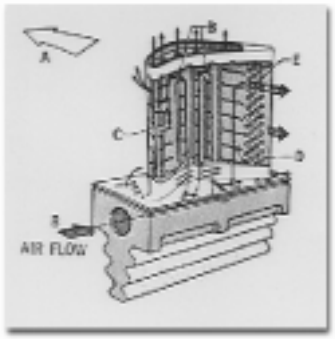
Michigan State University
College of Engineering

presents

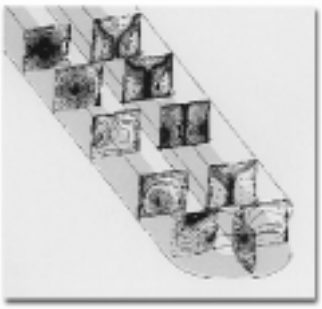
a short course on

Computational Fluid Dynamics
Fundamental and Practical Issues



June 14–16, 2000

University Faculty Club
East Lansing, Michigan



Sponsored by:

The Multiphysics Computational Research Laboratory of Michigan State University's Automotive Research Experiment Station (ARES)

The Computational Fluid Dynamics (CFD) Laboratory of MSU's Department of Mechanical Engineering

Center for Sensor Materials, MSU's National Science Foundation–sponsored Materials Research Science and Engineering Center

A course for CFD practitioners and managers who are serious about using CFD to obtain useful answers to realistic engineering problems

MICHIGAN STATE
UNIVERSITY

This course focuses on issues that affect accuracy and interpretation of CFD results; utility of CFD to impact design through analysis and optimization; and new application areas where CFD can be expected to make a significant contribution. Topics addressed include those related to modeling such as turbulence and free surface flows and those related to simulations such as grid-quality measures and solution algorithms.

Course Synopsis

Day 1—June 14, 2000
8:30 a.m. - 5:00 p.m.

Welcoming Remarks (R. Rosenberg)

Numerical Methods for the Navier-Stokes Equations (T. Shih)
- An overview on CFD
- Grid-quality issues for structured and unstructured grids
- Space-time coupled and decoupled methods

Role of Experiments in Engine Component Simulations (H. Schock)
- Overview of components and key physical processes
- Experimental methods and results

Day 2—June 15, 2000
8:00 a.m. - 5:00 p.m.

An Introduction to Optimization (A. Diaz)
- Overview of methods
- What to optimize (dimensions, shape, or layout)?
- Multiple objectives and the characterization of optimal solutions
- Imposing constraints on time-dependent performance
- Sensitivity analysis (numerical, semi-analytical or analytical computation of gradients; adjoint variable; response surface approximations)
- Method for optimization without gradients (genetic algorithms)
- Latest trends (representation of shape as a material property, homogenization methods and their role in optimization)

Modeling and Numerical Methods for Free-Surface Flows (W. Shyy)
- Competing physical mechanisms responsible for interface dynamics and disparity in time and length scales
- Formulation of free and moving boundary problems with focus on interface shape, movement, and evolution
- Overview and assessment of models and methods including Lagrangian / Eulerian, sharp / smeared interface treatments, and multi-level techniques
- Detailed discussions on selected techniques

Day 3—June 16, 2000
8:00 a.m. - 4:30 p.m.

Introduction to Fuel Cells (A. Benard)
- Fuel cells: how do they work?
- Types of fuel cells and their applications
- Technology assessment
- Issues and research needs

Low-Order Turbulence Models and Tools for Their Evaluation (G. Brereton)
- A morphology of prediction methods
- Does it have to be an eddy-viscosity model?
- Is k-epsilon the best buy for your money?
- Flow-specific vs. universal calibration of turbulence models
- Instantaneous vs. gradual redistribution of Reynolds Stresses
- Turbulence modeling for highly unsteady flows

Second-Moment Turbulence Closure Models (K. Hanjalic)
- Needs, potential, and mathematical foundations
- Modeling principles and practices for pressure-strain (linear and non-linear models), turbulent transport, and dissipation rate
- Modeling the effects of viscosity and solid boundary
- Low-Reynolds-number and transitional flows
- Effects of rotation, swirl, streamline curvature, compression, and secondary currents
- Second-moment closures for passive scalar fields
- Modeling the effects of thermal buoyancy, double diffusion, and magnetic field
- Numerical implication associated with second-moment closures and current practice
- Illustrations of performance in generic and complex flows

Registration Information

Course fees
The course fee is $800. This fee includes tuition, course notes, continental breakfast and lunch (each day), and refreshments. This fee does not include hotel accommodations.

Location, lodging, and travel information
The course will be taught on the campus of Michigan State University in East Lansing. You will receive more information regarding the course location, travel, and accommodations with your registration confirmation letter.

Registration
A check or credit card information must accompany your registration form. We will mail you a confirmation letter with course details within 10 business days of receiving your registration.

On-site registration
On-site registration is possible, but course material will not be provided until one day after the registration.

For additional information about the course, contact:
Tom I-P. Shih, CFD Laboratory, Department of Mechanical Engineering
Michigan State University, East Lansing, MI 48824-1226
Phone: 517/432-3658; FAX: 517/353-1750; E-mail: tomshih@egr.msu.edu;
Web: http://www.egr.msu.edu/~tomshih

For questions about registration, contact:
Bobbie Slider, Phone: 517/353-3995; or Jan Chappell, Phone: 517/355-1789

Mail or FAX registration to:
Bobbie Slider, MSU Engine Research Laboratory
3361 Hulett Road, Okemos, MI 48864
FAX: 517/432-3341; E-mail: slider@egr.msu.edu

Instructors

André Benard

André Benard (Ph.D., University of Delaware) joined Michigan State University as an assistant professor in 1996. Previously, he was at the Los Alamos National Laboratory. Dr. Benard is active in research involving modeling and computation of complex transport phenomena with novel and traditional numerical methods. These include solidification processes with thermosolutal convection, burning of polymer and their composites, and numerical methods based on wavelets. Also, Dr. Benard is involved in modeling of transport phenomena encountered in fuel cells for rapid design purposes.

Giles Brereton

Giles Brereton (Ph.D., Stanford University) joined Michigan State University as an associate professor in 1997. Dr. Brereton conducts research in unsteady and turbulent fluid mechanics in applications ranging from IC engines to cardiovascular flows. In the area of turbulence modeling, he has specialized in the use of rapid-distortion approaches to model unsteady and non-equilibrium turbulent flows, in collaboration with industry and government laboratories.

Alejandro Diaz

Alex Diaz (Ph.D., The University of Michigan) joined Michigan State University in 1986, and is currently associate professor of mechanical engineering. Previously, he was a research scientist in Venezuela and a visiting professor in the Mathematical Institute of the Technical University of Denmark. Dr. Diaz has contributed significantly to the area of optimization and its application to mechanical systems and structures. Currently, he is an associate technical editor of ASME's *Journal of Mechanical Design*.

Kemal Hanjalic

Kemo Hanjalic (Ph.D., Imperial College; D.Sc., University of London) is professor of fluid mechanics and heat transfer and faculty of applied sciences at Delft University of Technology in the Netherlands. Dr. Hanjalic is internationally renowned for his work in turbulence modeling. In the late 1960s, he pioneered, together with Professor B.E. Launder, the first formulation and validation of the widely used k-ε and second-moment (Reynolds-stress) closures. Later contributions include low-Reynolds-number second-moment closure, multi-scale, and split-spectrum models. Dr. Hanjalic published extensively on refinements of low-Reynolds-number Reynolds-stress models and their extension to non-equilibrium, separating, unsteady and transitional flows. He also made notable contributions to modeling the effects of thermal/mass buoyancy and magnetic field on turbulence, with application to natural and double-diffusive convection in enclosures. Finally, Dr. Hanjalic is active in experimental research, primarily in turbulence and heat transfer interactions.

Harold Schock

Harold Schock (Ph.D., Michigan Technological University) is professor of mechanical engineering and director of Michigan State University's Automotive Research Experiment Station. Before joining MSU, he was deputy chief of the Turbine and Rotary Engine Branch and head of the Intermittent Combustion Engine Technology Section at NASA–Lewis Research Center. Dr. Schock has conducted extensive research for the automotive industry, the general aviation aircraft industry, and government laboratories in developing and applying laser diagnostic techniques for IC engine in-cylinder flow fields. He has also conducted research in wear, piston-ring design and analysis, and flow control.

Tom I-P. Shih

Tom Shih (Ph.D., The University of Michigan) joined Michigan State University as professor of mechanical engineering in 1998. Previously, he was a research engineer at NASA–Lewis Research Center, associate professor at the University of Florida, and professor at Carnegie Mellon. Dr. Shih has conducted extensive research for industry and government laboratories in developing and applying CFD to study a wide range of problems including piston and rotary engines, control of shock-wave/boundary-layer interactions with bleed, internal and film cooling of turbines, and DNS of particle-particle/particle-fluid interactions. Dr. Shih is a Fellow of ASME and an Associate Fellow of AIAA.

Wei Shyy

Wei Shyy (Ph.D., The University of Michigan) is currently professor and chairman of Aerospace Engineering, Mechanics and Engineering Science at the University of Florida (UF). Prior to joining UF in 1988, he was a staff scientist at GE Corporate Research and Development Center in Schenectady, New York. He is the author and co-author of three books dealing with computational and modeling techniques involving fluid flow, moving boundaries, and complex physics. He has also written reviews dealing with computational and modeling issues related to fluid dynamics, heat/mass transfer, combustion, and materials processing. In addition, Dr. Shyy is author or co-author of more than 200 research papers. He is a member of editorial board of *Numerical Heat Transfer: An International Journal of Computation and Methodology (Part A: Applications, and Part B: Fundamentals)*.

Workshop on CFD

To enhance the usefulness of this short course, there will be two panel discussions. The first panel **(June 14, 3:30–5:00 p.m.)** is composed of representatives from the following leading commercial CFD code companies: Adapco, AEA, ANSYS, AVL, and FLUENT. Members will describe their perspectives on CFD, present and future.

The second panel **(June 15, 10:15 a.m.–noon)**, is made up of invited experts and leaders from academia, industry, and government labs. Members will present the CFD community's point of view on needs, concerns, and challenges in both research and education. Invited participants for the second panel are:

David Caughey, Cornell University
Derlon Chu, Ford
Philip Keller, DaimlerChrysler
Keith Meintjes, General Motors
Charles Petty, Michigan State University
Louis Povinelli, NASA–Glenn Research Center
Juan Ramos, University of Málaga
Fred Shen, General Motors
Richard Sun, DaimlerChrysler
Nizar Trigui, Ford

Institutional Sponsor

This three-day short course is partially supported by MSU's Automotive Research Experiment Station (ARES). ARES is focused on serving the research and development needs of the automotive industry. ARES involves 28 professors and over 100 graduate students and research staff who perform research in the following laboratories:

- Powertrain Research Laboratory *(Harold J. Schock, Head)*
- Sensor Technology and Electric Motion Control Laboratory *(Elias Strangas, Head)*
- Multiphysics Computational Research Laboratory *(Tom I-P. Shih, Head)*
- School of Labor and Industrial Relations: Training Laboratories *(Theodore Curry, Head)*

For more information on the mission and research activities in ARES, contact:

Harold J. Schock
Professor of Mechanical Engineering and Director of ARES
Phone: 517/353-9328
FAX: 517/432-3341
E-mail: schock@egr.msu.edu

Registration: Short Course on CFD Fundamental and Practical Issues

June 14–16, 2000
Michigan State University, East Lansing, Michigan
Course fee: $800

(please type or print)

Name: _____

Title: _____

Company: _____

Address: _____

City/State/Zip: _____

Daytime phone (include area code): _____

FAX number: _____

E-mail: _____

Areas of interest: _____

Method of payment:

❑ Check, payable to: ***Michigan State University (ARES)***

❑ Charge: _____ Visa _____ Mastercard

Card number: _____

Expiration date: _____

Authorization signature: _____

Mail registration form together with check or credit card information to:
Bobbie Slider
MSU Engine Research Laboratory
3361 Hulett Road
Okemos, MI 48864

Michigan State University
Computational Fluid Dynamics (CFD) Laboratory
Department of Mechanical Engineering
2555 Engineering Building
East Lansing, MI 48824-1226