Registration Form

PLEASE - notify us if you have any dietary restriction, require wheelchair access, or other accommodations.

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Organization: _____

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AIAA Membership # _____

Mail fee along with this form to:

Office of Continuing Education
The University of Tennessee Space Institute
Becky Stines, MS 15
B. H. Goethert Parkway
Tullahoma, Tennessee 37388-8897

Ph: (931) 393-7276
Fax: (931) 393-7327
Toll Free: 888 822-8874 ext. 277

❑ COMBUSTION INSTABILITY: Analysis, Diagnosis, and Corrective Procedures
March 2-5, 2010
Course Fee: $1249.00
AIAA Member Course Fee: $1124.00

METHOD OF PAYMENT

☐ Check or Money Order Payable to:
The University of Tennessee Space Institute

☐ VISA ☐ MasterCard ☐ Discover

Account Number Exp. Date

Signature Date

UT Space Institute

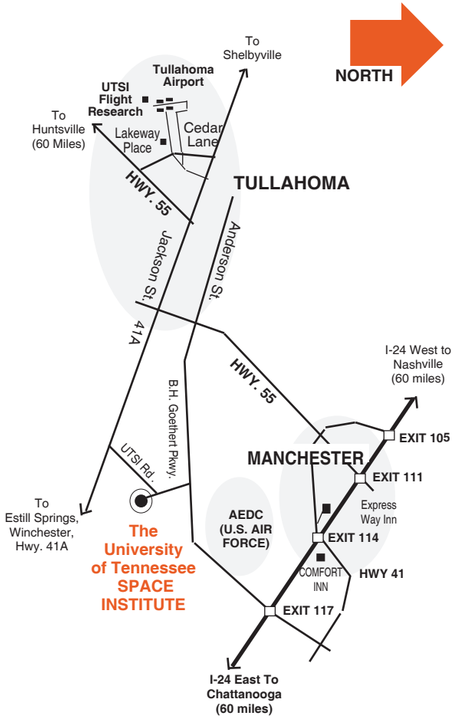
Located on the shore of the Woods Reservoir, The University of Tennessee Space Institute offers graduate education, research, post-doctoral study, and continuing education in advanced engineering and scientific disciplines. Qualified applicants may pursue full and part-time graduate programs leading to graduate degrees with majors in Aerospace, Mechanical, Chemical and Electrical Engineering, Engineering Science, Aviation Systems, Computer Science, Industrial Engineering, Physics or Applied Mathematics. Opportunities are available both for studies in conventional areas and for interdisciplinary studies, Experimental Flight Mechanics using flying test beds, Air Transportation Systems, Environmental Engineering, MHD-Electrical Power Generation, and Systems. The Institute, which is a part of The University of Tennessee, enjoys a close working relationship with the neighboring U.S. Air Force Arnold Engineering Development Center and its contract operators: Aerospace Testing Alliance, Pratt & Whitney, Siemens Westinghouse Power Corp., Navy Dept., and General Physics.

Through this and other "study-research-work" programs with industry and government, numerous "research assistant" positions are available to the students of the Institute. Several of the faculty and students participate in the Center's unique aerospace test facilities, and thus combine classroom instruction and laboratory research with current activities on advanced aircraft and aerospace vehicles.

Location

UTSI is adjacent to the Arnold Engineering Development Center (AEDC) and can be reached from Nashville, Chattanooga, and Huntsville airports. Nashville and Chattanooga are approximately 75 minutes drive from UTSI. Huntsville is 95 minutes. Motels are located about 12 miles from the Institute. Military personnel and government employees may stay at the Arnold AFB VOQ located about 2 miles from the Institute. The Office of Continuing Education will assist with your reservations. Rental cars are available at airports.

Location Map



The University of Tennessee Space Institute does not discriminate on the basis of race, sex, color, religion, national origin, age, handicap, or veteran status in provision of educational opportunities or employment opportunities and benefits. The University of Tennessee Space Institute does not discriminate on the basis of sex or handicap in the education programs and activities which it operates, pursuant to the requirements of Title IX of the Educational Amendments of 1972, Public Law 92-318, and Section 504 of the Rehabilitation Act of 1973, Public Law 93-112, and the ADA of 1990, respectively. The policy extends both to employment by and admission to UTSI. Inquiries concerning Title IX and Section 504 should be directed to the Affirmative Action Office, Mail Stop 11, The University of Tennessee Space Institute, Tullahoma, TN 37388-9700. Telephone (931) 393-7265. Charges of violation of the above policy should be directed to the Affirmative Action Officer.

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Short Course:
COMBUSTION INSTABILITY:
Analysis, Diagnosis, and Corrective Procedures
March 2-5, 2010
www.utsi.edu

THE UNIVERSITY of TENNESSEE
Space Institute
Tullahoma, Tennessee

Office of Continuing Education offers

COMBUSTION INSTABILITY: Analysis, Diagnosis, and Corrective Procedures

March 2-5, 2010

Course Director:
Dr. Gary Flandro

EARLY RESERVATIONS ARE SUGGESTED
- Please Forward To Departments Working In This Field -

COMBUSTION INSTABILITY: Analysis, Diagnosis, and Corrective Procedures
March 2-5, 2010

Course Description

Despite intensive work spanning five decades, the problem of oscillatory behavior of high-energy propulsion systems and industrial burners is still an important engineering problem. New problems continue to threaten important propulsion development programs such as the NASA Constellation program with its heavy-lift ARES system based on the five-segment version of the Shuttle SRB. Current mathematical and computational tools in widespread use have failed to yield reliable techniques for predicting and especially for controlling such problems. It is imperative that correct procedures be implemented, since combustion instability problems usually appear late in the development cycle resulting in large, unexpected expenditures and delays in schedule. They are too often the reason for propulsion system program cancellation.

New research has resulted in sharpened physical understanding, better diagnostic techniques, and improved predictive computational algorithms. This course will present a detailed and balanced coverage of the theory of combustion instability and the means to implement it in the design process. Emphasis will be on new findings including the effects of vorticity and other flowfield interactions not incorporated in the classical theories and computational tools. These will be discussed in detail along with a full treatment of established viewpoints including effects of flow-turning, velocity coupling, and distributed combustion effects. New techniques will be introduced that greatly improve the modal analysis procedures needed in identifying acoustic mode shapes and frequencies in complex system configurations. Vastly improved nonlinear analytical techniques now allow accurate determination of limit cycle amplitudes giving a much better indication of the threat of an instability to the motor system. New improvements also extend the mean flow Mach number range so that problems in supersonic combustion instability can be accommodated. The course also includes comprehensive treatment of vortex shedding, effects of nonlinear interactions, and new methods for controlling combustion instabilities. Applications in solid and liquid rockets, turbojet thrust augmentors, ramjets and scramjets are covered. A multitude of data sets from many research and development programs and from current encounters with combustion instability difficulties will be used as case studies. Emphasis is on avoiding instabilities in the design process of a new system and eliminating them in a effective manner if they appear in the development cycle.

Attendees will receive a comprehensive literature package and text material by Culick, Price, Yang, and Flandro covering all aspects of the course. These will be distributed in DVD format. Tables of experimental data and other visual supportive material and viewgraphs will be included Latest versions of predictive algorithms will be demonstrated. A practical problem solving session will be held to enable the attendees to gain hands on experience in solving realistic combustion instability problems.

Lectures

Dr. Gary A. Flandro is Boling Chair Professor of Mechanical Engineering at UTSI. He has devoted over four decades to the study of oscillatory flow phenomena. He received his Ph.D. from Caltech under Professors Marble and Culick.

Dr. Vigor Yang is Director of the School of Aerospace Engineering at the Georgia Institute of Technology. He has pioneered in the application of advanced numerical methods in the solution of unsteady internal flows with combustion. He has developed new algorithms that clarify the coupling of acoustic/shear waves to combustion. He also received his Ph.D. from Caltech under Professor Culick.

Dr. Fred S. Blomshield is Head, Propulsion Research Branch at the Naval Air Warfare Center, China Lake, CA. He is an expert in experimental methods and their application in combustion instability testing especially in nonlinear systems.

Dr. Jonathan French is an analyst at Software & Engineering Associates, Inc., Carson City, NV. He is currently developing improved versions of the standard combustion instability prediction algorithms (SSPP) that are universally used in solving combustion stability problems. He received his Ph.D. degree from UTSI.

Course Schedule

(NOTE: All Times are Central Time Zone)

Tuesday-March 2, 2010

Instructor: G. A. Flandro (UTSI)

7:45	Registration – UTSI Lobby
8:10	Welcome
8:20	Introduction (G. Flandro)
8:45	History of Combustion Stability Research (G. Flandro)
10:00	Break
10:15	Current Issues and Approach (G. Flandro)
10:45	Combustion Stability as a System Problem (G. Flandro)
12:00	Lunch
1:00	Analysis of Combustor Stability: Classical Approach (G. Flandro)
2:30	Break
2:45	Instability Problems in Liquid Rockets (G. Flandro)
3:30	Nonlinear Combustion Instability (G. Flandro)
4:30	Adjourn

Wednesday-March 3, 2010

Instructors: G. Flandro (UTSI), V. Yang (Penn State) , and J. French (SEA)

8:00	Prediction and Diagnosis of Combustion Instability (G. Flandro)
9:00	The Standard Stability Prediction Method (G. Flandro and J. French)
10:00	Break
10:15	Case Studies: Industrial Burners, Saturn F1, Shuttle SRB, Ariane Booster, MMII, tactical motor systems including Russian experience (G. Flandro and V. Yang)
12:00	Lunch
1:00	Modeling of Flow/Combustion Interactions and vortex shedding with emphasis on Shuttle SRB, Ariane and ARES five-segment SRB (G. Flandro and V. Yang)
2:30	Break
2:45	Numerical Modeling of Unsteady Reacting Flows (V. Yang)
4:30	Adjourn

Thursday-March 4, 2010

Instructors: G. Flandro (UTSI) and V. Yang (Penn State)

8:00	Nonlinear Effects – Triggering, Limit Cycles, Steepfronted waves. New methods for accurately predicting limit amplitude (G. Flandro)
10:00	Break
10:15	Modeling of the Combustion Zone – Admittance Approach (G. Flandro)
12:00	Lunch
1:00	Nonlinear Effects in Liquid Motor Instability (V. Yang)
2:00	Corrective Procedures (G. Flandro)
3:00	Active Control of Instabilities (G. Flandro and V. Yang)
4:30	Adjourn

Friday-March 5, 2010

Instructor: F. Blomshield (NAWC)

8:00	Tour of AEDC Test Facilities
12:00	Lunch
1:00	Experimental Methods in Combustion Stability Problems
2:00	Response Function Testing
2:30	Break
2:45	Modern Instrumentation Approach and Data Acquisition and Processing
3:30	Pulsed Combustor Testing
4:00	Novel Experimental Techniques (X-Ray, Laser, Microwave, etc.)
4:30	Adjourn

AEDC Tour Information

During some continuing education courses, a tour of the Air Force's Arnold Engineering Development Center is scheduled for those attendees interested in the facilities and mission of the Center. AEDC is one of the most modern test and development centers, at which a large complex of aerospace test facilities are located. Some of these facilities are of a unique nature including wind tunnels, airbreathing- and rocket- test facilities, space simulation chambers, and ballistic ranges.

In order to visit AEDC one must meet the Center's security clearance regulations as follows:

1. American Born Citizens must provide name, date of birth, and place of birth.

2. Foreign Born of American Parents must provide name, date, and place of birth, and evidence of citizenship, such as naturalization number or number of certificate of citizenship.

3. Naturalized American Citizens must provide name, date and place of birth, and naturalization number.

4. Visits to AEDC by foreign nationals from NATO, allied, and friendly countries generally can tour. Foreign nationals or American citizens representing foreign governments in cooperative military research and development with the government of the United States may be permitted to visit AEDC. Arrangements to visit on a government-to-government basis should be made by making application through their embassy in Washington, D.C., with the U.S. Air Force, requesting a visit during the time period of the course. This must be done in time for the clearance to reach AEDC, preferably 30 days in advance. Upon arrival at UTSI, provide your name, date of birth, and place of birth.

It is very important that these instructions be followed, as no one will be permitted to tour without compliance and approval.

Please call the Continuing Education Office with any questions.

Ph: (931) 393-7276
FAX: (931) 393-7327

CERTIFICATES OF CONTINUING EDUCATION UNITS (CEUs) WILL BE PRESENTED FOR ATTENDING THIS COURSE.

Office of Continuing Education

Reservations may be made by using the registration form. The registration fee of $1249.00 includes all necessary supplies. Early reservations are recommended. Refund of registration fee can be made if cancellation notice is received ten working days prior to beginning of the course. Cancellation received less than **10 working days prior to the course** will be assessed 20% of the registration fee. Registration within the 10 working days prior to the course is also subject to the same cancellation policy. Substitution may be made at any time.

Please register by mail, fax, or telephone. A telephoned, mailed, or faxed reservation made **by an official training office** is considered a firm registration and cancellation policy will apply. A letter of acknowledgment will be mailed to the individual for whom the reservation is made, or to the training office, as we are instructed. Class size will be limited to ensure optimum interaction among participants. UTSI reserves the right to cancel the course. The liability of The University of Tennessee Space Institute is limited to the registration fee. UTSI will not be responsible for airline ticket cancellation fees or any other expenses incurred because of course cancellation. Enrollees will be notified and a full refund will be made. Late applicants will be considered on a space available basis.

The course is payable in advance and includes the cost of notes, classroom material, refreshments, and lunches. The fee does not include expenses for motel accommodations or other meals. Payment may be made by check, money order, or credit card. Be sure to include attendee name(s) and course title with check. Please make checks payable to The University of Tennessee Space Institute. **VISA, MasterCard, and Discover are accepted.**

UTSI reserves the right to substitute speakers in the event of unusual circumstances. UTSI does not sell the course notes. You must attend the course in order to receive the material. Training taken to maintain or improve professional knowledge and skills is usually tax-deductible. Consult your tax advisor. **Please notify us if you require special meals, wheelchair access, or other accommodations.** Casual dress is appropriate.

Enrollment may be made by individuals or companies. Any number of persons may enroll from a single organization so long as there are vacancies. We suggest that you phone us of your intention to enroll as soon as you initiate your organization procedure so we can hold a place for you and be better able to plan the arrangements. Phone the Continuing Education Director at (931) 393-7276 and then follow with the written application.

A place in the course will be reserved for industry personnel and government employees who require time to obtain authorization. Organizations may enroll for a given number of individuals, supplying the names at a later date, if necessary. For all such enrollments or reservations, the individual names should be received by the Institute as soon as possible to ensure a place in the course. For additional applications, use separate sheet giving all particulars required on the application form.