M.Tech. IN
COMPUTATIONAL FLUID DYNAMICS (M.Tech.-CFD)

2 years, full-time and residential offered in academic articulation with UPES, Dehardun (www.upesindia.org)

FOCUS AREAS

- Theoretical and Computational Fluid Dynamics
- Hydrodynamic Modeling
- Computational Mechanics and Scientific Computation
- Aerodynamics
- Environmental Fluid

"Over the last twenty to thirty years considerable progress has been achieved, and the field of Computational Fluid Dynamics (CFD) is reaching a mature stage, where most of the basic methodology is, and will remain, well established." - Charles Hirsch

Computational Fluid Dynamics (CFD) is a revolutionary modern form of computational technology that numerically simulates fluid flow over virtual geometry. Until recently, CFD has only been effectively utilized within the aerospace and automotive industries because of high software costs and powerful computational requirements. With the development of computers that have high speed processing capability, it is now possible to run the majority of CFD models. CFD can be used in almost all industrial and non-industrial applications – starting with Aerodynamics and Gas Turbine Design, Automotive Engineering, Turbo-machinery, Chemical Processes, Marine Engineering, Environmental and Biomedical Engineering, Meteorology, Hydrology, Oceanography, etc. This 24-month, full-time, Master of Technology (M.Tech.) in Computational Fluid Dynamics is a unique program in India and South East Asia, designed to equip students to accept challenges in the engineering applications of fluid flow and heat transfer and computational modeling.

ELIGIBILITY

Minimum 60 percent marks at Higher & Senior Secondary level (10^{th} and 12^{th}). Bachelors Degree in Engineering / Technology in Aerospace / Mechanical / Chemical / Metallurgy / Civil / Environmental / Computer Science OR MSc in Applied Mathematics / Physics / Computer Science with minimum 60 percent marks or equivalent grade from a recognized University.

ADMISSION CRITERIA

Screening of application and interview. Candidates with valid GATE score can also apply.

M.Tech. IN
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COURSE STRUCTURE

SEMESTER	CODE	COURSE NAME	CREDITS
FOUNDATION	CFD501	Introduction to CAD, CAE and MATLAB	3
	CFD502	Advanced Mathematics	3
	CFD503	Basic Fluid Mechanics	3
	CFD504	Computational Mechanics & Numerical Mathematics	3
	CFD505	Mathematical Modelling & Simulation	3
	CFD506	Introduction to CFD	3
	AST508	Programming in C, C++ and JAVA	3
CORE	CFD601	Advanced Computational Fluid Dynamics	3
	CFD602	Environmental Fluid Dynamics	2
	CFD603	Advanced Heat and Mass Transfer	3
	CFD604	Computational Gas Dynamics	3
	CFD605	Programming Environment in Parallel Computing	3
	CFD606	Geometrical Modelling and Mesh Generation	3
	CFD607	Turbulence Modelling	3
ADVANCED	CFD701	Aerodynamics	2
	CFD702	Multiphase Flow	2
	CFD703	Hydrodynamic Instabilities	2
	CFD704	Inverse Modelling	3
	CFD705	Unsteady Flow through Porous Media	3
	CFD706	Graphics and Visualization	2
	MATH801	Artificial Intelligence and Neural Networks	3
SEMINAR	CFD608	Seminar I	1
	CFD707	Seminar II	1
MINI PROJECT	CFD901	Mini Project	2
PROJECT	CFD902	Project	18
		Life Skills Management (Compulsory subject)	
Total Credits			80

*1 Credit Hr = 12 Class Hrs / 24 Lab Hrs in a semester

Delivery of an elective will be subject to availability of domain expert / faculty as well as minimum number of students for that particular elective

MS Program in Computational Fluid Dynamics

In collaboration with & academic accreditation by Moscow State University, Moscow, Russia

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Program

This autonomous, four semester, 24-month, 72 Credits, full-time Masters Program in Software Technologies is designed to equip students to accept responsibilities in the following areas:

- Computational Methods in Fluid Dynamics
- Mathematical Modelling and Simulation Parallel and High Performance Computing
- Software Design, Development and Engineering
- Industrial and Environmental Fluid Mechanics

Distinctive Features

- Provides theoretical and computational foundations in Fluid Mechanics
- Provides relevant exposure towards industrial problems
- Teaching by leading experts from the industry
- Hands-on experience with ANSYS-FLUENT software
- Hands-on experience in Parallel Computing / High Performance Computing
- Hands-on experience with software design and development
- Option to work on industrial projects offered by the leading companies

Eligibility

Graduates with a Bachelors degree in Engineering (with First class or minimum 60%) of at least four years duration in Mechanical / Aerospace / Chemical / Civil / Environmental / Structural / Production / Metallurgy / Electrical / Electronics / Computer Science or MSC in Physics / Mathematics and allied areas in Engineering / Science from a recognized University / Institute

Program Commencement

The Program commences in July / October

Selection Process

The selection of an applicant for the course is based on the following:

- Application forms shall be scrutinized for academic profile in line with the eligibility criteria.
- Scores received at the Graduation level like BE / B Tech / M.Sc. etc
- Scores received at the "Accepted Qualifying Examinations" Like GRE / GATE
- Performance in the Entrance Test and Personal Interview

Bridge Courses

- Keeping in view the diverse background of students, variety of courses is offered under bridge courses to attain the requisite level of competency for further learning
- Students will undergo entrance examination and interview as a part of selection process
- Depending on the performance, students will be advised to undergo the bridge courses
- Duration of the bridge courses is 4 weeks prior to the beginning of the academic term
- Performance in the bridge courses count towards partial weightage in the relevant foundation course

CFD001: INTRODUCTION TO CAD, CAE AND MATLAB (Bridge course credits: Nil)
This course covers elements of interactive computer graphics, techniques for geometric modeling, transformation, manipulationand interactive modeling. Introductionto CAD and CAE related software. Part modeling, surface modeling and drafting will be conducted using I-DEAS / CATIA software. This course will also providehands on training in MATLAB numerical computing environment, programming language and mathematical functions. Students will learn plotting of functionsand data, creation of user interfaces and its applications.

AST001: COMPUTER ARCHITECTURE AND OPERATING SYSTEMS
(Bridge course credits: Nil)
Thiscourse covers operating system design concepts with examples from Linux and Windows operating systems. It also focuses on the study of the hardware structure of computer systems and sub-systems. The topics in computer architecture include: Processor architecture,Parallelism and pipelining Cacheand memory organization, I/O controllers and interconnection structures. The topics in operating system include: Operating system structures process and thread management, memory management virtual memory, file system I/O subsystem and device management communication protection and security.

AST003: DATA STRUCTURES AND ALGORITHMS (Bridge course credits: Nil)
This course focuses on the different data structures and their applications in computer programming. The data structures covered here are array, stack, queue, linked lists, binary tree and various sorting and searching algorithms.

AST005: FORTRAN AND C PROGRAMING (Bridge course credits: Nil)
This covers basics in FORTRAN and C programming languages for writing codes corresponding to scientific and engineering problems. In addition to covering basic syntax and semantics, the course emphasizes on problem solving methodology and modular programming techniques. The module focuses on imparting a working knowledge of FORTRAN and C programming languages (using STAT / MATH and ANSI standard C libraries).

NTC002: COMPUTER NETWORKS
This course shall emphasis on developing and understanding of the underlying principle of computer networking. Students will learn fundamental concepts of communication protocol stocks: OSI and TCP / IP, IP addressing schemes, subneting, LAN, MAN, WAN fundamentals, circuit and packets switching, networking devices, network protocols, standards, Internet Intranet, network security and allied technologies.

Foundation Courses

CFD501: ADVANCED MATHEMATICS (Credits: 2)
Advanced course in mathematics will prepare the students in vector space, vector calculus, linear algebra, eigen values and eigen vectors. Solving partial differential equation (PDE) using initial and boundary values, Maximum principle in solving PDE, Fourier transform, Fast Fourier transform, tensors, conformal mapping with application, coordinate transformation utilizing Jacobian, numerical method for differentiation and integration, jacobian method, conjugate gradient method, Norms and fundamentals of functional analysis.

CFD502 : MATHEMATICAL MODELING AND SIMULATION (Credits: 2)
This course on mathematical modeling and simulation will enable the students to develop mathematical models to represent deterministic and probabilistic systems using the mathematical tools they have studied. Students will be learning finite difference method, Monto-Carlo simulation, auto correlation, linear and nonlinear optimization, Markov process, probability and other basic stochastic processes. These concepts will be applied for modelling of fluid flow problems. Examples of modelling in related areas will be discussed and major emphasis will be given to develop mathematical models to represent simple engineering systems.

CFD503: BASIC FLUID MECHANICS (Credits: 2)
In this unit the students will be introduced to the basic concepts of fluid flow. The governing equations for incompressible / compressible fluids will be delivered and studied for a range of applications, elementary viscous flow, including Couette flow, boundary layers and tube flows; transition Reynolds number and concepts of turbulence; skin friction and pressure drop calculations. The latter half of the course will concentrate on the analysis of subsonic and supersonic flow past aerofoil, wings and related bodies.

CFD504:COMPUTATIONAL MECHANICS AND NUMERICAL MATHEMATICS (Credits:2)
This course is designed to teach students the underlying concepts of numerical solution techniques and specific methodologies for solving fundamental problems via computer programs. The course objective is to teach students the basic techniques used to discretize continuous systems, as well as common methods to solve the resulting equations. The course is designed to familiarize the students with the cornerstones of modern computer-based analyses, such as matrix equation solution techniques, polynomial approximation, treatment of nonlinearity, dimensionless analysis, advanced techniques in finite difference and finite volume methods applicable to fluid flow problems. An important objective and central theme of this course is to develop programming skills that will be drawn upon in other parts of the curriculum.

CFD505 : INTRODUCTION TO CFD (Credits: 2)
Here, students will be introduced to a range of computational techniques, stability analysis and modern acceleration techniques. In the second part of the course these ideas will be developed further with an introduction to incompressible flow solvers where artificial compressibility, pressure Poisson and pressure correction approaches will be introduced. This course emphasizes on classification of incompressible Navier-Stokes code with respect to various parameters, description of vorticity-stream function approach, SOLA code, SIMPLE / SIMPLER code, MAC code and Chorin code. Transformation of Navier-Stokes equation using generalized coordinate system and fundamental concepts of grid generation and turbulence modelling will also be covered.

CFD506 : PROGRAMMING ENVIRONMENT IN PARALLEL COMPUTING (Credits: 2)
The course lays stress on the use of parallel

machines by applications of substantive size, covered application domains including scientific and engineering computation, real-time systems, graphics, and parallel optimization. Overview of parallel computing, concepts and terminology, parallel computing memory architecture, parallel programming models, design of parallel programs, Operating systems, MPI / Open MPI calls, programming support for parallel computation, and specific example from fluid flow and heat transfer will be covered in this course. In addition, multicore, clusters and grid architecture will be taught.

CFD507 : C++ PROGRAMMING (Credits: 2)
This course introduces C++ as a general purpose computer language, leveraging the student's experience with C, C++, Java, or other computer languages. The focus is on software engineering principles in programming, data abstraction, object oriented concepts and understanding the purpose and intended application of language features. Topics include the application of abstraction and encapsulation using C++; interface design and implementation of independent object classes and user-defined types; the role of constructors, destructors, function, and operator overloading; I/O Streams facility and basic memory management programming techniques; the design and implementation of advanced container classes and class hierarchies.

CFD508: SEMINAR - I (Compulsory Credit:1)
Students have to study the pre-assigned topic in depth, prepare seminar report and present the same to the designated panel.

RUS001: RUSSIAN LANGUAGE LEVEL – I (Compulsory Credits: Nil)
The course aims to consolidate knowledge of the Russian language and to extend the students' active and passive vocabulary, improve fluency, pronunciation, accuracy and comprehension skills. It also aims to increase the students' awareness of cultural information and social conventions in countries where the target language is spoken. This course is compulsory for all CFD students.

Core Courses

CFD601 : FINITE DIFFERENCE METHODS FOR GAS DYNAMICS (Credits: 2)
This course will cover Eulers equations and conservation laws, exact solutions on linear advection equation, Cauchy problem, Riemann problem, vanishing viscosity solutions, numerical solutions for smooth data, finite difference and finite volume, geometric flux interpretation and conservative schemes, discontinuous data, nonlinear, scalar equations, exact behaviour, entropy conditions, Godunov's method, non-linear stability analysis, etc.

CFD602 : ADVANCED COMPUTATIONAL FLUID DYNAMICS (Credits: 3)
This course will emphasize on topics such as 3-D Euler equations, 3-D boundary layer theory; Navier-Stokes equations, model of thin viscous shock layer (TVSL), simplified parabolic Navier-Stokes equations, viscous shock layer, thin layer numerical simulation, numerical simulation, finite-difference methods, finite-volume methods, finite-element methods, Galerkins approaches, Fourier transform, etc. Computational algorithms based on numerical methods, surface and grid generation methods, curvilinear grid points, partial differential equation, rectangular Cartesian grid, Search algorithms, data structures and refinement techniques will also be covered in this course.

CFD603: RATIONAL PROGRAMMING FOR MATHEMATICAL MODELING (Credits: 2)
This course will emphasize the advantages of rational programming for coding mathematical models, increasing accuracy methods, methods to speed up modelling code, rational memory using memory / speed criteria optimization, effectiveness and accuracy estimation for numerical methods, character problem features for increasing performance of computations, parallel computing in mathematical modelling, parallel code speedup estimation, data exchange optimization.

CFD604: MATHEMATICAL MODELLING FOR NONLINEAR PROCESSES (Credits: 3)
This course will lay emphasis on conservative laws and equations for incompressible fluid in primitive variables and vorticity stream function formulations, conservative form of the equations, boundary conditions, one dimensional transfer equation, finite-difference scheme, etc. Direct and iteration methods for finite-volume type, generalizing methods for flows with free surface, non-homogeneous fluid flows will also be discussed.

CFD 605: NUMERICAL METHODS FOR MATHEMATICAL PHYSICS (Credits: 2)
The course will cover parabolic equation related to heat conduction problem, elliptic equation corresponding to Laplace and Poisson equations and hyperbolic equation for wave propagation problems. The basic notations and theory of difference schemes will be introduced along with the CFL criteria for the convergence of numerical scheme. Implementation of sweeping techniques for solving heat conduction and Poisson equations will also be taught in addition to spectral analysis and variational techniques to solve partial differential equations.

CFD 606: ENVIRONMENTAL FLUID DYNAMICS (Credits: 2)
This course will focus on applications of fluid mechanics to natural flows of water and air in any environmentally relevant systems. Fundamental concepts will be provided to computer based modeling and numerical simulation techniques to improve the understanding of complex interactions among different parameters. The evaluation of actual or proposed human-induced changes in environmental systems through modelling and simulation techniques will be dealt with. The knowledge of these processes is then sequentially applied to the following areas: surface and groundwater hydrology, hydraulic systems and meteorology where mixing, interaction and stratification processes are important.

AST602 : OBJECT ORIENTED ANALYSIS AND DESIGN (Credits: 2)
This course focuses on the major techniques of the Java Language, object-oriented analysis and design notation and how these techniques can be applied to improve quality of productivity during the analysis and design of application. The topics covered include object models, analyzing system requirements, modeling concepts provided by UML, analysis and documentation of software designs using

MS Program in Computational Fluid Dynamics

the unified process, identification of use cases, behavioral designs, design patterns to refine analysis and design models, implementation, testable and adaptable designs.

AST603 : SOFTWARE ENGINEERING AND PROJECT MANAGEMENT (Credits: 2)
This course provides a comprehensive analysis of software engineering techniques and shows how they can be applied in practical software projects, all with an object-oriented approach. This course extensively covers software processes technology, system integration, requirement management, software project management, verification and validation, risk analysis, pattern based reuse, dependable systems development, distributed system engineering and legacy systems.

CFD607 : SEMINAR- II (Compulsory Credit : 1)
Students have to study the pre-assigned topic in depth, prepare seminar report and present the same to the designated panel.

RUS002 : RUSSIAN LANGUAGE LEVEL - II (Compulsory Credits: Nil)
The level-II Russian language course will be delivered at Moscow and aims to improve fluency, pronunciation, accuracy and comprehension skills. The course aims to revise and extend high frequency language of personal relevance and to introduce students to informal and formal styles. This course is compulsory for all students.

Advanced Courses

CFD701 : GEOMETRICAL MODELING AND MESH GENERATION (Credits: 2)
This course will emphasize numerical simulations and computational grids, curvilinear grids, Winslow method, Godunov method, Structured and unstructured grids, spatial mappings and computational grids, Delaunay empty ball theorem and modern unstructured grid generation methods, construction of hybrid grid, basics of surface grid generation, surface flattening techniques, relations between curvature and manifolds parameterization, cone condition, isothermic, Chebyshev and quasi-isometric coordinates in MBC, adaptive meshing in numerical simulation, etc.

CFD702: CONVECTION, HYDRODYNAMIC INSTABILITIES AND TURBULENCE (Credits: 2)
Here, the emphasis will be on hydrodynamic equations (Euler and Navier-Stokes equations), nature of viscosity, compressible fluid, equitation state, thermodynamic properties of fluid, shock waves, convection, convective criterion, convective heat transfer, hydrodynamic instabilities, turbulence, stochastic description of the turbulence, direct numerical simulation of turbulence, role of large-scale structures in turbulence development for free shear fluid, combustion, slow combustion, instability of flames, etc.

CFD703: COMPUTATIONAL AERO-ACOUSTICS (Credits: 2)
This course will focus on acoustic wave propagation and noise generation, CFD models for compressible gases, and simulation of mean fields for turbulent flows, flow simulation within the LES (Large Eddy Simulation) approach, mathematical models in CAA, deterministic / stochastic approach to simulation of noise generation phenomenon for turbulent flows, methods for acoustic signal processing, unified models and high accuracy algorithms, numerical algorithm, finite-difference and finite-volume approaches for Cartesian and arbitrary unstructured meshes, etc.

CFD704: EFFICIENT NUMERICAL METHODS IN CFD PROBLEMS (Credits: 2)
This course will emphasize on the basics in physics, Navier-Stokes mathematical model and its properties, functional spaces and inequalities, linear problems, non-linear non-stationary problems, different coordinates systems, 2D and 3D grid generation, approximating differential operators on the arbitrary grids, properties of these approximations, applying Tikhonov's method to 2D and 3D problems, etc.

CFD705: HIGH ACCURACY AND ARBITRARY METHODS IN FLUID DYNAMICS (Credits: 2)
This course will give an overview of finite difference methods, approximation, stability, spectral properties, high order schemes applications in engineering and scientific problems, 3D and 5th order compact upwind differencing schemes with high resolution of fine details of solutions, finite-volume schemes based on compact approximations, application to the Euler and the Navier-Stokes equations, stability problems and direct numerical simulations, compressible CFD problems, cascade flows airfoils and wings, vortex wakes behind aircraft, problems with complicated geometries, domain decomposition with hybrid schemes combining compact ones and mesh less methods.

CFD706 : ADVANCED HEAT AND MASS TRANSFER (Credits: 2)
This course covers the topics such as diffusion kinetics, conservation laws, heat conduction, laminar and turbulent convection, mass transfer including phase change or heterogeneous reactions, and basic thermal radiation. Problems and examples will include theory and applications drawn from a spectrum of engineering design and manufacturing problems. One-dimensional steady and unsteady heat conduction, fins, elementary laminar and turbulent convection, natural convection and condensation, heat exchangers, simple blackbody and gray body radiation.

CFD707 : MULTI PHASE FLOW (Credits: 2)
This course will introduce the basic concept of multiphase flow, starting with single particle motion, bubble or droplet translation, its growth and collapse, cavitations, boiling and condensation phenomenon. It will also cover multiphase flow patterns for various topologies and disperse phase separation and dispersion, limits of separated flow and inhomogineity instability. It will also cover modeling of multiphase flows, drift flux model, granular flow and wave propagation in the multiphase flow.

CFD708: COMBUSTION AND REACTING FLOW (Credits: 2)
This course will provide essential background in thermodynamics and kinetics, equilibrium, enthalpy of reaction, adiabatic flame temperature, laws of thermodynamics, dissociation reaction and equilibrium constant, reaction rate, energy well, Arrheneous equation. Emphasis will be laid on introduction to premixed and diffusion flames, relevant physics and

applications; detonation and deflagaration, Hugoniot curve and detonation limits. In premixed combustion; flame, flame velocity, Laminar and turbulent flames, stability, limits, wall-quenching and in diffusion flames; introduction to droplet combustion, fuel injection, atomization, laminar diffusion flames will be covered. Students will also be exposed to numerical modeling of combustion and reacting flows.

ESD806 : GRAPHICS AND VISUALIZATION (Credits: 2)
This course starts with introductory mathematics of computer graphics, and physics and electronics of computer graphics. These aspects are followed with attributes of output primitives, 2D geometric transformations, 2D viewing, and numerical methods in computer graphics. Course concludes with lighting and color models, rendering aspects and parametric and nonparametric descriptions of curves and surfaces for Geometric modeling. Also covers Embedded hardware accelerators and graphics co-processors for real-time rendering.

Project

CFD 901: MINI PROJECT (2 Credits)
Students are expected to undertake a project that includes an extensive literature survey and/or design and development of system. An internal faculty guides the project. The project has to be submitted in the form of a report that will be examined by experts nominated by the institute.

CFD902 : PROJECT (Credits: 18)
Students can undertake an industry-sponsored project or a research-based project leading to Master's level competency. For industry-sponsored projects, the Career Management Center facilitates interaction between students and the industry. Students are encouraged to work on projects, which will enhance their understanding in certain technology domains within a real-life scenario. The research project includes researching on the given/chosen seminar topic, which will generally be state-of the-art in the field and then delivering the seminar to peers and faculty along with its documentation in the prescribed IEEE format. Following the seminar, the student has to undertake a research project under the guidance of tenure track/visiting faculty/and industry experts. The research project has to be submitted in the form of a dissertation, which will be examined by experts nominated by the institute. The research project is the culmination of the student's learning in the institute and is expected to be of high standards as demanded by the industry.

Total credits: 72

MS Program in Computational Fluid Dynamics

Course Structure

	Code	Course Name	Credits*
BRIDGE	CFD001	Introduction to CAD, CAE and MATLAB	
	AST001	Computer Architecture and Operating Systems	
	AST003	Data Structures and Algorithms	
	AST005	Fortran and C Programming	
	NTC002	Computer Networks	
FOUNDATION	CFD501	Advanced Mathematics	2
	CFD502	Mathematical Modelling and Simulation	2
	CFD503	Basic Fluid Mechanics	2
	CFD504	Computational Mechanics and Numerical Mathematics	2
	CFD505	Introduction to CFD	2
	CFD506	Programming Environment in Parallel Computing	2
	CFD507	C++ Programming	2
	CFD508	Seminar – I	1
	RUS001	Russian Language Level I	0
CORE	CFD601	Finite Difference Methods for Gas Dynamics	2
	CFD602	Advanced Computational Fluid Dynamics	3
	CFD603	Rational Programming for Mathematical Modelling	2
	CFD604	Mathematical Modelling for Non Linear Processes	3
	CFD605	Numerical Methods for Mathematical Physics	2
	CFD606	Environmental Fluid Dynamics	2
	CFD607	Seminar – II	1
	AST602	Object Oriented Analysis and Design	2
	AST603	Software Engineering and Project Management	2
	RUS002	Russian Language Level II	0
ADVANCED	CFD701	Geometrical Modelling and Mesh Generation	2
	CFD702	Convection, Hydrodynamic Instabilities and Turbulence	2
	CFD703	Computational Aero-Acoustics	2
	CFD704	Efficient Numerical Methods in CFD Problems	2
	CFD705	High Accuracy and Arbitrary Methods in Fluid Dynamics	2
	CFD706	Advanced Heat and Mass Transfer	2
	CFD707	Multiphase Flow	2
	CFD708	Combustion and Reacting Flow	2
	ESD806	Graphics and Visualization	2
MINI PROJECT	CFD901		2
PROJECT	CFD902		18

** 1 Credit Hr = 16 Class Hrs / 32 Lab Hrs in a semester*

M.Tech Computational Fluid Dynamics (M.Tech-CFD)

A Full-Time Residential Degree Course (24 months) offered in academic articulation with UPES, Dehradun **(www.upes.ac.in)**

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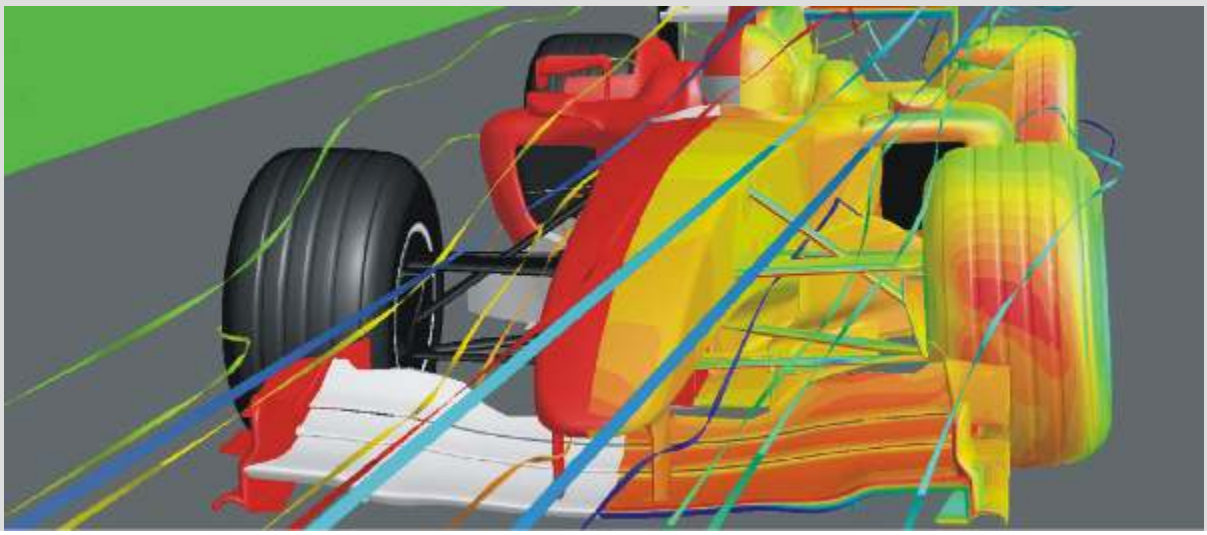

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This 24-month, full-time, Master of Technology (M.Tech) in Computational Fluid Dynamics is a unique program in India and South East Asia, designed to equip students to accept challenges in the engineering applications of fluid flow and heat transfer and computational modeling.

ELIGIBILITY

Minimum 60 percent marks at Higher & Senior Secondary level (10th and 12th). Bachelors Degree in Engineering / Technology in Aerospace / Mechanical / Chemical / Metallurgy / Civil / Environmental / Computer Science OR MSc in Applied Mathematics / Physics / Computer Science with minimum 60 percent marks or equivalent grade from a recognized University.

FOCUS AREAS

- Theoretical and Computational Fluid Dynamics
- Hydrodynamic Modeling
- Computational Mechanics and Scientific Computation
- Aerodynamics
- Environmental Fluid Dynamics
- Flow Through Porous Media
- Mesh Generation

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PROJECT	CFD902	Project	18
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Total Credits : 80

**1 Credit Hr = 12 Class Hrs / 24 Lab Hrs in a semester*