

## About IIT Kharagpur



Kharagpur - a dusty town tucked away in the eastern corner of India, famous until 1950 as home to the longest railway platform in the world - became the nursery where the seed of the IIT system was planted in 1951. IIT Kharagpur started its journey in the old Hijli Detention Camp in Eastern India, where some of the country's great freedom fighters toiled and sacrificed their lives for India's independence. Spurred by the success of IIT Kharagpur, four younger IITs sprouted around the country in the two following decades, and from these five came thousands of IITians, the brand ambassadors of modern India. It was the success of this one institution at Kharagpur that wrote India's technological odyssey.

The Institute takes pride in its relentless effort to provide the best platform for both education as well as research in the areas of science and technology, infrastructure designs, entrepreneurship, law, management, and medical science and technology. IITKGP is not just the place to study technology, it is the place where students are taught to dream about the future of technology and beam across disciplines, making differences enough to change the world.



### Program Features/ Structure

Classroom lectures – **80%**

Numerical/Problem solving, Case study and Discussion – **20%**

### Program Schedule and Venue

**5 days**, 16 – 20 September 2019 (9:30 AM – 4:30 PM)

IIT Kharagpur – Vinod Gupta School of Management

### Program Fee

**Nil** for TEQIP-III sponsored participants

**For others - INR 5,000/-** (Five thousand) + **GST @18%** per participant

### Who will benefit (Eligibility)

You are an advanced student (4<sup>th</sup> year undergraduate or higher) in Aerospace/ Mechanical Engineering Program.

### Last day of Registration

# 31

August 2019

### Accommodation

Accommodation will be provided to the TEQIP-III sponsored participants at the campus Guest House. For other participants, the same will be provided on chargeable basis as per rule.

## How to Apply

Use the link: <https://erp.iitkgp.ac.in/CEP/courses.htm> to apply ONLINE.



Payment if applicable is to be done **ONLINE** after getting short listed for the program.

## Contact Us

**Dr. Mrinal Kaushik**, Principal Coordinator  
Department of Aerospace Engineering  
Indian Institute of Technology Kharagpur  
Phone: +91-3222-283004  
Email: [mkaushik@aero.iitkgp.ac.in](mailto:mkaushik@aero.iitkgp.ac.in)



# NPIU

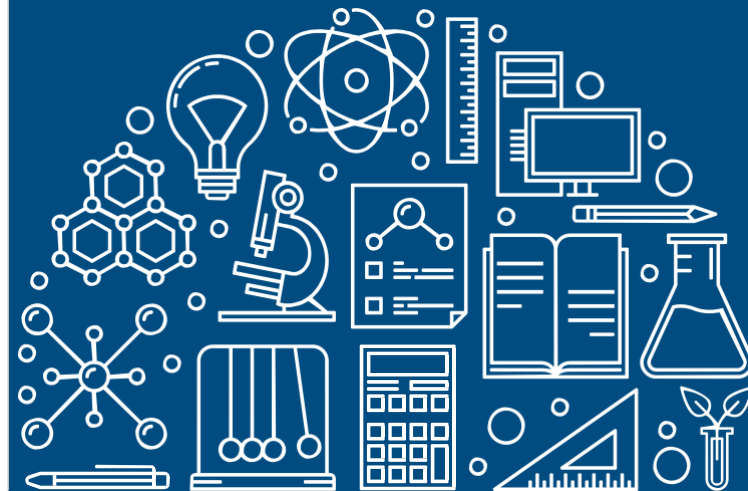
# TEQIP-KIT

NPIU - A Unit of MHRD, Govt of India for  
Implementation of World Bank Assisted Projects in Technical Education

Indian Institute of Technology Kharagpur

## NON-EQUILIBRIUM AEROTHERMODYNAMICS

16– 20 September 2019



## Introduction / Overview

The subject of “Non-equilibrium Aerothermodynamics” involves study of non-equilibrium gas flows from a microscopic (molecular) perspective. The approach is based on the kinetic theory, which is usually applied to the modelling of non-equilibrium gas flows, such as rarefied flows through micro/nano-channels and around high speed vehicles operating at high altitudes. Considering the ongoing focus of research/industries on micro/nano scale technologies and human space/planetary missions, it is important to have a short-term course such as “Non-equilibrium Aerothermodynamics”. Such a course would not only prepare graduate students for working on state-of-the-art research problems, but also would train them to suit to the changing job requirements in the market. The proposed course, organized by IIT Kharagpur, is one such initiative in this direction, with the objective of disseminating the knowledge in this interesting subject.

## Program Objectives

The specific objectives of the course on “Non-equilibrium Aerothermodynamics” are as follows:

- (i) To develop an ability to when and where to apply the microscopic description of fluids.
- (ii) To understand the concepts, procedures and applications of the kinetic theory of gases and the Boltzmann equation.
- (iii) To introduce the basic solution procedures of the Boltzmann equation using the particle based Direct Simulation Monte-Carlo (DSMC) approach.

## What you will learn

### Program Content

1. Introduction to Non-equilibrium Gas Flows: Need for a molecular description of fluid flow, concepts of equilibrium, continuum breakdown, degree of non-equilibrium.
2. Molecular Model & Collisions: Molecular model, elastic collisions, concept of collision cross-section, collision frequency, mean free path, collision rate constant, hard sphere model, variable hard sphere model, inelastic collisions.
3. Basic Kinetic Theory: Dilute gas flows, velocity distribution function, derivation of the Boltzmann equation and its importance, Maxwell-Boltzmann distribution, H-theorem.
4. Solution of the Boltzmann Equation: Introduction to particle based approach, Direct Simulation Monte Carlo (DSMC) method, how it works, different processes modeled, gas-surface interactions, calculation of macroscopic properties, scope/mandates of the method, example problems.

## About the Faculty

### Dr. Rakesh Kumar

He is an Associate Professor in the Department of Aerospace Engineering at IIT Kanpur, India. He earned his Ph.D in Aerospace Engineering from the Pennsylvania State University (USA) and M.Tech in Aerospace Engineering from the IIT Bombay. Prior to joining IIT Kanpur in 2012, he also worked at the Indian Space Research Organization (Trivandrum) for several years, where he was instrumental in various successful space missions of national importance such as, CHANDRAYAAN-I. His research interests include hypersonic flows, rarefied gas dynamics, micro/nano-fluidics, heat transfer and thermal design of aerospace systems. He has been actively contributing to these fields.

### Principal Coordinator

#### Dr. Mrinal Kaushik

He is an Assistant Professor in the Department of Aerospace Engineering at IIT Kharagpur, India. He earned his Ph.D., M.Tech and B.Tech degrees in Aerospace Engineering in 2012, 2003, and 1999, respectively, from the IIT Kanpur, India. Prior to joining IIT Kharagpur in 2013, he also worked at Defense Institute of Advanced Technology, General Motors Tech Center, Indian Space Research Organization; and Tata Consultancy Services for several years.

His research interests are Shock/Boundary-Layer Interactions and Jet Controls & Aeroacoustics. He is the reviewer of many international journals such as; Aerospace (MDPI), China Ocean Engineering (Springer), Physics of Fluids (AIP), Journal of Aerospace Engineering (ASCE), Cogent Engineering (Taylor & Francis), Cogent Physics (Taylor & Francis), Journal of the Institution of Engineers (India), etc.

He has authored four text books; Fundamentals of Gas Dynamics (Springer Nature, Singapore, In Progress); Theoretical and Experimental Aerodynamics (First Edition, Springer Nature, Singapore, 2018); Essentials of Aircraft Armaments (First Edition, Springer Nature, Singapore, 2016); and Innovative Passive Control Techniques for Supersonic Jet Mixing (Lambert Academic Publishing, Germany, 2012).

He has been acknowledged for his book by the Defense Minister of India (2016). His biography is included in the prestigious database Marquis Who's Who World (2016). He is also the recipient of a Young Researcher Award from Venus International Foundation, India (2015).

