

# Registration Form

PLEASE - notify us if you require special meals, wheelchair access, or other accommodations.

Name: \_\_\_\_\_

Organization: \_\_\_\_\_

Position: \_\_\_\_\_

Citizenship: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

Business Phone: \_\_\_\_\_

Home Phone: \_\_\_\_\_

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 37388-9700

Ph: (931) 393-7276  
 Fax: (931) 393-7433

<http://www.utsi.edu>

## DIGITAL SIGNAL PROCESSING FOR INSTRUMENTATION AND DATA ANALYSIS

November 16-18, 2010

Course Fee: \$1249.00

AIAA Member Course Fee: \$1124.10

### METHOD OF PAYMENT

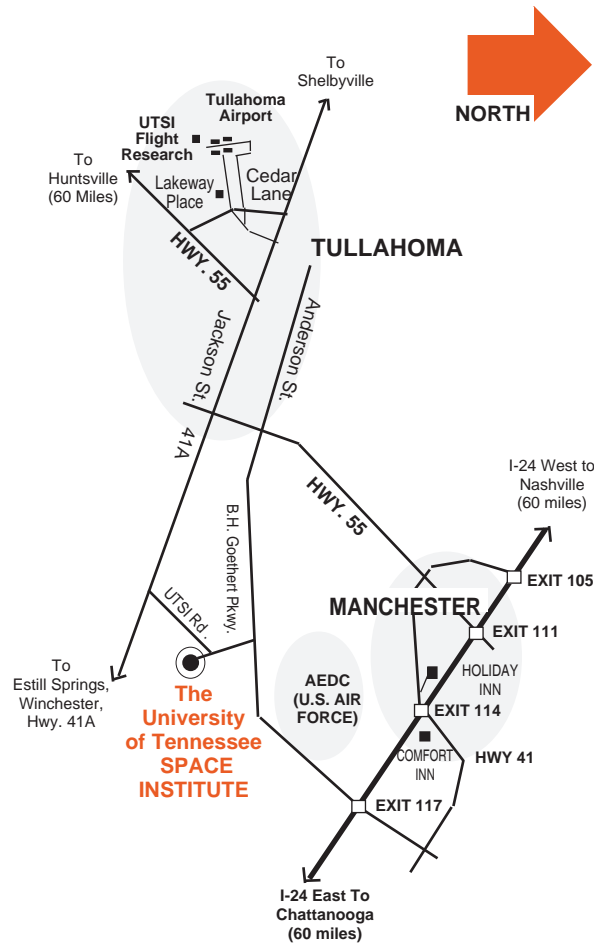
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Signature \_\_\_\_\_ Date \_\_\_\_\_

## The University of Tennessee Space Institute 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 37388-8897. Telephone (931) 393-7265. Charges of violation of the above policy should be directed to the Affirmative Action Officer.

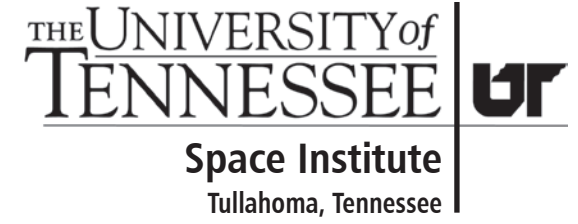
The University of Tennessee is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools. All UT degree programs are ABET accredited.

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The University of Tennessee  
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 Tullahoma, Tennessee 37388-9700

Short Course:  
**Digital Signal Processing  
 For Instrumentation  
 & Data Analysis**  
 November 16-18, 2010  
[www.utsi.edu](http://www.utsi.edu)



Office of Continuing Education offers

# DIGITAL SIGNAL PROCESSING FOR INSTRUMENTATION & DATA ANALYSIS

**November 16-18, 2010**

Course Directors:  
**Dr. Bruce W. Bomar &  
 Dr. L. Montgomery Smith**  
<http://www.utsi.edu>

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

## Digital Signal Processing for Instrumentation and Data Analysis November 16-18, 2010

### Course Description

This is a three day course intended for scientists and engineers involved in experimental data acquisition and analysis who wish to become familiar with recently developed methods of signal processing for use in their work. It provides a working knowledge of digital signal processing (DSP) techniques and systems with emphasis on those methods of interest in instrumentation and data analysis. Familiar applications to often-encountered experimental data types are emphasized. Examples of the DSP techniques will be given using the interactive numeric computation software package MATLAB®. Numerous exercises are provided during the course workable in The Student Edition of MATLAB®.

The course begins on day one with an introduction to the fundamental principles of discrete signals and DSP. The concept of frequency analysis of signals is introduced and developed to acquaint the participant with the widespread utility of this technique. Common numerical schemes such as differentiation, integration and smoothing of digitized data are examined in light of this approach. Frequency domain methods are developed further in a session on the discrete Fourier transform, including its computation via the fast Fourier transform (FFT) and its variations.

On the second day, useful techniques for performing spectral analysis of digitized data are covered in the first session. Principles of finite impulse response and infinite impulse response filtering are then addressed, and methods of filter design are presented. The second day concludes with a session where students will use computers to practice using MATLAB® for implementing DSP methods and filter design techniques.

Algorithms for efficiently implementing such filters in software are covered in the first session of day three with examples used to illustrate the fundamental principles. Methods for changing the sample rate of digital signals via interpolation and decimation are then discussed along with practical schemes for A/D and D/A conversion. The course material then moves into the use of high-speed digital signal processor chips for implementing DSP methods. Typical characteristics and architectures of floating-point digital signal processors are examined along with an overview of available personal-computer-based coprocessor cards utilizing these chips. The course considers how DSP methods would be implemented in the C programming language for efficient execution on DSP chips. The course concludes with sessions on finite wordlength effects and methods for the lossless and lossy compression and restoration of digital data.

### Lecturers

Dr. Bruce W. Bomar and  
Dr. L. Montgomery Smith  
The Course Lecturers are from:  
The Department of  
Electrical Engineering  
The University of Tennessee  
Space Institute  
Tullahoma, TN



### Course Schedule

(NOTE: All Times are Central Time Zone)

#### Day 1

- 8:00 - 8:30 Registration UTSI Lobby
- 8:30 - 9:00 MATLAB Fundamentals
- 9:00 - 10:15 Introduction to Digital Signals
- Example data sequences
  - Discrete systems
  - Concepts of linearity and shift-invariance
  - Convolution of discrete sequences
  - Difference equations
- 10:15 - 10:30 Break
- 10:30 - 11:45 Frequency Response of Digital Systems
- The Fourier transform of a discrete sequence
  - The impulse response and transfer function of a system
  - The z-transform
  - Convolution and transforms
  - A/D conversion and aliasing in data sampling
- 11:45 - 1:00 Lunch
- 1:00 - 2:30 Familiar Examples of Digital Signal Processing
- Differentiation
  - Integration
  - Data Smoothing
- 2:30 - 2:45 Break
- 2:45 - 4:15 The Discrete Fourier Transform (DFT)
- Definition of the DFT
  - Properties of the DFT
  - Computation of the DFT:  
the fast Fourier transform
  - Example computer programs

#### Day 2

- 8:15 - 10:00 Spectral Analysis of Signals Using the DFT
- Time-domain windowing
  - Effects of windowing: frequency resolution
  - Effects of windowing: amplitude attenuation
  - Effects of windowing: scallop loss
  - Frequency-domain windowing
  - Time-varying spectral analysis
- 10:00 - 10:15 Break
- 10:15 - 11:45 FIR Digital Filter Design
- Symmetry properties of digital filters
  - Frequency-sampling designs
  - Weighted least-squares designs
  - Windowing designs
  - Equiripple designs
  - Kth-band designs
- 11:45 - 1:00 Lunch

#### Day 2 continued

- 1:00 - 2:30 IIR Digital Filter Design
- Fundamentals of IIR filters
  - Stability of recursive systems
  - Design from analog filters using the bilinear transform
- 2:30 - 2:45 Break
- 2:45 - 4:15 Digital Filter Design Examples Using Computers
- MATLAB exercises
  - Data processing
  - FIR and IIR designs

#### Day 3

- 8:15 - 9:30 Realization Schemes for Digital Filters
- Direct convolution methods
  - Circular and linear convolution
  - Processing using the DFT
  - Realization schemes for IIR filters
- 9:30 - 9:45 Break
- 9:45 - 10:45 Sample Rate Conversion, A/D and D/A Conversion
- Decimation of discrete sequences
  - Interpolation of discrete sequences
  - Sample rate alteration
  - Realization schemes
- 10:45 - 11:00 Break
- 11:00 - 11:45 Practical aspects of A/D and D/A conversion
- 11:45 - 1:00 Lunch
- 1:00 - 2:00 Digital Signal Processors
- Architecture: memory organization
  - Architecture: input/output ports
  - Numeric formats (fixed and floating point)
  - Special-purpose coprocessors
  - Support software
  - Programming methods in C and assembler
- 2:00 - 2:45 Finite Wordlength Effects
- Roundoff noise
  - Coefficient quantization error
  - Limit cycles
  - Overflow oscillations
- 2:45 - 3:00 Break
- 3:00 - 4:15 Data Compression
- Lossless methods: Huffman, LZW, and block-predictive
  - Lossy method: transform coding
  - Standardized MNP algorithms

## 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.

**CERTIFICATES OF CONTINUING EDUCATION  
UNITS (CEUs) WILL BE PRESENTED FOR  
ATTENDING THIS COURSE.  
UT IS ABET ACCREDITED.**