

**AICTE QIP  
SHORT TERM TRAINING PROGRAMME**

*On*

**Theory and Analysis of Compressible  
Turbulence (TACT)**

**22-27 March 2021**

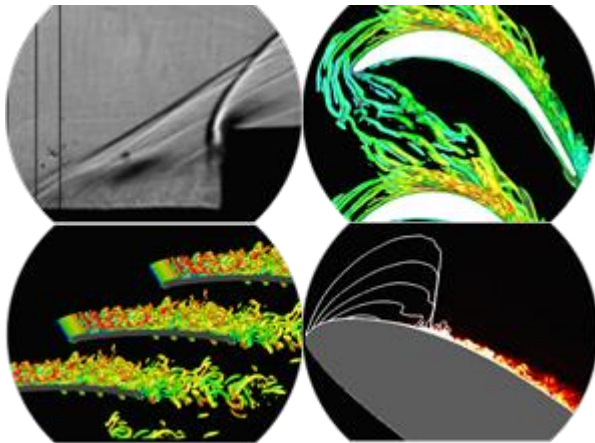
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**All India Council for Technical Education**



*Organized by*

**Department of Aerospace Engineering &  
Centre for Continuing Education  
Indian Institute of Technology Madras**



**BACKGROUND**

Turbulent flows are ubiquitous in nature and are encountered in a wide spectrum of engineering applications. The proposed short-term course is designed to enhance the basic knowledge on the theory and analysis of turbulent flows. Starting from the fundamental principles, the participants will be introduced to different experimental and numerical methods to capture, and subsequently analyse, the turbulent flow physics.

**COURSE CONTENT**

**Fundamentals of turbulent flows:**

- Characteristics of turbulence
- Transport equations for the kinetic energy, enstrophy of mean and fluctuating flow field.
- Energy cascading principles, Kolmogorov theory, Karman Howarth equation.
- Derivation of governing equations for second order correlations (Reynolds stresses),
- Effects of dilatation, pressure-strain correlations in compressible flows.
- Compressibility effects

**Computational techniques to capture turbulent flows:**

- Introduction to turbulence modelling (RANS/hybrid-RANS) and resolving strategies (LES/DNS)
- Non-dissipative high-order schemes
- Numerical techniques for multiphase flows

**Experimental techniques to capture turbulent flows:**

- Particle Image Velocimetry,
- Laser Doppler Velocimetry, Hot wire anemometers
- Kulite pressure sensors, shear stress sensors
- Schlieren and shadowgraph techniques

**Analysis of turbulent flow field & its applications:**

- Introduction to different methods to identify coherent structures.
- Turbulent Spectra/ Reynolds stresses/ Energy budgets, etc
- Turbulent flows in propulsion systems, multiphase flows and high-speed non-equilibrium flows.

**FACULTY**

Mar 22 MON	<ul style="list-style-type: none"> <li>• Introduction to Turbulent flows (<b>Prof. A. Sameen, AE, IITM</b>)</li> <li>• Turbulence Modelling of incompressible flows (<b>Prof. Vagesh Narasimhamurthy, AM, IITM</b>)</li> </ul>
Mar 23 TUE	<ul style="list-style-type: none"> <li>• Averaging of compressible turbulence equations and their modelling (<b>Prof. Kameswararao Anupindi, ME, IITM</b>)</li> <li>• Large Eddy Simulation of Compressible Turbulence (<b>Prof. Arul Prakash, AM, IITM</b>)</li> <li>• Imaging Techniques in High-Speed Flows (<b>Prof. G. Rajesh, AE, IITM</b>)</li> </ul>
Mar 24 WED	<ul style="list-style-type: none"> <li>• Turbulence modelling for compressible flows in propulsion systems (<b>Prof. T. Jayachandran, AE, IITM</b>)</li> <li>• Eddy Resolving simulations of turbulent flows in turbomachines. (<b>Prof. V. Nagabhushana Rao, AE, IITM</b>)</li> <li>• Shock Wave- Boundary Layer Interaction (<b>Prof. R. Sriram, AE, IITM</b>)</li> </ul>
Mar 25 THU	<ul style="list-style-type: none"> <li>• Towards hypersonic turbulent flow simulations (<b>Prof. Shankar Ghosh, AE, IITM</b>)</li> <li>• Introduction to Machine Learning for Turbulence Modelling (<b>Prof. Balaji Srinivasan, ME, IITM</b>)</li> <li>• High speed turbulent reacting flows - Experimental aspects (<b>Prof. T Muruganandam, AE, IITM</b>)</li> </ul>
Mar 26 FRI	<ul style="list-style-type: none"> <li>• Particles in Turbulence (<b>Prof. Manikandan Mathur, AE, IITM</b>)</li> <li>• Hands-on processing of turbulence data with post-processing techniques (<b>Prof. Nagabhushana Rao &amp; Prof. Sameen</b>)</li> </ul>
Mar 27 SAT	<ul style="list-style-type: none"> <li>• High Speed Propulsion Systems (<b>Prof. Lazar Chittilapilly, AE, IITM</b>)</li> <li>• Live demonstrations of experimental tools (<b>Prof. Rajesh</b>)</li> </ul>

**COURSE DURATION & VENUE**

The course is of six days duration from 22<sup>nd</sup> – 27<sup>th</sup> March 2021. Lectures will be delivered in online mode only.

**AICTE QIP**  
**SHORT TERM TRAINING PROGRAMME**  
*on*  
**Theory and Analysis of Compressible Turbulence**  
**Department of Aerospace Engineering, IIT Madras**  
**(22-27 March 2021)**

*Application Form*

- **Name (block letter):**
- **Designation:**
- **Education Qualification:**
- **Specialization:**
- **Organization:**
- **Experience (in years):**
  - (a) **Teaching:**
  - (b) **Industrial:**
- **Address:**
  
- **Phone No.:**
- **E-mail:**

**DECLARATION**

The information furnished above is true to the best of my knowledge. I also undertake the responsibility to inform the coordinators, at least 3 days in advance, in case I am unable to attend the course.

Place:

Date: \_\_\_\_\_ Signature of the Applicant

**CERTIFICATE**

Certified that Dr./Mr./Ms./Mrs./\_\_\_\_\_ is an employee of our institute/organization, working in the capacity of \_\_\_\_\_. His/her application is hereby deputed to attend the short-term course on “Theory and Analysis of Compressible Turbulence” at IIT Madras during 22<sup>nd</sup>-27<sup>th</sup> March, if selected.

Date: \_\_\_\_\_ Signature of Deputing Authority  
(with seal)  
Place: \_\_\_\_\_

**ELIGIBILITY**

The course is open to faculty in *Aerospace and Mechanical Engineering*, (with background in *Fluid Mechanics and Heat Transfer*) and allied branches from engineering colleges approved by AICTE. *No course fee* is charged for participants sponsored by AICTE approved institutions.

**IMPORTANT DATES**

Last date for application : **12<sup>th</sup> March**  
Intimation of selection (by email) : **15<sup>th</sup> March**  
Confirmation of participation (by email) : **17<sup>th</sup> March**

**COURSE COORDINATORS**

Prof. Nagabhushana Rao Vadlamani  
<https://home.iitm.ac.in/nrv/>

Prof. Sameen A  
<http://www.ae.iitm.ac.in/~sameen/profile.htm>

Prof. Rajesh G  
<http://www.ae.iitm.ac.in/~rajesh/index.html>

**ADDRESS FOR CORRESPONDENCE**

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