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सत्यमेव जयते

Introduction to Thermal Systems Design

Discipline of Mechanical Engineering
Indian Institute of Technology, Indore
Simrol, Indore, M.P. - 453552, India

OVERVIEW

The design of thermal systems requires an integrated approach that treats thermodynamics, fluid mechanics, and heat transfer as parts of one interconnected area, in which appropriate solutions to real-life design and analysis problems can be obtained only when all these aspects are considered simultaneously. This approach must be implemented through open-ended problems and design project-oriented teaching. Topics related to thermal systems include fluid flow networks, heat exchanger design, design and selection of pumps, fans and compressors, heat recovery systems, psychrometrics, air-conditioning systems, electronic cooling systems, fuels and combustion, solar thermal systems, and power plant design. This course is specifically designed to allay the fear of ill-defined problems by teaching the skills to model and translate a physical situation into the relevant equations. The use of equation-solving software facilitates the implementation of this focus by reducing the effort involved in solving equations and affording the opportunity for more discourse on the approach toward modeling of thermal systems. The students will learn the effect of individual component design on overall systems through parametric optimization studies.

Topics common to the design of all thermal systems will be taught briefly in an interactive lecture format, but the main emphasis will be on open-ended design problems to be formulated and solved in discussion format. The course will begin with the development of skills for the modeling and parametric investigation of individual thermal system components. As proficiency is gained in these exercises, the students will develop the capability to design overall thermal systems in projects of larger scope. The methodology of translating a problem statement into design tasks and executing them will be illustrated. The understanding of thermal component and system design will be encouraged by requiring the students to view the "solution" to the problem as the beginning rather than the end of a design. Discussion of the effects of changes in design conditions (flow rates, inlet temperatures, etc.) and component geometry (diameter, length, other features) on performance will be emphasized.

The specific software used for this course, Engineering Equation Solver (EES) (Klein 2017), which has thermodynamic and thermophysical properties of a wide variety of fluids built in and simplifies iterative calculations significantly, also facilitates the teaching of interactions between components in systems without the tedium involved in iterations and finding fluid properties. This allows the student to concentrate on the interpretation of results and trends, rather than simply reporting the numerical results. The software is not a "dumb-solver" or a spoon-feeding convenience because the students have to input every equation describing the governing processes based on their understanding of the physical problem. Thus, it offers convenience but does not provide a crutch or a substitute for the understanding of thermal phenomena, and it can be implemented as a common platform on a curriculum-wide basis for teaching most thermal sciences courses.

OBJECTIVE

The course addresses students of senior undergraduate and beginning graduate level (B.Tech., M.Tech.) as well as faculty engaged in the thermal sciences.

The objectives of the course are:

1.To learn the use of thermodynamics, fluid mechanics and heat transfer principles in an integrated manner to design thermal systems.

2.To learn the effect of operating conditions, design constraints, and design choices on performance.

3.To obtain a physical feel for what constitutes a reasonably designed thermal system.

4.To develop the background and proficiency to design any thermal system for a wide range of applications.

WHO SHOULD ATTEND?

•Senior undergraduates, M.Tech./M.Sc students. A basic background in thermodynamics, fluid dynamics and heat transfer is assumed.

•B.Tech/B.Sc. and M.Tech/M.Sc level teachers engaged in teaching thermal sciences courses.

•Executives, engineers and researchers from industry, service and government organizations including R&D laboratories who are engaged in thermal management problems.

COURSE CONTENT

The course is planned as a sequence of approximately 10 hours of instruction, five lectures of 2 hours each (e.g., from 1:30 to 3:30 PM) and 10 hours Tutorials, five tutorials of 2 hours each (e.g., from 4 to 6 PM) . The first part of each session will introduce of a new topic relevant to thermal system/component design, and the second part will discuss illustrative example systems in tutorial format.

September 11, 2017 : Monday

1A. Lecture: Fluid flow, piping networks, pumps and fluid movement.

1B. Illustrative Discussion: EES demonstration; Representative piping network design and analysis

September 12 2017 : Tuesday

2A. Lecture: Parallel and counterflow heat exchangers

2B. Illustrative Discussion: Tube-in-tube heat exchanger, parametric analysis; Crossflow heat exchanger discussion

September 13, 2017 : Wednesday

3A. Lecture: Thermodynamic cycle analysis: heat pumps

3B. Illustrative Discussion: Residential air-conditioning system design and parametric analysis

September 14, 2017 : Thursday

4A.Lecture: Rudimentary combustion analysis (thermo dynamics)

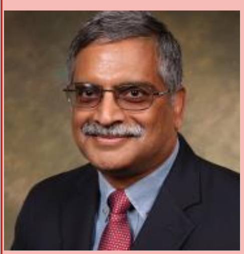
4B. Illustrative Discussion: Gas-fired water heater design; Group projects topics assignment

September 15, 2017 : Friday

5: Project proposal presentations, discussion, assessment Students will come prepared to class to present an outline of how to design a thermal system that they have selected from the suggested topics, or a topic of their own. Project groups will present 10 minute outlines of how such a design will be conducted, incorporating the learning from the previous lectures on how to design fluid flow, heat transfer and thermodynamics systems.

TEACHING FACULTY

Prof. Srinivas Garimella



Dr. Garimella is the Hightower Chair in Engineering and Director of the Sustainable Thermal Systems Laboratory at Georgia Institute of Technology. He received a Ph.D. degree (1990) and an M. S. degree in Nuclear Engineering from The Ohio State University.

He received a Bachelor's degree in Mechanical Engineering from The Indian Institute of Technology, Kanpur (India) in 1982. He was a Research Scientist at Battelle Memorial Institute in Columbus, OH from 1984-1990, and a Senior Engineer in the Delphi Harrison Thermal Systems Division of General Motors Corporation in Lockport, NY from 1990-1993. After serving as a Research Specialist in the Mechanical Engineering Department at The Ohio State University from 1993-1994, he joined Western Michigan University, where he served on the faculty of the Mechanical and Aeronautical Engineering Department from 1994-1998.

He conducts research in areas ranging from fundamental investigations of phase-change heat and mass transfer and supercritical fluid flow and heat transfer phenomena in single- and multi-component fluids at the micro- and mini-scales to the development of novel thermally activated absorption and vapor compression heat pumps, natural refrigerant space-conditioning systems, thermal management systems for high density Lithium-Ion batteries in vehicular applications, waste heat recovery for high flux, low temperature cooling in naval and refrigerated transport applications, miniaturized wearable and portable cooling systems, adsorption based carbon capture and gas cleaning, and waterless power plant condenser cooling. Professor Garimella has mentored approximately 75 postdoctoral researchers and graduate students. His research has resulted in over 250 archival journal and conference publications, a textbook on Heat Transfer and Fluid Flow in Minichannels and Microchannels (2nd Ed., Elsevier 2014), and book on Condensation Heat Transfer (World Scientific Press, 2015.) He has been awarded eight patents. Prof. Garimella is a Fellow of the American Society of Mechanical Engineers, past Associate Editor of the ASME Journal of Heat Transfer, and Editor of the International Journal of Air-conditioning and Refrigeration. He has also served as Associate Editor of the ASME Journal of Energy Resources Technology, and Past Chair of the Advanced Energy Systems Division of ASME. He was an Associate Editor of the ASHRAE HVAC&R Research Journal and Chair of the ASHRAE Technical Committee on Absorption and Heat Operated Machines, and was on the ASHRAE Research Administration Committee. He is the recipient of the NSF CAREER Award (1999), the ASHRAE New InvestigatorAward (1998), the SAE Ralph E. Teetor Educational Award for Engineering Educators (1998), and was the Iowa State University Miller Faculty Fellow (1999-2000) and Woodruff Faculty Fellow (2003-2008) at Georgia Tech. He received the ASME Award for Outstanding Research Contributions in the Field of Two-Phase Flow and Condensation in Microchannels, 2012.,

Dr. E. Anil Kumar

E. Anil Kumar is Associate Professor in the Discipline of Mechanical Engineering, IIT Indore. He obtained his Ph.D. Degree from the Department of Mechanical Engineering, IIT Madras.

His research interests are measurement of Thermodynamic and Thermophysical properties of solid state hydrogen storage materials, Carbon dioxide capture and sequestration. He has published more than fifty papers in peer reviewed International Journals and Proceedings of International and National Conferences.

REGISTRATION FEE

Students (UG/PG): Rs. INR 5000/-

Research Scholars: Rs. INR 8000/-

Faculty Members: Rs. INR 12000/-

Industry and Others: Rs. : USD 300

Foreigners: USD INR 15000/-

COURSE COORDINATOR:

You can find more details regarding eligibility fee payment, travel information, accommodation, etc., at **http://gian.iiti.ac.in/** or please contact the course coordinator via e-mail or phone.

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TRAVEL & ACCOMMODATION

Indore located in Central part of India in Madhya Pradesh State. It is well-connected by rail, road and air. The nearest railway station is Indore Junction and the nearest Airport is Devi Ahilyabai Holkar Airport. For queries regarding travel information, please contact the course coordinator.

Paid accommodation will be provided to participants on first-come-first-serve basis.