Motivated by Excellence
Sustained by Relevance

The art of visioneering

iitmadras

# Research and Consultancy Expertise and Facilities

Indian Institute of Technology Madras

## The art of visioneering

A vision to strive continuously for excellence in research. Engineering expertise to give shape to that vision. At IITM, we call it visioneering. An art that its Centre for Industrial Consultancy and Sponsored Research has perfected over the last few decades. Setting in the process, some pathbreaking trends.

The Indian Institute of Technology Madras has, since inception, served several organisations through R & D. World-class expertise and modern facilities have helped the Institute carve a niche for itself.


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## Our Vision

To be an academic institution in dynamic equilibrium with its social, ecological and economic environment striving continuously for excellence in education, research and technological service to the nation.

## Our Mission

- To create and sustain a community of learning in which students acquire knowledge and learn to apply it professionally with due consideration for ethical, ecological and economic issues.
- To pursue research and disseminate research findings.
- To provide knowledge-based technological services to satisfy the needs of society and the industry.
- To help in building national capabilities in science, technology, humanities, management, education and research.

## Quality Policy

To pursue global standards of excellence in all our endeavours namely teaching, research, consultancy and continuing education and to remain accountable in our core and support functions, through processes of self-evaluation and continuous improvement.

## Core Values

In pursuit of its mission IITM will

- Develop human resources to serve the nation
- Recognise teaching as a unifying activity
- Nurture integrity, creativity and academic freedom
- Retain a willingness to experiment with new paradigms

## Message from the Director

There have been three major paradigm shifts in recent decades, relating to innovation, competitiveness and the role of institutions such as the IITs, in wealth creation. To begin with, innovation is not a linear *"scientific push"* or a *"market pull"* process, but a *"system integration and global networking"* process. Secondly, competitive success depends more on localised concentration for skilled people and technology rather than a national effort. Thirdly, higher educational institutions should not only be investments for the future, but also direct contributors to wealth creation.

As a dynamic response to these shifts in paradigm, the Strategic Plan envisages several changes in IITM:

- Further liberalisation of industrial consultancy
- Promotion of entrepreneurship in the form of start-ups among faculty & students
- Setting up of a Research Park in the vicinity of the Institute, on land donated by the State Government, to provide the perfect ambience to promote R&D companies. This is expected, inter alia, to enable companies mentored by IITM to realise the commercial value of their IP.

The Centre for IC & SR has played an important role in IITM's resource-generation activities. In the last 5 years alone, the value of IC & SR activities has grown three fold. It is hoped that these changes will further lead to a significant and rapid growth in IC & SR activities in IIT Madras.

The Industrial Associateship Scheme helps promote industry-institute partnership by interaction at frequent intervals between faculty members and industry representatives. The number of Industrial Associates has increased to over 250. Several Technology Appreciation programmes have been conducted for Associates. Overall it has been a period of unprecedented growth and expansion.

This publication is brought out once in 3 years to highlight the research and consultancy expertise, as well as facilities available at IITM for research and testing. It is earnestly hoped that Industries and other sponsors will find it informative and that it will promote increased interaction between IITM and Industry.

M.S. Ananth
Director, Indian Institute of Technology, Madras

## Message from the Dean

In tune with the global trends in higher technological education, Centre for Industrial Consultancy and Sponsored Research (IC&SR) at IIT Madras strives to facilitate and promote the industry-academia interaction. The Centre encourages and channelises the relationships of IIT faculty with industry and external agencies.

Beginning in 1970s in a modest scale, the activities of IC&SR has grown in multiple directions. The annual outlay of projects undertaken by the 450 strong faculty has gone beyond the Rupees 1000 million mark in recent years. Three fourth of the faculty members of the Institute are involved in one form or other of the Institute's links with industries and external agencies. Some of the recent trends in IC&SR activities at IIT Madras are large value projects for establishing and augmenting centres of excellence and of topical relevance, enhanced interaction with international partners and growing awareness among the academia of intellectual property, innovation and of entrepreneurial incubation.

IC & SR works with all segments of IIT's academic community to negotiate and facilitate externally funded research support while ensuring that they remain consistent with the Institute's mission of education, research and of serving national needs. It is hoped that this compendium of expertise and facilities available at IIT Madras will serve as a useful data bank for current and prospective partners in research.

Job Kurian
Dean, Industrial Consultancy and Sponsored Research.

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## Indian Institute of Technology - Madras

Step into the Indian Institute of Technology Madras, Chennai and 250 verdant hectares greet you warmly. Travel along the tree lined avenues, and you will come face-to-face with herds of deer grazing lazily, looking up at the intrusion, but only momentarily. Before long, you are within the hallowed portals of IIT Madras, whose corridors have been witness to the creation of numerous scholars over the years.

It all began in 1956 when Pandit Jawaharlal Nehru, Prime Minister of India, was on an official visit to West Germany and was offered assistance by the Government of the Federal Republic of Germany, to set up a higher technological institute in India. The first Indo-German Agreement was signed in Bonn in 1959, for the establishment of an Indian Institute of Technology at Madras. It provided for the services of German professors and foremen, training facilities for Indian faculty members and the supply of scientific and technical equipment for the establishment of the Central Workshop and laboratories. And IIT Madras was born in 1959.

Declared an 'Institute of National Importance' by the Parliament of India in 1961, IIT Madras has sixteen academic departments and a few advanced research centres in various disciplines of engineering and pure sciences, with nearly 100 laboratories organised in a unique pattern of functioning. A faculty of international repute, a brilliant student community, excellent technical & supporting staff and an effective administration have all contributed to the pre-eminent status of IIT Madras.

Indian Institute of Technology Madras is among the foremost institutes of national importance in higher technological education as well as in research. The Institute, with a self contained campus, stands proud on about 250 hectares of beautiful wooded land in South Chennai, TamilNadu, India. At present, there are nearly 450 faculty members, 5700 students, 750 administrative and supporting staff in different departments and centres of this Institute. Growing from strength to strength, ever since it obtained its charter from the Parliament in 1961, IIT Madras has established itself as a premier Institute for teaching, research and industrial consultancy in the country.

The Institute's faculty members have taken up a number of joint collaborative research and consultancy projects with other institutions and industries. The technologies developed by the Institute have been commercialised not only within the country, but also in several other countries. Based on its overall performance, IIT Madras is ranked among the top few institutes in the Asian region.

The German Universities and the Government of Germany have given unstinted support to the Institute, making it one of the largest collaborative educational projects in the world, through a number of bilateral projects. More than 50 Joint Research projects have been taken up through BMBF, GTZ and other agencies in Germany in the last two decades. The exchange of students between German Institutes and IIT Madras is an on-going activity. Similar interactive programmes, with a number of international agencies and also Industries and Government agencies, have helped the Institute to constantly upgrade its infrastructural facilities for teaching and research.


## Interaction with Industries & Institutions

IIT Madras occupies a unique position among the academic institutions in the country as a leader in executing a variety of industrial consultancy and sponsored research projects. Its uniqueness lies in its wealth of world-class expertise and extensive modern facilities. The departments and research centres, manned by over 450 highly qualified engineers, scientists and social scientists, cover wide-ranging areas of specialisation. Over the past five decades, IIT Madras has served a large number of clients who have expressed great satisfaction. They include State and Central Government agencies, public and private sector industries and international institutions.

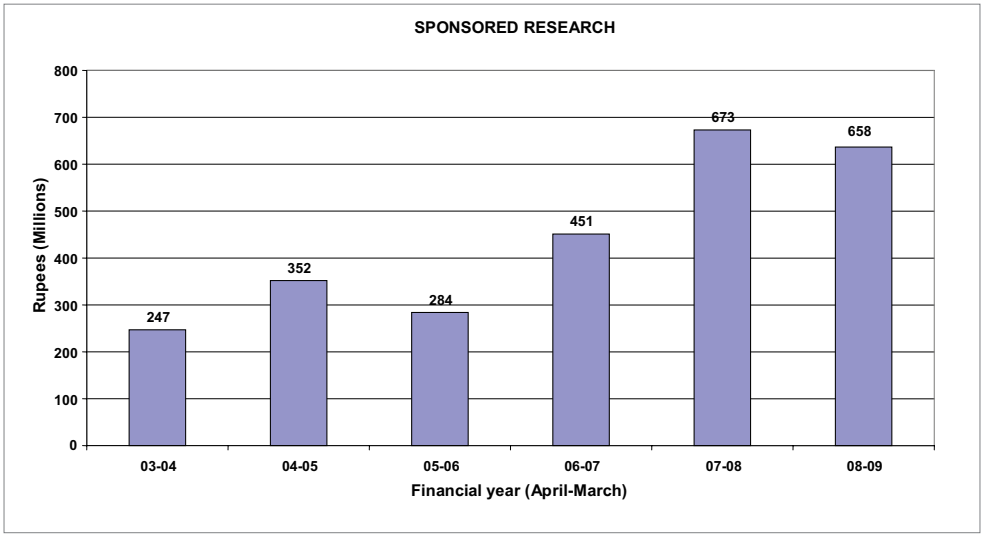
The role of the **Centre for Industrial Consultancy and Sponsored Research (IC & SR)** needs special mention in this context. IC & SR is responsible for the promotion, facilitation, coordination and administration of all the sponsored and consultancy projects handled by the faculty of IIT Madras. The Centre is proud to have been awarded the ISO 9001 Quality Certification.

### Sponsored Research Projects

Sponsored projects are R & D projects funded by government departments and agencies, industries or other institutes with a view to generate new knowledge, develop new technology or create new products in nation building. These programmes also help in the development of human resources in the premier areas of science and technology. The values of projects sponsored during the last six years are given in the bar chart.

Research projects are also undertaken in cell mode. Research institutions like ISRO and IGCAR have cells established at IIT Madras for carrying out joint research projects.

International collaborative joint research programmes of common interest are undertaken through Indo-US, Indo-German, Indo-Australian and Indo-European research initiatives.




Some on-going high value sponsored research projects are worth mentioning here:

- DST has sanctioned the project for "Establishment of a Nano Functional Materials Technology Centre (NFMTC) with Murugappa group and Orchid Chemicals and Pharmaceuticals as contributing partners for a total value of Rs.240 millions.
- An eight node consortium project titled "Smart and Secure Environment" for a value of Rs.80 millions has been sanctioned by National Technical Research Organization.
- "Facility for Spatially Resolved Magnetic Resonance: Methodology Development and Applications to investigation of Composite Materials & Biological Systems" for a total value of Rs.68 millions (DST).
- "National facility to identify potential drug targets through functional cell dynamics" for a value of Rs.40 millions (DST).
- NRB has sponsored a project "National Programme in Marine Hydrodynamics" for a total value of Rs.45 millions.
- "Mechanical Micromachining metals and non-metals" for a total value of Rs.35 millions (DST).
- "Center for Analog Mixed Signal Integrated Circuit Design" for a total value of Rs.30 millions has been sanctioned by DIT.
- "National facility to identify potential drug targets through functional cell dynamics" for a total value of Rs.50 millions (DST).
- "DBT programme support in Cancer Biology" for a total value of Rs.17 millions.

## Consultancy Projects

Industries from all sectors avail the expertise and facilities of the Institute through any one of the following avenues.

### Institutional Consultancy (IC)

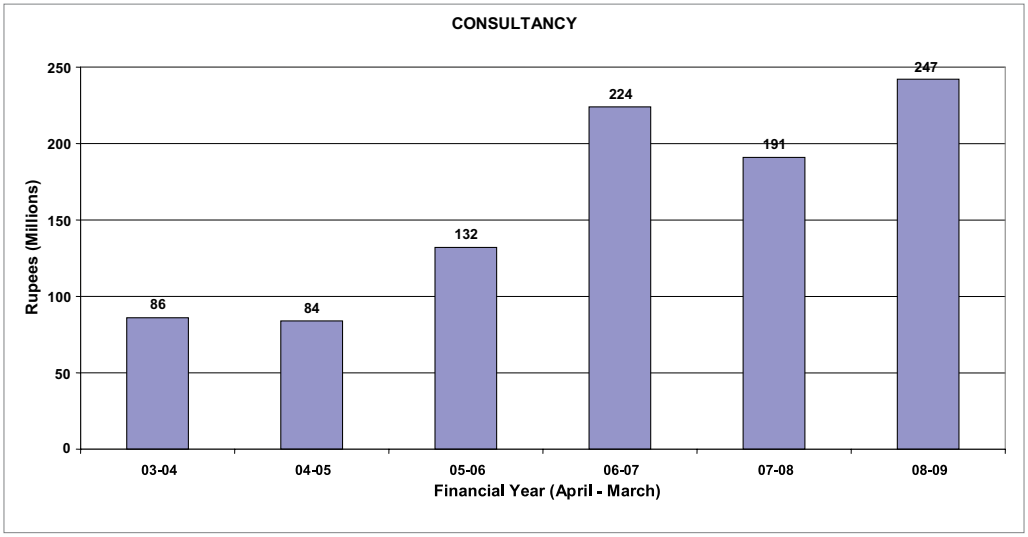
These are specific assignments that can be executed readily utilising the professional knowledge and expertise of the faculty and facilities of the Institute.

### Retainer Consultancy (RC)

The expertise of the IIT Madras faculty is utilised by retaining them as consultants for advice / guidance on any aspect of interest to the industries concerned for a specific duration. Several industries spread across the country have been availing this facility for a number of years.

Research Based Industrial Consultancy (RBIC)
Assignments which require applied research fall under this category. Under RBIC an industry or a group of industries can jointly sponsor a project of interest to them in an area where they agree to share the know-how generated. The project duration would be for a period ranging from six months to three years.

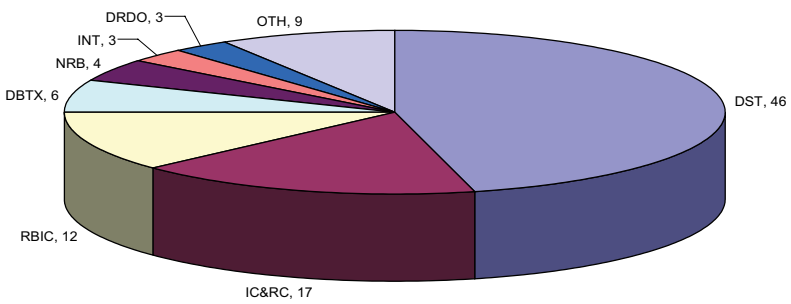
The value of the consultancy assignment is shown in the bar chart below.




## Major Areas of Consultancy

- Design & Analysis of Industrial structures, Bridges, Offshore and Aerospace structures
- Analysis and development of thermo fluid dynamic systems
- Design & Development of Equipments (mechanical & electrical) and Manufacturing Systems
- Maintenance engineering, Vibration, Acoustics, Seismic studies and Failure analysis.
- Process & Product development in the areas of Communication, Materials, Chemical & Bio-medicals
- Feasibility and Impact Assessment Studies.
- Characterisation and Calibration studies.
- Metallurgical & Instrumental analysis, Bio & Nano processes and Materials
- Software for industrial applications, Computational techniques and Computer technology
- Modeling & Simulation studies

## Break-Up of Consultancy and Sponsored Research



## Consultancy

| | | |
|---|---|---|
| IC & RC | – | Institutional Consultancy & Retainer Consultancy |
| RBIC | – | Research-Based Industrial Consultancy |

## Sponsored Research

| | | |
|---|---|---|
| DST | – | Department of Science & Technology |
| DRDO | – | Defence Research and Development Organisation |
| NRB | – | Naval Research Board |
| DBT | – | Department of Bio Technology |
| INT | – | International Projects |
| OTH | – | Others including |
| | | Aeronautical Development Agency |
| | | Atomic Energy Regulatory Board |
| | | Board of Research in Nuclear Science |
| | | Council for Scientific & Industrial Research |
| | | Indian Space Research Organisation |
| | | Indira Gandhi Centre for Atomic Research |
| | | Ministry of New and Renewable Energy |

## Technologies for Social Development

IIT Madras has also initiated activities for transfer of technologies which are of immediate relevance to society. For this purpose, the following three projects have been taken up.

- Socially Relevant Projects
- Rural Technology Action Group (RuTAG)
- Recognition and Mentoring Programme by Lemelson Foundation (USA).

### Socially Relevant Projects

These projects are undertaken by the faculty members of IIT Madras, with assistance from the students and supporting staff. Several projects were initiated under this programme and presently they are in different stages of completion. The alumni of 1967 and 1981 batches are currently funding projects under this programme.

### Rural Technology Action Group (RuTAG), Tamil Nadu at IIT Madras

The Rural Technology Action Group (RuTAG) for Tamil Nadu was established in the Indian Institute of Technology Madras in June 2004 to help rural Tamil Nadu upgrade its technologies. It has been conceived by the Office of the Principal Scientific Adviser to the Govt. of India (PSA) as a synergising and catalysing mechanism to provide a higher level of S&T intervention and support than hitherto achieved.

### L-RAMP (Lemelson Recognition and Mentoring Programme)

L-RAMP is a joint initiative of Indian Institute of Technology, Madras and Rural Innovations Network, supported by The Lemelson Foundation, USA. L-RAMP identifies innovators and harnesses their creativity to translate their innovations into sustainable, scalable enterprises. L-RAMP's goal is to transform living standards for poor communities through such initiatives.

## Research Park

The IIT Madras Research Park, located adjacent to the IIT Madras campus, endeavours to enable companies to set up a research base in the park and leverage the expertise of IIT Madras. Phase I of the Research Park, comprising a 12 storeyed structure with 2 basements with a built-up area of 420,000 sq ft, is scheduled to be ready for occupation by December 2009. Space is being rented to industries that collaborate with IIT and companies incubated by the faculty and students of IITM. It is hoped that this Park will emerge as a hub of collaborative R&D and innovation activity. It has received very enthusiastic response from the industry. Companies that have committed to taking space include Lattice Bridge, TCS, CTS, International Advance Research Center for Powder Metallurgy & New Materials (ARCI), Amada Soft (Japan), Maverick, Think Equity (an investment banking firm), Lucid Software. Orange Scape Technologies Ltd., CWET, The Neutraceuticals Division of E.I.D. Parry, Tata Elxsi, NMS Works, TCOE India, Convert Team, Good Earth Maritime Ltd., Benchmark Electronics Systems.

# Laboratories of the Departments

## Aerospace Engineering

- Aerodynamics / gas dynamics / flight mechanics
- Aerospace propulsion
- Structures

## Applied Mechanics

- Biomedical engineering
- Fluid mechanics
- Solid mechanics

## Biotechnology

## Chemical Engineering

- Biochemical engineering
- Environmental engineering
- Particle science & polymers
- Process dynamics & control
- Reactions and transport processes

## Chemistry

- Inorganic and analytical chemistry
- Organic and bioorganic chemistry
- Physical and Interfacial chemistry
- Theoretical chemistry and spectroscopy

## Civil Engineering

- Building technology & construction management
- Environmental and water resources engineering
- Geotechnical engineering
- Structural engineering
- Transportation engineering

## Computer Science and Engineering

- Artificial Intelligence & databases lab
- Computer vision lab
- Don lab
- Distributed & object systems lab
- High performance computing and networking lab
- Network systems lab
- Reconfigurable and Intelligent systems engineering lab
- System development lab
- Speech and Vision lab
- Theoretical computer science lab
- Visualisation & perception lab

## Electrical Engineering

- EE1 - Communications, wireless & optical networks and systems
- EE2 - Power systems, power electronics, high voltage machines and drives
- EE3 - Microelectronics and VLSI design
- EE3 - Micro electronics and MEMS
- EE4 - Control, robotics, measurements and instrumentation

## Engineering Design

## Humanities and Social Sciences

## Management Studies

## Mathematics

- Algebra
- Analysis
- Applied mathematics and mathematical physics
- Applied probability and stochastic prosesses
- Theoretical computer science and discrete mathematics

## Mechanical Engineering

### Design stream

- Machine design section

### Manufacturing stream

- Manufacturing engineering section
- Precision engineering and Instrumentation lab

### Thermal Section

- Heat transfer and thermal power lab
- Hydroturbomachines lab
- Internal combustion engines lab
- Refrigeration and air conditioning lab
- Thermal turbomachines lab
- Thermodynamics and combustion engineering lab

## Metallurgical & Materials Engineering

- Atomic force microscopy
- Chemical metallurgy
- Computing facility
- Electrometallurgy & corrosion
- Fuel cells
- Heat treatment
- High temperature materials, mechanical testing & tribology
- Materials forming & testing
- Materials joining
- Medical materials
- Metal casting
- Nanomaterials
- Non-destructive testing
- Physical metallurgy
- Powder metallurgy & ceramics
- Scanning electron microscopy
- Transmission electron microscopy
- X-Ray diffraction

## Ocean Engineering

## Physics

- Advanced magnetic materials
- Advanced materials, nanostructured thin films and nanomaterials
- Alternative energy technology
- Applied optics
- Atomic and molecular physics
- Classical and quantum dynamics
- Complex fluids and biological physics
- Condensed matter and field theory
- Dynamical systems, statistical physics and field theory
- Experimental particle physics
- Low temperature physics
- Microwaves and dielectrics
- Nanocomposites and nanowires using electrospinning
- Photonics and non-linear optics
- Quantum chaos and information
- Semiconductor physics and devices
- Solid state ionics lab
- String theory
- Thin film physics
- Ultrafast lasers and optical amplifiers and quantum optics

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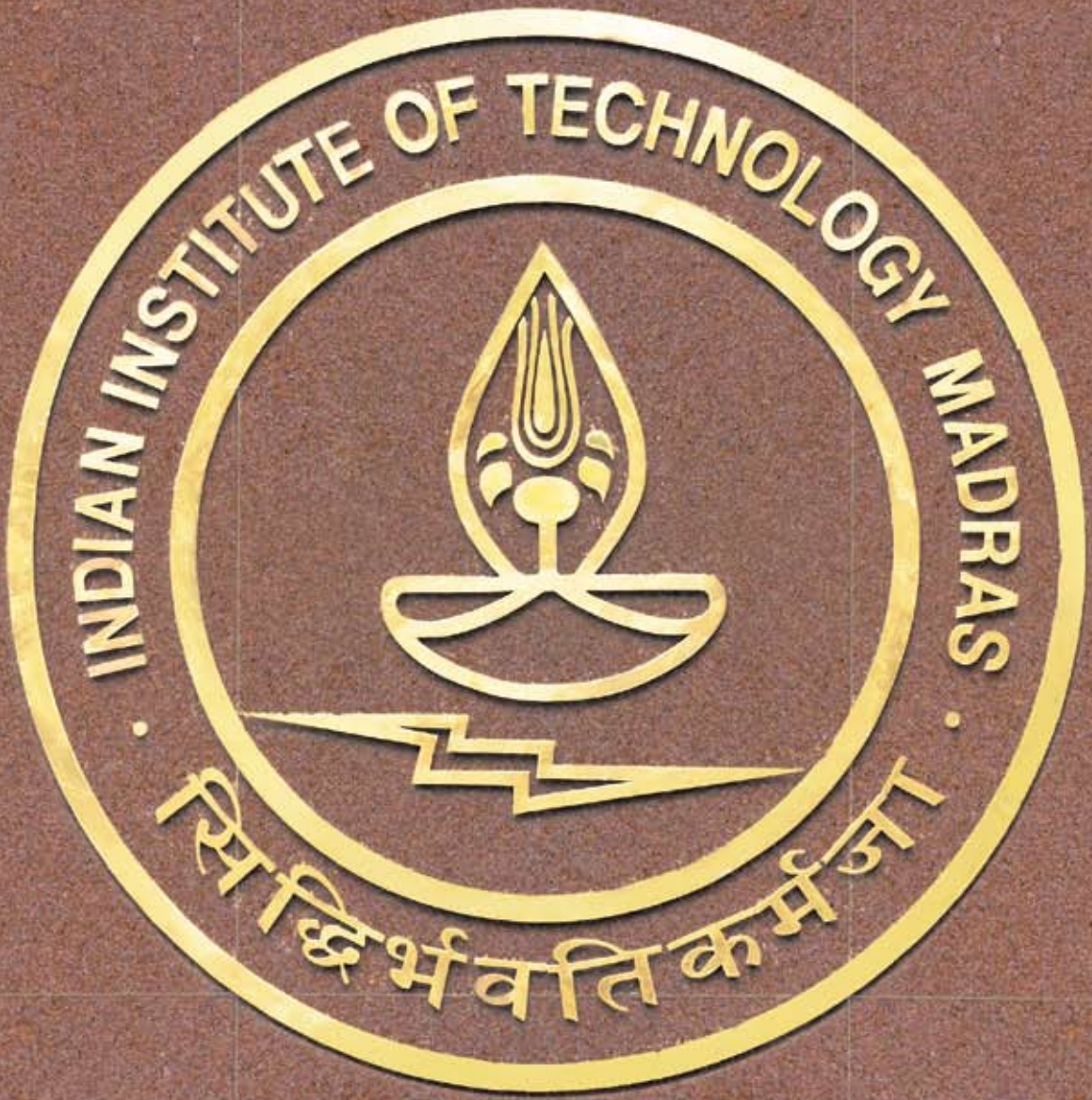

# THE SCIENCE OF SOARING

Leonardo da Vinci and aerospace? You may wonder at the link. But strangely, some of the first ideas for powered flight may have come from this renowned painter. Although he did not build any successful model, he did develop many sketches and ideas for “flying machines”. Historically, the origin of aerospace engineering can be traced back to the aviation pioneers of early 20th century. The word ‘aerospace’ itself, is a combination of the earth’s atmosphere and outer space.

*At IIT Madras however, the word has acquired many new dimensions.*

India has nearly achieved a developed-nation status in strategic high-tech areas such as atomic energy, aeronautics and space, for both civilian and defence needs. This is reflected in these areas being included in the recent Next Steps in Strategic Partnership (NSSP) with the USA, and many advanced countries launching their satellites on Indian space launchers. These have been possible, in part, by the strategy of setting up aerospace engineering departments in some of the premier academic institutions in the country. One such was, the Department of Aerospace Engineering at IIT Madras, set up in 1969.

Chennai is the hub of the golden triangle of aerospace engineering development in the country - Space in Thiruvananthapuram and Bangalore, Aeronautics in Bangalore, and the Missile Complex in Hyderabad. The Space Port of the country, Sriharikota, is also located close to Chennai. Aerospace Engineering at IIT Madras has been able to leverage this strategic location in its activities. Other national and international engagements, besides the above, also fully justify the Department’s role as an institution of international calibre.

# Aerospace Engineering

The Department is organised into the Aerodynamics / Gas Dynamics / Flight Mechanics, Aerospace Propulsion and Structures divisions. The faculty expertise in each of the divisions is listed below.

## Head of the Department

Sriram P., Ph.D.
Tel (O): 2257 4000
email:aeoffice@iitm.ac.in / sriram@iitm.ac.in

## Aerodynamics / Gas Dynamics / Flight Mechanics

### Faculty & Expertise

**Professors**

Job Kurian, Ph.D.
Gas dynamics, shocks, rarefied flows, experimental methods

Ramakrishna M., Ph.D.
Aerodynamics, fluid dynamics, CFD

Santhakumar S., Ph.D.
Aerodynamics, transonic flows, helicopters, wave energy, design

Sujith R.I., Ph.D.
Gas dynamics, acoustics, combustion

**Associate Professors**

Luoyi Tao, Ph.D.
Continuum mechanics, fluid mechanics, solid mechanics

Panchapakesan N. R., Ph.D.
Fluid mechanics, turbulence

**Assistant Professors**

Nandan Kumar Sinha, Ph.D.
Flight mechanics, non-linear dynamics, controls

Rajan S.C., M.Tech.
Aerodynamics, fluid mechanics, vortex dynamics

Sameen A., Ph.D.
Stability, transition and turbulence, computational fluid dynamics

Sunetra Sarkar., Ph.D.
Aerodynamics, flow-structure interactions

*Oscillatory Flow Rig*

## Aerospace Propulsion

### Faculty & Expertise

### Professors

Gokhale S.S., Ph.D.
Propulsion, combustion, multi-phase flows, system simulations

Chakravarthy S.R., Ph.D.
Propulsion, combustion, multi-phase flows, system simulations

### Assistant Professors

Amit Kumar, Ph.D.
Propulsion, combustion, CFD

Muruganandam T.M., Ph.D.
Combustion, gas dynamics, laser diagnostics, high speed flows

Ramakrishna P.A., Ph.D.
Propulsion, combustion, CFD

## Structures

### Faculty & Expertise

### Professors

Bhaskar K., Ph.D.
Structures, composite structures, theoretical techniques

Sriram P., Ph.D.
Structures, vibrations, parallel computing

Velmurugan R., Ph.D.
Structures, composite materials, experimental methods

### Assistant Professors

Gopal K.V.N., Ph.D.
Structures, FEM, fracture mechanics,
wind energy applications, composites & smart structures,
structural dynamics & aeroelasticity

Murthy Haradanahalli S. N., Ph.D.
Structures, dynamics, fretting fatigue,
experimental methods

*Low density tunnel*

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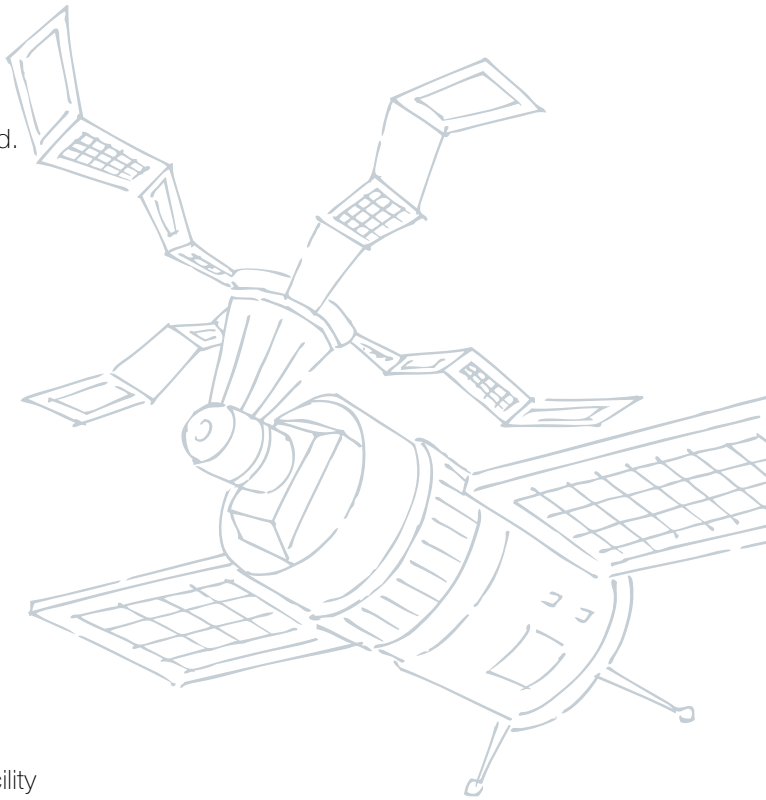
## Facilities

To aid research, the following facilities have been developed.

- Supersonic wind tunnel
- Self-correcting transonic wind tunnel
- Oscillatory flow test rig
- Supersonic free jet facilities
- Combustion-driven shock tube / shock tunnel
- Rarefied gas dynamics facility
- Phase Doppler Particle Analyser(PDPA)
- PLIF and PIV
- Fluid energy mill
- Solid propellant strand burner
- Composite solid propellant processing facility
- Slotted burner with acoustic drivers
- Dump/bluff-body combustors with optical access
- Supersonic combustion facility
- Erosive burning test facility
- Moire (interferometry, holography) image processing facility
- 10 T Fatigue testing machine, 5 T UTM



## Research & Consultancy and Continuing Education

Research is in the form of both academic as well as sponsored research. The latter is mainly utilised to upgrade laboratory research equipment and facilities. Industrial consultancy is also typically research-based (RBIC). Nearly 100 Million Rupees worth of sponsored research projects have been undertaken by our faculty in the last 6-7 years, including the project under the FIST Scheme of DST. The faculty members of this Department have also actively participated in the CFD Centre set up with DST support a few years ago.

Continuing education programmes are regularly organised. The 4-month training programme offered twice a year to the newly appointed management / design trainees of the Hindustan Aeronautics Limited (HAL), Bangalore, on a whole breadth of fundamentals of aerospace engineering, is exemplary for being the most comprehensive short-term course in the Institute. This has been successfully conducted for several years consecutively.

## Sponsored Research Projects

- Combustion instability: Developing on alternate framework incorporating non-normality and non linearities
- Enhancement of computational infrastructure for aerodynamics and aerothermal research at IIT Madras
- Investigation of non-linearities in thermoacoustic systems
- Tunable Diode Laser Absorption Spectroscopy (TDLAS) for measurement of temperature pattern factor in gas
- Experimental studies on high speed air intakes
- Studies on friction coefficient in contact interface under fretting conditions
- Investigation of the onset of acoustic instability in turbulent combustion systems

- Investigation of mixing in confined co-flowing subsonic jets subjected to acoustic excitation
- Experimental studies on hybrid rocket motors
- Investigation of multiple scales in separated shear layers
- Turbulent mixing of multiple round jets
- Study of composite laminates under biaxial stress field
- Numerical simulation of flapping wing aerodynamics
- Computational studies on regression rate enhancement in hybrid rocket motors
- A Lagrangian approach to capture the unsteady aerodynamics of insect-like flapping flight
- Spin characterisation and trajectory simulation for generic non-linear aircraft model
- Numerical studies on effect of coke deposition on heat transfer in regenerative cooling of kerosene based liquid rocket engines

## Consultancy Projects

- Performance and stability calculation for a conceptual 4 seater aircraft
- Characterisation of glass fabric using epoxy resin used in wind turbine
- Design of composite hut
- Water absorption studies of laminated composites
- Studies on high speed imaging or engine bird ingestion
- Development of computational models for predictive analysis of three dimensional dynamic stall in horizontal axis wind turbine rotor blades
- Computational models for predictive analysis of dynamic response and rolling resistance of radial tyres
- Constitutive modelling of rubber & simplified analysis procedures for tyre design
- Heat transfer rate measurements on the 1:17.3 scale model of the cruise vehicle of HSTDV in shock tunnel
- Development of 80 Hz acoustic horn
- Studies on Debris Pattern and Consequence (SODPAC) analysis
- Development of a laser - excitation based sensor for soot volume fraction measurement
- Aerodynamic data modeling and simulation for spin investigation of a non-linear aircraft model
- PDPA characterisation of the ladenburg injector
- Development of test facility for fretting fatigue studies on LP steam turbine blading steel

*Shock tube*

*Transonic induction tunnel*

# THE SCIENCE OF CARING

Applied Mechanics, as we all know, bridges the gap between physical theory and its application to technology. While Isaaac Newton's laws set the whole proceedings in motion, the modern practice of Applied Mechanics application can be traced back to Stephen Timoshenko, considered the father of modern engineering mechanics.

The Department of Applied Mechanics at IIT Madras has been in existence since 1959 and has grown into a full fledged inter-disciplinary graduate research Department over the years. The Department focuses on academic activities in three broad areas-Biomedical Engineering, Fluid Mechanics and Solid Mechanics.

Current R & D activities of the Department focus on Virtual Reality with touch feedback, medical simulation, imaging of heart, flow control of shear layers, buoyancy driven turbulence, interfacial phenomena, boundary layer studies, fluid structure interaction, bio-fluid mechanics, buckling control, digital photoelasticity, digital image correlation, fatigue and fracture, thermoelasticity, modeling of shape memory polymers and building smart devices using materials such as SMAs, PZTs, magnetic gels.

Future plans include heart variability studies, early detection of cancer through interferometer, laser induced fluorescence studies, flow control, fluid structure interaction, residual stress measurement of glass articles, probabilistic mechanics, finite element modeling of smart applications, vibration damping and isolation systems using smart materials.

The Department has to its credit several achievements over the years. A few notable ones are, development of a squeeze casting machine, pedo-powergraph for early detection and diagnosis of diabetic ulcers and innovation in multimedia course development. Details regarding this are briefly summarised.

A squeeze casting facility has been indigenously developed as part of the Technology Development Mission (TDM) project in association with India Pistons, Chennai. Using the machine, selectively reinforced squeeze cast metal matrix composite piston is developed. Only the piston groove area is reinforced. It was found to perform better than conventional pistons.

# Applied Mechanics

The portable pedo-powergraph for early diagnostics of diabetic foot has been jointly developed by IIT Madras and Sundaram Medical Foundation. Commercialised by the TVS Group, it is expected to benefit a large number of diabetic patients and enable them understand the condition of their foot and if possible, save their foot from being amputated. The Department has also come up with suitable footwear for diabetic patients, which could be useful for leprosy patients too.

The Department has initiated a new concept in engineering education by writing innovative e-books that are fully animated in a way that they mimic the classroom experience. Such books would simplify the effect of industries in training manpower for emerging and specialised areas.

The Department is organised in three groups comprising Biomedical Engineering, Fluid Mechanics and Solid Mechanics. The faculty expertise and facilities in each of the groups are listed below.

## Head of the Department

Ramasubba Reddy M., Ph.D.
Tel (O): 2257 4051
email: apoffice@iitm.ac.in / rsreddy@iitm.ac.in

## Biomedical Engineering

### Faculty & Expertise

#### Professor

Ramasubba Reddy M., Ph.D.
Bio-signal processing, bio-instrumentation

#### Assistant Professors

Manivannan M., Ph.D.
Haptics, medical simulation, biomechanics

Sujatha N., Ph.D.
Biomedical imaging, speckle metrology

#### Adjunct Faculty

Murthy, V. B. N., FRCS.
Plastic surgery, diabetic foot

Thanikachalam S., MDDM.
Cardiology

### Facilities

- Signal processing station
- 2D ultrasound scanner
- Barograph for dynamic foot pressure studies
- 8 channel surface EMG measurement
- Optical imaging of biological tissues
- High resolution ECG analyser
- Image processing system
- Haptic feedback devices
- Laparoscopic medical simulation
- Combat tactile jacket

## Fluid Mechanics

### Faculty & Expertise

#### Professor

Lakshminarasimhan J., Ph.D.
Incompressible aerodynamics, turbulent internal flows, curved flows and wakes, wind effects on structures

#### Associate Professor

Vengadesan S., Ph.D.
Fluid mechanics, turbulence modeling, LES, URANS, CFD

#### Assistant Professors

Arulprakash K., Ph.D.
CFD and heat transfer, thermal hydraulics, LES and related techniques, parallel computing

Baburaj A. P., Ph.D.
Convection, interfacial phenomena

Prasad Patnaik B. S. V., Ph.D.
CFD, FEM, active flow control, flow induced vibrations, phase-field modeling, micro and / or bio-fluid flow systems

Rinku Mukherjee, Ph.D.
Applied aerodynamics flow modeling, unsteady wake phenomenon, dynamic stall and formation flight, CFD

## Facilities

- Particle imaging velocimetry (PIV)
- Laser induced fluorescence measurements
- Flow visualisation table
- Closed circuit, open test section wind tunnel (1.5 m diameter Test Section)
- Open circuit wind tunnel (0.6 m x 0.6 m)
- Parallel processing, computational clusters
- Boundary layer tunnel
- Jet tunnels
- Micro PIV
- Shadowgraphy for drops & bubble sizing
- Hotwire anemometry

## Solid Mechanics

### Faculty & Expertise

### Professors

Lakshmana Rao C., D.Sc.
Fracture mechanics, smart materials & structures, continuum mechanics, granular flow numerical modeling

Palaninathan R., Ph.D.
Structural mechanics, composite structures and materials, finite element method, thermal structures

Raamachandran J., Ph.D.
Solid mechanics, experimental stress analysis, finite and boundary elements, bio-mechanics, smart structures

Ramesh K., Ph.D.
Computer application in experimental mechanics, fracture mechanics, digital photoelasticity

Sivakumar M. S., Ph.D.
Solid mechanics, plasticity, multiscale modeling, thermo-mechanical fatigue

*Particle Image Velocimetry*



### Assistant Professors

Anuradha Banerjee., Ph.D.
Solid mechanics, fracture mechanics, composites

Arunachalakasi Arockiarajan., Ph.D.
Smart materials, ferroelectrics, electro-active polymers, constitutive modeling

Santhanakrishnan G., Ph.D.
Solid mechanics

Sayan Gupta, Ph.D.
Structural dynamics, probabilistic mechanics, risk assessment

## Facilities

- 100 kN Servo-Hydraulic fatigue and fracture testing machine
- Digital photoelasticity for both 2D and 3D problems
- Multi channel static strain measurement system
- Contact pressure measurement facilities
- Crack profile simulation and monitoring facilities
- Residual stress measurement in glass
- Testing equipment UTM : up to 10 T
- Data logger (static) complete with automatic selector, timer and recorder
- Holography set-up
- Smart materials and structures
- High performance computing facilities
- Packages such as ANSYS, ABAQUS and NASTRAN

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*Drag Measurement in a Low Speed Wind Tunnel*

## Current areas of Research Activities

- Constraint effects in fracture
- Smart materials modeling and design of structures
- Thin film flows and interfacial phenomena
- Autonomous data acquisition in digital photoelasticity
- Quantification of optical nerve disorders
- Foot pressure measurements in diabetic patients
- Image / signal processing of biological structures / tissues
- Turbulence modeling
- Computational fluid dynamics, large eddy simulation
- Computational adaptive system
- Residual stress measurement in glass articles
- Buckling control of nozzle shell using smart materials
- Ballistic impact simulation
- High Ra convection
- Microscale flows

*Multimedia e-Books*

## Major Achievements

- Squeeze casting of metal matrix composites
- Early detection of diabetic ulcers & therapeutic footwear design
- Communication kit for spastics
- Software modules for digital photoelasticity
- Active / passive control through smart sensors
- Atmospheric dispersion studies using hybrid model
- Assessment of osteoporosis
- Wind tunnel studies of industrial structures
- Fracture assessment of structures
- Erosion modeling of C-C composites in hypersonic vehicles
- Analysis modules for smart materials/structures
- Rate dependent studies on ferroelectrics

*Wind Tunnels*

## Software Developed

- Ablative thermal protection for hyper thermal loading conditions
- PressFilm: Evaluation of pressure using pressure sensitive films
- P_Scope: Virtual polariscope
- PhotoSif: SIF evaluation by photoelasticity
- Fem Fringes: Plotting of fringe contours from FE results
- Smart-Solver: To model shape memory alloys and ferroelectric materials
- Rh Adapt: A posterior r-h adaptive scheme for finite element analysis
- 2D BEM Solver, 3D FEM codes for non-linear coupled problems
- CFD codes, post stall predictive tool for single and multiple wing configurations (3D) using decambering approach
- RANS and LES solvers using FD / FE methods
- A number of UDFs for a wide spectrum of turbulence models

## Sponsored Research Projects

- Characterisation of polymeric piezoelectric thin films used as sensors in aerospace applications
- Diagnosis through three radial artery pulse
- Testing of lubrication in bearings
- Air flow through false tiles
- Mathematical modeling of SMPs and preparation of material design guidelines
- LES investigation of interference effect due to bluff body at moderate reynolds number
- Finite element simulation of biofluid flows
- Evaluation of turbulence model for prediction of hydrodynamic properties in TVC
- Performance of newly developed turbulence model for low speed and high speed underwater vehicles
- Isoclinic unwrapping and colour adaption in digital photoelasticity
- Stress state dependence ductile fracture model
- Numerical simulation of coupled navier-stokes cahn hilliard solver for binary phase separation under chaotic mixing
- CFD analysis for flow and distribution in the passages of PEM fuel cell stack
- Experiment, analysis and survey of profiles for air pre-heaters
- Thermo structural analysis of metallic thermal protection systems

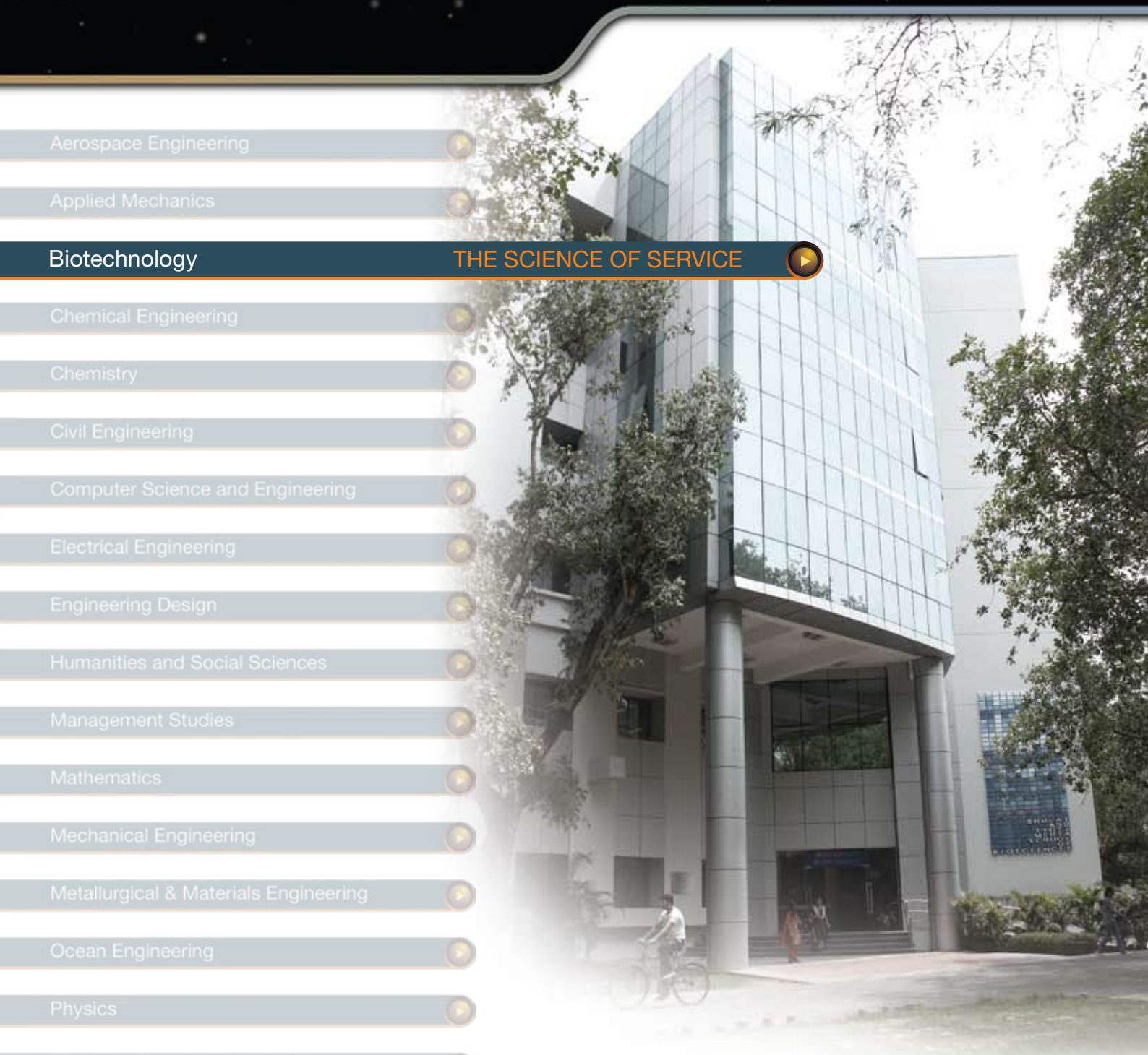
## Consultancy Projects

- Stress analysis of ball drifted plate
- Calibration of orifice plate
- Design and testing of controller for fatigue tests
- Analysis of gas cut-off device
- Calibration of pitostatic and flow elements
- Thermostructural analysis of metallic thermal protection system
- Mechanics of a new product designed by sportmate
- Mathematical modelling of SMPs and preparation of material design guidelines
- Testing of techpassion bearings
- Development of algorithms for analysis & modeling of SMA components
- Development of SMA actuator design guidelines for aerospace/defence applications
- Simulation of ballistic impact on armour plates

*Displacements by digital image correlation*

*Instrumented mannequin to train doctors*

## THE SCIENCE OF SERVICE



Biotechnology is nothing short of a revolution. Scientists have developed and continue to develop cures for diseases that have plagued people for decades and even centuries. Biotechnology has helped create crops that can withstand the brutalities of nature, helping farmers retain their yield and even increase their output manifold. A real boon, Biotechnology has brought hope in many areas.

The Department of Biotechnology comprises faculty members with expertise and significant accomplishments in the relevant areas of Biological Sciences and Engineering. The Department is relatively new, it came into formal existence in 2004. The growth has been significant, and we currently have 23 faculty members, significant research funding, good collaborations with hospitals, other institutions and industry, besides good infrastructure including a new six-storied building. Also, our research contributions through journal publications in the past few years have been significant.

# Biotechnology

The vision of the Department is to make an international impact through research, teaching, technology innovation, and service to society.

**The current research thrust areas are:**

- Bioprocesses Engineering
- Chemical Biology
- Computational Biology
- Medical Biotechnology

The Department's faculty members have recently received significant funding as programme support from the Department of Biotechnology (DBT), GoI, for work in cancer related areas. The short term goal of the programme is to provide a state-of-the-art research environment in cancer biology and study the signaling mechanisms in cancer cells, whereas the long term goal is to identify therapeutic targets and develop therapeutic approaches with the knowledge generated. In addition, a sophisticated cell imaging facility is being set up with significant funding from the Department of Science and Technology (DST), GoI. The Department is also setting up a Centre of Excellence in Bioprocess Engineering funded by MHRD. GoI.

The faculty members are researchers essentially in the areas of engineering sciences, biological sciences, chemical sciences and their interfaces. Their research has resulted in significant contributions in the above mentioned thrust areas.

## Head of the Department

Ramachandran K. B., Ph.D.
Tel (O): 2257 4100
email:biotech@iitm.ac.in / kbram@iitm.ac.in

## Faculty & Expertise

### Professors

Anju Chadha, Ph.D.
Bio-catalysis, enzymes in organic (asymmetric) synthesis, green chemistry, biosensors, enzyme mechanisms

Chandra T. S., Ph.D.
Biomass recycling, bio-transformations, microbial biotechnology, biochemistry, industrial enzymes

Guhan Jayaraman, Ph.D.
Recombinant protein production, novel bioseparation processes

Jayakrishnan A., Ph.D.
Biomaterials, chemistry of medical devices

Karunagaran D., Ph.D.
Cancer biology

Mukesh Doble, Ph.D.
Reactor modeling, design, scale-up, process development, molecular modeling, drug design

Ramachandran K. B., Ph.D.
Bioreactor design and analysis, modeling, simulation and control of bioprocesses, enzyme engineering

Suraishkumar G. K., Ph.D.
Bioprocesses, reactive oxygen species from a bioreactor perspective, cell stresses, liquid phase oxygen-supply strategy.

*Bioinformatics lab*

### Associate Professors

Mahalingam S., Ph.D.
Virology

Rama Shanker Verma, Ph.D.
Stem cell culture, folate receptors, cloning and scaling of therapeutic proteins

Sathyanarayana Gummadi N., Ph.D.
Enzymes and other metabolites: biochemical eng. aspects, phospholipid flippases, lipid traffic, toxics degradation

Srinivasa Chakravarthy, Ph.D.
Computational neuroscience, character recognition, neural networks

Suresh Kumar R., Ph.D.
Cancer biology, growth factor receptor signaling, therapeutic micro RNAs

### Assistant Professors

Amal Kanti Bera, Ph.D.
Signal transduction, ion channel structure-functions

Baskar R., Ph.D.
Genetics, plant developmental biology

Chandraraj, K., Ph.D.
Metabolic engineering, ethanol from biomass, molecular bioremediation, industrial enzymes

Gopala Krishna A., Ph.D.
Membrane proteins: structure-function relationship, G-proteins, signal transduction mechanism

Kesavan V., Ph.D.
Drug design, SAR, RNA mechanism and siRNA delivery

Madhulika Dixit, Ph.D.
Cardiovascular physiology, diabetes related studies

Manoj N., Ph.D.
Crystallography, bioinformatics

Murugan R., Ph.D.
Random walks and jumps in biology, kinetics of DNA-protein & DNA-DNA interactions, biochemical & genetic networks - systems biology

Nitish Mahapatra, Ph.D.
Genetics of hypertension

Sanjib Senapati, Ph.D.
Computational biophysics: molecular modeling, protein-ligand docking, computer simulation, structure based drug design

*Bioprocess lab*

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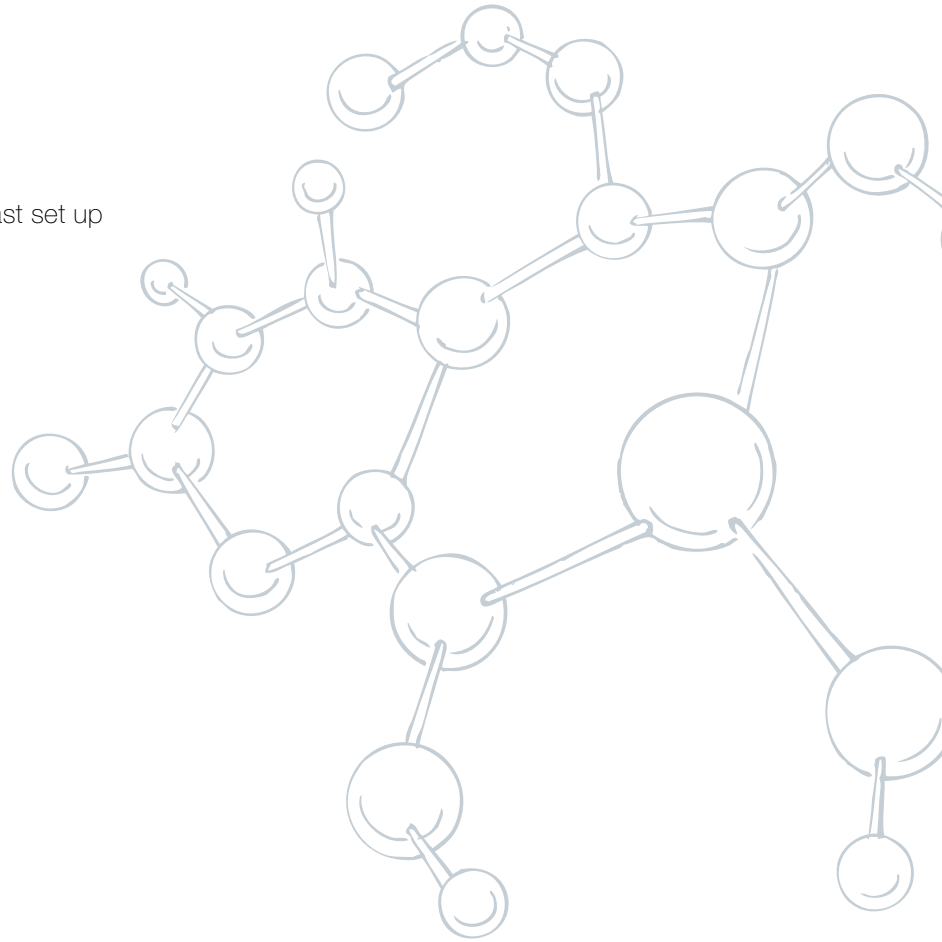
## Facilities

- Flow cytometer
- Lumino meter
- Inverted fluorescent microscope
- Nomarski-differential interference contrast set up
- Electrical cell impedence system
- High pressure liquid chromatography
- Fast protein liquid chromatography
- Protein purification system
- Gas chromatography
- Micro plate spectrometer
- UV-vis spectrophotometer
- Bioreactors
- Gas analyser
- Lyophilizer
- Membrane ultra-filtration unit
- Gel electrophoresis units
- Gel documentation system
- High speed and ultra-centrifuges
- Cold rooms and -80° C,-40° C freezers



## Sponsored Research Projects

- National  facility to identify potential drug targets through functional cell dynamics
- Role of nucleolar GTPases on cell proliferation during tumorigenesis
- Application of electrospun nanofibres in biology for packaging of foods, biofertilizers and biocides
- Design and synthesis of peptide mini-vectors for receptor mediated delivery of siRNAs
- Antibacterial polymers based on new hydantoin monomers
- Development of a bioprocess for the production of polyhydroxy butyrate (PHB) from bio-diesel industry generated glycerol
- Genetic dissection of pattern formation in the cellular slime mold polysphondylium
- Polymorphisms in the physiological anti-hypertensive peptide catestation in an Indian population
- Regulation of endothelial barrier function by chronic hyperinsulinemia and lipotoxicity: Implications in diabetic vasculopathy
- Characterisation of Gabl (Grb2-associated binder protein-1) for therapeutic neovascularisation: study of compromised collateral vassal growth in diabetic macrovascular complications
- Studies on proliferation and differentiation of stem cells and cancer cells under microgravity
- Modulation of the voltage dependent anion channel of mitochondria by the proteins of BCL-2 family

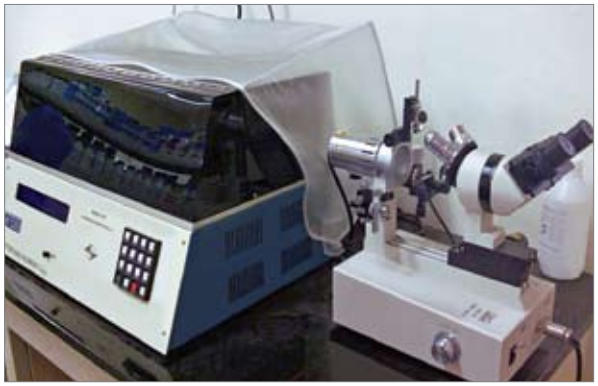
- Functional and structural analysis of the GABAA receptor Y subunit during channel activation and benzodiazepine potentiation
- Molecular characterisation of functional polymorphisms in mouse HMG-CoA reducaste gene
- Biocompatibility studies on nanoparticle coated polymer surface
- Wearable wireless sensors for tracking trainee's body
- Reactive oxygen species and chlorine based microbial inactivation

*Fluorescence assisted cell sorting*

*Cell culture cabinet*

## Consultancy projects

- Enzyme production, purification, characterisation and immobilisation
- Biodegradation of propylene
- Quantitative assessment of effect of rider posture on riding fatigue and vehicle handling
- Biotransformation / bioprocessing technologies for the manufacture of Cephalosporin derivatives
- Biotransformations for the Nutraceutical industry
- Development of Automatic Defect Recognition (ADR) system for Real Time Radioscopy (RTR) of hancock valve welds



*Micro pipette pooler*

*Organic Chemistry lab*



Chemical Engineering as a discipline, is a little over one hundred years old. It dates back to the Industrial Revolution which created an unprecedented demand for bulk chemicals. This created the need for an engineer who not only understood machines, but also chemicals. And thus was born the chemical engineer and a brand new discipline called Chemical Engineering.

At IIT Madras, the Department of Chemical Engineering is actively engaged in research in the fundamental aspects of chemical engineering science as well as exploring potential new emerging technologies. The focus areas of the Department are in energy (fuel cells, coal gasification and combustion), systems and control (data analysis, fault diagnosis, optimisation, advanced control), process intensification (ultrasonics, microwaves, microfluidics and microreactors), biochemical and environmental engineering (waste water treatment, bioremediation of soils, air pollution monitoring), and materials (polymers, electronic materials, catalysts). The Department is equipped with good analytical facilities and is poised to significantly enhance them through grants recently obtained from IIT Madras, the Department of Science and Technology and Chevron Corporation, USA.

# Chemical Engineering

## Head of the Department

Pushpavanam S., Ph.D.
Tel (O): 22574150
email:cheoff@iitm.ac.in / spush@iitm.ac.in

## Biochemical Engineering

### Faculty & Expertise

### Professor

Panda T., Ph.D.
Bioprocess optimisation, bioprocess technology and enzyme design, biochemical engineering and biotechnology, protoplast fusion technology.

## Current Areas of Research

Research in the Biochemical Engineering Group is directed towards various aspects of chemical biotechnology such as control of hypercholesterolemia and atherosclerosis by regulation as well as degradation of HMGCoA reductase and molecular design of drugs. Other programmes include lignite bioconversion to produce humic acids and energy molecules, and non-thermal sterilisation of liquid foods. Recent research projects include experimental and modeling studies in production, kinetics, control of enzymes for various applications; sterilisation using electrical pulsing and protoplast fusion technology.

## Facilities

- Bioreactor
- Gas chromatograph with FID and TCD
- Electrophoresis
- Spectrophotometer
- Laminar flow chamber
- UV-trans illuminator

*Optical microscope in the Reaction Engineering lab*

## Environmental Engineering

### Faculty & Expertise

### Professor

Swaminathan T., Ph.D.
Environmental management, biotechnology, membrane technology, environmental risk assessment

### Assistant Professors

Raghuram Chetty, Ph.D.
Electrocatalysis, fuel cells, carbon nanotubes

Ravikrishna R., Ph.D.
Remediation of contaminated sediments, contaminant rate and transport, air pollution- processes and control, waste treatment methods

## Current Areas of Research

Research in the Environmental Engineering Group focuses on the development of methods for waste treatment and also in understanding the processes that govern the behaviour of pollutants in the environment. Current projects include photocatalytic degradation of waste water, waste gases and contaminated sediment, biomembranes, biofilters, removal of metals from wastewater using biological processes and monitoring of pollutants in urban atmosphere.

*Remodelled undergraduate lab facilities*

## Facilities

- Phase contrast / flourescent microscope with digital camera
- Stack monitoring kit
- High volume sampler
- TCLP apparatus
- Respirable particle sampler
- Ozoniser
- Fine particulate monitor
- Toxic gas analyser
- Meteorological station with data logger
- Gel doc system
- VOC sampler
- Demineraliser
- Reverse osmosis module
- Portable water quality analysis spectrophotometer
- Portable turbidity meter
- Atomic absorption spectrophotometer
- Ion electrodes, SOx & NOx analysers
- Rapid COD analyser
- Ion chromatograph
- UV visible spectrophotometer
- Seven digit balance
- GC with TCD, FID and ECD
- OC/EC analyser
- Gradient HPLC with RI and UV/VIS detectors
- TOC analyser

*Level control in coupled tanks*



## Particle Science & Polymers

**Professor**

Nagarajan R., Ph.D.
Fine particle science & technology, chemical vapor transport & deposition, ultrasonic cavitation in liquids

### Associate Professors

Abhijit Deshpande P., Ph.D.
Rheology of complex fluids, polymer and polymeric composite processing, microscopic flow visualisation

Natarajan U., Ph.D.
Computational materials science, statistical mechanics & thermodynamics, molecular simulation, macromolecular engineering, nanoscale heterogenous materials.

Susy Varughese, Ph.D.
Physics & mechanics of polymeric materials, polymeric nano composites

### Assistant Professor

Ramanathan S., Ph.D.
Surface reaction kinetics, chemical mechanical polishing (CMP), electrochemical methods, air-pollution monitoring

## Current Areas of Research

Research in the Particle Science and Polymers Group is directed towards various fundamental and applied aspects of using ultrasound for process intensification as well as for nanoparticle synthesis. Understanding and quantification of behaviour of complex fluids containing polymers and surfactants form an important area of current research in the Group. Another active thrust area includes use and development of theoretical approaches including computer simulations of molecular scale behaviour and prediction of properties of polymers and polymeric systems.

## Facilities

- Single screw extruder
- Zwick Universal testing machine (50 kN) with temperature chamber
- Extrusiometer
- Impact testing facility
- Cone and plate viscometer
- Contact angle goniometer: GBX digidrop
- Rheometer (Anton Paar MCR 301)
- Dynamic shear rheometer
- Optical microscope with shearing cell & hot stage
- Malvern particle sizer
- Size reduction equipment
- Air classifier
- Magnetic separator
- Vacuum filter
- Rheograph 2001
- Compression moulding press
- Class 10 K/Class 100 clean rooms
- Single & dual frequency ultrasonic systems
- Cavitation intensity meter
- Turbidimeter
- Laser liquid particle counter
- Airborne Particle counter
- TSI Multi-parameter monitoring system for clean rooms (T/H, Air velocity, AP)
- Microbalance & analytical balance (0.01 mg sensitivity)
- High-temperature oven
- Lab scale chemical mechanical planariser
- Particle size analyser (1 nm - 3µ )
- Filmetrics thin film analyser (nm-µ )
- Advanced electrochemical workstations (PAR, CH instruments)
- Dynamic mechanical analyser

## Process Dynamics and Control

### Faculty & Expertise

### Professors

Chidambaram M., Ph.D.
Process control, non-linear control, periodic operation of reactors

Ramachandra Rao V S., Ph.D.
Advanced control strategies, neuro-fuzzy control

Shankar Narasimhan, Ph.D.
Data mining, fault diagnosis, process design and optimisation

### Assistant Professors

Niket Kaisare., Ph.D.
Microreactors, fuel processing, fuel cells, process intensification, process control, approximate dynamic programming

Sridharkumar Narasimhan., Ph.D.
Fault diagnosis, optimisation, process control, system identification, systems biology

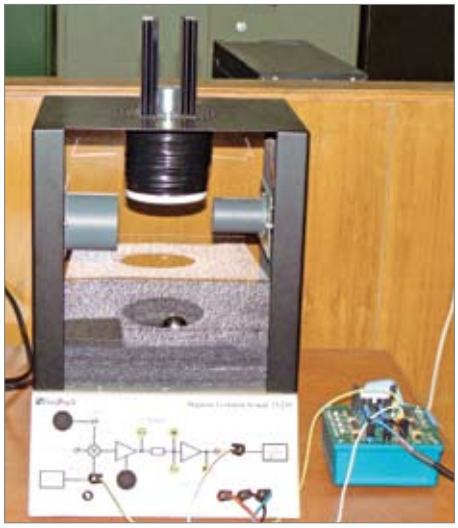
Tangirala A. K., Ph.D.
Controller performance monitoring, data mining, fault diagnosis, wavelet applications & spectral analysis, fuel cells

## Current Areas of Research

Current research in the Process Dynamics and Control Group is focused on areas such as modelling, control and monitoring of fuel cell systems, control loop performance monitoring, multivariate data analysis, fault detection and diagnosis, wavelet analysis of processes and system identification. The Group has an active collaboration with the R&D divisions of several industries. These collaborations have led to the development and field installations of software packages for data reconciliation, leak detection in gas pipeline networks, and blending and scheduling. The faculty have also authored seven books, and a patent for controlling humidity in a fuel cell was also recently filed.

## Facilities

- Lab set-ups for liquid level, temperature and control
- Inverted pendulum
- Magnetic levitation
- Software for non linear, fuzzy, neural and AI based controls
- Process simulators (ASPEN, HYSYS, BATCH CAD)
- Programmable logic controllers
- SCADA package transport processes



*Magnetic levitation demo experiment*

## Reactions and Transport Processes

### Faculty & Expertise

### Professors

Ananth M. S., Ph.D.
Thermodynamics, mathematical modeling

Balakrishnan A. R., Ph.D.
Heat transfer, energy conservation, computer aided design

Krishnaiah K., Ph.D.
Chemical reactor analysis and design fluidisation

Pushpavanam S., Ph.D.
Modeling and simulation, non-linear dynamics, flow visualisation

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*Chevron founded state-of-the-art catalytic reactor system*

Ravi R., Ph.D.
Applied statistical mechanics, statistical thermodynamics,
process control of integrated systems, property estimation of liquid metals

Sesha Talpa Sai P., Ph.D.
Chemical reactor analysis and design, rotary kilns, liquid-solid fluidisation

Sreenivas Jayanthi, Ph.D.
Computational fluid dynamics

Tanmay Basak, Ph.D.
Microwave application, mathematical modeling and simulation



### Associate Professor

Kannan A., Ph.D.
Mass transfer processes, separation processes, software development

### Assistant Professor

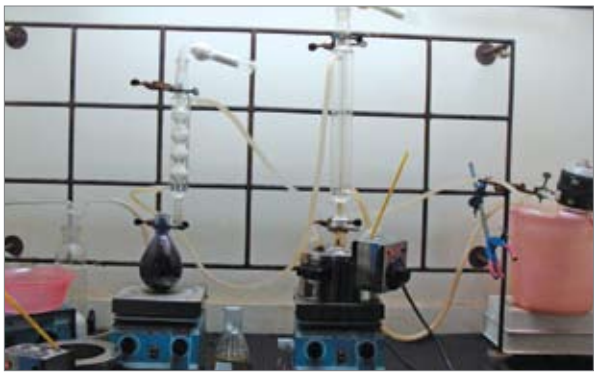
Ramnarayanan R., Ph.D.
Electrochemistry, micro power sources, scale-out, appropriate science and technology

## Current Areas of Research

Current research activities of the Group include developing models for thermodynamic and thermophysical properties of mixtures, solutions and liquid metals, finding environmentally-friendly alternatives to conventional hydrofluorocarbon (HFC)-based refrigerants, exploring clean coal technologies such as coal gasifiction, coal washing, hot gas cleaning, simultaneous removal of SOx and particulates, inverse fluidised bed reactor, three-way catalytic converters; investigating $CO_2$ Capture and sequestration possibilities such as oxyfuel combustion, post-combustion capture technologies, modeling studies of hydrogen-fed as well as alcohol-based fuel cells, process intensification through ultrasound and microwave, scale-in, scale-out, multiscale modeling and developing new computational algorithms based on finite element techniques and computational fluid dynamics.

## Facilities

- Gas chromatograph
- Thermo gravimetric analyser
- UV spectrometer
- Mercury porosimeter
- VLE apparatus
- Turbulent bed contactor (TBC)
- High temperature fluidised bed furnance
- Liquid solid fluidised bed for color removal
- Slurry reactor
- Software for distillation column analysis and design
- Inverse fludised bed
- Particle image velocimeter (PIV)
- Bubble cap distillation column
- Fluidised slurry reactor
- Thin film evaporator
- Rotary dryer
- Fluidised bed dryer
- Double drum dryer
- Pulsed packed column
- Trickle bed
- HPLC
- Packed vacuum distillation column
- State-of-the-art process simulation software for steady-state, dynamic and batch processes
- Packed bed acid gas absorption column



*Students enhance their experimental skills in reaction & separation processes*

- Gas chromatographs
- UV-VIS spectroscope
- Thermal conductivity gas analyser
- Long tube natural convection evaporator
- Infrared gas analyser

## Laboratory Scale Integrated Experimental Facilities of the Department

- Aerobic and anaerobic waste water treatment systems
- Bench scale reverse osmosis unit and electrochemical treatment unit
- Photocatalytic reactors for waste water & waste gas treatment
- Biofilters for VOC removal
- Water-water neutralisation plant control set-up using DSPACE card
- Pilot scale fixed bed, fluidised bed and inverse fluidised bed
- High pressure test facility for two-phase flow and heat transfer studies up to critical pressure for multicomponent mixtures
- Pilot scale packed tower using structured packings with and without catalyst
- Ultrasonic probe / tank systems
- Facilities for analysis of water & wastewater samples, stack and ambient air monitoring & analysis
- Rotating photocatalytic reactor
- Ultrasonic assisted solid dissolution apparatus
- Set-up for heat transfer studies under oscillatory conditions
- Set-up for two-phase flow and heat transfer studies in mini & micro-channels
- 3 kW test facility for polymer electrolyte membrane Fuel cell system

## Sponsored Research Projects

- Multiple steady-states in azeotropic distillation process
- Microscopic observation of wetting dynamics in porous and particulate solids
- Development of a flow visualisation center
- Fine particle application in high precision manufacturing semiconductor wafer surface contaminations and cleaning
- Experimental characterisation of additive effects on particle size distribution and removal rate in chemical mechanical polishing
- Development of methods for leak detection and isolation in gas pipelines
- Optimisation of proton exchange membrane (PEM) cell stack design using advanced computational techniques
- Particulate monitoring and control of VOC's towards improved air quality in Chennai city
- Development of polymer blend membranes for fuel cell applications
- Biodegradable natural composites for consumer durable applications
- Design and development of high efficiency gas-liquid contactor for air pollution control and waste water treatment
- Modeling and experimental studies on development and optimal design of pulsed three phase fluidised systems
- Regeneration and reclamation of carbon molecular sieves
- Heterogeneous photo-catalytic degradation of hazardous organic contaminants
- National Chemical Data Programme to generate thermochemical data for industrially important chemicals
- Oxygen enrichment of yttrium barium copper oxide in a high temperature fluidised bed furnace
- Colour removal from industrial waste water
- Generation of biogas from industrial waste water, tannery waste
- Rheological studies related to the curing reaction of polyol with TDI
- Effect of tube diameter on flooding characteristics of gas liquid annular counter current flow
- Effect of sea waves induced oscillations on critical heat flux and convective heat transfer in bridge mounted heat exchangers

## Consultancy Projects

- Modeling coal gasification
- Proof-of-principle layered double hydroxide synthesis
- Seal pot design standards development for circulation fluidised bed boilers
- Tea extraction studies in vending machines
- CFD analysis of gas particulate flow through an electrostatic precipitator (ESP)
- CFD modelling of flow through a scaled-down electrostatic precipitator (ESP)
- Modeling a realistic catalytic converter
- Thermochemical analysis of omcts $O_2$ reactive mixture
- State estimation techniques for non-linear Model Predictive Control (NMPC) of FBR process
- Air quality monitoring

# Chemistry

Chemistry as we know today, dates back to more than 4,000 years ago when the Egyptians pioneered the art of synthetic “wet” chemistry. By 1000 BC ancient civilisations were using technologies that formed the basis of the various branches of chemistry.

Today, a perfect chemistry of expertise and sophisticated facilities, makes the Chemistry Department at IIT Madras truly remarkable. The Department has well-equipped laboratories and expertise in analytical, inorganic, organic, bioorganic, physical, interfacial, theoretical, and computational chemistry as well as in spectroscopy, imaging and quantum computing. In addition, some of the faculty contribute to the DST sponsored, National Center for Catalysis Research (NCCR), which is also housed in the vicinity of the Department.

Current research activities of the Department are focused on the design and synthesis of novel molecules, polymers, functional materials including nanomaterials, fuel cells, electrochemical systems, catalyst development, chemometry, molecular dynamics, stochastic modeling, gas phase kinetics, and theoretical chemistry. The Department has transferred technologies to a number of process industries.

# Chemistry

The Department is organised into the Inorganic and Analytical Chemistry, Organic and Bioorganic Chemistry, Physical and Interfacial Chemistry, Theoretical Chemistry and Spectroscopy divisions. The faculty expertise in each of the divisions is listed below:

## Head of the Department

Dhamodharan R., Ph.D.
Tel (O): 2257 4200
email:cyoffice@iitm.ac.in / damo@iitm.ac.in



## Inorganic and Analytical Chemistry

### Faculty & Expertise

### Professors

Archita Patnaik, Ph.D.
Colloid and interface science

Bhyrappa P., Ph.D.
Bioinorganic chemistry

Sudheendra Rao M .N., Ph.D.
Main group inorganic chemistry

Varadaraju U. V., Ph.D.
Materials science, solid-state chemistry

Vidyasagar K., Ph.D.
Solid-state chemistry

### Associate Professor

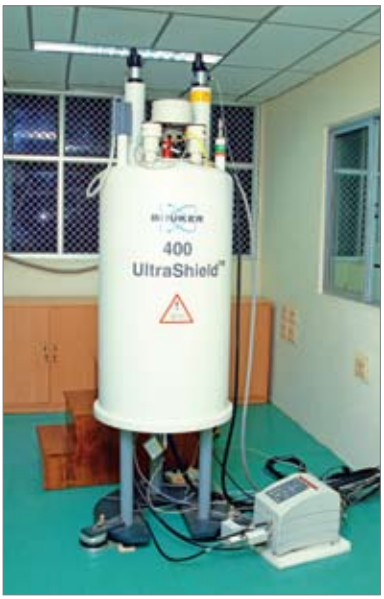
Narasimha Murthy N., Ph.D.
Bioinorganic chemistry

### Assistant Professors

Debashis Chakraborty, Ph.D.
Synthetic organometallic chemistry

Dillip Kumar Chand, Ph,.D.
Supramolecular chemistry, metal driven self assembly

Sundargopal Ghosh, Ph.D.
Metallaboranes and metallacarborances, functionalisation of hydrocarbons




*NMR*

## Organic and Bioorganic Chemistry

### Professors

Baskaran S., Ph.D.
Organic synthesis

Indrapal Singh Aidhen, Ph.D.
Synthetic organic chemistry, synthetic carbohydrate chemistry

Loganathan D., Ph.D.
Synthetic organic chemistry, carbohydrate chemistry

Sankararaman S., Ph.D.
Synthetic and physical organic chemistry

### Assistant Professors

Muraleedharan K .M., Ph.D.
Medicinal chemistry, bioorganic chemistry

Nandita Madhavan, Ph.D.
Bioorganic chemistry

Santosh J. Gharpure., Ph.D.
Organic synthesis, natural products, asymmetric synthesis

Sekar G., Ph.D.
Organic synthesis



## Physical and Interfacial Chemistry

### Professors

Dhamodharan R., Ph.D.
Polymer chemistry

Mishra A. K., Ph.D.
Fluorescence spectroscopy

Pradeep T., Ph.D.,
Chemical physics, spectroscopy

Ranga Rao G., Ph.D.,
Heterogeneous catalysis and surface science

Sangaranarayanan M.V., Ph.D
Electrochemistry and statistical mechanics

Selvam P., Ph.D.
Solid state and catalysis

Varadarajan T. K., Ph.D.
Heterogeneous catalysis

### Assistant Professors

Arti Dua, Ph.D.,
Statistical mechanics of polymers

Prasad Edamana, Ph.D.
Divalent lanthanides chemistry and dendrimers

*GPC / FT-IR*

*Synchronous Fluorescence Spectrometer*

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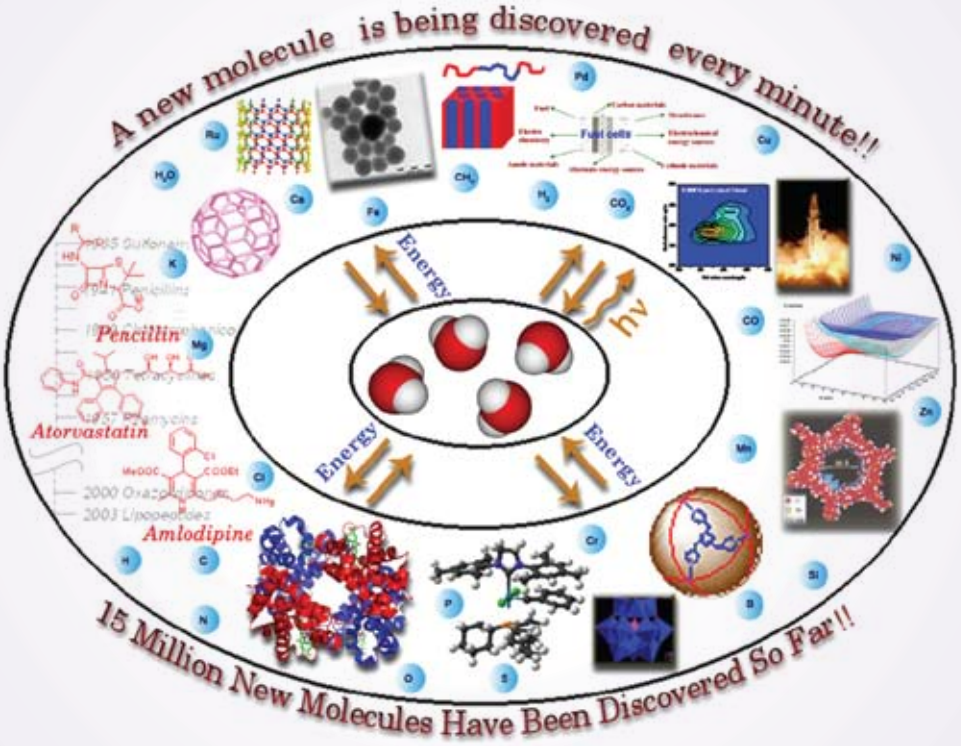



Rajakumar B., Ph.D.,
Gas phase kinetics

## Theoretical Chemistry and Spectroscopy

### Professors

Chandrakumar N., Ph.D.
Magnetic resonance spectroscopy

Mangala Sunder K., Ph.D.
Theoretical chemistry and spectroscopy

Sanjay Kumar, Ph.D.
Theoretical chemistry, molecular dynamics

### Assistant Professor

Amrendra Vijay, Ph.D.
Theoretical physical chemistry



## Facilities

- High Resolution NMR Spectrometer: Bruker Avance 400
- High Resolution ESI Mass Spectrometer3 Micromass Q-TOF
- CHN Analyzer: Perkin Elmer 2400 series
- TPD, TPR: Micromeritics, Chemisorb-2750
- Porosimeter: Micromeritics, ASAP-2020
- Single Crystal XRD: Bruker, X8 Apex
- FT-IR: Moblet-6700, JASCO 410, JASCO 660
- GPC: Waters

## Sponsored Research Projects

- Augmentation of research facilities in the Department (FIST)
- Domino reaction based strategy for the stereoselective synthesis of biologically active azacyclic ring systems
- Enantioselective total synthesis of anti-HIV michellamines A, B & C and their unnatural isomers by asymmetric ullmann coupling
- B-pyrrole substituted tetraphenylporphyrins: synthesis and their properties
- Design and physico-chemical studies of thermoreversible gels: Towards controlled release of substrates
- Excited Stated proton transfer and fluorescence decay dynamics of certain ESPT molecular probes in lipid billayer membranes
- Photochemistry and Photophysics of functional Macromolecules based on PAMAM Dendrimers
- Electron transfer processes at the Interface between two immiscible electrolyte solutions
- Catalytic conversion of carbohydrates as renewable raw materials to key platform chemicals using novel metal supported mesoporous materials
- Raft polymerisation as a tool towards water soluble block copolymers of polystyrene using novel chain transfer agents (Trithiocarbonates)
- Synthesis and applications of pore-modified novel nano-porous materials
- Text transcription of technical video lectures and creation of searchable video index, metadata and online quizzes
- Synthesis of some organic compounds of industrial significance using eco-friendly clay catalysts
- Schmidt reaction based strategy for the synthesis of biologically active molecules

*Q-TOF Mass Spectrometer*

*HPLC*

## Consultancy Projects

- Analysis of the double metal salts of hydroxy citric acid
- Analysis of the process - double metal salts of hydroxy citric acid
- NMR/Mass spectrum/TPR & TPD/Sorptometer/XRD/CHN elemental analysis
- Analysis of the double metal salt (one) of hydroxy citric acid - process
- Analysis of chemicals (Raw Materials) and advise
- Testing of odoriferous substances
- Analysis of shelf life of polyurethane paints
- Chemical composition of polymer modified bitumen
- Online and video supplemented laboratory instructions in chemistry
- Synthesis of polyoxa / aza macrocycles
- Technology enhanced learning modules in elementary schools
- Synthesis of nitrogen containing fused heterocyclic carboxylic acid
- Online and video supplemented instructions for the election process




# Civil Engineering

## THE SCIENCE OF SUSTAINABILITY


*Books recently published by faculty*

Civil engineers provide for the basic needs of humans. As civilisation progresses, human needs too are increasing and becoming technologically challenging. The Civil Engineering Department at IIT Madras is in the thick of the nation's infrastucture development and human resource generation to meet the needs of the country.

At IIT Madras, the Department of Civil Engineering has three major missions: 1) Excellence in teaching and research 2) Relevance to industry and society 3) Contribution to sustainable development. To carry forward this mission effectively, the Department is organised into five major functional divisions as follows:

- Building Technology and Construction Management (BTCM)
- Environmental and Water Resources Engineering (EWRE)
- Geotechnical Engineering (GT)
- Structural Engineering (ST)
- Transportation Engineering (TR)

These five divisions have well-equipped laboratories for teaching, research and industrial consultancy supported by various agencies and organisations. The academic programmes of the Department are among the best in the country and Asia. Many faculty members have received advanced degrees and training from reputed institutions and industries in India and abroad. Many of the alumni hold prestigious positions in leading academic institutions, industries and government organisations across the world.

# Civil Engineering

## Head of the Department

Rajagopal K., Ph.D.
Tel (O): 2257 4250
email:cehod@iitm.ac.in / gopalkr@iitm.ac.in

*Auto-desk laboratory*

## Building Technology & Construction Management

### Faculty & Expertise

#### Professors

Koshy Varghese, Ph.D.
Automation and computer integrated construction

Mathews M.S., Ph.D.
Maintenance and repair of constructed facilities

Ramachandraiah A., Ph.D.
Acoustics and noise control

Ramamurthy K., Ph.D.
Sustainable building technology, concrete materials

Ravindra Gettu, Ph.D.
Concrete technology, material characterisation

Satyanarayana K.N., Ph.D.
Construction management, public private partnerships

*Creep test facility*

#### Associate Professors

Ananthanarayanan K., Ph.D.
Project planning and control

Manu Santhanam, Ph.D.
Construction materials, durability

*Walk-in environmental chamber*

#### Assistant Professor

Ashwin Mahalingam, Ph.D.
Infrastructure and construction management

#### Adjunct Faculty in the Department

Ramakrishna A., Ph.D. (Hon)
Construction management, large-scale construction

## Facilities

This division has laboratory facilities in the areas of construction materials and systems, acoustics, lighting, thermal comfort and surveying. The construction materials laboratory has a range of material testing equipment for determining strength, non-destructive evaluation (NDE) and durability testing of concrete. The functional design laboratory equipment includes noise and vibration measuring equipment and real time analyzer. Computer facilities include state-of-the-art Integrated Construction Practice Laboratory.

## Environmental and Water Resources Engineering

### Faculty & Expertise

### Professors

Ligy Philip, Ph.D.
Environmental biotechnology, rural water supply

Mohan S., Ph.D.
Water & environmental systems modeling

Murty B.S., Ph.D.
Computational hydraulics, contaminant transport modeling

Srinivasan K., Ph.D.
Water resources planning and management

*Gas chromatograph, Atomic absorption spectrometer, Ion chromatograph, UV-visible spectrophotometer*

### Associate Professor

Sudheer K., Ph.D.
Soft computing, hydrologic modeling

### Assistant Professors

Balaji Narasimhan, Ph.D.
GIS and remote sensing, hydrologic and water quality modeling

Gopalakrishna K. M.Tech.
Industrial waster water treatment, solid waste management

Indumathi Nambi, Ph.D.
Contaminant transportation in ground water

Shiva Nagendra S.M., Ph.D.
Urban air quality management, vehicular pollution modeling.

*Towing tank, hydraulic benches, flumes and outdoor experimental facilities*

Suresh Kumar G., Ph.D.
Groundwater hydrology, contaminant hydro geology, numerical modeling.

## Facilities

Excellent facilities for computing with advanced hydraulic/hydrologic models, GIS and remote sensing, conducting open-air model studies and characterisation fo water, wastewater and leachate are also available. The Environmental Engineering Laboratory in this Division is equipped with state-of-the-art equipment like atomic absorption spectrometer, gas chromatograph, ion chromatograph, air pollution monitoring equipment, total organic carbon analyser, equipment for microbiological studies, towing tank, several flumes, and hydraulic table-top models.

*Technology for control of SOx and NOx in flue gas. Pilot plant is successfully operating at Futur.*

## Geotechnical Engineering

### Faculty & Expertise

#### Professors

Boominathan A., Ph.D.
Soil dynamics and earthquake engineering

Gandhi S. R., Ph.D.
Shallow and deep foundations

Rajagopal K., Ph.D.
Geo-synthetics, finite element analysis,
reinforced soil structures

#### Associate Professor

Robinson R. G., Ph.D.
Tropical soils and soft clay engineering

#### Assistant Professors

Dali Naidu Arnepalli, Ph.D.
Geo-environmental engineering, unsaturated soil mechanics

Dodagoudar G. R., Ph.D.
Reliability, earthquake geo-techniques

Thyagaraj T., Ph.D.
Unsaturated soil behaviour, ground improvement,
use of waste materials in civil engineering applications

Vidya Bhushan Maji, Ph.D.
Rock mechanics, instrumentation & field monitoring,
numerical modeling

*Cyclic triaxial test facility*

*Geosynthetics test facility*

## Facilities

The labs in this Division have testing equipment for static, cyclic and dynamic loads, like servo controlled cyclic triaxial testing apparatus, bender element device, shake table with a laminar box, a 40 channel data acquisition system, cyclic and dynamic lateral load testing facility, geo-synthetics testing lab capable of performing all tests on different types of geo-synthetics, large-scale apparatus to test for block-reinforcement interaction, interface strength between soil and geo-synthetics, large size direct shear test apparatus, multi-channel analysis surface wave equipment, seismic cross hole apparatus, field dynamic pile load testing, block vibration test equipment, field monitoring devices such as settlement gauges, piezometers, inclinometers, etc. The Division's computer lab is equipped with software packages such as PLAXIS 2D&3D, FLAC 3D, SASSI 2000, SAGE CRISP 2D, GEOFEM etc.

*Shake table facility*

## Structural Engineering

### Faculty & Expertise

#### Professors

Devdas Menon, Ph.D.
Structural concrete, bridge engineering

Kalyanaraman V., Ph.D.
Stability analysis and CAD of steel structures

Meher Prasad A., Ph.D.
Structural dynamics, offshore structures

#### Associate Professors

Alagusundaramoorthy P., Ph.D.
FRP composite structures, steel structures

Amlan K Sengupta., Ph.D.,
Structural concrete, earthquake engineering

Appa Rao G., Ph.D.,
Fracture mechanics, structural concrete

Nageswara Rao B., Ph.D.
Computational fracture mechanics

Satish Kumar S.R., Ph.D.
Earthquake engineering, steel structures

#### Assistant Professors

Raghukanth S. T. G., Ph.D.
Earthquake engineering and seismology, wave propagation, rainfall modeling

Rupen Goswami, Ph.D.
Earthquake resistant design

Saravanan U., Ph. D.
Non-linear elasticity, constitutive modeling

#### Visiting Faculty

Raghavan N, M.Tech. AICTE-INAE,
Structural engineering, construction management

*Static and dynamic test frames*

*Actuator, UTM and CTM*

## Facilities

The lab has two bays for testing purposes, a casting yard and facilities for fabricating specimens. The first bay has a structural testing floor, with a loading frame of capacity 2000 kN. There are testing machines with capacities up to 6000 kN in compression, high and low frequency pulsators for fatigue tests. The second bay has a strong wall and floor system, with a 1000 kN computer controlled actuator for pseudo-dynamic tests. In addition, there is a relaxation test set-up and a smart materials testing facility.

*Complex material testing lab*

## Transportation Engineering

### Faculty & Expertise

#### Professors

Sivanandan R., Ph.D.
Traffic engineering, transportation planning, intelligent transportation system

Thamizh Arasan V., Ph.D.
Transportation systems planning and evaluation

Veeraragavan A., Ph.D.
Infrastructural and pavement engineering

#### Associate Professor

Karthik K Srinivasan, Ph.D.
Travel demand modeling, network optimisation

#### Assistant Professors

Lelitha Devi V., Ph. D
Traffic flow theory, intelligent transportation system

Murali Krishnan J., Ph.D.
Constitutive modeling of bituminous material

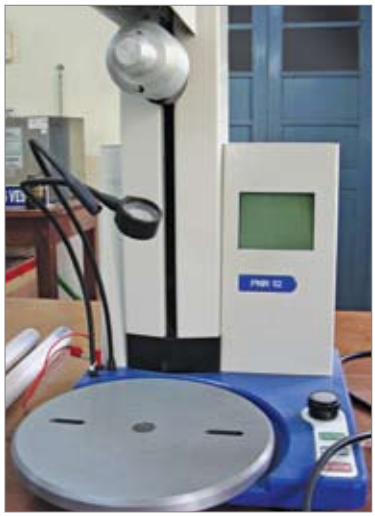
#### Visiting Faculty

Gitakrishnan Ramadurai, Ph.D.
Dynamic traffic assignment, network modeling, ITS


*Traffic Engineering test facilities*

## Facilities

The Pavement Engineering and Asphalt lab is well-equipped with facilities for a range of tests on pavement materials like gyratory compactor and bitumen extraction equipment. Equipment, like bump integrator, pavement unevenness measuring device are available for pavement evaluation. The traffic engineering lab has equipment like RADAR speed meter, image processing sensors and others for all traffic related studies. Adequate computing facilities with latest software related to traffic engineering and transportation planning are also available.



*Automatic penetration testing equipment*

## Centre for Finite Element Analysis and Design (CFEAD)

## Facilities

### Hardware

- The Department has a wide local area network, linking all the labs of the Department with a centralised file server located in the Departmental Computer Facility.
- Networked environment with 16 port switch for distributed computing equipped with 50 systems comprising workstations, personal computers and peripherals.

### Software

- ABAQUS / Post (Standard/Explicit)
- GTSTRUDL

- NISA
- IDEAS
- ANSYS
- MSC / NASTRAN
- SAP
- PRIMAVERA PROJECT PLANNER
- STADD PRO
- QE-PRO (Quantity estimation and project management software)
- Turbo CAD

## Departmental Computer Facility (DCF)

The Department of Civil Engineering boasts one of the best computing facilities of the institute for students and faculty of the Department. The Departmental Computing Facility (DCF) is housed in a large air-conditioned and well furnished hall (BSB 108) and accommodates 60 personal computers powered by 25 KVA UPS. This facility is being utilised as an on-line classroom for conducting computer based courses such as Computing techniques, Building Drawing, Geographical Information System (GIS), Remote Sensing etc. as well as for continuing education activities. Peripherals such as A3 laser printers, scanners and data storage facilities are available in the DCF for use by students and faculty. The DCF is equipped with software packages such as Visual Studio, Borland C++, SAP, STADD Pro, AutoCAD Map, ArcGIS, and ENVI+IDL.

*Sample performance test equipment*

## Sponsored Research Projects

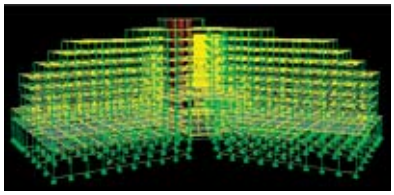
- Development of experimental set up to perform multi-axial mechanical tests on soft tissues and 3D reconstruction of their gross structure through optical Imaging
- Studies on seismic behaviour of non-seismically designed RC beam column joints with haunch element retrofit
- Studies on permissible temperature in FBR vault concrete
- Integrated construction practice lab
- Investigation on the performance grade properties of bitumen processed at Chennai Petroleum Corporation Limited (CPCL), Chennai and development of warrants for modification
- Spatio-temporal modeling of ground water quality using artificial neural network
- Behaviour of slender reinforced concrete beams
- Towards understanding the standard bond test and development of model for bond strength of lap splices in reinforced concrete
- Highway & airport pavement engineering
- Development of economical and easy-to-use water quality test kits for rural areas and training the trainers
- Estimation and prediction of traffic parameters under mixed traffic conditions for its applications
- Study of granite and sandstone - their weathering characteristics and structural properties in ASI monuments
- National competitiveness in the knowledge economy
- Monitoring water quality in rural habitats of Krishnagiri
- Evaluating the applicability and benefits of 4D - CAD in the Indian construction industry
- Earthquake resistant I-Beam-to-Box-column (IBBC) Connections
- Investigations on vacuum consolidation of soft clay soils

*Retrofitting of Pamban bridge*


## Consultancy Projects

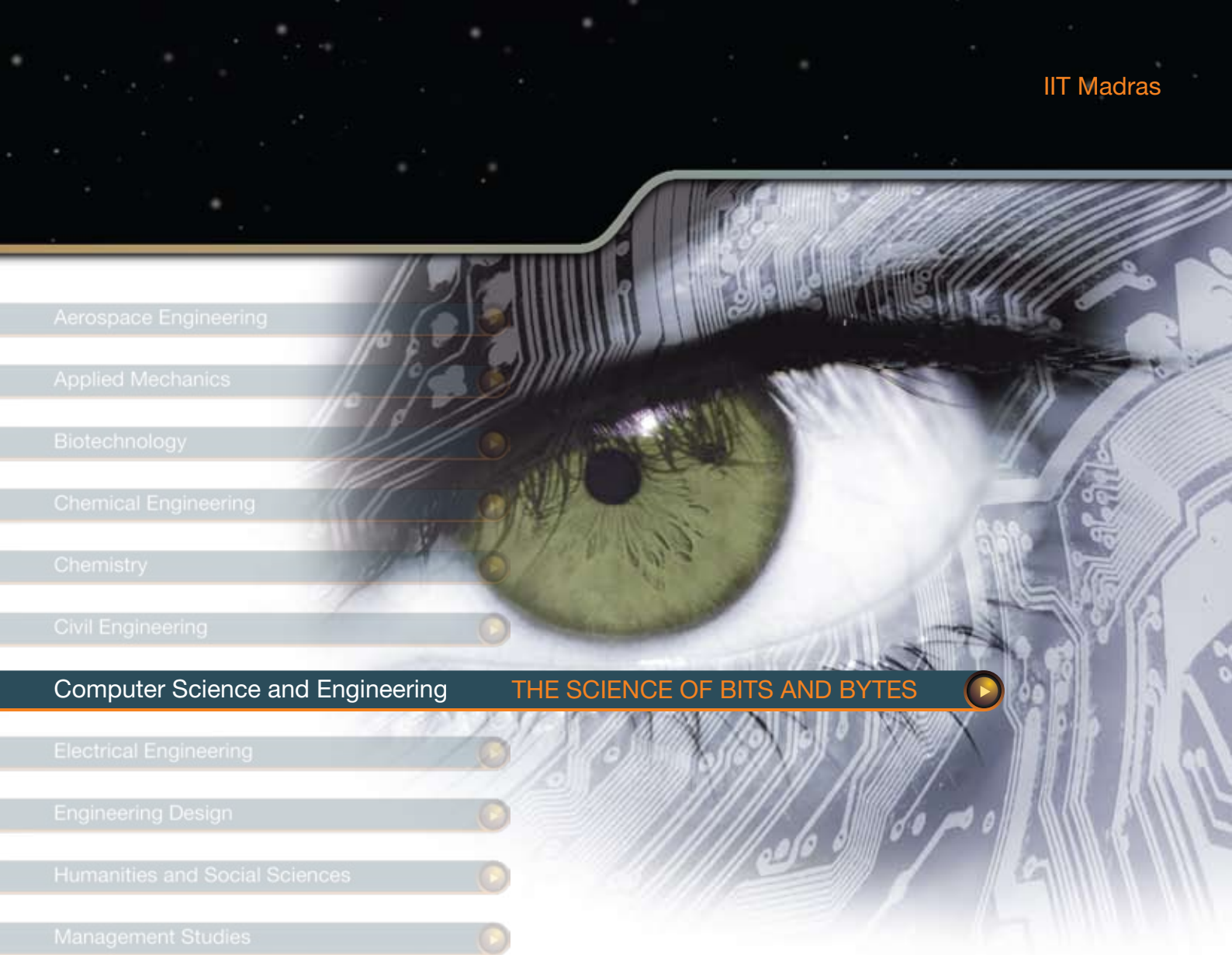
- Seismic cross hole tests at GIFT site
- Proof checking of structural design of residential apartment "PURVA SWANLAKE" at Chennai
- Proposed residential township at Sriperumbudur
- Structural proof checking of "PURVA MONETA" project at Chennai
- Design proof check for cyclic activated sludge technology
- Testing of anchorages
- Dynamic pile load tests at CPCL
- Thirty Storey Maretto Pimento
- Testing of grouts
- Seismic cross hole tests at Mettur Thermal Power Project
- Proof checking of AAI runway across Adyar River -Chennai
- Structural safety certificate and proof checking of design of Abirami Theatre
- Evaluation of design of proposed landfill at Ramky Pharma City (India) Ltd
- Site specific seismic study at GIFT site, Gandhi Nagar (Gujarat)
- Design of earth dams for Polavaram project
- Proof checking of structural designs for academic cluster building of APIIT campus, Andhra Pradesh
- Vibration study for Chennai Metro Project
- Evaluation of solid waste processing facility in Municipal Corporation, Guntur
- Fatigue test of leaf spring assembling
- Proof checking of reinforced soil retaining wall designs at Mangalore

*Restoration of 1000 year old temple in Ta Prohm Cambodia*



*Seismic evaluation of Delhi Secretariat building*

*Tallest retaining wall in india*





## THE SCIENCE OF BITS AND BYTES

If there's one item that's truly indispensable today, it is the ubiquitous computer. Across industries, computers have become a permanent fixture. At IIT Madras the Computer Centre was set up in 1973 and rechristened in 1983 as the Computer Science and Engineering Department. The research and development activities of the Department fall into 5 broad areas.

Theoretical Computer Science: Unconventional models of computing, cryptography, computational geometry, algorithms, cellular automata, graph theory.

Hardware Systems: Reconfigurable hardware design, design for testability, software aspects of VLSI design.

Networks & Distributed Systems: Wireless networks, optical networks, network security, network management systems, grid computing, distributed/mobile object systems, traffic modeling, web based software systems.

Human Computer Interaction: Speech recognition and synthesis, multi-modal interfaces including keyboard/display for Indian languages, image processing, computer vision.

Intelligent Systems and Knowledge Engineering: Artificial Intelligence, machine learning, XML and semi-structured databases, semantic web, ontologies, data mining, information retrieval, and memory based reasoning.

# Computer Science and Engineering

## Head of the Department

Gonsalves T. A., Ph.D.
Tel (O): 2257 4350
email:csoffice@iitm.ac.in / tag@iitm.ac.int

The faculty expertise and the activities of R&D Labs in the Department are described below:

## Artificial Intelligence & Databases Lab

### Faculty & Expertise

#### Professors

Deepak Khemani, Ph.D.
Artificial intelligence, knowledge based systems, case based reasoning, knowledge management, planning, logic and natural language processing

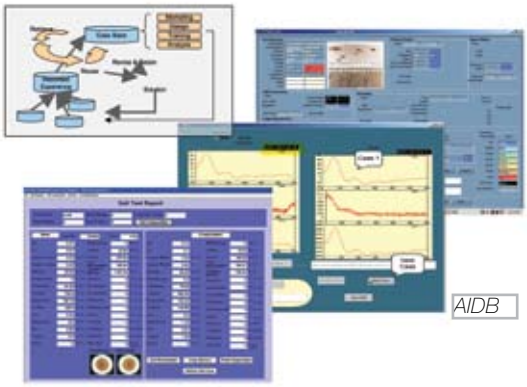
Sreenivasa Kumar P., Ph.D.
Database systems, semi-structured data and XML, data mining, graph algorithms, parallel computing

#### Associate Professor

Narayanaswamy N. S., Ph.D.
Analysis of algorithms, complexity theory, artificial intelligence

#### Assistant Professor

Sutanu Chakraborti, Ph.D.
Information retrieval, memory-based reasoning, machine learning



AIDB

### Research/Development Activities

- Knowledge management with case based reasoning, planning and constraint satisfaction
- Machine learning
- Semantic interoperability using ontologies
- XML data handling – storage indexing and query languages
- Online and exact algorithms

## Computer Vision Lab

### Faculty & Expertise

#### Associate Professor

Anurag Mittal, Ph.D.
Computer vision, multi-camera vision systems, sensor planning, surveillance, computer graphics


CVLAB

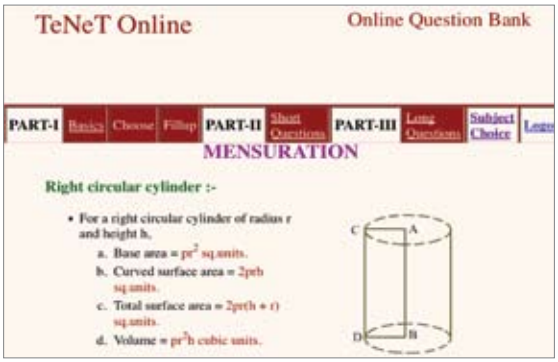
### Research/Development Activities

- Multi-camera vision systems
- Surveillance under occlusion
- Gesture recognition
- Pose and gait recognition

## Don Lab

## Indic Computing and Communication Systems

### Faculty & Expertise




*DON Lab*

#### Professors

Gonsalves T. A., Ph.D.
Computer networks, distributed systems, telecom software, performance evaluation

Hema A. Murthy, Ph.D.
Speech processing, speech recognition, computer networks, multimodal interfaces to a computer, computer graphics

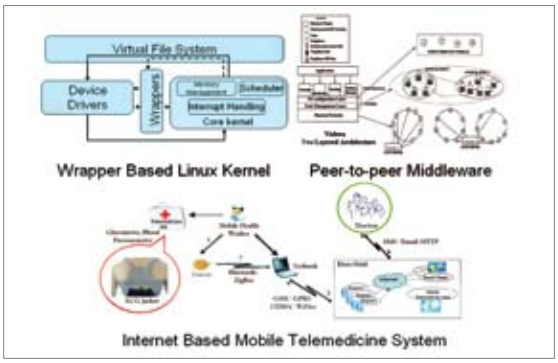
Krishna Moorthy Sivalingam, Ph.D.
Wireless networks, sensor networks, optical networks, network security

#### Visiting Faculty

Gaurav Raina, Ph.D.
Communication and transport networks, stochastic processes, congestion control

### Research / Development Activities

- Advanced network management and planning
- Multimodal interfaces to the computer
- Speech synthesis and recognition, speaker recognition, speech recognition for Indian languages, spoken language identification
- DSP virtual machine
- Internet-based education programmes
- Wireless sensor networks
- Network traffic modeling and analysis




*DOS Lab*

### Equipment/Facilities

- Networking planning and management software
- Speaker identification software

## Distributed & Object Systems Lab

### Faculty & Expertise

#### Professor

Janakiram D., Ph.D.
Object oriented systems, software engineering, parallel and distributed computing, distributed systems, databases

### Research/Development Activities

- Distributed Systems - Cluster computing, concurrency control, parallel programming
- Object-oriented Systems - Component customisation, role modeling, cost estimation
- Software Engineering - Pattern oriented software design, refactoring design

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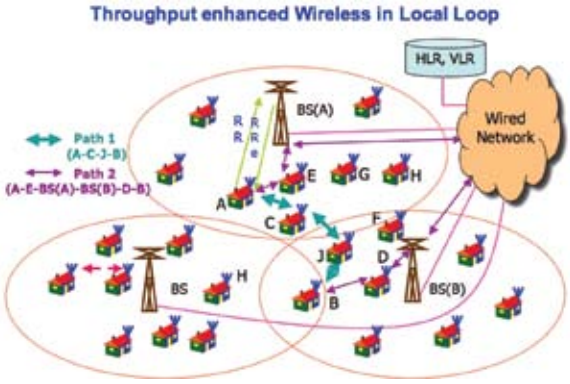
## Equipment / Facilities

- Heterogeneous cluster of workstations
- Wireless sensor network test bed (set up by HTSL)




*HPCN*

## High Performance Computing and Networking Lab

### Faculty & Expertise

**Professor**

Siva Ram Murthy C., Ph.D.
Ad hoc wireless networks, parallel and distributed computing, real-time systems, computer networks

## Research/Development Activities

- Protocols for hybrid wireless networks
- Ad-hoc wireless networks
- Wireless sensor networks
- WDM optical networks – routing and wavelength assignment, traffic grooming, survivable multicast

## Equipment/Facilities

- Interconnected Pentium workstations
- LynkSys IEEE 802.11b access points
- LynkSys/US robotics IEEE 802.11b clients
- PicoPeta simputers
- ZigBee-complaint Crossbow Wireless Network Testbed

## Network Systems Lab

### Faculty & Expertise

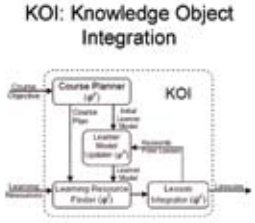
**Professor**

Raghavan S. V., Ph.D.
Research, development and performance analysis related to computer networks and protocols with emphasis on high speed and multimedia, security, electronic commerce, data warehousing, role of IT in education, culture and heritage

## Research/Development Activities

- Ultra-high speed computing
- Universal learning space
- Information technology management
- Electronic forensics and judiciary
- Society and IT development






## Equipment/Facilities

- Xeon/Itanium based Rack servers
- RAID clients
- High-speed switches
- Wireless access points and devices

## Reconfigurable and Intelligent Systems Engineering (RISE) Lab

### Faculty & Expertise

#### Professor

Kamakoti V., Ph.D.
Software aspects of VLSI design, cluster computing,
high performance computing, application specific hardware design,
hardware verification

#### Associate Professor

Ravindran B., Ph.D.
Machine learning, reinforcement learning, data and text mining

#### Assistant Professors

Madhu Mutyam., Ph.D.
Computer architecture, CAD systems for VLSI design

Shankar Balachandran, Ph.D.
CAD for VLSI, reconfigurable computing, computer architecture

#### Visiting Faculty

Ashish Tendulkar, Ph.D.
Computational biology, bio-Informatics, text mining

## Research / Development Activities

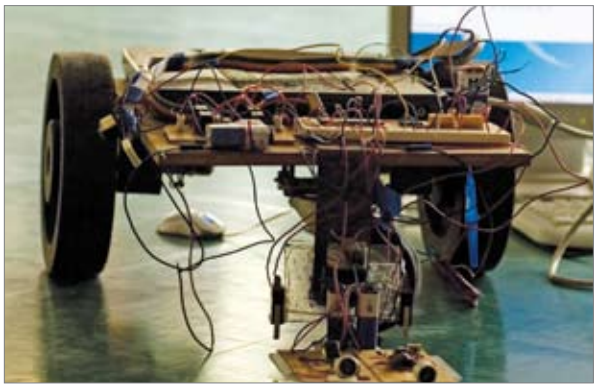
### VLSI

- Design and testing of reconfigurable architectures and VLSI systems
- Fault tolerant architectures

- Sensor remote development
- Power-aware system design
- Modern FPGA architectures
- Multi-core and parallel architectures

### Intelligent Systems

- Reinforcement learning
- Data mining
- Text and web mining
- Social network analysis
- Autonomous agents
- Computational biology



*RISE*

## Equipment / Facilities

### VLSI CAD Tools

- Magma - RTL to GDSII - Complete digital flow - 15 licences
- Mentor graphics - complete digital flow - 12 licences
- Altera Quartus tool - 20 licences
- Xilinx tools

### Hardware

- Quad processor, V880 SUN-SPARC server
- NIOS development board
- DSP development kit
- PCI development kit
- NVIDIA GPGPUs

## System Development Lab

### Faculty & Expertise

**Professor**

Kalyana Krishnan R., Ph.D.
Computer architecture, computer system design, microprocessors, digital electronic systems, computer graphics, statistical signal processing

## Speech and Vision Lab

### Faculty & Expertise

**Associate Professor**

Chandra Sekhar C., Ph.D.
Speech recognition, neural networks, kernel methods, computer architecture

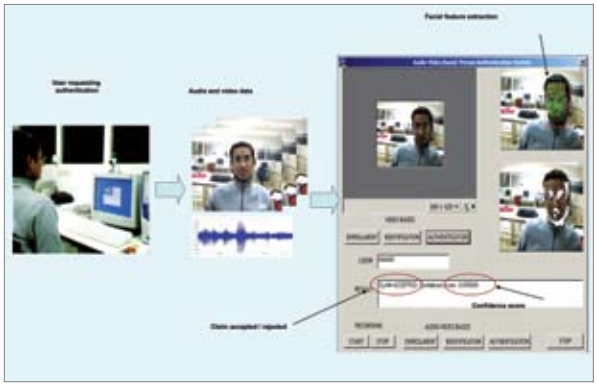
## Research/Development Activities

- Speech signal processing
- Speaker verification, recognition and segmentation
- Speech enhancement
- Spoken language identification

- Content-based information retrieval
- Artificial neural networks, kernel methods and support vector machines

## Equipment / Facilities

- ESPS and HTK toolkit for speech analysis
- Audio, image and video data acquisition facility



*Speech and vision*

## Theoretical Computer Science Lab

### Faculty & Expertise

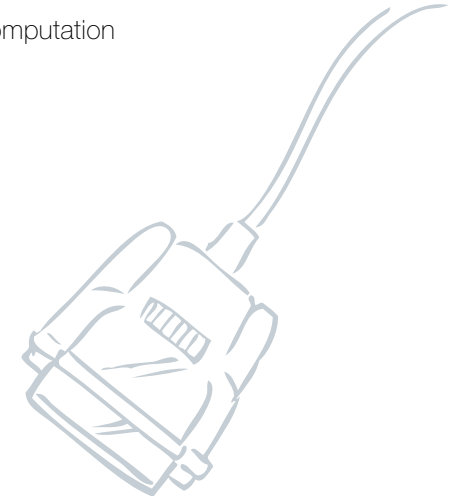
### Professors

Kamala Krithivasan, Ph.D.
Theoretical computer science, computational geometry, formal languages and automata theory, unconventional models of computing

Pandu Rangan C., Ph.D.
Algorithms, parallel and VLSI algorithms, graph theory, computational geometry, randomised algorithms, computational learning theory, cryptography

### Visiting Faculty

Shailesh Vaya, Ph.D.
Analysis and design of algorithms, theory of cryptography, secure computation



## Research/Development Activities

- Optimal, secure multiparty computations and communications
- Unconventional models of computing
- Cryptography
- Computational biology
- Computational geometry
- Randomised algorithms

## Visualisation & Perception Lab

### Faculty & Expertise

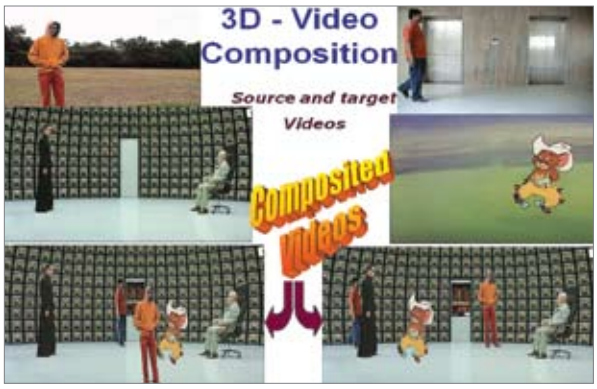
### Associate Professor

Sukhendu Das, Ph.D.
Visual perception - Computer vision, digital image processing, pattern recognition, computer graphics, neural networks, soft computing, visualisation, computational science and engineering, digital and analog systems

## Research / Development Activities

- Multi-modal biometry
- Texture analysis and classification
- Digital video analysis
- Modeling of soft objects

- Event analysis
- Aerial image exploitation
- Super-resolution mosaic



*VP Lab*

## Equipment/Facilities

- FACE-VACS SDK
- S-DVR (Stereo Digital Video Recorder)
- Network cameras
- Camcorder unit
- Fingerprint device

## Departmental Computing Facility

The Department computing facility is equipped with the following types of systems to support teaching, research and development in various areas of Computer Science and Engineering.

## Equipment / Facilities

### Hardware

- SUN Enterprises 220R and ULTRA SPARC SENSOR
- Qmax Intel Dual Xenon 2.3GHz Servers with SRCU31A Ultra 160 RAID Controller
- 16-processor, HP Blade Servers
- 16-processor, AMD Opteron Servers
- 16-Terabyte NAS storage system
- 150 PCs and Macs

*CSE*

### Supported Platforms

- Solaris 8.0
- Sun Ray Enterprises 1.1
- Windows
- Mac OS X

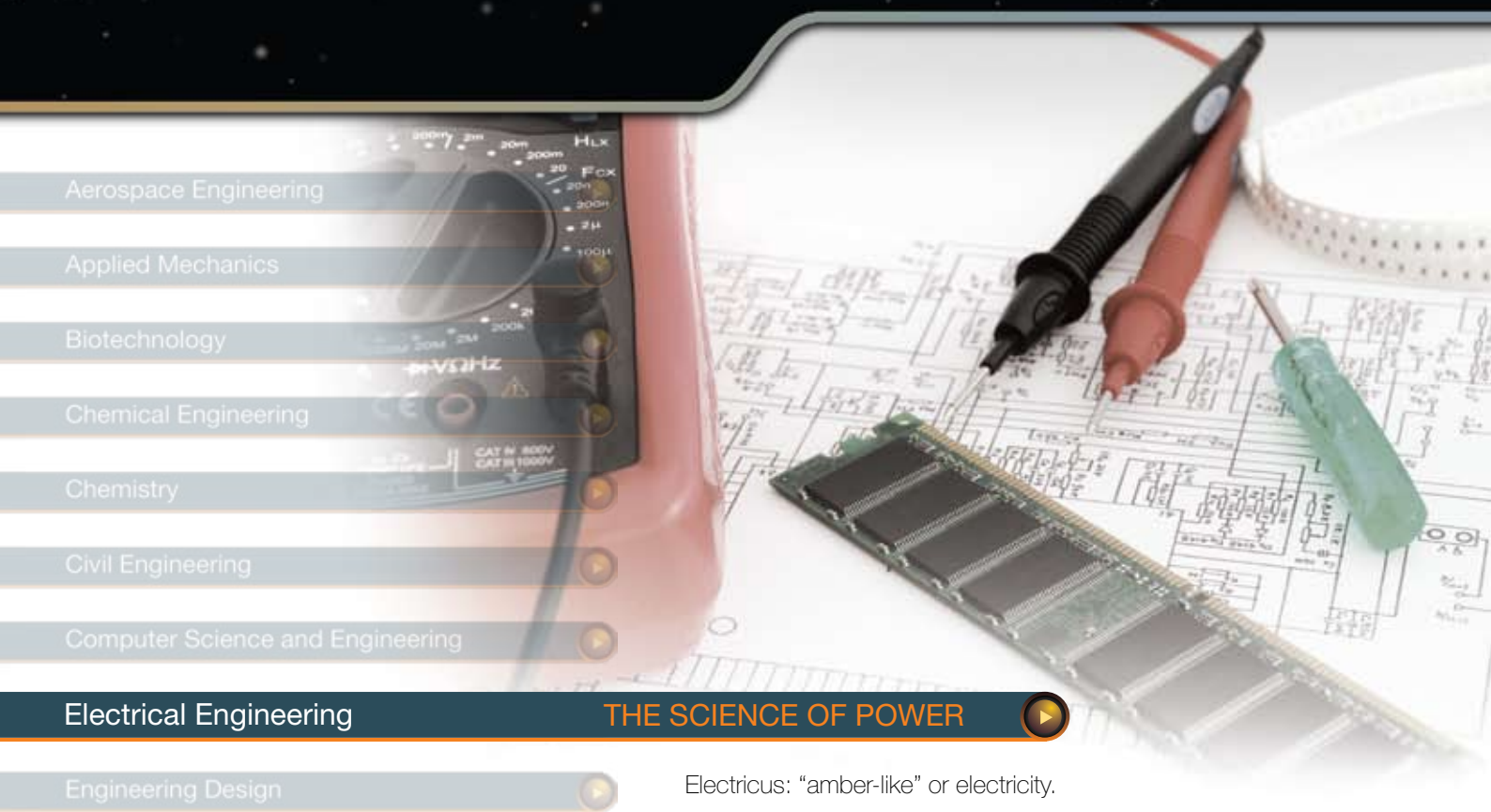
## Sponsored Research Projects

- Academic and research collaboration between DRDO and IIT Madras on communication and information technology
- Protecting critical infrastructure from denial of service attacks: Tools, technologies and policies
- Development of text to speech system for Indian languages
- Formal equivalence checking of digital designs
- Distributed software engineering
- Reinforcement learning of visual routines in autonomous systems
- Multimodal command and control by integrating two-handed gestures and speech
- Patterns to Decisions: Making data mining actionable
- RAS: An end-to-end real-time alert system based on real-time Java (IBM Real - time Innovation Award)

- Microsoft windows technologies lab
- Development of wireless sensor networks for civilian applications
- Research and development of multi-camera algorithms for security and surveillance
- Knowledge acquisition for textual case-based reasoning
- Issues in transactional memory
- Telemedicine station for rural health monitoring and diagnosis of epidemic diseases

## Consultancy Projects

- Device grid storage network
- Algorithms for concept learning
- Thales @ IITM
- Comments on fault attack on AES
- National Informatics Centre
- Sizing of sensors for tracking trainee movements in simulation arena
- Speaker identification
- Investigation of methods for resume processing
- A mobile data grid framework for Telemedicine
- Ontology server
- An NLP engine for sentiment analysis of unstructured documents in English
- Institute for Development & Research in Banking Technology
- Refactoring C# code to design pattern based code
- Ontology based knowledge management
- Analysis of customer call data records





## THE SCIENCE OF POWER

Electricus: "amber-like" or electricity.

A subject that has fascinated man since the 17th century. The first electrical engineer was probably William Gilbert who designed the versorium: a device that detected the presence of statically charged objects. In 1882, Edison switched on the world's first large-scale electrical supply network. Since then, there has been no looking back.

The Department of Electrical Engineering at IIT Madras concentrates on education and research. It focuses on research and development activities for Indian and global industries in all areas of electrical engineering, namely, communication, power system, high voltage, power electronics, electrical machines, drives, microelectronics, very large scale integration (VLSI), control and instrumentation.

The Department has strong industry interaction and has been involved in the development of state-of-the-art products, in its quest to make Indian industry stand up to the very best in the world. It has extensive calibration and testing facilities. Recently, sophisticated facilities in the areas of RF design, VLSI systems, microelectronics, supervisory control and data acquisition (SCADA), energy management systems (EMS), flexible AC transmission (FACTs), custom power devices, condition monitoring of power apparatus, multilevel inverters, electric machines, drives, robotics, control and virtual instrumentation have been established. The Department is also creating centres of excellence for ( i ) communication systems ( ii ) Analog VLSI design

SOI based piezo-resistive poly silicon pressure sensors, digital mixed signal "Application Specific Integrated Circuits" (ASICs) for data collection, very high frequency bipolar transistors, electroless metallisation on polished silicon and calibration-free pulse oximeter are some of the notable products/processes that have been developed in the recent past.

In the area of communications, the Department has taken a lead in developing technologies which would make telecom and computer networks affordable and widely available in developing countries. Based on these, several enterprises have been incubated.

The current research activities of the Department are focused on design and development of silicon micro accelerometers and SOI based sensors, analytical modeling and new concepts in GaN HEMTs, superjunctions, solar cells, next generation wireless mobile technologies, optical component development, digital and mixed signal systems on chip design (SOC), FPGA design, virtual instrumentation, power system automation and control, custom power devices, power electronics and machine drives, condition monitoring of power apparatus, nano powder generation, measurement and analysis of "partial discharge" and optical and ultrasonic biomedical instrumentation systems.

Future plans include design, fabrication and modeling of Micro Electro Mechanical System (MEMS) based sensors and actuators, nano electronic devices and materials, advanced research in wireless and optical technologies, signal processing applications, establishment of complete range of test facilities for fabricated Integrated Circuits (ICs), a nodal centre for virtual and power systems instrumentation, PQ interpretation unit, smart power grid, brushless DC machines, development of energy management systems and implantable biomedical devices.

The Department has several labs, which are grouped into four major areas:
EE1 – Communications, wireless and optical networks and systems
EE2 – Power systems, power electronics, high voltage, machines and drives
EE3 – Microelectronics and VLSI Design
EE4 – Control, Measurements and Instrumentation

## Head of the Department

Jagadeesh Kumar V., Ph.D.
Tel (O): 2257 4400
email:eeoffice@iitm.ac.in / vjk@iitm.ac.in

## EE1 - Communications, Wireless & Optical Networks and Systems

### Faculty & Expertise

### Professors

Anil Prabhakar, Ph.D.
Optical devices and networks, nonlinear systems, magnetic and magnetic-semiconductor devices

Aravind R., Ph.D.
Communications, video, estimation theory

Ashok Jhunjhunwala, Ph.D.
Fibre-optic communication, communication network, computer networking, microprocessor based systems, SAW

Bhaskar Ramamurthi, Ph.D.
Digital communication systems, DSP, wireless networks

David Koilpillai R., Ph.D.
Cellular and broadband wireless systems, DSP applications in wireless, cognitive radio

Devendra Jalihal, Ph.D.
Statistical signal processing, estimation theory

Giridhar K., Ph.D.
Communication systems, adaptive signal processing

Harishankar Ramachandran, Ph.D.
Optical link design and planning, non-linear optics, computational plasma physics and optics, edge plasma physics

Prabhu K.M.M., Ph.D.
Algorithms for digital signal processing, spectral estimation, DSP applied to radar

Rajagopalan A N., Ph.D.
Image processing and computer vision

Umesh S., Ph.D
Speech and signal processing

### Associate Professors

Andrew Thangaraj, Ph.D.
Digital telecommunications, error control coding, secure communications

Ramalingam C. S., Ph.D.
Signal processing, speech recognition, synthesis, and coding

Srikrishna B., Ph.D.
Wireless multimedia communications, signal processing for communication systems, information theory

### Assistant Professors

Balaji Srinivasan, Ph.D.
Optical components, active and passive fibre devices, distributed fiber optic sensors

Manivasakan R., Ph.D.
Performance analysis of communication networks in general, optical and computer networks

Mathiazhagan C., Ph.D.
Telematics, RF communication, analog circuits

Shanthi Bhattacharya, Ph.D.
Optical components, diffractive optics, applied optics

Venkatesh. T. G., Ph.D.
Stochastic modelling, computer networks, computer architecture

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### Visiting Faculty

Arun Pachai Kannu, Ph.D.
Wireless and cellular communications

Deepa Venkitesh, Ph.D.
Non-linear fibre optics

Venkatesh R., Ph.D.
Stochastic modeling, queuing theory, wireless communication

### Adjunct Faculty

Kiran Kumar Kuchi, Ph.D.
Wireless and cellular communications

Mani Subramanian, Ph.D.
Networking, network management,
broadband communication systems

### Scientific Officer

Prabhakar Rao P., M.S.

## Facilities

- Vector network analyser
- Circuit simulation and layout tools
- True RMS voltmeter
- RF frequency generator and spectrum analysers
- Wide band noise generator
- Logic analysers
- DSP emulators
- FPGA facilities
- Digital communication trainer
- Fibre optic educator
- HP ADS system
- Lightwave multiframe BER tester, optical spectrum analyser
- Optical Time Domain Reflectometer (OTDR)

## EE2 - Power Systems, Power Electronics, High Voltage Machines and Drives

### Faculty & Expertise

### Professors

Krishna Vasudevan, Ph.D.
Electrical machines, industrial drives and power electronics

Mahesh Kumar, Ph.D.
Custom power devices, power quality monitoring, analysis and interpretation

Sarathi R., Ph.D.
High voltage engineering

Shanthi Swarup K., Ph.D.
Power systems, computational intelligence and energy management systems

### Assistant Professors

Kalyan Kumar B., Ph.D.
Power system stability, FACTs, power quality

Krishna S., Ph.D.
Power system stability analysis and control

Srinivas S., Ph.D.
Electrical machines, power electronics and industrial drives

## Facilities

### Machines and Drives Lab

- Motor generator sets
- Cradle type DC dynamometer
- Regulating transformer
- Torque transducer
- Data acquisition systems
- Vector visualizer
- Special purpose AC supply generators
- Measurement storage oscilloscopes
- Microprocessor based drive systems
- Simulation software for power electronic systems, PSIU
- Magnet 2D,3D FEM software
- Motor control DSP kits
- FPGA Kits - Altera, Xilinx
- Multilevel inverters

### High Voltage and Power System Lab

- HV testing transformer (800 kV, 400kVA)
- Lightening impulse generator (1.5 MV, 37.5kJ)
- High frequency voltage generator
- Digital-wide bandwidth storage oscilloscopes
- Capacitance and loss tangent measurement unit
- PD detector unit
- Power system simulator
- Power system analysis and application software
- Power quality, monitoring and analysis unit
- FACTs and custom power devices experimental units
- DSP based power controllers

## EE3- Microelectronics and VLSI design

### Faculty & Expertise

#### Professors

Amitava Das Gupta, Ph.D.
Silicon and gallium arsenide devices-technology, modeling and simulation, MEMS

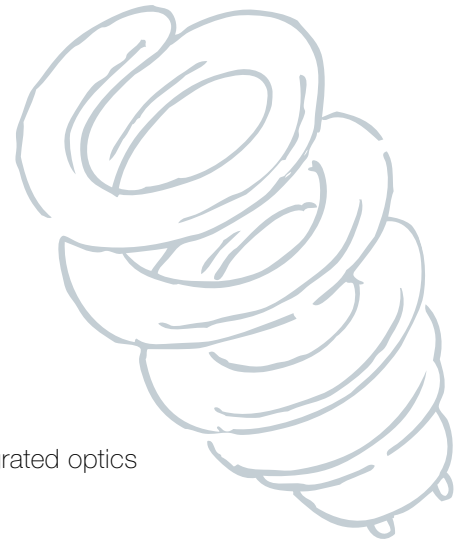
Enakshi Bhattacharya, Ph.D.
Amorphous, porous and polycrystalline silicon material and devices, MEMS and biosensors

Nandita Das Gupta, Ph.D.
Silicon and III-V semi-conductor devices-technology and modeling, MEMS

Shanthi Pavan, Y., Ph.D.
Analog VLSI, RF and microwave ICs

Shreepad Karmalkar, Ph.D.
Modeling and fabrication of semiconductor devices, MEMS/microfluidics, nano technology, education

Srinivasan S., Ph.D.
Digital systems, computer architecture, digital signal processing, VLSI design



Vinita Vasudevan, Ph.D.
Statistical & noise analysis of circuits, VLSI design

#### Assistant Professors

Anjan Chakravorty, Ph.D.
Compact modeling of SiGe HBTs, LDMOS, NanoFETs

Bijoy Krishna Das, Ph.D.
Optoelectronic devices and circuits, silicon photonics, lithium niobate integrated optics

Nagendra Krishnapura., Ph.D.
Analog VLSI, RF & microwave ICs

Nitin Chandrachoodan, Ph.D.
Digital systems, microprocessors, VLSI design

#### Adjunct Faculty

Ravikumar C.P., Ph.D.
Digital VLSI design and testing

Ravishankar A., Ph.D.
Digital VLSI, CAD

**Senior Scientific Officer**
Ponnuraju K., Ph. D.
Semi-conductor devices and technology

## Facilities

- Workstations and EDA tools for complete IC design flow
- EPLD / FPGA design software and workstations
- DSP kits and workstations
- IC test facilities
- Class 100 /class 10000 clean rooms
- Laser writer for mask making
- E-beam metallisation unit
- Furnaces for oxidation and diffusion
- Double sided mask aligners and exposure systems
- PECVD system for silicon dioxide and silicon nitride deposition
- LPCVD system for polysilicon deposition
- Reactive Ion etching system
- Substrate bonder characterisation
- Autogain ellipsometer
- Interferometric 3 -D surface profiler
- Four point probe
- Contact angle measurement system
- DLTS system
- Manual wafer probe station
- Semiconductor parametric analyser
- Multifrequency LCR meters
- Lock-in amplifier and chopper
- Device simulation

## EE4 – Control, Robotics, Measurements and Instrumentation

**Faculty & Expertise**
**Professors**
Jagadeesh Kumar V., Ph.D.
Instrument transformers, ferromagnetic materials, instrumentation, digital and microprocessor systems

Janakiraman P. A., Ph.D.
Robotics and vision, electronic instrumentation of IC engines, design of control systems, digital control and identification of systems

Jayashankar V., Ph.D.
High voltage, power systems and biomedical instrumentation

Sridharan K., Ph.D.
Robotics, vision, architectures for transforms, FPGA-based system design

### Assistant Professors

Arun D. Mahindrakar, Ph.D.
Non-linear and optimal control with application to underactuated systems

Bharath Bhikkaji, Ph.D.
Identification algorithms for resonant systems, vibration control of resonant and active structures and control and actuation of mechatronic systems

### Visiting Faculty

Mohana Shankar S.
Biomedical instrumentation, implantable devices

## Facilities

### Control Engineering Lab

- Micro selection C development systems for VLSI based control
- Simulation packages: MATLAB, PSPICE, MAXPLUS II
- Motor control systems
- Speed control systems (analog and digital)
- Benchmark vision system
- High precision measuring instruments
- Cobra RS-23-5 axis robot
- Eshed ERIII, eshed E&V: 5 axes robots
- Position control systems (AC and DC)



### Measurements and Instrumentation Lab

- Precision indicating instruments
- Virtual instrumentation
- Instrument calibrator
- Energy meter testing desk
- Instrument transformer calibrator
- High current AC and DC supply units
- Biomedical instrumentation (ultrasonic and optical)

## Departmental Computer Facility

- A cluster of 90 networked PC's running linux
- A wide variety of circuit simulation, mathematical, image processing and word processing software

## Sponsored Research Projects

- Centre for analog mixed signal integrated circuit design
- Development of integrated optical single channel add-drop multiplexer (SCADM) in SOI platform for fibreoptic communication systems
- Development of passive integrated photonic components in silicon-on-insulator platform
- Upgrading facilities for MEMS design activities at national resource centres

- Multi-fusion sensor system for condition monitoring of gas insulated system
- Design and development of network security simulator for training and exercise
- Algorithms and switching control strategies of UPQC with minimum VA loading for handling power quality problems
- Design and development of a novel calibration-free pulse oximeter
- Development of gigabit capable passive optical network (G-PoN) technology and its performance analysis under a new DBA algorithm
- Investigation and compact modeling of noise in SiGe heterojunction bipolar transistors
- Development fo 400 Hz inverters for air-borne application under NaMPET
- Simulation and performance of Gigabit capable passive optical network (GPON)
- SOI integrated optical chip for sensor applications
- Creation of infra structure for the synthesis of metallic nano particles by wire explosion technique

## Consultancy Projects

- Impulse voltage testing of power transformers (10 MVA, 110/33 kV)
- Impulse voltage testing of current limiting series reactor (132 kV)
- Analysis of busbar configurations for inverters
- Field plot of disc insulator
- Development of tactical field wireless system
- Optical Time Domain Reflectometer
- Modeling of the safe operating area of power SiC MOSFETs
- Development Coding and testing of algorithm for AC motor protection
- Consultation on thyristor application
- Measurement of losses of power transformers
- Measurement of errors of LT/HT current and potential transformers
- Verifying neutral current in electrical auxiliary power distribution network
- Measurement of power quality at facilities
- Design of shunt reactor and NGR for 400 kV transmission line

# THE SCIENCE OF BLUEPRINTING SUCCESS

From concept to a component that meets a desired function, aptly describes Engineering Design. It is a decision-making process, often iterative, in which the basic sciences and the engineering sciences are applied to convert resources optimally to meet a stated objective. Among the fundamental elements of the design process are the establishment of objectives and criteria, synthesis, analysis, construction, testing and evaluation.

The country's first, and providing the much required leadership in engineering design, is the Department of Engineering Design. Established in 2006, it was the sixteenth department to be set up at IIT Madras with a focus on interdisciplinary teaching and research. The department launched the novel dual degree programme in Engineering Design which constitutes a B.Tech. specialisation in Engineering Design and an M.Tech. specialisation in Automotive Engineering with a strong thrust on the modern practices of design. A second dual degree programme that offers a B.Tech. specialisation in Engineering Design and an M.Tech. specialisation in Biomedical Design commenced in 2008.

Engineering design involves the development of a concept and a form to meet a function. The designer has to be well versed in the fundamentals of engineering and possess interdisciplinary skill sets to create cutting edge products within a competitive business environment. The design has to be aesthetically appealing yet robust; long lasting, yet inexpensive; incorporate light-weight material, and yet be sensitive to environmental concerns. This broad-based programme combines all the above aspects of design along with managerial acumen.

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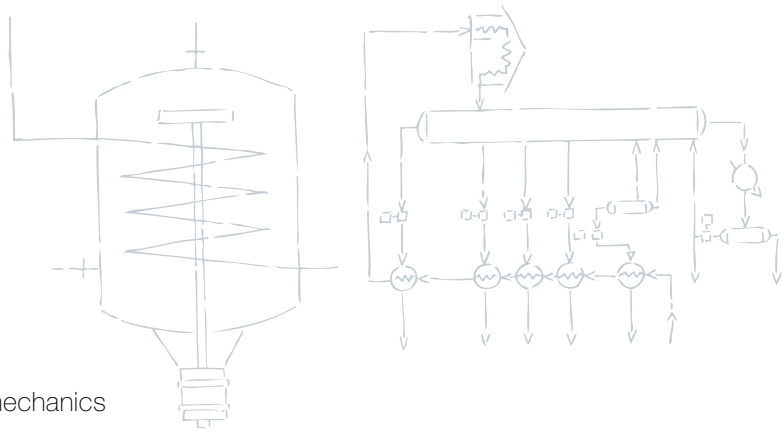
*Vehicle Dynamic Laboratory*

## Engineering Design

**Current research activities of the department are mainly in the following areas**

- Automotive Engineering: Vehicle dynamics, tyre mechanics, automotive systems, control and fault diagnosis
- Robotics: Parallel manipulators, underwater robots, path planning, system dynamics and control
- CAD/CAM: Geometric and solid modeling, computational geometry, shape search, shape optimisation, reverse engineering and image based reconstruction, solid free form fabrication
- Finite element analysis
- Biomedical Design: Medical imaging, biomechanical modeling, soft tissue mechanics, biofluid mechanics, prosthetic and scaffold design
- Ergonomics
- Design theory, reliability, fatigue and fracture



### Head of the Department

Krishnakumar R., Ph.D.
Tel (O): 2257 4730
email:edoffice@iitm.ac.in / rkkumar@iitm.ac.in

### Faculty & Expertise

**Professor**

Krishnakumar R., Ph.D.
Nonlinear finite elements, vehicle dynamics, tyre mechanics

**Associate Professors**

Asokan T., Ph.D.
Robotics, mechatronics, control, electro hydraulic servo systems

Sankara J. Subramanian, Ph.D.
Mechanics of materials, nano-indentation, digital image correlation and computational mechanics

Vasa N. J., Ph.D.
Optoelectronics, laser based remote sensing, laser assisted manufacturing, mechatronics

Venkatesh Balasubramanian, Ph.D.
Biomechanics, human factors and ergonomics, biomedical devices development, rehabilitation engineering, injury and sports biomechanics, perceptional psychophysics and technology management.

**Assistant Professors**

Bandyopadhyay S., Ph. D.
Robotics, computational kinematics, design of parallel manipulators, prosthetic devices, multibody dynamics

Ramanathan M., Ph.D.
Geometric and solid modeling, computational geometry, computer graphics, computational biology

Saravana Kumar G., Ph.D.
Computer aided design, rapid product development, layered manufacturing, soft computing

Shankar Ram C. S., Ph.D.
Model-based control and fault diagnosis, brakes, automotive systems, vehicle dynamics

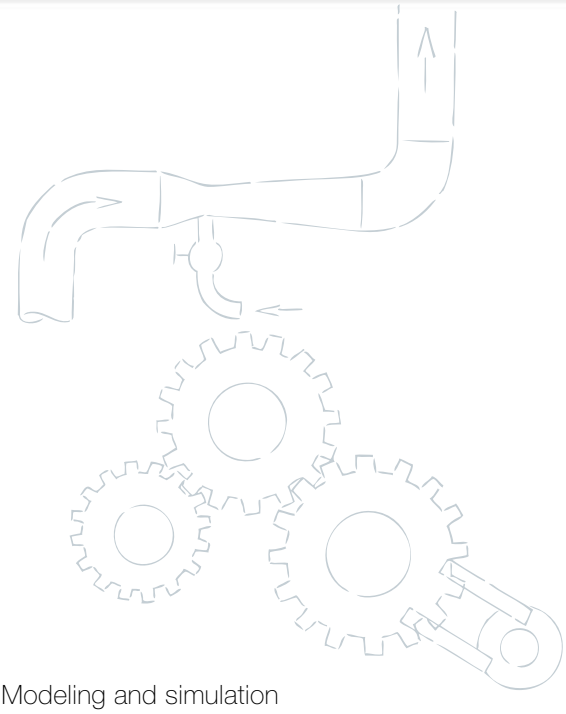
## Facilities

The followings labs have been set up:

- Vehicle dynamics
- Automotive systems
- Mechatronics
- Controls
- Product design
- Computer aided design
- Microprocessor

Labs which are planned to be set up soon:

- Ergonomics
- IC Engines
- New art studio, design studio and a modern garage



## Sponsored Research Projects

- Dynamics and control of autonomous underwater robotic vehicles: Modeling and simulation
- Development of mathematical model for jet pipe servo valve
- Development of vehicle control and guidance system for autonomous underwater vehicle
- Low cost flexible automation using robot arm
- Technology development for proportional solenoid valve for space applications
- Development of a superluminescent diode based gas sensor for environmental monitoring
- Measurement of elemental species for space exploration applications by using laser-induced breakdown spectroscopy technique
- Model-based control and diagnostic tools for brake systems
- Raghupathi Singhania Centre of Excellence for tyre and vehicle mechanics - JK Tyres
- Caterpillar Centre of Excellence for heavy vehicles engineering
- Design, fabrication and control of a three-degrees-of- freedom planar parallel manipulator
- Medial axis transform using theory of moving frames
- Computer aided design and analysis of sculpted engineered porous structures for bone tissue engineering
- Multi material representation in CAD for layered manufacturing

*Product design lab*

*Automotive systems lab*

Humanities and Social Sciences emphasise overall intellectual and social development, expanding the horizons of knowledge to encompass a wide range of human problems and social, cultural phenomena.

The Department of Humanities and Social Sciences is one of the earliest departments established at IIT Madras.

The Department offers a five-year integrated masters programme in Development Studies, Economics and English Studies and doctoral programme in Humanities and Social Sciences.

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## Humanities and Social Sciences

### Head of the Department

Muraleedharan V R., Ph.D.
Tel (O): 2257 4500
email:hshead@iitm.ac.in / vrm@iitm.ac.in

### Faculty & Expertise

#### Professors

Evangeline Manickam., Ph.D.
American literature

Malathy D., Ph.D.
Economics of human resources, technical education, labour economics.

Muraleedharan V R., Ph.D.
Healthcare economics, history of healthcare in South India, environmental health policy

Shreesh C Chaudhary, Ph.D.
Linguistics, history of English in India

Sudhir Chella Rajan, Ph.D.
Energy policy, climate change and sustainable development

#### Associate Professors

Devaki Reddy S., Ph.D.
Sociolinguistics, applied linguistics; language-culture-and society

Srilata K., Ph.D.
Translation studies, women's writing, creative writing (poetry and fiction)

Umakanth Dash, Ph.D.
Energy management, financial economics, health economics and policy

#### Assistant Professors

Aysha Iqbal, Ph.D.
American literature, film studies & media, English language teaching & communication, contemporary Indian novels and plays

Debashis Acharya, Ph.D.
International trade and finance, applied econometrics, and healthcare financing

John Bosco Lourdusamy, Ph.D.
History of Indian science, science and religion, science, technology and rural development

Jyotirmaya Tripathy, Ph.D.
Literary theory, post colonial studies

Milind Brahme, Ph.D.
German studies, literary theory, comparative studies

Mohan S., M.A.
Technical communication, science fiction, Indian fiction in English, business communication

Prema Rajagopalan, Ph.D.
Sociology of science & technology, sociology of development

Sonika Gupta, Ph.D.
International relations theory, China's domestic politics and defence & foreign policy, human rights

Sreekumar N., Ph.D.
Continental philosophy, philosophy of language, hermeneutics

Sudarsan Padmanabhan, Ph.D.
Social and political philosophy, aesthetics, Indian philosophy and culture, comparative philosophy

Suresh Babu M., Ph.D.
Applied macroeconomics, industrial organisation, trade and development

Swarnalatha R., Ph.D.
American literature, ecocriticism

Tabraz S.S., Ph.D.
International relations theory, US involvement in West Asia, Israel-Palestinian conflict

## Facilities

- The Department offers access to state-of-the-art facilities for learning and research on the fully networked campus
- The Department has a multimedia lab, self-learning multimedia centre, library and a conference hall
- All classrooms have LCD & multimedia facilities

## Sponsored Research and Consulting Projects

- Consortium for research on equitable health systems
- How equitable is Employees' State Insurance Scheme in India: A case study of Tamil Nadu
- Do the poor benefit from public spending on healthcare in India: results from benefit incidence analysis in Tamil Nadu and Orissa
- The other side of gender: Issues of men and masculinities in gender studies
- Comparative European Union Studies
- Extent of migrants due to various levels of global warming scenarios particular to India and the East Coast
- Economic analysis of scaling up HIV prevention interventions in Southern India
- Workforce management and infrastructure rationalisation study in Chhattisgarh
- Monitoring of Sarva Shiksha Abhiyan in Tamil Nadu (13 Districts)
- Output and outcome efficiency of health expenditures
- ICT Innovation in India
- Impact of improvement in water supply and sanitation facility on health and level of living of the population in Tirupur town and surrounding regions
- Enrolment & retention of girls in elementary education in Tamil Nadu: a study of two districts

*Seminar room*

*Language lab*


## THE SCIENCE OF EXCELLING

*Quiet Excellence Demonstrated (QED)*. Guided by this principle, the Department of Management Studies seeks, in its vision, *to be a globally unique and most valuable source of knowledge, insight, creativity and expertise in management thought and practice.*

The Department enjoys strong and active all-round relationships (through its continuing education, training, consultancy, internship and placement programmes) with leading multinational and national industrial and business organisations.

# Management Studies

## Programmes

The Department offers MBA, MS (Entrepreneurship), MS (by Research) and PhD programmes. The practical business perspective and curriculum content of the MBA and MS (Entrepreneurship) programmes serve as benchmarks for several other institutions. The MBA programme prepares students to serve as intelligent, insightful, creative and sensible managers. The MS (Entrepreneurship) programme is designed to develop young technopreneurs and business persons through a rigorous technology and business mentorship experience. The MS (by Research) and PhD programmes develop researchers with a strong analytical, quantitative, philosophical and interdisciplinary orientation to management thought and practice. The research work and culture of the Department are highly acclaimed and the number of well-qualified and experience-rich applicants, especially from industrial and business organisations, has been growing exponentially. The research output of the Department has regularly earned international awards and prizes.

The students and alumni of the Department continue to make significant contributions through their work, and have earned laurels for themselves as well as the organisations they work for located in different countries and continents. Many have earned explicit recognition and acclaim in the form of honours, awards, prizes and formal appreciation within their organisations and from their peer groups.

The full-time and visiting faculty members form an eclectic mix in terms of academic expertise and professional experience. They collectively bring in practical experience, intellectual rigour, business perspectives, and methodological mastery into their academic and professional work.

## Head of the Department

Rajendran C., Ph. D.
Tel (O): 2257 4550
email:doms@iitm.ac.in / crai@iitm.ac.in



### Faculty & Expertise

#### Professors

Ganesh L. S., Ph.D.
Systems thinking and applications, project management, technology management, knowledge management, data and decision analysis, forecasting

Jayachandran S., Ph.D.
Marketing management

Kamalanabhan T. J., Ph.D.
Industrial psychology, organisational behaviour, human resources management, entrepreneurship

Narendran T. T., Ph.D.
Operations management, supply chain management, rail traffic management systems

Rajendran C., Ph.D.
Production and operations management, scheduling, computer simulation, total quality management, meta heuristics

Srinivasan G., Ph.D.
Group technology, production management, operations research

Thenmozhi M., Ph.D.
Financial management, strategic management, computational finance

### TTK Chair Professor

Vijayaraghavan P., Fellow
Strategic marketing, advertising and sales promotion, brand management, industrial and services marketing

### Associate Professors

Arun Kumar G., Ph.D.
Market microstructure, IPOs, mergers and acquisitions, joint ventures and multinational business

Madhumathi R., Ph.D.
Financial management and accounting, forex research, bank management, capital market studies

Prakash Sai L., Ph.D.
Strategic management, business and information technology consulting, technology management

Sanghamitra Bhattacharyya, Fellow
Organisational behaviour, human resources management

### Assistant Professors

Arshinder Kaur
Operations and supply chain management

Ganesh M.P.
Human resources management, organisational behaviour

Rahul Marathe, Ph.D.
Operations research, supply chain management

Thillairajan A., Fellow
Project finance, venture capital, business strategy, corporate finance

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## Facilities

### Library and Knowledge Resources

- Large collection of paper and electronic books, academic and trade journals, reports, magazines, newspapers
- Databases - Prowess, CapitalLine

### Computing Resources

- Latest hardware including IBM, Silicon Graphics, and SUN servers
- Software systems, programming languages and packages
- Business data analysis - SAS, SPSS, EQS, AMOS, LISREL
- Optimisation - GINO, LINDO, QSB
- Simulation - GPSS/H, ARENA, Pro Model
- Accounting - Tally, Wings
- Applications - MS Project

### Academic Infrastructure

- State-of-the-art, well-equipped, web-enabled classrooms, library, and lab

## Sponsored Research Activities

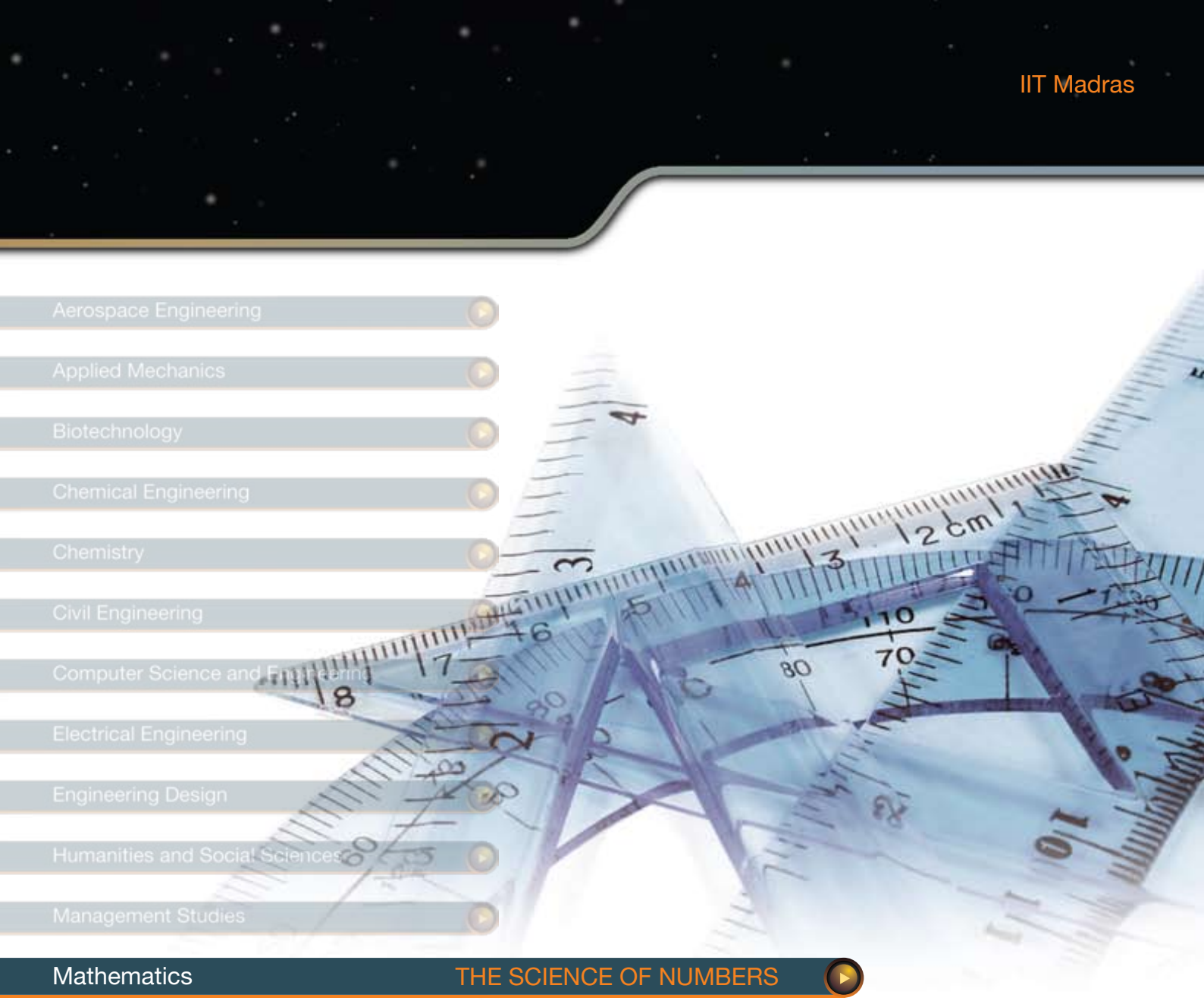
- Information technology incubation and entrepreneurship support facility
- Design of a knowledge management system architecture
- Venture capital investment in Indian firms: trends, value addition, and performance of investee companies
- Executive development lab
- "Tech motivator" - an electronic newsletter on technology management
- Innovative institutional responses to urban challenges
- International collaborative co-development in the machine tools sector

## Consultancy Projects

- Economic cost benefit analysis of the Hyderabad Outer Ring Road (ORR) project
- Evaluating alternate financing approaches for phase II B of ORR project
- A study to evaluate the schemes/programmes under Indian leather development programmes of tenth five year plan
- Portfolio optimisation in ground handling operations
- Optimisation in a chemical production system
- Statistical analysis and development of predictive models for product testing
- Simulation of chip inspection processes
- Production planning and forecasting for cutting tools business
- Transportation models for a product distribution system
- Destination planning module - algorithm development
- Scheduling pharmaceutical operations
- Scheduling operations in a sheet metal industry
- Optimisation for a distribution system
- Study on direct remittances of fresh notes from presses to currency chests
- Automating self-tuning of a local search based dynamic scheduler implementation for mobile resources

## Continuing Education Programmes

The Department's continuing education programmes (executive / management / leadership development) for professionals, executives, administrators, and managers are in great demand from reputed multinational and national companies, and also from government and non-government organisations. The faculty members have frequently offered their expert services and guidance in all general and specialisation areas, listed alongside their names. Offering continuing education programmes is a vital means for the Department to realise its vision.



## Mathematics

### THE SCIENCE OF NUMBERS



Mathematics, hailed as the "Queen of the sciences" by Carl Friedrich Gauss, dreaded by many and loved by an equal number, has progressed rapidly since the beginning of recorded history. Mikhail B. Sevryuk noted in January 2006 that "the number of papers and books included in the Mathematical Reviews database since 1940 (the first year of publication of MR) is now more than 1.9 million and about 75 thousand items are added to the database each year.

At IIT Madras, the Department of Mathematics was set up in 1960. Abstraction and application, rooted in quantitative reasoning sustain all its activities. International cooperation, effected through MOUs signed by the Institute, aids the exchange of faculty members and students. Several eminent mathematicians visit the Department from time to time and collaborate with the faculty members of the Department. Research monographs brought out by well-known international publishers form part of the research output of the members of the faculty.

The Department conducts research in Algebra, Analysis, Computational & Theoretical Fluid Dynamics, Mathematical Physics, Stochastic Processes, Theoretical Computer Science and Discrete Mathematics. The faculty expertise in each of these divisions is listed below.

# Mathematics

## Head of the Department

Subrahmanyam P. V., Ph.D.
Tel (O): 2257 4600
email:maoffice@iitm.ac.in / pvs@iitm.ac.in



## Algebra

### Faculty & Expertise

### Assistant Professors

Jayanthan A. V., Ph.D.
Commutative algebra and algebraic combinatorics

Uma V., Ph.D.
Geometry and topology of toric varieties

Vasantha W. B., Ph.D.
Group theory, application of algebra, fuzzy algebra and linear algebra

Venkata Balaji T. E., Ph.D.
Commutative algebra, algebraic geometry

## Current Research Interests

The focus of research is in the areas of applied algebra, algebraic geometry, commutative algebra, semi-groups and fuzzy algebra. More specifically, azumaya algebras and their degenerations, theory of moduli and bi-algebraic structures are being studied.

## Analysis

### Faculty & Expertise

### Professors

Kulkarni S. H., Ph.D.
Functional analysis and numerical analysis

Ponnusamy S., Ph.D.
Complex analysis, functional spaces, special functions and conformal geometry

Subrahmanyam P. V., Ph.D.
Fixed point theory and applications, fuzzy sets, functional equations, summability theory

Thamban Nair M., Ph.D.
Spectral approximation, operator equations, inverse and ill-posed equations

Veeramani P., Ph.D.
Fixed point theorems and their applications to problems in optimisation, fuzzy set theory

Vetrivel V., Ph.D.
Non-smooth analysis, optimisation theory, fixed point theory

### Associate Professors

Radha R., Ph.D.
Harmonic analysis, wavelets, sampling theory

Sivakumar K.C., Ph.D.
Functional analysis and mathematical programming

### Assistant Professors

Arya Kumar Bedabrata Chand., Ph.D.
Fractals, wavelets, approximation theory.

Shaiju A J., Ph.D.
Control theory, game theory

## Current Research Interests

Complex analysis, functional analysis, harmonic analysis, nonlinear analysis, non-smooth analysis, control theory and optimisation theory are the areas studied by the faculty of this group. Topics of research are: approximate solutions of operator equations, inverse and ill-posed problems, generalised inverses and applications, quasi-conformal mappings, generalised Newton methods and applications, optimal best proximity pair solutions, iterative functional equations, non-smooth optimisation, fuzzy set theory and applications, fractals, fractal interpolation functions, semi-definite linear complementarity problems, wavelets and their applications.

## Applied Mathematics and Mathematical Physics

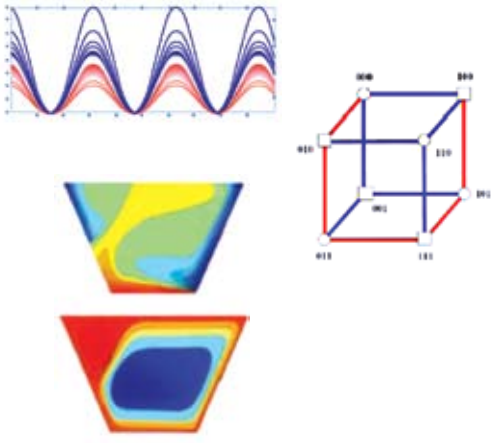
### Faculty & Expertise

### Professors

Kamath S. G., Ph.D.
Mathematical physics

Satyajit Roy, Ph.D.
Convective heat and mass transfer, computational fluid dynamics

Sundar S., Ph.D.
Computational fluid dynamics,numerics for partial differential equations, mathematical modeling



Usha R., Ph.D.
Fluid mechanics and bio-fluid mechanics

### Associate Professors

Sanyasiraju Y.V.S.S., Ph.D.
Computational fluid dynamics

Swaminathan K., Ph.D.
Fluid dynamics, ship hydrodynamics, mathematical problems related to naval architecture and ocean engineering

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### Assistant Professors

Manam S. R., Ph.D.
Integral and differential equations, water waves

Srinivasa Rao Ch., Ph.D.
Non-linear differential equations

## Current Research Interests

Members of this group work on the applications of variational principles, bio-fluid mechanics, convective heat and mass transfer, computational fluid dynamics, modeling and simulation and ship hydrodynamics. Topics of specific interest include anomalies in quantum theory, Lattice Boltzmann method, higher order semi-compact schemes for viscous incompressible flows, instabilities in thin film systems, regularisation techniques for PDE's, applied integral equations and water waves and Wave-structure interactions. calculation of the casimir energy density in flat and curved spaces, trace anomalies with dirichlet boundary conditions.

## Applied Probability and Stochastic Processes

### Faculty & Expertise

### Professors

Kalpakam S., Ph.D.
Applied probability and stochastic processes, operations research

Parthasarathy P. R., Ph.D.
Applied probability and stochastic models, mathematical ecology, operations research

## Current Research Interests

Research is focused on applied probability and stochastic models, operations research and theory of fuzzy sets, communication network problems, option pricing models, queuing models and stochastic inventory systems.

## Theoretical Computer Science and Discrete Mathematics

### Faculty & Expertise

### Professors

Arindama Singh, Ph.D.
Theoretical computer science, numerical analysis

Choudum S. A., Ph.D.
Graph theory, combinatorics and discrete mathematics

Rama R., Ph.D.
Formal language & automata theory / molecular computing

### Assistant Professors

Kalpana Mahalingam, Ph.D.
DNA Computing, theory of codes and formal language theory.

Sounaka Mishra, Ph.D.
Approximation algorithms, combinatorial optimisation

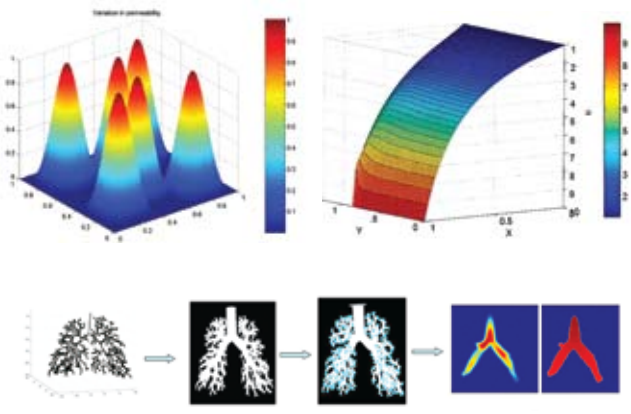
## Current Research Interests

Graph theory, algebraic theory of automata, combinatorial optimisation, approximate algorithms and mathematical logic are the areas in which research is undertaken by this group. Knowledge compilation, discrete optimisation problems of interconnection networks of multiprocessor systems and unconventional methods of computation are among the topics of special investigation.

## Facilities

The Department is equipped with the state-of-the-art computer labs catering to the teaching and research requirements of the faculty and students. The facilities include:

- Windows and Unix based systems for teaching and development of codes
- Itanium2 based HP rx2600 two-way with two CPU populated server for high performance computing
- Sun blade 100 workstation for computing and visualisation
- Network licence to application software like Matlab, Mathematica and Fluent
- Microsoft MSDN tool kit and Microsoft Office suite



## Sponsored Research Projects

- Parameter estimation and inverse solution of non-linear heat conducting problems
- Non-uniform single/multiple slot injection (suction) into water boundary layer flows
- A numerical study of multiple jets with particulate suspension
- Non-uniform multiple slot-boundary layer flows
- Knowledge based systems for spatial databases and geographic information systems
- Apollonian Metric and problems in geometric function theory
- Studies in numerical harmonic analysis
- Queuing models of computer performance
- Knowledge compilation with non-propositional clauses
- Theoretical and experimental investigation of heat transfer from a totally blocked fuel sub-assembly of a liquid metal fast breeder reactor
- Desingularisation, deformations, singularities and specialisations of important moduli spaces in algebraic geometry
- Combinatory of Coxeter group and its applications
- Geometry and representation theory. Hilbert-Kunz Multiplicities of ideals and their blow-up algebras
- A study on approximation of optimisation problems relation to generalisation of domainset
- Stochastic modeling of cellular damage and repair in cancer radiation therapy
- Numerical study of spin-coating of liquid film on a rotating disk
- Inverse problems in boundary layer flows
- Optimisation with set functions
- Stochastic modeling of radiation damage, repair of cells and cancer chemotherapy
- Application of formal languages in computing environments
- Compact higher order implicit scheme (CHOIS)
- Studies in contextual grammars
- Applications of Ramanujan's theory in geometric function theory
- New ARQ protocols using concatenated RD-codes
- On estimating errors in regularisation methods for ill-posed operator equations
- Embeddable properties of graphs and inter connection networks
- Non-smooth calculus and proximal bundle methods
- Wavelet Based methods for partial differential equations governing fluid flows



## THE SCIENCE OF FORCE

Applications of mechanical engineering are found in the records of many ancient and medieval societies throughout the globe. The works of Archimedes (287 BC–212 BC) and Heron of Alexandria (c. 10–70 AD) deeply influenced mechanics in the Western tradition. Among the broadest of engineering disciplines, the work of mechanical engineering ranges from the depths of the ocean to outer space.

At IIT Madras, the Department of Mechanical Engineering commenced its activities at the inception of the Institute in the year 1959 and has been one of the largest departments of the Institute, in terms of students, faculty, research and publications.

There are 58 faculty members in the Department as on date and all of them have their higher degrees from premier research institutions abroad as well as in India. Automotive pioneer, Ford has established a Chair Professor in the Department.

The faculty of the Department is actively involved in pursuing academic, sponsored research and industrial consultancy to various agencies – national and foreign, and the spectrum of agencies ranges from government departments to private industries.

# Mechanical Engineering

The Department is organised into the Design, Manufacturing and Thermal streams. The faculty expertise of each of the divisions is listed below.

## Head of the Department

Venkateshan SP., Ph.D.
Tel (O): 22574650
email:meoffice@iitm.ac.in

## Design Stream

### Labs

## Machine Design Section

### Current Areas of R & D

- Design with advanced materials (metals, composites)
- Mechanics (solid–linear, non-linear, fatigue and fracture mechanics, continuum, visco-elastic)
- Machine elements (gears, transmission systems, pressure vessels, large scale equipment)
- Computer integrated design and manufacturing, product design
- Contact mechanics
- Materials characterisation (wear, tribology, fretting wear and fretting fatigue)
- Non-destructive evaluation
- Dynamics, vibration and control, active noise control, suspension systems and rotor dynamics
- Finite element and numerical methods
- Structural health and condition monitoring
- Residual life assessment, random load fatigue
- Prosthetics biomechanics and bio materials, human factors engineering
- Nano-composites
- Computer aided engineering

### Faculty & Expertise

### Professors

Chandramouli P., Ph.D.
Fluid-structure-acoustic interactions, non-linear and multi-body dynamics

Ganesan N., Ph.D.
Vibration, acoustic, finite element, smart materials, fluid structure interaction, coupled thermo mechanical problems, viscoelastic, buckling

Gnanamoorthy R., Ph.D.
Mechanical design, advanced materials and processing, surface engineering, fatigue and fracture mechanics, tribology

Gopinath K., Ph.D.
Gears, bearings, brakes, friction-material, rolling contact fatigue, surface-treatments, tribology, powder-metallurgy

Krishnan Balasubramaniam, Ph.D.
Non-destructive evaluation, materials characterisation, structural health monitoring, inverse methods and wave propagation

Mayuram M. M., Ph.D.
Surface engineering-wear control, tribo design, multi axial fatigue

Muthuveerappan G., Ph.D.
Machine design, vibrations of structures in fluid environments, gear teeth profile and fillet for geometry, stress analysis and design of gears, finite element analysis

Narayanan S., Ph.D.
Vibration, acoustics, random vibration, non-linear dynamics, noise control, smart structures

Raju Sethuraman, Ph.D.
Computational solid mechanics, fatigue and fracture of materials

Seshadri Sekhar A., Ph.D.
Rotor dynamics, machine fault diagnostics and condition monitoring

Siva Prasad N., Ph.D.
Machine design, finite element analysis, computer aided engineering

Sujatha C., Ph.D.
Vibration, condition monitoring, acoustics

Swarnamani S., Ph.D.
Vibrations, acoustics, condition monitoring, machinery diagnostics, smart structures, structural health monitoring, signal processing

### Associate Professors

Raghu Prakash V., Ph.D.
Structural integrity assessment, fatigue life prediction, fatigue under random loading, non-traditional methods of damage characterisation, mechanical behavior of materials, miniature specimen testing, human factors engineering and work-space design

Shankar Krishnapillai, Ph.D.
Vibrations, structural dynamics, design optimisation, inverse problems and system identification

Sujatha Srinivasan, Ph.D.
Biomechanics, rehabilitation engineering, orthotics and prosthetics

### Assistant Professors

Krishna Kannan, Ph.D.
Continuum mechanics, elasticity, plasticity, viscoelasticity, mixture theory, thermodynamics, mathematical modeling of the behaviour of materials

Parag Ravindran, Ph.D.
Continuum mechanics, viscoelasticity and constitutive modeling

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## Facilities and Methods

- Acoustic horn
- Computer aided engineering
- Cryogenic treatment
- Ferrography
- Fretting fatigue/wear test facility
- Gear and rolling contact fatigue test rigs
- Impedance tube for acoustic absorption measurement
- Laser vibration measurement system
- Modal analysis facility
- Novel peening processes
- NDE Systems
  - o Eddy current, X-ray
  - o C-Scan
  - o Laser Shearography
  - o Thermal Imaging
  - o Ultrasonic
- Rolling contact fatigue test machines
- Fatigue test systems
- Seismic test facility
- Servo hydraulic universal test machine
- Sintering facility powder compacting press
- Standard and special purpose friction and wear test rigs
- Thermal spraying, APS, flame and arc units

## Manufacturing Stream

### Labs

- Manufacturing Engineering Section
- Precision Engineering and Instrumentation Lab

### Current Areas of R & D

- Machining (conventional – Boring Trepanning Association (BTA) machining, gear cutting etc, non-conventional methods – Laser Beam Machining (LBM), Abrasive Water Jet Machining (AWJM), friction welding etc),
- Micro-machining, Micro EDM, Micro ECDM
- Machine vision applications
- Metrology and computer aided inspection
- Manufacturing systems – Flexible Manufacturing Systems (FMS), Automated Guided Vehicle (AGV) and Self Guided Vehicle
- Robot path planning, AI applications, virtual manufacturing
- Planning and control in wheeled mobile robots, networked and tele-robotic systems.
- Robotics, multi-body dynamics, robot calibration
- MEMS, mechatronics, microcontroller based system design
- Electro-hydraulics, medical instrumentation, optical devices, optical instrumentation and laser based measurements
- Smart materials & shape memory alloy actuators
- System simulation and power bond graph modeling
- Fluid power systems and applications

- Active noise control
- Suspension systems
- Micro controllers and embedded control systems
- Parallel manipulators

## Manufacturing Engineering Section

### Faculty & Expertise

### Professors

Ramamoorthy B., Ph.D.
Metrology, computer aided inspection, manufacturing

Ramesh Babu N., Ph.D.
Computer assisted manufacture of sculptured surfaces, theoretical and experimental studies on laser dressing of grinding wheels, simulation of manufacturing systems, studies on abrasive water jet machining, quality control loops, rapid prototyping

Shunmugam M. S., Ph.D.
Metrology, manufacturing - gear, BTA machining, reaming, centreless grinding, EDM, friction welding, manufacturing automation & robotics, computer application in manufacturing-process planning, inspection planning, quality control

Vijayaraghavan L., Ph.D.
Metal cutting, machine tools, CAD, grinding, condition monitoring

### Assistant Professors

Amitava Ghosh
Development of brazed grinding wheel, ecofriendly machining, tribological coating on cutting tools, metal ceramic joining

Balakrishna C Rao, Ph.D.
Machining of aerospace and automotive alloys, modeling manufacturing processes and process design, production of novel nanocrystalline materials, design of MEMS devices


Samuel G. L., Ph.D.
Micro machining, computer aided design and manufacturing, measurements and computer aided inspections, machine tool error measurement and compensation, vision systems

## Precision Engineering and Instrumentation Lab

### Professors

Nagarajan T., Ph.D
Robotics, parallel and serial manipulators, precision and harmonic gear drives, magneto-strictve actuators, mechatronic systems, multi-body dynamics, smart materials, SMA actuators

Singaperumal M., Ph.D.
Fluid power systems, power bond graph modeling, system simulation, robotics and robot calibration, mechatronics, MEMS and micromachining

**Assistant Professor**
Somashekhar S. Hiremath, Ph.D
Fluid power systems and applications, electro hydraulic servo valves, non-conventional machining processes, mechatronic system design, FEM analysis - fluid-structure interaction

## Facilities and Methods

- Abrasive water jet machining system (ABWJM)
- Weiler turn mill centre
- Deckel-CNC milling machine
- Denford- turning centre
- Horizontal CNC machining centre with ATC and APCs
- Extrusion honing machine
- CNC trainer lathes, milling machines
- Micro machining – micro milling and drilling set-up
- Laser cutting machines
- Flexible manufacturing system
- Assembly, trainer and industrial robots
- CIM training system and software
- Dynamometer and sensors for condition monitoring
- Laser Interferometer and calibrating accessories
- 2D/3D surface roughness measuring system
- Contact and non-contact coordinate measuring machine
- Vision inspection and measurement systems
- Capacitance based surface roughness measurement system
- Non contact spindle error measurement system
- Roundness measuring instruments
- PVD –dc magnetron sputtering
- Cartridge valve test rig
- Climatic chamber
- Dynamic balancing machine
- Embedded development tools
- Hydraulic trainer
- Hydrostatic transmission test rig
- Quarter-car and half-car test rig for automobile suspensions
- Scara and 5 axis robots with optic ROM camera
- Sintered bearings test rig
- Stewart platform / hexapad
- Test rig for active noise control in ducts



## Thermal Stream

**Labs**

- Heat Transfer and Thermal Power Lab
- Hydroturbomachines Lab
- Internal Combustion Engines Lab
- Refrigeration and Air-conditioning Lab
- Thermal Turbomachines Lab
- Thermodynamics and Combustion Engineering Lab

## Current Area of R & D

- Fluidised beds, bio-mass combustion and gasification, fuel cells, multi-phase heat transfer, atmospheric radiation, solar and renewable energies, energy conservation
- Computational fluid dynamics, cavitation free design and operation of pumps, micro hydro power, pumps, hydroturbomachines, multiphase flows
- Performance and emission control of IC engines, engine instrumentation and control, alternate fuels, flow visualisation using optical methods, HCCI, GDI, hybrid systems, mathematical modeling of engine systems
- Cryogenic engineering, refrigeration and air-conditioning, alternate refrigerants, solar energy, hydrogen storage devices, food processing, absorption cooling and heating systems, refrigerant mixtures
- Axial and radial compressors, steam and gas turbines, turbine blade cooling, rotor-stator interactions, CFD in turbo machines
- Design of gas, oil and solid fuel burners, flame image analysis, supersonic combustion, droplet combustion, active and passive flow control, supersonic reacting jet flows

## Heat Transfer and Thermal Power Lab

### Faculty & Expertise

#### Professors

Ajit Kumar Kolar, Ph.D.
Circulating and bubbling fluidised beds, biomass combustion, renewable energy and fuel cells, heat transfer

Balaji C., Ph.D
Computational heat transfer, radiative heat transfer, mixed convection, stochastic optimisation, inverse heat transfer and multi parameter estimation, satellite meteorology, climate modeling

Sarit Kumar Das, Ph.D.
Design, dynamics and flow distribution in heat exchangers, nano-fluids, transition to turbulence, computational fluid dynamics and heat transfer, jet oscillation and impingement, cooling of turbine blades, nuclear heat transfer, flow distribution in fuel cells and heat transfer analogy

Venkateshan SP., Ph.D.
Heat transfer with and without phase change, approximate methods, space applications, free convection, interaction with conduction and radiation

#### Associate Professor

Srinivas Reddy K., Ph.D.
Renewable energies, solar energy, energy and environment, heat transfer, two-phase materials

#### Assistant Professor

Arunn Narasimhan, Ph.D.
Modelling hydrodynamics and heat transport in porous media, convection heat transfer, phase change material applications, manufacturing processes in microlithography and heat transfer applications in biology and medicine

## Facilities and Methods

- 10 cm circulating fluidised bed facility
- 100 mm regenerator test bed with computerised data acquisition system

- Biomass combustion facility
- Bubbling and circulating fluidised beds
- Gas analysers
- Heat exchanger test facility
- Hot wire anemometry
- Liquid conductivity measuring apparatus
- Mixed convection test tunnel
- Nano particle test facility
- Nuclear reactor heat transfer facility
- Porous media heat transfer facility
- Fuel cell testing

*Pelton Turbine*

## Hydro Turbo Machines Lab

### Faculty & Expertise

**Professor**

Kumaraswamy S., Ph.D

Fluid mechanics-pumps and hydro turbines-design, analysis and testing, cavitation in hydro turbo machines-computer aided design and instrumentation

**Assistant Professor**

Dhiman Chatterjee, Ph.D

Cavitation, multiphase flows, turbo machines, microscale fluid flow and machinery

## Facilities and Methods

- 10 m deep well for cavitation studies
- Computerised pump testing units with data logger and transducers
- Computing facilities for design, analysis and CFD work
- Digital stroboscope
- High speed motion picture camera and motion analysis projector
- Piezoelectric crystals, function generator and power amplifier
- Pressure transducers, hydrophones and accelerometers
- Signal analysers
- Scanivalve
- Test set-up for axial flow pump turbine models, pumps
- Water to water jet pump research facility
- Variable frequency driver for pumps



## Internal Combustion Engines Lab

### Faculty & Expertise

**Professors**

Ganesan V., Ph.D

Theoretical and experimental studies in fluid flow, heat transfer and combustion in IC engines, gas turbines, after burners and related engineering equipment

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*PIV Setup for In-Cylinder Flow Studies*

Pramod S Mehta, Ph.D.
Engine processes, combustion and emission simulation, soot emission studies, air motion and transport processes studies in engines

Ramesh A., Ph.D.
Performance improvement control of engines, alternative fuels, two stroke engine, engine instrumentation and electronic management

### Assistant Professors

Mallikarjuna J. M., Ph.D.
Simulation of IC engine processes, design of IC engines, HCCI engine, hydrogen & biodiesel engine, analysis of IC engines

Shamit Bakshi, Ph.D.
CFD, IC engines, liquid atomisation and spray systems

### Henry Ford Chair Professor

Gajendra Babu M., Ph.D.
Alternative fuels for IC engines, computer simulation, instrumentation, fuel efficient and energy conservation

## Facilities and Methods

- Electrical, eddy current and hydraulic dynamo meters (0.5 kW to 200kW)
- Gas chromatograph
- Exhaust analyser for HC & CO and NOx
- Hartridge and bosch smoke meters
- High speed PC based data acquisition systems and software
- Hot wire anemometer and low velocity wind tunnels
- Instruments for cylinder, manifold pressure and fuel injection pressure
- Particle Image velocimetry system
- Software and hardware for EMS development
- Swirl evaluation rings
- Viscometer and bomb calorimeter

## Refrigeration and Air-Conditioning Lab

### Faculty & Expertise

### Professors

Maiya M P., Ph.D
Sorption technology, hybrid air-conditioning, ventilation, effluent evaporation, drying, energy recovery

Mani A., Ph.D
Compression refrigeration, absorption refrigeration, jet refrigeration, liquid effluent concentrating systems, desalination, cryogenic heat transfer, solar thermal application, heat and mass transfer in refrigeration systems, heat pipe

Srinivasa Murthy S., Ph.D
Heat and mass transfer, refrigeration, renewable energy, hydrogen storage, low carbon technologies

Venkatarathnam G., Ph.D
Vapour compression refrigerators, refrigerant mixtures, compact heat exchangers, cryogenic systems, cryocoolers, liquefaction of natural gas, low cost liquefaction of nitrogen, process simulation and optimisation

**Assistant Professor**
Shaligram Tiwari S., Ph.D
CFD, vortex dynamics, flow transitions, marangoni convection, desiccant cooling, absorption refrigeration

## Facilities and Methods

- Air-conditioned space monitoring instrumentation
- Energy auditing instrumentation
- Environmental chamber
- Gas chromatograph with TCD
- He / $H_2$ / HC leak detectors
- Testing of cryogenic heat exchangers
- Testing of domestic refrigerators and window air-conditioners
- Testing of new refrigerants and mixtures
- Testing of refrigeration compressors
- Testing of solar collectors


*Vapour absorption refrigeration*

## Thermal Turbomachines Lab

**Faculty & Expertise**

**Professors**

Govardhan M., Ph.D
Cascade secondary flows, forward sweep in axial compressors, tip clearance flows, CFD in turbo machinery, cross flow fans

Prasad BVSSS, Ph.D
Heat transfer in rotating systems, heat flux measurements, CFD

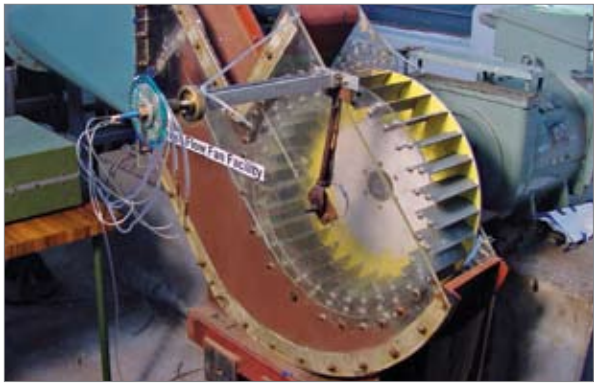
Sitaram N., Ph.D
Experimental and computational fluid dynamics of turbomachines

**Assistant Professor**
Viswanath Kota, Ph.D
Aerodynamics and aero acoustics of turbo machinery

## Facilities and Methods

- Axial flow fan test rigs
- Calibration tunnel
- Centrifugal compressor test rigs
- Fast response data logger system

- Heat flux probe calibrating rig
- Hot wire anemometer
- Low speed cascade tunnels
- Micro manometers and scanning boxes
- Real time spectrum analyser
- Scanivalve and pressure transducers



*Cross flow fan*

## Thermodynamics and Combustion Engineering Lab

### Faculty & Expertise

#### Professors

Babu Viswanathan, Ph.D.
Simulation of high speed reacting flows, predictions of noise from high subsonic jets

Shet USP, Ph.D.
Swirl combustion, development of low NOx burners, development of eco-friendly and efficient gas stoves, turbulent premixed flames, sodium combustion, flame stabilisation, jet-combustion, supersonic combustion and utilisation of solar energy

Sundararajan T., Ph.D.
Heat transfer, spray combustion, reacting jets, CFD

#### Associate Professor

Srinivasan K., Ph.D.
Aero-acoustics of jets and resonant flows, flow control

#### Assistant Professors

Raghavan V., Ph.D.
Heterogeneous combustion and gas-phase chemical kinetics, experimental and numerical investigations

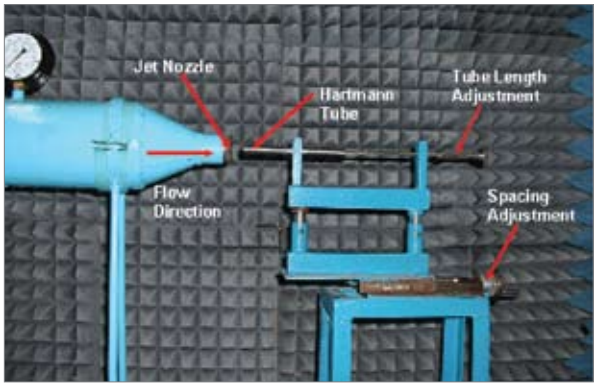
Ravikiran Sangras, Ph.D.
Turbulent flow, reacting and non-reacting flows and fluid mechanics

#### Visiting Professor

Ramamurthi K., Ph.D.
Combustion and explosion, propulsion, instability and control

## Facilities and Methods

- 2D Mach 1.8 ducted supersonic flow facility
- Anechoic chamber for aero-acoustics
- Emission measuring equipment
- Porous sphere apparatus dry and wet
- Combustion characterisation of alternative fuels




*Anechoic chamber*

- Schlieren optical bench
- Swirl-burner set-up
- LPG burner testrig

## Sponsored Research Projects

- Development of a numerical model for predicting flame spread over liquid fuels
- Development of advanced NDE techniques for enhanced sensitivity, reliability, and reduced inspection time for detection and characterisation of defects in nuclear components
- Development of compression desiccant hybrid system for low humidity air-conditioning
- Experimental and numerical investigations on cold-flow of Gasoline Direct Injection (GDI) Engine using Particle Image Velocimetry (PIV) and Computational Fluid Dynamics (CFD)
- In-process measurement and evaluation of surface roughness using non-contact sensor based measurement system
- Integrated multitray solar desalination system
- Investigations into mechanical micro-machining of metals and non-metals
- Multisensor hot film anemometry for periodic flow measurement
- Numerical computation studies on air breathing propulsion system
- Numerical predictions of evaporation rate constants of kerosene droplets at elevated pressures and temperatures in high pressure semi-cryogenic rockets
- Parametric identification of structures using a substructure approach in the time domain
- Structural health monitoring using rapid hybrid array based ultrasound NDT methods
- Study of flame characteristics in vibrating burners
- The role of size and volume fraction of nano particles to enhance heat transfer property of nanofluids
- Use of straight vegetable oil in IC engines

## Consultancy Projects

- FEA of ducting and loop seal between gassifier, cyclones and evaporator at elevated temperature
- Biodiesel engine performance emissions and combustion study
- Seismic test equipment of transformers
- Development of hopper heating systems
- Development of a “Smart” layer-by-layer nano polymer based coating for in-situ damage monitoring of composite and metallic air frame structures
- New Nesting engine R & D
- New bend CAM engine R & D
- Review of CFB design & component performance prediction
- Design, development and performance evaluation of 250 kW solar parabolic dish thermal power generating systems
- Feasibility evaluation for the development of a non-destructive method for the surface and near surface defect detection in ceramic ball bearing elements
- CFD study of 182MW gasifer along with loop seal pressure balance and the effect of recycling
- Evaluation of feasibility for monitoring the health of marine engines
- Simulation of solid state hydrogen storage devices
- Mathematical modeling of power train dynamics of tracked vehicle
- Development of mobile lift systems
- Fatigue testing of automotive components



## THE SCIENCE OF PROCESSING

The material of choice of a given era is often its defining point. The Stone Age, Bronze Age and Iron Age are examples of this. Today, we live in the materials age with an abundance of metallic and non-metallic materials. Metallurgical and Materials Engineering provides an understanding of how they behave, how they can be used and improved, knowledge which is essential to the development of new products and the practical realisation of a new scientific phenomena.

The Department of Metallurgical and Materials Engineering (MME) is one of the oldest departments of IIT Madras, established in 1959 as Department of Metallurgy at the very inception of the Institute. It is actively engaged in research, education and industrial consultancy and offers B.Tech., M.Tech., M.S. and Ph.D. degrees. The Department's teaching, research and consultancy activities cover a broad spectrum of materials science & engineering and industrial metallurgy (metal casting, metal joining, metal forming and materials technology). The Department developed a unique character at the very outset, owing to its strong linkages with the industry and the expertise of the faculty in industrial metallurgy. Over the years, the research interests of the faculty have diversified into many areas of materials science & engineering. The Department has excellent research infrastructure in the broad areas of materials processing (forming, joining, casting, particulate processing, nanostructured materials), characterisation (X-ray diffraction, electron microscopy, thermal analysis, scanning probe microscopy), mechanical testing, environmental degradation, surface engineering and computational materials science. The Department continues to strive for excellence and realise its vision of becoming 'a pioneering Department in the country for teaching, research, and consultancy in emerging areas of materials science and engineering, while consolidating the Department's strengths in traditional areas of metallurgical engineering.'

## Metallurgical & Materials Engineering

### Head of the Department

Kesavan Nair P., Ph.D.
Tel (O): 2257 4750
email:mtoffice@iitm.ac.in / pkn@iitm.ac.in

### Faculty & Expertise

**Professors**

Bhattacharya S. S., Ph.D.
Nanocrystalline materials, superplasticity of materials (analytical and experimental), superplastic forming, metal forming, high temperature deformation behaviour of materials, advanced materials testing

Ganesh Sundara Raman S., Ph.D.,
Fatigue, fracture mechanics, fretting fatigue, fretting wear, short cracks, mechanical behaviour of materials and weldments, surface modifications, thermal spray processes

Guha B., Ph.D.
Fatigue fracture mechanics of welded joints, FEM/CAD application to weld joint design and fatigue life prediction, computer simulation in welding technology, testing and design of weldments' strength and stability

Kamaraj M., Ph.D.
Surface engineering, development of wear surfacing materials, tribological behaviour of surface coatings, mechanical behaviour of materials (creep and fretting fatigue), metal matrix composites

Kesavan Nair P., Ph.D.
X-ray diffraction, residual stress analysis, electroless coatings, synthesis and characterisation of carbon nanotubes

Murty B. S., Ph.D.
Thermodynamics and kinetics of phase transformations, mechanical alloying and rapid solidification processing, nanocrystallisation of bulk metallic glasses, nanocrystalline metals, alloys and intermetallic compounds, nanocomposites, grain refinement of Al alloys, in-situ composites, transmission electron microscopy

Paramanand Singh, Ph.D.
Study of advanced ceramics (both functional and structural ceramics), nanostructured materials, shape memory alloys and electronic materials, ceramic matrix composites, metal matrix composites, mechanical alloying, metallic foam and warm compaction, powder metallurgy, powder characterisation

Pathak S. D., Ph.D.
Mechanical metallurgy, fatigue and fracture mechanics, short crack initiation and propagation, fracture toughness of HSLA steels, stress rupture behaviour and life assessment of high temperature materials

Prasad Rao K., Ph.D.
Welding, surface engineering (corrosion)

Prasanna Kumar T. S., Ph.D.
Process modelling, CAD/CAM, finite element analysis, higher level automation, establishment of mathematical modeling techniques related to steel plant technology

Raghavan S., Ph.D.
Thermodynamics of metal oxide systems using solid electrolyte galvanic cells, solid state chemical sensors in industry, hot corrosion and creep of superalloys, computer simulation of phase diagrams and theoretical models

Sampath Kumar T. S., Ph.D.
Biomaterials, microwave processing, surface science, intermetallics, high $T_c$ superconductors, analytical instrumentation

Sampath V., Ph.D.,
Shape memory alloys and smart materials, composite materials, powder metallurgy, sol-gel processing, physical metallurgy, structure-property correlations

Seshadri, S. K., Ph.D.
Electro- and electroless deposition, corrosion and wear, surface technology, biomaterials

Venugopal, P., Ph.D.
Metal forming processes, component development, press tool design (inclusive of applied maths), metal forming machine tools dynamics, design & applications (inclusive of applied maths), cold extrusion of materials, solid state joining of dissimilar powder metallurgical preforms, ironing of friction prone materials, deep drawing and bending of sheet materials – powder metallurgical characterisation, viscous extrusion of ceramics (YBCO, nanomaterials etc.), energy related aspects relevant to metal deformation.

### Associate Professors

Balasubramanian M., Ph.D.
Ceramics and composites, nanocrystalline materials and nanocomposites, materials characterisation, sol-gel processing

Hari Kumar K. C., Ph.D.
Computational thermodynamics, CALPHAD: computer coupling of phase diagrams and thermochemistry, thermodynamic database for technologically important materials, process metallurgy, physical metallurgy, ab-initio methods

Prathap Haridoss, Ph.D.
PEM fuel cells, production and characterisation of carbon nanotubes, carbon nanotube based composites, synthesis and characterisation of semiconducting nanocrystals

Uday Chakkingal, Ph.D.,
Metal forming and materials processing, severe plastic deformation processes, aluminium alloys, fatigue

### Assistant Professors

Bauri, R., Ph.D.
Metal matrix composites, aluminium alloys, solid oxide fuel cells

Gandhi, A.S., Ph.D.
Physical ceramics, ceramic nanomaterials, high temperature protective coatings (environmental and thermal barrier coatings), materials for energy systems (solid oxide fuel cells), phase stability and transformations, metastable effects, thermally driven interactions in layered systems, surface engineering, zirconia ceramics, non-equilibrium phenomena in oxides

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Janaki Ram, G.D., Ph.D.
Joining of materials, rapid manufacturing, aerospace materials

Phanikumar G., Ph.D.
Experimental and computational studies on laser welding, laser surface alloying, solidification using electromagnetic levitation and Bridgemann techniques, transport phenomena in manufacturing processes, microstructural evolution

Ravi Kumar N.V., Ph.D.
Polymer derived ceramics, silicon carbide/silicon nitride ceramics, nanostructured materials, high temperature mechanical properties, object oriented finite element programming-for prediction of macroscopic properties

Ravi Sankar K., Ph.D.
High temperature deformation, superplasticity, nanocrystalline materials, size effects in plastic deformation

Sankaran S., Ph.D.
Thermomechnical processing, electron microscopy, microstructure-property correlations, mechanical behaviour of materials and modern materials

Sarkar Sabita, Ph.D
Process modeling / design / intensification of metallurgical and chemical processes, modeling and simulation of flow through packed bed, fluidised bed, heat and mass transfer, granular flow, multi-phase flow, reacting flow

Subramanya Sarma V., Ph.D.
Materials processing, development, characterisation and microstructure-mechanical properties correlations in engineering materials

## Facilities

### Labs

- Atomic force microscopy
- Chemical metallurgy
- Computing facility
- Electrometallurgy & corrosion
- Fuel cells
- Heat treatment
- High temperature materials, mechanical testing & tribology
- Materials forming & testing
- Materials joining
- Medical materials
- Metal casting
- Nanomaterials
- Non-destructive testing
- Physical metallurgy
- Powder metallurgy & ceramics
- Scanning electron microscopy
- Transmission electron microscopy
- X-Ray diffraction

*Superplastically formed propellant tank part for space application*

*Friction welding of aluminium to copper*

## Equipment

- Scanning potentiostat
- Plating facilities
- Hot corrosion set-up
- Computer controlled potentiokinetic test unit
- Intergranular corrosion, stress corrosion cracking, pitting corrosion facilities
- HIOKI 3535 LCR meter
- Pin-on-disc wear tester (room temperature & high temperature)
- Dry & slurry erosion test
- Galling test
- Digital instruments scanning probe microscope
- Philips CM12 & CM20 transmission electron microscopes with EDAX attachment & CCD camera
- FEI quanta 200 scanning electron microscope with EDAX, ESEM & EBSD attachments
- Specimen preparation facility for electron microscopy
- Bruker discover D8 X-Ray diffractometer with residual stress analysis & texture attachments
- Shimadzu XD-D1 X-Ray diffractometer
- Portable Rigaku MSF strainflex residual stress analyser with retained austenite attachment
- Optical microscopes with digital image analysis attachments
- Thermogravimetric and differential thermal analyser
- Netzsch STA 409 PC high temperature differential scanning calorimeter
- Dartec servo hydraulic testing machine (100 kN)
- Universal testing machines (10, 100 & 600 kN)
- Rotary bending fatigue testing machine
- Vertical pulsator fatigue testing machine (200 kN)
- Impact testing machine
- Creep testing equipment
- Hardness testing machines (Vickers, Rockwell, Brinell, Microhardness)
- Schenck servo hydraulic testing machine, 400 kN static and 320 kN dynamic loading
- Cracktronic 7 kN - CM resonant testing machine
- Wolpert instrumented pendulum impact testing machine
- Schenck trebel 250 kN room and high temperature testing machine
- MTS Servo hydraulic testing machine (100 kN)
- 100 kN low cycle fatigue testing machine
- 1000 kN hydraulic press with 500 kN hydraulic die cushion
- 1800 kN one wheel bi-directional friction screw press, 960 Kg-met work
- 1800 kN friction screw press
- 500 kN eccentric press
- 350 kN single action hydraulic press for superplastic forming
- 100 kN mechanical type testing machine
- Instrumentation for measuring forming parameters
- Various sub-press equipment for open die extrusion of sintered p/m preforms ironing and bending sub-press equipment for friction prone materials & equi-channel angular extrusion
- Insmart cryomilling facility
- Fritsch P5 & P6 ball mills
- Chemical vapour synthesis set-up
- Sol-gel synthesis set-up

- Dip-coating unit
- Set-up for synthesis of carbon nanotubes by electric arc discharge
- Microwave oven
- Hydrothermal autoclave
- Vacuum heat treatment furnace
- Induction melting furnace
- Mould and core making facilities
- Sand testing equipment
- Software for thermodynamic calculations, process modeling, solidification modeling and FEA
- Pusher type sintering furnace of industrial type
- Miller synchrowave 350 LX TIG welding machine
- Lincoln electric power wave 455 mig welding machine
- Flash butt welding machine
- Friction welding machine
- Linde LCG800 submerged arc welding machine
- Plasma welding and cutting machine
- Thermocouple wire welding unit
- Ferrite scope and magnagauge
- Varestraint hot cracking test facility
- Sintering furnace
- Attritor mill
- Microtrac S-3500 laser particle size analyser
- High temperature furnaces (up to 1700°C)



## Computational Tools

### Thermodynamic Modeling

- Thermo-Calc for thermodynamic and phase diagram calculations in multi-component systems
- Pandat Integrated Computational Environment for phase diagram calculation and materials property simulation of multi-component systems
- FactSage Thermochemical database and computing system in chemical thermodynamics
- HSC chemistry
- Density Functional Theory (DFT)
- WIEN2k for electronic structure calculations of solids employing full-potential (linearised) augmented plane-wave ((L)APW) + local orbitals (lo) method
- VASP for ab-initio quantum-mechanical molecular dynamics (MD) using pseudopotentials and a plane-wave basis set

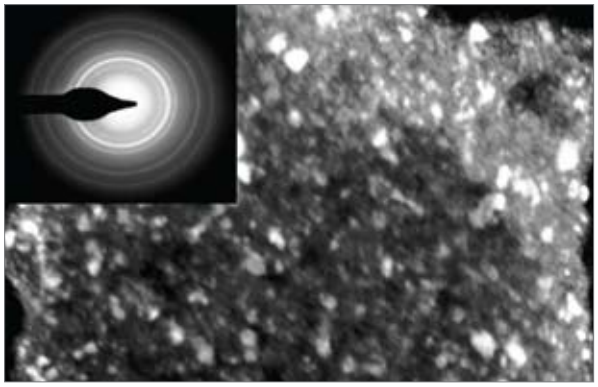
## Sponsored Research Projects

- Synthesis and evaluation of impact energy absorption characteristics of Al-SiC composite foams
- Microstructural evolution at the interface of dissimilar joints between austenitic stainless steel during PWHT and long term aging
- Evaluation of high cycle fatigue behaviour of repair welds of AISI 410 stainless steels made using (a) ER 316L and (b) ER 410 filler wires and its comparison with the AISI 410 base metal
- Effect of rare-earth dopants on thermal stability and fracture toughness of nanocrystalline zirconia-based thermal barrier materials
- Understanding the adhesion mechanisms, quantification of adhesion strength and characterisation of the adhesive of barnacles
- Large scale production of W based nanocomposites by mechanical alloying
- Development and characterisation of nano-electrode materials for novel complex hydride fuel cell
- Hot corrosion behaviour of rare-earth stabilised zirconia for thermal barrier applications

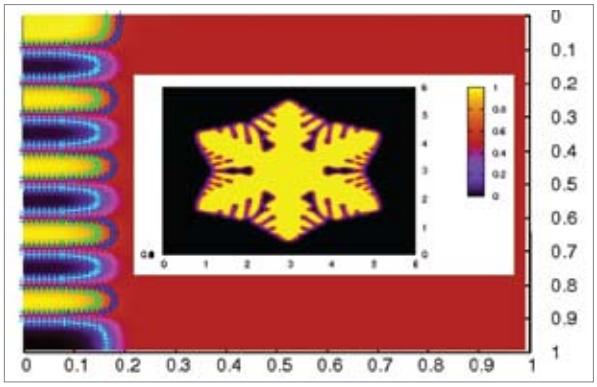
- Development of bulk nanocrystalline materials: nanoparticle synthesis and consolidation
- Synthesis, characterisation, functionalisation and investigation of electrochemical properties of aligned carbon nanotubes
- Processing of pre-ceramic polymers in the quaternary Si-B-C-N system for ultra-high temperature applications beyond 2000°C
- Estimation of heat flux on Plasma Facing Components (PFC) from temperature measurement by inverse conduction method
- Mechanically activated leaching of chromite concentrates
- Semisolid processing of Al-TiB2 and Al-TiC in-situ composite foams
- Friction stir spot welding of aluminum alloy 2014

## Consultancy Projects

- Residual stress analysis on various industrial components and materials
- X-ray qualitative analysis of various industrial components and materials
- Metallurgical characterisation & dry erosion tests
- Fatigue testing of industrial materials and components
- Creep testing
- High strain tensile test
- Measuring retained austenite for DFP-1 hydraulic head & cam drive shaft samples
- SEM EDX work of A1-alloys weld samples
- Thermodynamic modeling
- Evaluation of warm ECAP behaviour of an Al alloy
- Establishing a procedure for validating and optimising thermodynamic database for common engineering materials
- SEM & TEM analyses
- Improvement in the strength of Al-Si alloys by grain refinement and modification
- Metallurgical characterisation and dry erosion tests on thermal spray coatings
- Eutectic solidification in aluminium alloys and the effect of grain refiners, modifiers and other alloy addition
- Burden distribution model for the bell top blast furnaces
- Computer aided design of composites
- Fatigue behaviour of two grades of steel
- Retained austenite & residual stress analysis on machined samples
- Development of mathematical models for burden distribution in blast furnace 6 & 7 of Bhilai Steel Plant
- Development of alternate materials for electrostatic precipitator emitting electrodes
- Development of protective coatings on refractories based on nanomaterials
- Welding related issues in the manufacture of stainless railway coaches



*Nanocrystalline iron aluminide with very high strength*




*Phase-field simulation of dendritic growth*



The Department of Ocean Engineering has infrastructure and expertise to carry out R&D work in several key areas of ocean engineering such as offshore structures, ships and other floating systems, wave hydrodynamics and coastal engineering, port and harbour structures, hydrodynamics of underwater vehicles, ocean acoustics, ocean energy, ocean environment and pollution, underwater instrumentation, coastal zone management and ocean policy, materials in marine environment and marine foundation.

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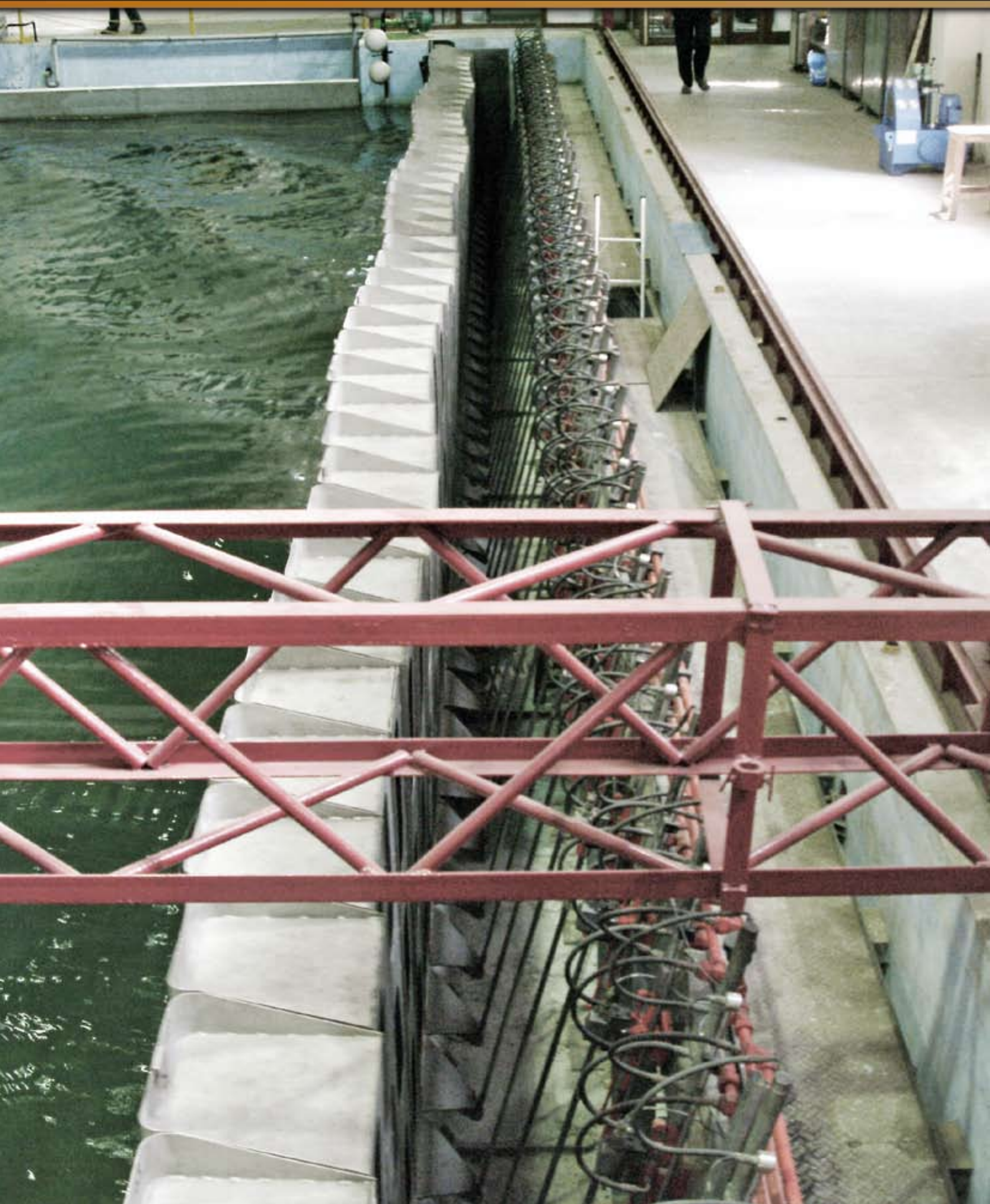

## Ocean Engineering

The Department is actively engaged in creating educational and research opportunities at graduate and doctoral levels to train manpower from industry, R&D organisations and other educational institutions in order to enable them to carry out tasks in various areas of Ocean Engineering. The expertise of the faculty is listed below:

### Head of the Department

Bhattacharyya S.K., Ph.D.
Tel (O): 2257 4800
email:oeoffice@iitm.ac.in

*Model Studies on Wave Energy Device*

### Faculty & Expertise

#### Professors

Anantha Subramanian V., Ph.D.
Computer aided ship design, ship hydrodynamics, CFD applications

Bhattacharyya S. K., Ph.D.
Computer aided analysis of ship and offshore structures, dynamics of floating bodies, underwater acoustics

Ganesh Babu K., Ph.D.
Behaviour of materials in ocean environment, durability and corrosion of structures, performance evaluation and rehabilitation of constructed facilities

Idichandy V. G., Ph.D.
Experimental techniques, instrumentation, structural diagnostics

Mani J. S., Ph.D.
Modeling of coastal engineering problems, numerical modeling of coastal processes

Murali K., Ph.D.
Numerical modeling of coastal hydrodynamics, sediment and pollutant transport, CFD applications in ship and underwater vehicle hydrodynamics

Natarajan R., Ph.D
Naval architecture, design of small crafts, model studies, mooring analysis of floating structures

Sannasiraj S. A., PhD.
Wind-wave generation, data assimilation, breaking wave simulation and its dynamics, wave-structure interaction, dynamics of floating bodies

Subramanian S. P., Ph.D.
Geological oceanography, engineering geology, marine mineral resources

Sundar V., Ph.D.
Coastal engineering problems, design of nearshore structures, wave-structure interaction, fluid flow problems, port and harbour structures

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*Ship resistance test in towing tank*

Sundaravadivelu R., Ph.D.
Coastal, port and offshore structures, intake and outfall structures, retrofitting and rehabilitation, offshore wind energy.

Vendhan C.P., Ph.D.
Dynamics of offshore systems, numerical modeling, wave propagation problems.

### Associate Professors

Krishnankutty P., Ph.D.
Numerical marine hydrodynamics, ship motions, wave-structure interaction.

Nallayarasu S., Ph.D.
Analysis and design of offshore structures, wave-structure interaction, reliability in offshore structural design.

Surendran S., Ph.D.
Naval architecture, dynamics of moored systems, ship structure, ship motion and control.

### Assistant Professors

Panner Selvam R., Ph.D.
Stochastic modeling and simulation, system identification, non-linear dynamics, fluid-structure interaction.

Shanmugam P., Ph.D.
Ocean optics, ocean remote sensing, geological and physical oceanography.

## Facilities

The Department has unique experimental facilities with excellent instrumentation and computational support such as

- Wave basin (30 x 30 x 3m deep) with capability for generating short crested waves
- Deepwater wave flume (90 x 4 x 2.5m deep) for generating random waves
- Wave-cum-current flume (30 x 2 x 1m deep)
- Shallow water wave flume (85 x 2 x variable depth up to 2m)
- Towing tank (82 x 3.2 x 2.5m deep with max. carriage speed of 5m/s)
- Shallow water basin (19.7 x 16.5 x 0.45m with movable bed)
- Glass flume for flow visualisation studies using PIV

*Glass Flume with PIV*

## Computational Facilities

The Department has excellent computational facilities with in-house developed software for non-linear analysis of offshore structures (NAOS), wave-structure interaction (FLUID 3D), shoreline evaluation (SLSP), refraction and diffraction (WAVE) and tidal flow (TIDE) etc. It also has the following general purpose software:

- NAPA
- NAVCAD
- SHIPMO
- SEAWAY
- SACS
- SESAM
- OrcaFlex
- STAADPRO
- PLAXIS
- MIKE21
- WAM IT
- SWAN
- SAP
- COMET
- FLUENT
- STARCCM
- SHIPFLOW
- NASTRAN and DYTRAN

## Future Research Areas

- Development of deepwater technology for oil and gas exploitation and seabed mining
- Development of compliant offshore structures
- Underwater vehicles research
- CFD in marine hydrodynamics

## Sponsored Research Projects

- Assessment of functional performance of groyne field north of Chennai harbour
- Enhancing wave forecasting capabilities in Indian Ocean using buoy and altimeter derived wave data
- Coupled dynamics of sloshing of liquid in a barge
- Assimilation of satellite data to improve wave forecast
- Optical modeling of coloured dissolved organic matter
- Low frequency acoustic propagation in shallow water ocean with seabed effects
- System identification for seakeeping and maneuvering of ships
- Automatic control of ships
- Large amplitude ship motion by non-linear finite element method

## Consultancy Projects

- Numerical modeling of shore protection on the Kerala coast
- Moon pool water surge in vessel
- Shipyard-cum-minor port design in Tamil Nadu
- Passive tank stabiliser design for a ship by numerical and experimental studies
- Design of outfall in Mangalore
- Feasibility studies of fishing harbour in Kerala
- Design review of 220MW barge mounted power plant
- Resistance and propulsion studies for ships
- Conceptual and detail design of pipeline touchdown
- Engineering review of offshore pipeline replacement project
- Structural design review of offshore process platforms
- Drag reduction in underwater vehicles
- Impact dynamics of space capsule on sea

# THE SCIENCE OF MATTER

The predictable behaviour of the sun and the moon puzzled most people in ancient times. Several theories were presented, most of them disproved. But somewhere they laid the foundation for modern physics. Today, many centuries later, man has even landed on the moon. Research in physics is continually progressing on many fronts.

Leading from the front in physics research is the Department of Physics at IIT, Madras. Established in 1959 it carries out research and teaching in frontier areas in basic as well as applied physics. The Department has major research programmes in experimental condensed matter physics, nanoscience and technology, optics and laser physics, low temperature physics, statistical physics, biological physics, dynamical systems and chaos, quantum information theory, atomic and molecular physics, field theory and string theory, and has excellent facilities for these research programmes. The Department also undertakes a large number of sponsored and consultancy research projects.

The Department is organised in Advanced Magnetic Materials, Advanced Materials, Alternative Energy and Nanotechnology, Applied Optics, Atomic and Molecular Physics, Classical and Quantum Dynamics, Complex Fluids and Biological Physics, Condensed Matter and Field Theory, Dynamical Systems / Statistical Physics, Experimental Particle Physics, Low Temperature Physics, Microwave and Dielectrics, Nanocomposites and Nanowires, Photonics and Non-Linear Optics, Quantum Chaos and Information, Semiconductor Physics, Solid State Ionics, String Theory, Thin Film Physics, Ultrafast Lasers, Optical Amplifiers & Quantum Optics and Nanofunctional Materials Technology Centre Divisions. The faculty expertise in each of the divisions is listed below.

# Physics

## Head of the Department

Markandeyulu G., Ph.D.
Tel (O): 2257 4850
email:office@physics.iitm.ac.in / mark@iitm.ac.in

*RF/DC Integrated Sputtering Unit - prepartation of magnetic multilayered films*

## Advanced Magnetic Materials Laboratory

### Professors

Markandeyulu G., Ph.D.
Magnetism and magnetic materials

Murty V. S., Ph.D.
Magnetic materials and atmospheric science

### Assistant Professors

Harish Kumar N., Ph.D.
Condensed matter physics - superconductivity, magnetic materials

Prahallad Padhan, Ph. D.
Devices for spin electronics and exploration of nanostructure

## Facilities

Arc and induction furnaces, melt spinning facility to prepare metallic ribbons, ball mill, DC and RF magnetron sputtering units, CVD system, vibrating sample magnetometer (12K - 300 K, up to 1.4 T) and B-H loop tracer

## Advanced Materials, Nanostructured Thin Films and Nanomaterials

### Professor

Ramachandra Rao M. S., Ph. D.
Electronic and magnetic materials, thin films and bulk oxide electronics, magnetotransport studies in manganites and spintronics.

## Facilities

High temperature furnaces for bulk sample preparation, pulsed laser deposition system, RF Magnetron and DC sputtering units, closed cycle refrigerator, AC susceptometer, X-ray diffractometer, Hall measurement set-up, spectrophotometer, and impedance analyser

## Alternative Energy Technology

### Professor

Ramaprabhu S., Ph. D.
Carbon nanotubes, hydrogen energy and fuel cells, energy related and biological/biomedical applications of various carbon based nanostructures

## Facilities

Alloy casting furnace, RF magnetron sputter and E-beam thin film coating units, gas sensor test station, high energy planetary ball milling unit, thermal and automated catalytic CVD facility, hydrogen pressure composition isotherm facility, fuel cell test station and membrane electrode assembly, electrochemical work station, field emission set-up, thermal end electrical conductivity and super capacitor test cells

## Applied Optics

### Professor

Kothiyal M. P., Ph.D.
Applied optics, interferometry, optical instrumentation and testing

### Associate Professor

Ganesan A. R., Ph.D.
Adaptive optics, vision science, laser instrumentation, interferometry, holography and optical metrology

## Facilities

Optical fabrication workshop, Interferometers, Shack-Hartmann Wavefront sensor and holographic systems

## Atomic and Molecular Physics

### Professor

Deshmukh P. C., Ph.D.
Relativistic & Correlation effects on atomic photoabsorption, autoionisation resonance in atoms/ions, photoionisation studies of confined atoms, non-dipole transitions at low photon energies, synchrotron radiation spectroscopy, spin polarisation parameters of photoelectron, (e, 2e) studies of atoms and molecules, molecular photo fragmentation, saturation absorption spectroscopy of alkali atoms

### Assistant Professor

Kadhane U. R., Ph. D.
Atomic and molecular physics, high and low energy collision physics, ion storage, molecular ion spectroscopy and mass spectroscopy

## Facilities

Density matrix computations on degenerate two level atoms. Spectroscopy using Laguerre-Gaussian laser beams. Absorption Zero-Field Level Crossing (Hanle) Spectroscopy. Electromagnetically induced absorption and transparency using pump-probe tunable diode laser spectroscopy

## Classical and Quantum Dynamics

### Professor

Lakshmi Bala S., Ph. D.
Classical and quantum dynamics, quantum entanglement, wavepacket dynamics, chaos, extreme value and recurrence statistics, non-equilibrium statistical mechanics

### Associate Professor

Satyanarayana, M. V., Ph.D.
Quantum optics, laser physics, photonics

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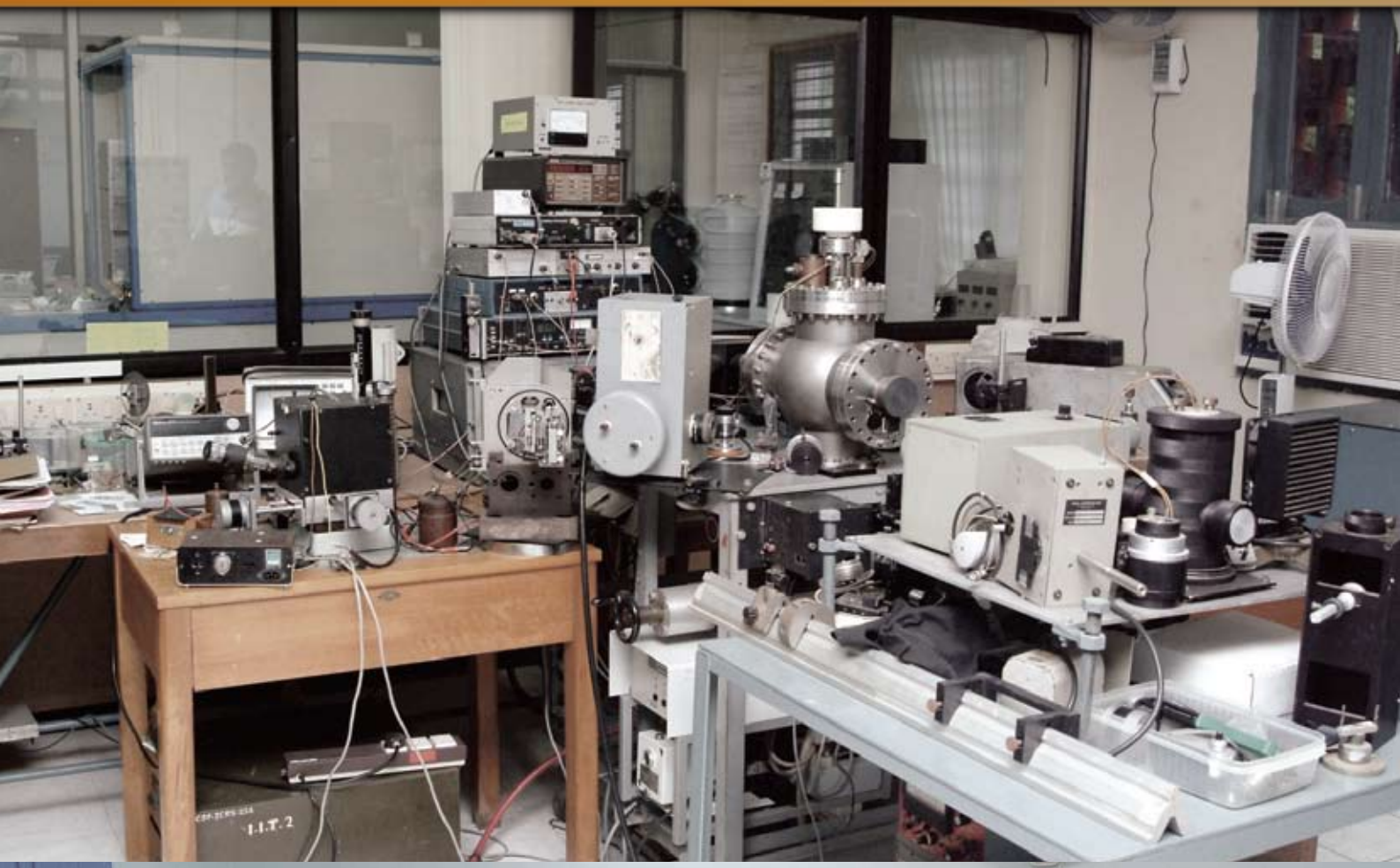
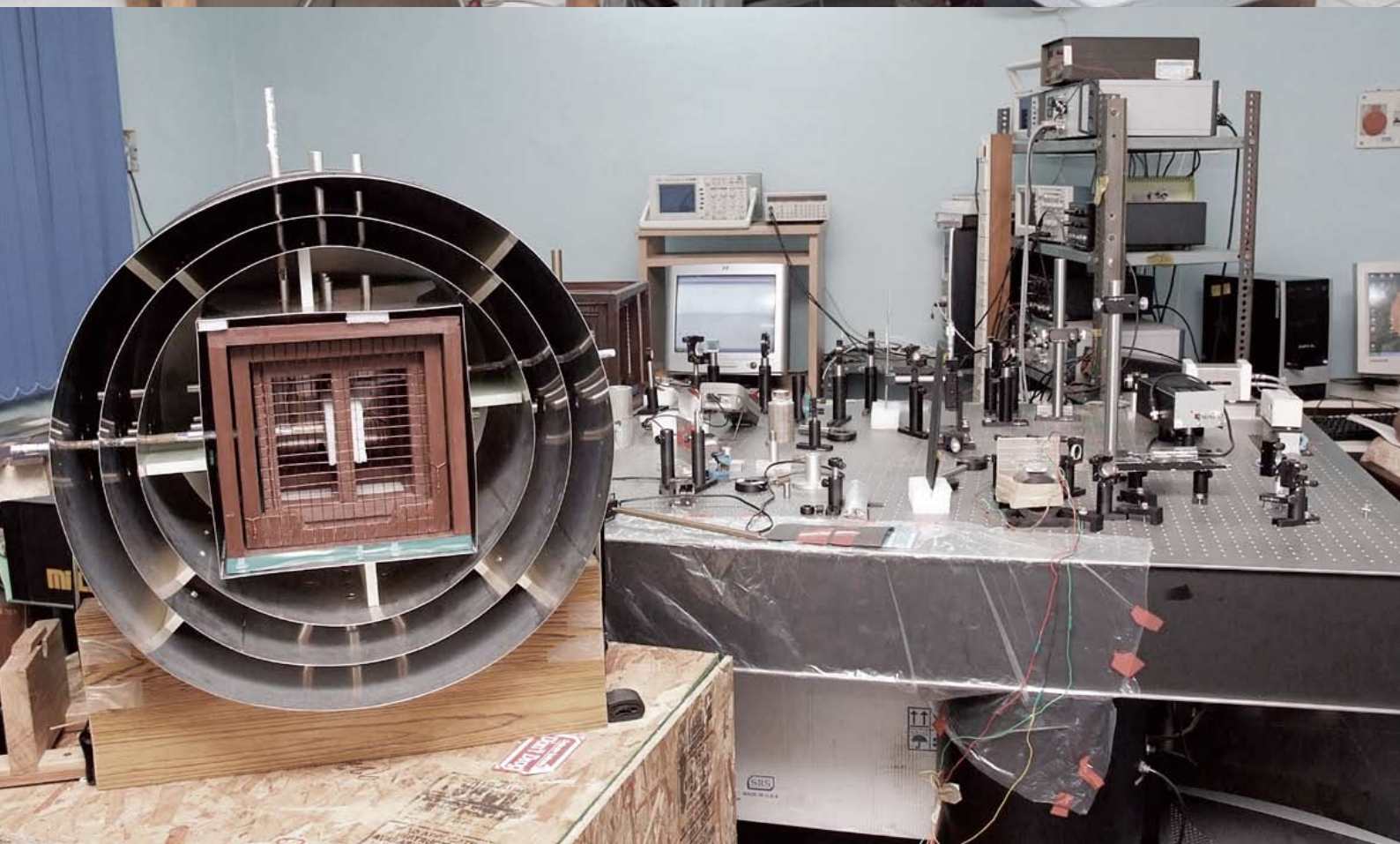
Golden Jubilee 2008-09



## Complex Fluids and Biological Physics

### Professor

Sunil Kumar P. B., Ph.D.
Biological physics, electrostatic effects in softmatter, equilibrium and far from equilibrium properties of lipid membranes, elasticity of cytoskeletal network, liquid crystals and surfactant solutions. the computational techniques include dissipative particle dynamics, brownian dynamics, and Monte Carlo techniques. experimental techniques include rheometry and light microscopy



### Assistant Professors

Gopalakrishnan Manoj, Ph. D.
Theoretical biophysics, stochastic processes, non-equilibrium statistical physics

Simha Aditi, Ph. D.
Non-equilibrium statistical physics: heat conduction, drifting flux lattices, sedimental suspensions, sheared complex fluids, 'active' matter and transition rates in some nonequilibrium steady states

## Condensed Matter and Field Theory

### Assistant Professor

Narayanan Rajesh, Ph. D.
Condensed matter theory: quantum field theories applied to condensed matter systems and quantum phase transitions, strong disorder physics.

## Dynamical Systems, Statistical Physics and Field Theory

### Professor

Gupte Neelima M., Ph. D.
Dynamics of spatially extended systems, transport in chaotic systems, complex networks and clustering algorithms: dynamical systems approaches.

## Experimental Particle Physics

### Assistant Professor

Libby, J., Ph. D.
Experimental particle physics, CP-violation and flavour physics.

## Low Temperature Physics

### Professors

Sankaranarayanan V., Ph.D.
Low temperature physics, cryogenics, thermal and electrical properties

Sethupathi K., Ph.D.
Low temperature physics, superconductivity and magnetic materials

### Assistant Professors

Nirmala, R., Ph. D.
Rare earth intermetallics

Pattabiraman M., Ph. D.
Laser cooling and trapping of atoms,
low temperature physics and magnetism

Santhosh P. N., Ph. D.
Magnetism in condensed matter physics, electro ceramics,
X-ray crystallography

*Microwave hall effect*

## Facilities

Nitrogen and Helium liquefiers, closed cycle refrigerator, various bathtype and continuous flow cryostats, SQUID magnetometer, He3 cryostat with superconducting magnet, high temperature furnaces, arc furnace and DC Magnetron sputtering unit.

## Microwaves and Dielectrics

### Professor

Ramakrishna Murthy V., Ph.D.
Microwaves and dielectrics

### Associate Professor

Subramanian V., Ph.D.
Microwaves, semiconductors, ferroelectrics

### Assistant Professor

Murugavel P., Ph.D.
Physics of dielectric, ferroelectric and magnetoelectric oxide materials in bulk,
film and nanocrystalline forms

## Facilities

Various microwave test benches, microwave Vector Network Analysers, digital LCZ meter (0.04 - 200 KHz), 308 nm Excimer Laser Ablation Unit, digital storage oscilloscopes, microwave frequency counter, microprocessor controlled high temperature furnaces, microwave sintering unit, planetary ball mill and glove box .

## Nanocomposites and Nanowires Using Electrospinning

### Professor

Natarajan T. S., Ph. D.
Conducting polymers and instrumentation electronics

## Facilities

Automated AC conductivity measurement setup, thin film coating unit with quartz crystal thickness monitor, Keithely LCZ meter, high temperature furnaces, vacuum-oven, home built set-up for conductivity

## Photonics and Non-Linear Optics

**Professor**

Vijayan C., Ph.D.
Optical processes and materials such as semiconductor, quantum dots (nanostructures), porphyrins and dyes

## Facilities

Q-swicthed Nd:Yag laser (pulse width 9 ns; pulse energy 100mJ; rep rate 10 Hz) and dual channel lock-in amplifier

## Quantum Chaos and Information

**Associate Professor**

Arul Lakshminarayan, Ph. D.
Quantum entanglement and spin chains, quantum computation and quantum chaos, extreme values statistics in quantum eigen functions. Integrable systems elliptic and zeta functions

## Semiconductor Physics and Devices

**Professor**

Subrahmanyam A., Ph.D.
Semiconductor devices, transparent conducting oxides, photocatalysts for bio-medical applications, electrochromics, hard coatings, plasmonics, photovoltaics and chemical sensors

**Assistant Professor**

Mahaveer Kumar Jain, Ph.D.
Semiconductor, photovoltaics and chemical sensors

## Facilities

Three target sputter coater, vacuum coater, electron beam evaporators, pulsed laser deposition system, CVD system, Kelvin probe set up, Hall effect, ellipsometer, filmetrics, fluorospectrometer and spectrophotometer

## Solid State Ionics Laboratory

**Professor**

Hariharan K., Ph.D.
Solid state ionics, conducting polymers, molecular electronics and instrumentation

## Facilities

Impedance analysers, thin film coating units, high energy ball milling unit, glove box for handling metals like Na, Li and nanomaterials, high temperature ( up to 300 °C) low temperature ( -100 °C) conductivity set-ups and high temperature furnaces

## String Theory

**Professor**

Govindarajan Suresh, Ph.D.
Effective potentials in string theory, microscopic counting of BPS states in string theory and field theory. Aspects of the Ads-CFD and Ads-CMT correspondence. Ricci-flat metrics, modular forms and counting problems, generalized kac-moody algebras, qulvers and their representations.

### Assistant Professor

Tripathy Prasanta K., Ph.D.
Moduli stabilization in string theory, black hole entropy and the attractor mechanism, non-supersymmetric attractors



## Thin Film Physics

### Professor

Kasi Viswanathan S., Ph.D.
Physics and chemistry of thin films, electron microscopy, semiconductor physics, cryogenics, surface and interface studies of semiconducting thin films, vacuum tunneling spectroscopy, surface plasmon resonance and SPR microscopy, magnetic circular dichroism, digital signal processors for physical measurements

## Facilities

Linear translators with sub nanometer resolution, UHV pumping system, ultrasonic cleaners, quartz crystal thickness monitor, thin film coating units, automated thermo-electric and electrical conductivity measurement facility, lock-in amplifier, pulsed diode lasers, SPR measurement unit, vacuum tunnel junction DC sputtering unit

## Ultrafast Lasers and Optical Amplifiers and Quantum Optics

### Professor

Bisht P. B., Ph.D.
Ultrafast laser optics and microscopy (Cavity QED effects), excitation energy transfer and relaxation processes, fluorescence upconversion and supersonic free jet.

## Facilities

Picosecond and femtosecond lasers, confocal fluorescence microscope, time-correlated single photon counting technique for fluorescence lifetime measurements, four wave mixing and transient grating set- ups, noncolinear optical parametric amplifiers and autocorrelators

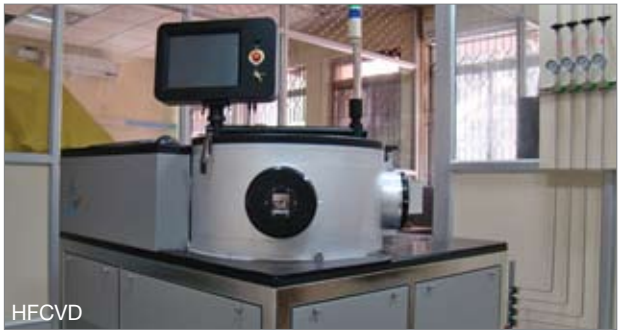
*Femtosecond Laser*

## Nanofunctional Materials Technology Centre

To establish a centre of excellence for product development by carrying out research at the highest competitive level with impending emphasis to become self-reliant in technology development in the emerging field of Nanomaterials and Nanotechnology

## Highlights

- We have a number of active MOU-s and exchange programmes with universities abroad. Our students and faculty have visited NUS (Singapore), GSU (Atlanta), Ecole Polytechnique (France) under these programmes.
- Students under an Indo-Swiss Bilateral agreement of exchange are enrolled in our Master's programme.
- Several of our colleagues are recipients of prestigious fellowships such as Humboldt, JSPS and Fullbright, the fellowship of the Indian Academy of Sciences. Several serve on the editorial boards of various reputed journals.
- The Department has attracted several sponsored and consultancy projects. The funding agencies are DST, CSIR, DRDO, BRNS, HCL, NRB, DIT, besides many industries.
- We have an active visitor and seminar programme in the Department. We had about 50 seminars annually delivered by eminent scholars from institutions all over the world.


HFCVD


Fuel cell test stations


PPMS


Raman Spectrometer

*Facilities established at the Nano Functional Materials Technology Centre*

## Sponsored Research Projects

- Augmentation of research facilities in Low Temperature Physics area (FIST Programme)
- Development of scanning near field microwave microscope for nano imaging of dielectric and magnetic materials
- High frequency carrier mobility measurements in semiconductors using microwave techniques
- Studies on synthesis and characterisation of p- type Zinc Oxide (ZnO) thin films for electronic paper and spintronic applications
- Development of smart materials based on non - linear optical absorption and optical limiting in nanomaterials
- Hybrid dye sensitised organic solar cells
- Multiferroism, charge ordering, colossal magnetoresistance, orbital ordering and their correlation in perovskite manganates
- Retention of nanocrystallinity in bulk ferroelectrics and metals with the development of single mode microwave cavity sintering furnace

- Microscopic TV holography for vibration fringe analysis of Micro Electro Mechanical Systems (MEMS)
- Development of electrospun nanofibrous membranes for separation and electrochemical processes
- Equilibrium and dynamical properties of polyelectrolytes: Effects of external fields and substrates
- Clustering algorithms: A dynamical systems approach
- Rare earth intermetallic compounds for magnetic cooling / heating applications
- Theoretical studies of microtubule dynamics
- Development of heated gloves for soldiers in cold mountain areas
- Development of light emitting devices based on zinc oxide nanowires and nanostructures
- Fe-Ni nanoparticles as catalysts for the synthesis of carbon nanotubes
- Investigation of structural and magnetic properties of half metallic heusler alloys

## Consultancy Projects

- Preparation of transparent conducting oxide thin films
- Development of magneto caloric effect alloys of required shape and physical properties
- Study of high frequency dielectric property of foam materials
- Design of dish reflectors
- Testing glass samples for light transmission
- Refractive index measurement for slides and cover glasses
- Focal length measurement of intra ocular lenses
- Regarding the measurement of wavelength of UV LED
- Analysis of transmission properties of MRTS samples
- Development of device for extracorporeal oxygenation of human blood
- Conception and synthesis of a stable p-type doped ZnO
- Evaluation of porous carbon materials for hydrogen storage
- Preparation of metal hydride blended nanoporous carbon based materials for storage of hydrogen
- Synthesis of carbon nanotube based nanofluids as decontamination solutions for chemical warfare agents
- Functionalised carbon nanotubes as chemical and biological sensors
- Development of carbon nanotube / metal / metal-oxide / polymer composites for electrochemical biosensors
- Design and development of science enrichment activities in CBSE schools to develop analytical problem solving skills among school children from Class 6 - 12

## Centre for Continuing Education

The Centre for Continuing Education co-ordinates continuing education programmes for the at industry, as well as short term courses under QIP (Quality Improvement Programmes) for the faculty in engineering institutions. Further, the Centre facilitates other programmes such as Book Writing Schemes, User Oriented Programmes, Curriculum Development Programmes and publication of IITM's International Journal of Engineering Sciences and Applied Mathematics. A web studio has been established at the Centre for production of web-enabled courseware. The Centre facilitates the NPTEL (National Programme of Technology Enhanced Learning) activities pertaining to production of web based and video based courses in collaboration with other IITs and IISc. Distance Education and Faculty Development programmes are the immediate goals of the Centre.

**Chairman**
Ajit Kumar Kolar., Ph.D.
Tel (O): 2257 4900
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### Activities

- Quality improvement programme (QIP)
- Short term courses under QIP and ISTE
- Continuing Education Programmes
- Educational Consultancy Programmes
- Curriculum Development
- Book Writing Scheme
- IITM Journal co-ordination
- User Oriented Programmes
- National Programme on Technology Enhanced Learning ( NPTEL)

*A view of the state-of-the-art Broadcast quality Digital T.V Studio*

### Facilities

- Educational Technology Cell
- Web studio
- Portable digital video cameras
- 2 Nos. 3-camera based, sound proofed, broadcast quality Digital Television studios
- Video post-production unit consisting of non-linear editing facilities
- Electronic classroom
- 3-D Graphics and animation computers with multimedia facility
- Hardware and software for online content creation of web sites
- Central photographic section

## Centre for Industrial Consultancy & Sponsored Research

IIT Madras is one of the first educational institutes in India to establish good industry-academia interaction as early as the 1970s. It was based on its philosophy of encouraging cross flow of knowledge and experience between the Institute and industries.

### Objectives

- Fostering strong links with industry for collaborative research, technology transfer, and specialised human resource development
- Identifying and protecting intellectual property
- Promoting commercialisation and application of technologies and inventions
- Creating and incubating spin-off companies
- Facilitating access to research, expertise and technology databases and selective dissemination of information
- Developing and nurturing international linkages for research and development

The Centre for IC & SR, in addition to its role of facilitating, coordinating and administering Sponsored and Consultancy projects, is responsible for the following activities of the Institute.

### Memorandum of Understanding

In order to formalise the interaction with industries, a number of MoUs have been signed with various national and international industries / institutions for Research and Consultancy projects.

We have signed 40 Memoranda of Understanding during the Year 2008 – 2009 with industries such as Autodesk India Pvt. Ltd., AMADA Co. Ltd., Japan, Xerox Corporation, Intellectual Ventures Asia Lte. Ltd., The Procter & Gamble Company, Saint Gobain Glass India Ltd., Bharat Heavy Electricals Ltd., Reliance Industries Ltd., Bharat Petroleum Corporation Ltd., Ramco Industries Ltd., Tata Tea Ltd., Hindustan Aeronautics Ltd., Easun Reyroll Ltd., Tata Power Company Ltd., Visakhapatnam Steel Plant.

### Intellectual Property

The faculty members are encouraged to take patents for their inventions. Between 2003 and 2009, IIT Madras filed 122 patents. Twelve patents were awarded to the Institute during the year 2008-2009.

Eighteen patents were filed during the year 2008-2009. Some of them are:

- Online security system serving as a unique and exclusive password generator for every internet transaction
- Spacerless carbon nanotubes for cancer treatment and drug delivery
- Process and an apparatus for the removal of solids from water
- A method of oxy-fuel combustion
- An automated system for early detection of diabetic retinopathy
- Nanopowders by electrolytic oxidation

## Technology Transfer

IIT Madras has successfully transferred several technologies to industries based on the research and development work in the Institute. A typical list of technology transfers made is given below:

- Development of LAN Trainer Kit (Benchmark Electronic Systems Pvt. Ltd.)
- Development of wireless systems (Midas Communication Technologies Pvt. Ltd.)
- Development of sandwich immunoassay for human cystatin C. - (Emcure Pharmaceutical Ltd.)
- Process to produce wear resistant coating - (Lakshmi Ring Travellers (Coimbatore) Ltd.)
- Pesticide removal attachment based on nano - technology (Aquamall Water Solutions Ltd.)
- Sonic Module - (SIEGER Spintech Equipment Pvt. Ltd.)

## Industrial Associateship Scheme

To strengthen its ties with the industry, the Industrial Associateship Scheme was started by IIT Madras in 1987. The members of the scheme can avail a number of facilities and participate in the activities promoted by IIT Madras. At present, about 250 industries and organisations from all over the country are members of this scheme.

More than 100 Technology Appreciation Programmes have been organised in the areas of Energy, Environment, Materials, Information Technology & Communication, Manufacturing, Engineering Software, Management, Electronics, Instrumentation & Control.

## Publication

The Centre brings out a number of publications highlighting the expertise and facilities of IITM for the benefit of industries and other sponsoring agencies.

## Conference Facilities

The IC & SR building has been constructed with the resources generated from consultancy projects providing all conference facilities so as to enable the faculty members to have greater interaction with industries, institutions, government departments and other agencies.

**Dean**
Job Kurian, Ph.D.
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email:deanicsr@iitm.ac.in

**Chief Techno-Economic Officer**
Sundaram R., B.Tech, PGDIE

**Senior Techno-Economic Officer**
Suresh V., Ph.D

*Front View of CEC*

## Central Electronics Centre

The Central Electronics Centre (CEC) was established in 1971 within IIT Madras with the main objective of servicing and maintaining a wide variety of sophisticated electronic equipment. The infrastructural and equipment facilities have been adequately strengthened over the years by successive collaborative Indo-German projects.

This Centre is ISO 9001:2000 certified, as well as NABL accredited. The first to acquire such distinction, the centre has a significant advantage over other similar organisations by virtue of its mixed environment, which is a smart blend of an academic and industry type work atmosphere. The Centre has rendered service to over 220 industries and other organisations in and outside the country. Going beyond, it has continuously enlarged and diversified its activities to offer the following services to its clients:

**Servicing Assignments:** The Centre has modern labs equipped with state-of –the-art diagnostic facilities for servicing complex instruments.

**Training Programmes:** The training programmes offered by this Centre are practice-oriented and their duration varies from three days to two years. The programmes are targeted towards fresh engineers, college students and working professionals in the area of Electronics.

**Testing and Calibration Service:** Testing and Calibration Services of this Centre conform to ISO/IEC 17025:2005 Standard in the area of Electro-technical Testing and Calibration. The Centre undertakes Testing and Calibration of electronic test and measuring instruments and issues testing / calibration certificates with traceability to International standards.

**Product Development:** This Centre has developed prototype products from time to time for specific requirements of clients. The range includes Transducers, Instrumentation System, Power Electronic Products and PV Systems.

**Renewable Energy Programmes:** To promote Solar Photo Voltaics (SPV), an important source of Renewable Energy, SPV Lab facilities have been established and an SPV Park developed.

**Energy Conservation Measures:** The Centre is involved in the development of energy conservation products like High Speed Energy Efficient Electronic Cutting Tools and development of LED Lighting Systems.

## Servicing Laboratories

**Special Facilities:**

*In-circuit tester as a fault diagnosing facility*

- Arbitrary Waveform Generators
- Device Programmers
- Digital LCR Meter
- Digital Scope cum Multimeters
- Digital Storage Oscilloscopes
- HV Probes
- In-Circuit Tester
- Logic Analyzer
- Logic Pattern Generator
- Mixed Signal Functional Test System
- Programmable Function Generator
- Programmable Oscilloscopes
- Programmable Pulse Generator
- Signature Multimeters
- SMD Rework Stations

## Training Laboratories

**Special Facilities:**

- Analog Trainer Kits
- Digital Trainer Kits
- Embedded System Trainers
- Fibre Optics Trainer Kits
- Microcomputer Trainer Systems
- Microprocessor Kits
- PLC Trainer Kits
- Power Electronics Trainer Kits
- Process Control Trainers
- Transducer Trainer Kits
- Universal Trainer Kits

*A view of a Training Laboratory*

## Calibration Laboratories

**Special Facilities:**

*A view of the Calibration Laboratory*

- AC Calibration Standard
- Computing Voltmeter
- DC Calibration Standard
- Digital Frequency Synthesiser
- Multifunction Multiproduct Calibrator
- Oscilloscope Calibration Standard
- Precision Voltmeter
- Reference Multimeter
- Universal Counter
- LCR Meter

## Electronics Testing Laboratories

**Special Facilities:**

- Distortion Measurement Unit
- Environmental Chamber
- Humidity/Temperature Indicators
- Measurement Plotting System
- Power Analyser
- Programmable Loads
- Semiconductor Curve Tracer
- Sound Level Meter
- Storage Oscilloscopes
- Variable Frequency Variable Voltage Source
- Withstanding Voltage Tester
- EFT Generator
- ESD Generator
- Electrical Surge Generator

*A view of a Testing Laboratory*

*A View of Solar PV Park*

*PV Installation for Suryajal Plant*

## Solar Photo Voltaics (SPV) Laboratories

**Special Facilities:**

- Battery Bank
- BOS Testing Setup
- Charge Controllers
- Data Acquisition System
- Inverters
- Lighting Systems
- Linear Current Boosters
- Lux Meters
- Maximum Power Point Trackers
- Solar Lanterns
- Solar Path Finder
- Solar Irradiation Meter
- SPV Panels
- SPV Training Modules
- White LED Based Street Lighting Systems
- Water Pumping Systems

## Suryajal

A prototype 'Suryajal' system has been developed and commissioned to provide fresh water from sea water, fully powered by solar energy through Photo Voltaic modules, with battery less configuration and this is the first of its kind.

## For further information, contact

Kumaravel M., Ph.D.
The Head, Central Electronics Centre, IIT Madras
Ph: 044 – 22574945 / 4946
Fax: 044 – 22570509 / 22574946
email: cechead@iitm.ac.in

## Computer Centre

The Computer Centre was established in 1973 to provide Central Computing resources, facility and support to the research initiatives of the Institute. Be it the IBM 370 in the 70s, Siemens system in the 80s, SGI and Sun system in the earlier part of this millennium, the Computer Centre at IIT Madras has maintained a reputation for being a professionally managed centre with very sophisticated facilities. In keeping with this, a High Performance Computing Environment (HPCE) has been set up to cater to the ever-increasing demand for supercomputing facilities for researchers at IIT Madras. It is on par with the "Top 500" computing facilities in the world. The centre has been awarded ISO 9001-2000 certificate.

### PG Senapathy Centre for Computing Resources

The Centre houses an excellent data centre, designed as per TIER III Standards of UPTIME Institute. It has been christened PG Senapathy Centre for Computing Resources. The data centre is controlled and monitored by a state-of-the-art central command system, BMS (Building Management System) and equipped with three levels of security system and biometric access. The VESDA laser based aspirating smoke detection system is a threshold set for an ultra clean environment. The BMS is backed by a 30 kVA UPS with redundancy and 2 sets of 600 kVA Diesel Generators with automatic load sharing.

### High Performance Computing Environment

The Vega Super Cluster has compute nodes based on HP Proliant DL160 G5 servers with Intel Xeon processors. This Cluster consists of 256 nodes, of which 128 nodes are in infiniband (IB) and the remaining 128 nodes are in gigabit (GB) with one head node in each. Each compute node consists of a Dual Processor, Quad-core, Intel E5472 processor, 16 GB RAM and 250 GB SATA Hard disk. The HP Proliant Rack server DL160 based Cluster options are built with Seven HP 10642 G2 Racks hosting 2048 core Compute Server with HP's XC cluster software and PBS-Pro for batch processing.

### Application Software

MSc Products – Marc, Dytran & Nastron, and Star CD 4.0
Abaqus 6.7 EF1, Ansys CFX Ver 11.0, Fluent 3.26, Gambit 2.46, Mathematica 5, Mat lab 7, Gaussian, Altera

**Compilers:** Intel C++ and FORTRAN 10.1

**Libraries:** Intel Cluster Open MPI for Intel Compilers for Linux, Intel MPI Lib. 3.1, Intel Math Kernel Lib. 10.0, GSL and GSLCBCLAS Lib., and IT++ 4.0.6.

**Tools:** Intel Trace Analyzer and Collector 7.1, Intel MPI Benchmarks 3.1, and Intel Debugger 10.1

## Campus Network

IITM campus network is equipped with fibre based ATM-10 gigabit-high speed network catering to about 6000 campus users. A hierarchically structured, optimal, scalable design is used for the implementation of the fibre backbone. The backbone has been upgraded with dual link to each one of the building in the academic zone and has three core locations and six nodal locations, hostel zone has three nodal locations and the residential zone has three nodal locations. About 600 network switches of various capabilities are used and are managed using NMS. The current internet bandwidth is 90 Mbps.

## PC Maintenance Cell

The PC Maintenance Cell of Computer Centre provides service for repair and maintenance of Personal Computers in the Institute.

## Work Flow

The Computer Centre is involved in computerisation efforts through several services such as academic, accounting, administration, entrance examinations, hostels, hospitals, stores and purchase. The Centre provides and maintains the Institute websites.

## Computer Centre Committee

### Chairman

Prasad B.V.S.S.S., Ph.D.
Tel (O): 2257 4975
email:ccoffice@iitm.ac.in

### Members

Sunil Kumar P.B., Ph.D.
Srinivasan K., Ph.D.
Koshy Varghese., Ph.D.
Murali K., Ph.D.

### Technical Staff

#### Sr. Systems Engineers

Jayaprakash S., Ph.D.
Ramesh S.K.

#### Systems Officer Gr. I

Sourirajan C.S.

#### Assistant Systems Engineers

Banavath Baman.
Venkatesan C.S.

#### Technical Officers (Systems) Gr. I

Ravichandran V.
Vijayaragavan C.N.

#### Assistant Engineer (Systems)

Sreekumar P.Y.

#### Senior Superintendent

Hariharan D.

#### Technical Superintendents

Selvaraju V.
Venkata Subbarao T.
Anand Kumar S.

# Central Library

The Central Library has a total collection of over 4 lakhs documents covering all disciplines of science, engineering, technology, humanities, management, social sciences and other new emerging areas. This collection comprises books, pamphlets, back volumes, theses, standards, atlases, patents, specifications, video cassettes. Currently 1433 national and International journals are subscribed to the Central Library.

The Central Library has arranged under MHRD Consortia, a large number of digital resources for on-line access including Science Direct, ACM digital library core package, JCCC, IEEE Xplore, Web of Knowledge, SciFinder Scholar, Mathscinet, Springer link, ASCE, ASE on-line journals, Nature, Engineering Village-II, COMPENDEX, INSPEC, ABI inform Trade and Industry, EBSCO business source premier, Business source complete, Indian Standards, Emerald full text, ASTM Standards, IEC Standards, Capitaline Plus, Euro Monitor. In addition to this, the Central Library has 5 user terminals to search databases, technical reports, books, conference proceedings. The Library also provides access to most well known patent data bases for patents search. Library membership is open to corporate organizations, public and private sectors through Industrial Associateship Scheme (IAS).

### Librarian

Harish Chandra, Ph.D.
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### Deputy Librarian

Mahendra N Jadhav

### Assistant Librarians

Sekar C.R.
Natarajan P.

## Facilities

- Web based Services
- Digital Knowledge Centre
- CD-ROM/On-line Databases
- Photocopying
- On-line Catalogue Search
- Media Resource Centre
- Wireless Networking
- Scanning
- Automatic Binding
- Book Bank
- Advanced Deposit Accounting
- Contactless Smartcard enabled Access Control System
- Children Library Corner
- Research Carrels
- Students Discussion Hall
- Expanded Reference Hall
- Consultation Cards

## Services

- On-line Information Retrieval
- Inter-Library Loan
- Retrospective Literature Search
- Digital Library
- Technical Consultancy
- Web-based Services
- Patents Information
- Library Automation
- Institution Repositories
- Open Source
- Compilation of Bibliographies
- Document Delivery Service

## On-LIne Full Text Databases /Journals

- SCIENCE DIRECT: Online access on Intranet to over 2500 full text journals published by Elsevier science and leading scientific and technical publishers
- ACM DIGITAL LIBRARY PACKAGE: Access on Intranet to full text of all ACM journals and magazines
- IEEE XPLORE: Provides full-text access to IEEE transactions, journals magazines and conference proceedings published since 1988 all current IEEE standards
- SPRINGER LINK: Is a powerful central access point for researchers and scientists.
- ASCE ON-LINE: Access to journals for civil engineers, designers and builders of the quality of life
- ASME ONLINE: All ASME journals can be accessed on-line
- EMERALD FULL TEXT JOURNALS : The Emerald world's leading publisher of management research, provides access to over 190 journals
- JSTOR: Offers high quality interdisciplinary archive to support scholarship and teaching

- DOWN TO EARTH
- NATURE JOURNALS
- AMERICAN INSTITUTE OF PHYSICS
- INSTITUTE OF PHYSICS
- AMERICAN CHEMICAL SOCIETY
- AMERICAN MATHEMATICAL SOCIETY
- WILEY INTER-SCIENCE
- JOHN WILEY
- OXFORD UNIVERSITY PRESS
- THE ROYAL SOCIETY
- SAGE
- SIAM
- THOMAS TELFORD
- TAYLOR & FRANCIS

## On-Line Bibliographical Databases

- WEB OF KNOWLEDGE: The web of knowledge is an integrated platform designed to support research in academic, corporate, government, and not-for- profit organisations
- SCIFINDER SCHOLAR: SciFinder scholar is today's leader in providing the most accurate and comprehensive chemical and related scientific information
- MATHSCINET: MathSciNet is a comprehensive database covering the world's mathematical literature since 1940
- ENGINEERING VILLAGE-II: Engineering village-II is a web-based information service that offers a wide range of quality resources in the applied science and engineering fields
- COMPENDEX: This is the most comprehensive interdisciplinary engineering database.
- INSPEC: Inspec is a leading bibliographic information database covering the fields of physics, electronics computing, control engineering and information technology.
- ABI / INFORM DATELINE: Local and regional business news coverage of large corporations, privately held companies, local start-ups, executive profiles, marketing, finance and industry news
- ABI / INFORM GLOBAL: Search 1000 premier worldwide business periodicals for information on advertising, marketing, economics, human resources, finance, taxation, computers and more

- ABI / INFORM TRADE AND INDUSTRY: Search more than 700 publications for trade and industry information
- CAPITALINE PLUS: Explore the wealth of financial and non-financial information on more than 7000 Indian listed and unlisted companies.
- EBSCO BUSINESS SOURCE PREMIER: As the world's largest full text business database, business source premier provides full text for nearly 3,600 scholarly business journals, including full text for nearly 1050 peer-reviewed business publications.
- EUROMONITOR (GMD): Global market information database
- INDIAN STANDARDS
- ISO Standards on Civil Engineering
- IEC Standards and Journals

## Open Source Materials

- e-books
- e-reference sources
- e-journals
- e-patents

## Linkages

The Central Library is linked to MALIBNET, INFLIBNET, DELNET, INDEST and other international Library networks

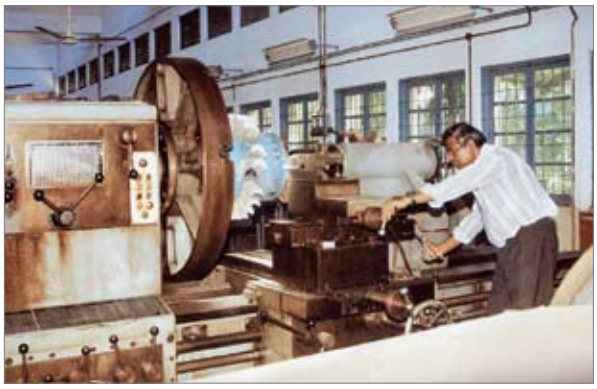
## Consultancy Services

The Central library has the expertise to offer consultancy service on digital library, planning library building, website design, library automation, establishment of library and information systems, media resource centre, implementing bar-coding, RFID/Smart Card, application of ISO-9001:2000 and conducting training, workshops, tutorials and conferences.

## Central Workshop

The various units of the Central Workshop are:

- Carpentry shop
- Fitting shop and tool-room
- Machine shop
- Gear shop and gear testing
- Instrument shop
- Welding shop
- Electrical shop
- Foundry shop
- Smithy and heat treatment
- Pneumatics and hydraulic lab
- FRP lab
- Auto shop



*Machine Shop*

The Central Workshop, in addition to providing hands-on-training to UG students on modern workshop, also provides services to the faculty and research scholars in the fabrication of their research related devices.

### Professor - in - Charge

Jayashankar V., Ph.D.
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### Senior Technical Officers

John George P.
Balaganesan G.

## Sophisticated Analytical Instrument Facility

The Sophisticated Analytical Instrument Facility (SAIF) was established at the Indian Institute of Technology Madras, by the Department of Science and Technology (DST), as the first such regional facility. The centre creates, maintains and provides sophisticated electronic instruments and equipment to the scientific community for advanced research, at nominal charges. The facility has grown into a major centre for spectral measurements, structure determination and materials characterisation, housing modern and computer controlled equipment.

### Head of the Facility

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### Scientific Officers

Babu Varghese, Ph.D.
Moni M.S., Ph.D.
Murugesan R., Ph.D.

*FEI Quanta FEG 200 High resolution Scanning Electron Microscope*

### Facilities

- Varian E-112 X and Q band EPR spectrometer
- CAD-4 enraf-nonius single crystal X-ray diffractometer
- Varian Cary 5E UV-VIS-NIR spectrophotometer
- Netzsch STA 409C (Simultaneous Thermal Analyser)
- Netzsch DSC 204 (Differential Scanning Calorimeter)
- PE 5300 DV ICP OES (Inductively Coupled Plasma – Optical Emission Spectrometer)
- Perkin Elmer Spectrum I - FT-IR Spectro Photometer
- Jobin Yvon Fluorolog – 3 Spectro Fluoro Meter
- Bruker Axs – S4 PIONEER X-Ray Flurosence Spectrometer
- Horiba Jobin Yvon Lifetime System
- Bruker 500 MHz FT – NMR Spectrometer
- JEOL GC – MATE II – GC - Mass Spectrometer
- Bruker Axs Kappa Apex II Single Crystal X – Ray Diffractometer
- Quanta 200 FEG HRSEM with EDAX and WDS

### Consultancy Projects

As SAIF is a service-oriented centre, consultancy services have been provided to various industries. SAIF on specific request undertakes servicing of sophisticated instruments at other institutions and provides training for operation and maintenance. Also, SAIF faculty members have taken up consultancy work for industry to provide specific analytical service of non-routine nature.

For further details contact

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