

# FUNDAMENTALS OF MULTISCALE HEAT TRANSFER

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## Overview

Scientific advances in nanotechnology and nanoscience have grown leaps and bounds over the last two decades, and with that questions have emerged about suitably employing the knowledge gained from these investigations at the atomistic scale to the utilization of humankind. While the subject is multidisciplinary, mechanical engineering forms a significant part of research and development in nanoscale thermal sciences. For example, with the increasing number of transistors being squeezed into the microprocessor chip to enhance computer performance, novel thermal management strategies need to be designed for efficient energy removal from such small-scale devices and prevent formation of hot spots. Here, the length scales of the systems considered are comparable to those of energy (lattice vibrations known as phonons) and charge carriers (electrons), which make continuum theories insufficient to understand the molecular scale transport. Thus, for awareness of such contemporary scientific and technological challenges and to provide next generation of researchers with tools to address these problems, exposure to nanoscale heat transfer is important. A holistic representation of thermal transport problems varying across scales of length and time, require integrated discussions of continuum and molecular heat transfer topics.

This course will provide researchers across various scientific disciplines engaged with multiscale thermal management problems a broad exposure to analytical, numerical and experimental techniques that cohesively describe heat transfer processes across nano-to-macro length scales. A “bottom-up” strategy will be adopted and the uniqueness of this course offering lies on its cross-disciplinary character by bridging the boundaries of engineering and pure sciences.

<b>Modules</b>	<b>A: Nano/microscale heat transfer : October 9 - October 11</b> <b>B: Micro/continuum heat transfer : October 12 – October 13</b> <b>Number of participants for the course will be limited to thirty five.</b>
<b>You Should Attend If...</b>	<ul style="list-style-type: none"><li>▪ you are an electronics or mechanical or materials engineer or researcher interested in designing novel thermal management solutions for packaging and nanomaterial applications.</li><li>▪ you are scientist interested in understanding fundamental energy transport processes in metals, semiconductors and dielectrics</li><li>▪ you are a student or faculty from academic institution interested in learning about how the nanoscale atomic features contribute to macroscopic thermal properties</li></ul>
<b>Fees</b>	The participation fees (including 18% GST) for taking the five-day course is as follows: <b>Participants from abroad: US \$500</b> <b>Industry/ Research Organizations: Rs 25,000/-</b> <b>Government R&amp;D/Academic Institutions: Rs 10,000/-</b> <b>Students &amp; Research Scholars: Rs 3,000/-</b> The above fees include all instructional materials, computer use for tutorials and assignments, laboratory usage charges, free internet facility. The participants will be provided with accommodation on payment basis. (for details of fee payment – please see page 3)

## The Faculty



**Dr. Ganesh Balasubramanian** is an Assistant Professor of Mechanical Engineering at Lehigh university. His research and teaching interests are in computational materials engineering, nanoscale thermal and fluid transport, structural and mechanical properties of multi-component systems, developing novel curriculum for teaching emerging technologies.



**Dr. Sandip Kumar Saha** is an Associate Professor of Mechanical Engineering at Indian Institute of Technology Bombay. His research interests include thermal management of electronics, thermal storage system for solar thermal applications, green buildings, heat transfer and computational fluid dynamics.

### For Registration

**First register at GIAN site:** <http://www.gian.iitkgp.ac.in/GREGN>

**Then sent Application with Fees to Course coordinators:**

**Prof. Sandip Kumar Saha,**  
Course Coordinators,  
Department of Mechanical Engineering,  
Indian Institute of Technology Bombay,  
Powai, Mumbai – 400 076  
Phone: +91 22 25767392  
Fax: +91 22 2572 6875  
Email: [sandip.saha@iitb.ac.in](mailto:sandip.saha@iitb.ac.in)

**Deadline for submitting application: 22 September, 2018**

**Notification of acceptance: 24 September, 2018**

- Incomplete application forms will not be entertained.
- For additional copies of the registration form, please photocopy or type in the format given. For further details: <http://www.iitb.ac.in/~cep/>

### **Boarding & Lodging**

Limited accommodation is available in the Institute Guest house/ Hostels for a very limited number of participants on payment as per actual and with advance request.



## Course Coordinator

**Prof. Sandip Kumar Saha**  
Phone: 022 2576 7392  
E-mail: [sandip.saha@iitb.ac.in](mailto:sandip.saha@iitb.ac.in)

<http://www.gian.iitkgp.ac.in/GREGN>

**GIAN Short Term Course on**  
**FUNDAMENTALS OF MULTISCALE HEAT**  
**TRANSFER**

**9-13 October 2018**

**Registration Form**

Name(in block letters): \_\_\_\_\_  
\_\_\_\_\_

Qualification: \_\_\_\_\_

Designation: \_\_\_\_\_

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

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

Mobile: \_\_\_\_\_

Fax: \_\_\_\_\_

Email: \_\_\_\_\_

Payment: Rs: \_\_\_\_\_

IIT Guest House/ Hostel accommodation required (will be provided as per availability and on a payment basis): YES / NO (Please contact the course co-ordinator for the availability details).

Signature of Applicant: \_\_\_\_\_

Date: \_\_\_\_\_

**Venue for Classes**

Classes will be held at Van Vihar Guest House, IIT Bombay

**Lecture Notes**

To fully realize the objectives of the course, the lecture notes will be made available at the time of registration at IIT Bombay.

**Date & Time of Registration:**

9<sup>th</sup> October 2018, 9.00 AM at Van Vihar Guest House, IIT Bombay.

**COURSE FEE (Including 18% GST)**

**Participants from abroad: US \$500**

**Industry/ Research Organizations: Rs 25,000/-**

**Govt. R&D/Academic Institutions: Rs 10,000/-**

**Students & Research Scholars: Rs 3,000/-**

The above fees include all instructional materials, computer use for tutorials and assignments, laboratory usage charges, free internet facility. Subject to availability, the participants will be provided with accommodation on payment basis. This payment will be made separately by the participant at the accommodation venue.

The course fees have been paid by (Please tick appropriate option)

(i) Logging in at

<https://portal.iitb.ac.in/ceqipapp>.

You will have to create a login ID, look up this course and fill up a registration form. After approval of the faculty co-ordinator, you can pay the fees.

OR

(ii) Demand draft drawn in favour of "**The Registrar, IIT Bombay - CEP Account**". **If payment is by DD, please furnish the following details:**

(iii) DD No.: \_\_\_\_\_ Dt: \_\_\_\_\_

All completed registration forms with bank transaction details may be mailed to:

[sandip.saha@iitb.ac.in](mailto:sandip.saha@iitb.ac.in) (Prof. Sandip Kumar Saha), IIT Bombay, Powai, Mumbai 400076