line. Update as required. (Probably frequently! Annually at a minimum.).
- **Permanent Advisor** – Talk to faculty and choose as soon as you can. Notify Ms. Tipton and Ms. Muenchen by submitting form.
- **Complete** tax forms on-line if on Assistantship support (now or later). Help: Ms. Leva Wilson (ASE/EM Bus. Mgr), 745A Baldwin, 556-9101.
Note on Choosing Advisor

• Graduate Director will be your temporary advisor until you select your permanent advisor

• Choice of “permanent” advisor is up to the student, but…
  – RA support is tied directly to professor’s research grant, hence changing advisors means you lose that support
  – GA support is not tied to an advisor unless it is supplemented (example: ½ and ½ GA/RA)

• Suggestion: Talk to the faculty in your interest area, find the research you want to do, and be honest about your interests with all involved.

• Check School and faculty websites for a quick idea of faculty activity … but be aware that some are notoriously out of date! Talking to them is better!
International Students

- **Check in** first with the UC International Services Office (One Edwards Center, room 3134)
- **Sign in** with Ms. Muenchen in 665 Baldwin Hall
  - Submit final transcript listing your degree.
  - **Notify** Ms. Muenchen of your social security and student ID numbers (**update** if they change).
- **Take** Oral English Proficiency Test (OEPT). Must take 2 times per year until passed. Courses in English as a Second Language are offered by UC International.
  - Pass of OEPT **required** to work as lab GA or teach recitation
Financial Aid (cont’d)

• See Ms. Wilson or Ms. Tipton to begin assistantship payment and for help with any problems – all GA/RA pay issues are handled at the Department level.
  – Note: UGS (tuition waiver) issues are handled at the College level with Ms. Muenchen
• Paychecks can be directly deposited (sign up) or paper check by snail mail to local addresses on pay-days, starting mid to late Sept.
• Financial aid for next year must be requested in February even for those with multi-year appt’s. E-mail reminders will be sent in January.
• Annual Review must be turned in by March for any financial aid consideration (GA/RA/UGS) next year. Forms will be e-mailed mid-Spring semester.
Financial Aid (cont’d)

• Most students receive UGS tuition scholarship.
  – Does not include student fees/health insurance/ITIE fees
  – Requires $2,200 payment per semester from student
  – Comes from School allocation of real funds, i.e., it is a limited resource, so:
    • Available a MAXIMUM of 3 semesters for MS
    • Available a MAXIMUM of 4 semesters for Ph.D. with MS
    • Available a MAXIMUM of 7 semesters for Ph.D.
  – Must maintain full-time student status
  – Will be suspended if student is not following Program of Study (or none submitted) or is deficient in GPA or does not submit report (GA/RA) of annual reviews.
Financial Aid (cont’d)

• Department GA support
  – Mostly for 1st year students, sometimes 2nd year
  – Minimum $ 850.00/bi-weekly, only a few in Summer semester
  – Department commitment of about 16-18 hours per week
  – Research commitment of 2 - 4 hours per week

• Research assistantship (RA) support
  – Grant-based research, 20 hrs/wk, professor supervises
  – Typically 12-month appointments (depends on grant)
  – Stipend varies (minimum $ 850.00/bi-weekly through each semester depending on grant specs)

• ½ and ½ support
  – Mix of School and research commitment
Financial Aid (cont’d)

• Maintaining Support
  – All MS students receiving aid must do MS thesis
  – GPA > 3.0 at all times
  – Make progress in your research and reliably perform your Department duties
  – File semester progress reports and annual report on time with signatures!
  – Request aid for next year in February by deadline
  – Keep your Program of Study up to date!
Registration

- Must register for **at least 15 credits each semester** (except Summer) to be a full-time student.
- Must register for **at least 1 credit every semester** (except Summer) – College rule.
- EGFD courses offered by AsE and MINE **count as AsE courses** (do NOT count as “outside School”).
- Course requirements are on Department website.
- Meet with your advisor before registering!!!
  - Fill out a first-cut Program of Study at this time.
- Audit/UG/ESL courses do **not** count toward degree.
  - UG/ESL **do** count toward registration requirement
  - Audit classes do not count toward anything.
Example Course Loads

**Typical Full-Time Student (non GA or TA)**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>4 academic classes*</td>
<td>12 cr</td>
</tr>
<tr>
<td>Research (under advisor)</td>
<td>2 - 6 cr</td>
</tr>
<tr>
<td>School Seminar</td>
<td>1 cr</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15 - 18 credits</strong></td>
</tr>
</tbody>
</table>

*May include ESL or UG classes

Talk with your advisor to define a program that is right for you!

Only a certain number of research credits can be used.
General Degree Requirements

- See Department website for course requirements for each major area (Fluids/Propulsion, Solids/Structures, Dynamics & Control)
- Technical Electives
  - AsE/EM classes – automatic approval
  - Other areas – Need Graduate Committee permission (by petition)
- Out-of-Department credits (other than Math) are limited:
  - 6 for MS, 9 beyond MS or 15 maximum for PhD
  - EGFD credits are inside Department
- Graduation
  - Degree requests MUST be submitted on-line at beginning of graduating semester by the deadline, else no degree that semester
  - Register for at least 1 credit in year of graduation
  - Complete revised final Plan of Study in last semester
  - Complete thesis/mini-thesis requirements (defense, document, signatures)
Master of Science in Aerospace Engineering
Any Major Area

<table>
<thead>
<tr>
<th></th>
<th>Thesis</th>
<th>Non-Thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Option</td>
<td>9 cr. hrs.</td>
<td>12 cr. hrs.</td>
</tr>
<tr>
<td>Mathematics</td>
<td>3 cr. hrs.</td>
<td>6 cr. hrs.</td>
</tr>
<tr>
<td>Technical Electives</td>
<td>6 cr. hrs.</td>
<td>9 cr. hrs.</td>
</tr>
<tr>
<td>M. S. Thesis Research</td>
<td>12 cr. hrs.</td>
<td>--N/A--</td>
</tr>
<tr>
<td>Mini-Thesis Research</td>
<td>--N/A--</td>
<td>3 cr. hrs.</td>
</tr>
<tr>
<td>AsE &amp; EM Graduate Seminar</td>
<td>2* cr. hrs.</td>
<td>2* cr. hrs.</td>
</tr>
<tr>
<td>Total</td>
<td>32 cr. hrs.</td>
<td>32 cr. hrs.</td>
</tr>
</tbody>
</table>

* indicates 2 credit hours
# Master of Science in Engineering Mechanics

## Any Major Area

<table>
<thead>
<tr>
<th></th>
<th>Thesis</th>
<th>Non-Thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamics &amp; Controls, Fluids &amp; Propulsion, and Structures &amp; Solids</td>
<td>9 cr. hrs., with at least 3 cr. hrs. in each area</td>
<td>12 cr. hrs., with at least 3 cr. hrs. in each area</td>
</tr>
<tr>
<td>Mathematics</td>
<td>3 cr. hrs.</td>
<td>6 cr. hrs.</td>
</tr>
<tr>
<td>Technical Electives</td>
<td>6 cr. hrs.</td>
<td>9 cr. hrs.</td>
</tr>
<tr>
<td>M. S. Thesis Research</td>
<td>12 cr. hrs.</td>
<td>--N/A--</td>
</tr>
<tr>
<td>Mini-Thesis Research</td>
<td>--N/A--</td>
<td>3 cr. hrs.</td>
</tr>
<tr>
<td>AsE &amp; EM Graduate Seminar</td>
<td>2* cr. hrs.</td>
<td>2* cr. hr.s</td>
</tr>
</tbody>
</table>

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<th>Thesis</th>
<th>Non-Thesis</th>
</tr>
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<tbody>
<tr>
<td>Total</td>
<td>32 cr. hrs.</td>
<td>32 cr. hrs.</td>
</tr>
</tbody>
</table>
Ph.D. Program Requirements – AE and EM Degree (semester credits)
Minimum course requirements

**beyond a bachelor’s degree**

**DOCTOR OF PHILOSOPHY IN AEROSPACE ENGINEERING**
**OR ENGINEERING MECHANICS AFTER B.S.**

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Option</td>
<td>18 cr. hrs.</td>
</tr>
<tr>
<td>with at least 9 cr. hrs. in 7000 level or above courses</td>
<td></td>
</tr>
<tr>
<td>Technical Electives</td>
<td>6 cr. hrs.</td>
</tr>
<tr>
<td>Mathematics</td>
<td>6 cr. hrs.</td>
</tr>
<tr>
<td>Ph.D. Research</td>
<td>58 cr. hrs.</td>
</tr>
<tr>
<td>with at least 48 cr. hrs. in Ph.D. Dissertation Research</td>
<td></td>
</tr>
<tr>
<td>Seminar</td>
<td>2 cr. hrs.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>90 cr. hrs.</strong></td>
</tr>
</tbody>
</table>
# DOCTOR OF PHILOSOPHY IN AEROSPACE ENGINEERING
OR ENGINEERING MECHANICS

**AFTER M.S.**

<table>
<thead>
<tr>
<th>Category</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Option</td>
<td>9 cr. hrs. with at least 6 cr. hrs. in 7000 level or above courses</td>
</tr>
<tr>
<td>Technical Electives</td>
<td>6 cr. hrs.</td>
</tr>
<tr>
<td>Mathematics</td>
<td>3 cr. hrs.</td>
</tr>
<tr>
<td>Ph.D. Research</td>
<td>46 cr. hrs. with at least 38 cr. hrs in Ph.D. Dissertation Research</td>
</tr>
<tr>
<td>Seminar</td>
<td>2 cr. hrs.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>66 cr. hrs.</td>
</tr>
</tbody>
</table>
Major Requirements

*Dynamics and Controls*

20-AEEM-6003  Analytical Dynamics
20-AEEM-6015  Modern Control
and a 3-credit-hour courses at the 6000 level or higher in the Dynamics & Controls area.

*Fluid Dynamics and Propulsion Systems*

(Three out of Four Listed Courses)
20-AEEM-6011  Combustion
20-AEEM-6041  Compressible Flow and Thermodynamics
20-AEEM-8030  Advanced Propulsion
20-EGFD- 7041  Viscous Flow and Heat Transfer

*Solids and Structural Mechanics*

20-AEEM-6001  Advanced Strength of Materials
20-AEEM-7052  Finite Element Method
and a 3-credit-hour courses at the 6000 level or higher in the Solids and Structural Mechanics area.
MS Specific Requirements (cont’d)

• Minimum Academic Performance
  – Dismissal if GPA < 3.0 (courses only, Pass/Fail for Research)

• Thesis Defense and Submission
  – Note early deadlines for approval (not just submission)
  – Forms from Ms. Muenchen for scheduling and passing oral defense
  – Signatures of all Committee members required
  – Submit thesis electronically to Office of Research and Advanced Studies

• Mini-Thesis Submission
  – Note early deadlines for approval (not just submission)
  – Forms from Ms. Muenchen – approval needed by 2 faculty members
  – College mini-thesis requirements are on College website
PhD Specific Requirements

- 90 credits beyond BS or 66 past MS
- 2 credits School Seminar (can be from MS studies)
- Residence requirement – 10 or more graduate credits for 2 out of 4 consecutive semesters (University rule) with 12 credits in fall semester
- Forms from Office of Research and Adv. Studies for scheduling defense, acceptance of dissertation
- Request for degree forms - online
- GPA < 3.0 means dismissal from program
Objective:
- understanding of engineering concepts and ability to apply these concepts in research and design
- ability to critically analyze an engineering problem
- ability to organize and communicate a body of knowledge
- ability to answer questions related to a defined body of knowledge

Must have GPA 3.0+ overall and 3.0+ in major area

Faculty member must sign as potential dissertation advisor – does not guarantee financial support

EM students must choose a major area

Can be given throughout the year

Two Parts:
- submission of a research paper
- Oral Exam based on presenting of the research paper

Exam Committee: 3 department faculty in the student’s major area
PhD Qual. Exam – Research Paper

- Prepared in accordance with the best practices for preparing peer reviewed journal papers and will be evaluated based on:
  - Interest. The paper has to address a topic of significant importance to the fields of aerospace engineering or engineering mechanics
  - Novelty. The paper must present original methods or results which are not available in the open literature
  - Validity. The paper must be accurate and free from errors
- Exam Committee members will vote on the quality of the work based on the three criteria above. A consensus vote is required to pass. Students failing the evaluation will be given the possibility of resubmitting the research paper for a second and final time within six months subject to the time limitations of Section V.E.1.
- If paper accepted for journal, student is first author, and work done at UC, the review may not be needed.
PhD Qual. Exam - Oral

• Student will present an uninterrupted seminar open to all faculty and students of twenty (20) minutes in length.
• Presentation based on best practices for preparing presentations for conferences and seminars. Besides the clarity and conciseness of the presentation, the exam will establish the student’s ability to respond to questions aimed at assessing:
  – Critical thinking skills.
  – Understanding of technical material and fundamental knowledge in the field.
  – Ability to relate their research to the field as a whole.
• The Q&A period will typically last 30-60 minutes and is open only to the Department faculty and any designated persons outside the faculty to whom the Department faculty present indicate no objections.
• Exam Committee members will then vote.
Doctoral Candidacy

- All coursework satisfactorily completed
- Qualifying exam (both parts) passed
- Dissertation proposal accepted
  - Must occur at least 1 year prior to dissertation defense
- Ph.D. time limitations: 9 years maximum
  - 5 year limit until candidacy
  - 4 year limit on candidacy until degree
Bottom Line

- Good luck!
- Work hard!
- Be responsible for your own progress!
- Have some fun!
- Keep a positive attitude!
- Be Inquisitive!
- Achieve greatness!

Any constructive feedback on website, communication, or process, let Professor Abdallah know.
Aerospace Faculty Research

These sides provide an overview of the department research and then the specific research areas of each individual.
Core research thrust areas

Aerospace Systems

- Disastr Management
- UAV Integration in National Airspace
- Collaborative Robotics
- Disaster Management
- UAV Integration in National Airspace
- CFD
- FEA
- CFD
- Imaging Methods
- Sensor Systems
- Signal Processing
- CFD
- Thermal Management
- Visualization
- CAA
- Acoustic
- Combustion
- Fluid Dynamics
- Erosion
- Fire Safety
- NASA’s ACES Software
- UCAV Operations
- UAVs for Fire-Fighting
Faculty Decision Making

Kelly Cohen
UAV Surveillance for Forest Fires and Urban First Response, Mission Planning, Intelligent Controls

Catharine McGhan
Spacecraft robotics

? To be named later, starting in January
Fixed wing UAVs
Faculty Modeling and Simulation

Shaaban Abdallah
Computational Fluid Dynamics (CFD) Techniques, Engine Shutdown Dynamics

Yao Fu
Molecular dynamics simulation; Phase field modeling; Electro-thermomechanical properties of polymeric materials; Microstructure evolution control of additive manufacturing process
Arriving 1/17

Awatef Hamed
CFD, Thermal Management, Blade Coating Erosion, Aeroacoustics, Flow Control
Director CIPALMS

G.R. Liu
Finite Element Simulation and Modeling, Solids/Fluids/Heat Transfer Multi-Physics Simulation, Mesh Free Methods, Material Crack Propagation
Ohio Eminent Scholar

Paul Orkwis
Large Scale CFD Analysis, Aeroacoustic Simulation, Algorithm Development, Turbomachinery Design Optimization, 3D Visualization, 3D Printing, Shock Wave/Boundary Layer Interaction, Conjugate Heat Transfer
Department Head

Mark Turner
Faculty  Experimentation and Testing

Peter Disimile  Aircraft Fire Extinction, Blast Mitigation Fire Detection


Jong-Guen Lee  Ohio Research Scholar

Samir Tambe  Ohio Eminent Scholar

Ephraim Gutmark  Chevron Jet Noise Reduction, Pulse Detonation Engines, Afterburners, Turbine Blade Heat Transfer and Aerodynamics, Oil Drilling, Thermoacoustics, Flameless Combustion

Jie Chen

David Munday
Faculty Diagnostics

Peter Nagy  

Francesco Simonetti  
Ohio Research Scholar
Aerospace Engineering
Clifton Campus Laboratory Facilities

Old Chemistry
- Morphing and Optimization Systems Technology for Aerospace Lab (Cohen)
- Spacecraft Robotics Lab (McGhan)

Engineering Research Center
- Spray Diagnostics Lab (Jeng)
- Propulsion Systems and Aeroacoustics Research Lab (Hamed)

Rhodes/Baldwin Halls
- Acoustic Liner Lab (Gutmark)
- Gas Turbine Simulation Laboratory (Orkwis, Turner)
  - Gas Dynamics and Propulsion Lab (Gutmark)
  - Nondestructive Evaluation Lab (Nagy)
  - Ultrasonic Imaging Lab (Simonetti)
Aerospace Engineering
Off-Campus Laboratory Facilities

Victory Parkway Campus
- (UAVs) Morphing and Optimization Systems Technology for Aerospace Lab (Cohen)
- Advanced Manufacturing Lab (UCRI)

Center Hill Research Facility
High Temperature Erosion Lab (Hamed)

Gas Turbine Combustion Lab (Gutmark/Munday)

Wilmington Air Park
UAV Test Facility (Cohen, Kumar, Sharma)

Combustion Research Lab (Jeng/Lee)
GE (Aviation, Cincinnati, OH)
- Engine shutdown physics Core compartment cooling and ventilation at engine soakback
- New hybrid nozzle for jet engine deicing

CFD Research
- Mesh Free method for solutions of Navier-Stokes equations

Turbomachinery Research
- Multistage co-rotating propellers
- Innovative wind turbine design

Patents
- US patent, ”Two-Level Flow Controller,” 2009
- US Provisional patent on Navigated Catheter, 2013
- Counter-Rotating Radial, Centrifugal or Mixed-Flow Compressor, Pump or Turbine,
  University of Cincinnati, Invention Disclosure
- Back-To-Back Centrifugal Impeller,
  University of Cincinnati, Invention Disclosure
Intelligent Systems and Mission Planning:
• Battle management system for missile defense
• Multi-agent optimal task planning for UAVs
  o AFRL (DAGSI)

System Identification of Rotorcraft:
• System identification of Morphing Unmanned Rotorcraft
  o Modus Recte, Inc.

Surveillance for Intelligent Emergency Response Robotic Aircraft
• Small UAV platforms for forest fire monitoring and situational awareness
  o Marcus UAV, Inc.
• Forest fire growth prediction algorithms
  o NSF: I-Corps Program with University of Toledo

Intelligent Control Systems:
• Attitude Control of a “CubeSat”
  o Sierra Lobo ([http://www.sierralobo.com](http://www.sierralobo.com))
  o Ohio Consortium with NASA Glenn, Univ. of Toledo, Univ. of Dayton and AFIT
Research Activity

- Fuel spurt characterization due to HRAM.
- Fire Suppressant Transport
- Blast mitigation techniques.
- Hot Surface ignition & thermal management.
- Composite thermal conductivity measurements.
- Flame impingement and damage assessment.
- Turbulent flow over rectangular cavities.
- Fluid Structure Interactions.

Core facilities

- **OJATS:** A 9 ft² subsonic open jet can expands into a 3100 ft³ acoustic chamber at speeds up to 30kts.
- Full scale Rotorcraft Engine Nacelle Fire Simulator.
- Three wind tunnels (test sections up to 16 ft² and speeds to 130 kts).
- Blast chamber with a square 2.5” shock tube and 18” diameter blast tube.
- Fan Acoustics Test & Evaluation Bed.
- 3”x3” Thermal Conductivity Test Bed
Peter J. Disimile  
Peter.Disimile@uc.edu  
Focus: Aircraft Safety & Survivability  
Fire Explosion Science & Technology Research Group (UC-FEST)

**Applied R&D Activities:**

* A small independent high speed passive fire protection system for rotorcraft engine nacelles.
* Development of a high speed microprocessor based fire detection & locating system development for aircraft spaces.
* Smart fire protection system for aircraft engine nacelles and dry bays.

[Images of Rotorcraft Engine Nacelle Fire Simulator with captions:]

- **8 GPH JP-8 Fire Initiated**
- **A red circle highlights the ignition @ t=0 msec and extinction @ 123 msec later.**
Current Research Directions

- **Prediction of electro-thermomechanical properties of polymeric materials**
  - Rheological behavior of epoxy resin
  - Shock response of polymer nanocomposites (PNCs) and large-scale deformation behaviors
  - Electrical and mechanical response of charged neutral diblock copolymer

- **Microstructural evolution during additive manufacturing process**
  - Coupled phase field evolution to mechanical, chemical and electric field prediction during AM process

- **Electrochemical process and dendrite growth in lithium secondary battery**
  - Understand the electrochemical and mechanical process in batteries; control processing parameters to mitigate the dendrite growth
GE (Aviation, Global Research, Power)
• Reduction of commercial and military jet noise (4 joint patents)
• Developing new afterburners concepts (1 joint patent)
• Constant volume/pressure gain combustors (1 joint patent)
• New methods for boiler cleaning (1 joint patent)
• Turbine blades heat management and aerodynamics

The Boeing Company
• Shape Memory Alloys for vertical takeoff (V-22)
• Heat transfer from advanced aerodynamic airfoils
• Shock and flow separation control at high speeds (1 joint patent)

Honeywell International, Inc.
• Extension of surge margin in turbochargers

Halliburton Company
• Innovative hydrodynamics for oil drilling and production (1 joint patent)

Siemens/Alstom/ABB
• Prevention of thermoacoustic in power generation combustors (35 joint patents)

Goodrich Aerospace
• Multiple Lean-Direct Inject burners in high pressure combustors
• Low emissions, efficient and stable “Flameless” combustion (1 joint patent)
GE Aviation, Rolls Royce, BRYCOAT Inc, Expatial

• **Erosion of Turbomachinery Blades and Thermal Barrier Coatings**
  - Experimental investigation of blade and coating erosion by particle impacts at high velocities and temperatures

**GE Aviation**

• **Thermal Management**
  - Optimization of aircraft environmental control systems
  - Subsystem modeling of the Adaptive Power Thermal Management System (APTMS) for 5th Gen. military aircraft

**NASA**

• **Flow Control in Shock Wave Boundary Layer Interactions**
  - Computational simulations of bleed hole row interactions with shock/turbulent boundary layer interactions
  - Development of flow expansion physics bleed models for supersonic inlet design
Combustion Research Laboratory
San-Mou Jeng and Jong Guen Lee
(jengsu@ucmail.uc.edu)   (jongguen.lee@uc.edu)

GE (Aviation, Global Research, Power) and Parker Hannifin Gas Turbine Fuel Systems

• **Combustion and Spray**
  • Characterization of spray at high-pressures
  • Reacting and non-reacting aerodynamics
  • Multi-swirl cup swirler-swirler interactions
  • Advanced multi-point Lean Direct Fuel Injection
  • Cokings in fuel nozzle and fuel line
  • Combustion dynamics measurements to assist model development
  • NOx emissions from a perfectly premixed combustor
  • Fuel/air mixing measurement in micro-mixing device using acetone-PLIF
  • Development of (a) high altitude relight facility and ignition study, (b) Flame radiation emission probe (fiber-optic) for high pressure combustion chamber, and (c) Fuel vapor concentration probe using Infrared Extinction Technique

• **Fire Safety and Thermal Management**
  • FAA fire certifications and engineering tests
  • Fire resistant properties of advanced composite material
  • Spray cooling systems
GR Lab--computation for sustainability
G. R. Liu (liugr@uc.edu)

Supported by
US Department of Defense (DTRA); US Department of Army Research Laboratory
National Science Foundation

Area of Research

- Novel theory and methodology for automation in modeling and simulation.
- Computational technology for structures under extremely conditions.
- Computational technology for crack path capturing and crystal-plasticity.
- Computational techniques for automatic shock capturing in fluids.
- Computational techniques for SWBLI problems.
- Computational techniques for complex fluid-structural problems.
- Computational biomechanics for medical applications.
- Computational techniques for energy systems.

www.ase.uc.edu/~liugr
System-of-Systems, Model-Based Sys. Engineering

What is the impact of different design decisions on the system?
- Algorithms used at different levels of reasoning (delay, stability)
- State spaces defined for each process (levels of abstraction)

How do we track high-level symbolic goals for total system stability?
- Formal specification and verification, consistency of constraints
- Contract-based design, correct-by-construction synthesis

Resilient Risk-Aware Autonomy

Safe, Physically-Proximal Human-Robot Interaction

Robotics in the human realm:
- Risk and safety in shared workspaces
- Safety-efficiency tradeoffs
- Human intent prediction
- Mental workload, belief states, internal models
- Robot action-choice, risk-informed contingency planning
Ongoing Research Projects

- Nondestructive creep damage assessment (Battelle/DoE)
- NDE of diffusion bonded components (Rolls-Royce Corp.)
- Nonlinear ultrasonic NDE of fatigue (Rolls-Royce Corp.)
- Thermoelectric NDE for thermal aging (EPRI)
- Magnetic field mapping for online welding monitoring (EPRI)
- Electric nondestructive monitoring of corrosion (NNL)
- Residual stress assessment by electromagnetic NDE (FAA)

Core Facilities

- **Ultrasonic NDE** (RAM-10000 high-power ultrasonic system, DPSS-532 Fabry-Perot interferometer, OFV-302 heterodyne interferometer, Brilliant 10 laser pulser, A1270 EMA electromagnetic acoustic gauge, etc.)
- **Electric NDE** (LR700 AC potential drop system, SR921 AC impedance analyzers, etc.)
- **Magnetic NDE** (SMM-701U SQUID magnetic scanner, MAG-03 magnetic scanner, RollScan300 Barkhausen noise analyzer, Magnetoscop 1.069 susceptibility meter, MP30E-S Feritscope, etc.)
- **Electromagnetic NDE** (Nortec 2000 and US-450 eddy current analyzers, etc.)
- **Dielectric NDE** (Agilent 4294A and SR720 impedance analyzers, etc.)
- **Thermoelectric NDE** (ATS-6044 and TE-300 TEP analyzers, etc.)
GE Aviation, AFRL, NASA, Siemens Energy, Cornerstone Research

- **Capabilities**
  - **Hardware:** 1000+ cores in parallel cluster in protected network, high memory workstations, 3D visualization, GPUs
  - **Solvers:** XDG, Tacoma, Overflow, Fine/Turbo, FDL3DI, CFX, ANSYS
  - **Post Processing:** Tecplot, NPLOT3D, Asgard, Fieldview
  - **Grid Generation:** Pointwise, Numeca Autogrid & IGG
  - **Turbomachinery Design:** meanline, axisymmetric, 3D geometry

- **Simulation Applications & Flow Physics**
  - Compressor tip flows with unsteadiness and multistage apps
  - Turbine Aero and Cooling including hub purge cavity flows that affect unsteadiness such as hot streak migration
  - Turbomachinery Design & Optimization
  - Supersonic Inlets & SWBLI, Acoustics, Heat Transfer, LES

- **CFD Development**
  - High Order Discontinuous Galerkin: 10-100 times faster!
  - Harmonic Balance
  - Optimization, Post Processing, GPUs
Ongoing research projects

• Novel nondestructive inspection techniques for CMC engine components - GE Aviation
• Super-resolution ultrasonic imaging methods for the inspection of cast austenitic components – EPRI
• Guided wave tomography for corrosion and erosion monitoring in inaccessible regions – Cincinnati NDE
• Guided microwave detection of corrosion under insulation
• Ultrasound tomography for the early detection of breast cancer
• Ultrasonic measurement of surface tension

Core facilities

• Ultrasonic Microscope up to 300MHz
• 128-channel phased array system
• Microwave vector network analyzer up to 64GHz
• FLIR Infrared camera 640×512 res. -20°C to 500°C
• Laser doppler vibrometer 24MHz bandwidth

Full list available at www.ase.uc.edu/USIL/core_facilities.html