Registration Form

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

Name: _____

Organization: _____

Position: _____

Citizenship: _____

Address: _____

_____

Business Phone: _____

Home Phone: _____

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. 276

☐ **Modern Liquid Rocket Design**
August 27-31, 2007
$1,195.00

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

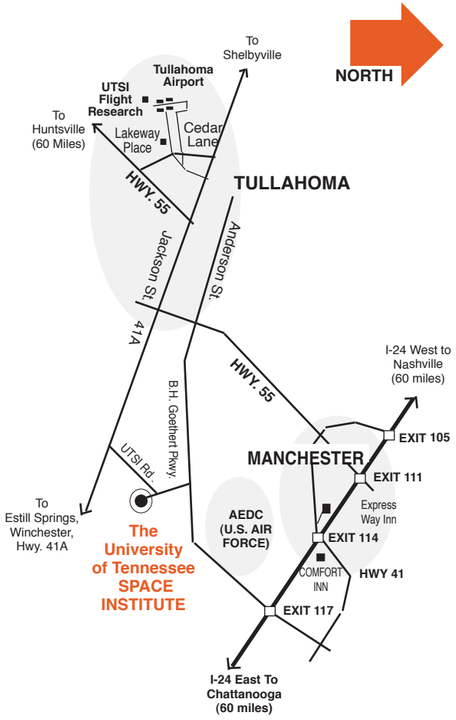
Located on the shore of the Woods Reservoir, The University of Tennessee Space Institute offers graduate education, research, post-doctoral study, and continuing education in advanced engineering and scientific disciplines. Qualified applicants may pursue full and part-time graduate programs leading 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



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Short Course:
Modern Liquid Rocket Design
August 27-31, 2007
www.utsi.edu

THE UNIVERSITY of TENNESSEE
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Tullahoma, Tennessee
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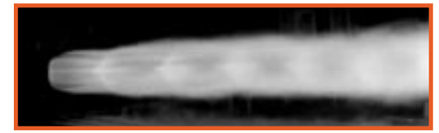

Modern Liquid Rocket Design

August 27-31, 2007

Course Director:
Dr. Gary Flandro

Course Lecturer:
Paul Gloyer

US Citizens ONLY

EARLY RESERVATIONS ARE SUGGESTED

- Please Forward To Departments Working In This Field -

Modern Liquid Rocket Design
August 27-31, 2007

Course Description

This course will provide an in-depth examination of the design of modern liquid rockets, including the design of propellant feed systems and engine thrust chambers. The material will go beyond standard textbook information and show how modern tools and technologies can impact design decisions and lead to innovative solutions. Additionally, the course will discuss how a small team of engineers can produce sophisticated rocket systems. While the course will focus on medium to large propulsion systems suitable for launch vehicles and missiles, the approaches and technologies can be applied to smaller satellite propulsion systems.

Who Should Attend

This course is designed for engineers and managers who wish to understand the issues, techniques, and approaches involved in the design of modern liquid rockets. A basic understanding of rocket analysis techniques would be helpful, but is not necessary to benefit from the course. Due to ITAR restrictions, the course is limited to U.S. citizens only.

Lecturers

Dr. Gary Flandro is Boling Chair Professor of Mechanical Engineering at UTSI. He has devoted almost four decades to the study of oscillatory flow phenomena. He received his PhD from Caltech.

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.

Mr. Paul Gloyer is President of Gloyer-Taylor Laboratories LLC and is actively developing advanced liquid rocket propulsion technologies. Mr. Gloyer was the lead engineer on the PacAstro PA-X suborbital rocket program and the program manager of the PA-E liquid rocket engine program.

Dr. Joe Majdalani is professor of Mechanical, Aerospace, and Biomedical Engineering at UTSI. He earned his PhD in Mechanical Engineering from the University of Utah. He is known for his work on acoustic instability theory in solid rocket motors and vortex engine technology in both liquid and hybrid rocket applications.

Mr. Zachary Taylor is the Vice-President of Gloyer-Taylor Laboratories and is one of the nation's leading composite experts. Mr. Taylor developed the composite propellant tanks for the PA-X, USFE and Rocketplane-XP programs, including the successful development of composite LOX tanks.

Course Schedule
(NOTE: All Times are Central Time Zone)

Monday

8:00 a.m. Registration UTSI Lobby
8:30 a.m. Welcome
8:30-4:00

I. Introduction
- A. Overview
  1. History
  2. State-of-the-Art
  3. Modern Approaches
- B. Mission Architectures, Issues and Sizing

II. Propellant Feed Systems
- A. Propellant Options
  1. Cryogenic propellants
  2. Storables
  3. "Green" propellants
- B. Propellant Storage
  1. Propellant tank sizing & design
  2. Metal tank design & fabrication
  3. Composite tank design & fabrication
  4. Cryo-composite tank issues

Tuesday, (8:00-4:00)
- C. Propellant Delivery
  1. Rocket Cycles
  2. Pressurization Options
  3. Pressure Supply Sizing
  4. Pressure Fed System Design
  5. Turbopump Fed System Design
  6. Pump Design
  7. Turbine Design
  8. Alternate Pump Designs

Wednesday, (8:00-4:00)

III. Thrust Chamber Analysis & Modeling
- A. Overview
- B. Chamber Flow Fields
  1. Conventional Flows
  2. Advanced Flow Fields
- C. Nozzles
  1. Theory & Analysis
  2. Conical and Bell Nozzles
  3. Plug and Spike Nozzles
  4. Nozzle Analysis and Simulation Tools
- D. Chambers
  1. Combustion Chemistry
  2. Combustion Analysis Tools
  3. Combustion Process
  4. Combustion Performance

Thursday, (8:00-4:00)

IV. Rocket Chamber Stability
- A. History of "Combustion Stability"
- B. Modern Rocket Chamber Stability
  1. Waveforms
  2. Empirical data
  3. Analysis
  4. Results and Predictions
- C. Instability Mitigation
  1. Historical Trial & Error
  2. Resonators & Baffles
  3. Modern Mitigation Approaches

V. Chamber Design
- A. Chamber Design Approach and Issues
  1. Thermal Management Issues
  2. Cooling Techniques
  3. Combustion Management
- B. Ablative Chamber Design
  1. Ablative Cooling Process
  2. Ablative Materials
  3. Ablative Chamber Fabrication
- C. Regen Chamber Design
  1. Regen Cooling Process
  2. Regen Design and Analysis
  3. Regen Chamber Fabrication

Friday, (8:00-4:00)

VI. Injector Design
- A. Requirements and Issues
  1. Combustion Performance
  2. Throttling
  3. Stability
- B. Impinging Elements
  1. Analysis and Sizing
- C. Pintle Elements
  1. Analysis and Sizing
- D. Swirl Elements
  1. Analysis and Sizing
- E. Manifold Design
- F. Injector Fabrication

VII. Rocket Performance
- A. Analysis
  1. Efficiency Calculations
  2. Loss Calculations
- B. Testing
  1. Traditional Test Approach
  2. Modern Test Approach

U.S. Citizens ONLY

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 $1,195.00 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.