

ANNUAL REPORT

IISc 2016-17



INDIAN INSTITUTE OF SCIENCE

Visitor
THE PRESIDENT OF INDIA

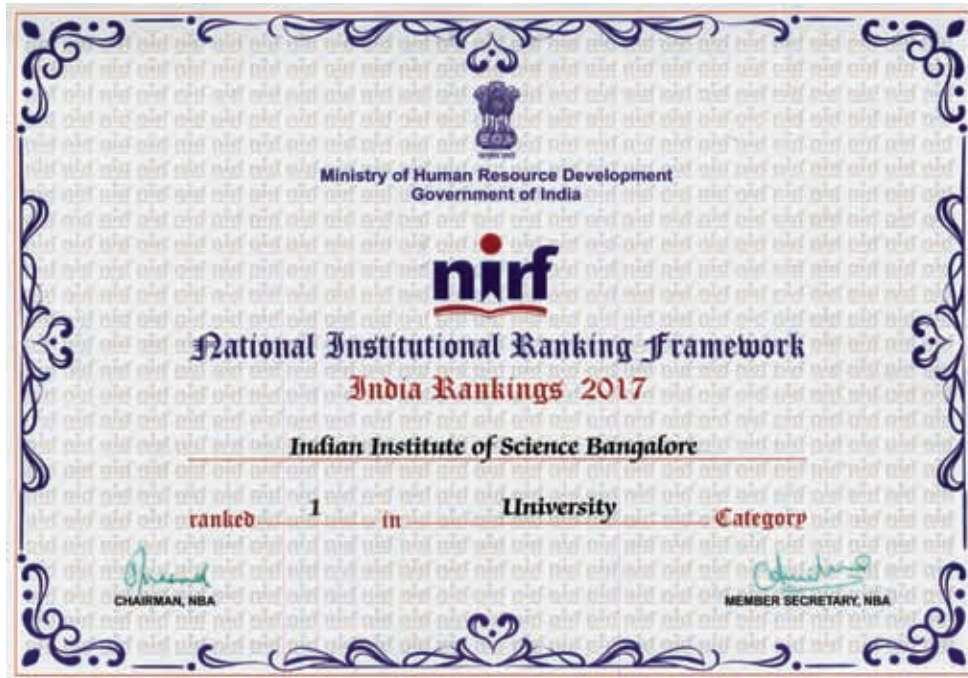
President of the Court
K KASTURIRANGAN

Chairman of the Council
P RAMA RAO

Director
ANURAG KUMAR

Deans
Science: **TN GURU ROW**
Engineering: **MK SURAPPA**
UG Programme: **ANJALI A KARANDE**

Registrar
V RAJARAJAN



IISc RANKED INDIA'S TOP UNIVERSITY

In 2016, IISc was ranked Number 1 among universities by the National Institutional Ranking Framework (NIRF) under the auspices of the Ministry of Human Resource Development.

It was the first time the NIRF came out with rankings for Indian universities and institutions of higher education. In 2017, the Institute was again ranked first among universities, as well as first in the overall category.

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FOREWORD

The Indian Institute of Science (IISc, or just “The Institute”) was established in 1909 by a visionary partnership between the industrialist Jamsetji Nusserwanji Tata, the Maharaja of Mysore, and the Government of India. Over the 108 years since its establishment, IISc has become the premier institute for advanced scientific and technological research and education in India. Since its inception, the Institute has laid a balanced emphasis on the pursuit of basic knowledge in science and engineering, as well as on the application of its research findings for industrial and social benefit. In the words of its founder, J. N. Tata, the objectives of the Institute are *“to provide for advanced instruction and to conduct original investigations in all branches of knowledge as are likely to promote the material and industrial welfare of India.”*

During the year 2016-17, the Institute participated in the second round of national rankings of higher education institutions in India, conducted by NIRF, a body set up by MHRD. This year IISc topped the rankings not only in the universities category, but also overall among all ranked institutions. In the Times Higher Education rankings, IISc is ranked in the range 201-250. The QS rankings place IISc at the 11th position in the world on the metric of Citations per Faculty, which, on this score, places IISc in the company of MIT (10th) and Harvard (8th).

The Institute faculty, numbering about 450, is active in a broad spectrum of research, in science and in engineering, and maintains a high annual publication output. Several faculty members of the Institute have won national and international awards and honours in recognition of their contributions to the growth of knowledge in science and engineering. Among the current faculty members, there are 57 Shanti Swarup Bhatnagar Awardees, 79 INSA fellows, 97 IASc Fellows, 65 NASI fellows, 55 INAE fellows, 25 TWAS Fellows, 68 J.C. Bose National Fellows, and 30 Swarnajayanti Fellows which is indicative of the high level of academic excellence of the Institute faculty.

Out of a student population of about 4,100, approximately 2,680 are enrolled in doctoral degree programs in science and in engineering. In 2011, the Institute introduced an undergraduate program, with separate classrooms, laboratories, and its own Dean. The undergraduate degree

is the four-year Bachelor of Science (Research), in which, apart from their course and laboratory work, the students are exposed to research in the laboratories of the Institute. Students in the four-year Bachelor of Science (Research) degree can also choose to graduate with a dual degree (i.e., a Master of Science as well) by putting in a total of five years of study. There are about 500 students enrolled in these undergraduate programs. The Institute also offers several Masters Degree programs in engineering (MTech, ME, MDes, and MMgmt) in which about 700 students are enrolled.

The support for recurring expenses, and also for a part of the annual research expenses, is provided by the Ministry of Human Resource Development, Government of India. The faculty of the Institute also undertake a large number of research projects funded by various agencies, including the Department of Science and Technology (DST), the Department of Biotechnology (DBT), the Council of Scientific and Industrial Research (CSIR), the Defence Research and Development Organization (DRDO), the Ministry of Communications and Information Technology, and many other organizations, in the public and the private sectors. Over the past few years, the external funding for such research has grown at an annual rate of about 19.5%. Interactions between the Institute and industry are strengthened through the Centre for Scientific and Industrial Consultancy (CSIC), the Society for Innovation and Development (SID), and several centres specifically set up for interaction with the government, the society, and the industry.

Substantial expansion of funding is required to catapult the Institute from being the leader in India to being among the best in the world. In keeping with its history of having been set up via a “public-private partnership,” in the recent years, several initiatives at the Institute have been supported by funding from private sources. Notable ones are: the Centre for Brain Research, which is being set up with support from the Pratiksha Trust founded by Mr. Kris Gopalakrishnan and Mrs. Sudha Gopalakrishnan; a facility for brain imaging set up with funding from the Tata Trusts; the Robert Bosch Centre for Cyber Physical Systems, a centre of IISc in an emerging highly topical area, supported by a philanthropic grant from the Robert Bosch Foundation; and international visiting chairs and Young Investigators in physics and mathematics

supported by the Infosys Foundation, and international visiting chairs in neurocomputation and data science supported by the Pratiksha Trust.

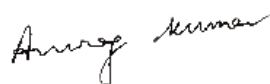
In order to further expand the sources of support for the Institute's activities, in 2015, the Institute set up an Office of Development and Alumni Affairs (ODAA). This office has been aiming to raise funds from organizations under Corporate Social Responsibility, as well as from philanthropists and alumni. During the past year, ODAA has raised funds for the construction of a Skill Development Centre (SDC) in IISc's Challakere campus, additional scholarships for students, and conversion of the street lights in IISc to LED lighting.

The Alumni Affairs part of ODAA organized the first Alumni day in December 2016. This event attracted a large number of alumni from India and abroad. It was an occasion to reconnect with the alumni, and for them to get a glimpse of how the Institute has moved forward, and to participate in deliberations on how to take the Institute even higher. The event will be continued annually every December.

The founder's vision was that the faculty and students of IISc should conduct fundamental investigations in science and engineering, and this should lead to furthering "the material and industrial welfare of India." In keeping with the best practices around the world, IISc encourages its faculty and students to protect any translatable intellectual property (IP) that emanates from their scientific investigations. Faculty members and students, and even outside agencies, can license this IP in order to start-up companies that develop products based on that IP. IP can also be licensed (by IPTeL) to existing companies that wish to exploit it in their product or technology roadmap. During the past years there have been several new start-ups based on research conducted in IISc. One company, started by a faculty member and his PhD student, has developed a single device that can measure the levels of 8 biomarkers that are important for monitoring early and advanced diabetes. Another faculty member has developed a zero-waste, water purification device that can remove even arsenic and fluoride, and has formed a company to develop his technology into a product. Yet another example of a start-up based on doctoral research conducted in IISc is a device for training doctors in gastric endoscopy, a technology that combines mechanical design and computer visualization.

I am honoured to present the IISc Annual Report which reports the academic output and related achievements during the period 2016-17. The volume of high quality work reported goes to the credit of the intellectual activities of the faculty members and the students, to the support of the technical and administrative personnel, and to financial support from various funding agencies.

As I complete my third year as Director of this unique institution, I place on record my personal gratitude to the Chairman and the Members of the Council of the Institute for their valuable support and guidance.



ANURAG KUMAR

Director

September 2017



ACADEMIC STRUCTURE

Division of Biological Sciences

BC	Biochemistry
CAF	Central Animal Facility
CES	Centre for Ecological Sciences
CIDR	Centre for Infectious Disease Research
CNS	Centre for Neuroscience
MCB	Microbiology and Cell Biology
MBU	Molecular Biophysics Unit
MRDG	Molecular Reproduction, Development and Genetics

Division of Chemical Sciences

IPC	Inorganic and Physical Chemistry
MRC	Materials Research Centre
NRC	NMR Research Centre
OC	Organic Chemistry
SSCU	Solid State and Structural Chemistry Unit

Division of Electrical Sciences

CSA	Computer Science and Automation
ECE	Electrical Communication Engineering
EE	Electrical Engineering
ESE	Electronic Systems Engineering

Division of Interdisciplinary Research

BSSE	Centre for Bio Systems Science and Engineering
CCS	Centre for Contemporary Studies
CiSTUP	Centre for Infrastructure, Sustainable Transportation and Urban Planning
CeNSE	Centre for Nano Science and Engineering
CDS	Computational and Data Sciences
MS	Management Studies
ICER	Interdisciplinary Centre for Energy Research
ICWR	Interdisciplinary Centre for Water Research
RBCCPS	Robert Bosch Centre for Cyber Physical Systems
SERC	Supercomputer Education and Research Centre

IISc AT A GLANCE

2016-17

Division of Mechanical Sciences

AE	Aerospace Engineering
CPDM	Centre for Product Design and Manufacturing
CH	Chemical Engineering
MT	Materials Engineering
ME	Mechanical Engineering
CiE	Civil Engineering
CEaS	Centre for Earth Sciences
CAOS	Centre for Atmospheric and Oceanic Sciences
CST	Centre for Sustainable Technologies
DCCC	Divecha Centre for Climate Change

Division of Physical and Mathematical Sciences

CCT	Centre for Cryogenic Technology
CHEP	Centre for High Energy Physics
IAP	Instrumentation and Applied Physics
MA	Mathematics
PHY	Physics

Centres under the Director

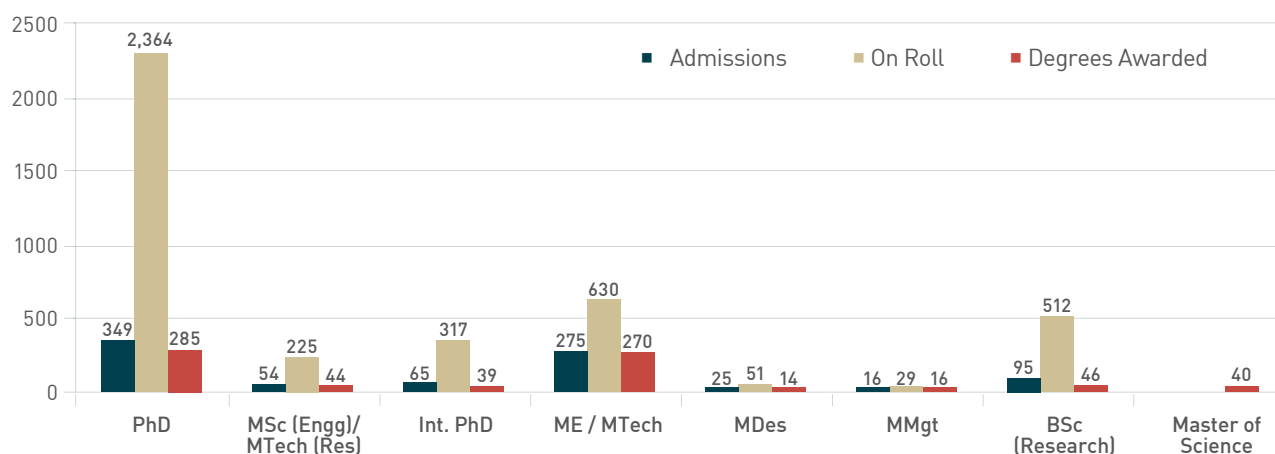
LIB	JRD Tata Memorial Library
APC	Archives and Publications Cell
OIR	Office of International Relations
CCE	Centre for Continuing Education
CSSP	Centre for Sponsored Schemes & Projects
ODAA	Office of Development and Alumni Affairs
IPTeL	Office of Intellectual Property and Technology Licensing
CC	Challakere Campus
CSIC	Centre for Scientific and Industrial Consultancy
DIGITS	Digital Campus and IT Services Office

Other Centres/Activities

SID	Society for Innovation and Development
CBR	Centre for Brain Research
KVPY	Kishore Vaigyanik Protsahan Yojana
KSCST	Karnataka State Council for Science and Technology
IIScAA	IISc Alumni Association

STUDENTS

STUDENTS – ADMISSIONS, ON ROLL AND DEGREES AWARDED 2016-17



HOSTELS (2,904)

Men	2,129
Women	775
Messes (4)	

CONTINUING EDUCATION (1,366)

QIP Degree program	15
QIP Short Term Courses	400
CCE Proficiency	551
Industry sponsored courses	400

SCHOLARSHIPS/FELLOWSHIPS (2,477)

IISc	2,054
UGC/CSIR/Others	423

FACULTY 2016-17

STAFF (989)

	SC/ST	OBC	GN
Academic, Scientific & Technical (552)			
Academic	9	8	408
Scientific	26	3	51
Technical	18	1	28
Support (437)			
Officers	6	3	15
Administrative	63	8	93
Technical	22	3	39
Maintenance	68	5	107
Other	2	1	2

PUBLICATIONS (2,603)

Biological Sciences	376
Chemical Sciences	336
Electrical Sciences	415
Mechanical Sciences	912
Physical & Mathematical Sciences	280
Interdisciplinary Research	284

ACADEMIC DIVISIONS: 6

DEPARTMENTS: 42

Biological Sciences	8
Chemical Sciences	5
Electrical Sciences	4
Mechanical Sciences	10
Physical & Mathematical Sciences	5
Interdisciplinary Research	10

INTERACTIONS

On Campus

Institute Lectures	16
Conferences	194
Visitors	872
Delegations	44

Staff

Visits	686
Conferences	908
Lectures delivered	936
Assistance in other Institutions	963

AWARDS AND DISTINCTIONS (215)

Fellows

National Academies	16
Others	30

Shanti Swarup Bhatnagar Prize

3

CNR Rao National Prize

1

Awards

62

Medals/Prizes

12

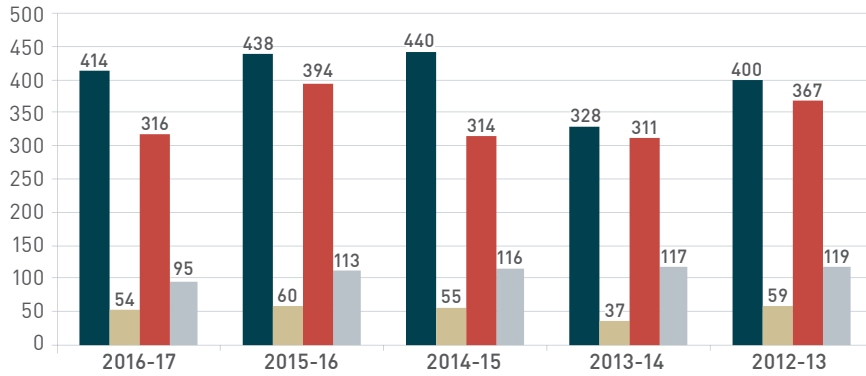
Others

91

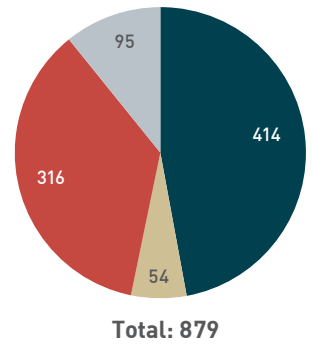
STUDENTS

ADMISSIONS, CONFERMENTS, ON ROLL

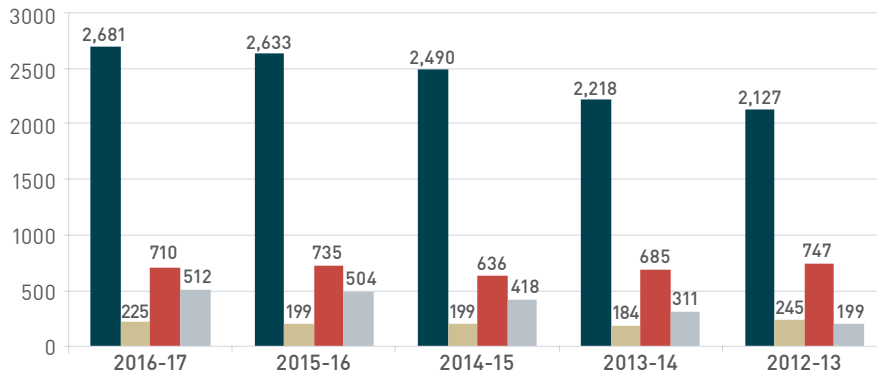
STUDENTS ADMISSIONS FROM 2012 TO 2017



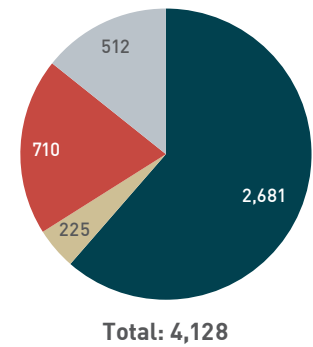
2016-17



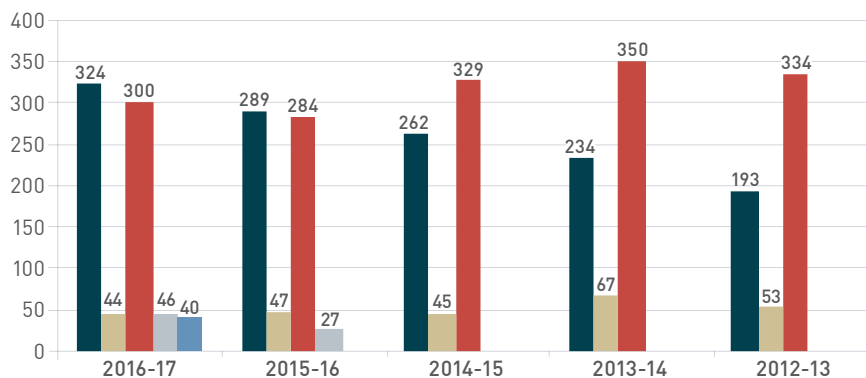
ON ROLL FROM 2012 TO 2017



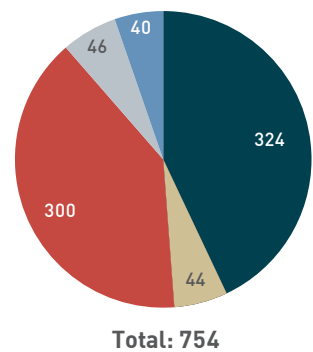
2016-17



CONFERMENTS FROM 2012 TO 2017



2016-17

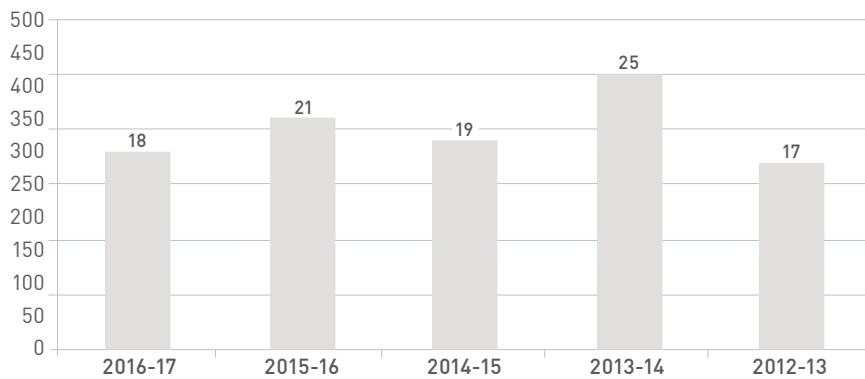


■ PhD / Int PhD ■ MSc (Engg) / MTech (Res) ■ Masters Programme ■ BSc (Research) ■ Master of Science

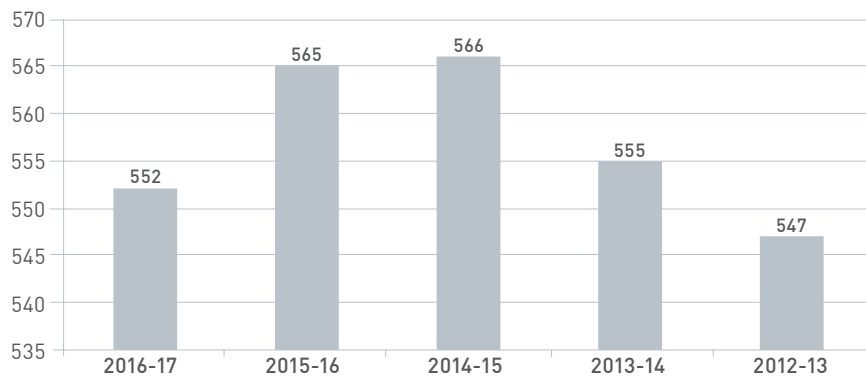
FACULTY

INDUCTION, ACADEMIC AND TECHNICAL STAFF

NEW FACULTY INDUCTED DURING 2012-2017

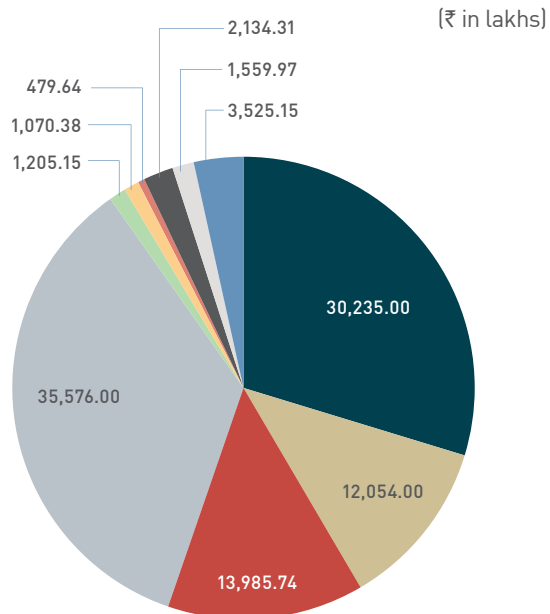


ACADEMIC, SCIENTIFIC AND TECHNICAL STAFF ON ROLL FROM 2012-2017



FINANCE 2016-17

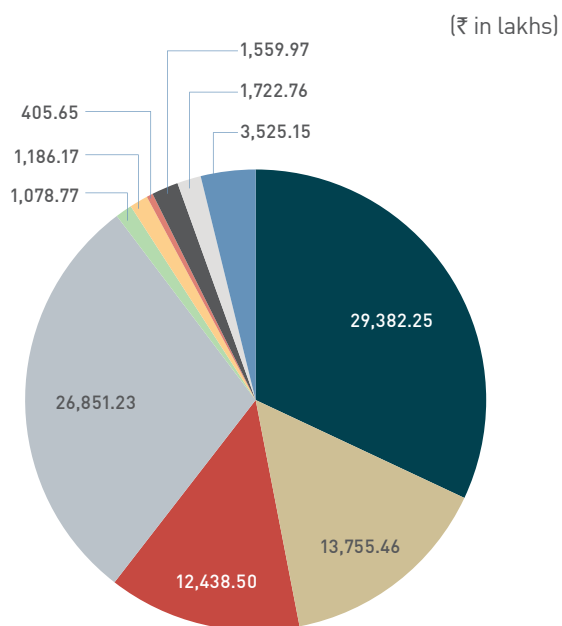
RECEIPTS



Total: 1,01,842.34

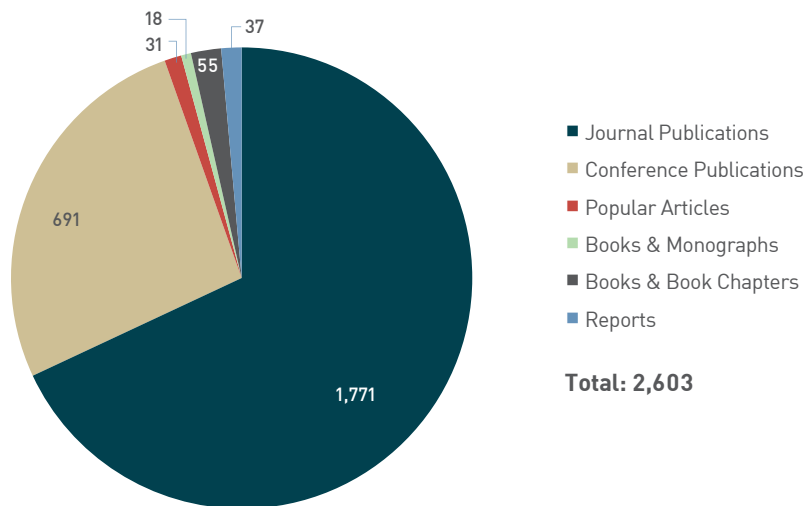
- Non-Plan Grant - Recurring
- Plan Grants
- Developmental Projects
- Sponsored Research Schemes
- Scientific & Industrial Consultancy
- ODAA Projects
- Continuing Education Programme
- Sponsored Scholarships (CSIR/UGC/AICTE etc)
- Academic/Other Income
- Interest earnings/Project Overheads

PAYMENTS

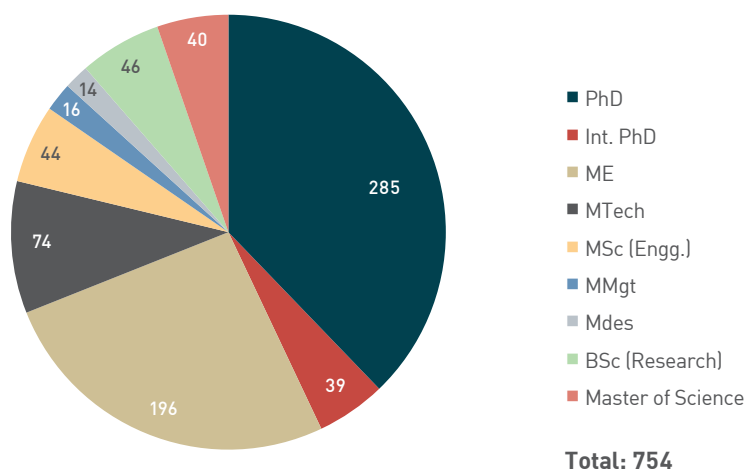


Total: 91,905.91

PUBLICATIONS 2016



DEGREES AWARDED 2016



PROGRAMMES

RESEARCH

● PhD ● Int. PhD ● MSc (Engg)

SCIENCE

Biochemistry	●	●	
Ecological Sciences	●	●	
Microbiology and Cell Biology	●	●	
Molecular Biophysics	●	●	
Molecular Reproduction, Development and Genetics	●	●	
Neurosciences	●		
Inorganic and Physical Chemistry	●	●	
Materials Research	●	●	
Organic Chemistry	●	●	
Solid State and Structural Chemistry	●	●	
Mathematics	●	●	
Physics	●	●	
Astronomy and Astrophysics	●	●	
High Energy Physics	●	●	
Earth Sciences	●		■
Interdisciplinary Programme	●		+
Undergraduate Programme			+

COURSES

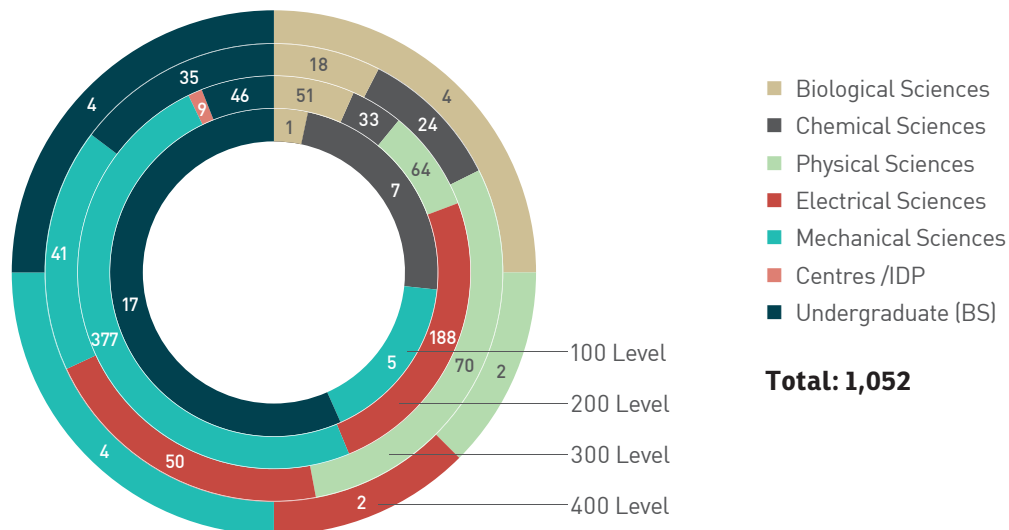
■ ME ■ MTech ■ MDes ■ MMgt + BSc (Research)

ENGINEERING

Civil Engineering	●	●	■	■
Computer Science and Automation	●	●	■	
Electrical Engineering	●	●	■	
Electrical Communication Engineering	●	●	■	
Electronic Systems Engineering	●	●	■	■
Aerospace Engineering	●	●	■	
Chemical Engineering	●	●	■	
Mechanical Engineering	●	●	■	
Materials Engineering	●	●	■	
Product Design and Manufacturing	●	●		■
Atmospheric and Oceanic Sciences Instrumentation	●	●		■
Computational and Data Science	●	●		■
Nano Science & Nano Technology	●			■
Energy Research	●			
Management Studies	●	●	■	
Bio Systems Science and Engineering	●			
Water Research	●			

COURSES OFFERED 2016-17

Teaching Courses are offered from 100 level to 400 level for undergraduate, postgraduate and advanced research topics.







1.

The

INSTITUTE

The Indian Institute of Science is an institution of higher learning and research established in 1909 under the Charitable Endowments Act 1890. With the establishment of the University Grants Commission in 1956, the Institute came under its purview as a Deemed University. The principal authority governing the Institute is the Council, which is advised by The Court in the formulation of policies. The Director is the Chief Executive of the Institute and is assisted in its management by the Senate and the Faculties of Science and Engineering.

1.1 The Court

The membership of the Court is drawn from different cross sections of the country such as Industry, Universities, Scientific Institutions, etc. In addition to eminent persons of science, learning and industry, it also contains the nominees of the Government of India, the Government of Karnataka and the Tata Trusts. The Professors of the Institute and the members of the Council are also ex-officio members of the Court. The following are the members of the Court:

K KASTURIRANGAN

President of the Court Former
Chairman, Governing Council
Raman Research Institute Bangalore
(Nom. Council)

SOM MITTAL

Former President NASSCOM
New Delhi (Nom. Visitor)

SURESH CHANDRA MUKUL

Former Air Marshal
New Delhi (Nom. Visitor)

KK SHARMA

Secretary, MHRD, Dept. of Higher
Education, GOI New Delhi (Nom. GOI)

APPARAO MALLAVARAPU

Chairman and Managing Director
Centum Electronics, Bangalore
(Nom. GOI)

PRADEEP VASANT NAIK

Former Chief of the Air Staff Pune
(Nom. GOI)

MN AJAY NAGABHUSHAN

Commissioner, Dept. of Collegiate
Education Bangalore (Nom. GOK)

RK KRISHNA KUMAR

Director, Tata Sons Limited Mumbai
(Nom. Tata Trusts)

SAROJ K PODDAR

Chairman, Gillette India Ltd.
Kolkata (Rep. FICCI)

SN AGARWAL

Chairman, Boruka Power Corporation
Ltd. Bangalore (Rep. All India Orgn. of
Ind. Employers)

RAJINDER SINGH MAKER

Director General, The Employers
Federation of India, Mumbai (Rep.
Employers Federation of India)

ANIL D SAHASRABUDHE

Chairman AICTE, New Delhi
(Rep. AICTE)

GIRISH SAHNI

Director General
CSIR, New Delhi (Rep. CSIR)

DS CHAUHAN

President, AIU & Vice Chancellor GLA
University, MATHURA

CK KOKATE

Vice Chancellor, K L E University,
Belgaum (Rep. Indian Universities)

SURANJAN DAS

Vice Chancellor
Jadavpur University Kolkata

SHIVAJIRAO S KADAM

Vice Chancellor
Bharti Vidyapeeth Univ, Pune

VS RAMAMURTHY

Former Director
National Institute of Advanced Studies
Bangalore (Nom. Council)

RATAN N TATA

Former Chairman, Tata Sons Ltd.,
Mumbai (Nom. Council)

LN SATAPATHY

President, IISc Alumni Association
(Rep. Assn. of Past Students)

ANURAG KUMAR

Director
(Ex-officio)

ALL PROFESSORS OF THE INSTITUE

(Ex-officio)

ALL MEMBERS OF THE COUNCIL

(Ex-officio)

V RAJARAJAN

Registrar
(Ex-officio Secretary)

During the year, the Court met once on Mar 24, 2017.

1.2 The Council

The Council is the principal governing authority of the Institute and its membership includes the Nominees of the Court, Parliament, Government of India, Government of Karnataka, Tata Trusts, Representatives of Indian Universities, University Grants Commission and Scientific bodies. The following are the members of the Council:

P RAMA RAO

Chairman of the Council
Former Vice Chancellor
University of Hyderabad
Hyderabad (Nom. GOI)

KK SHARMA

Secretary, MHRD
Dept. of Higher Education
GOI New Delhi (Nom. GOI)

PRAVEEN KUMAR

Joint Secretary (Admin), MHRD
Dept. of Higher Education, GOI
New Delhi (Nom. GOI)

BHARAT LAL MEENA

Pr. Secretary to GOK, Higher Edu. Dept.
Bangalore (Nom. GOK)

ISN PRASAD

Pr. Secretary to GOK Dept. of Finance
Bangalore (Nom. GOK)

JJ IRANI

Director, Tata Sons Limited
Jamshedpur (Nom. Tata Trusts)

R VENKATARAMAN

Executive Trustee, Sir Dorabji Tata Trust
Mumbai (Nom. Tata Trusts)

SK JOSHI

Former Director General CSIR
Gurgaon, (Rep. UGC)

MURLI MANOHAR JOSHI

Member of Parliament (Lok Sabha)
New Delhi (Rep. Parliament)

SURESH C ANGADI

Member of Parliament (Lok Sabha)
New Delhi (Rep. Parliament)

RAJEER CHANDRASEKHAR

Member of Parliament (Rajya Sabha)
New Delhi (Rep. Parliament)

SN AGARWAL

Chairman, Boruka Power Corporation
Ltd., Bangalore (Nom. Court)

VS RAMAMURTHY

Former Director, National Institute of
Advanced Studies Bangalore (Nom. Court)

SURANJAN DAS

Vice Chancellor
Jadavpur University, Kolkata

SHIVAJIRAO S KADAM

Vice Chancellor
Bharti Vidyapeeth University, Pune

ANIL D SAHASRABUDHE

Chairman, AICTE, New Delhi (Rep. AICTE)

GIRISH SAHNI

Director General
CSIR, New Delhi (Rep. CSIR)

ANURAG KUMAR

Director (Ex-officio)

TN GURU ROW

(Ex-officio) Dean, Science Faculty

MK SURAPPA

(Ex-officio) Dean, Engineering Faculty

V RAJARAJAN

Registrar (Ex-officio Secretary)

The Council met quarterly on Jun 25, 2016; Sep 24, 2016; Dec 3, 2016 and Mar 25, 2017.

1.3 Finance Committee

The following are the members of the Finance Committee:

P RAMA RAO

Former Vice Chancellor University
of Hyderabad, Chairman of the Council
(Ex-officio)

B SINDHU

Deputy Secretary
(Budget & Resources) Finance
Department Bangalore (Nom. GOK)

RF SAVAKSHA

Secretary & Chief Accountant Sir Dorabji
Tata Trust Mumbai (Nom. Tata Trusts)

DARSHANA M DABRAL

Joint Secretary & Financial Adviser,
Dept. of Higher Education MHRD, GOI
(Nom. GOI)

BURZIS S TARAPOREVALA

Secretary & Chief Accountant Sir Ratan
Tata Trust, Mumbai (Nom. Tata Trusts)

VS RAMAMURTHY

Former Director, National Institute of
Advanced Studies, Bangalore
(Nom. Council)

PRAVEEN KUMAR

Joint Secretary (Admin), MHRD Dept. of
Higher Education, GOI New Delhi (Nom. GOI)

R NARESH

Pr. Accountant General (G&SSA)
Karnataka, Bangalore (Ex-officio)

ANURAG KUMAR

Director (Ex-officio)

V RAJARAJAN

Registrar (Ex-officio Secretary)

The Finance Committee met quarterly on Jun 24, 2016; Sep 21, 2016; Dec 2, 2016 and Mar 23, 2017.

1.4 The Senate

The Senate is one of the authorities of the Institute that consists of the Director as the Chairman, all Professors and Associate Professors, one elected representative (Assistant Professor) from each of the Faculties, the Librarian, and the Registrar (Secretary). The Senate meets at least once a term.

This principal academic body functions to (a) plan and coordinate the research activities of the Institute; (b) regulate and organise courses of instruction and study, admission of students, examinations, etc; (c) formulate conditions for the award of Degrees of the Institute; and (d) recommend names to the Council for the award of Degrees.

During the year, the Senate met on May 24, 2016; Aug 26, 2016, Nov 9, 2016 and Feb 20, 2017.

The Senate recommended the award of various degrees as follows:

• PhD	285
• Int. PhD	39
• MSc (Engg)	44
• ME/MTech	270
• MDes	14
• MMgt	16
• BSc (Research)	46
• Master of Science	40
TOTAL	754

1.5 Faculties

The faculties act as advisory bodies to the Senate and assist in the discharge of its duties. Each Faculty consists of the respective Dean as Chairman, all Professors, Associate Professors, Chief Research Scientists, Principal Research Scientists, Assistant Professors and Senior Scientific Officers as members and the Assistant Registrar as the Secretary.

The Science Faculty met on Apr 26, 2016 and Nov 3, 2016. The Engineering Faculty met on Apr 27, 2016 and Nov 8, 2016 during the year.

The Joint meetings of Faculty members were held on Aug 19, 2016 and Jan 4, 2017. The Director chaired the Joint meetings.



2. STAFF

DIRECTOR: ANURAG KUMAR

DEAN, FACULTY OF SCIENCE
T N GURU ROW

DEAN, FACULTY OF ENGINEERING
M K SURAPPA

DEPUTY DIRECTOR (INFRASTRUCTURE AND PLANNING)
S RAMAKRISHNAN

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JAYANT M MODAK

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UMESH VARSHNEY

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Y NARAHARI

CHAIR, DIVISION OF INTERDISCIPLINARY RESEARCH
G RANGARAJAN

CHAIR, DIVISION OF MECHANICAL SCIENCES
VIKRAM JAYARAM

CHAIR, DIVISION OF PHYSICAL & MATHEMATICAL SCIENCES
RAHUL PANDIT

DEAN, UG PROGRAMME: ANJALI A KARANDE

REGISTRAR

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M C Jayaprakash, MCom, MBA, BL
Joydeep Deb, MSc (Jadavpur)
B N Sreedhar, MBA (KSOU)
P Selva Kumar, MA (KSOU)

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FINANCIAL CONTROLLER

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DEPUTY FINANCIAL CONTROLLERS

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INTERNAL AUDITOR

Gurumurthy, MCom

Health Centre

OFFICER-IN-CHARGE

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L Sharada, MBBS, DGO (CMC, Vellore)

Campus Management and Development

PROJECT ENGINEER-CUM-ESTATE OFFICER

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Prabhakar M P

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Gymkhana

PRESIDENT

Ambedkar Dukkupati, PhD (IISc)

Student Affairs

CHAIR, COUNCIL OF HOSTEL WARDENS

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Prabal K Maiti, PhD (IIT/K)
Partha Pratim Mondal, PhD (IISc)
Ravishankar Narayan, PhD (IISc)

A photograph of a university building with a large tree in the foreground and a statue on the roof. The building is a multi-story structure with a red-tiled roof and several windows. The tree is large and leafy, partially obscuring the building. The sky is clear and blue. The overall scene is a typical university campus setting.

3.

DEPARTMENTS/ CENTRES/UNITS





3.1.

Division of

BIOLOG

SCIENCES

The Division of Biological Sciences forges important links between basic science and innovative research. It is committed to enhancing frontline studies in almost all aspects of modern biology: Neuroscience in health and disease, Infectious Disease, Structural Biology, Oncology, DNA Repair and Genomic Stability, Systems Biology and Bioinformatics, Immunology, Enzymology, Reproductive and Developmental Biology, Diverse Ecological Studies and more.

DEPARTMENTS | CENTRES | UNITS

- ◆ BIOCHEMISTRY
- ◆ CENTRAL ANIMAL FACILITY
- ◆ CENTRE FOR ECOLOGICAL SCIENCES
- ◆ CENTRE FOR INFECTIOUS DISEASE RESEARCH
- ◆ CENTRE FOR NEUROSCIENCE
- ◆ MICROBIOLOGY AND CELL BIOLOGY
- ◆ MOLECULAR BIOPHYSICS UNIT
- ◆ MOLECULAR REPRODUCTION, DEVELOPMENT AND GENETICS

IN NUMBERS

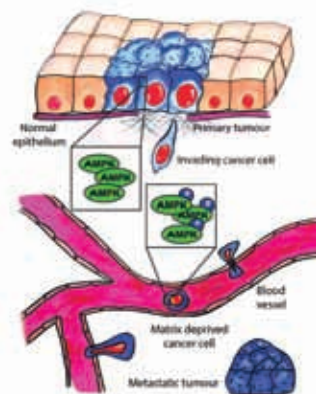
- ◆ **71** FACULTY MEMBERS
- ◆ **84** FELLOWSHIPS OF SCIENCE ACADEMIES IN INDIA
- ◆ **395** PhD STUDENTS
- ◆ **100** INTEGRATED PhD STUDENTS

THEMES

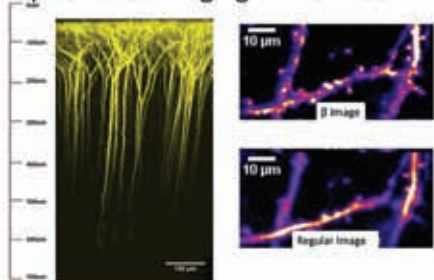
Investigators in the Division focus on numerous processes central to the understanding of life, emphasising areas with considerable translational potential, namely, Cognition and Neuronal Reprogramming, Infectious Diseases, Drug and Molecular Design, Diagnostics and Therapeutics in Cancer, Gene Targeting, Genetic Disorders and Genetic Diversity.

Chairperson: **UMESH VARSHNEY**

Cancer cells overcome natural cell death to transit through the circulatory system and metastasize. The study shows that these cancer cells are protected by detachment-triggered phosphorylation (P) and activation of AMPK (Sundararaman A, Amirtham U and **Rangarajan A**. Calcium-Oxidant Signaling Network Regulates AMP-activated Protein Kinase (AMPK) Activation upon Matrix Deprivation. *Journal of Biological Chemistry*. 2016. 291: 14410-14429).



β contrast imaging in live mice



The saturation dynamics of the photo physical process occurring in the fluorophore helps us generate a new contrast that depends on the local environment. This allows us to tease apart the dendritic spines in a neuron. (Kumar S, Singh A, Singh VR, George JB and **Balaji J**. Saturation Dynamics Measures Absolute Cross Section and Generates Contrast within a Neuron. *Biophysical Journal*. 2016. 111:1328-1336).

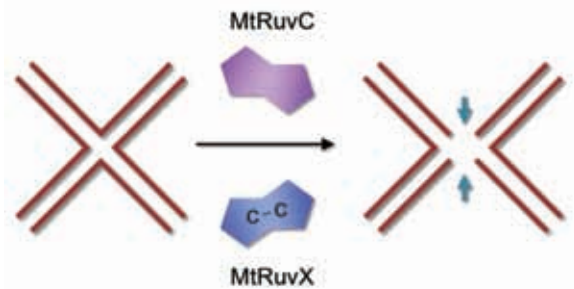


A foetus with anencephaly, a fatal condition in which a child is born without a brain, or only residual brain. This study discovered TRIM36 as the causative gene for anencephaly (Singh N, Kumble Bhat V, Tiwari A, Kodaganur SG, Tontanahal SJ, Sarda A, Malini KV and **Kumar A**. A Homozygous Mutation in TRIM36 Causes Autosomal Recessive Anencephaly in an Indian Family. *Human Molecular Genetics*. 2017. ddx020).



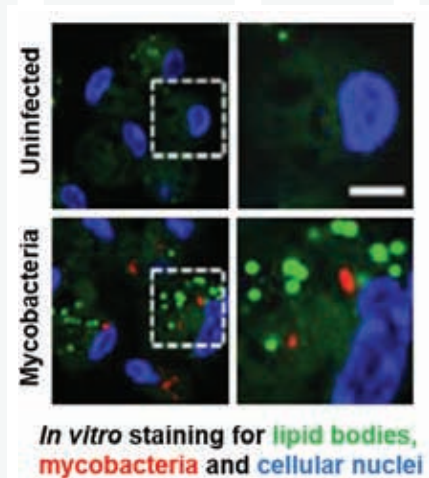
RESEARCH SNAPSHOTS 2016

Mycobacterium tuberculosis uses an unprecedented mechanism for the assembly of the Holliday junction resolvase (Nautiyal A, Rani PS, Sharples GJ and **Muniyappa K**. *Mycobacterium tuberculosis* RuvX is a Holliday Junction Resolvase Formed by Dimerisation of the Monomeric YggF Nuclease Domain. *Molecular Microbiology*. 2016. 100(4):656-74).



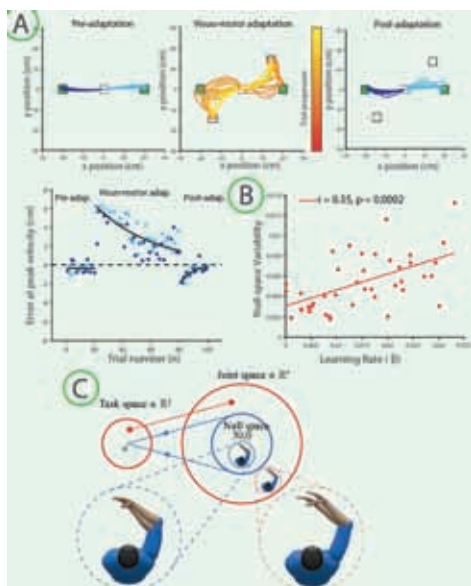
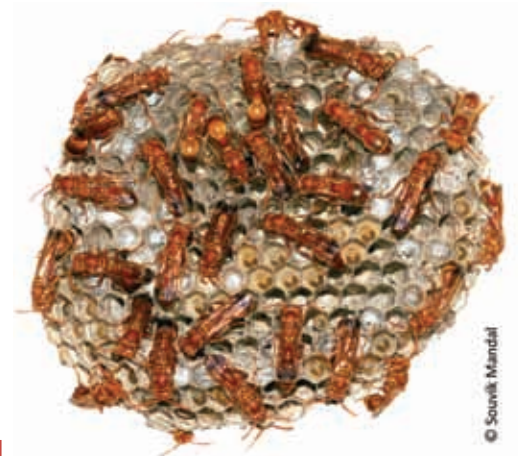
A pair of blackbuck at the Great Indian Bustard sanctuary, Maharashtra. The study found that wild blackbuck use even tiny refuges to persist in a human-dominated landscape (Krishna CY, Kumar A and **Isvaran K**. Wild Ungulate Decision-Making and the Role of Tiny Refuges in Human-Dominated Landscapes. *PLoS One*. 2016. 11(3): e0151748).

Tuberculosis infection results in epigenetic changes, leading to lipid accumulation in the host (Holla S, Prakhar P, Singh V, Karnam A, Mukherjee T, Mahadik K, Parikh P, Singh A, Rajmani RS, Ramachandra SG and **Balaji KN**. USASHI-Mediated Expression of JMJD3, a H3K27me3 Demethylase, is Involved in Foamy Macrophage Generation During Mycobacterial Infection. *PLoS Pathogens*. 2016. 12(8):e1005814).



Protein families can be grouped into higher hierarchical schemes depending on their structural and evolutionary closeness. Many of these families unable to connect through natural linkers (red dots) are bridged through computational protein sequence design (blue and white dots) (Vishwanath S, Sukhwal A, Sowdhamini R and **Srinivasan N**. Specificity and stability of transient protein-protein interactions. *Current Opinion in Structural Biology*. 2017. 44:77-86).

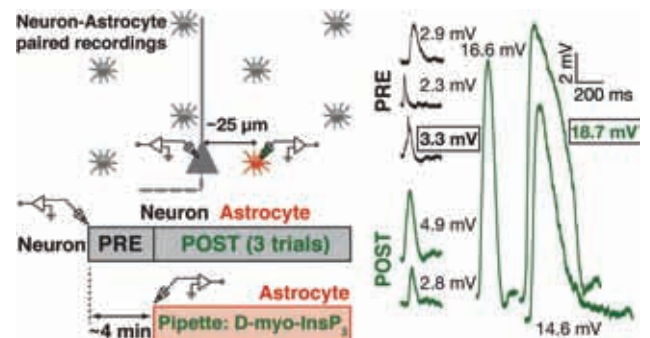
A nest of *Ropalidia marginata*, a wasp species in which, a new study argues, altruistic behaviour cannot always be explained by kin selection theory (**Gadagkar R.** Evolution of Social Behaviour in the Primitively Eusocial Wasp *Ropalidia Marginata*: Do We Need To Look Beyond Kin Selection? *Philosophical Transactions of the Royal Society B.* 2016. 371:20150094).



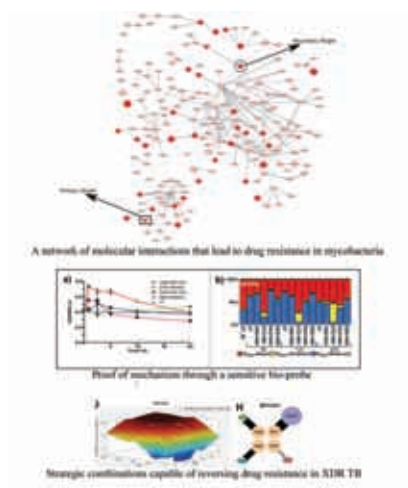
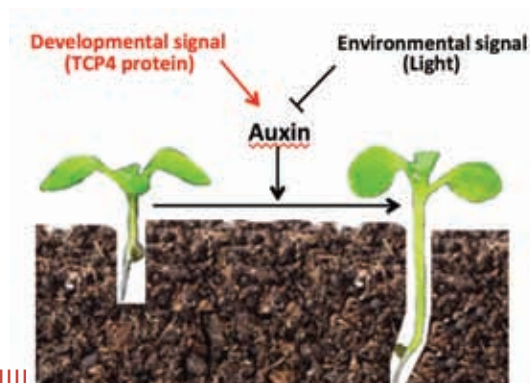
The ability to learn a novel visuomotor task (A) is predicted by the degree to which subjects explore null space-variability (B), an aspect of motor variability due to joint redundancy (C) (Singh P, Jana S, Ghosal A and **Murthy A.** Exploration of joint redundancy but not task space variability facilitates supervised motor learning. *Proceedings of the National Academy of Sciences.* 2016. 113(50): 14414-14419).



In paired astrocyte-neuron electrophysiological recordings, infusion of inositol trisphosphate into the astrocyte resulted in large-amplitude, long-duration plateau potentials in neurons (Ashhad S and **Narayanan R.** Active Dendrites Regulate the Impact of Gliotransmission on Rat Hippocampal Pyramidal Neurons. *Proceedings of the National Academy of Sciences (USA).* 2016. 113(23): E3280-E3289).



Developmental signals in a plant, like environmental signals, lead to the production of auxin, which spurs growth (although each signal leads to growth in different ways) (Challa KR, Aggarwal P and **Nath U**. Activation of YUCCA5 by the Transcription Factor TCP4 Integrates Developmental and Environmental Signals to Promote Hypocotyl Elongation in Arabidopsis. *The Plant Cell*. 2016. tpc.00360.2016).



Reversal of drug resistance in tuberculosis: Deciphering resistance mechanisms, identifying and targetting the Achilles' heel of drug-resistant bacteria with new drug-combinations (Padiadpu J, Baloni P, Anand K, Munshi M, Thakur C, Mohan A, Singh A and **Chandra N**. Identifying and Tackling Emergent Vulnerability in Drug-Resistant Mycobacteria. *Infectious Diseases* 2016. 2(9): 592-607).

RESEARCH HIGHLIGHTS

The Division of Biological Sciences consists of the Departments of Biochemistry, Microbiology & Cell Biology, Molecular Reproduction, Development & Genetics, Molecular Biophysics Unit, Ecological Sciences, Centre for Neuroscience, Centre for Infectious Disease Research and Central Animal Facility including Primate Research Laboratory.

The Department of Biochemistry (BC) started in 1921. It was recognised as a Centre of Advanced Study by UGC in 1965. There are 15 Faculties, 3 Emeritus Scientists, 86 PhD students 32 PDF/ DST Young Scientists/UGC Kothari Fellows 2 administrative staff, 5 permanent helpers and 45 temporary staff in the department.

Current Research

A. PROTEINS, NATURAL PRODUCTS AND METABOLIC ENGINEERING

The transcriptional regulation of tropane alkaloids pathway is poorly understood. Based on sequence of the AP2/ERF domain transcription factor ORCA3 from *C. roseus*, gene specific primers were designed. DORA was expressed as a fusion protein in *Escherichia coli* and purified. Gel mobility shift assays revealed that recombinant DORA binds specifically to GCC box, a cis-acting element. A transcription factor known as Mxr1p was identified as a global regulator of multiple metabolic pathways in the yeast, *Pichiapastoris*. *H. pylori* strains are genetically diverse and display strain

specific phenotypes. *H. pylori* strain 26695 harbors a single m4C cytosine methyltransferase, M2.HpyAll which recognizes 5' TCTTC 3' sequence and methylates the first cytosine residue. The data shows that upon the loss of m4C modification a total 102 genes belonging to virulence, translation and cellular components were differentially expressed. The growth reduction of *E. coli* lacking Lon protease due to exposure to sodium salicylate, a non-steroidal anti-inflammatory compound, was investigated. Further studies investigated the roles of Lon protease, MarA, a transcription factor, and the AcrAB-TolC efflux pump in the induction of phenotypic antibiotic function in bacteria. Chimeric virus-like particles of the Sesbania mosaic virus expressing the B- domain of Staphylococcus protein A (SLB)

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86 PhD STUDENTS

12 INT PhD STUDENTS

4 INT PhD CONFERMENTS

8 PhD CONFERMENTS

95 PUBLICATIONS

Chairperson: C JAYABASKARAN

3.1.1

BIOCHEMISTRY

were shown to act as nano carriers for the intracellular delivery of antibodies and were much more effective than treatment with antibodies alone.

B. DNA REPAIR, RNA TRANSACTIONS AND GENOMIC STABILITY

Genetic and biochemical studies in *S. cerevisiae* revealed that interaction between SAE2 and MRE11 is essential for the alleviation of DNA replication stress. Elucidation of the mechanism of nucleotide excision repair in *M. tuberculosis* showed that UvrB is responsible for DNA damage recognition via its robust DNA-stimulated ATPase and structure-specific ATP-dependent DNA helicase activity. We discovered that G/C-rich sequences in the ACC1 gene promoters fold into G-quadruplex DNA, which, in turn, plays a decisive role in transcriptional regulation and consequently may serve as a therapeutic target for human disease. The defects in chromosome stability and subunit-interactions of smc5/6 mutants were characterised. The functional significance of sumoylation of Mms21-mediated sumoylation targets in chromosome stability was investigated using non-sumoylatable variants. Studies show that XRCC2, a RAD51 paralog, restrains pathological replication during depletion of dNTPs and this function is dependent on XRCC2-S247 phosphorylation by ATR. The identification of microhomology mediated DNA end joining in mitochondria, various forms of SCR7, an inhibitor of NHEJ, the impact of SCR7 in reducing radiation dose in radiotherapy, Disarib as a novel BCL2 inhibitor, role of G-quadruplex in chromosomal

translocations and mechanism of Endosulfan action, a pesticide used commonly in India, were elucidated. A subset of RNA-binding proteins (with RGG-motifs) is involved in regulating translation. The roles of arginine methylation in regulating the function of RGG-motif proteins and consequently mRNA fate are being studied. Four mammalian genes whose transcripts exhibit translational read through have been identified. The mechanism and functional significance of these events is being investigated. This knowledge might help us develop novel therapeutics to treat genetic diseases caused by premature stop codon.

C. BIOLOGY OF CHAPERONES

The first whole genome sequence of a newly emerging multidrug resistant form of *Candida auris* isolated from a patient has been reported. Metabolomics approach has been used to identify the triggers of gametocytogenesis in malaria. The uncovering of novel genes involved in the ROS homeostasis in eukaryotic system; b) design and synthesis of potential biomimetic artificial antioxidant enzymes; c) understanding mechanism of Fe/S clusters biogenesis and its relevance to multiple inherited genetic disorders is being studied

D. IMMUNOBIOLOGY

Blood from healthy controls and TB patients for RNA Seq analysis and the RNA abundances thereby obtained were

CORE RESEARCH

Protein, natural products and metabolic engineering; DNA repair, RNA transactions and genomic stability; biology of chaperones; immunobiology; and systems biology.

used to construct condition-specific whole genome protein interaction networks. Top-activity paths observed in healthy and patient networks were compared to identify blood-based biomarkers (genes) for tuberculosis infection. Cell culture studies had suggested earlier that Glycodelin A regulates the cytolytic activity of CD8+T cells. Using nude mice harboring target human cells we demonstrated that the activity of the cytotoxic cells generated in vitro were able to kill the explant cells in vivo. Infection of several cell lines including mouse

brain astrocytes and human brain microendothelial cells results in the induction of MHC I. In contrast to mouse cell lines, infection of human brain endothelial cells results in the solubilization of HLA-A, -B, -C and HLA-E molecules. Additional differences between mouse and human cells were investigated. Mouse Apolipoprotein L9 was shown to bind phosphatidylethan-olamine and function as a pro-viral host factor for Japanese Encephalitis Virus. Curcumin was shown to protect mice against cerebral malaria.

Faculty and Staff

NAGASUMA CHANDRA | PhD (Bristol), Associate Professor

PATRICK D'SILVA | PhD (IIT Bombay), Associate Professor

SANDEEP M ESWARAPPA | PhD (IISc), Assistant Professor

C JAYABASKARAN | PhD (IISc), MNASc, Professor

ANJALI ANOOP KARANDE | PhD (Bombay), Professor

SHIKHA LALORAYA | PhD (Wisconsin), Associate Professor

R MANJUNATH | PhD (IISc), Associate Professor

K MUNIYAPPA | PhD (IISc), FASc, FNASc, FNA, FTWAS, Professor

GANESH NAGARAJU | PhD (IISc), Assistant Professor

DIPANKAR NANDI | PhD (California-Berkeley), Professor

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PURUSHARTH RAJYAGURU | PhD (CCMB), Assistant Professor

PN RANGARAJAN | PhD (IISc), FASc, FNASc, Professor

D NARASIMHA RAO | PhD (IISc), FASc, FNASc, FNA, Professor

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Emeritus Professors

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Chairperson: **KUMARAVEL SOMASUNDARAM**

3.1.2

CENTRAL

ANIMAL FACILITY

The Central Animal Facility (CAF) breeds, maintains and supplies pure and inbred strains of experimental animals for biomedical research activities at the Institute. The animal species includes New Zealand white rabbits, Wistar rats, Sprague Dawley rats and several strains of mice (Swiss albino, BALB/c, FVB/N, CD1, C57BL/6, and C3HeJ) including knockout mice (IFN γ KO, iNOS KO, etc.).

Faculty and Staff

KN BALAJI | PhD (IISc), Professor

KUMARAVEL SOMASUNDARAM | PhD (Madurai), Professor

SG RAMACHANDRA | Chief Research Scientist

RAVINDRANATH H ALADAKATTI | Senior Scientific Officer

CORE RESEARCH

The experimental animals are provided to several investigators who are using animals for research activities in the Division of Biological Sciences (Biochemistry, Microbiology and Cell Biology, Molecular Reproduction, Development and Genetics, Molecular Biophysics Unit, Centre for Neuro Sciences) and other departments such as Mechanical Engineering, Material Research Centre, Materials Engineering, Inorganic and Physical Chemistry and Centre for Nano Science and Engineering.

The Centre for Ecological Sciences (CES) has continued to do cutting-edge research in diverse areas of ecology, behaviour and evolutionary biology. We study a range of systems from insects, herpetofauna and birds to the largest land mammals, the Asian elephant, including climate change. We employ diverse tools from molecular ecology to mathematical modeling of ecosystems.

Current Research

The work of CES has covered many important areas in the field of ecology and evolution. Issues such as what makes some individuals behaviourally more dominant than others have been addressed in species such as the primitively eusocial wasp *Ropalidia marginata*. Predator-prey space use patterns were also examined in two systems. In the tree cricket-spider system, space use of predators and prey were investigated at two different spatial scales. In the katydid-bat predator-prey system, studies on site selection and calling activity of the prey species were completed and studies on movement and use of the landscape by the bat predator during foraging. In other research on animal behaviour, endocrinological analyses indicated hormonal correlates of the costly lekking behaviour in the endemic

blackbuck antelope, *Antelope cervicapra*, and behavioural analyses revealed possible sexual selection mechanisms maintaining multiple signals in the dimorphic rock agama, *Psammophilus dorsalis*. Applied research suggested the usefulness of a functional trait approach to predict the response of butterflies to internal forest fragmentation caused by roads and an invasive plant. In molecular ecology and phylogenetic studies, research was conducted on the biogeography of blindsnakes, phylogeography of blackbuck, comparative phylogeography of *Hemidactylus* geckoes, species status of Himalayan langurs, malarial parasites in Indian primates, freshwater snail biogeography and evolution, and the phylogenetic diversity of Western Ghats forests. Significant contributions were made to our

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IN NUMBERS

10 ACADEMIC AND **1** SCIENTIFIC STAFF
44 PhD STUDENTS
10 INT PhD STUDENTS
2 INT PhD CONFERMENTS
2 PhD CONFERMENTS
64 PUBLICATIONS

3.1.3

Chairperson: **RENEE M BORGES**

CENTRE FOR ECOLOGICAL SCIENCES

understanding of how fire regulates forest dynamics in the seasonally dry tropical forests of the Western Ghats. The urban ecology of lizards was investigated as was the effect of wind turbines on lizard behaviour and community structure in the Western Ghats. Grassland ecosystems in Karnataka

were surveyed for setting up long-term research. The nexus between life-history traits and resource availability in governing dispersal propensities were examined, and the dichotomy between slow- and fast-paced insect life histories was clearly established.

Faculty and Staff

SUMANT BAGCHI | PhD (Syracuse), Assistant Professor

ROHINI BALAKRISHNAN | PhD (TIFR), Professor

RENEE M BORGES | PhD (Miami), FASc, FNA, Professor

RAGHAVENDRA GADAGKAR | PhD (IISc), FASc, FNA, FTWAS, Foreign Associate, US Natl Acad Sci, Professor

VISHWESHA GUTTAL | PhD (Ohio), Assistant Professor

KAVITA ISVARAN | PhD (Florida), Assistant Professor

NV JOSHI | PhD (IISc), Associate Professor

PRAVEEN KARANTH | PhD (SUNY, Albany), Associate Professor

RAMAN SUKUMAR | PhD (IISc), FASc, FNA, FTWAS, Professor

MARIA THAKER | PhD (Indiana State), Assistant Professor

Associate Faculty

NH RAVINDRANATH | PhD (IIT Bombay), Professor

CORE RESEARCH

Animal behaviour; behavioural ecology; bioacoustics; chemical ecology; climate change; community ecology; ecosystem ecology; evolution; fire ecology; forest dynamics; grassland ecology; marine and coastal ecology; mathematical ecology and modeling; molecular ecology; movement ecology; nutrient cycling; phylogenetics; phylogeography; plant–animal Interactions; predator–prey Interactions; sensory ecology; and stress physiology.

The main goal of Centre for Infectious Disease Research (CIDR) is to integrate research activities in the area of infectious diseases with interactions and collaborations and provide avenues for multidisciplinary activities with translational outcomes. Research activities in CIDR are spearheaded by senior fellows, who have procured competitive grants for studies related to infectious disease research.

Associate Faculty

SAUMITRA DAS | PhD (Calcutta), Professor

DIPANKAR NANDI | PhD (California-Berkeley), Professor

D NARASIMHA RAO | PhD (IISc), FASc, FNASc, FNA, Professor

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IN NUMBERS

12 PUBLICATIONS

Convenor **DIPANKAR NANDI**

3.1.4

CENTRE FOR INFECTIOUS DISEASE RESEARCH

CORE RESEARCH

Work on understanding and targeting drug tolerance in *M. tuberculosis* and application of network biology to identify new drugs combination, and studies to understand the principal immune mechanisms that contribute to reactivation of tuberculosis in the context of HIV infection are being carried out. A systems approach has verified a 10-gene minimal molecular signature, which distinguishes blood cells from patients with tuberculosis versus healthy controls. Also, the pattern of mutations accumulating in *M. tuberculosis* strains in India was found to be highly distinct from those accumulating in other regions (Africa), which has important implications for vaccine design. It has been shown that Treg cell function is significantly impaired / abolished in tuberculosis due to T effector cells from tuberculosis subjects becoming poorly susceptible to Treg mediated control. Studies on a protein, namely WFDC1/ps20, which belongs to an ancient family of immunomodulatory proteins is dramatically downregulated upon T cell activation, Concomitant with the expression of key effector cytokines. Further, using combinatorial approaches (computer programming, genetic assays, chemical, and sensor based tools), a complete landscape of genetic and phenotypic changes in mycobacteria during evolution of drug-resistance has been obtained. One of the prominent phenotypic changes was its ability to respond to oxidative stress which revealed that drug-resistant mycobacterium have a diminished capacity to tolerate oxidative stress. Phenotypic microarrays to identify compounds, which target the antioxidant capacity of mycobacteria identified new drugs including Ebsleen, phenyl-arsenate oxide, auranofin, and vancomycin. These compounds when combined with existing anti-TB drugs such as isoniazid can reduce the viability of drug-resistant mycobacterium. One of the drugs identified by our study (vancomycin) is already in use for treating other bacterial infections, hence can be easily applied to the treatment of drug-resistant TB infection (repurposed).

Understanding the structure, function and development of the brain in health and disease requires studying the brain across different levels of organisation using molecular, cellular, systems, cognitive and computational approaches. The Centre for Neuroscience (CNS) recruits faculty across wide-ranging disciplines to establish a strong program in basic neuroscience and builds links to existing expertise in IISc as well as with clinical centres to develop translational research.

Current Research

Centre for Neuroscience (CNS) is a multidisciplinary department with the common goal of understanding brain functions in health and diseases. The department currently has eight faculty members, one Wellcome-DBT Intermediate Fellow, and two Ramalingaswami Fellows. The department is actively growing and is recruiting new faculty, expanding its infrastructure, renovating existing space and constructing new laboratories. In the context of sensory information processing, it has been investigated how the brain performs visual object recognition and has recently shown that object attributes combine additively in visual search. Furthermore, they found that single

IT neurons keep track of occluded objects and generate surprise/match signals indicating their unexpected or expected reappearance. Furthermore, single IT neurons decouple patterns from surfaces, enabling complex percepts such as seeing a line as straight even when it is overlaid on a bent surface.

In the context of motor control, the existence of two distinct computational architectures underlying coordinated eye-hand movements has been proposed. These architectures, for the first time, provide a mechanistic understanding underlying the flexible coupling between eye and hand

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DEGREE PROGRAMS OFFERED **PhD and Int. PhD**

IN NUMBERS

8 ACADEMIC STAFF

34 PhD STUDENTS

2 INT PhD STUDENTS

6 PhD CONFERMENTS

35 PUBLICATIONS

3.1.5

CENTRE FOR NEUROSCIENCE

Chairperson: **ADITYA MURTHY**

movements. In other work, how joint redundancy can promote motor learning has been shown. Specifically, motor variability has two components – one part related to task-space variability and the other component arising out of redundancy that does not affect task-space variability yet it is correlated with motor learning.

In the context of cognitive processing, a model for analysis of behaviour that enables distinguishing two distinct neural mechanisms – perceptual and decisional, that operate during attention has been developed. EEG signatures by which multiple stimuli compete for attention in the brain and developing and applying novel algorithms for identifying “hub-nodes” in the brain with functional and diffusion magnetic resonance imaging (fMRI/dMRI) are being identified. In a related but distinct area of research, a microelectrode arrays in the visual cortex of a monkey, and recorded salient gamma oscillations have been successfully implanted.

In the area of molecular, cellular and developmental neuroscience, studies on the molecular mechanisms regulating astrocyte differentiation and development are being performed. It is found that mouse brain astrocytes lacking the transcription factor, SRF, become reactive and this reactive astrogliosis persisted throughout life. Lipid metabolism has been shown to hold the key to major fundamental processes including neuronal differentiation. The molecular mechanisms underlying neuronal polarity and how it contributes to neuronal differentiation and development are being unraveled. Towards deeper

understanding of the molecular architecture of the synapse, the functional units of neuronal communication, the nano organisation laboratory utilizes ultra-high resolution imaging approaches to investigate assembly and regulation of synaptic transmission machinery. Novel imaging paradigms like nanoscale imaging combined with optical and chemical stimulations are used to observe real-time organisation of a chemical synapse.

In the area of disorders of the nervous system, research is focused on elucidating the early pathogenic mechanisms leading to Alzheimer’s disease (AD), a progressive neurodegenerative disorder often seen in the elderly and manifests clinically as memory loss and cognitive impairment. It is shown that synaptic dysfunction including loss of activity-dependent protein translation and cytoskeletal F-actin occurs in AD long before the manifestation of disease pathology. Loss of synaptosomal F-actin is associated with impaired recall upon fear conditioning and can be reversed by actin polymerizing agents. Studies are also being performed on how ubiquitination and deubiquitination of metabolic G-protein coupled receptors and their adaptor protein, β -arrestin2 contribute to the agonist induced synaptic functions in cellular models and mouse models of Alzheimer’s disease. These findings may provide new avenues for therapeutic intervention and prevention of AD progression.

In the context of learning and memory CNS researchers are actively working towards understanding remote memories (memories of past lifetime events) that are

CORE RESEARCH

Motor control; neurobiology of disease; neural mechanisms of attention; neuronal differentiation and development; astrocyte biology; neurobiology of learning and memory; molecular organisation of synapse; neuronal receptor biology; visual object recognition; neural mechanisms of selective attention.

vital for shaping behaviour. The technical impediment to image synaptic architecture of neuronal networks in deep brain regions limits our ability to understand the neuronal underpinnings of remote memories. This limitation has been overcome using a novel contrast that is generated without the use of any additional agents but by utilising the photophysical properties of fluorophores present within neurons. It is also shown that the nature and specificity of memory recall of past events is highly modulated by the interaction between multiple instances of encoding occurring

in different brain regions. In a related but distinct area of research, studies on how hippocampal network creates a coherent representation of events within their spatial context are being performed. Specifically, the interplay between sensory-derived spatial and nonspatial information brought in by the lateral entorhinal cortex (LEC) and the internally generated, path-integration-based spatial representation in the medial entorhinal cortex (MEC).

Faculty and Staff

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- SP ARUN** | PhD (Johns Hopkins), Assistant Professor
- BALAJI JAYAPRAKASH** | PhD (TIFR), Assistant Professor
- DEEPAK NAIR** | PhD (Leibniz Institute for Neurobiology), Assistant Professor
- NAREN RAMANAN** | PhD (NUS), Associate Professor
- SRIDHARAN DEVARAJAN** | PhD (Stanford), Assistant Professor
- SUPRATIM RAY** | PhD (Johns Hopkins), Assistant Professor
- VIJAYALAKSHMI RAVINDRANATH** | PhD (Mysore), Professor

Associate Faculty

- GOVINDAN RANGARAJAN** | PhD (Maryland), Professor
- POLANI B SESHAGIRI** | PhD (IISc), FNASc, FAMS, Professor
- CHANDRA SEKHAR SEELAMANTULA** | PhD (IISc), Associate Professor

The Molecular Biophysics Unit (MBU) is currently engaged in frontline research in contemporary biophysics, structural biology and physiology. Research activities in the Unit focus on the structure, conformation and interactions of biomolecules and their functions, with the main objective of explaining biological activity in molecular terms.

Current Research

Integral membrane transporters play a critical role in overcoming the hydrophobic barrier of the membrane bilayer for cells to transport important metabolites and toxins using ionic electrochemical gradients. Transporters in the solute carrier family (SLC) are involved in the sodium or proton dependent symport or antiport of neurotransmitters in the neurons, respectively. Transporters in the neural synapse at plasma membrane and synaptic vesicles are critical to establish the neurotransmitter cycle for chemical neurotransmission. The prokaryotic homologues of neurotransmitter transporters employ similar ion-

based mechanisms to uptake amino acids into cells or efflux antibiotics to render multidrug resistance to pathogenic strains. People in the department intend to study the transport mechanisms and pharmacology of candidate members of both these classes of molecules through crystallographic structure determination and functional studies using biochemical methods. Information obtained from crystal structures of transporter(s) would provide a glimpse into the multi-substrate specificity, inhibitor binding sites, substrate-ion stoichiometry and a framework for future drug discovery platforms.

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12 ACADEMIC STAFF

88 PhD STUDENTS

13 INT PhD STUDENTS

6 INT PhD CONFERMENTS

18 PhD CONFERMENTS

63 PUBLICATIONS

Chairperson: **RAGHAVAN VARADARAJAN**

3.1.6

MOLECULAR BIOPHYSICS UNIT

Tissue acidosis and increase in lactate concentrations are associated with cerebral ischemia. Ischemic concentrations of lactate (30 mM) potentiated the single channel activity of the neuroprotective human TREK1 potassium (hTREK1) channels in inside-out patch clamp recordings, while similar concentration of lactate at pH 6.0 to 5.5, commonly observed in hyperglycemic ischemia reduced channel activity. A histidine residue in the 328th position (H328) in the carboxy-terminal domain of hTREK1 was found to be important in mediating the differential effect of pH in the presence of lactate. Researchers in the department have developed a robust synthetic protocol to obtain well-folded b-hairpin peptides in aqueous solution via the incorporation of N-methylated heterochiral amino acids. This will allow one to engineer stable hairpin peptides by introducing any heterochiral amino acids at the b-turn that was not possible so far.

Crystal structures of three oligomeric forms of a bacterial small heat shock protein have been determined by researchers in the department, which provided insights

into the diversity in oligomerization and the importance of dynamic equilibrium between different states of these stress-related molecular chaperones. Structures of the cyclase homology domain of a class III AC from *Mycobacterium avium* and its mutants in complex with ATP and GTP have provided the structural basis for substrate selection by the nucleotidylcyclases and novel modes of substrate binding at the atomic level.

Two electrophysiological studies from the department, involving dendritic patch clamping, have unveiled novel roles for active dendritic structures in neuronal physiology. Whereas the first of these studies demonstrated a critical role for transient potassium channels in regulating active dendritic spectral tuning, a second study delineated a novel role for active dendrites in regulating the spatiotemporal spread of the impact of gliotransmission on neurons.

CORE RESEARCH

Protein folding and dynamics; lectins and lectin carbohydrate interaction; peptide synthesis and design; X-ray crystallography of proteins and viruses; computer modeling and dynamics of biological molecules; theoretical studies on the conformation of peptides and Proteins; conformational analysis of nucleic acids; DNA-protein interactions; unusual DNA structures and control of transcription; ionophores and drugs and their interaction with membranes; genome organisation; synthetic protein design and protein engineering; ion channels and electrophysiology; neurophysiology and computational neuroscience; membrane channel forming peptides.

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JAYANTA CHATTERJEE | PhD (Munich), Assistant Professor

SOMNATH DUTTA | PhD (Kolkata), Assistant Professor

B GOPAL | PhD (IISc), FASc, FNASc, Professor

RISHIKESH NARAYANAN | PhD (IISc), Assistant Professor

SIDDHARTHA P SARMA | PhD (Maryland), Professor

SIKDAR SUJIT K | Dr MedSci (Kyushu), FASc, Professor

MAHAVIR SINGH | PhD (Munich), Assistant Professor

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K SUGUNA | PhD (IISc), Professor

RAGHAVAN VARADARAJAN | PhD (Stanford), FASc, FNA, Professor

Associate Faculty

RAHUL ROY | PhD (Illinois), Assistant Professor

Honorary and Emeritus Professors

A SUROLIA | PhD (Madras), FASc, FNASc, FNA, FTWAS, M-IMBN, Bhatnagar Fellow, Honorary Professor

DIPANKAR CHATTERJI | PhD (IISc), FASc, FNASc, FNA, FTWAS, Honorary Professor

P BALARAM | PhD (Carnegie Mellon), FASc, FNASc, FNA, FTWAS, Honorary Professor

SARASWATHI VISHVESHWARA | PhD (New York), CSIR Emeritus Scientist

The Department (MCB) conducts cutting edge research in modern biology. Fifteen groups use prokaryotic (*E. coli*, *Salmonella*, mycobacteria) and eukaryotic models (yeast, worms, mice, human cells and plants) to address fundamental questions. Research on gene regulation, mechanisms in pathogenesis, cell division and signaling, protein sorting and cancer are areas of focus.

Current Research

The Department of Microbiology and Cell Biology is a leading centre performing front-line research in disease biology (bacterial, viral and fungal) and in basic cellular processes. The key findings, over the past year, in the core areas are summarised.

A. BACTERIAL PATHOGENESIS OF MAJOR DISEASES

Using network biology approach, we have provided a complete landscape of genetic and phenotypic changes in tuberculosis-causing bacterium *M. tuberculosis* (Mtb)

during the evolution of drug-resistance. *Mtb* acquires new phenotypes during transition to drug-resistant variants and this can be targeted by available drugs. In another study, we show that the Mtb cell size is correlated with antibiotic sensitivity/ resistance a finding pertinent to the long duration of TB treatment. We have also elucidated that Mtb glycoproteins interact with C-type lectin receptors of host innate immune cells and found novel signaling pathways that modulate cell death. The key to develop vaccines, antiviral or antibacterial agents is to unravel host mechanisms that orchestrate pathogenesis and the various immune evasion strategies

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2 INT PhD CONFERMENTS

12 PhD CONFERMENTS

46 PUBLICATIONS

Chairperson: USHA VIJAYARAGAVAN

3.1.7

MICROBIOLOGY

AND CELL BIOLOGY

employed by the pathogens. We are studying these host-pathogen interactive processes using *Mtb*, *Salmonella*, *Shigella*, *Listeria*, *Candida* and *Aspergillus* species.

B. VIRAL PATHOGENESIS AND VACCINE DESIGN

Hepatitis C (HCV) is major cause of viral hepatitis which can lead to cirrhosis and liver cancer. Recently a candidate vaccine has been developed using HCV virus like particles (VLPs) capable of eliciting neutralising antibody production in mice. This has the potential to be the first vaccine against HCV-3a, a strain specific to Indian subcontinent. In another study, we have shown that the intra-cellular membrane stress induced by flaviviral infection affects host immune responses.

C. CELLULAR PROCESSES AND CANCER BIOLOGY

In cancer biology, we identified the role of specific differentially methylated genes relevant to the biology of glioma, the most common type of brain tumor. We

also identified a microRNA, miR-326, that acts as a tumor suppressor molecule. In the area of organelle (melanosome) biogenesis and associated diseases such as Hermasky-Pudlak syndrome, we have shown that specific adaptor proteins are required for the selective transport of cargo to melanosomes. Moreover, by dynamic imaging of the trafficking process we show the role of cytosolic protein complexes (BLOC1/2/3) in the sorting from endosomes to melanosomes. In the process of mitosis during cell division, we have shown that the evolutionarily conserved Aurora kinase A is required for proper spindle orientation in organisms as diverse as worms and humans. Additionally, a specific inhibitor of this kinase had been found. In the field of gene regulation and non coding RNAs, we study the metabolism of microRNAs using *C. Elegans* a model. Our findings here uncover a previously uncharacterised microRNA turnover pathway.

CORE RESEARCH

Regulatory processes in gene expression, protein synthesis; DNA repair and stress responses in prokaryotes and eukaryotes; control of cell division, cell cycle, cell fate, differentiation, morphogenesis and intracellular protein trafficking; MicroRNA turnover and translational control of viral and cellular mRNAs; pathogenesis of mycobacterium, *Salmonella*, enteroviruses, flavivirus, hepatitis C virus, Coxsackie virus, and HIV; and genetics of glioma, diabetes and cardiovascular diseases.

D. GENE REGULATION, DEVELOPMENT AND LIFESTYLE DISEASES

In prokaryotes we characterised a new nucleoid-associated protein from *Mtb*; studied chemical perturbation of DNA topology and assessed genomic landscape of topology modifying enzymes. Using another prokaryotic model, we showed that evolutionarily conserved features in the anticodon stem of initiator tRNAs license the final steps of ribosome maturation. Eukaryotic models such as fission yeast are being used to study pre-mRNA splicing and splice-site recognition mechanisms. Genome-wide transcript isoform analysis shows that roles for specific splicing factors are substrate-specific and can have effects on cell division cycle. In eukaryotic developmental biology,

we show that cell fate during rice floret development is guided by regulatory factors that enable dynamic gene expression and differentiation. Another area of research shows cell shape and cell expansion are key steps in plant development and some of which are linked to environmental plasticity. The Arabidopsis TCP4 transcription factor is an example of a molecular link between developmental and the environmental control of cell expansion. In mouse diabetes models, we identify a novel deacetylation of a signalling protein, which is responsible for developing insulin-resistance.

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UMESH VARSHNEY | PhD (Calgary), FNA, FASc, FNASc, Professor

S VIJAYA | PhD (IISc), Professor

USHA VIJAYARAGHAVAN | PhD (Caltech), FNA, FASc, Professor

Research pursued in the department of MRDG aims to understand the mechanisms of cellular signalling in the course of normal development, adaptation, and under patho physiological conditions including cancer, Mendelian disorders and infection. The labs use approaches including biochemistry, genetics and cell biology/microscopy to understand signalling in bacteria, nematodes, fruitfly, zebrafish, mice, mammalian cell lines, and in human clinical samples.

Current Research

A. CELL SIGNALING

In the area of cellular senescence, a study showed that nitric oxide or NO can induce growth arrest accompanied by DNA damage foci, SA β Gal secretory phenotype, and inflammation via ATM kinase- ROS-iNOS axis. Thus nitric oxide mediates cellular senescence through a novel, free radical dependent, genotoxic stress pathway. In the area of reproductive biology, role of 17β -estradiol (E2) on corpus luteum (CL) steroidogenesis, morphology and proliferation was studied. E2 affects CL function via insulin signaling pathway molecules IGFBP2 and PI3Kinase/Akt.

B. GENETICS OF HUMAN DISEASES

In a study of 22 families with patients of neurodegenerative diseases INAD, ANAD and DPC, 13 mutations found in PLA2G6 (Phospholipase A2 Group VI) gene linked to these disorders. Five of mutations in these families were novel ones. Congenital sodium diarrhoea (CSD) is a secretory diarrhoea with intrauterine onset and high faecal losses of sodium without congenital malformations. Whole exome sequencing of 4 unrelated CSD patients revealed mis sense mutations in receptor guanylatecyclase gene GUCY2C. GUCY2C is expressed in intestinal brush border cells and

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53 PhD STUDENTS

11 INT PhD STUDENTS

1 INT PhD CONFERMENTS

7 PhD CONFERMENTS

53 PUBLICATIONS

Chairperson: **PATURU KONDAIAH**

3.1.8

MOLECULAR REPRODUCTION, DEVELOPMENT AND GENETICS

serves as receptors for guanylin, uroguanylin and bacterial enterotoxin. Dominant, CSD associated mutations in GUCY2C led to increase in cyclic GMP and chronic diarrhoea. Mutations associated with PLA2G6 and GUY2C can be used as diagnostic tools and carrier detection.

C. CANCER AND FIBROSIS BIOLOGY

Increased expression of drug transporters is associated with chemotherapy failure. In breast cancer, levels of two ABC family transporter proteins ABCC3 and ABCC1 were found to be upregulated. Down modulation of ABCC3 level resulted in increased chemosensitivity, reduction in cancer stem cells and reduced ability to form tumors in mice suggesting that chemotherapy combined with drug transporter knockdown is a potentially more effective cancer therapy. A nutrient sensor called AMP activated protein kinase or AMPK allows cancer cells to survive as matrix detached cells. In a new study, AMPK was shown to be activated by liver kinase B1 (LKB1) and Ca²⁺/calmodulin-dependent protein kinase kinase β (CaMKK β) during matrix deprivation, without the need for energy stress. Aggressiveness of glioblastoma (GBM) is associated with high IGFBP2/insulin signalling. IGFBP -2 was found to potentiate GBM tumor growth by the activation of the β -catenin pathway leading to worse patient prognosis. Oral submucous fibrosis (OSF) is potentially premalignant, irreversible extracellular matrix deposition in the oral cavity driven by TGF- β signalling, and caused by prolonged chewing of areca nut. Arecanut was found to activate JNK/MAP kinase and ATF2 transcription factor causing cellular changes leading to OSF.

D. DEVELOPMENTAL GENETICS

Skeletal muscles are formed by myoblast fusion and differentiation. A *Drosophila* transcriptional factor *ewg* was required for cell cycle arrest in myoblasts preceding fusion. *Drosophila* flight muscles and zebrafish trunk muscles were found to control expression of antimicrobial peptides during infection with bacteria. Some of the *Drosophila* subspecies have different traits. Cytoraces created from these showed evolutionary divergence in terms of life span and immunity to infection. Cytorace 9 had a tradeoff between lifespan and immunity to infection necessitating a careful molecular study of the cytoraces for mechanistic details of the tradeoff.

E. BACTERIAL GENETICS, DEVELOPMENT AND ADAPTATION

Two-component signaling systems (TCSs), composed of sensor kinases (SK) and response regulators (RR), allow bacterial cells to respond to external cues. Cross-talk between different SK and RR allows cells to integrate information from different SKs as well as generated diverse responses. A non-radioactive, *in vitro* Fluorescence resonance energy transfer (FRET) assay was developed to study interaction between different SK and RR modules. Many bacteria maintain cryptic operons which can be turned ON by mutations. The cryptic *chb* operon of *E. coli* needs



CORE RESEARCH

Human molecular genetics, cancer biology, developmental biology, reproductive biology, stem cell biology, cell signaling, aging and senescence, immunity, and bacteriology.

two mutation events to allow utilisation of plant derived nutrient chitooligosaccharides while a single mutation turns ON the same operon in related bacterium *Shigella sonnei*. The diversity of transposable elements in the strain backgrounds results in evolution of novel metabolic functions. Many pathogenic bacteria make pore forming toxins (PFT) such as clyA which forms multimeric, nanoscale pores in host cell membrane, causing leakage and cell death. The C terminal domain of clyA was shown to be important for stability of this PFT, by facilitating pore assembly through intermediary steps.

Faculty and Staff

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R M MEDHAMURTHY | PhD (Saskatchewan), Professor

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3.2.

Division of

CHEMISTRY SCIENCES

The faculty members of the Division work on all contemporary topics in chemistry, ranging from Chemical Synthesis, Drug Design, Chemical Biology, Materials Chemistry, Surface and interface Science, Nanochemistry, Molecular Spectroscopy, Ultrafast Chemical Dynamics, Computational and Theoretical Chemistry, Solid State Chemistry and Nuclear Magnetic Resonance spectroscopy.

DEPARTMENTS | CENTRES | UNITS

- ◆ INORGANIC AND PHYSICAL CHEMISTRY
- ◆ MATERIALS RESEARCH CENTRE
- ◆ NMR RESEARCH CENTRE
- ◆ ORGANIC CHEMISTRY
- ◆ SOLID STATE AND STRUCTURAL CHEMISTRY UNIT

IN NUMBERS

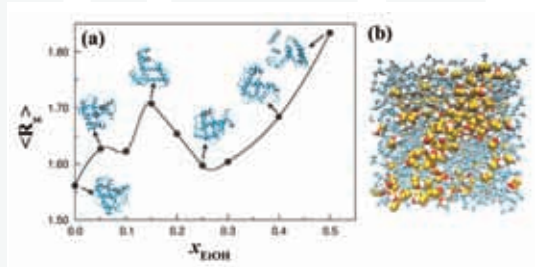
- ◆ 40 FACULTY MEMBERS
- ◆ 77 FELLOWSHIPS OF SCIENCE ACADEMIES IN INDIA
- ◆ 265 PhD STUDENTS
- ◆ 95 INTEGRATED PhD STUDENTS

THEMES

The Division of Chemical Sciences has consistently maintained its position among the top 50 chemistry departments in world rankings over the past decade. It is a globally competitive Division with clear focus on top quality research in specific current areas such as bio-inorganic chemistry and chemical biology of drugs with a particular aim on disease control and cure, ultrafast spectroscopy and dynamics of molecules towards.

Chairperson: PK DAS

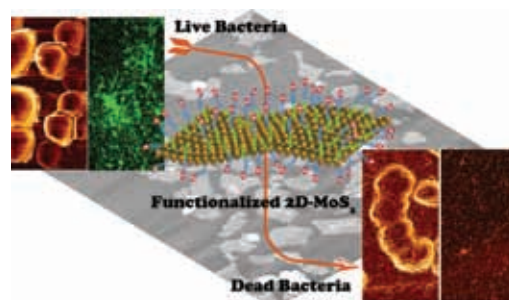
The image shows the anomalous non-monotonic composition dependence of physico-chemical properties of water-ethanol binary mixtures. This was investigated and explained for the first time in terms of a percolation transition at low concentration (Ghosh R and **Bagchi B.** Temperature Dependent Static and Dynamic Heterogeneities in Water-Ethanol Mixtures: Signatures of Enhanced, Short-Lived Density Fluctuations at Low Concentrations. *The Journal of Physical Chemistry B.* 2016. 120(49):12568).



Top: CAD models of gradient and homogeneously porous scaffolds; Middle: Printed scaffolds, shrinkage after sintering, and sintered scaffolds; Bottom: 3D printed femoral stem prototype, before and after sintering (Barui S, Chatterjee S, Mandal S, Kumar A and **Basu B.** Microstructure and Compression Properties of Ti-6Al-4V Scaffolds with Designed Porosity: Experimental and Computational Analysis. *Materials Science and Engineering C.* 2017. 70:812-823).

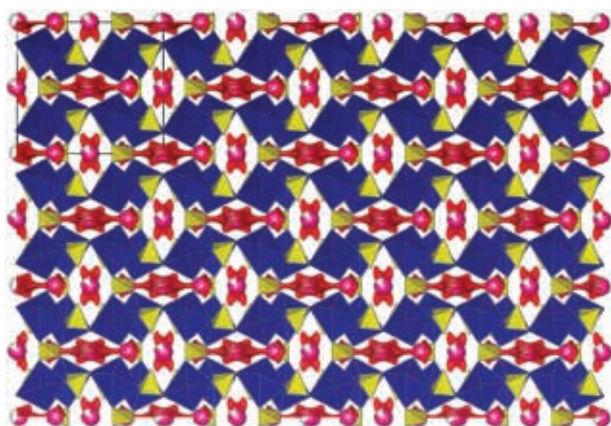
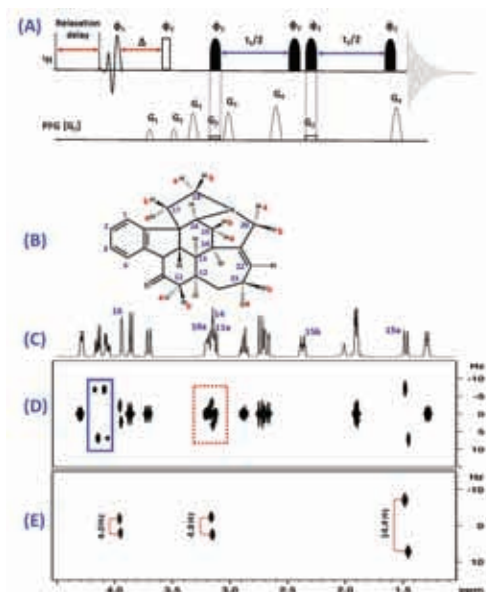


Functionalized two-dimensional MoS₂ has been developed as a potent antimicrobial agent against multi-drug-resistant bacteria. A comparison with widely used small molecules and other nanomaterial-based therapeutics conclusively establishes a better efficacy of modified 2D MoS₂ as a new class of antibiotics (Pandit S, Karunakaran S, Boda SK, Basu B and **De M.** High Antibacterial Activity of Functionalized Chemically Exfoliated MoS₂. *ACS Applied Materials & Interfaces.* 2016. 8(46):31567-31573).

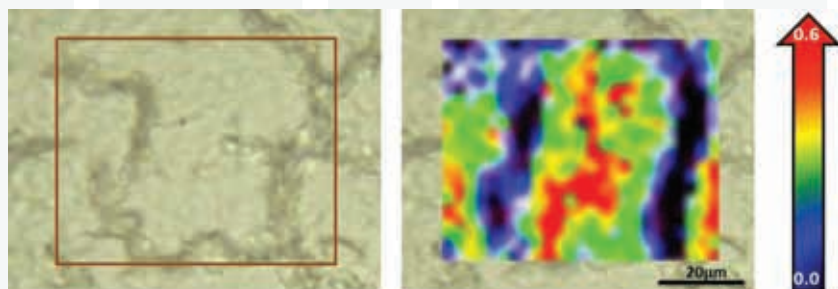


RESEARCH SNAPSHOTS 2016

Clean G-SERF, the novel pulse sequence designed for accurate determination of scalar coupling strengths from a complex proton NMR spectrum, in an orchestrated manner, with complete eradication of axial peaks and false couplings (Mishra SK, Lokesh N and **Suryaprakash N**. Clean G-SERF an NMR Experiment for the Complete Eradication of Axial Peaks and Undesired Couplings from the Complex Spectrum. *RSC Advances*. 2017. 7:735-741).

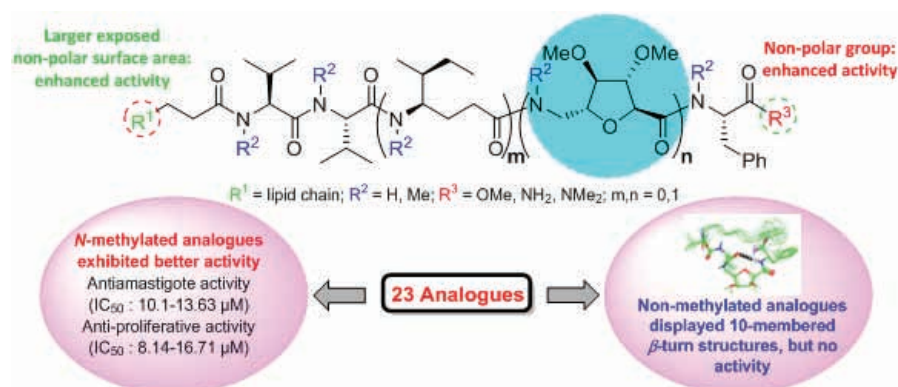
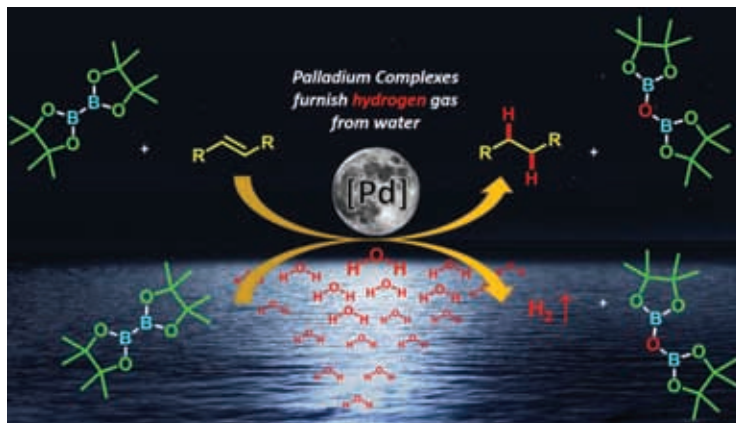


The molecular structure of the newly synthesised $\text{Na}_{2.32}\text{Co}_{1.84}(\text{SO}_4)_3$ allows the movement of sodium ions, making it a good battery cathode (Dwivedi D, Gond R, Dayamani A, Araujo RB, Chakraborty S, Ahuja R and **Barpanda P**. $\text{Na}_{2.32}\text{Co}_{1.84}(\text{SO}_4)_3$ as a New Member of the Alluaudite Family of High-Voltage Sodium Battery Cathodes. *Dalton Transactions*. 2017. 46:55-63).



Raman Image of a spleen tissue depicting the distribution of protein to lipid ratio (**S Umopathy**, unpublished work)

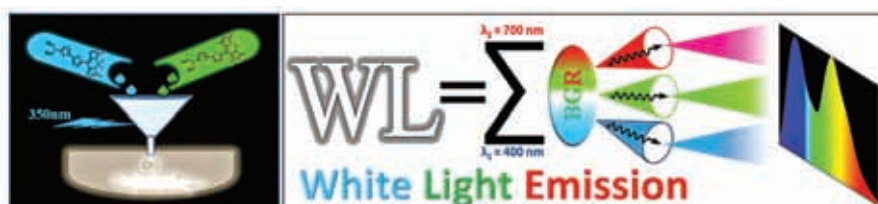
Generation of hydrogen from water:
 A Pd-catalyzed reduction of water using a diboron reagent at ambient conditions (Ojha DP, Gadde K and Prabhu KR. Generation of Hydrogen from Water: A Pd-Catalyzed Reduction of Water Using Diboron Reagent at Ambient Conditions. *Organic Letters*. 2016. 18(19):5062–5065).



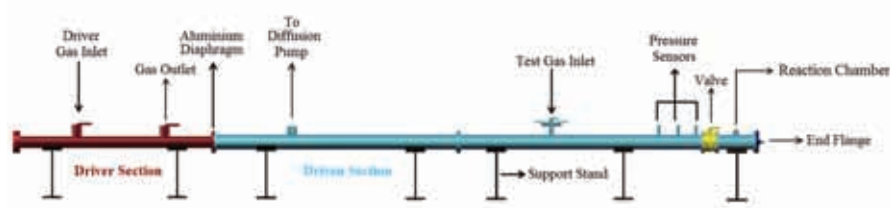
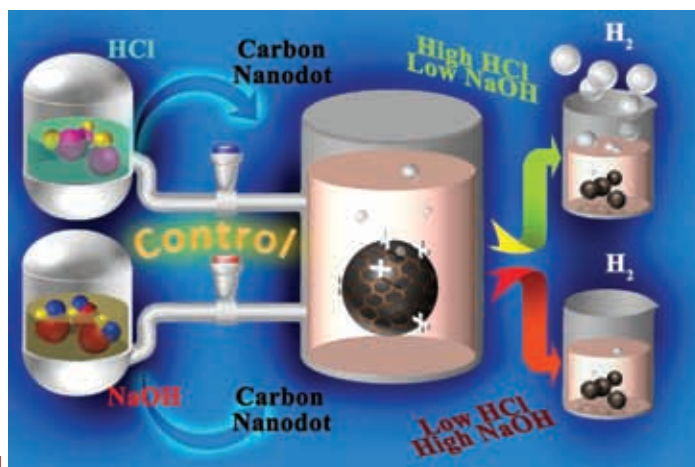
Antileishmanial activities of a library of sugar amino acid based almiramide analogues have been examined with the aim to identify potential lead molecules to develop new drug candidates to treat visceral leishmaniasis (Chakrabarti TK, unpublished work).



Two fluorescent compounds with similar absorption profiles and complementary luminescent colours can be regarded as the ideal couple for the generation of white-light. With this idea, molecular siblings 2 and 3 with analogous absorption spectra and complementary luminescence features have been engineered (Sarkar SK, Kumar GR and Thilagar P. White Light Emissive Molecular Siblings. *Chemical Communications*. 2016. 52:4175–4178).



Positively charged functionalized carbon nanodots for the generation of hydrogen via hydrolysis of sodium borohydride and the effect of H^+ and OH^- for the on/off control over the production (Santra S, Das D, Das NS and **Nanda KK**. An efficient on-board metal-free nanocatalyst for controlled room temperature hydrogen production. *Chemical Science*. 2017. Advance article).



The reaction between carbon atoms and molecular hydrogen has been investigated using a home-built material shock tube. This appears to be the first report on the formation of hydrocarbons following the big bang (Etim EE and **Arunan E**. Interstellar isomeric species: Energy, stability and abundance relationship. *Eur. Phys. J. Plus*. 2016. 131:448).



RESEARCH HIGHLIGHTS

The Division of Chemical Sciences comprises the Department of Inorganic and Physical Chemistry, Department of Organic Chemistry, Solid State & Structural Chemistry Unit, Materials Research Centre and NMR Research Centre.

Established more than a century ago in 1909, when the Institute was founded, the Inorganic and Physical Chemistry Department (IPC) has specialized in both fundamental and applied research. In particular molecular spectroscopy, chemical dynamics, analytical and computational theory, electrochemistry, polymer chemistry, transition metal and non-metal chemistry, bioinorganic and biophysical chemistry and functional materials are the research areas, at present, pursued in the department.

Current Research

In the area of inorganic chemistry, significant contributions have been made on several important topics. For example, work has been done on urea functionalized cage compounds and organic cages. Bacteria are known to use the enzyme phosphotriesterase (PTE) to break down nerve agents such as paraoxon, patathion and malathion. Vacancy-engineered nanoceria (VE CeO₂ NPs) as PTE mimetic hotspots for the rapid degradation of nerve agents have been developed in the department.

In addition, curcumin-based metal complexes as photo-chemotherapeutic agents were designed and synthesized

to selectively target the mitochondria or endoplasmic reticulum (ER), as desired by the oncologists, instead of the nuclear DNA to avoid nuclear excision mechanism to be operative.

Electron rich half-sandwich complex of ruthenium with an aromatic ring system linked to a potential NHC ligand has been synthesized. A comparison of the structure and reactivity of the tethered complex and the corresponding untethered complex was carried out and interesting reactivity changes were observed in the tethered complex.

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EMAIL **office@ipc.iisc.ernet.in**

URL **http://ipc.iisc.ac.in/**

DEGREE PROGRAMS OFFERED **PhD and Int. PhD**

IN NUMBERS

19 ACADEMIC AND **3** SCIENTIFIC STAFF

106 PhD STUDENTS

29 INT PhD STUDENTS

6 INT PhD CONFERMENTS

8 PhD CONFERMENTS

97 PUBLICATIONS

Chairperson: **S UMAPATHY**

3.2.1

INORGANIC AND PHYSICAL CHEMISTRY

The department also made significant advances in the area of physical chemistry. For example the electrochemically deposited amorphous Co-phosphate, Co-acetate, Mn-phosphate and Ir-phosphate are shown to exhibit high electro catalytic activity towards oxygen evolution reaction (OER). Similarly, electro deposited Ni-Co-S acts as an excellent HER catalyst in neutral electrolytes.

Hydrogen-bond, though ubiquitous, is still not fully understood. The intensity variation of spectral bands as a function of H-bond strength has been explored. Results suggest that overtones might be enhanced instead of being suppressed for medium and strong H-bonds.

Chemistry of metal nanoparticle surfaces has been explored in recent years. It was found that gold nanoparticles (GNP) can adsorb proteins on the surface and a modified Langmuir adsorption isotherm was employed to extract the binding constant, free energy change and the number of protein molecules adsorbed on the gold nanoparticle surface. Femtosecond two-pulse correlation spectroscopy, temperature programmed desorption spectroscopy and density functional theory calculations have been employed to elucidate the mechanisms and the ultrafast dynamics of carbon monoxide oxidation reaction on palladium nanoparticle surfaces have been investigated.

Polymer synthesis is another active area of research in the department. Chain folding of periodically grafted amphiphilic graft copolymers bearing long hydrocarbon chains in the backbone and pendant PEG segments, leads to the

generation of sub-10 nm lamellar morphology, which had not been earlier possible with block copolymers. Fine-tuning the lamellar dimension by co-grafting with a mixture of PEG chains of different lengths has been demonstrated.

Charge transfer is the fundamental process in chemistry. Charge and heat conduction properties of single molecular or quantum junctions were explored. A theoretical formulation was developed to study such charge transfers in the limit of strong coupling to charge reservoirs. The induced life-time due to the reservoirs coupling was found to be an important parameter in pumping charges through the junction.

Solvent influences various physico-chemical and biological processes. Raman spectroscopic techniques in conjunction with full-atomistic classical molecular dynamics simulation and density functional theoretical studies have been utilized to comprehend the solvation at the molecular level.

Faculty and Staff

ARUNAN E | PhD (Kansas), FASc, Professor

ATANU BHATTACHARYA | PhD (Colorado), Assistant Professor

AR CHAKRAVARTY | PhD (Calcutta), FASc, FNA, Professor

BINNY J CHERAYIL | PhD (Chicago), Professor

PK DAS | PhD (Columbia), FASc, Professor

K GEETHARANI | PhD (Madras), Assistant Professor

UPENDRA HARBOLA | PhD (JNU), Assistant Professor

BALAJI R JAGIRDAR | PhD (Kansas), FASc, Professor

ED JEMMIS | PhD (Princeton), FASc, FNA, Professor

G MUGESH | PhD (IIT Bombay), FASc, FNASc, Professor

PARTHA SARATHI MUKHERJEE | PhD (Jadavpur), Associate Professor

N MUNICHANDRAIAH | PhD (IISc), Professor

The Materials Research Centre (MRC) was established in 1978 to foster interdisciplinary research in different areas of materials science and technology with an emphasis on electronic and functional materials. Recently the centre has diversified to biomaterials, multi scale simulation and properties of nano materials. "From basic science to device prototypes" is the slogan of the Centre.

Current Research

A. ENERGY HARVESTING MATERIALS

Faculty of the centre are involved in addressing the challenges associated with development of efficient energy harvesting materials using state-of-the-art density functional theory based methods. An extensive study is in progress to develop guidelines for designing high ZT thermoelectric materials and ambient condition efficient hydrogen and Li storage materials. Nanostructurization of transition metal silicides is carried out for high temperature thermoelectric applications.

B. 2D MATERIALS AND META MATERIALS

Faculty of the centre are working on 2D materials as they are considered as materials for next generation devices. In order to use 2D materials as building blocks in electronic, optical, and sensing applications, their electronic properties need to be modified. A focused effort aiming towards gaining the ability to modify the band gaps of these materials in a controlled and non-invasive way is currently underway. Meta-structure based on Vanadium oxide phase change materials for perfect absorbers at IR and microwave frequencies have been demonstrated.

FACT FILE

ESTABLISHED **1978**

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DEGREE PROGRAMS OFFERED **MSc (Engg), PhD and Int. PhD**

IN NUMBERS

7 ACADEMIC STAFF

51 PhD STUDENTS

5 INT PhD STUDENTS

1 INT PhD CONFERMENTS

10 PhD CONFERMENTS

5 PUBLICATIONS

Chairperson: **ARUN M UMARJI**

3.2.2

MATERIALS

RESEARCH CENTRE

C. WHITE LIGHT-EMITTING-DIODES FOR GREEN ENERGY

The LED project evolved for this initiative deals with “White” LEDs, typically blue LEDs working in conjunction with yttrium aluminum garnet (YAG) phosphor used for lighting applications. A commercial white LED produces 110 lm/W at an injection current of 700 mA, exemplifying the state-of-the-art in solid-state lighting. The work at MRC developed highly efficient white LEDs higher than commercially available LEDs in three phases over the past 6 years in collaboration with an industry.

D. BIOMATERIALS FOR ORTHOPEDIC AND DENTAL APPLICATIONS

One of the on-going projects at the centre of excellence on biomaterials for orthopedic and dental applications is related to the development of acetabular socket materials based on hybrid polymer-ceramic composite for Total Hip Joint Replacement and the deliverables of this specific project

hold promise for immediate commercialization for use as acetabular sockets in THR. The Zirconia-toughened Alumina (ZTA) based femoral ball head prototype will be developed using integrated manufacturing steps to obtain smoothly polished femoral ball heads with better strength, fracture toughness and wear resistance. Development of dental implants with Ti6Al4V-based dual ceramic coated abutment and screw implants are being developed.

E. NANOSTRUCTURED MATERIALS FOR ENERGY AND ENVIRONMENT APPLICATIONS

Faculty of our centre are involved in designing nanostructured based catalysts for water splitting, water purification and fuel cells. A few faculty members are associated with the development of materials for gas sensing applications at room temperature and infra-red and UV detection.

CORE RESEARCH

Semiconducting materials for blue LEDs, phosphors for white light applications, absorber for photovoltaic applications, infra-red and UV detection, gas sensing, biomaterials for orthopedic and dental applications, catalytic materials for water splitting, water purification energy harvesting and storage materials for thermoelectric, Li-ion/Na-ion battery, hydrogen storage, fuel cells, thermo electric and meta-materials are some of the research areas covered by MRC.

Faculty and Staff

PRABEER BARPANDA | PhD (Rutgers), Assistant Professor

BIKRAMJIT BASU | PhD (Kuleuven), Professor

KARUNA KAR NANDA | PhD (IOP), Associate Professor

N RAVISHANKAR | PhD (IISc), Professor

BALARAM SAHOO | PhD (Duisberg), Assistant Professor

ABISHEK K SINGH | PhD (Tohoku), Associate Professor

ARUN M UMARJI | PhD (IIT Madras), Professor

Associate Faculty

ASHOK M RAICHUR | PhD (Nevada), FRSC, Professor

NAVKANT BHAT | PhD (Stanford), Professor

V VENKARARAMAN | PhD (Princeton), Professor

Emeritus Professor

G ANANTHAKRISHNA | PhD (Texas), INSA Senior Scientist

The NMR Research Centre began with the installation of the first superconducting magnet based high field NMR spectrometer in the year 1977. Today the Centre has grown to be a nodal centre for research in the area of magnetic resonance in the country and has retained its leadership in the areas of spectral service, in-house research and developmental work. The Centre at present has eight NMR spectrometers under one roof, a unique national distinction. The spectrometers cover a range of frequencies from 400 MHz to 800 MHz and have different capabilities. The Centre has been at the forefront of research in the area of magnetic resonance and has been leading the country in this area.

Current Research

- A number of novel NMR methods have been designed for structural and dynamic studies of a variety of biological systems that include large proteins, intrinsically disordered proteins, and metabolites in body fluids, nucleic acids and drug molecules.
- A very important area has been the development of new methods for metabolomics and their application for elucidating key biomarkers in detecting cancer cells and for in-vitro fertility for selecting healthy embryos for transfer.
- Novel NMR methods for fast data acquisition, providing orders of magnitude gain in measurement time.
- Numerous examples of hydrogen bond involving fluorine containing organic molecules have been investigated. Unambiguous evidence for the engagement of CF₃ group in N-H...F-C hydrogen bond in a low polarity solvent, a rare observation and the first of its kind has been discovered.
- Novel bio-nanoconjugates have been developed and studied that have potential applications in drug delivery and anti-microbial activity.

FACT FILE

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URL **http://nrc.iisc.ernet.in**

IN NUMBERS

2 ACADEMIC AND **1** SCIENTIFIC STAFF]

12 PUBLICATIONS

Chairperson: **S VASUDEVAN**

3.2.3

NMR RESEARCH CENTRE

Faculty and Staff

HANUDATTA S ATREYA | PhD (Bombay), Associate Professor

N SURYAPRAKASH | PhD (Bangalore), FNASc, Professor

Associate Faculty

BALAJI R JAGIRDAR | PhD (Kansas State), Professor

JAYANTHA CHATTERJEE | PhD (Munich), Assistant Professor

MAHAVIR SINGH | PhD (Munich), Assistant Professor

KP RAMESH | PhD (Bangalore), Associate Professor

SIDDHARTHA SARMA | PhD (Maryland), Professor

S VASUDEVAN | PhD (IIT Kanpur), Professor

CORE RESEARCH

Research interests of the faculty at the Centre are in the following areas: Development of techniques and applications to liquids, solids and mesophases, multi-dimensional and multiple-quantum spectroscopy; application of NMR techniques to biological systems such as peptides, proteins and model membranes to study their conformations and obtain 3 dimensional structures, high resolution solid state NMR techniques and applications, development of pulsed NQR spectroscopy in one and two dimensions, NMR imaging and NMR quantum computing etc., are areas of research systems studied include oriented samples, various liquid crystalline phases and biological macromolecules such as peptides and proteins.

The Department of Organic Chemistry (OC) is one of the oldest, started in the year 1911. Currently the department has ten faculty members, one honorary professor, about 85 PhD students, project assistants and research associates. Research in the Department covers contemporary organic chemistry, interfacial subjects and publishes ~60 papers per year.

Current Research

ASYMMETRIC CATALYSIS

Enantioselective synthesis of (i) quinone-Diels-Alder adducts through organocatalytic alkylation using nitroalkanes and (ii) cyclic α -aminophosphonates through dearomatization using chiral anion-binding catalysis are accomplished.

TOTAL SYNTHESIS

Syntheses of (i) C₂-symmetric bis-sulfinamides and their use in rhodium (I) catalyzed asymmetric conjugate additions; (ii) decanolactone achaetolide, (-)-, (+)-lasubines, and piperidine alkaloid (+)-241-D are accomplished.

PEPTIDOMIMICS

Synthesis of (i) peptidomimics with imidate and thioimide functional groups; (ii) high throughput molecular sensors and (iii) self-assembled helical peptides are accomplished.

PHYSICAL ORGANIC CHEMISTRY

A study on anomeric effect in furanose systems is conducted and novel aspects of molecular chirality and asymmetric synthesis are pursued.

FACT FILE

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URL <http://orgchem.iisc.ernet.in>

DEGREE PROGRAMS OFFERED PhD and Int. PhD

IN NUMBERS

9 ACADEMIC STAFF

46 PhD STUDENTS

10 INT PhD STUDENTS

3 INT PhD CONFERMENTS

10 PhD CONFERMENTS

124 PUBLICATIONS

Chairperson: N JAYARAMAN

3.2.4

ORGANIC CHEMISTRY

SYNTHETIC METHODOLOGIES

Strategies involving metallic, non-metallic, organometallic and organocatalysts to prepare biologically active compounds under benign conditions using C-H activation and Cross Dehydrogenative Coupling strategies are developed.

CHEMO- AND BIOSENSORS

A paper-based assay for important enzymes has been developed. A lanthanide based hydrogel containing a pro-sensitizer, releasing sensitizer by an enzyme, and turn-on the emission, is developed.

2-D MATERIALS

Evaluating the potential of two-dimensional chemically exfoliated MoS₂ (ce-MoS₂) toward bactericidal activity, mechanism of oxidative stress, leading to a new class of antibiotics, are accomplished.

CHEMICAL BIOLOGY

G-quadruplex structures within the human ACC1 gene promoter region, whose activity is suppressed by stabilizing ligands, thereby revealing a novel regulatory mechanism and as a possible therapeutic target, are established.

SUGAR AMINO ACIDS

Effect of glycosylation on small ring homooligomers derived from sugar amino acids (SAA) and asymmetric total synthesis of naturally occurring resorcylic acid lactones (RALs) are accomplished.

CARBOHYDRATES AND DENDRIMERS

Glycosidic-bond expanded cyclic oligosaccharides possess binding affinities to drugs significantly higher than natural analogues. Dendron-appended poly (diacetylenes) exhibit reversible chromism up to 300°C; dendromesogens show a modulated smectic A phase.

SYNTHETIC METHODS

A general method for the geminal diamination, aminoxygenation of vinylarenes using hypervalent iodine reagent, and new m-CPBA mediated aminoxygenation are accomplished.

CORE RESEARCH

The accomplishments cover areas including design, synthesis, characterization and analyses of physical and biological properties. Core areas are in: Organic Synthesis, Molecular Design, Physical Organic Chemistry, Chemistry of New Materials, Bioorganic Chemistry/Chemical Biology, Methodology Development and Asymmetric Catalysis.

Faculty and Staff

TUSHAR KANTI CHAKRABORTY | PhD (IIT Kanpur), FNA, FASc, FNASc, Professor

SOSALE CHANDRASEKHAR | PhD (London), Professor

MRINMOY DE | PhD (Massachusetts), Assistant Professor

N JAYARAMAN | PhD (IIT Kanpur), FASc, Professor

UDAY MAITRA | PhD (Columbia), FASc, FNA, Professor

SANTANU MUKHERJEE | PhD (Cologne), Assistant Professor

EN PRABHAKARAN | PhD (IIT Kanpur), Associate Professor

KR PRABHU | PhD (IISc), Associate Professor

KAVIRAYANI R PRASAD | PhD (Pune), Professor

Associate Faculty

TN GURU ROW | PhD (IISc), Professor



The Solid State and Structural Chemistry Unit (SSCU) was founded in 1976 by Bharat Ratna Professor CNR Rao. The unit has provided major thrust to frontier areas of chemistry. Besides developing its own research and teaching programs, unit members interact closely with other departments of the institute. The unit is a premier research centre of global repute in the areas of solid state and physical chemistry. Our faculty and students work on interdisciplinary research topics at the intersection of physics, chemistry and materials science.

Current Research

Experimental and theoretical research pursued in the unit aims to understand diverse phenomena associated with solids and condensed phases as well as liquids at a fundamental level. Apart from fundamental research, there is also significant emphasis on research activities aimed at development of prototypes for commercialization. Some ongoing cutting-edge research areas pursued in the Unit are as follows:

- Synthesis, structure, electronic and magnetic properties of oxides
- X-ray diffraction and charge density analysis
- Organic solid state and crystal engineering
- Synthesis, structure and electronics properties of molecular semiconductor
- Open framework solids
- Materials electrochemistry for renewable energy
- Theory of organic non-linear optical materials, molecular magnets
- Chemical reaction dynamics
- Statistical mechanics of condensed matter and biological systems
- Classical and quantum simulations
- Diffusion in porous solids

FACT FILE

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DEGREE PROGRAMS OFFERED **PhD and Int. PhD**

IN NUMBERS

11 ACADEMIC AND **6** SCIENTIFIC STAFF

62 PhD STUDENTS

13 INT PhD STUDENTS

5 INT PhD CONFERMENTS

6 PhD CONFERMENTS

98 PUBLICATIONS

Chairperson: **S YASHONATH**

3.2.5

SOLID STATE

AND STRUCTURAL CHEMISTRY UNIT

Faculty and Staff

BIMAN BAGCHI | PhD (Brown), FASc, FNASc, FNA, FTWAS, Professor

ANINDA J BHATTACHARYYA | PhD (Jadavpur), Associate Professor

GAUTAM R DESIRAJU | PhD (Illinois), FASc, FNASc, FNA, FTWAS, Professor

A GOVINDARAJ | PhD (Mysore), Principal Research Scientist

V JAYARAM | PhD (IISc), Principal Research Scientist

KR KANNAN | MSc (Engg) (IISc), Senior Scientific Officer

S NATARAJAN | PhD (IIT Madras), FASc, FNASc, Professor

NAGA PHANI B AETUKURI | PhD (Stanford), Assistant Professor

ANSHU PANDEY | PhD (Chicago), Assistant Professor

SATISH A PATIL | PhD (Wuppertal), Associate Professor

GOVARDHAN REDDY | PhD (Wisconsin), Assistant Professor

TN GURU ROW | PhD (IISc), FASc, FNA, FRSC, Professor

DD SARMA | PhD (IISc), FASc, FNASc, FNA, FTWAS, Professor

R SATHISHKUMAR | MTech (Madras), Scientific Officer

C SHIVAKUMARA | PhD (IISc), Senior Scientific Officer

NY VASANTHACHARYA | PhD (IISc), Senior Scientific Officer

S YASHONATH | PhD (IISc), FASc, FNA, Professor

CORE RESEARCH

The unit has the following thrust areas of research:

- Materials for Energy Generation and Storage
- Statistical Mechanics
- Quantum Chemistry and Electronic Structure
- Spectroscopy
- Crystallography and Structural Chemistry
- Chemistry and Physics of Organic and Inorganic Materials

Associate Faculty

GIRIDHAR MADRAS | PhD (Texas A&M), Professor

S VASUDEVAN | PhD (IIT Kanpur), Professor

HANUDATTA S ATREYA | PhD (Bombay), Associate Professor

N SURYAPRAKASH | PhD (Bangalore), FNASc, Professor

Honorary and Emeritus Professors

AK SHUKLA | PhD (IIT Kanpur), FASc, FNAE, FNASc, FNA, UGCBSR Faculty, Honorary Professor

S RAMASESHA | PhD (IIT Kanpur), FASc, FNA, FTWAS, Honorary Professor

MS HEGDE | PhD (IIT Kanpur), FASc, CSIR Emeritus Scientist, Emeritus Professor

KJ RAO | PhD (IIT Kanpur), FASc, FNASc, FNA, FWIF, Emeritus Professor





3.3.

Division of

ELECT SCIENCES

Even while working on high impact artefacts, The Division is assiduously seeking fundamental advances in the following core areas: Signal Processing, Communications, Networks, Microelectronics and Devices, Photonics, Theoretical Computer Science, Computer Systems and Software, Artificial Intelligence and Machine Learning, Control and Optimization, Power Systems, Power Electronics and High Voltage Engineering.

DEPARTMENTS | CENTRES | UNITS

- ◆ COMPUTER SCIENCE AND AUTOMATION
- ◆ ELECTRICAL COMMUNICATION ENGINEERING
- ◆ ELECTRICAL ENGINEERING
- ◆ ELECTRONIC SYSTEMS ENGINEERING

IN NUMBERS

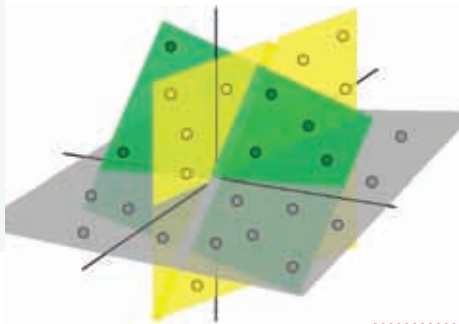
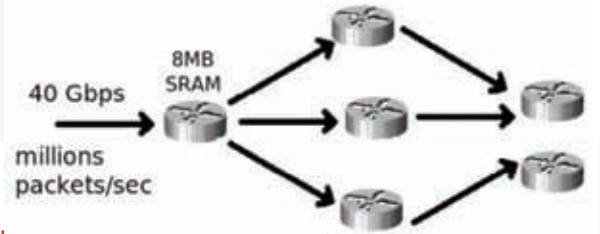
- ◆ **77** ACADEMIC AND **19** SCIENTIFIC STAFF
- ◆ **35** FELLOWSHIPS OF SCIENCE AND ENGINEERING ACADEMIES IN INDIA
- ◆ **387** PhD STUDENTS
- ◆ **444** MASTER'S STUDENTS

THEMES

A feature of the Division's R&D activities is its focus on rigorous innovation in contemporary, interdisciplinary themes: Cyber Physical Systems, Big Data Analytics, 5G Technologies, Devices for Healthcare, Electronics for Strategic Sector, Network Science, Cybersecurity, Neuromorphic computing, Image and Video Processing, and Smart Grids.

Chairperson: **Y NARAHARI**

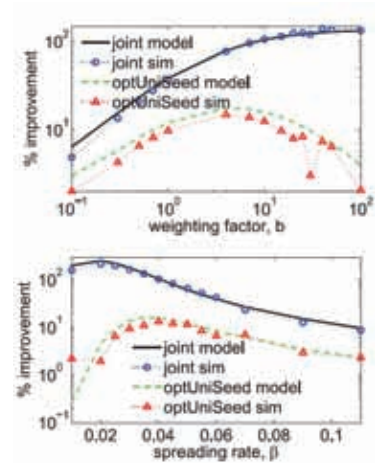
An algorithm to find the most frequent items in a data stream will have only a single pass since the huge amounts of data cannot be stored. With goal of minimizing the space used in such a computation, a new algorithm has been developed (**Bhattacharyya A**, Dey P and Woodruff DP. An Optimal Algorithm for ℓ_1 -Heavy Hitters in Insertion Streams and Related Problems. *Proceedings of the 35th ACM SIGMOD-SIGACT-SIGAI Symposium on Principles of Database Systems (PODS '16)*. 2016. 385-400).



In many applications, such as machine learning, it is useful to partition a hypergraph—find strongly connected groups of nodes with sparse connections between groups. An error bound for a hypergraph partitioning algorithm has been derived using statistical analysis (Ghoshdastidar D and **Dukkipati A**. Consistency of Spectral Hypergraph Partitioning under Planted Partition Model. *Annals of Statistics*. 2017. 45(1):289-315).

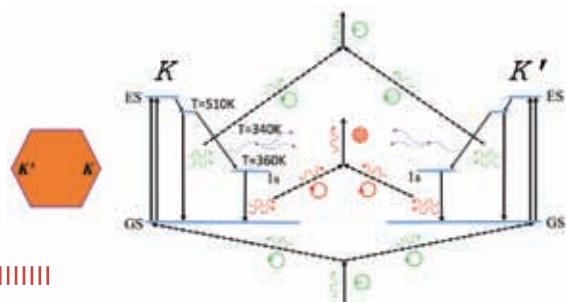


To spread information in a social network that has nodes of various degrees, it is better to allocate campaign resources using an optimal control method rather than use other strategies such as allocating resources uniformly throughout the campaign period, or doing so only during initial periods of the campaign (Kandhway K and **Kuri J**. Optimal Resource Allocation Over Time and Degree Classes for Maximizing Information Dissemination in Social Networks. *IEEE/ACM Transactions on Networking*. 2016. 24(5):3204-3217).



RESEARCH SNAPSHOTS 2016

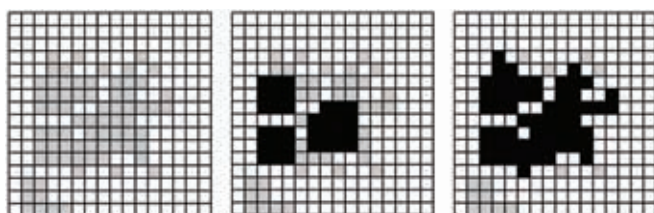
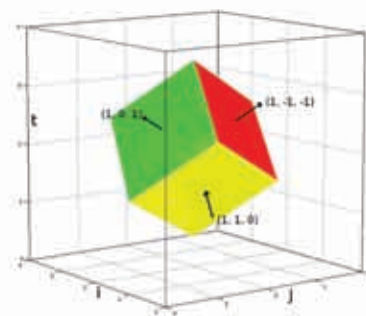
Room temperature valley coherence established using off-resonant excitation in monolayer transition metal dichalcogenides. Hot photoluminescence and Raman probe reveal energy relaxation pathways for photoexcited valley-coherent hot carriers (Kallatt S, Umesh G and **Majumdar K**. Valley-Coherent Hot Carriers and Thermal Relaxation in Monolayer Transition Metal Dichalcogenides. *Journal of Physical Chemical Letters*. 2016. 7(11):2032–2038).



Recording articulatory movements during speech production using electromagnetic articulograph involves placing several sensors on lips, jaw, tongue, and velum in the midsagittal plane, which can reconstruct the vocal tract shape with an average error of 2-3 mm (Afshan A and **Ghosh PK**. Improved Subject-Independent Acoustic-to-Articulatory Inversion. *Speech Communication*. 2015. 66:1-16).

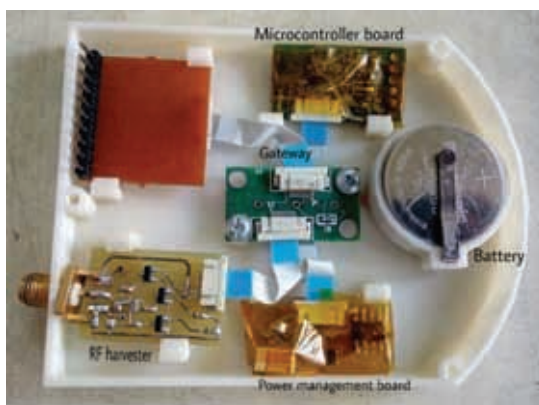
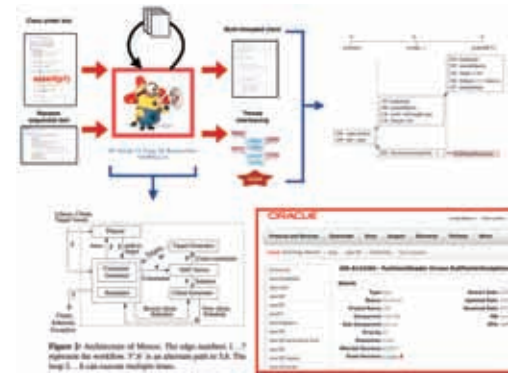


Tiling of iterations is used for parallel execution of loops in stencil computing, but existing methods for tiling can be inefficient. A better method is to use tiles of “diamond” shape, and an algorithm to find such tiles has now been developed (**Bondhugula U**, Bandishti V and Pananilath I. Diamond Tiling: Tiling Techniques to Maximize Parallelism for Stencil Computations. *IEEE Transactions on Parallel and Distributed Systems*. 2016. 99:1-16).



In magnetic media, artifacts that occur due to thermal asperities and media defects can lead to data erasures. Locating such erasures and recovering the data from these regions is necessary for reliable storage. A new model to study such defects and identify burst erasures has been developed, having greater than 90% accuracy (Matcha CK and **Srinivasa SG**. Defect Detection and Burst Erasure Correction for TDMR. *IEEE Transactions on Magnetics*. 2016. 52(11)).

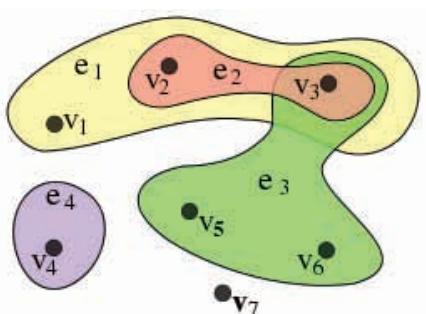
A dynamic program analysis framework to automatically generate crashes in concurrent software libraries (Samak M, Tripp O and **Ramanathan MK**. Directed synthesis of failing concurrent executions. *Proceedings of the 2016 ACM SIGPLAN International Conference on Object-Oriented Programming, Systems, Languages, and Applications*. Pages 430-446).



A battery-cum-harvested energy platform for guaranteed sensing and life time extension of sensor nodes. The novelty lies in the power management board. This modular design permits one or several harvesting sources that can be interfaced. The system is expected to work for at least 10 years (**Prabhakar TV**, Boeing ANRC project 2016).

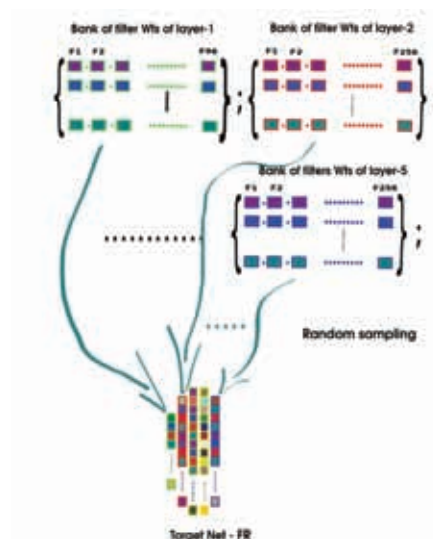


Demonstration of the feasibility of sparse signal recovery based wireless channel estimation. The experiment shows that by exploiting the inherent sparsity of wireless channels in the lag domain, one can reduce the pilot density (number of symbols used for channel estimation) by a factor of four and yet obtain the same performance as conventional channel estimation algorithms. This demonstration was presented by the lab of **CM Murthy** at the 9th International Conference on COMMunication Systems & NETworkS (COMSNETS, January 2017).



Separating any pair of disjoint edges of a hypergraph using a hyperplane normal to one of the axes may require embedding the vertices of the hypergraph in a higher-dimensional space. The smallest such dimension where this is possible is the separation dimension of the hypergraph. This study shows that the separation dimension of a hypergraph equals the boxicity of its line graph. (Basavaraju M, **Chandran LS**, Golumbic MC, Mathew R and Rajendraprasad D. Separation Dimension of Graphs and Hypergraphs. *Algorithmica*. 2016. 75:187-204).

Deep Neural Networks are among the most successful machine learning algorithms today. The figure represents a proposed method for efficient learning of deep Convolutional Neural Networks (CNNs) by reusing previously learnt filters. (Keerthi S, **Sastry PS** and Ramakrishnan KR. Bank of weight filters for deep CNNs. 8th Asian Conference on Machine learning (ACML2016), Hamilton, New Zealand, November 16 -18, 2016).



RESEARCH HIGHLIGHTS

The Division of Electrical Sciences comprises four Departments: Computer Science and Automation; Electrical Communication Engineering; Electrical Engineering; and Electronic Systems Engineering.

A feature of the Division's R&D activities is its forays into contemporary, inter-disciplinary, and nationally relevant themes including Cyberphysical Systems, Cybersecurity, Data Science, and Neurocomputing. The Division is also actively participating in Institute level programs on Smart Energy, Smart Water, Smart Cities, and Devices for Healthcare, and Electronics for the Strategic Sector.

Research activities of the department of Computer Science and Automation (CSA) can be classified broadly into three streams: Theoretical Computer Science, Computer Systems and Software and Intelligent Systems.

Current Research

GRAPH ALGORITHMS

The well-known and long standing Hadwiger conjecture was settled for a subclass of graphs. A novel Hypergraph partitioning method was proposed, with applications in community detection in social media networks.

ALGORITHMS AND COMPLEXITY

There have been several notable contributions in designing and characterising the inherent computational complexity of important problems. The first optimal algorithm for computing the list of most frequently occurring items in a data stream was obtained. A local search algorithm for

geometric set cover and dominating set of non-piercing objects was developed and analyzed. Algorithms for fair division were also designed and analyzed. Finally, various hardness of approximation results for problems in coding and learning theory, and improved lower bounds on the number of gates of arithmetic circuits that compute multilinear polynomials, were obtained.

INFORMATION SECURITY

In the important area of Information Security, novel non-malleable codes, or codes that cannot be distorted to other legitimate codes by an adversary, were exhibited. Several

FACT FILE

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DEGREE PROGRAMS OFFERED **PhD, MSc (Engg), ME (Computer Science and Engineering), ME (Systems Science and Automation) (Jointly with EE)**

IN NUMBERS

26 ACADEMIC, **1** SCIENTIFIC
AND **1** TECHNICAL STAFF

91 PhD, **59** ME, **35** MSc (ENGG), **12** MTech (RES)
AND **50** MTech STUDENTS

13 MSc (ENGG), **55** ME
AND **10** PhD CONFERMENTS

117 PUBLICATIONS

Chairperson: **JAYANT R HARITSA**

3.3.1

COMPUTER SCIENCE AND AUTOMATION

secure protocols for identity-based encryption and asynchronous networks were also constructed.

DATABASES

In the area of databases, a variety of techniques were designed to efficiently implement the Plan Bouquet approach to declarative query processing with robustness guarantees.

COMPILERS, HIGH-PERFORMANCE COMPUTING, AND ARCHITECTURE

New domain-specific compiler optimization techniques were developed to deliver high parallel performance for the domains of image processing pipelines, geometric multigrid for solving PDEs, and dense linear algebra computations. A new domain specific language, FALCON, for implementing graph based applications on GPUs and multi-core CPUs has been designed and implemented. Novel and scalable techniques were proposed for precise estimation of worst case execution time estimation of concurrent programs. Work was performed on memory system design for multi-core architectures, and on compiler and runtime systems for heterogeneous parallel architectures. A study was also performed to characterise the behaviour of GPGPU programs.

PROGRAM ANALYSIS AND SOFTWARE ENGINEERING

Research was carried out on concurrency analysis of multi-threaded event-driven programs, using machine learning techniques for software engineering. A novel technique was developed to automatically analyze and test web-applications. A new technique was developed to perform LTL property checking of counter systems. Research was conducted on targeted client synthesis for detecting various kinds of bugs.

OPERATING SYSTEMS AND NETWORKS

On operating systems, techniques were developed to improve the effectiveness of memory allocation affected by aspects such as RCupd, huge pages, and VM. A TDMA-based reliable multicast MAC protocol was developed for WSNs with flexibility to trade-off between latency and reliability, and weighted average-based improved clock synchronization protocols for wireless sensor networks.

VISUALIZATION

Integrated geometric and topological methods were developed to compute cavities in biomolecules, align molecular surfaces, and to compute voids and pockets in molecules. A topology based visual exploration framework was designed to analyse cold dark matter simulation data.

CORE RESEARCH

Theoretical Computer Science: Algorithms and Complexity Theory, Combinatorial and Computational Geometry, Cryptography, Distributed Computing, Game Theory, and Graph Theory.

Computer Systems and Software: Programming languages, Software engineering, High-performance computing, Compilers, Computer architecture, Operating Systems, Wireless network systems, Databases, Systems security, Scientific Visualization.

Intelligent Systems: Machine Learning; Reinforcement Learning; Game Theory; Mechanism Design; Stochastic Optimisation and Control Algorithms; Computational Biology; Data Analytics in Computer Systems.

INTELLIGENT SYSTEMS

Key research contributions include development of an axiomatic clustering framework for proving the existence of a clustering algorithm, stability and convergence analyses for stochastic approximation algorithms and feature adaptation in reinforcement learning.

Some important problems such as noisy non-negative matrix factorization and approximating packing semi-definite programs were also studied. In the world of Bayesian nonparametrics, an exact approach for generating a Poisson process was provided and its application in topic modeling was investigated. Novel algorithms for complex prediction problems were developed. Parallelization of popular pattern recognition algorithms on very large data sets was proposed.

In the context of applications such as crowdsourcing and Internet advertising, multi armed bandit (MAB) mechanisms have been developed. These mechanisms advance the state-of-the-art by embedding mechanism design into

online learning algorithms in order to take into account the strategic nature of the users. Use of semi-supervised learning for predicting private information in social networks was investigated. In the context of computational voting theory, several long-standing open questions on the complexity of well known voting problems were settled.

Online education has seen a rapid growth in recent times and is expected to transform the education scenario worldwide. There are many challenges facing online education today which include automatic grading of short answers and automatic fixing of common programming errors in programs written by students. Several novel techniques for these problems were developed. It is planned to make these techniques available on some national platforms.

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SANJIT CHATTERJEE | PhD (ISI Kolkata), Assistant Professor

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AMBEDKAR DUKKIPATI | PhD (IISc), Associate Professor

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KV RAGHAVAN | PhD (Wisconsin), Associate Professor
MURALI KRISHNA RAMANATHAN | PhD (Purdue), Assistant Professor
B UDAY KUMAR REDDY | PhD (Ohio State), Associate Professor
CHANDAN SAHA | PhD (IIT Kanpur), Assistant Professor
SHIRISH K SHEVADE | PhD (IISc), Associate Professor
YN SRIKANT | PhD (IISc), Professor
V SUSHEELA DEVI | PhD (IISc), Principal Research Scientist
MATTHEW JACOB THAZHUTHAVEETIL | PhD (Wisconsin), Professor

INSA Senior Scientist

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JAYANT R HARITSA | PhD (Wisconsin), FASc, FNASc, FNAE, FIEEE, Professor
PARTHA PRATIM TALUKDAR | PhD (Penn State), Assistant Professor

Adjunct Faculty

RAVI KANNAN | PhD (Cornell), FACM, Adjunct Professor
RAMESH HARIHARAN | PhD (Courant), FASc, FNAE, Adjunct Professor

Current Research

SIGNAL PROCESSING

Algorithms for audio processing and identification of raagas in Indian Classical music were developed. Human-Robot communication system design using microphone arrays was enhanced. Novel algorithms for sparse signal recovery using multiple measurement vectors were developed.

ELECTROMAGNETICS

In the areas of microwaves and antennas, finite element code has been developed for electromagnetic analysis. Also, an efficient scheme to power IoT devices using RF power transfer using an RFID reader has been developed. Further in this line of work, RF energy harvesting circuits to power CMOS chips from an incident RF power of -20dB has been developed. The department is also working on the design and characterization of CMOS based millimeter-

wave components for 60 GHz integrated broadband transceivers relevant to 5G communication systems. A low cost microwave phase shifter operating with electrostatic principles has been developed on a microwave laminate. A new algorithm developed for a stochastic finite element procedure for analyzing manufacturing uncertainties in millimeterwave systems. A novel eigen-based framework has been introduced to accelerate the solution of 3D full-wave Electric Field Integral Equation (EFIE)-based systems resulting in a significant speed-up of existing methods.

NANOELECTRONICS AND SEMICONDUCTOR DEVICES

Experimentation with novel devices using emerging material systems has been the focus of work which include electronics and optoelectronics of 2D materials, and ferroelectric gate MOSFET and ferroelectric tunnel junction memories.

FACT FILE

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DEGREE PROGRAMS OFFERED **PhD, MSc (Engg), ME (Communication & Networks), ME (Signal Processing) jointly with EE, ME (Microelectronics) jointly with ESE**

IN NUMBERS

22 ACADEMIC, **6** SCIENTIFIC AND **1** TECHNICAL STAFF

134 PhD, **48** ME, **16** MSc (ENGG), **5** MTech (RES) AND **25** MTech STUDENTS

2 MSc (ENGG), **30** ME AND **15** PhD CONFERMENTS

106 PUBLICATIONS

Chairperson: **KVS HARI**

3.3.2

ELECTRICAL COMMUNICATION ENGINEERING

INFORMATION THEORY

The feedback capacity of the general binary-input binary-output channel under a no-consecutive-ones input constraint has been determined. The capacity of the deterministic Z-interference channel with unidirectional cooperation between the transmitters and under secrecy constraints at the receivers has been determined. A feedback-capacity-achieving coding scheme for a general binary-input binary-output channel under a no-consecutive-ones input constraint has been devised. Several upper and lower bounds on the communication complexity of secret key generation within the multi-terminal source model have been developed.

EMBEDDED SYSTEMS, COMMUNICATIONS, AND SIGNAL PROCESSING

Wearable health sensor technologies are being developed for health care applications. Adaptive radio front-end near-threshold mixed signal SoC techniques are being researched and developed. Wireless water level indicators are being developed for smart connected systems. Simple distributed algorithms for computing a key component of centrality measures in networks. New results on distributed algorithms for forwarding packets in a wireless sensor networking by circumventing local minima and for base station association and power control have been developed and their performance studied.

PHOTONICS

Distance-aware adaptive modulation schemes for optical networks, In-service, out-of-band fiber fault monitoring

techniques for passive optical networks using 2-D wavelength/time optical code-division-multiplexing technique has been studied. The traditional method of OTDR method of monitoring optical links fails as there could be reflections from different branches overlapping in time, as a result branch specific faults cannot be identified without ambiguity using this method in PONs. To overcome this problem, we proposed a method where the branches can be monitored using unique pulse shapes, and branch specific fault isolation can be done even when two reflected pulses overlap, in case of single branch failures. This is a centralized, low cost time based measurement.

COMMUNICATIONS AND NETWORKING

Developed novel algorithms for spectrum sensing under a Bayesian framework and designed algorithms and analyzed performance of multiple antenna single-RF spatial modulation systems with finite-rate feedback. Analytical models leading to the design of efficient communication protocols for ad-hoc networks with high mobility has been investigated. Capacity analysis, distributed self-organisation, and algorithms for table-free forwarding in static or mobile ad hoc networks; mobile opportunistic networks, and social influence spread over such networks, and distributed event detection problems in wireless sensor networks have been studied. Developed algorithms to maximize influence in a network, which is useful in detecting the most influential part of a network which can be used to carry out dissemination or control diffusion of information processes over the network.

CORE RESEARCH

The Department (ECE) pursues research areas in all core areas relevant to electrical communication engineering: Communication theory, Communication networking, Signal processing, Photonics, Electromagnetics, and Nanoelectronic devices and VLSI.

Faculty and Staff

T BADRINARAYANA | PhD (IISc), Principal Research Scientist
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K ELIZABETH RANI | BTech (JNTU), Technical Officer
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SV GOPALAIAH | MSc (Engg) (IISc), Senior Scientific Officer
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DIPANJAN GOPE | PhD (Washington), Assistant Professor
KVS HARI | PhD (UC San Diego), FIEEE, FNAE, Professor
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HIMANSHU TYAGI | PhD (Maryland), Assistant Professor
NAVIN KASHYAP | PhD (Michigan), Professor
KAUSIK MAJUMDAR | PhD (IISc), Assistant Professor
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NEELESH B MEHTA | PhD (Caltech), FNASc, FNAE, Professor
UTPAL MUKHERJI | ScD (MIT), Associate Professor
CHANDRA R MURTHY | PhD (UC San Diego), Associate Professor
PARIMAL PARAG | PhD (Texas A&M), Assistant Professor
RAJAN, SUNDAR B | PhD (IIT Kanpur), FASc, FNAE, FNASc, FNA, FIEEE, Professor
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TALABATTULA SRINIVAS | PhD (IISc), Associate Professor
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VARUN RAGHUNATHAN | PhD (UCLA), Assistant Professor
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NAVAKANTA BHAT | PhD (Stanford), Professor

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Adjunct Faculty

KUMAR SIVARAJAN | PhD (CalTech), FNAE, Adjunct Professor



Current Research

POWER SYSTEMS

A novel approach for smooth transition between islanded and grid connected modes of a microgrid based on optimal control based bumpless switching and a pole placement based approach are proposed. Applicability of Adomian decomposition method to real-time simulations has been established for the first time. A numerical Adomian decomposition method has been adopted for large power system simulations which help in reducing the computational time. Indigenously developed real-time simulator mini-FSS has been tested on complex nonlinear models. A current controlled hardware interface is developed for the mini-FSS. New approach for implementation of topology control in smart grids is proposed. Due to the high penetration of distributed Generators (DG) power, traditional protection schemes fail to operate. An Improved protection scheme

has been proposed to detect Single line to ground fault in distribution line interconnected with DG source which is operating in current controlled mode. In the area of transmission line protection, behaviour of Distance relay characteristics on interconnected lines fed from Wind farms has been investigated.

POWER ELECTRONICS

Novel pulse width modulation (PWM) techniques were developed to reduce pulsating torque and acoustic noise in inverter fed induction motors. Novel control method has also been developed for switched reluctance motor drives. Computationally efficient, high-performance PWM techniques have also been developed for split-phase induction motor drives. Stability issues arising out of inverter

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DEGREE PROGRAMS OFFERED **PhD, MSc (Engg), ME (Electrical Engineering), ME (Systems Science & Automation) jointly with CSA, ME (Signal processing) jointly with ECE**

IN NUMBERS

20 ACADEMIC, **5** SCIENTIFIC AND **1** TECHNICAL STAFF

95 PhD, **60** ME, **28** MSc (ENGG), **5** MTech (RES) AND **29** MTech STUDENTS

4 MSc (ENGG), **16** ME AND **12** PhD CONFERMENTS

138 PUBLICATIONS

Chairperson: **A G RAMAKRISHNAN**

3.3.3

ELECTRICAL ENGINEERING

dead-time were studied in inverter fed induction motors. A small-signal model has been developed for induction motor drives, incorporating dead-time effect, to predict oscillatory behaviour by induction motor drives. Power converters need to meet EMI and ground current standards, which are important for performance and safety. The VDE standards for solar inverters require ground current to be less than 300mA. Methods have been developed that can realize ground current levels as low as 10mA. This is achieved by a combination of power converter circuit topology, LCL filter configuration, PWM method, and electromagnetic design. Research done on high performance PLLs show that it is possible to meet tight harmonic requirements, that reject DC offsets and is optimized to have the fastest response, while maintaining low complexity.

HIGH VOLTAGE ENGINEERING

Oxides of nitrogen present in biodiesel exhaust was cleaned utilizing the waste associated with marine industry and fossil fuel based thermal power plant. The oyster shells waste thrown across the coastal regions were tested successfully for their NO_x adsorption when the exhaust was pre-treated with electrical discharge plasma. Similarly, lignite ash waste from lignite coal was proved to be a better alternative

for commercial NO_x adsorbents while treating an exhaust coming through an electric plasma curtain.

A novel generalized analytical framework was developed to diagnose true radial and axial displacements in an actual single isolated air-cored transformer winding. Simple yet accurate and robust Galerkin's finite element method based scheme for the analysis of electromagnetic flowmeters and similar problems involving rectilinearly moving conductor has been developed. Current induced in one of the commonly employed experimental setup due to an isolated avalanche has been evaluated and it is shown that the avalanche current is different from the induced current. Further, physical dimensions of the circuit are shown to significantly modulate the induced current.

SIGNAL PROCESSING

The work in the area of signal processing is focused on the notion of risk minimization and developed new techniques for denoising speech signals and images within this new framework in various types of challenging noise conditions that are encountered in practice. New techniques are developed in the context of sparse signal processing and demonstrated applications to image super-resolution.

CORE RESEARCH

The research work of the Department of Electrical Engineering (EE) falls in two major fields, namely (1) Power and (2) Systems and Signal Processing. The area of Power includes Power Systems, Power Electronics, and High Voltage Engineering. The Systems and Signal Processing area includes Signal Processing, Speech and Audio, Image and Video Processing, Computer Vision, Multimedia, Machine Learning, and Pattern Recognition.

Considering biomedical imaging, new tools for solving the problems of segmentation and tracking have been developed. The development work includes new sampling schemes and associated reconstruction methodologies, as well as techniques for solving the phase retrieval problem with applications to optical imaging.

MACHINE LEARNING

Sufficient conditions are derived for risk minimization to be robust to label noise in training data for both 2-class and multi-class cases. For learning neural networks, the loss function based on mean absolute error is shown to be robust. The utility of these theoretical results are illustrated for learning deep networks for image/document classification. Deep convolutional neural nets (CNNs) are very effective in many image classification problems and they learn the needed feature representation of images. Interesting empirical investigations are carried out to show that the features learnt by CNNs are easily reusable across different image recognition tasks.

COMPUTER VISION

Matching across different domains/modalities is a very challenging problem in computer vision. It has several applications like image-text matching, NIR-visual facial image matching for surveillance applications, etc. This year, we developed several novel algorithms for addressing this problem. The algorithms, in addition to performing significantly better than the state-of-the-art, overcomes several limitations faced by previous approaches, like requiring paired training data, and not being discriminative for classification tasks. We also developed algorithms for

traffic surveillance applications, like licence plate detection, recognition, vehicles counting and classification. These have been tested on real traffic data collected from outside IISc.

IMAGE PROCESSING

New algorithms (and software) have been developed in the areas of non-linear image filtering, image restoration and rigid point-cloud registration.

ACOUSTICS AND SPEECH PROCESSING

A facility has been set up to record electroencephalogram (EEG) from humans and to recorded spikes, local field potential (LFP), electrocorticogram (ECoG) and EEG data from non-human primates (NHP). Signals from two NHPs have been successfully recorded. Signal processing techniques have been developed to study brain signals recorded from various electrode types in spectral domain. The learning and extraction of acoustic patterns (LEAP) for analyzing and understanding patterns in audio and speech data has been set up. Research in unsupervised feature representations for noise robust speech recognition lead to data driven methods for learning modulation filters of speech is underway. A novel deep network architectures were developed for keyword spotting tasks. Joint factor analysis methods were derived for modeling speaker and spoof variabilities in speech for speaker verification.

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Current Research

NANOELECTRONICS

We employed atomistic modeling techniques along with density functional theory and quantum transport model to understand carrier transport in 2D material interfaces, which is difficult to access by experiments. Two key findings are: (i) mechanism of the Schottky Barrier modulation in a graphene-inserted MoS₂-metal system and (ii) electronic properties of metallic to semiconducting phase-boundaries of monolayer MoS₂. In the experimental front we achieved lowest reported contact resistance in a CVD graphene-palladium interface system by orbital engineering.

NETWORKS

We have worked on information dissemination in social networks. Using epidemiological and mean field models, we have formulated and analyzed several optimal control problems related to incentivizing information dissemination, subject to different constraints. Our approach based on Pontryagin's Principle enables us to compute optimal control strategies for much larger networks than hitherto possible. We have proposed algorithms for fair and optimal mobile assisted offloading in cellular networks. As a part of this work, we proposed a message passing based algorithm for capacitated facility location problems. We have studied capacity of delay tolerant networks with Markovian arrivals. Here, we studied two-hop routing with spray and wait relaying and investigated throughput delay tradeoffs with respect to the "spray" parameter.

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DEGREE PROGRAMS OFFERED **PhD, MSc (Engg), MTech and ME**

IN NUMBERS

9 ACADEMIC AND **4** SCIENTIFIC STAFF

67 PhD, **1** ME, **3** MSc (ENGG), **67** MTech
AND **1** MTech (RES) STUDENTS

2 MSc (ENGG), **30** MTech, **9** ME AND
7 PhD CONFERMENTS

54 PUBLICATIONS

Chairperson: **JOY KURI**

3.3.4

ELECTRONIC SYSTEMS ENGINEERING

POWER ELECTRONICS

The research focussed on new multilevel inverter topologies and modulation schemes for induction motor drives using reduced number of semiconductor devices, higher number of voltage levels in the phase voltage, extended linear modulation operation, common mode eliminated operation, stacked inverter topologies with lower device voltage rating, multilevel dodecagonal space vector structure using single DC source. We have made significant progress in solar photovoltaic integration into the grid.

VLSI

We have developed an FPGA based coprocessor to accelerate classification task of Convolutional neural network (CNN). Coprocessor can be dynamically configured for any CNN architecture without resynthesizing or rerouting the hardware. Caching and prefetching of input features and filter weights have been implemented, using on-chip memory, to reduce off-chip memory bandwidth requirement. Coprocessor has been designed to keep computational throughput relatively consistent with change in size of input features

and filter kernels. The throughput remains almost consistent with change in size of input features and filter kernels.

SIGNAL AND INFORMATION PROCESSING

We worked on channels engineering for two dimensional magnetic recording (TDMR) including both foundational algorithmic work as well as conceiving circuits for the same. Two valuable patents were filed. We worked on quantum information processing, developed the quantum stochastic LDPC decoders and measurement based quantum communication algorithms. We also have a fundamental theory and algorithms for Turing self-organising maps with potential applications to brain models and circuits.

CORE RESEARCH

The core research areas pursued in the department include: Nanoelectronics and power semiconductor devices; Signal and quantum information processing; Communication Networks; Internet of Things and Embedded Systems; Very Large Scale Integration (VLSI); Power electronics Drives; Energy Harvesting; Mechatronics; Microengineering of diagnostic devices.

Faculty and Staff

HARESH DAGALE | MSc (Engg) (IISc), Principal Research Scientist

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JOY KURI | PhD (IISc), Professor

KURUVILLA VARGHESE | MTech (IISc), Principal Research Scientist

SANTANU MAHAPATRA | PhD (EPFL), Professor

GV MAHESH | MSc (Engg) (IISc), Principal Research Scientist

TV PRABHAKAR | PhD (TU Delft), Principal Research Scientist

SHAYAN GARANI SRINIVASA | PhD (Georgia Tech), Assistant Professor

CHANDRAMANI SINGH | PhD (IISc), Assistant Professor

MAYANK SRIVASTAVA | PhD (IIT Bombay), Assistant Professor

L UMANAND | PhD (IISc), Professor

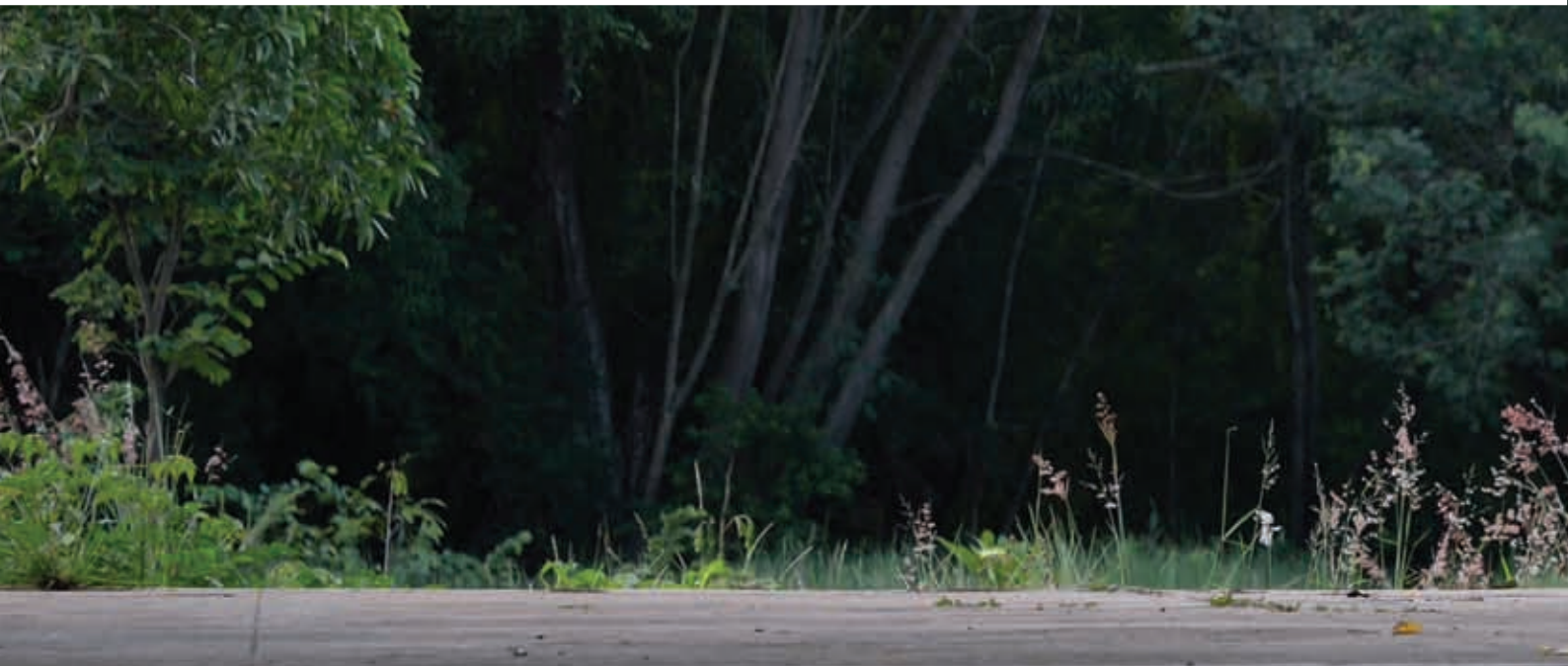
HARDIK J PANDYA | PhD (IIT Delhi), Assistant Professor

Associate Faculty

BHARADWAJ AMRUTUR | PhD (Stanford), FNAE, Professor

GAURAB BANERJEE | PhD (Washington), Assistant Professor

SK NANDY | PhD (IISc), Professor







3.4.

Division of

INTERDISCIPL RESEARCH

Interdisciplinarity is the characteristic feature of the research carried out in this Division. Specific research areas include Bioengineering, Urban infrastructure and transportation, Nanoscale materials, Nano devices and systems, Economics, Finance, Human resource management, Marketing, Optimization, Public policy, Energy, Water, Internet of things, Distributed sensing, Computer systems, Computational science, Data sciences and bioinformatics.

DEPARTMENTS | CENTRES | UNITS

- ◆ CENTRE FOR BIOSYSTEMS SCIENCE AND ENGINEERING
- ◆ CENTRE FOR CONTEMPORARY STUDIES
- ◆ CENTRE FOR INFRASTRUCTURE, SUSTAINABLE TRANSPORTATION AND URBAN PLANNING
- ◆ CENTRE FOR NANO SCIENCE AND ENGINEERING
- ◆ COMPUTATIONAL AND DATA SCIENCES
- ◆ MANAGEMENT STUDIES
- ◆ INTERDISCIPLINARY CENTRE FOR ENERGY RESEARCH
- ◆ INTERDISCIPLINARY CENTRE FOR WATER RESEARCH
- ◆ ROBERT BOSCH CENTRE FOR CYBER PHYSICAL SYSTEMS
- ◆ SUPERCOMPUTER EDUCATION AND RESEARCH CENTRE

IN NUMBERS

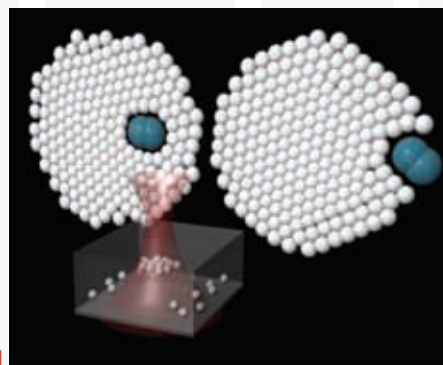
- ◆ **31** FACULTY MEMBERS
- ◆ **12** FELLOWSHIPS OF SCIENCE AND ENGINEERING ACADEMIES IN INDIA
- ◆ **301** PhD STUDENTS
- ◆ **95** MASTER'S STUDENTS GRADUATED IN 2015-16

THEMES

Interdisciplinary research has emerged as a crucial part of the research landscape in recent years. By breaking down departmental barriers, interdisciplinary research facilitates novel breakthroughs that may not be possible within the confines of a particular discipline. The Division of Interdisciplinary Research has a wide range of Departments/Centres with the common theme of a strong interdisciplinary focus.

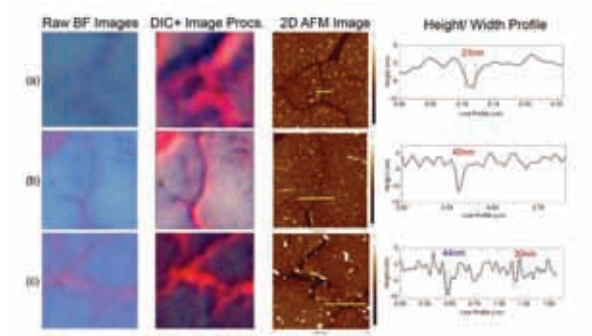
Chairperson: **G RANGARAJAN**

In order to make photonic crystals which are used to make a variety of optical devices, it is important to study how particles interact in a small system and give rise to new properties. This image shows fate of an intruder (impurity) governed by entropy (Kakoty H, Banerjee R, Dasgupta C and **Ghosh A**. Role of Entropy in the Expulsion of Dopants from Optically Trapped Colloidal Assemblies. *Physical Review Letters*. 2016, 117:258002).



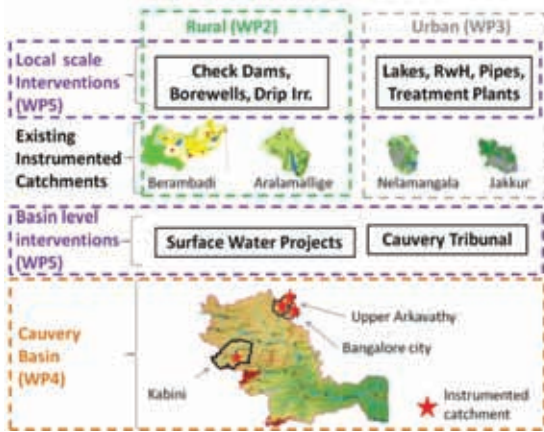
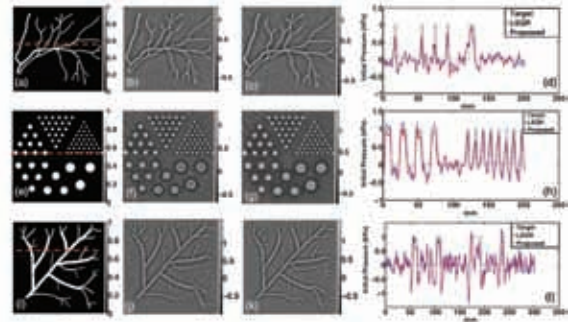
A wearable health-monitoring device for neonates developed at the Robert Bosch Centre for Cyber Physical Systems (RBCCPS) is helping in the prevention of neonatal deaths (Rao H, Saxena D, Kumar S, Sagar GV, **Amrutur B**, Mony P, Thankachan P, Shankar K, Rao S and Bhat S. Design of a Wearable Remote Neonatal Health Monitoring Device. *Biomedical Engineering Systems and Technologies*. 2016. 511:34-51).

A novel technique called bright-field nanoscopy was developed to visualize nanostructures down to a few nanometers using a conventional bright-field microscope without requiring additional molecular tags such as fluorophores. This technique will help image extremely small objects and may have future implications in biomedical tests, water purification, etc. (Suran S, Bharadwaj K, Raghavan S and **Varma MM**. Bright-field Nanoscopy: Visualizing Nano-structures with Localized Optical Contrast Using a Conventional Microscope. *Scientific Reports*. 2016. 6:25011).



RESEARCH SNAPSHOTS 2016

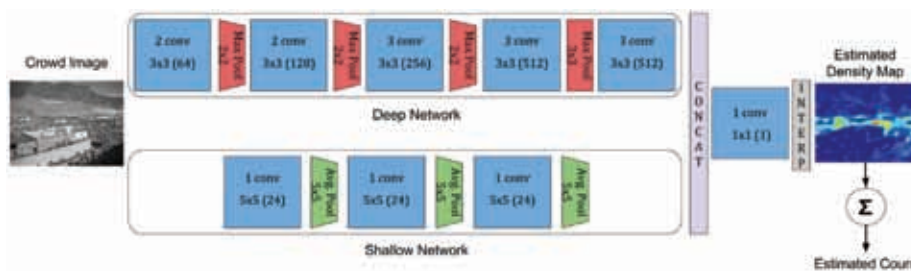
This photoacoustic tomography image combines near infrared light and ultrasound to image blood vessels. An error estimate method provides a 4.5X speed-up without compromising image quality [Bhatt M, Acharya A and **Yalavarthy PK**. Computationally Efficient Error Estimate for Evaluation of Regularization in Photoacoustic Tomography. *Journal of Biomedical Optics*. 2016. 21(10):106002].



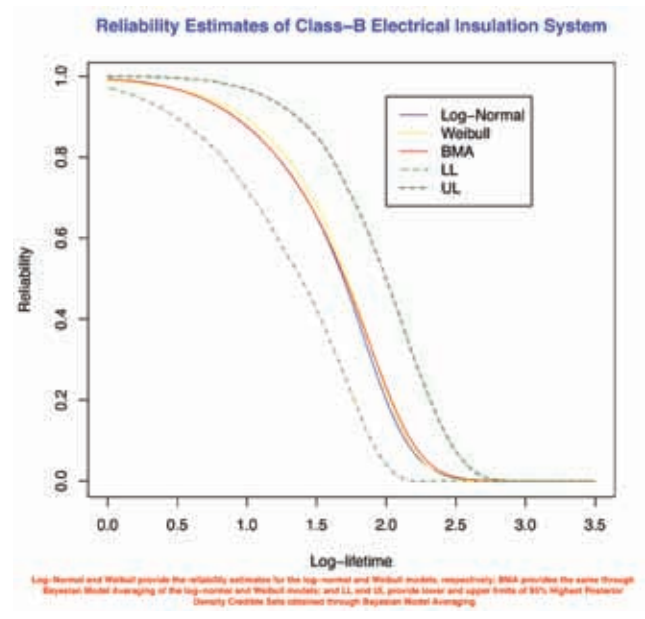
Upscaling Catchment Processes for Sustainable Water Management in Peninsular India (UPSCAPE) is part of the Newton Bhabha “Sustaining Water Resources Programme”, funded jointly by the UK Natural Environment Research Council and the India Ministry of Earth Sciences. It aims to solve water management challenges in Cauvery basin, one of the largest growing urban areas and rapidly expanding agricultural fields through innovative research on how localized, small-scale water management interventions like check-dams, bunds and boreholes, affect water availability at the wider basin-scale, and influence large-scale decision-making [**Mujumdar PP**, unpublished].



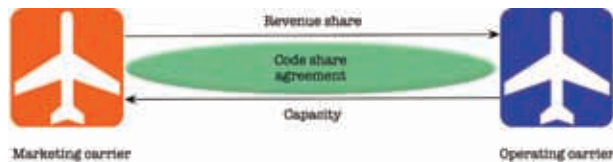
CrowdNet is a deep learning framework that can estimate the number of people in scenes, from a few hundred to a few thousand people. It achieves this by detecting entire person or blob like heads, adaptively, depending on visibility in the scene [Boominathan L, Kruthiventi S and **Babu RV**. CrowdNet: A Deep Convolutional Network for Dense Crowd Counting. *Proceedings of the 2016 ACM on Multimedia Conference, Amsterdam*. 2016].



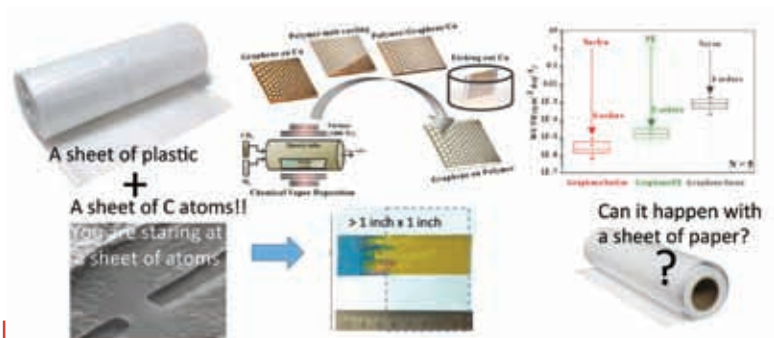
Reliability estimates of Class-B Electrical Insulation System: Log-Normal and Weibull provide the reliability estimates for the log-normal and Weibull models, respectively; BMA provides the same through Bayesian Model Averaging of the log-normal and Weibull models; and LL and UL provide lower and upper limits of 95% Highest Posterior. Density Credible Sets obtained through Bayesian Model Averaging (Roy S and **Mukhopadhyay C.** Bayesian D-optimal Accelerated Life Test plans for series systems with competing exponential causes of failure.v2016. 43(8):1477-1493).



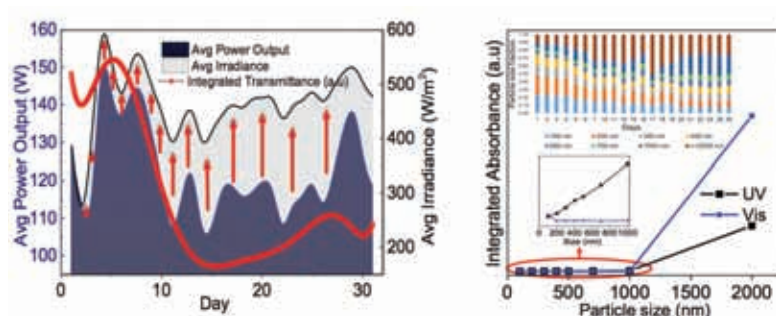
An airline's self-valuation of their shared capacity under code share agreements is typically private information and could be overstated to increase their share of revenue generated through codeshare agreements. We develop a bargaining framework and derive the conditions under which a specific point in Core of the cooperative game can be achieved (Vanamala VS and **Ramachandran P.** A bargaining framework for the airline alliance revenue sharing problem. **International Journal of Revenue Management.** 2016. 9(4):201-220).



Graphene has been combined with plastic to make a hybrid sheet, thus reducing water permeability by a million times. The hybrid sheet which can be used in electronics is flexible, transparent and can be made in large sizes exceeding a square inch (Seethamraju S, Kumar S, Bharadwaj K, Madras G, **Raghavan S** and Ramamurthy PC. Million-Fold Decrease in Polymer Moisture Permeability by a Graphene Monolayer. *ACS Nano.* 2016. 10(7):6501-6509).



Influence of dust on Ultra-Violet and Visible region during early stage of deposition on performance of photovoltaics. The present study primarily aims at unraveling the effect of dust deposition at the initial days on the light absorbance and hence conversion efficiency. (A) Major decrease in power output from the solar panel, happens during 5 – 15 days of dust deposition. (B) Drop in power output during early stage of dust deposition, is due to the UV spectral range absorbance, by the smaller dust particles (Hemaprabha E, Upasna R, Jagdish AK, **Ramamurthy PC** and Chattopadhyay K. Performance of Monocrystalline Silicon solar cell: Influence of dust on Ultra-Violet and Visible region during early stage of deposition. Act Number: 253 IEEE-PVSC 44, Washington D.C).



RESEARCH HIGHLIGHTS

The Division of Interdisciplinary Research consists of the Centre for BioSystems Science and Engineering, Centre for Contemporary Studies, Centre for Infrastructure, Sustainable Transportation and Urban Planning, Centre for Nano Science and Engineering, department of Computational and Data Sciences, Department of Management Studies, Interdisciplinary Centre for Energy Research, Interdisciplinary Centre for Water Research, Robert Bosch Centre for Cyber Physical Systems and Supercomputer Education & Research Centre.

The Centre for BioSystems Science and Engineering (BSSE) was founded as an academic department in June 2015, to facilitate interdisciplinary research in bioengineering. Its five-year old PhD programme currently has 26 PhD students advised by more than 40 faculty from 18 departments. The Centre has one primary and 14 associate faculty.

Current Research

DEVELOPING FUNCTIONAL BIOMATERIALS

The aim of this work is to fabricate biomaterials that may be controlled through external energy sources. Applications of such work lie in the area of drug delivery and developing micro-robots for disease diagnosis and surgery. Manipulating motor proteins: The principal focus is to study the cytoskeletal structures of a cell. Specifically, ongoing work focuses on imaging a variety of cytoskeletal proteins to characterize their role in the regular cellular processes.

MODULATING IMMUNITY USING ENGINEERING TOOLS

Research in this area is directed towards the development of drug delivery systems and biomedical implants that have the capacity to modulate inflammatory immune responses with the ultimate goal of treating specific diseases.

An interdisciplinary team of five faculty members from diverse backgrounds initiated a project entitled "CyberGut" to investigate gut biology using gut-on-a-chip technology, active scaffolds, in situ force-sensing, cell signaling, machine learning, and bionetwork analysis. This project is funded by the Robert Bosch Centre for Cyber Physical Systems at IISc.

The topics of research of BSSE PhD students include pore-forming toxins, mechanobiology of HCV-infected hepatocytes, motor-learning, control issues in saccadic eye-movements, biomaterial scaffolds in cancer biology, motion analysis of dynein motor proteins, shock waves in biology, biodegradable bio-nano composites, nanoparticles of targeting pathogens, application of nuclear magnetic resonance and Raman spectroscopy in biology, dynamics of two-component signaling systems, membranes for water-filtration, microfluidics, etc.

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DEGREE PROGRAMS OFFERED **PhD**

IN NUMBERS

1 ACADEMIC STAFF

29 PhD STUDENTS

5 PUBLICATIONS

Chairperson: **G K ANANTHASURESH**

3.4.1

CENTRE FOR BIOSYSTEMS SCIENCE AND ENGINEERING

Faculty and Staff

SIDDHARTH JHUNJHUNWALA | PhD (Pittsburgh), Assistant Professor

Associate Faculty

GK ANANTHASURESH | PhD (Michigan), Professor

SANDHYA S VISWESWARIAH | PhD (IISc), Professor

GANAPATHY AYAPPA | PhD (Minnesota), Professor

BIKRAMJIT BASU | PhD (Katholieke), Professor

DIPSHIKHA CHAKRAVORTTY | PhD (NCCS), Professor

NAGASUMA CHANDRA | PhD (Bristol), Professor

KAUSHIK CHATTERJEE | PhD (Penn State), Assistant Professor

SAUMITRA DAS | PhD (Kolkata), Professor

NARENDRA DIXIT | PhD (Illinois), Associate Professor

NAMRATA GUNDIAH | PhD (Berkeley), Associate Professor

ASHOK M RAICHUR | PhD (Nevada), Professor

ANNAPOORNI RANGARAJAN | PhD (NCBS), Associate Professor

RAHUL ROY | PhD (Illinois), Assistant Professor

DEEPAK KUMAR SAINI | PhD (AIIMS), Assistant Professor

CORE RESEARCH

BSSE's research areas include biomaterials, biomechanics, and bionetworks. Biosensors, computational bioengineering, drug-delivery, immuno-engineering, motor proteins, neuro-engineering, and systems biology. Development of biomedical devices and theme-based research on diabetes are also initiated in BSSE.

The Centre for Contemporary Studies (CCS) was established in the academic year 2004-2005 with the aim of opening a window to the Social sciences, Humanities and Arts. By organizing a series of seminars, lectures and discussions, the Centre also maintains a steady stream of visiting scholars, hence providing opportunities to the scientific community in IISc, to experience a sample of the best scholarship and creativity outside the traditional boundaries of natural science.

Current Research

The Centre for Contemporary Studies, brings to the campus some of the best practitioners of different disciplines in the human sciences, such as philosophy, sociology, economics, law, literature, poetry, art, music, cinema etc. These scholars, drawn from all over the world, visit and lecture at the Institute and some are in residence for periods ranging from a few days to several months. Students, faculty and staff of the Institute as well a number of people from other

institutes in Bangalore attend these lectures. In addition to such one-off lectures, the Centre offers (presently, once in two years), a one-semester course entitled "The Production of Knowledge – A comparison of Natural and Social Sciences". The Centre also prepares the curriculum and organises six courses in the Humanities for the undergraduate programme of the Institute.

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IN NUMBERS

19 PUBLICATIONS

Chairperson: RAGHAVENDRA GADAGKAR

3.4.2

CENTRE FOR CONTEMPORARY STUDIES

Associate Faculty

RAGHAVENDRA GADAGKAR | PhD (IISc), FASc, FNA, FTWAS, Foreign Associate, US Natl Acad Sci, Professor

HN CHANAKYA | PhD (UAS), Chief Research Scientist

RUDRA PRATAP | PhD (Cornell), Professor

S RAMAKRISHNAN | PhD (Massachusetts), Professor

CORE RESEARCH

The aim of the Centre is to forge useful and meaningful interactions between the natural sciences and human sciences with special focus on understanding the diverse research methodologies of different disciplines and create opportunities to rethink the foundations of our own disciplines.

The Department of Computational and Data Sciences (CDS) focusses on interdisciplinary programs driven by computation and data-intensive methods, systems and applications. The research is aligned along Computational science and Computer systems. The former explores computational methods and applications to scientific domains, while the latter into design, implementation and evaluation of high performance hardware and software systems.

Current Research

The department published a total of 49 papers of which 25 were in journals and the remaining in conferences. Papers were published across the two broad areas of the department, namely Computational Science and Computer&Data Systems. In Computational Science, the major findings span the domains of dynamical systems, and signal processing. Finite element methods were used to study flow dynamics of an impinging droplet on a hot surface. To better solve fluid flow problems, parallel finite element schemes for partial differential equations, non-iterative algorithm for computing diffusion velocities and

formulations for applications to Navier Stokes equation was developed. In the area of signal processing several applications were developed for Magnetic Resonance based imaging, namely for perfusion quantification. Methods were developed for optical and photoacoustic image reconstruction and Image restoration. On a more fundamental note, numerical solutions to Sommerfeld integral relation of the half-space radiator problem were developed in biophotonics. Related to the applications in the area of computational science, the foremost studies has been the models built for determination of

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DEGREE PROGRAMS OFFERED **MSc (Engg), MTech and PhD**

IN NUMBERS

14 ACADEMIC STAFF

39 PhD, **16** MSc (ENGG) AND **22** MTech
AND **9** MTech (RES) STUDENTS

4 MSc (ENGG), **16** MTech
AND **3** PhD CONFERMENTS

49 PUBLICATIONS

Chairperson: **PHANEENDRA YALAVARTHY**

3.4.3

COMPUTATIONAL AND DATA SCIENCES

multipole coefficients in toroidal ion trap mass analysers and the numerical analysis of segmented-electrode Orbitraps – the most advanced state-of-art mass analyzer. The other highlight is in the area of Internet Computing for biology with archives developed for nucleoside compounds, Ebola virus and webservice for hydrogen bond detection. Several other studies were performed that has experimental validation tied to the computational analysis. Of these the landmark study is on documentation of the first experimental corroboration of the weak CH...S hydrogen bond in macromolecular structure through Nuclear Magnetic Resonance spectroscopy, X-ray Crystallography, thermal shift assay, mutation studies, computational modelling and quantum mechanics. In the domain of Computer&Data Systems, several advancements were achieved during the year. In the area of database query optimization new techniques were designed based on PlanBouquet approach. Along similar lines linear-programming based techniques were used to derive efficient queue configurations for high performance computing (HPC). Several advances

were made in research targeted towards design and development of accelerators for HPC and reactive applications. Among them RHyMe: REDEFINE HyperCellmMulticore for accelerating HPC kernels and AccuRA: Accurate alligner of short genomic reads on scalable reconfigurable accelerators were landmarks. Innovative vector processing architectures have also been implemented to learning Neural Networks and QR factorization for several other applications. In specific to data systems, application of Graph Theory based models has been the emphasis. Goal-directed schema induction, interpretable representation learning, quality estimation in crowdsourcing, various problems in knowledge graphs has been the highlights of the study. Distributed data stream processing is another approach that has been tried.

CORE RESEARCH

Computational methods for: Compressed Domains, Dynamical Systems, Finite elements, Natural language processing, Numerical analysis, Signal processing, Statistics Architectures and platforms for: Big Data, Cloud computing, Databases, Accelerators, Reconfigurable Architectures Applications to: Climate modeling, Electromagnetics, Fluid mechanics, Internet of Things, Knowledge Harvesting, Medical imaging, Video Analytics, Photonics, Structural biology, Systems Biology.

Faculty and Staff

SIVARAM AMBIKASARAN | PhD (Stanford), Assistant Professor

SASHIKUMAAR GANESAN | PhD (Otto-von-Guericke), Assistant Professor

JAYANT R HARITSA | PhD (Wisconsin-Madison), Professor

K SEKAR | PhD (Madras), Associate Professor

ATANU MOHANTY | PhD (Brooklyn Polytechnic), Associate Professor

DEBNATH PAL | PhD (Jadavpur), Associate Professor

R VENKATESH BABU | PhD (IISc), Assistant Professor

SOUMYENDU RAHA | PhD (Minnesota), Professor

SK NANDY | PhD (IISc), Professor

YOGESH SIMMHAN | PhD (Indiana), Assistant Professor

MATTHEW JACOB THAZHUTHAVEETIL | PhD (Wisconsin-Madison), Professor

PARTHA PRATIM TALUKDAR | PhD (Penn), Assistant Professor

SATHISH S VADHIYAR | PhD (Tennessee), Associate Professor

MURUGESAN VENKATAPATHI | PhD (Purdue), Assistant Professor

PHANEENDRA YALAVARTHY | PhD (Dartmouth College), Associate Professor



The Centre for Nano Science and Engineering (CeNSE) is an interdisciplinary research centre with a focus on nanoscale systems. The research facilities include national nanofabrication facility (14,000 sft clean room) and characterization labs that cater to material, electronic, mechanical, chemical and optical characterization. At present, the centre has 11 faculty, 150 PhD and 20 MTech students.

Current Research

NEMS RESONATORS

- Electrostatic tuning of nonlinearities in nanoscale electro-mechanical devices to enhance the dynamic range of the device by more than 30 dB
- Fabrication of an array of resonant devices using CVD MoS₂ a few atomic layers thick.
- Exploiting 2D material imperfections (such as ripples, wrinkles, initial slag, departure from rectangular shape, and fabrication residue) to study additional source of nonlinearity in ultra thin nano resonators.

NANOTRANSISTORS WITH 1D AND 2D MATERIALS

- High performance MoS₂ transistors with an all nitride dielectric environment

- Solving the problem of the large variability and poor contact nature at the metal/MoS₂ interface by employing a facile sulphur treatment technique
- High performance HfO₂ back-gated graphene and MoS₂ transistors have been fabricated and characterized. Record transconductance values, $g_m = 60 \mu S$ @ $V_{ds} = 100$ mV, $75 \mu S$ @ $V_{ds} = 1$ V have been achieved in 30 nm HfO₂ back-gated graphene and MoS₂ transistors, respectively.
- Fabrication of both p-type and n-type CNTFETs with exfoliated few-layer graphene as the contact electrode material, and extraction of the true barrier heights for hole and electron transport at CNT-graphene junction by studying the electrical (I_{ds} - V_{gs}) characteristics of CNTFETs at different temperatures. The detailed experimental study and analysis demonstrates that the true barrier height at CNT-graphene junction is negligibly small (only a few meV) for both p-type and n-type CNTFETs and that the barrier height is practically independent of the number of graphene layers.

FACT FILE

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DEGREE PROGRAMS OFFERED **MTech and PhD**

IN NUMBERS

11 ACADEMIC STAFF

147 PhD AND **19** MTech STUDENTS

10 MTech AND **15** PhD CONFERMENTS

151 PUBLICATIONS

Chairperson: **NAVAKANTA BHAT**

3.4.4

NANOSCIENCE AND ENGINEERING

ELECTROLITHOGRAPHY

- Study of controlled electromigration, leading to its development as a tool for material transport at the nanoscale, with some fascinating applications in patterning.
- Exploration of ways of enhancing piezoresistive sensitivity of thin metallic films and lines with nanoscale inhomogenization using electromigration.
- Mechanodiagnosics and Bioinspired sensors:
- Exploration of the dynamics of biological cells for developing mechano-diagnostic tools for pathology identification.
- A study of the bio-acoustics of crickets is focused on understanding the design of transducers involved in cricket song production and learning the design principles of multifunctional natural transducers, such as the incredibly smart design of angular rate sensing halteres in dipteran insects.

BIOSENSORS AND GAS SENSORS

- Founding of the start-up, *PathShodh Healthcare*, to commercialize handheld diagnostic device capable of measuring 8 biomarkers - 5 blood tests and 3 urine tests - enabling a transformation in managing diabetes and its complications. The tests include Hb, HbA1c, Serum Albumin, Glycated Albumin, Glucose, Microalbuminuria, Urine Creatinine, Albumin-to-Creatinine ratio.
- Development and fabrication of a packaged gas sensor array on a single chip for monitoring four air pollutants, i.e., CO, CO₂, NO₂ and SO₂.

NANOMATERIALS

- Demonstration that the diffusion of water through nano-channels, 20-100 nm in height, increases by 100 to 1000 times on lining them with graphene.

- Demonstration that a monolayer of graphene can reduce, by a million fold, the permeability of water into many commonly used polymers. Such low permeability polymers are very important for packaging with EMI shielding in organic electronics, and the emerging fields of flexible electronics and light weight electronics.
- Titanium Nitride (TiN) thin films using DC and Pulsed DC Magnetron sputtering for gate electrode applications and localized heating in MEMS
- Design and optimization of Silicon Nano wires for using them as Piezo-resistors in pressure sensor applications.
- Development of new classes of metalorganic precursors for application in CVD, ALD, and solution-based synthesis of metal oxides and metal chalcogenides.

PRESSURE SENSORS

- Design and development of HIGH ACCURACY and EXCELLENT LINEARITY pressure sensors chips capable of operation over a wide range of temperatures and pressures using SPECIALLY DESIGNED SILICON DIAPHRAGM structures, suitable for aerospace applications. Flight-testing in helicopters for sensing altitude and air speed.
- Optimization and Standardization of Ga doping of silicon using Focused Ion Beam (FIB) implantation for application in resistors having nano-scale dimensions of piezo-resistors for pressure sensors.

PHOTONICS AND LASERS

- Oxide thin films such as SiO₂ and Ta₂O₅ have been optimized using Dual Ion Beam Sputtering for high power laser mirrors.

CORE RESEARCH

Current research topics include, but are not limited to nanoelectronics, MEMS/NEMS, nanomaterials, photonics, lasers, nano-biotechnology, Biosensors, GaN RF and power electronics, Oxide/ chalcogenide electronics, 3D systems scaling, photovoltaics and energy harvesting devices, Sensors for agriculture, food and environment, computational nano-engineering.

Faculty and Staff

NAVAKANTA BHAT | PhD (Stanford), Professor

RUDRA PRATAP | PhD (Cornell), Professor

AMBARISH GHOSH | PhD (Brown), Associate Professor

MANOJ VARMA | PhD (Purdue), Associate Professor

SRINIVASAN RAGHAVAN | PhD (Penn State), Associate Professor

AKSHAY NAIK | PhD (Maryland), Assistant Professor

N DIGBIJOY NATH | PhD (Ohio State), Assistant Professor

PROSENJIT SEN | PhD (California), Assistant Professor

SHANKAR KUMAR SELVARAJA | PhD (Ghent), Assistant Professor

SUSHOBHAN AVASTHI | PhD (Princeton), Assistant Professor

VR SUPRADEEPA | PhD (Purdue), Assistant Professor

Associate Faculty

SUJIT KUMAR SIKDAR | Dr Med Sci (Kyushu), Professor

KJ VINOY | PhD (Penn State), Professor

GK ANATHASURESH | PhD (Michigan), Professor

V VENKATARAMAN | PhD (Princeton), Professor

PS ANIL KUMAR | PhD (Pune), Associate Professor

C RAMAMURTHY PRAVEEN | PhD (Clemson), Associate Professor

GAURAB BANERJEE | PhD (Washington), Assistant Professor

ARINDAM GHOSH | PhD (IISc), Associate Professor

BHARADWAJ AMRUTUR | PhD (Stanford), Professor

The Centre for infrastructure, Sustainable Transportation and Urban Planning (CiSTUP) was established in the year 2009 at the Indian Institute of Science with the support of several departments of the Government of Karnataka. CiSTUP is involved in research programs which cut across different disciplines including environmental science, ecological sciences, transportation engineering, intelligent and smart systems, water sciences and others which are useful for city planning and development. The Centre currently focuses on four major thrust areas of research involving sustainable transportation, development of smart and cities, disaster management and environment management.

Current Research

- Development of Decision support system for location of depots and allocation of buses to depots in urban road transport organisation
- Characterization of Bengaluru groundwater for BTEX contamination and development of procedures for remediation of BTEX contaminated groundwater
- Intelligent traffic monitoring
- Cloud-Mobile-Device framework for cost effective crowd-participatory bus monitoring and Bus-Arrival Time prediction
- Reliability analysis for storm water drain network in Byatarayanapura, Mahadevapura and East core zones of Bangalore
- Development of long range, optical trip wire-based early-warning systems for accident prevention

FACT FILE

ESTABLISHED 2009

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Chairperson: J M CHANDRA KISHEN

3.4.5

CENTRE FOR

INFRASTRUCTURE,
SUSTAINABLE

TRANSPORTATION AND URBAN PLANNING

- Impact of TEG on fuel economy and emissions in urban buses-A simulative approach
- Sewage to potable water: Automation for a novel membraneless, chemical free water filtration and desalination system
- Graphene based electronic nose for pollution monitoring
- Multi-stage recourse model for sustainable utilization of groundwater
- Vehicle counting and classification in traffic videos

CORE RESEARCH

- Traffic management system – traffic surveys, traffic demand
- Data Analytics
- Sensor development
- Intelligent transportation system
- Integrated transportation
- Urban planning
- Safety / threats of public utilities – detection / mitigation
- Preparedness for catastrophic events triggered by social networks / media in crowded places
- Novel techniques for treatment of waste water and storm water for re-use
- Urban floods
- Monitoring and remedial action of surface and ground water bodies for contamination
- Impact of solid waste disposal on the environment with respect to urban Centres
- Novel methods for re-use of construction and demolition wastes in construction industry

Associate Faculty

- JM CHANDRA KISHEN** | PhD (Colorado), Professor
- CALEB RONALD MUNIGETY** | PhD (IIT Bombay), Research Scientist
- TG SITHARAM** | PhD (Texas), Professor
- M SUDHAKAR RAO** | PhD (Pune), Professor
- MH BALASUBRAMANYA** | PhD (ISEC), Professor
- B GURUMOORTHY** | PhD (Carnegie Mellon), Professor
- MS MOHAN KUMAR** | PhD (IISc), Professor
- SHALABH BHATNAGAR** | PhD (IISc), Professor
- ANANTH RAMASWAMY** | PhD (Louisiana State), Professor
- BHARADWAJ AMRUTUR** | PhD (Stanford), Professor
- GL SIVAKUMAR BABU** | PhD (IISc), Professor
- L UMANAND** | PhD (IISc), Associate Professor
- M SEK HAR** | PhD (IISc), Professor
- MONTO MANI** | PhD (IIT Madras), Professor
- GURTOO ANJULA** | PhD (IIM Ahmedabad), Professor
- PARTHASARATHY RAMACHANDRAN** | PhD (Oklahoma State), Professor
- ASHISH VERMA** | PhD (IIT Bombay), Assistant Professor
- ANBAZHAGAN** | PhD (IISc), Assistant Professor
- HN CHANAKYA** | PhD (UAS), Chief Research Scientist
- KS NANJUNDA RAO** | PhD (IISc), Principal Research Scientist
- PARAMESHWAR P IYER** | PhD (California), Principal Research Scientist
- TV RAMACHANDRA** | PhD (IISc), FNESA, FIE, FIEE(UK), FIH, Scientific Officer



This new centre (ICER) is uniquely placed to address the research challenges in the diverse fields related to energy, by engaging in interdisciplinary studies across many different fields as well as research that cover areas from the basics through to application and development. Thus, the Centre has taken a highly interdisciplinary approach toward translating fundamental knowledge into practical solutions that will enable sustainable energy production both in the urban and rural sector. Some major projects which have been initiated under the Centre include the India-US consortium named Solar Energy Research Institute for India and the United States (SERIUS) under the US. India Joint Clean Energy Research and Development Centre (JCERDC) programme, the National Centre for Combustion Research & Development (NCCRD), Research Centre for Solar Power in Challakere Campus for development of research test beds in solar thermal as well as in photovoltaics, Adsorption based Solar Cooling, Solar Research and Reliability Dashboard, Optoelectronic Materials and Devices laboratory and Photovoltaic laboratory.

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DEGREE PROGRAMS OFFERED **PhD**

IN NUMBERS

26 PhD STUDENTS

2 PUBLICATIONS

Chairperson: **GIRIDHAR MADRAS**

3.4.6

INTERDISCIPLINARY CENTRE FOR **ENERGY RESEARCH**

Associate Faculty

HN CHANAKYA | PhD (UAS), Chief Research Scientist

CHATTOPADHYAY KAMANIO | PhD (BHU), Professor

PRADIP DUTTA | PhD (Columbia), Professor

GIRIDHAR MADRAS | PhD (Texas A&M), Professor

CHARLIE OOMMEN | PhD (IISc), Principle Research Scientist

PRAVEEN C RAMAMURTHY | PhD (Clemson), Professor

RV RAVIKRISHNA | PhD (Purdue), Professor

BN RAGHUNANDAN | PhD (IISc), Professor

DD SARMA | PhD (IISc), Professor

CORE RESEARCH

During the last year, the primary installation of the test bed for organic ranking cycle power block with solar field deploying newly designed parabolic reflector as well as a PV field is completed. These are being instrumented. Simultaneously we have been developing a dash board in collaboration with Robert Bosch Centre for Cyber Physical Systems.

For photovoltaic research, the centre has set up a set up facilities for synthesizing new solar cell materials and printing of solar cell. In the area of concentrated solar thermal the centre is setting up an ambitious test loop for supercritical CO₂ power system. Most of the installation has already been completed. As a part of the national centre for combustion, several fully instrumented state of art combustion systems have been set up for studying various combustion processes.

Reaches across traditional disciplinary boundaries Interdisciplinary Centre for Water Research (ICWAR) aim to provide a comprehensive understanding of impact of complex environmental factors on areas related to water science and technology and offer efficient and effective engineering solutions to environmental problems. Students in ICWAR receive a broad education and carry out research addressing some of the grand science and engineering challenges of modern society.

Current Research

RESEARCH AND TEACHING IN THE ICWAR PROGRAM FOCUS ON THE FOLLOWING AREAS

Hydrologic Impacts of Climate Change and Water Resources Systems Changes in global climate significantly affected the local and regional hydrological regimes, which will in turn affect ecological, social and economical systems. The climate-change impact studies on hydrologic regime have been relatively rare until recently, mainly because Global Circulation Models, which are widely used to simulate future climate scenarios. The course provides

broad guidelines to student on hydrologic impact analysis, method of downscaling precipitation and temperature etc.

EARTH SYSTEM SCIENCE

The aim of this course is to introduce student to the challenge, we strive to examine the complexity of the global system, including the interactions, synergies, and feedbacks that link the land surfaces, freshwater, oceans, and atmosphere systems.

FACT FILE

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IN NUMBERS

3 PhD STUDENTS

2 PUBLICATIONS

Chairperson: **P P MUJUMDAR**

3.4.7 INTERDISCIPLINARY CENTRE FOR WATER RESEARCH

Associate Faculty

PP MUJUMDAR | PhD (IISc), Professor

ASHOK M RAICHUR | PhD (Nevada), Professor

GOVINDASAMY BALA | PhD (McGill), Professor

MS MOHAN KUMAR | PhD (IISc), Professor

D NAGESH KUMAR | PhD. (IISc), Professor

M SEKHAR | PhD (IISc), Professor

VV SRINIVAS | PhD (IIT), Professor

S SUBRAMANIAN | PhD (Mysore), Professor

M SUDHAKAR RAO | PhD (Pune), Professor

PROSENJIT GHOSH | PhD (Devi Ahiliya Vishwa Vidhyalaya, Indore), Professor

V VENUGOPAL | PhD (Minnesota), Professor

RAMANANDA CHAKRABARTI | PhD (Rochester), Assistant Professor

CORE RESEARCH

Urban hydrology, Water quality and purification, Regional hydrology, Impact of climate change on regional hydrology.

The oldest management education department (MGS) in the country tracing its origin back to 1947 currently has a masters and a doctoral program. The department faculty and students engage in research in a wide array management topics and seeks to set standards of excellence in management research and education.

Current Research

One important research area is on technology entrepreneurship based start-ups, their ecosystem, structure and components, the role that these ecosystem components play in the three life cycle stages of tech start-ups are probed. In the process, an ideal ecosystem feasible in the context of Indian economy is defined, and the prevailing ecosystems for tech start-ups in Bangalore and Hyderabad are probed, comparatively analyzed, and the gaps are identified. Appropriate policy initiatives are recommended for filling-up the gaps, to accelerate the rate of emergence, sustenance and growth of tech start-ups in the two start-up hubs.

Another area of research focuses on reliability of series systems. Statistical problems are that of inferring about the reliability of such systems under normal usage

conditions, based on the life testing data collected under such accelerated conditions, and determination of the optimal settings of the accelerating conditions. In this research, a Bayesian solution to the inference problem was developed first in a piecemeal fashion, by developing methodologies for specific life distributions in a step by step manner, which eventually culminated in a general analysis for the log-location-scale family, with some novel contributions in the frequentist domain on the way. The optimal setting design problem was solved within the nascent Bayesian design framework, only for the case of the exponential distribution. The study of sustainability transitions of various economic systems is an emerging research domain. The current research has mainly focused on benchmarking, modelling, planning, assessment, policy analysis of sustainable transitions of national electricity

FACT FILE

ESTABLISHED **1985**

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DEGREE PROGRAMS OFFERED **PhD and MMgt**

IN NUMBERS

5 ACADEMIC AND **4** SCIENTIFIC STAFF

60 PhD STUDENTS

29 MMgt STUDENTS

16 MMgt CONFERMENTS

5 PhD CONFERMENTS

37 PUBLICATIONS

Chairperson: **PARTHASARATHY RAMACHANDRAN**

3.4.8

MANAGEMENT STUDIES

systems, rural energy-enterprise systems, urban mobility, corporate sector and urban system. One of the major initiatives (research project) within this domain is to conceptualize, develop and field demonstrate package of bioenergy solutions as EnergyPlus intervention for rural empowerment.

The work of revenue management studies the role of remanufactured products in the market place and its effect on substitutable new products. Specifically, the research addresses the effect of market cannibalization, product life cycle, and used core procurement competition.

Faculty and Staff

KB AKHILESH | PhD (IISc), Professor

MH BALA SUBRAHMANYA | PhD (ISEC), Professor

P BALACHANDRA | PhD (IISc), Principal Research Scientist

GURTOO ANJULA | Fellow (IIM Ahmedabad), Associate Professor

P PARAMESHWAR IYER | PhD (California), Principal Research Scientist

M MATHIRAJAN | PhD (IISc), Chief Research Scientist

C MUKHOPADHYAY | PhD (Missouri), Professor

PARTHASARATHY RAMACHANDRAN | PhD (Oklahoma State), Associate Professor

YADNYVALKYA | MS (Engg) (Moscow), MA (Russian) (CIEFL), Principal Research Scientist

CORE RESEARCH

Technology Start-ups: Ecosystem and Lifecycle; Accelerated Life Testing of Series Systems; Energy & Environment; Technology and Sustainability and Sustainability Transitions; Dynamic Pricing and Revenue Management; Human Resource Management; Production Operations & Supply Chain Management; Public Policy.

The Robert Bosch Centre for Cyber-Physical Systems (RBCCPS) draws upon the existing deep strengths within the Indian Institute of Science to drive multidisciplinary research programs in selected application areas involving complex interacting systems, while simultaneously developing key foundational strengths in important core areas within the Centre.

Current Research

Since 2011, 31 research projects have been successfully completed at RBCCPS and currently 15 research projects are running in the areas of smart cities, health systems, and Smart Manufacturing, Smart Grids and Autonomous systems. These projects offer enormous opportunities for developing and applying Cyber Physical Systems Concepts to solve problems of great societal and industrial impact. Some examples are:

AUTONOMOUS SYSTEMS AND ROBOTICS

- Autonomous navigation of drones
- Development of chemotactic robots
- Understanding swarming and collective motion in bacterial populations

SMART GRIDS

- Condition based solar PV plant maintenance and monitoring using sparse, low cost sensors
- Distributed multi-agent algorithms for micro grid control

SMART CITIES

- Efficient architectures and algorithms for distributed video analytics for Smart Cities IISc Smart Campus
- Smart city test bed
- Study of India appropriate technology (IoT) solutions for Smart Cities

SMART MANUFACTURING SYSTEMS

- A smart manufacturing test bed for biomedical devices

HEALTH SYSTEMS

- Affordable and robust *E.Coli* biosensor development for rapid detection of faecal contamination in water
- A BioCPS approach to understand and control gut-biology (CyberGut)

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IN NUMBERS

17 PUBLICATIONS

Chairperson: BHARADWAJ AMRUTUR

3.4.9

ROBERT BOSCH CENTRE FOR CYBER PHYSICAL SYSTEMS

Technical Staff

ASHISH JOGLEKAR | PhD (IISc), Member of Technical Staff

VASANTH RAJARAMAN | MSc Computer Science (Aalto), Member of Technical Staff

VENKATESH N SHESHADRI | PhD (Madras), Member of Technical Staff

VISHNU PRASAD | PhD (Madras), Member of Technical Staff

ALOK RAWAT | PhD (IISc), Member of Technical Staff

Associate Faculty

BHARADWAJ AMRUTUR | PhD (Stanford), FNAE, Professor

MANOJ VARMA | PhD (Purdue), Associate Professor

GK ANANTHASURESH | PhD, (Michigan), Professor

RAJESH SUNDARESAN | PhD (Princeton), Associate Professor

MS MOHAN KUMAR | PhD (IISc), Professor

SHALABH BHATNAGAR | PhD (IISc), FNAE, Professor

CHIRANJIB BHATTACHARYYA | PhD (IISc), FNAE, Professor

AMARESH CHAKRABARTI | PhD (Cambridge), Professor

S ASOKAN | PhD (IISc), FNASc, Professor

CORE RESEARCH

Our research programs address significant challenges facing our country and society. We apply advances in sensing, computing and analytics to solve these problems. Our research focuses on Smart Cities, health systems and autonomous systems, out of their importance for the country and their opportunities for research, innovation and societal impact.

The Supercomputing Education and Research Centre (SERC), at IISc provides the state-of-the-art computing environment, which compares well with the top Computing Centres anywhere in the world, catering to the ever-increasing demands of high performance computing for scientific and engineering research. The centre pursues advanced research and education in various aspects of supercomputing systems and applications. In addition, the Centre leads several national initiatives and provides consultancy services.

Current Research

- Memory system design for multi-core architectures and compiler and runtime systems for heterogeneous architectures
- Efficient warp scheduling methods using Reinforcement Learning for Graphic Processing Units (GPUs)
- Efficient compile/runtime techniques for heterogeneous architectures.

FAST SOLVERS IN COMPUTATIONAL ELECTROMAGNETICS

In computational electromagnetic solvers, a surface or interface mesh give rise to a smaller matrix size but in dense form which presents a time and memory bottleneck. Several fast iterative solver algorithms have been devised to

mitigate the problem, namely, Fast Multipole Method (FMM), low-rank based methods (matrix compression). While these algorithms are capable of reducing the cost of matrix vector products to $O(N)$ or $O(N\log N)$, the solution time is impeded by the convergence rate of the iterative solution and will require better pre-conditioning techniques particularly for full-wave applications. For the solution of very large number of right-hand-side (RHS), a different iteration-free variant of fast solvers or in other words, fast direct solvers or a good preconditioner can be very effective in expediting the matrix solution. The challenges involve reducing a traditionally $O(N^3)$ LU decomposition process to a faster linear complexity method exploiting the underlying physics of the interactions between basis functions.

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IN NUMBERS

2 PUBLICATIONS

Chairperson: R GOVINDARAJAN

3.4.10

SUPERCOMPUTER EDUCATION AND RESEARCH CENTRE

Faculty & Staff

R GOVINDARAJAN | PhD (IISc), Professor
H KRISHNAMURTHY | ME (IISc), Chief Research Scientist
FILBERT MINJ | MTech (JNU), Principal Research Scientist
J LAKSHMI | PhD (IISc), Principal Research Scientist
YOGENDRA KUMAR NEGI | MTech (Delhi), Scientific Officer
KP RAGHURAMAN | MSc (Bharatidasan), Technical Officer
TA CHANDRAPPA | MSc (Bangalore), Scientific Assistant
KH GOWRANGA | MSc (Engg) (IISc), Scientific Assistant
NALINI SREESHYLAN | MSc (Bangalore), Scientific Assistant

Associate Faculty

S YASHONATH | PhD (IISc), Professor
VIJAY NATARAJAN | PhD (Duke), Associate Professor
MATTHEW JACOB THAZHUTHAVEETIL | PhD (Wisconsin), Professor

Honorary Professor

N BALAKRISHNAN | PhD (IISc), Honorary Professor

CORE RESEARCH

Supercomputing systems and applications, Cloud Computing, networking, digital library, information security, computational electromagnetics.



3.5.

Division of

MECHA SCIENCES

Geotechnical Engineering, Civil & Aerospace Structures, Transportation, Water Resources, Environmental Engineering and Sustainable Habitat, Climate, Structural and Functional Materials, Manufacturing, Design Theory and Methodology, Geochemistry, Tectonics, Planetary Evolution, Remote Sensing and GIS Applications, Aerodynamics, Combustion, Navigation and Guidance, Solid Mechanics, Fluid Mechanics, Thermal Sciences, Acoustics, Robotics, Dynamics, Biomolecular Engineering, Catalysis, Colloids and Interfacial Science, Nanotechnology, Thermodynamics and Simulations across length scales.

DEPARTMENTS | CENTRES | UNITS

- ◆ AEROSPACE ENGINEERING
- ◆ CENTRE FOR PRODUCT DESIGN AND MANUFACTURING
- ◆ CHEMICAL ENGINEERING
- ◆ MATERIALS ENGINEERING
- ◆ MECHANICAL ENGINEERING
- ◆ CIVIL ENGINEERING
- ◆ CENTRE FOR EARTH SCIENCES
- ◆ CENTRE FOR ATMOSPHERIC AND OCEANIC SCIENCES
- ◆ CENTRE FOR SUSTAINABLE TECHNOLOGIES
- ◆ DIVECHA CENTRE FOR CLIMATE CHANGE

IN NUMBERS

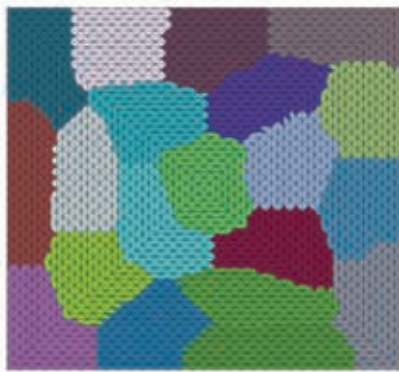
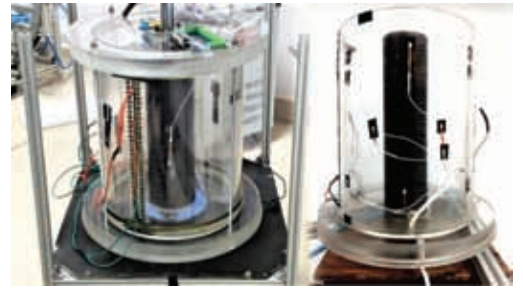
- ◆ **126** FACULTY MEMBERS
- ◆ **84** FELLOWSHIPS OF SCIENCE AND ENGINEERING ACADEMIES IN INDIA
- ◆ **694** PhD STUDENTS
- ◆ **380** MASTER'S STUDENTS

THEMES

Research work in the Division encompasses diverse areas. Seismology and climate change — modelling as well as paleo studies — are focus areas, which lead naturally to work on environmentally sustainable materials and design and on waste management. The work on materials includes study and modelling of biomaterials, polymers and photovoltaics. Fluid dynamics, including shock waves and other phenomena at hypersonic speeds, is another key area of study that cuts across the various departments in this Division. Researchers in this Division also work on identifying novel drug and vaccine targets for viral infections such as HIV, hepatitis C and dengue.

Chairperson: **VIKRAM JAYARAM**

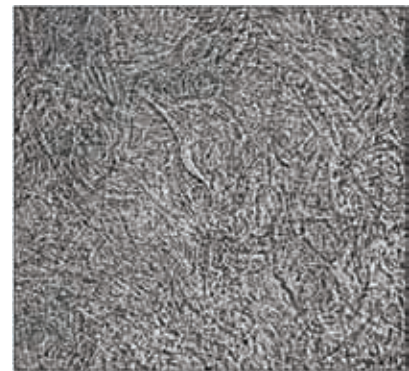
Left: Rotating apparatus designed to simulate thermal core-mantle coupling in the Earth. Right: Concentric cylinder assembly, which forms part of the rotating apparatus designed to simulate thermal core-mantle coupling in the Earth (Aujogue K, Pothérat A, Bates I, Debray F and **Sreenivasan B**. Little Earth Experiment: An Instrument to Model Planetary Cores. *Review of Scientific Instruments*. 2016. 87:084502).



When a system becomes more complex, predicting its behaviour becomes computationally daunting. This problem has now been addressed by decomposing the physical domain, thus increasing the computation speed (Pranesh S and **Ghosh D**. Addressing the Curse of Dimensionality in SSFEM Using the Dependence of Eigenvalues in KL Expansion on Domain Size. *Computational Methods in Applied Mechanics and Engineering*. 2016. 311:457-475).

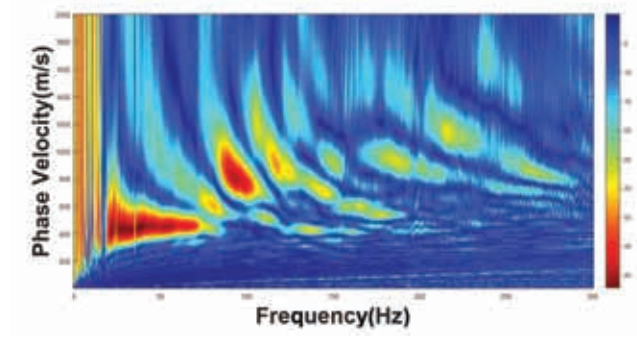


An instantaneous laser shadowgraph used in the intensity measurements in the study of light propagation through buoyancy driven turbulence. This study investigated how light is distorted as it passes through atmospheric turbulence (Pawar SS and **Arakeri JH**. Intensity and Angle-of-Arrival Spectra of Laser Light Propagating through Axially Homogeneous Buoyancy-Driven Turbulence. 2016. *Applied Optics*. 55(22): 5945-5952).



RESEARCH SNAPSHOTS 2016

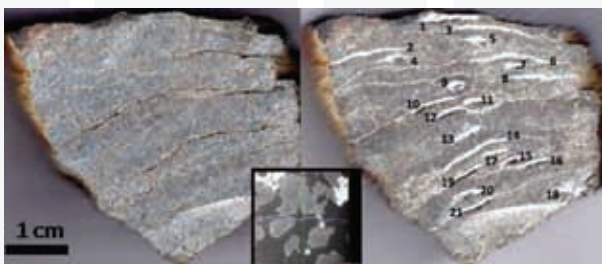
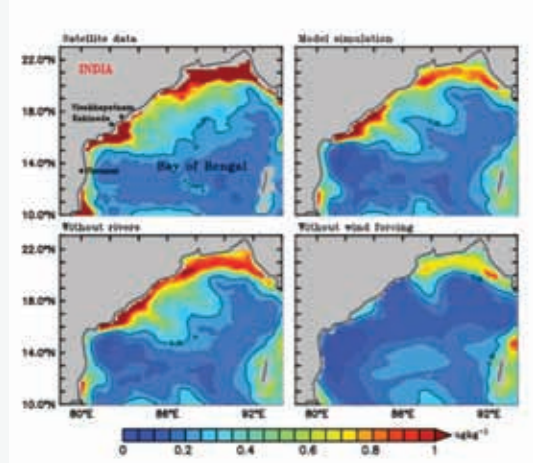
To understand the dynamic properties of a medium just below the surface of the ground, a novel approach has been proposed that accurately computes the theoretical dispersion spectra for the various modes of wave propagation (**Kumar J** and Naskar T. A Fast and Accurate Method to Compute Dispersion Spectra for Layered Media using a Modified Kausel-Roësset Stiffness Matrix Approach. *Soil Dynamics and Earthquake Engineering*. 2017. 92:176-182).



A recently upgraded 9kW_z Building Integrated Photovoltaic system (BIPV) facility with an inset of indoor natural lighting (Aaditya G and **Mani M**. BIPV: A Real-Time Building Performance Study for a Roof-Integrated Facility. *International Journal of Sustainable Energy*. 2016. 35:1-19).

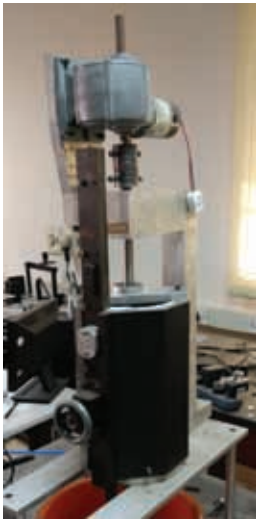
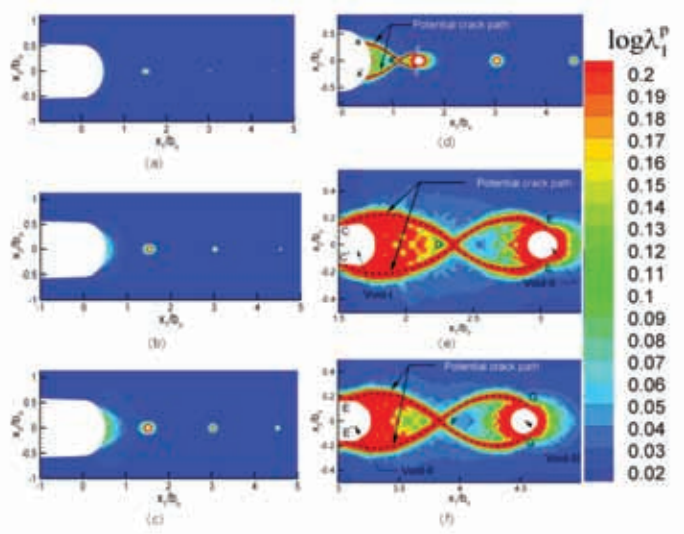


A phytoplankton bloom makes a dramatic summer appearance in the Bay of Bengal (top left). The other panels show simulated bloom formation using a coupled physical-biological ocean model (Thushara V and **Vinayachandran PN**. Formation of summer phytoplankton bloom in the northwestern Bay of Bengal in a coupled physical-ecosystem model. *Journal of Geophysical Research: Oceans*. 2016. 121(12): 8535–8550).



Spheroidal weathering of a diabase in hand-specimen scale. (Banerjee A, **Chakrabarti R** and Mandal S. Geochemical Anatomy of a Spheroidally Weathered Diabase. *Chemical Geology*. 2016. 440:124-138).

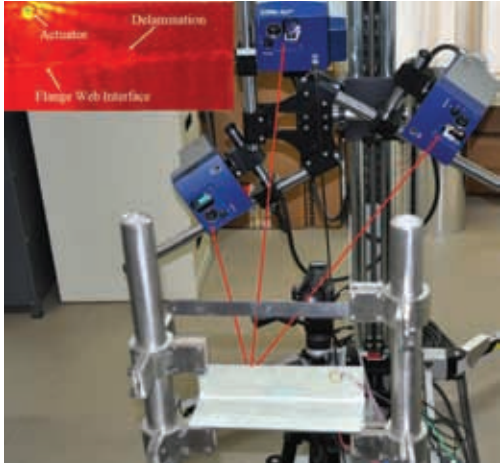
Fracture mechanism in brittle bulk metallic glasses. Cavitation in weak zones followed by coalescence through curved shear bands give rise to nanocorrugations on fracture surface (Singh I, **Narasimhan R** and Ramamurty U. Cavitation-Induced Fracture Causes Nanocorrugations in Brittle Metallic Glasses. *Phys. Rev. Lett.* 117(4): 044302).



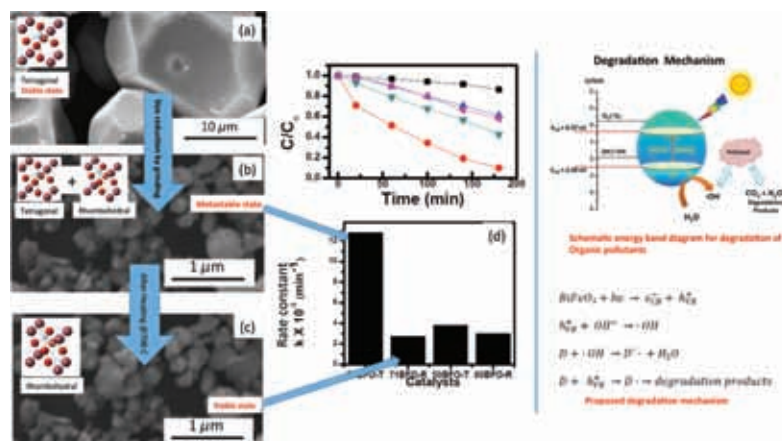
The Couette Cell and apparatus to conduct experiments to understand vortex flow in sheared granular materials (Krishnaraj KP and **Nott PR**. A Dilation-Driven Vortex Flow in Sheared Granular Materials Explains a Rheometric Anomaly. *Nature Communications*. 2016. 7:10630).



Remote monitoring of structures with laser Doppler ultrasound; image shows a 3D Laser scanning of a composite structural joint with hidden damage. Inset shows the hidden damage detected with the help of a new technique of ultrasound Doppler imaging and computation (Geetha GK, **Mahapatra DR**, Gopalakrishnan S, Hanagud S. Laser Doppler imaging of delamination in a composite T-joint with remotely located ultrasonic actuators. *Composite Structures*. 2016. 147:197-210).



A semiconducting ferroelectric material $\text{BiFeO}_3\text{-PbTiO}_3$ shows a tetragonal stable phase for large grains (~ 10 microns) (a) When the grains were reduced to ~ 0.5 micron by manual grinding at room temperature (b), a minor rhombohedral phase appeared which coexists with the majority tetragonal phase. On heating this ground powder above the Curie point (~ 650°C) and cooling back to room temperature, the major tetragonal phase vanished completely and the rhombohedral phase becomes stabilized (c). This proved that the tetragonal phase in the ground small grains is metastable in nature. The powders with metastable tetragonal phase and stable rhombohedral phase were used as photocatalysts for degradation of a typical organic pollutant, Rhodamine B. We found that the degradation rate increased five times when the catalysts were in the metastable state (d) (Narayan B, Adhikari S, Madras G and **Ranjan R**. Trapping a Metastable Ferroelectric Phase by Size Reduction in Semiconducting Ferroelectric $\text{BiFeO}_3\text{-PbTiO}_3$ and its Implications for Photocatalytic Response. *Physical Review Applied*. 2017. 7:024018).



RESEARCH HIGHLIGHTS

The Division consists of departments of Aerospace Engineering (which includes DRDL-IISc Joint Advanced Technology Programme and ISRO-IISc Space Technology Cell), Civil Engineering, Chemical Engineering, Materials Engineering, Mechanical Engineering, Centre for Atmospheric & Oceanic Sciences, Centre for Earth Sciences, Centre for Product Design and Manufacturing, Centre for Sustainable Technologies and Divecha Centre For Climate Change.

The Department of Aeronautical Engineering (AE) was started in December 1942 and subsequently renamed as Department of Aerospace Engineering. This year is the Platinum Jubilee year of the Department. The Department has 35 Faculty members and over 200 graduate students. The academic and research activities are in the four major areas of Structures, Aerodynamics, Combustion and Propulsion, and Guidance and Controls.

Current Research

The Department of Aerospace Engineering, Indian Institute of Science, Bangalore, is known mainly for its activities in academics and research contributing very significantly to aerospace and allied fields. The research highlights of the department in four major areas during the year 2016 are as follows.

A. STRUCTURES

The group has been working on many research areas of aerospace structures such as:

- Wave propagation studies for bifurcation in triatomic granular cyclic chains, nonlinear dynamics, wave stability analysis and structural dynamics.
- Isospectral continuous systems and discrete systems, Electroactive polymers.
- A robust design approach for placing flaps on the helicopter.
- Nano-composite materials for thermal protection, mechanical strengthening and integrated sensing.

FACT FILE

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DEGREE PROGRAMS OFFERED **PhD, MSc (Engg) and ME**

IN NUMBERS

25 ACADEMIC AND **10** SCIENTIFIC STAFF

6 MTech (RES), **18** MTech-D, **39** ME,
29 MSc (ENGG) AND **158** PhD STUDENTS

5 MSc (ENGG), **30** ME AND
12 PhD CONFERMENTS

228 PUBLICATIONS

Chairperson: **S GOPALAKRISHNAN**

3.5.1

AEROSPACE

ENGINEERING

- Thermo-elastic wave generation using high power laser beam for structural health monitoring, non-destructive evaluation of hygro-thermal effects.
- Failure Mechanism based failure theory.
- Qualitative assessment of 3-D failure criteria, Damage tolerance analysis, fatigue and failure, fracture mechanics, Vibrations, Aeroelasticity.

B. COMBUSTION AND PROPULSION

The combustion and propulsion group carries out research on various aspects of combustion fundamentals in flames, liquid-droplet dynamics, propellant characterization, and novel electric propulsion methods. New energetic materials are being developed for application as rocket propellants. These include nano-materials for energetic compositions, and green propellants. Liquid jet/sheet instability, ligament breakup, spray-wall interaction, and secondary atomization. Impact dynamics of liquid drops. Computational investigations and stability analyses. New facilities are created for PIV in reacting and non-reacting flows, high speed combustion to support SCRAMJET, a three cup swirl rig for Gas turbine combustion, an optical based spray drop size measurement system (SPRAYTEC).

C. AERODYNAMICS

The group is involved in the research areas of hydrogen-oxygen combustion based fluid jet delivery method, the feasibility of using alternate thermal protection systems

including mass transfer cooling for re-entry vehicles. Large Eddy Simulation of evaporating dilute sprays with explicit filtering approach, Aeroacoustics of shrouded supersonic jets, convective-absolute instability boundary of compressible, swirling pipe flows. Combination of shockwave therapy along with antibiotics. The facilities available are Vertical Shock tube, PLIF System(OH, NO, acetone), DiCam Pro- ICCD Camera, High Vacuum system and test section – HST2 , FPST, dual tube vertical shock tube, Carbon Nano Tube (CNT) sensors, Elliptic Sharp Tipped Shallow (ESTS) lobed nozzle, shock/blast tube.

D. GUIDANCE AND CONTROL

The group has worked on various aspects of aerospace guidance and control methods including MPSP (model predictive static programming) based techniques, "Partial IGC". Novel guidance methodologies were proposed for rendezvous of same speed unmanned aerial vehicles (UAVs) based on deviated pursuit geometry. Path following is critical for autonomous UAV operations and a trajectory shaping based guidance law was developed.

Novel solutions were found for achieving impact angle and time constraints for missile engagements, guidance for seeker-less missiles, radar deception using electronic combat aerial vehicles, and broadcast algorithms in multi-UAV systems.

CORE RESEARCH

Wave propagation, structural health monitoring, design optimization, nanocomposites, composite structures, smart materials, functionally graded materials, non-linear analysis, finite element methods, vibrations, Non Destructive Evaluation, Aerodynamics, Aero-elasticity, hypersonic, subsonic, supersonic, shock tubes, shock waves, combustion and propulsion, guidance and controls, fluid mechanics, fluid dynamics, wind tunnel, unmanned aerial vehicles, Nonlinear control.

Faculty and Staff

- N BALAKRISHNAN** | PhD (IISc), Associate Professor
- M RAMACHANDRA BHAT** | PhD (IISc), Chief Research Scientist
- M SEETHARAMA BHAT** | MPhD (IISc), FNAE, Professor
- SWETAPROVO CHAUDHURI** | PhD (Connecticut), Assistant Professor
- RANJAN GANGULI** | PhD (Maryland), FNAE, Professor
- DEBASISH GHOSE** | PhD (IISc), FNAE, Professor
- S GOPALAKRISHNAN** | PhD (Purdue), FASc, FNAE, Professor
- DINESH KUMAR HARURSAMPATH** | PhD (Georgia Tech), Assistant Professor
- SANTOSH HEMCHANDRA** | PhD (Georgia Tech), Assistant Professor
- GOPALAN JAGADEESH** | PhD (IISc), FNAE, Professor
- SB KANDAGAL** | PhD (IISc), Principal Research Scientist
- PS KULKARNI** | PhD (IISc), Chief Research Scientist
- KN LAKSHMISHA** | PhD (IISc), Professor
- V MANI** | PhD (IISc), Professor
- JOSEPH MATHEW** | PhD (MIT), FNAE, Professor
- G NARAYANA NAIK** | PhD (IISc), Principal Research Scientist
- SN OMKAR** | PhD (IISc), Chief Research Scientist
- CHARLIE OOMMEN** | PhD (IISc), Principal Research Scientist
- RADHAKANT PADHI** | PhD (Missouri), Associate Professor
- NKS RAJAN** | PhD (IISc), Chief Research Scientist
- ON RAMESH** | PhD (IISc), Associate Professor
- S V RAGHURAMA RAO** | PhD (IISc), Associate Professor
- ASHWINI RATNOO** | PhD (IISc), Assistant Professor
- KPJ REDDY** | PhD (BIT-Ranchi), Professor
- MAHAPATRA D ROY** | PhD (IISc), Associate Professor
- ARNAB SAMANTA** | PhD (Illinois), Assistant Professor
- S SARAVANAN** | PhD (IISc), Principal Research Scientist
- TS SHESHADRI** | PhD (Georgia Tech), Associate Professor
- D SIVAKUMAR** | PhD (IISc), Associate Professor
- SUHASINI GURURAJA** | PhD (Washington), Assistant Professor
- V SURENDRANATH** | MSc (Engg) (IISc), Principal Research Scientist
- B VASUDEVAN** | MASc (Toronto), Principal Research Scientist
- KARTIK VENKATRAMAN** | PhD (IIT Madras), Associate Professor
- SOURABH SUHAS DIWAN** | PhD (IISc), Assistant Professor
- SRISHA RAO M V** | PhD (IISc), Assistant Professor

Established in 1982, Centre for Atmospheric & Oceanic Sciences (CAOS) carries out research in the broad field of tropical climate focussing on the monsoons and offers academic programs leading to MTech and PhD degrees. The centre has played a leading role in shaping research in atmospheric and ocean sciences in India.

Current Research

NEW BEGINNINGS

During the year 2016, CAOS took up major research initiatives in atmospheric and ocean observations science.

- Three major field campaign jointly funded by NERC (UK) and MoES (India) have been conducted:

1. South West Asian Aerosols Monsoon Interactions (SWAAMI) to understand Aerosol-Cloud-Precipitation Interactions
2. Interaction of Convective Organization and Monsoon Precipitation, Atmosphere, Surface and Sea (INCOMPASS) to allow a unique and unprecedented characterisation of monsoon processes

3. Bay of Bengal Boundary Layer Experiment (BOBBLE) to study the air sea interaction over Bay of Bengal and monsoons.

Data collected using the ship and aircraft campaigns of the three projects will be used to further our capability to understand and predict monsoons.

- A Climate Observatory has been set-up at the Challakere campus to carry out international level research on climate, to provide training to undergraduate and graduate level students and for continuous and long term monitoring of various parameters relevant to climate change.

FACT FILE

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DEGREE PROGRAMS OFFERED **PhD, MSc (Engg) and MTech (Climate Science)**

IN NUMBERS

8 ACADEMIC STAFF

39 PhD, **6** MSc (ENGG)
AND **8** MTech STUDENTS

7 MTech AND
4 PhD CONFERMENTS

58 PUBLICATIONS

Chairperson: **DEBASIS SENGUPTA**

3.5.2 CENTRE FOR ATMOSPHERIC AND OCEANIC SCIENCES

SUPERROTATION

Superrotation is a phenomenon wherein the zonal mean winds have an angular momentum that exceeds that of the surface of the planet at the equator. We probed this phenomenon using a model and found that superrotation is possible when the system experiences systematic vorticity forcing.

MONSOON VARIABILITY

- Sub-seasonal variability of Indian summer monsoon can be split further into two modes i) Low frequency 20-90 day mode and ii) High Frequency 10-20 day mode. The low frequency mode moves poleward and shows a decreasing trend.
- There is an increase in extreme rainfall events in the break phase which could have an impact on the mean monsoon rainfall.
- Deep Learning techniques can outperform both numerical and statistical models in predicting the Indian Summer Monsoon.

COMPUTATIONAL ACCELERATORS FOR CLIMATE MODELING

Offloading computations to Xeon-Phi accelerators is more beneficial than running the same computations on CPUs and accelerators. The offloading improves throughputs upto 45% in models.

REVERSE AIR-SEA HEAT FLUX

Over the western and central Arabian Sea, during the summer monsoon season, the air heats up the ocean beneath. This is due to the horizontal advection of heat and the heat flux derived via mixing and entrainment of air from above.

CLOUD STRUCTURE DISTRIBUTION

The vertical structure of cumulonimbus clouds shows close similarity across the ocean basins, while differences over land areas are large. Foothills of the Western Himalayas, southeast South America and Indo-Gangetic Plain contain the most intense cumulonimbus clouds.

CORE RESEARCH

- Monsoons and its diurnal to decadal variability
- Oceanography: Indian Ocean dynamics and modeling, observations, ecosystem processes
- Aerosols physics: Observations, chemistry and interaction with clouds and climate
- Geophysical Fluid Dynamics: models of flows at different spatio-temporal scales
- Land-atmosphere interaction: response of different types of land and ocean
- Atmospheric measurements
- Climate change: observations and simulation, Carbon sources and sinks
- Satellite meteorology

CLIMATE CHANGE

Efficacy of solar forcing to climate change in models is about 80% when compared to that by carbon dioxide. This research is useful for estimating the magnitude of climate change caused by volcanic eruptions, solar geo engineering and past climate changes.

MARINE ECOSYSTEM DYNAMICS

- The intense winter phytoplankton bloom during November–February in the northeastern Arabian Sea (NEAS) was thought to be controlled only by a convective deepening of the mixed layer. We found that remote winds through the

West India Coastal Currents inhibit mixed layer deepening here and thus affect productivity.

- There exists a large phytoplankton bloom in the northwestern Bay of Bengal during summer which is caused by local wind driven coastal upwelling.

THERMODYNAMICS OF BAY OF BENGAL

Rainfall and river water contribute equally towards the warming of the Bay of Bengal during summer. On the other hand, during winter, the river water causes cooling of the bay.

Faculty and Staff

G BALA | PhD (McGill), Professor

GS BHAT | PhD (IISc), FASc, Professor

ARINDAM CHAKRABARTHY | PhD (IISc), Associate Professor

RAVI S NANJUNDIAH | PhD (IISc), Professor

PN VINAYACHANDRAN | PhD (IISc), FASc, FNA, Professor

VENUGOPAL VURPUTUR | PhD (Minnesota), Associate Professor

SK SATHEESH | PhD (Kerala), FASc, FNASc, FNA, Professor

DEBASIS SENGUPTA | PhD (Bombay), Professor

JAI SUKHATME | PhD (Chicago), Assistant Professor

Associate Faculty

PROSENJIT GHOSH | PhD (Devi Ahiliya Vishwa Vidhyalaya, Indore), Associate Professor

Honorary Professor

J SRINIVASAN | PhD (Stanford), FASc, FNAE, FNA, Honorary Professor

Faculty members are involved in innovative, multidisciplinary research using geological, geophysical and geochemical tools to understand Earth processes. Equipped with state-of-the-art analytical facilities and wide-ranging expertise, they are working on diverse problems in earthquake geology, global tectonics, core dynamics, ocean-atmosphere interaction, modern and paleoclimate studies, petrology and geochemistry of igneous, sedimentary and metamorphic rocks.

Current Research

Research for this year focused on some of the following topics:

- Advances in understanding the time history of past great earthquakes in the central Himalaya; source processes of earthquakes and their relation to the tectonics.
- Mechanisms that support topography such as those in the India-Eurasia collision zone, evaluation of tomography and viscosity models that would give the best fit to the global geoid. Identification of the possible source of the Indian Ocean geoid low.
- Insights obtained on tectonic correlation of India and Madagascar; CO₂ migration during charnockites genesis modeled; evidence of crustal-scale subduction in Neo-Archean from high P-T granulites of Scotland and from chromite-silicate chemistry of the Sittampundi complex of southern India.

FACT FILE

ESTABLISHED **2007**

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DEGREE PROGRAMS OFFERED **PhD, MSc (Engg) and MTech**

IN NUMBERS

6 ACADEMIC STAFF

28 PhD, **1** MSc (ENGG)
AND **6** MTech STUDENTS

3 MTech AND **5** PhD CONFERMENTS

36 PUBLICATIONS

Chairperson: **D NAGESH KUMAR**

3.5.3

CENTRE FOR EARTH SCIENCES

- Stable isotopic compositions of the Hooghly river estuary has provided new insight on seasonality in the eastern part of the Indian sub-continent; Chromium recycling in the earth was explored using Cr stable isotopes in mantle-derived rocks and their weathering products. Geochemical signatures of middle and late Permian mass extinctions were studied.
- A new experiment has been set up to model convection in Earth's tangent cylinder region. The selection of axial dipole polarity in rotating dynamos was investigated. New experimental and analytical models are being developed for core-mantle interaction in the Earth.
- Estimating temperature of oil and gas formation in sedimentary strata. Retrieval of seasonality from fossil record of Phanerozoic age. Reconstruction of climate during Harappan civilization.

CORE RESEARCH

- Dynamo theory, Planetary magnetism, Magnetohydrodynamics, Vortex dynamics
- Paleoclimatology, Geobiology, Isotope Hydrology, Climate-Tectonics interaction
- Geochemistry, Microchronology Tectonics, Metamorphism and lower crustal processes Isotope geochemistry, origin and evolution of the Solar System, crust-mantle processes
- Paleoclimate reconstruction, early life signatures
- Solid Earth, Geophysics, Lithosphere dynamics, Mantle convection
- Mechanics of Faulting, Intraplate Seismicity, Seismic Hazard

Faculty and Staff

KUSALA RAJENDRAN | PhD (South Carolina), Professor

BINOD SREENIVASAN | PhD (Cambridge), Associate Professor

PROSENJIT GHOSH | PhD (DAV, Indore), Associate Professor

SAJEEV KRISHNAN | PhD (Okayama), Associate Professor

ATTREYEE GHOSH | PhD (Stony Brook), Assistant Professor

RAMANANDA CHAKRABARTI | PhD (Rochester), Assistant Professor

Associate Faculty

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DEBASIS SENGUPTA | PhD (Bombay), Professor

VENUGOPAL VURPUTUR | PhD (Minnesota), Associate Professor

JAI SUKHATME | PhD (Chicago), Assistant Professor

SUBRAMANIAN S | PhD (Mysore), FIIM, Professor



The Department of Chemical Engineering (CH) is a centre of excellence in chemical engineering research and education. It has 12 faculty members, 1 senior scientific officer, 1 junior scientific assistant, and 67 students carrying out research in both fundamental and applied areas with a strong synergy with industry.

Current Research

DEFLUORIDATION OF DRINKING WATER

Model predictions for the adsorption of fluoride onto activated alumina were fitted to data on batch titration and batch adsorption. The performance of the model was not very satisfactory. Similarly, the predicted breakthrough curve for column experiments was steeper than that observed.

GRANULAR FLOW

The discrete element method (DEM) was used to predict the lift force and the torque on a disc immersed in a

rotating granular material. The origin of the lift force is being investigated. A combination of rheometry, DEM simulations, and continuum modelling was used to understand dilatancy-driven secondary flows in dense granular materials.

HIV TREATMENT

Modeling of patient data showed that the fitness of the HIV strain in India was less than that in the west, suggesting that treatment may work better here.

FACT FILE

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DEGREE PROGRAMS OFFERED **PhD, MSc (Engg) and ME**

IN NUMBERS

15 ACADEMIC AND **1** SCIENTIFIC STAFF

5 MSc (ENGG), **4** MTech (RES), **9** MTech-D,
12 ME AND **47** PhD STUDENTS

3 MSc (ENGG), **6** ME AND **4** PhD CONFERMENTS

41 PUBLICATIONS

Chairperson: **GANAPATHY K AYAPPA**

3.5.4

CHEMICAL

ENGINEERING

SOFT-PARTICLE SUSPENSIONS

The rheology and shape dynamics of soft particles suspended in a viscous fluid are being studied. Droplet microfluidics was used to synthesize particles of tunable stiffness.

TRANSITION IN SOFT-WALLED TUBES

The critical Reynolds number for transition to turbulence was experimentally found to be much lower for a soft-walled channel than for one with rigid walls. Hence the mixing times were 100,000 times smaller than those due to diffusive mixing in microfluidic applications.

FLEXIBLE ELECTRONICS

Process development to fabricate nanostructured thin films on flexible substrates using low-cost additive patterning techniques such as inkjet printing, and product development to fabricate low-cost sensors for chemical/mechanical sensing were pursued.

CLATHRATE HYDRATES

Clathrate hydrates were studied using Monte Carlo and molecular dynamics simulations. The theory has been considerably improved by including the flexibility of the water lattice in the partition function.

CRYSTAL NUCLEATION

Crystal nucleation in systems such as binary hard-sphere mixtures, protein solutions and molecular crystals has been

studied by calculating the free energy of formation of the critical nucleus inside the fluid phase.

SUPERCAPACITORS AND FLOW BATTERIES

Supercapacitors are electrochemical devices that store energy and fall in between rechargeable batteries and dielectric capacitors in terms of power and energy densities. Techniques for atomistic simulation are being developed. Continuum models developed in our lab showed that the existing theories for macropores considerably underestimate the capacitance changes.

The soluble lead redox flow battery can be used for medium to large scale installations. New designs that use natural convection are being examined.

POINT-OF-CARE DIAGNOSTICS

Development of paper-based microfluidic devices that can conduct ultra-sensitive immunoassays for the detection of urine tuberculosis markers and highly accurate molecular assays for the detection of drug-resistance tuberculosis infections.

MEMBRANE BIOPHYSICS

Molecular dynamics simulations were used to study the interaction of pore forming toxins on lipid bilayer membranes. Coarse grained models reveal the intermediate pathways for the monomer to protomer transition. Super-resolution STED microscopy shows that pore blocking with dendrimers can potentially be used as a therapeutic strategy in disease prevention.

CORE RESEARCH

- Biomolecular Engineering • Catalysis and Reaction Engineering
- Colloids and Interface Science • Complex Fluids and Transport Processes • Nanotechnology • Energy Science and Engineering
- Environmental Engineering • Thermodynamics, Statistical Mechanics and Molecular Simulations

FLUIDS AT INTERFACES

Molecular simulations of water structure and dynamics on graphene-oxide materials reveal the influence of hydrophobic and hydrophilic patches on water adsorption and film growth. Molecular dynamics of fluids confined in slit pores reveal a glass-like structure and dynamics.

CATALYSIS

A microkinetic model for CO oxidation over palladium-substituted ceria was developed.

Platinum and ruthenium substituted titania catalysts were synthesized using the sonochemical method, and used for reforming and partial oxidation.

Photocatalysts using AgBr and Ag₃PO₄ with ceria nanoflakes as a substrate, and graphene oxide foams showed a high degradation of dyes and antimicrobial activity.

GLYCOPROTEIN ENGINEERING

The Pichia N-glycosylation pathway was re-engineered to mimic the human type N-glycosylation. These modifications

resulted in the conversion of the yeast Man₉₋₂₀GlcNAc₂ glycan structure to a more human like GlcNAc₂Man₃GlcNAc₂ form. Nanoparticle synthesis: A new spinning-disc spinning-bowl contactor was developed. The role played by molecules in influencing the birth of new particles is being examined.

NANOPORE ASSEMBLY

The kinetics of nanopore assembly by pore forming toxins was studied using imaging. Cholesterol was found to be a critical component for effective pore formation.

QUANTITATIVE VIRAL GENOMICS

A DNA sequencing workflow that allows accurate and error-free sequencing and quantification of the variability in virus infections was developed.

Faculty and Staff

GANAPATHY AYAPPA | PhD (Minnesota), Professor

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JAYANT M MODAK | PhD (Purdue), Professor

K KESAVA RAO | PhD (Houston), Professor

V KUMARAN | PhD (Cornell), Professor

PRABHU R NOTT | PhD (Princeton), Professor

SANJEEV KUMAR GUPTA | PhD (IISc), Professor

NARENDRA M DIXIT | PhD (Illinois), Associate Professor

SUDEEP PUNNATHANAM | PhD (Purdue), Associate Professor

RAHUL ROY | PhD (Illinois), Assistant Professor

S VENUGOPAL | PhD (Purdue), Assistant Professor

BHUSHAN J TOLEY | PhD (Massachusetts), Assistant Professor

PT RAGHURAM | MSc (Engg) (IISc), Senior Scientific Officer

The Department of Civil Engineering (CiE) was established in the year 1950 and has grown many fold over the years to become one of the finest centres of advanced research and training in the field. The Department focuses on research and education in the broad areas of Geotechnical Engineering, Structural Engineering, Transportation Engineering and Water Resources & Environmental Engineering.

Current Research

The research highlights in the department is discussed under four core areas.

GEOTECHNICAL ENGINEERING

The major focus was on mechanics and its real-life applications such as drilling, dredging, trawling, indentation, earthquake and foundation engineering. These include geomaterials such as soil, cemented sand, and rocks, pavement materials such as geocells. Various experimental techniques such as image based deformation analysis and computational tools such as finite element analysis

have been used to study severe plastic deformation in geomaterials such as soft rocks, inter-grain cementation, and mechanics at multiple length scales. This details study also involves multiple processes such as fracture, pore collapse, and plastic deformation. Computational models were developed for accurately quantifying the parameters needed to characterize sand particle morphology, including roundness, sphericity, angularity and roughness. Image based techniques for understanding the micro topographical surface changes in geosynthetics sheared by sands and relating them to stress-displacement response of sand-geosynthetic interfaces was carried out. A related

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DEGREE PROGRAMS OFFERED **PhD, MSc (Engg), ME (Civil Engineering with specialization in Geotechnical Engineering, Structural Engineering, Water Resources & Environmental Engineering) and MTech (Transportation & Infrastructure Engineering)**

IN NUMBERS

20 ACADEMIC AND **4** SCIENTIFIC STAFF

3 MSc (ENGG), **1** MTech, **6** MTech (RES),
32 MTech-D, **26** ME AND **112** PhD STUDENTS

2 MSc (ENGG), **2** MTech, **16** ME
AND **15** PhD CONFERMENTS

145 PUBLICATIONS

Chairperson: **SUDHAKAR M RAO**

3.5.5

CIVIL ENGINEERING

development was development of design methods for pavements using geocells and geogrids. Toward making buildings safer against earthquakes, a mixture material containing sand and waste tyre crumbs is developed that is found to reduce the seismic force by 40 to 70%. This development will provide low cost seismic isolation layer around footing for low to medium rise buildings, as well as recycle waste, thus making the technology environment-friendly. In the same context, dispersion curves from the field are arrived both by employing spectral analysis of surface waves (SASW) and multi-channel analysis of surface waves (MASW) using geophones. Considering the multimodal dispersion curves arrived from the inversion analysis, the shear wave velocity of ground was determined for different depths. On the environmental aspect, reliability analysis of landfill liners, covers and landfill locations are carried out. Furthermore, there were studies on methane emissions, settlement response of conventional and bio-reactor landfills and back analysis of landslides. The engineering response of soft clays to loading is challenging foundation engineering problem. Experimental studies demonstrated role of electrical forces of clays in governing the undesirable engineering response of soft marine clays. Besides, electrical forces, soil suction prevailing in shallow soil deposits have been shown to play significant role in minimizing contaminant transport from near-surface, hazardous waste disposal facilities.

WATER RESOURCES AND ENVIRONMENTAL ENGINEERING

New fuzzy approaches were developed for estimation of reliability of storm water drains in urban environment, and for prediction of hydro-meteorological variables and environmental extreme events (for example, floods, droughts, rain storms) at sparsely gauged and ungauged locations. Vadose zone flow model encompassing 2D, 3D situations is developed for a forested watershed especially by monitoring the watershed using geophysical tools and modelling using HYDRUS. Flow and transport model is developed to understand the behaviour of transport of virus and colloids in porous media and pore scale, especially under unfavourable condition and its upscaling and linkage to pore network

model to understand the flow and transport at Darcy scale. Methods were developed to estimate evapo-transpiration under cloudy conditions using microwave remote sensing satellite images.

Structural engineering; the research varied between mechanics of materials, structural mechanics, computational mechanics, and reliability engineering. Analytical models are developed to study the fracture and fatigue behavior of cementitious materials using multi-scale analysis. The effects of aggregate bridging, interfacial transition zone and microcracking on the post-peak behavior of concrete under flexure are studied. Metal-polymer contact mechanics, 3D computational contact problems, and large strain plasticity in sliding contacts. A hygro-thermo chemo mechanical model for concrete to predict the long term time dependent deformation of concrete capturing the drying process (shrinkage) and sustained loading (creep) has been developed. The same model has also been extended to capture the degradation of concrete under high temperature conditions. Studies are conducted on mechanics of natural fibre reinforced rammed earth, geopolymer based masonry units, and fine aggregates from granulated blast furnace slag. For solving very large scale problems using parallel computers, a domain-decomposition based method for solving stochastic mechanics problems is developed. Further on the computational mechanics, performance evaluation of isogeometric collocation method for bending analysis of laminated composite plates is carried out. An efficient primal shear locking free formulation for Reissner-Mindlin formulation is developed.

TRANSPORTATION ENGINEERING

The "Kumbh Mela Experiment", focussed on understanding crowd dynamics in mass gatherings, and the CLIMATRANS project focusing on climate change mitigation and adaptation from transport sector in developing countries. Both of these projects involve international and inter-institutional collaborator.

CORE RESEARCH

Geotechnical Engineering, Structural Engineering, Transportation Engineering, Water Resources and Environmental Engineering.

Faculty and Staff

- ANANTH RAMASWAMY** | PhD (Louisiana), Professor
- JM CHANDRA KISHEN** | PhD (Colorado), Professor
- DEBASISH ROY** | PhD (IISc), Professor
- GALI MADHAVI LATHA** | PhD (IIT Madras), Professor
- JAYANT KUMAR** | PhD (IISc), Professor
- CS MANOHAR** | PhD (IISc), Professor
- MS MOHAN KUMAR** | PhD (IISc), Professor
- PP MUJUMDAR** | PhD (IISc), Professor
- D NAGESH KUMAR** | PhD (IISc), Professor
- M SHEKAR** | PhD (IISc), Professor
- SITHARAM G THALLAK** | PhD (Waterloo), Professor
- GL SIVA KUMAR BABU** | PhD (IISc), Professor
- VV SRINIVAS** | PhD (IIT Madras), Professor
- M SUDHAKAR RAO** | PhD (Pune), Professor
- BV VENKATA RAMA REDDY** | PhD (IISc), Professor
- DEBRAJ GHOSH** | PhD (Johns Hopkins), Associate Professor
- P ANBAZHAGAN** | PhD (IISc), Assistant Professor
- ASHISH VERMA** | PhD (IIT Bombay), Assistant Professor
- NARAYAN K SUNDARAM** | PhD (Purdue), Assistant Professor
- TEJAS GORUR MURTHY** | PhD (Purdue), Assistant Professor
- KS NANJUNDA RAO** | PhD (IISc), Principal Research Scientist
- P RAGHUVeer RAO** | M Sc (Engg) (Bangalore), Principal Research Scientist
- R VIDYA SAGAR** | ME (Bharatiyar), Principal Research Scientist
- S VENKATESHA** | BE (Bangalore), Senior Scientific Officer

Centre for Product Design and Manufacturing (CPDM) is among the most research and technology intensive design and manufacturing schools in India, steeped in the ambience of Indian Institute of Science (IISc), Bangalore. IISc is one of the top institutions in the world, and CPDM is its design and manufacturing face.

Current Research

Research achievements at CPDM carried out in the following areas of product development are briefed below:

INNOVATION PROCESS AND INFORMATICS

A novel, multi-modal, online, crowd-source-enabled tool called Idea-Inspire 3.0 has been developed for structuring information on biological and engineered systems to be used as stimuli for supporting design ideation. Based on another novel representation, a tool called CRIS4P has been developed for structuring design rationale as issues faced and resolutions developed in designing

complex spacecraft mechanisms. In the second phase of the Entrepreneur in Residence (EIR) program, four new individuals have been selected for translation from prototype through product development to incubation. From the first phase, two start-ups have been founded and one has already generated revenues.

HUMAN FACTORS

A new laboratory called Intelligent Inclusive Interaction Design (I3D) Lab has been developed to undertake research

FACT FILE

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DEGREE PROGRAMS OFFERED **PhD, MSc (Engg) and MDes**

IN NUMBERS

7 ACADEMIC AND **1** SCIENTIFIC STAFF

51 MDes, **7** MSc (ENGG), **1** MTech (RES)
AND **51** PhD STUDENTS

14 MDes, **2** MSc (ENGG) AND
4 PhD CONFERMENTS

39 PUBLICATIONS

Chairperson: **AMARESH CHAKRABARTI**

3.5.6

CENTRE FOR PRODUCT DESIGN AND MANUFACTURING

in human computer interaction, intelligent user interfaces and inclusive design. A number of new interaction techniques for people with different range of abilities, automotive and military aviation environments have been proposed, using systems involving eye gaze, head, hand and finger movement trackers.

MATERIALS AND MANUFACTURING

A novel iso-contours based algorithm has been developed for planning deposition path for additive manufacturing of smooth heterogeneous material objects. The algorithm reduces the number of stops and starts in the deposition and improves the quality of the build. A smart manufacturing test bed has been developed for aerospace assembly; Another test bed is being developed for smart manufacturing of medical devices. The goal is to support big data analytics to enable manufacturing intelligence at the factory level, by real-time tracking, storage and integration of part, process, tools, people and environment parameters in a factory.

SUSTAINABILITY

Based on a novel Space-Time representation and an uncertainty-model based environmental sustainability assessment methodology, a tool called Space-Time LCA has been developed for supporting decision-making in distributed, complex, global manufacturing processes such as for aircraft manufacturing. An approach to support sustainability by design that includes a descriptive model for interaction and a prescriptive model for intervention has been developed. An approach to multi-criteria decision making for supporting design for disassembly at the End-of-Life stages of a system has been developed on a tool called 'Ide-Assemble'. An approach has been developed for evaluating energy-neutrality in the design of energy saving devices for buildings. A portable water treatment unit integrating filtration through activated nano-tubes and UV has been developed. The system is envisaged as an IOT device with sensors to detect water and geo-referencing for potential water-contamination risks.

CORE RESEARCH

- Product Development Process, Informatics, Innovation - Creativity, Biomimetics, KBS, Entrepreneurship
- Human Factors – Digital anthropometry, Modelling, HMI, OHAS
- Technology Integration – Medical Devices, CAD/CAE Sustainability – green buildings, sustainable materials, Design for BoP
- Materials and Manufacturing - computational metrology, metal foams, biocomposites, smart factory, additive mfg
- Entrepreneurship and Education – Translation and Design Innovation

Faculty and Staff

AMARESH CHAKRABARTI | PhD (Cambridge), Professor

ANINDYA DEB | PhD (New York), Professor

B GURUMOORTHY | PhD (Carnegie Mellon), Professor

DIBAKAR SEN | PhD (IISc), Associate Professor

RINA MAITI | PhD (IIT Bombay), Assistant Professor

MANISH ARORA | PhD (Twente), Assistant Professor

PRADIPTA BISWAS | PhD (Univ of Cambridge), Assistant Professor

ND SHIVAKUMAR | ME (Bangalore), Principal Research Scientist

Associate Faculty

GK ANANTHASURESH | PhD (Michigan), Professor

JAYWANT ARAKERI | PhD (Caltech), Professor

ASHITAVA GHOSAL | PhD (Stanford), Professor

SATISH VASU KAILAS | PhD (IISc), Professor

MONTO MANI | PhD (IIT Madras), Professor

MARY MATHEW | PhD (IISc), Professor

NV CHALAPATI RAO | Principal Research Scientist



The Centre for Sustainable Technologies established 1974 as ASTRA (Application of Science and Technology for Rural Areas), pursues cross-cutting collaborative research in areas of sustainable energy, buildings and environment. Current research addresses a host of global concerns while focusing on decentralized S&T based interventions: efficient use of primary resources, development of low energy buildings, building integrated photovoltaics, waste & sanitation, clean & renewable energy, waste management including sanitary land filling, waste to energy, waste recycling & waste disposal, bio-mass for energy, plasma technology, bio-methanation, turbomachinery research for energy & water pumping, and climate change & response.

Current Research

- Anaerobic digestion of biomass for energy and treatment of wastewater, including biofilms to treat xenobiotic dosed greywater.
- Development of a stove-mould assembly for rapid self-construction of fuel-efficient domestic cooking and bath stoves, jaggery furnaces and driers with high operating efficiency and lower cooking time in comparison to other technologies.
- Important real-time assessment of Life-cycle energy for vernacular and conventional buildings providing crucial insight into energy in buildings and reference database.
- Experimental investigation into the temperature dependent conductivity for conventional and alternate building materials, and conducting simulations for various climatic zones.

FACT FILE

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DEGREE PROGRAMS OFFERED **PhD and MSc (Engg)**

IN NUMBERS

5 ACADEMIC AND **1** SCIENTIFIC STAFF
1 MSc (ENGG), **1** MTech (RES)
AND **26** PhD STUDENTS
4 PhD CONFERMENTS
31 PUBLICATIONS

Chairperson: **HN CHANAKYA**

3.5.7

CENTRE FOR SUSTAINABLE TECHNOLOGIES

- Developing and testing an integrability methodology for BIPV performance, including building climatic-response and PV performance for various climatic zones and supports evaluation of suitable building design.
- Development of a de-skilling technology for rapid self-construction of sanitation units based on portable mould design adopting (local) rammed-earth technology. The waste-handling is based on pre-charged water-based composting pit, suitable for habitations with very low-water table.
- Landfills are examined by characterization of municipal solid waste, leachate and landfill gas. Model bioreactors are setup and their performance is analyzed against available literature models. Design of landfill components such as liners, covers, leachate collectors and site location are studied using risk and reliability analysis principles.
- The research focuses on designing and building turbomachinery equipment covering both generation and utilization aspects of renewable energy including decentralized systems. Hydro turbomachinery (turbine and water pumps) and thermal turbomachinery (organic rankine cycles, high pressure ration steam, and super critical CO₂) are included. Innovative machinery for pumped hydro energy storage to ensure greater renewable energy penetration and grid stability are also envisaged.
- Projection of Climate Change at State and District level and Assessment of Impact of Climate Change on Forests and Vulnerability of Forests to Climate Change.
- Impacts of climate change on forests and vulnerability of forests to climate change has been assessed at the National Level and most vulnerable forest types and regions have been identified.
- Non-Thermal Plasma Cleaning, Enrichment and Reforming of Gaseous Hydrocarbons. Plasma activated water characterization and its application for surface hygiene and food preservation. Plasma grey water treatment for recycling purposes.
- The major focus on the thermo-chemical conversion of biomass is towards generating PEM quality hydrogen-99.999% purity for transport sector.
- Establishing renewable energy fuel for Solid Oxide fuel cell (SOFC).
- Industrial waste blast furnace slag is being studied for its use as fine aggregate in mortar and concrete.

CORE RESEARCH

- Biomethanation • Energy Efficient Wood Burning Devices
- Alternative & Green Building Technologies
- Sustainable Architecture and climate-responsive designs
- Building Integrated Photovoltaics
- Sanitation • Waste Management
- Turbomachinery for Renewable Energy
- Forestry, Bioenergy and Climate Change
- Hydrogen from Biomass, SOFC
- Granulated blast furnace slag as fine aggregate

Faculty and Staff

NH RAVINDRANATH | PhD (IIT Bombay), Professor

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PUNIT SINGH | PhD (Karlsruhe), Assistant Professor

LAKSHMINARAYANA RAO M P | PhD (McGill Univ, Canada), Assistant Professor

HN CHANAKYA | PhD (UAS), Chief Research Scientist

HI SOMASHEKHAR | MSc (UAS), Technical Officer

D VENKATAKRISHNAPPA | MSc (Bangalore), Scientific Assistant

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G L SIVA KUMAR BABU | PhD (IISc), Professor

M SUDHAKAR RAO | PhD (Pune), Professor

BV VENKATA RAMA REDDY | PhD (IISc), Professor

TV RAMACHANDRA | PhD (IISc), FNESA, FIE, FIEE(UK), FIH, Scientific Officer

P BALACHANDRA | PhD (IISc), Principal Research Scientist

The primary goal of the Divecha Centre for Climate Change (DCCC) is to understand climate variability and climate change and its impact on the environment. The Centre is working with various departments to identify technologies to mitigate/reduce the severity of climate change. The Centre frequently undertakes outreach activities to create awareness among people and policy makers about climate change and its consequences especially on society.

Current Research

DIVECHA CENTRE GRANT FROM THE GRANTHAM FOUNDATION (GFPE-001)

Mainly, we are involved in various topics related to atmospheric science, Himalayan glaciers and basic and applied research in renewable energy. Experiments using high-altitude balloons have shown large amounts of black carbon aerosols at higher atmospheric levels. Model simulations have shown that while biomass burning and near-surface anthropogenic activities together with boundary layer dynamics can explain at least part of the lower layer; upper layer can be explained only by including emissions

from high-flying aircrafts. Our studies indicate that once black carbon aerosols are emitted at higher atmospheric levels, they can be lofted further via absorption-warming-convection cycles, which could propel them even to the stratospheric heights. Once they reach stratospheric heights, chemical reactions occurring over their surfaces could have strong implications for the ozone layer.

The effect of atmospheric conditions like aerosols, temperature and water vapour on the power output has been studied using Concentrated Photo Voltaic (CPV) modules on

FACT FILE

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IN NUMBERS

17 PUBLICATIONS

Chairperson: **S K SATHEESH**

3.5.8

DIVECHA CENTRE FOR CLIMATE CHANGE

a dual-axis sun tracker. We are also involved in research to fabricate thin film solar cells, which are semi-transparent following low cost processes. The envisaged application for these cells is for windows and skylights of buildings.

We have studied various aspects of GHG inventory, mitigation and adaptation for India to meet the requirements of the Paris Agreement. They have identified requirements for modelling and measurements at the national, state, industry and municipal levels as well as research and capacity building requirements for enabling India to meet these requirements.

DST GRANT

Studies on glaciers have shown that though the rates of retreat of individual glaciers are uncertain, on the whole the Himalayan glaciers are losing mass at an increasing rate over the past few decades. With the changing climate, glaciers would continue to shrink and the rates of retreat may increase even further. This can lead to the formation of glacial lakes, which, with continued accumulation of glacier melt could burst leading to catastrophic impacts on human life, settlement and infrastructure downstream.

By using glacier surface velocity, estimated using high spatial resolution satellite data and slope, we have calculated ice thickness, by applying a basic parallel flow model, subsequently outlining the bed topography and located potential lake sites in over-deepening in the bedrocks. We have also developed a model to predict the future expansion of lakes. The measurements go in line with the model projection. The model predictions have been validated using field investigations. A proposal to avoid flash flood has been accepted by the government of Sikkim, a north eastern state in India.

CORE RESEARCH

- Glaciers, Renewable Energy, Aerosols and their impacts on climate, Atmospheric boundary layer, Cloud Physics, Geophysical fluid dynamics.
- Monsoon variability and predictability, Numerical simulation of the Atmosphere-Ocean-Climate system, Paleoclimate studies, Physical-Chemical-Biological oceanography, Satellite meteorology, Space-time structure and scaling in geophysical data, Tropical convection.

Associate Faculty

G BALA | PhD (McGill), Professor

GS BHAT | PhD (IISc), FASc, Professor

ARINDAM CHAKRABARTHY | PhD (IISc), Associate Professor

PROSENJIT GHOSH | AP/CEaS, Associate Faculty

ANIL V KULKARNI | PhD (Kolhapur), Distinguished Visiting Scientist

PP MUJUMDAR | PhD (IISc), Professor

RAVI S NANJUNDIAH | PhD (IISc), Professor

SHEELA K RAMASESHA | PhD (IISc), Consultant Scientist

NH RAVINDRANATH | PhD (IIT Bombay), Professor

SK SATHEESH | PhD (Kerala), FASc, FNASc, FNA, Professor

DEBASIS SENGUPTA | PhD (Bombay), Professor

J SRINIVASAN | PhD (Stanford), FASc, FNAE, FNA, Emeritus Professor

RAMAN SUKUMAR | PhD (IISc), Professor

PN VINAYACHANDRAN | PhD (IISc), FASc, FNA, Professor

VENUGOPAL VURPUTUR | PhD (Minnesota), Associate Professor



Established in 1945 as Department of Metallurgy and re-named in 2006, the Department of Materials Engineering (MT) has a rich history of accomplishments, with active groups pursuing research into materials phenomena spanning multiple length and time scales. With over 150 research papers published each year, and with academic programmes leading to bachelors, masters and doctoral degrees, it is recognized as a leading academic centre in materials education and research.

Current Research

A new class of reflector materials has been developed by tuning intermetallic phases in Cu-Sn and Cu-Al system for solar thermal applications. Another notable study explored the origin of tin-whiskering; through a combination of metallurgical and mechanistic tools, this study showed for the first time that it is possible to pin-point the location of a whisker grain before a whisker could begin to grow. Specifically, this study categorically revealed that whisker grew from the grains with low index (100) or near (100) grain orientation. A study of deformation mechanisms in nanocrystalline Ni-Co alloys, in which the stacking fault energy (SFE) spans a wide range,

has revealed that deformation texture and microstructures depends both on grain size and SFE. A detailed study of texture development in sputter deposited films of NiMnGa has showed ways of preparing with texture (ranging from biaxial to epitaxial) by a suitable choice of substrates (Si, Sapphire, MgO) and processing parameters.

Significant advances in biomaterials research include (a) development of nanoscale topography on titanium that mimics the topography observed on insect wings to impart bactericidal and osteogenic activity to the metal for

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DEGREE PROGRAMS OFFERED **PhD, MSc (Engg), ME and BS**

IN NUMBERS

22 ACADEMIC AND 4 SCIENTIFIC STAFF

21 MTech-D, 26 ME AND 119 PhD STUDENTS

1 MSc, 15 ME AND 22 PhD CONFERMENTS

200 PUBLICATIONS

Chairperson: **TA ABINANDANAN**

3.5.9

MATERIALS

ENGINEERING

orthopedic applications; (b) development of a new technique for drug loading in polymers for controlled release of the drug; in contrast to conventional techniques, drugs were conjugated in the backbone of the polymers for sustained release at high concentration; (c) development of a mesoporous silica-based drug delivery system and albumin based systems for treating typhoid and cancer, respectively; and (d) an enhancement of flotation selectivity of sphalerite using mineral stressed *Paenibacillus polymyxa* and its cellular components.

Research on novel graphene-based materials and composites has made great progress in 2016. For example, electrochemical exfoliation and mechanical milling have been used to synthesize graphene and graphene-nanoparticle composites. Further, electrochemical behaviour of Graphene-Zn, Graphene-Cr and Graphene-Sn coatings has been characterized. In another study, a single graphene layer embedded in a flexible polymer film was shown to retard water vapor transmission (WVT) through the film by up to a million times; this effect, which offers a great potential to extend the life of organic photovoltaics, has been demonstrated on a large-area transparent films which showed an ultra-low WVT rate even after 1000 cycles of bending. A novel approach, based on crystallization-induced phase separation was used to develop nanoporous designer membranes for water purification; their unique architectures were shown to result in higher water flux than in conventional membranes. Similarly, site-specific decoration of various ferrites on graphene oxide sheets was used to design and develop radar-absorbent composite materials that can absorb more than 90 % of the incoming electromagnetic radiation.

A new technique of small-scale cantilever bending creep has been developed to study high temperature deformation in thin films and coupons extracted from components in service. The research group on functional ceramics has demonstrated for the first time that the crystallographic phase of the ferroelectric phase can be changed by size reduction on a supertetragonal model system based on the system bismuth ferrite - lead titanate. The group has also proposed an alternative structural mechanism involving electric-field driven long-period modulated to non-modulated structural transformation to explain the anomalously large high-field electro-strain behaviour of lead-free piezoceramics based on sodium bismuth titanate.

Research in computational modeling addressed a variety of problems in 2016. The classical Zener theory of precipitate growth has been extended to generic multi-component alloys with arbitrary diffusivities. A novel phase-field model has been developed for studying (i) electromigration of voids under the influence of electronic current in metallic interconnects, (ii) pitting corrosion in metallic alloys. Another study has examined Rayleigh instability of cylindrical (infinite, finite-closed, and finite-open) pores.

The department has begun a new in the field of flexible printed electronics, bringing in a significant addition to our portfolio of research in electronic materials and devices.

CORE RESEARCH

Polymers; Biomaterials; Structural metal alloys including steels; High temperature coatings; Electronic and structural ceramics; Electronic packaging materials; Mineral processing; Energy materials; Computational Materials Science.

Faculty and Staff

- TA ABINANDANAN** | PhD (Carnegie Mellon), Professor
- GS AVADHANI** | PhD (IISc), Principal Research Scientist
- DIPANKAR BANERJEE** | PhD (IISc), FASc, FNA, FNAE, FNASc, FIIM, Professor
- SURYSARATHI BOSE** | PhD (IIT Bombay), Assistant Professor
- KAUSHIK CHATTERJEE** | PhD (Penn State), Assistant Professor
- ATUL H CHOKSHI** | PhD (USC), FASc, FNASc, FNA, FNAE, FIIM, Professor
- ABHIK N CHOUDHURY** | PhD (Karlsruhe), Assistant Professor
- SUBHO DASGUPTA** | PhD (TUD, Germany), Assistant Professor
- RJ DESHPANDE** | MSc (Engg) (IISc), Senior Scientific Officer
- GOVIND S GUPTA** | PhD (Wollongong), Professor
- VIKRAM JAYARAM** | PhD (Stanford), FASc, FNASc, FNAE, FACerS, FIIM, Professor
- S KARTHIKEYAN** | PhD (Ohio State), Associate Professor
- PRAVEEN KUMAR** | PhD (USC), Assistant Professor
- SUBODH KUMAR** | PhD (London), Professor
- P PADAIKATHAN** | MSc (Engg) (Bangalore), Senior Scientific Officer
- ALOKE PAUL** | PhD (Delft), Associate Professor
- ASHOK M RAICHUR** | PhD (Nevada), FRSC, Professor
- PRAVEEN C RAMAMURTHY** | PhD (Clemson), Associate Professor
- U RAMAMURTY** | PhD (Brown), FNA, FNAE, FASc, Professor
- RAJEEV RANJAN** | PhD (BHU), Associate Professor
- R RAVI** | PhD (IISc), Principal Research Scientist
- VIJAY SETHURAMAN** | PhD (South Carolina), Assistant Professor
- CHANDAN SRIVASTAVA** | PhD (Alabama), Associate Professor
- S SUBRAMANIAN** | PhD (Mysore), FIIM, Professor
- MK SURAPPA** | PhD (IISc), FNAE, FNA, Professor
- SATYAM SUWAS** | PhD (IIT Kanpur), Professor

Honorary and Emeritus professors

- KAMANIO CHATTOPADHYAY** | PhD (BHU), FASc, FNASc, FNA, FNAE, FIIM, Honorary Professor
- KISHORE** | PhD (IISc), Emeritus Professor
- KA NATARAJAN** | PhD (Minnesota), DSc (IISc), FASc, FNASc, FNAE, FIIM, Emeritus Professor
- KT JACOB** | PhD (London), DSc (Engg) (London), FASc, FNASc, FNA, FNAE, FIIM, Emeritus Professor
- S RANGANATHAN** | PhD (Cambridge), FASc, FNA, FNASc, FNAE, FTWAS, FIIM, Emeritus Professor

The Department of Mechanical Engineering (ME) offers Masters (MTech and MTech (Research)) and PhD programmes and provides the opportunity to the students to do research in a large set of thrust areas. Some of the specific areas are Computer-Aided Design and Manufacturing, Rapid Prototyping, Robotics and Controls, Turbomachinery and Combustion Systems, IC Engines, Multi-Phase flow, Turbulence, Nano-mechanics, Tribology, Computational Fluid Dynamics and Acoustics. The alumni and staff of this department occupy high positions in institutions of higher learning, research laboratories and industries in India and abroad.

Current Research

SOLID MECHANICS

Continuum finite element analysis of tensile loading of nano-sized notched metallic glass specimens were conducted using a thermodynamically consistent non-local plasticity model. It was found that plastic zone size in front of the notch attains a saturation level at the stage when a dominant shear band forms extending across the specimen. This size scales with an intrinsic material length associated with the interaction stress between flow defects (shear transformation zones). A transition in deformation behavior from quasi-brittle to ductile was shown to occur when this critical plastic zone size is larger than the

uncracked ligament length. These observations provide key insights on molecular dynamics and experimental results from a mechanics perspective. Brittle metallic glasses exhibit a unique and intriguing fracture morphology of periodic nanocorrugations whose spacing and amplitude are of the order of tens of nanometers. Continuum simulations were employed to show that they fail by spontaneous and simultaneous cavitation within multiple weak zones arising due to intrinsic atomic density fluctuations ahead of a notch tip. Dynamic crack growth would then occur along curved but narrowly confined shear bands that link the growing cavities. This mechanism involves little dissipation and also explains

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DEGREE PROGRAMS OFFERED **PhD, MSc (Engg) and ME**

IN NUMBERS

18 ACADEMIC AND 5 SCIENTIFIC STAFF

**114 PhD, 16 MSc (ENGG), 4 MTech (RES),
21 MTech-D AND 20 ME STUDENTS**

**5 MSc (ENGG), 19 ME AND
23 PhD CONFERMENTS**

117 PUBLICATIONS

Chairperson: **PRADIP DUTTA**

3.5.10

MECHANICAL ENGINEERING

the formation of nanocorrugations – a long unresolved mystery pertaining to mechanics of fracture of these materials.

Finite element simulations of cylindrical void growth corresponding to different stress states in Mg single crystal were performed. Two lattice orientations were considered with the c-axis along the thickness in one orientation and major principal stress direction in the other. Profuse tensile twinning occurred in the second orientation. The results showed pronounced effect of texture hardening triggered by tensile twinning in slowing down void growth. The simulations also predicted a transition in void coalescence mechanism from internal ligament necking to shear localization along an inclined band with reduction in biaxiality stress ratio when tensile twinning occurs.

TRIBOLOGY

1. Study of contact conditions in a Continuous Variable Transmission (CVT) – Renault Technology and Business Centre India Private Limited. The project is to study the tribological phenomena occurring during the contact between the pin and the pulley in a Continuous Variable Transmission.

2. Surface and Sub-Surface Characterization of Holes Drilled/ Reamed in 4340M Steel and its Relation to Mechanical Properties – Boeing. The project is to study the parameters that control the life of a drilling and reaming tool during machining of steels. The parameter include the effect of transformed layer thickness near the drilled hole and surface roughness of the drilled hole on the fatigue strength and residual stress.

3. Mechanical joining of sheets – Technology Development Mission, ARCI. The project envisages the study of clinching and Self-piercing riveting of steels and aluminum sheets

DESIGN AND BIOMATERIALS

1. Compliant mechanisms, design optimization: Analysis and design of bimodal bistable compliant mechanisms with applications to an assistive chair, circuit-breakers, and RF MEMS switch.

2. Mechanobiology, tissue mechanics, biomaterials and biomimetics: Arterial mechanics studies shows the importance of hierarchical organisation in the composite, nonlinear and anisotropic constitutive properties of biological tissues. Mechanobiology studies on breast cancer cells shows the use of traction forces to characterize the cell contractility. Biomaterials studies using fig wasp ovipositors and stem borer mandibles suggests novel zinc enrichment mechanisms that are employed by insects in increasing the material hardness. Such studies are useful in design of pesticides and in using biomechanical studies to characterize plant-insect interactions.

FLUID MECHANICS AND THERMAL SCIENCES

Buoyancy influences in turbulence are important in many natural (eg. in the atmosphere and in the oceans) and industrial flows. A new and relatively unexplored type of buoyancy driven turbulent flow – axially homogeneous convection in a vertical tube - has been studied in the Mechanical engineering department for the past several years. Recent experiments have been done at very high Rayleigh numbers (highest anywhere in the world) and using heat to drive the turbulence. Some of the new results in this flow are discovery of the existence of two regimes of turbulent convection, effects of buoyancy on the kinetic energy and scalar spectra and the nature of light propagation through convective turbulence.



CORE RESEARCH

- Solid Mechanics • Fluid Mechanics • Materials
- Combustions • Thermal Science • Design
- Biomechanics • Technical Acoustics and vibrations

Faculty and Staff

GK ANANTHASURESH | PhD (Michigan), Professor
ASHITAVA GHOSAL | PhD (Stanford), Professor
CHANDRASEKHAR S JOG | PhD (Urbana), Professor
JAYAWANT H ARAKERI | PhD (Caltech), Professor
R NARASIMHAN | PhD (Caltech), Professor
PRADIP DUTTA | PhD (Columbia), Professor
R V RAVIKRISHNA | PhD (Purdue), Professor
SATISH V KAILAS | PhD (IISc), Professor
K R YOGENDRA SIMHA | PhD (Maryland), Professor
M S BOBJI | PhD (IISc), Associate Professor
NAMRATA GUNDIAH | PhD (California), Associate Professor
RAGHURAMAN N GOVERDHAN | PhD (Cornell), Associate Professor
SAPTARSHI BASU | PhD (Connecticut), Associate Professor
VENKATA R SONTI | PhD (Purdue), Associate Professor
GAURAV TOMAR | PhD (IIT Kanpur), Assistant Professor
PRAMOD KUMAR | PhD (IISc), Assistant Professor
RATNESH K SHUKLA | PhD (California), Assistant Professor
RAMSHARAN RANGARAJAN | PhD (Stanford), Assistant Professor
GSVL NARASIMHAM | PhD (IISc), Chief Research Scientist
C DHARUMAN | MSc (Engg) (IISc), Senior Scientific Officer
M HIMABINDU | PhD (Anna), Senior Scientific Officer
MK VENKATARAMAN | MSc (Engg) (IISc), Scientific Officer
R THIRUMALESWARA NAIK | PhD (IIT Delhi), Scientific Officer

Associate Faculty

B GURUMOORTHY | PhD (Carnegie Mellon), Professor
DIBAKAR SEN | PhD (IISc), Associate Professor



3.6.

Division of

**PHYSICAL
AND
MATHEMATICAL
SCIENCES**

Research in the Division covers a wide variety of areas in the Physical Sciences, including fundamental investigations in String Theory, Particle Phenomenology, Field Theory, Condensed Matter Physics, both theoretical and experimental, Soft-Matter and Complex Systems, Biology-Inspired Physics, Biomolecular Structure and Biophysics, Atomic and Optical Physics, Astronomy and Astrophysics, and cutting-edge Applied Physics research including MEMS-based and Fibre-Optic Sensors, Multifunctional Materials, such as graphene and carbon nanotubes, Super-Resolution Fluorescence Microscopy, Nano-Scale Imaging, Optics and Microfluidics, Energy- and Health-Monitoring Instrumentation, and Cryogenic Technologies, including Cryocoolers, Cryogenic Instrumentation, and Cryogenic treatment on materials. Research in Mathematics covers major areas, both pure and applied, including Probability, Partial Differential Equations, Analysis, Geometry, Topology, Algebra, Algebraic Geometry, and Analytic Number Theory.

DEPARTMENTS | CENTRES | UNITS

- ◆ CENTRE FOR CRYOGENIC TECHNOLOGY
- ◆ CENTRE FOR HIGH ENERGY PHYSICS
- ◆ INSTRUMENTATION AND APPLIED PHYSICS
- ◆ MATHEMATICS
- ◆ PHYSICS

IN NUMBERS

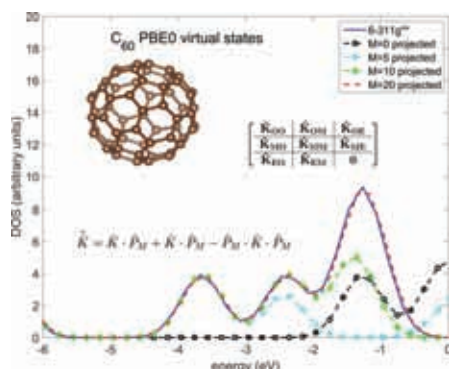
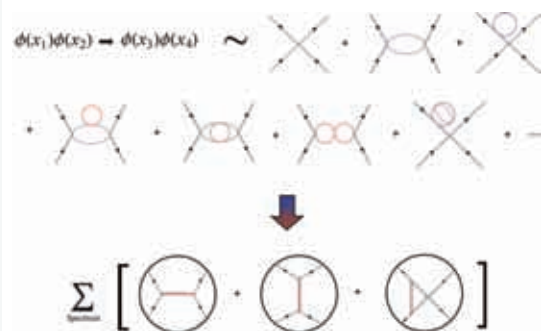
- ◆ **73** FACULTY MEMBERS
- ◆ **58** FELLOWSHIPS OF SCIENCE ACADEMIES IN INDIA
- ◆ **319** PhD, **16** MASTER'S AND **122** INTEGRATED PhD STUDENTS
- ◆ **39** PhD AND **2** MASTER'S STUDENTS GRADUATED IN 2015-16

THEMES

Given the diversity of this Division, there is a diversity of themes in research. These can be gleaned from the core research areas mentioned above. Many of these areas lie in the exact sciences, both theoretical and experimental. Along with these, there are growing interdisciplinary programmes, such as in Mathematical Biology and Nanoscience. Translational research is also being carried out and products, based on innovative and cutting-edge technologies, are being brought into the market by faculty entrepreneurs in the division.

Chairperson: **RAHUL PANDIT**

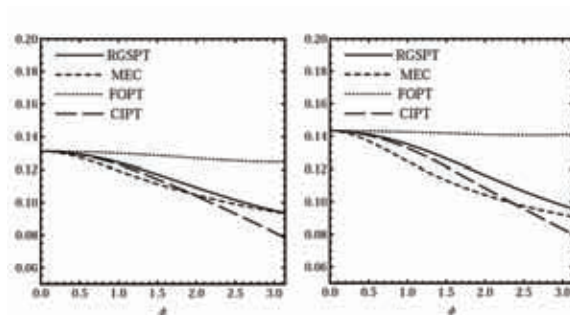
The usual expansion in quantum field theory in terms of Feynman diagrams is tedious and leads to infinities. A new method, which is finite, uses a different basis in terms of a new set of diagrams. The method correctly reproduces old results and promises to produce new results which have never been computed using the Feynman diagram expansion [Gopakumar R, Kaviraj A, Sen K and **Sinha A**. Conformal Bootstrap in Mellin Space. *Physical Review Letters*. 2017. 118(8):081601].



Computing the properties of molecules using density functional theory is computationally expensive, especially for larger systems. A new scheme speeds up such computations by two orders of magnitude [Boffi NM, **Jain M**, and Natan A. Efficient Computation of the Hartree–Fock Exchange in Real-Space with Projection Operators. *Journal of Chemical Theory and Computation*. 2016. 12:3614–3622].

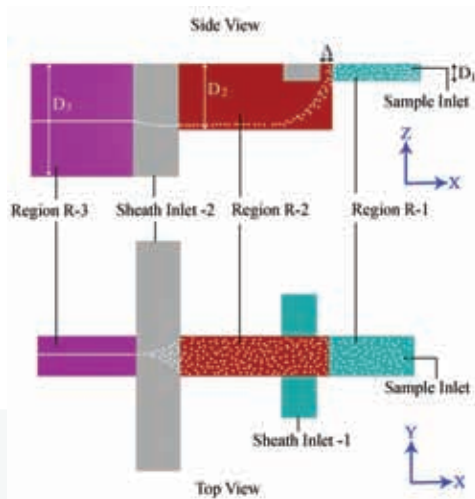
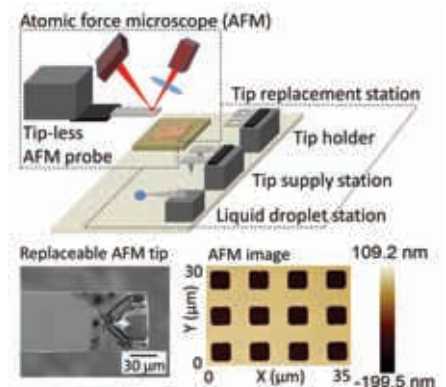


The strange quark cannot be seen in isolation, making the notion of its mass tricky. A new method, renormalization group summed perturbation theory, or RGSPT, has been developed to extract the mass of the strange quark from experimental data, and the results compare well with existing methods (**Ananthanarayan B** and Das D. Optimal Renormalization and the Extraction of the Strange–Quark Mass from Moments of the tau-decay Spectral Function. *Physical Review D*. 2016. 94:116014).



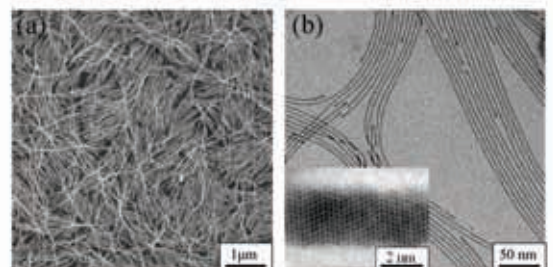
RESEARCH SNAPSHOTS 2016

A system to quickly replace and reuse tips in an atomic force microscope has been developed. A prototype with the replaceable tip gave images of similar quality as conventional AFM tips (Mrinalini RSM and **Jayanth GR**. A System for Replacement and Reuse of Tips in Atomic Force Microscopy. *IEEE/ASME Transactions on Mechatronics*. 2016. 21(4)).

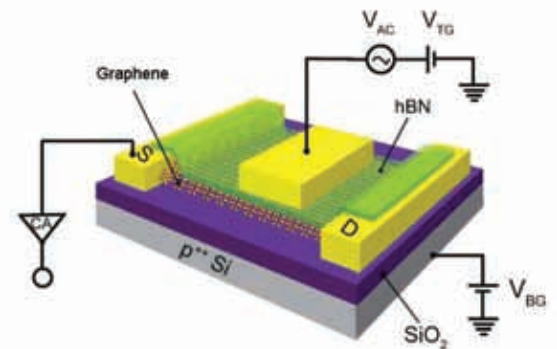


A new method to achieve both 2D and 3D flow focusing in a microfluidic device. The method uses abrupt channel depth variation and a shift in one of the junctions where the sample and sheath fluids meet (Eluru G, Julius LAN and **Gorthi SS**. Single-Layer Microfluidic Device to Realize Hydrodynamic 3D Flow Focusing. *Lab on a Chip*. 2016. 16:4133-4141).

Gold nanowires of diameter 2 nm were found to be very sensitive to their ambient environment and could detect methanol or acetone. This may enable them to be used for making chemical sensors, hitherto made using wires of semiconductors or metal-oxides (Amin KR, Kundu S, Biswas S, Roy A, Singh AK, Ravishankar N and **Bid A**. Effect of Ambient on Electrical Transport Properties of Ultra-Thin Au Nanowires. *Applied Physics Letters*. 2016. 109: 253108).



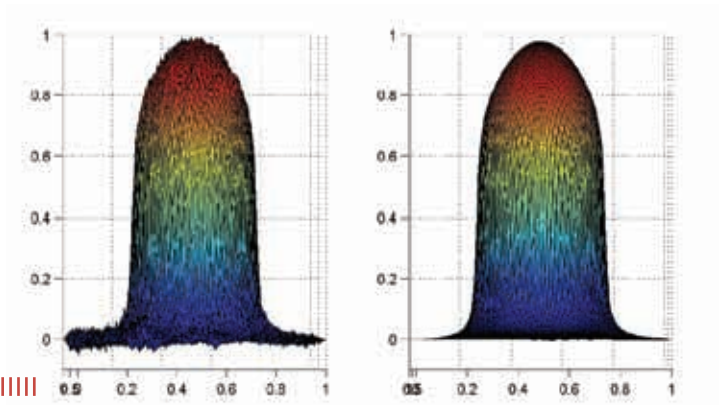
Electrons behave differently depending on whether they are present inside or outside a solid. This image shows the schematic of the measurement setup, where an atomic layer of graphene is encapsulated between insulating atomic layers of boron nitride. Electrons in graphene flow from the source (S) to the drain (D) when a small bias voltage is applied; the number of electrons is monitored by applying gate voltages (Kumar C, Kuiri M, Jung J, Das T and **Das A**. Tunability of $1/f$ Noise at Multiple Dirac Cones in hBN Encapsulated Graphene Devices. *Nano Letters*. 2016. 16(2):1042-1049).



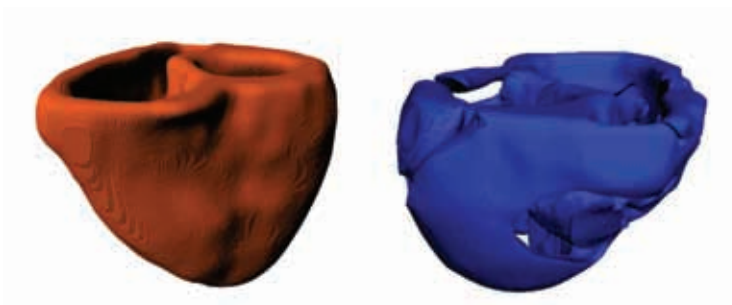
The Hasse diagram of all partially-ordered sets of size 5 ordered according to order relations. Next to each partially-ordered set P is the second-largest eigen value of the transition matrix of the P -random-to-random shuffle Markov chain (Ayyer A, Schilling A and Thiery NM. Spectral gap for random-to-random shuffling on linear extensions. *Experimental Mathematics*. 2017. 26: 22-30).



Suppressing spurious oscillations efficiently by a new patch-wise local projection method for the convection-diffusion equation. Unstabilized solution (left) and Stabilized Solution (right) (Dond AK and **Gudi T**. Patch-wise local projection stabilized finite element methods for convection-diffusion problem. To be published).



Left: Image of our anatomically realistic simulation domain for the right and left ventricles of a human heart. Right: Screenshot from a movie showing the transmembrane potential from simulations of the chaotic spatiotemporal evolution of a broken scroll wave of electrical activation in this anatomically-realistic, 3D simulation domain (512^3 collocation points and with information about muscle-fiber orientation); it uses the Ohara-Rudy ionically realistic mathematical model for cardiac cells. These simulations have been carried out on the SahasraT by Soling Zimik (in the group of **Rahul Pandit**). Such simulations help us to develop a detailed understanding of life-threatening cardiac arrhythmia like ventricular fibrillation, which is the leading cause of death in the industrialized world (one in every six deaths).



RESEARCH HIGHLIGHTS

The Division of Physical and Mathematical Sciences comprise the Departments of Instrumentation and Applied Physics, Mathematics, and Physics, including the Astronomy and Astrophysics Programme, and the Centres of High Energy Physics (CHEP) and Cryogenic Technology (CCT). Faculty members in this Division have received several awards and honours for their research. Their research has been supported by grants from major agencies and ministries such as the Department of Science and Technology, The Council for Scientific and Industrial Research, the Department of Biotechnology, the Defence Research and Development Organization, the Indian Space Research Organization, and the University Grants Commission.

The Centre for Cryogenic Technology (CCT) supports low-temperature research across the Institute through the regular supply of liquid nitrogen and liquid helium. Major users of the facility are experimental groups in Physics, Chemistry, Biology, and the NMR Research Centre. Apart from its role as an Institute facility, the faculty of the Centre also undertake research projects in diverse areas of cryogenics.

CORE RESEARCH

Cryocoolers, calibration of temperature and cryogenic liquid-level sensors, thermal conductivity measurement systems, cryogenic treatment on metals, cryo-adsorption studies, and cryogenic instrumentation and systems. Illustrative highlights of research and development carried out over the past year given below.

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IN NUMBERS

1 ACADEMIC AND 2 SCIENTIFIC STAFF

7 PUBLICATIONS

Chairperson: V VENKATARAMAN

3.6.1

CENTRE FOR CRYOGENIC TECHNOLOGY

Current Research

The CCT has had a long-standing collaboration with ISRO. In particular, it calibrates LOX and LH₂ cryogenic level sensors to support the launch activities of ISRO. Eight level sensors of both LOX and LH₂ were successfully calibrated and handed over to LPSC, Bangalore. Technical support to LPSC, Mahendragiri has continued for more than a decade; their temperature sensors are calibrated in the range of 300-4.2K. This year more than 100 temperature sensors of different types have been successfully calibrated and delivered. A new project has started to cryo-treat pressure-transducer diaphragms, machined from APX4; these are cryo-treated at 98K for 36 hours. Nearly 1000 diaphragms have been cryo-treated and delivered to ISRO for use in launch vehicles.

Other representative developments of cryo systems and sensors include the following: (1) A two-stage pulse-tube cooler for a helium-recondensation system has been technically modified to enhance its performance. (2) A multilayer, planar inductor-based cryogenic position

centre has been designed, developed and tested (for operation below 10K); its sensitivity is 10 micrometre in the displacement range of 0-5mm. (3) A multiplexed, multilayer-inductor-array-based angular-displacement sensor and its associated cold electronics has been designed and tested (sensitivity of 1 degree at 4.2K). (4) An electrical-conductivity sensor has been developed for thin-film-coated niobium samples by using the principle of differential measurement and an array of planar multilayer inductors (sensor and associated cold electronics tested and calibrated for operating in the range of 300K to 4.2K). New projects include some funded by BRNS and BRFST for applications in fusion research (e.g., estimating the pumping speeds for hydrogen and helium used in fusion applications) and by industries (e.g., "Development of adsorption based cooling system" funded by M/S Ingersoll Rand, Bangalore and "Cryogenic deflashing of different types of rubber components" funded by M/s. Surface Improvements Pvt. Ltd., Bengaluru).

Faculty and Staff

R KARUNANITHI | PhD (IISc), Associate Professor

DS NADIG | MTech (IIT Kharagpur), Principal Research Scientist

UPENDRA BEHERA | PhD (IISc), Principal Research Scientist

Associate Faculty

V VENKATARAMAN | PhD (Princeton), Professor

Faculty members in the Centre for High Energy Physics (CHEP) study a wide variety of problems in particle physics, field theory, and condensed-matter physics.

CORE RESEARCH

In this Centre, research is carried out on many aspects of particle phenomenology, field theory, experimental high-energy particle physics, string theory, theoretical condensed-matter physics, and quantum computing and quantum information. Illustrative highlights of research, carried out over the past year are given below.

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DEGREE PROGRAMS OFFERED **PhD and Int. PhD**

IN NUMBERS

13 ACADEMIC STAFF

17 PhD STUDENTS

12 INT PhD STUDENTS

2 INT PhD CONFERMENTS

1 PhD CONFERMENTS

43 PUBLICATIONS

Chairperson: **B ANANTHANARAYAN**

3.6.2

CENTRE FOR HIGH ENERGY PHYSICS

Current Research

Until last year, faculty members in CHEP specialized in theoretical studies. Two experimentalists joined the faculty of CHEP last year. They work on the Compact Muon Solenoid (CMS) experiment at the Large Hadron Collider (LHC) at CERN. Through their efforts IISc, has formally joined the CMS experiment and became a part of the India-CMS consortium. One of these faculty members is the b-tagging software & algorithms subgroup convenor (Level-3 position) from 1 September 2016 for a two year term. The other member of this team is taking part in Physics Object Identification at the CMS experiment (e.g., Tau Lepton Identification at LHC Run-2) and other studies such as triggering with muons and very light NMSSM Higgs bosons.

SEVERAL THEORETICAL STUDIES HAVE BEEN CARRIED OUT IN THE AREA OF PARTICLE PHENOMENOLOGY REPRESENTATIVE EXAMPLES ARE GIVEN BELOW

Optimal renormalization theory has been developed in order to apply it to the extraction of the mass of s-quark from tau-lepton decay spectral functions. This improved method gives a robust determination of the mass and is in accordance with lattice determinations as well as prior phenomenological evaluations. The constraints on the omega-pi form factor, coming from unitarity and analyticity, has been thoroughly analysed by using methods of optimization theory in order to show that there is a discrepancy between experiment and theory above 0.6 GeV.

The minimal supersymmetric standard model (MSSM) has been used to discuss the possibility of the lightest Higgs boson being consistent with the 2.3-sigma deviation excess observed at the LEP. This analysis shows that such a possibility can hardly be ruled out even at the high-luminosity run of the LHC. The decay of the MSSM heavy Higgs bosons into neutralino and chargino pairs has been considered and estimates have been provided for the possible exclusion/discovery reaches at the high-luminosity LHC. An s-channel resonance R has been investigated as a viable candidate for the diboson excess reported by the ATLAS experiment at the LHC.

An indirect test of degenerate supersymmetry has been investigated. A detailed survey has been carried out of all models with matter-messenger mixing in minimal-gauge-mediated models with the inverse-seesaw mechanism.

While examining theoretical possibilities for the reported 750 GeV excess, various unique features of the physics possibilities of future colliders have been investigated. In studies of top-quark physics, it has been demonstrated

that the polarization of the top quark, produced in the decay of a gluino into a top-stop pair, probes directly the mixing in the stop sector. In the context of dark-matter studies, the new, simplified model for Gluino Dark Matter has been investigated with strongly interacting mediators. Spin Physics in QCD: Clean probes of the Gluon Sivers Function of transversely polarised protons in D-meson production in proton-proton and electron-proton scattering have been studied.

ILLUSTRATIVE STUDIES IN THE GENERAL AREA OF FIELD THEORY ARE

A Neumann problem for gravity has been developed and applied in the context of AdS/CFT. The Dirichlet problem for gravity has been well-understood since the work of Gibbons, Hawking and York, but, despite 40 years of work on quantum gravity, a Neumann boundary term has not been known so far. This problem has now been solved and it has been shown that this leads to a new version of holography. This is one of the first examples of a hairy black hole in a box, which has connections to holographic superconductors.

A new class of compactifications has been introduced in heterotic string theory. The new supersymmetric index as well as one-loop gauge thresholds for these compactifications have been studied. Furthermore, it has been shown that the leading correction because of the width of a local quantum quench to entanglement entropy in 1+1 dimensional CFT is universal.

A new approach to the conformal bootstrap has been initiated. This makes use of crossing-symmetric partial waves and Mellin space and yields Wilson-Fisher critical exponents in a Feynman-diagram-free manner.

In manifolds with a spatial boundary, the BRST formalism can be used to quantize gauge theories. It has been shown that, in a U(1) gauge theory, only a subset of all the boundary conditions allowed by the self-adjointness of the Hamiltonian preserves BRST symmetry. Hence, the theory can be quantized by using the BRST formalism only when that subset of boundary conditions is considered. It has also been shown that, for such boundary conditions, there exist fermionic states which are localized near the boundary.

Various studies of lattice quantum chromodynamics (QCD) have been carried out. In particular, the QCD equation of state has been obtained at finite density. This is an important input in relativistic hydrodynamics, which is used to model the expansion of the quark-gluon plasma.

This calculation is made difficult by the sign problem fact that all lattice techniques suffer from. This study uses a Taylor-series approach (expansion coefficients up to sixth order) to construct a fourth-order equation of state, which is demonstrated to be valid for beam energies down to approximately 20A-GeV.

REPRESENTATIVE APPLICATIONS OF FIELD-THEORY METHODS IN CONDENSED-MATTER PHYSICS INCLUDE THE FOLLOWING

1. By studying edge states, spin transport across barriers, and impurity-induced changes in the local density of states in graphene, with Kane-Mele and Rashba spin-orbit coupling, it has been shown that barriers can change the spin polarization of incident electrons and give rise to an electrically controllable spin current.

2. Multiple peaks in the differential conductances between different wires, in transport across a junction of three p-wave superconducting wires, has been related to the presence of one or three Majorana modes.

3. The effects of periodic delta-function kicks on different parameters of the Hamiltonian of graphene have been shown to modify the quasienergy dispersion in various ways.

An efficient algorithm for quantum Hamiltonian evolution, with computational complexity poly-logarithmic in the output precision, has been extended to all local Hamiltonians and to construct an efficient quantum algorithm for solving the linear algebra problem $Ax=b$. The quantum trajectory formalism for weak measurements has been analysed in cases of white noise and shot noise, demonstrating that the Born-rule constraint is equivalent to a fluctuation-dissipation relation.

Faculty and Staff

B ANATHANARAYAN | PhD (Delaware), Professor

APOORVA PATEL | PhD (Caltech), Professor

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ROHINI M GODBOLE | PhD (Stony Brook), FASc, FNA, FNASc, FTWAS, Professor

ANINDA SINHA | PhD (Cambridge), Associate Professor

JUSTIN RAJ DAVID | PhD (TIFR, Mumbai), Associate Professor

SACHINDEO VAIDYA | PhD (Syracuse), Associate Professor

SUDHIR KUMAR VEMPATI | PhD (Gujarat), Associate Professor

CETHAN KRISHNAN | PhD (Texas), Assistant Professor

BIPLOB BHATTACHERJEE | PhD (Calcutta), Assistant Professor

JYOTHSNA RANI KOMARAGIRI | PhD (TIFR), Assistant Professor

PRASAD SATISH HEGDE | PhD (Stony Brook), Assistant Professor

SOMNATH CHOUDHURY | PhD (CEA Saclay), Assistant Professor

Emeritus Faculty

N MUKUNDA | PhD (Rochester), FASc, FNA, Professor

J PASUPATHY | PhD (Rochester), FASc, Professor

The Department of Instrumentation and Applied Physics (IAP) pursues a wide area of interdisciplinary research activities in the domain of Applied Physics, and it provides post-graduate degrees in this area. Its 14 faculty members teach 15 courses. They have generated 3 StartUps in 2016. The Department is striving to work in areas that create a social impact.

Current Research

Faculty members in this Department work in several branches of Applied Physics. Illustrative research highlights from work carried out over the last year are given below.

A Fiber-Bragg-Grating Bite-Force Recorder (FBGBFR) has been developed for the dynamic measurement of the bite force generated by an individual tooth. A novel optical ballisto-cardiography technique, which is non-invasive, for the simultaneous measurement of cardiac and respiratory activities has been developed by using a Fiber Bragg Grating Heart Beat Device (FBGHBD).

A high-speed atomic-force microscope (AFM) has been designed and developed. The novel probe has been demonstrated to image conventionally inaccessible sample features. A magnetic-tweezers system, with a force-sensing capability, has been developed and calibrated.

Energy harvesting by the crumpling of large polymer piezoelectric sheets has been studied to understand how the mechanics of buckled substrates influences the device physics of thin-film transistors. An active-dielectric-based low-power ESD protection device has been developed.

FACT FILE

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DEGREE PROGRAMS OFFERED **PhD, MSc (Engg) and MTech**

IN NUMBERS

8 ACADEMIC AND **6** SCIENTIFIC STAFF

3 MTech-D, **83** PhD, **5** MSc (ENGG)
AND **8** MTech STUDENTS

1 MSc (ENGG), **6** MTech
AND **10** PhD CONFERMENTS

39 PUBLICATIONS

Chairperson: **S ASOKAN**

3.6.3

INSTRUMENTATION AND APPLIED PHYSICS

Studies of the effects of plasma treatment on vertically aligned graphene nano walls (GNWs) have been carried out. The superhydrophobicity of these structures has been demonstrated. The application of GNWs to anodes in microbatteries has been investigated. Thin-film strain gauges have been developed for the health monitoring of compressor blades in turboengines.

The matched-filter technique, for the detection of a periodic structure in a random surface, has been developed. Raman-

Nath scattering has been used for the detection of wave fronts. The analysis of the data, collected using DECT (Dual Energy Computed Tomography), has been suggested for medical diagnosis.

An innovative, optofluidic, point-of-care device has been developed for conducting molecular and biochemical diagnostics.

Associate Faculty

S UMAPATHY | PhD (Otago), Professor

K RAJAN | PhD (IISc), Professor

ATANU K MOHANTY | PhD (Polytechnic University), Associate Professor

CORE RESEARCH

Amorphous Semiconductors, Phase-Change Memories, Fiber-Optic Sensors, Nanometrology and Precision Motion Control, Nano Science, Fluorescence Microscopy, Sensors, Nanostructured Materials for Energy Harvesting, Vacuum and Thin-Film technology, Plasma Science and Technology, Semiconductor Devices and Integrated Circuits, Flexible Electronic Systems, Optofluidics, Biomedical Instrumentation, Microfluidics and Lab-on-a-Chip, Computational Imaging, Optical Metrology, and Microfluidic Nanotechnology.

Faculty and Staff

ASOKAN S | PhD (IISc), FNASc, Professor

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CHATTERJEE VANI V | PhD (IISc), Senior Scientific Officer

SAI SIVA GORTHI | PhD (EPFL), Assistant Professor

K R GUNASEKHAR | PhD (IISc), Principal Research Scientist

G R JAYANTH | PhD (Ohio State), Assistant Professor

ABHA MISRA | PhD (IIT Bombay), Assistant Professor

T K MONDAL | PhD (IISc), Principal Research Scientist

PARTHA P MONDAL | PhD (IISc), Associate Professor

KONANDUR RAJANNA | PhD (IISc), Professor

S RAMGOPAL | MSc (Engg) (IISc), Principal Research Scientist

G MOHAN RAO | PhD (IISc), Professor

SANJIV SAMBANDAN | PhD (Waterloo), Assistant Professor

NC SHIVAPRAKASH | PhD (Mysore), Chief Research Scientist



The Department of Mathematics (MA) has 22 faculty members and over 60 affiliated researchers. Its research profile represents diverse interests, ranging from pure to applied mathematics, and collaborations with related fields. It has a vibrant atmosphere in which members with different interests collaborate with each other and with mathematicians internationally.

Current Research

The research work carried out at the Department of Mathematics in 2016 falls into the broad categories listed below. Some of this work is cross-disciplinary, with collaborations with researchers working in communication engineering, mathematical finance, and physics. Illustrative highlights are given below.

A. ALGEBRAIC GEOMETRY

Recent work in this area has focused on triangulated categories. Loosely speaking, these provide a unified framework for the category of modules over reasonably “nice” rings as well as the cohomology theory of algebraic varieties.

B. COMPLEX GEOMETRY

Research in this area has focused on using invariant metrics, which are special types of distance-functions that are preserved by invertible complex-analytic mappings, to probe the geometry of domains in complex space.

Among the highlights are a very general continuous-extension result—establishing, e.g., the extension of complex geodesics to the unit circle—for a large class of domains, and the introduction of a new method for obtaining results of this type. These grew out of an example that disproves an oft-cited hypothesis (made without proof) of Krantz, Royden and Wong.

FACT FILE

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DEGREE PROGRAMS OFFERED **PhD and Int. PhD**

IN NUMBERS

22 ACADEMIC STAFF

58 PhD STUDENTS

10 INT PhD STUDENTS

3 INT PhD CONFERMENTS

8 PhD CONFERMENTS

36 PUBLICATIONS

Chairperson: **GADADHAR MISRA**

3.6.4

MATHEMATICS

C. HARMONIC ANALYSIS

The sum of squares of vector fields—viewed as linear differential operators—is the analogue of the Laplacian on the Heisenberg group and on a wide range of Lie groups and spaces that have properties similar to the Heisenberg group. In a recent result, a Hardy-type inequality on the trace of the fractional powers of such operators was obtained. In several special cases (e.g., sub-Laplacians for a class of Lie groups known as stratified groups), sharp constants for these inequalities were obtained.

D. DIFFERENTIAL GEOMETRY

Recent research in differential geometry has focused on the study of the global geometry of manifolds through the solutions of partial differential equations (PDEs) related to them. A notable project completed recently introduces some new PDEs in the study of an important class of complex manifolds and vector bundles on them. Results on the existence of solutions for these new PDEs as well as an improved existence result from an already existing PDE were obtained.

E. OPERATOR THEORY

Research in this area has been devoted to diverse problems pertaining to understanding classes of operators or operator-tuples on Hilbert space more explicitly: finding functional models for commuting operators related to a domain in control theory, classifying or producing tractable models for certain non-normal operators, etc. Among the highlights is a result on Cowen–Douglas operators:

these are, loosely speaking, operators possessing a fat set of eigenvalues that are far-removed from the normal operators. A complete set of tractable unitary invariants were found for a slightly smaller subset of the full set of Cowen–Douglas operators. Furthermore, for the unit ball, homogeneous n -tuples of such operators have been shown to be similar to direct sums of certain elementary n -tuples.

F. PROBABILITY

Research in this area included the study of stationary Gaussian processes, the statistical mechanics of one-dimensional models — asymmetric exclusion processes, in particular — and the asymptotics of random graphs. In notable work on exclusion processes, the full nonequilibrium phase diagram was derived for a class of multi-species asymmetric exclusion processes, and a complete explanation of all its macroscopic features was given.

G. TOPOLOGY

Research in topology has focused on the study of triangulations of manifolds. An object that has been in focus in particular is the Pachner graph for manifolds, which is a graph whose vertices are the distinct triangulations of the given manifold, and where adjacency represents a certain natural transformation between two triangulations. In recent work, it has been shown—among several results—that the Pachner graph of an n -vertex flag 2-sphere that is different from the double cone is connected.

CORE RESEARCH

Algebraic and combinatorial topology, automated theorem-proving, combinatorics, commutative algebra and algebraic geometry, complex geometry, differential geometry, harmonic analysis, mathematical physics, nonlinear dynamics, numerical analysis, operator theory, partial differential equations, probability and stochastic processes, several complex variables, statistical mechanics, time-series analysis, Teichmüller theory.

Faculty and Staff

- ARVIND AYYER** | PhD (Rutgers), Assistant Professor
- ABHISHEK BANERJEE** | PhD (Johns Hopkins), Assistant Professor
- GAUTAM BHARALI** | PhD (Wisconsin), Associate Professor
- TIRTHANKAR BHARRACHARYYA** | PhD (ISI), Professor
- SOUMYA DAS** | PhD (HRI, Allahabad), Assistant Professor
- BASUDEB DATTA** | PhD (ISI), FASc, FNASc, Professor
- SIDDARTHA GADGIL** | PhD (Caltech), Professor
- MK GHOSH** | PhD (TIFR-IISc), FASc, FNASc, Professor
- SUBHOJOY GUPTA** | PhD (Yale), Assistant Professor
- SRIKANTH KRISHNAN IYER** | PhD (UC Santa Barbara), Professor
- MANJUNATH KRISHNAPUR** | PhD (UC Berkeley), Associate Professor
- GADADHAR MISRA** | PhD (SUNY Stony Brook), FNA, FASc, FNASc, Professor
- AK NANDAKUMARAN** | PhD (TIFR-IISc), Professor
- EK NARAYANAN** | PhD (ISI), Associate Professor
- DILIP P PATIL** | PhD (TIFR Mumbai), Professor
- G RANGARAJAN** | PhD (Maryland), FASc, FNASc, Professor
- HARISH SESHADRI** | PhD (SUNY, Stony Brook), Associate Professor
- POOJA SINGLA** | PhD (IMSc), Assistant Professor
- S THANGAVELU** | PhD (Princeton), FASc, FNA, Professor
- VAMSI PRITHAM PINGALI** | PhD (Stony Brook Univ), Assistant Professor
- THIRUPATHI, GUDI** | PhD (IIT Bombay), Assistant Professor
- KAUSHAL VERMA** | PhD (Indiana), FASc, Associate Professor

Emeritus Professors

- USAHDEVI NARENDRA BHOSLE** | PhD (TIFR Bombay), Professor (Raja Ramanna Fellow)
- ALOKNATH CHAKRABARTI** | PhD (Calcutta), Professor (NASI Honorary Scientist)
- PHOOLAN PRASAD** | PhD (IISc), Professor (NASI Senior Scientist Platinum Jubilee Fellow)

NMI Distinguished Professor

- MS NARASIMHAN** | PhD (TIFR BU), FRS, FNA, FASc, FNASc
- KB SINHA** | PhD (Rochester), FNA, FASc, FTWAS
- VS BORKAR** | PhD (Berkeley), FNA, FASc, FNASc, FNAE, & FIEEE, FTWAS, FAMS

The Department of Physics (PHY) was established in 1933 by the Nobel Laureate C V Raman and several other illustrious names of Indian Science such as Homi Bhabha, Vikram Sarabhai, R S Krishnan, G N Ramachandran, S Ramaseshan and T V Ramakrishnan have been associated with this department. It is now a large and established research centre for condensed matter physics and astrophysics.

Current Research

Several studies have been carried out over the last year in the areas mentioned above. Some illustrative highlights are given below.

SOFT MATTER AND BIOPHYSICS

Membrane-protein interactions play a central role in membrane-mediated cellular processes ranging from signaling, budding, and fusion to transport across the cell membrane. Of particular significance is the process of efficient protein oligomerization and transmembrane

pore formation on the membrane surface, the primary virulent pathway for the action of antimicrobial peptides and pore forming toxins (PFTs). The suggested nanoscopic length scales and dynamic nature of such membrane lipid-protein interactions makes their detection extremely challenging. By using a combination of super-resolution stimulated emission depletion nanoscopy, with fluorescence correlation spectroscopy (STED-FCS), the emergence of nanoscale lateral heterogeneity, in supported bilayer membranes made up of phospholipids and cholesterol upon interaction with PFTs, has been

FACT FILE

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DEGREE PROGRAMS OFFERED **PhD, Int. PhD and BSc (Research)**

IN NUMBERS

31 ACADEMIC, **5** SCIENTIFIC AND **1** TECHNICAL STAFF

135 PhD STUDENTS

40 INT PhD STUDENTS

4 INT PhD CONFERMENTS

17 PhD CONFERMENTS

155 PUBLICATIONS

Chairperson: **V VENKATARAMAN**

3.6.5 PHYSICS

unraveled. A distinct length-scale-dependent dynamical crossover (~200 nm) from a Brownian, diffusive regime has been observed at 33% and 50% cholesterol compositions, indicating the partitioning of lipids into domains with variable cholesterol content.

NANOSCALE PLASMONICS

Quantum dot (QD) films are well-known as promising materials for photo-detectors, photo-voltaics and next-generation display devices. From experimental studies, it has been observed that compact monolayer films of cadmium selenide (CdSe) QDs, with compact assemblies of partially aligned metal nanorods placed in close proximity, can be used to enhance the photoluminescence (PL) emission intensity by a factor of 10 while the PL anisotropy can be increased to almost 0.9. Finite-difference time-domain (FDTD) simulations on smaller-scale gold-nanorod (GNR) arrays on the CdSe QD layer not only explain this huge emission enhancement and anisotropy but they also provide insights into the parameters which, if further optimised,

can lead to even larger enhancement and emission anisotropy in similar hybrid systems. This paves way for creation of large-scale, simple and inexpensive, but highly efficient, metal nanorod-QD hybrid films, which can find wide-ranging potential applications in displays, detectors and photovoltaics.

ULTRA-LOW NOISE IN SILICON NANOWIRES

Low electrical noise in materials and circuitry is a key requirement for both conventional and future quantum information processing. Experimental work has shown that ultra-thin Si:P nanowires, which have been proposed as interconnects for a scalable silicon-based quantum computers, form one of the most stable conductors, with the phenomenological Hooge parameter of electrical noise as low as $\sim 10^{-8}$ at 4.2 K, lower than any known 1D nanostructure of metal or semiconductor. These results confirm the promising prospects for precision-doped Si:P in atomic-scale circuitry for the 11 nm technology node and beyond.



CORE RESEARCH

- Astronomy and Astrophysics: Cosmology, black holes, Nuclear astrophysics, Galactic dynamics, interstellar matter, solar physics
- Atomic and Optical Physics: Laser cooling and atom trapping, laser tweezers
- Experimental condensed-matter physics: Spectroscopy, Electrical Transport, Bulk and Thin films, Low temperature physics
- Theoretical condensed-matter physics: Strongly correlated electrons, topological insulators, soft matter and biophysics, and turbulence.

CONTACT NOISE IN GRAPHENE FIELD- EFFECT TRANSISTORS

Contacts are known to affect severely the performance of electronic devices. Evidence for dominant contact noise in graphene transistors has been demonstrated for the first time; this noise arises because of the random, time-dependent fluctuations in the contact resistance at the metal-graphene interface. This contact noise can exceed the intrinsic (graphene) channel noise by several orders of magnitude, and appears to be a crucial, performance-limiting factor in graphene electronics, especially when the channel carrier mobility becomes large.

TOPOLOGICAL INSULATORS (TIS)

These are materials that are electrical insulators in the bulk but the surface encompasses conducting states Topological Surface States (TSS). In the early days of TI research, it was assumed that these surface states could support robust spin currents and that a mechanism to manipulate their spin texture would provide significant advances in spintronics technologies. It is now understood that the spin texture in TIs is protected by unusually large spin-orbit fields that are virtually impossible to manipulate by electrical means. An alternative is to use the spin transport properties of Rashba surface states (RSS) that co-exist with the TSS. Unlike the TSS, the RSS can be readily manipulated by controlling inversion-symmetry breaking at sample surfaces by electric fields. Investigations of low-temperature electrical transport in BiSbTe 1.25 Se 1.75 /hexagonal- BN van der Waals heterostructure devices, with electrical gating, have indicated the presence of Rashba spin-split states, confined to the sample surface, apart from the usual topological surface states(TSS). It has been shown that these states support high-mobility conduction, with Hall-effect mobilities $\sim 2000 - 3000 \text{ cm}^2/\text{V-s}$, which are, paradoxically, much larger than the mobilities of the topological surface states $\sim 300 \text{ cm}^2/\text{V-s}$ at $T=2\text{K}$. The spin-split nature of these states has been confirmed by magneto- resistance measurements.

First-principles band-structure calculations have been instrumental not only in the process of discovering new classes of topologically interesting materials, but also for identifying salient characteristics of topo-logical states. A recent review published in Reviews of Modern Physics (with one of the faculty members of the Department as an author) has discussed the underpinnings of topological band theory and assessed topological properties of band structures beyond the standard band theory construct. This review discusses the theoretically predicted properties and protections of topological states, which have been verified experimentally, including work on topological crystalline insulators, disorder- or interaction-driven topological insulators (TIs), topological superconductors, Weyl-semimetal phases, and topological phase transitions.

The functionalisation of quantum dots (QDs), with a single biomolecular tag using traditional approaches in bulk solution, has met with limited success. In recent work, published in Nature Nanotechnology, a group from the Department has discussed the use of DNA polyhedra for this purpose. These polyhedra, which consist of an internal void bounded by a well-defined three-dimensional structured surface, can house cargo and the surface can be functionalised with stoichiometric and spatial precision. They show that monofunctionalised QDs can be realised by encapsulating QDs inside DNA icosahedra and functionalising the DNA shell with an endocytic ligand. These DNA-encapsulated QDs, which bear a unique stoichiometry of endocytic ligands, represent a new class of molecular probes for quantitative imaging of endocytic receptor dynamics.

The astrophysics group has, in the past, concentrated on theoretical studies. A young radio astronomer who has joined this group, brought in much-needed observational expertise. The group is carrying out cutting-edge research in the physics of galaxy clusters, the interstellar medium, compact objects, the solar dynamo, and galactic dynamics. The group members have collaborated with each other and written papers in these areas with their students and postdoctoral fellows.

Faculty and Staff

ARNAB RAI CHOUDHURI | PhD (Chicago), FASc, FNASc, FNA, Professor

CHANDA J JOG | PhD (New York), FASc, FNASc, FNA, FTWAS, Professor

CHANDAN DASGUPTA | PhD (Pennsylvania), FASc, FNA, FTWAS, Professor

JAYADEEP KUMAR BASU | PhD (Calcutta), Professor

KSR KOTESWARA RAO | PhD (IISc), Professor

HR KRISHNAMURTHY | PhD (Cornell), FASc, FNASc, FNA, FTWAS, Professor

K RAJAN | PhD (IISc), Professor
REGHU MENON | PhD (IISc), Professor
RAHUL PANDIT | PhD (Illinois), FASc, FNA, FTWAS, Professor
SRIRAM RAMASWAMY | PhD (Chicago), FASc, FNA, FRS, Professor
VASANT NATARAJAN | PhD (MIT), Professor
V VENKATARAMAN | PhD (Princeton), Professor
VIJAY B SHENOY | PhD (Brown), Professor
PS ANIL KUMAR | PhD (Pune), Associate Professor
ARINDAM GHOSH | PhD (IISc), FASc, FNASc, Associate Professor
BANIBRATA MUKHOPADHYAY | PhD (Calcutta), Associate Professor
PRABAL K MAITI | PhD (IIT Kanpur), Associate Professor
KP RAMESH | PhD (Bangalore), Associate Professor
SUBROTO MUKERJEE | PhD (Princeton), Associate Professor
ANINDYA DAS | PhD (IISc), Assistant Professor
AVEEK BID | PhD (IISc), Assistant Professor
MANISH JAIN | PhD (Minnesota), Assistant Professor
PRATEEK SHARMA | PhD (Princeton), Assistant Professor
RAMESH CHANDRA MALLIK | PhD (IIT Madras), ASSISTANT Professor
TARUN DEEP SAINI | PhD (Pune), Assistant Professor
TANMOY DAS | PhD (Northeastern), Assistant Professor
VIBHOR SINGH | PhD (TIFR), Assistant Professor
PRERNA SHARMA | PhD (TIFR Bombay), Assistant Professor
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SRIMANTA MIDDEY | PhD (Calcutta), Assistant Professor
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PRASAD VISHNU BHOTLA | PhD (IISc), Chief Research Scientist
SUJA ELIZABETH | PhD (IISc), Chief Research Scientist
R GANESAN | PhD (IISc), Principal Research Scientist
K RAMESH | PhD (IISc), Principal Research Scientist
DV SUVISHESHA MUTHU | PhD (IIT Kanpur), Principal Research Scientist
VC SRINIVAS | BE (Bangalore), Technical Officer

Associate Faculty

AMBARISH GHOSH | PhD (Brown), Associate Professor

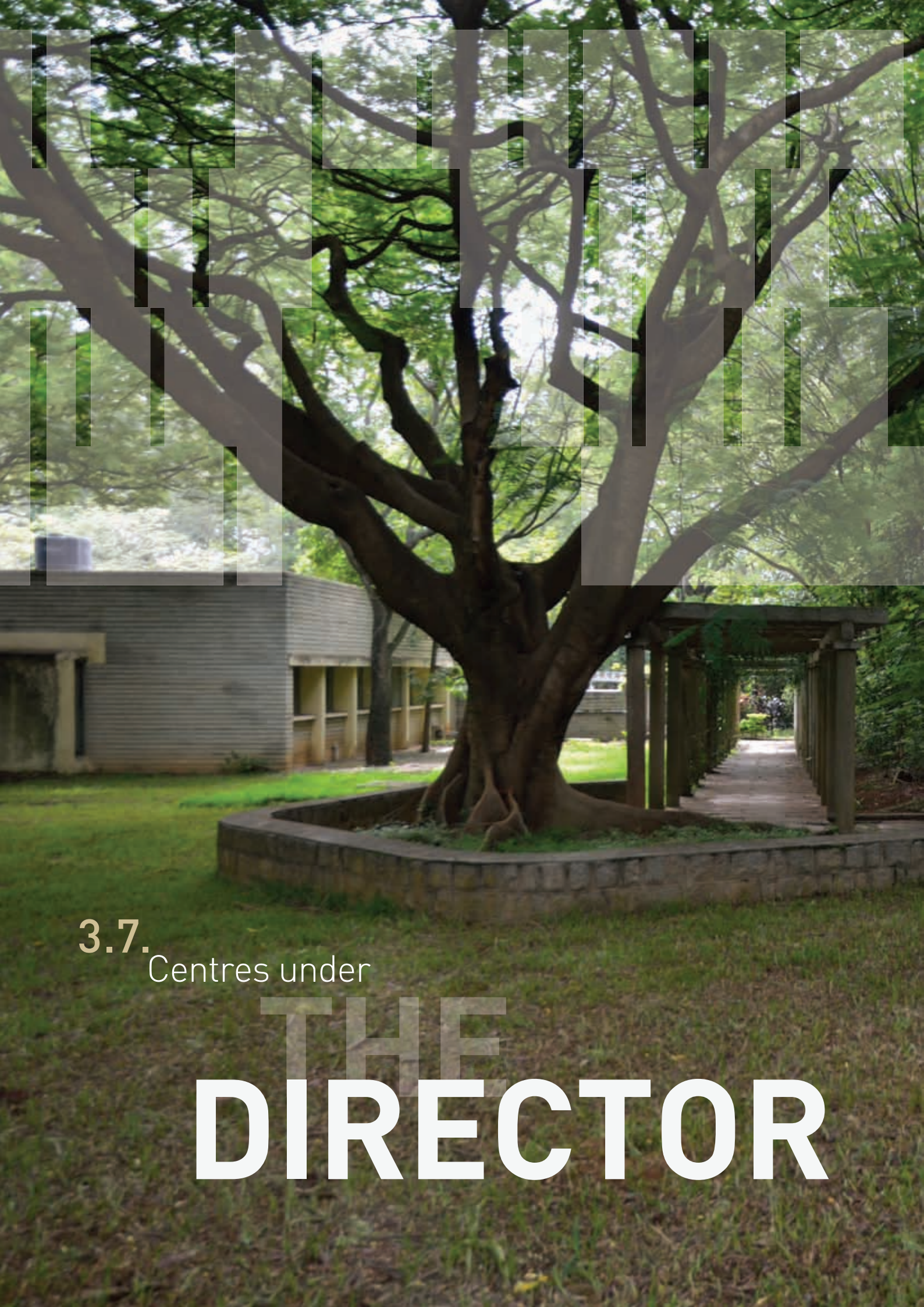
Honorary Professor

AK SOOD | PhD (IISc), FASc, FNASc, FNA, FTWAS, FRS, Honorary Professor

Distinguished Faculty

TV RAMAKRISHNAN | PhD (Columbia), FNASc, FASc, FNA, FTWAS, FRS, Foreign Associate, Academie Des Science (Paris), Distinguished Associate





3.7.
Centres under

THE
DIRECTOR



The JRD TATA Memorial Library, at the Indian Institute of Science, is one of the oldest yet modern Science and Technology library in India. Started in 1911, as one of the first set of department in the Institute, it has become a precious national resource Centre in the field of Science and Technology. The collection of the Library which includes books, journals, reports, theses, Indian Patents and standards is regarded as one of the richest collections in the country. This rich and valuable collection built over nine decades has some of the rare reference materials and back volumes of several important journals. Apart from its print resources, the Library has access to a large collection of e-journals, eBooks and databases. Functioning as an effective support system for information services across the campus continues to be the primary goal of the library.

During the year 2016-17, the Library added 5213 documents including 1204 books, 3,300 bound volumes and 709 Gift books. eBook cataloguing service is being continued. The total holdings of the Library is now increased to about 5,18,651 physical documents which includes other materials like Technical Reports, Standards, Theses & Dissertation. Library continues to primarily subscribe e-only journals and over 765 e-journals are being subscribed spending nearly ₹ 15 crores. The 'Electronic Theses Repository' contains about 2530 theses.

The Circulation section has registered 838 new members. Total number of 18,241 transactions were carried out by the Circulation section during 2016-17. Work such as reshelving, shelf rectification, shifting etc. are being carried out in the library regularly.

The Library continues to maintain pre-eminence in providing access to a large number of e-resources. Some of major e-resources include the complete journal publication of the following Societies:

1. American Chemical Society - ALL journals and its Archive
2. Royal Society of Chemistry - ALL Journals and its Archive
3. American Society for Microbiology - ALL Journals
4. Society for Industrial and Applied Mathematics (SIAM) - Complete journal collection and Archive
5. American Institute of Physics - Journals and Archive
6. American Physical Society Journals, including Physical Review Online (PROLA) Collection
7. Institute of Physics Publishing - Complete collection including its Archive
8. Oxford University Press - Complete Mathematics, Physical and Life Science Collections
9. JSTOR Archive

Some of the Backfile collections to which access is provided on a perpetual access basis include:

1. Elsevier Backfiles in eleven subjects categories such as Bio-chemistry, Organic Chemistry, Inorganic Chemistry, Physical and Analytical Chemistry, Chemical Engineering, Materials Science, Mathematics, Physics General, Pharmacology, Neuroscience, Engineering Technology.

LIBRARIAN - IN - CHARGE

N C SHIVAPRAKASH | Chief Research Scientist, Instrumentation And Applied Physics

3.7.1

JRD TATA

MEMORIAL LIBRARY

2. Wiley InterScience backfiles in eight subject categories which include Biochemistry, Polymer Science, Analytical Science, Cell and Developmental Biology, Chemistry, Genetics & Evolution, Materials Science, Physics and Astronomy.

3. With the support of Authorities and approval of the Journal Purchase Committee, the following backfiles have been added to the e-collection:

- Nature backfiles
- American Chemical Society Legacy Archive
- Institute of Physics Publishing Journal Archive
- OUP Archive

Apart from the above, as a core member of e-Shodh Sindhu Consortium of MHRD, access is provided to over 9000 plus electronic journals, several databases and major e-resources including:

1. Association of Computing Machinery Journals
2. IEEE / IEE Journals
3. Elsevier Science Direct
4. Springer Link Journals
5. ASTM Journals and Standards
6. ASCE Journals
7. ASME Journals
8. Emerald full-text
9. SIAM Journals
10. Oxford University Press Journals

E-SHODH SINDHU CONSORTIA

Ministry of HRD, Government of India has formed a new Consortia merging erstwhile consortiums such as INDEST-AICTE, UGC Infonet and N-List Programme. The new consortia is named as e-Shodh Sindhu and is managed by INFLIBNET head quartered at Ahmedabad. Apart from several other resources, some of the resources subscribed by the Library in 2015 are now being subscribed in 2016 by Consortia effecting substantial savings to the Institute. They include:

	Publisher	Approx. savings in ₹
	List of e-resources ordered under e-Shodh Sindhu in 2016	
1	Nature	3,93,822.00
2	Oxford University Press	26,32,311.00
3	ASTM Digital Library	7,32,056.00
4	John Hopkins Univ. Press (Project Muse) Persp. In Bio & Med	12,740.00
5	MathSciNet	8,14,766.00
6	SIAM	5,59,347.00
7	Web of Science	31,27,273.00
8	SciFinder	62,41,253.00
	Approximate savings in 2016 (in ₹)	1,45,13,568.00

LIBSYS SOFTWARE/DATABASE

Library has been using LIBSYS, a Library Management Software for its functions such as Acquisition, Cataloguing, Serials Control, and Circulation. Online access to Library holdings data is through WEB-OPAC. Users have the facility to browse and search the Library database and view the status of a document or their own transactions and make on-line reservations for a document issued out. Presently, the OPAC database has about 1,97,184 books and 2,12,587 records of bound volumes of periodicals.

HARDWARE-SOFTWARE RELATED

Library was using LIBSYS-4 for its housekeeping operations from two decades. As the software support for this version

was discontinued, library has purchased 'LIBSYS 7' a web-centric Library Information Management Software. Also, computing facilities in the places like user area, computer section and operational units are augmented.

The Library has been providing photocopies of documents available in the Library within the copyright laws to Scientists/academicians/ students. UGC has identified the Library as Document Delivery Centre for the Southern Region and fixed charges for these services. Initially financial assistance was provided by UGC-INFLIBNET for the purpose. The Library continues to provide this service. In addition, as a member of Consortium, the Library provides document delivery to other Consortium members.

In addition, the Library continues to provide, e-mail based services like, new additions of books and journals, Interactive services like reminders, reservations and overdue intimation and e-mail based reference service. Library web page has been designed to disseminate up-to-date information from the Library. The web-page provides comprehensive information on the collections, e-resources, databases, new additions and all the services provided by the Library. The page also serves as a portal to access e-resources.

The Library procures books by placing order on vendors who offer substantial discount while providing prompt supply. This has resulted in a discount ranging from 25% to 34% across various publishers. The Library is recognised as the Resource Centre for Mathematics for the South Region by the National Board of Higher Mathematics, Dept. of Atomic Energy, Government of India., and is receiving financial assistance for developing this collection on Mathematics.

EPRINTS & ETD DIGITAL REPOSITORIES

ePrints@IISc (eprints.iisc.ernet.in) is one of the earliest and largest Institutional Repositories in the country. The ePrints@IISc was started by the erstwhile National Centre for Science Information. It is currently being managed by the JRD Library. The repository collects, preserves, and disseminates in digital format the research output created by the IISc research community. The repository content can be accessed through the search and browse functionalities. As on date, the total number of publications in the repository is about 44000+.

etd@IISc (etd.iisc.ernet.in) is the digital repository of Theses and Dissertations of IISc, Bangalore, India. This repository has been developed to capture, disseminate and preserve the research theses of IISc. The repository content can be accessed through the search and browse functionalities. As on date, the total number of records in the repository is about 2500+.

NEW INITIATIVES

- **Mobile App:** Users can search OPAC through Mobile by downloading the Mobile App.
- **Receipt Generation:** Generates the receipt for overdue fines and avoids writing the receipt manually.
- **Membership and borrowing facility to Library Alumni (retired staff members)**

The Librarian In-charge had brought to the notice of the SLC that since several years, retired staff members have been requesting borrowing facility as applicable to alumni members may be considered favorably. The committee discussed the issue and approved, as a special gesture, that retired Library staff may avail the facility of borrowing books from the library as the Alumni members.

EVENTS ORGANISED / CONDUCTED BY THE LIBRARY

- Two days NDL-IISc workshop on Institutional Digital Repository in association with National Digital Repository Programme of MHRD- IIT Kharagpur, on 21-22nd May 2016 at UG Seminar Hall, IISc, Bangalore.
- Dr T B Rajashekar's Memorial Lecture Series was organised in association with NCSI-net Foundation on LIS-Education and research in India: Some issues from the practitioners perspective by Dr M S Sridhar, Formerly, Head, Library & Documentation Division, ISRO on Friday, 17th June, 2016, at JRDTML.
- Celebrated Librarian's Day to commemorate the birth anniversary of Late Dr S R Ranganathan (12th Aug) on 11th August 2016.
- Counter Terror Mock exercise was conducted in the Library on 9th August 2016 by Karnataka Police Force in coordination with Institute Security.
- The International Open Access Week 2016, was observed during 24-30th October. JRD Library had organised an interactive session on Open Access on Friday, 28th October 2016 in the library seminar hall. Dr Francis Jayakanth spoke on open access initiative at IISc.
- 12th Dr T B Rajashekar Memorial Seminar (2016): Infographics and its relevance for LIS Professionals on 10th December 2016, at Choksi Hall, Indian Institute of Science (IISc), Bangalore – 560012.
- An Author Workshop session on Book and journal publishing in collaboration with M/S Elsevier Science on Friday the 17th February 2017.
- A training session on 'Advantage Mendeley': writing made easy with reference manager for the benefit of Researchers at the Institute on 20th February 2017.

The Archives Cell was established in 2007 with a mandate to collect, catalogue and preserve all documents, images, and other articles of relevance to the Institute. It became Archives and Publications Cell (APC) in 2008 with the additional responsibility to coordinate and facilitate the publication activities of the Institute through the IIScPress. APC also hosts the DST- Centre for Policy Research devoted to research on policies related to science and technology research in Indian universities and R&D centres.

ARCHIVES

Institute's original correspondences and land documents, administrative manuals and bye-laws, schemes of instruction, building committee reports, faculty profiles and speeches of Sir M. Visveswaraya have been uploaded to D-Space, the digital archiving platform.

The Tata Central Archives, Pune organised a moving exhibition of J N Tata for 7 days in the Reception Hall, Main Building, IISc, entitled: "Experience the Inspiration - Jamsetji N Tata, Entrepreneur, Philanthropist and Visionary". The IISc Archives also curated an exhibition on the life and times of Morris Travers, the first Director of IISc, entitled 'The Road Traversed', the exhibition was inaugurated during the release of the IIScPress book 'Morris Travers –Scientist and Pioneer – an Autobiography'.

IN-HOUSE PUBLISHING

APC coordinates the design, copy-editing and printing of KERNEL (the annual magazine of IISc), Mini Kernel 'IISc at a Glance', Connect (quarterly magazine of IISc), and four issues of the Journal of the Indian Institute of Science. In addition, the following IISc documents are published: Annual reports (English and Hindi), Annual Accounts (English and Hindi), Budget Estimates and Revised Estimates, Directory and Planner, Student Information Brochure, Undergraduate Scheme of Instruction, Quarks (a magazine of the undergraduate students), Desk Calendar and Wall Calendar, Faculty Information Brochure, Certificates and Transcripts.

IIScPRESS

A new committee for IIScPress has been formed with effect from January 2017:

Chair:	Amaresh Chakrabarti
Members:	Diptiman Sen Series Editor, Lecture Notes Series
	Prabal Kumar Maiti Series Editor, Research Monographs
	S P Arun Series Editor, Popular Science Series
Ex-officio Chair, APC:	Kaushal Verma
Admin.:	Kavitha Harish

CHAIRPERSON

KAUSHAL VERMA | Associate Professor, Mathematics

3.7.2

ARCHIVES AND PUBLICATIONS CELL

IIScPRESS – CAMBRIDGE SERIES

The IIScPress has entered into a collaboration with Cambridge University Press, United Kingdom and has launched the following book series:

IISc – Cambridge Research Monographs Series (ICRMS)

The monographs published in this series will address contemporary topics of science and engineering.

IISc – Cambridge Centenary Lecture Series (ICCLS)

As part of the 2009 Centenary celebrations, IISc instituted a series of lectures by eminent scientists. In this series, books are based on lectures delivered at IISc by distinguished books speakers.

IISc-Cambridge Lecture Notes Series (ICLNS)

This series fulfils an important need in higher education in science and engineering, particularly in India. These books are authored by distinguished scholars.

Under this co-publishing arrangement, IIScPress and Cambridge University Press have published the following books in the Lecture Notes series:

- *Mechanics, Waves and Thermodynamics* by Sudhir R Jain
- *Finite Elements – Theory and Algorithms* by Sashikumaar Ganesan and Lutz Tobiska
- *Ordinary Differential Equations* by A. K. Nandakumaran, P. S. Datti and Raju K George

OTHER BOOKS PUBLISHED BY IIScPRESS

- *Arting Science* edited by Bitasta Das.
- *Morris W. Travers – Scientist and Pioneer: Autobiography* edited by David M. W. Travers and John R. Ainsle.

JOURNAL OF THE INDIAN INSTITUTE OF SCIENCE

The Journal of the Indian Institute of Science has been published by the Institute since 1914. Previously, the Journal published original research work carried out by the faculty and students of the Institute as well as other institutions around the world. Since 2007, however, the Journal format has been changed. It became a quarterly Journal and publishes only invited review articles, each issue being guest edited by eminent researchers.

During 2016, Volume 96 of the Journal was published in which the following special issues appeared:

- Vol. 96 No.1 | January – March 2016
Advances in Flow Diagnostics
Guest Editors: G. Jagadeesh, Dept of Aerospace Engineering, IISc and Gopalakrishna Hegde, Centre for Nano Science and Engineering, IISc
- Vol. 96 No.2 | April – June 2016
Transport in Mesoscopic Systems
Guest Editors: Aavek Bid, and Anindya Das, Dept of Physics, IISc
- Vol. 96 No.3 | July – September 2016
Phase-Field Methods for Pattern Formation
Guest Editors: Abhik Choudhury, Dept of Materials Engg., IISc, Rajdip Mukherjee, Dept of Materials Science and Engg., IIT-Kanpur, Saswata Bhattacharyya, Dept of Materials Science and Metallurgical Engg., IIT, Hyderabad
- Vol. 96 No.4 | October – December 2016
Materials Electrochemistry
Electrochemical Processes and Systems
Guest Editors: Aninda Jiban Bhattacharyya, Solid State and Structural Chemistry Unit, IISc

Since its inception, the primary goal of the Office of International Relations (OIR) is to facilitate cooperation and association of the Institute with global academic partners by engaging in various programmes. The Office of International Relations acts as a liaison to oversee and coordinate all international programmes of the Institute, which includes:

- Admission of full-time international students for studies leading to M Tech Research (Engg.) and PhD degrees of IISc.
- To facilitate international academic and industrial collaborations for research and education, as formulated in various Memoranda of Understanding (MoU).
- To promote academic collaborations and student/faculty exchange programmes with institutions and universities abroad.
- To facilitate partnerships for collaborative research and aid in seeking appropriate international funding opportunities.
- To organise the visits of representatives from international universities and delegation of public bodies.
- To organise thematic workshops between IISc faculty and faculty from partner institutions.
- To coordinate the visits of IISc delegation to institutions worldwide.
- To publicise and facilitate special/endowed lectures of the Institute, delivered by internationally acclaimed scientists.

- To act as an advisory body to the growing number of foreign students and visitors at the Institute.

During the past year, OIR has coordinated various activities to strengthen our Institute's International profile. It included the following major activities:

VISITING ACADEMIC/ INDUSTRIAL DELEGATIONS

A number of foreign delegations, dignitaries and diplomatic staff from various parts of the world visited the Institute. These meetings were primarily aimed at learning more about the Institute activities, identify possible areas for mutual collaboration in research and education, and facilitate modes to increase existing collaborations. Presentations regarding the Institute, research activities, student profiles, and mechanisms for collaboration/ hosting visitors were made by the Chair of OIR or a OIR faculty member. In the period April 1, 2016 to March 31, 2017, 45 such meetings were held. A few significant delegations included the Vice Chancellor of University of Cambridge, the President, Vice-President and the Rector of Tel Aviv University, the CEO of Volvo Group, Associate Vice-Chancellor of Curtin University and the Dean, EEMCS of Technical University of Delft.

The Institute visits that resulted into important joint partnerships/workshops included CNRS labelled International Associated Laboratory (LIA) workshop with the Centre for High Energy Physics at the Institute and Technical University of Delft with the Electrical Communication Engineering department at the Institute. In addition to these visits, the OIR coordinated 3 special lectures which were

CHAIRPERSON

USHA VIJAYRAGHAVAN | Professor, Microbiology and Cell Biology

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OFFICE OF

INTERNATIONAL

RELATIONS

delivered by the visiting faculty/delegates at institutional level and included Prof Sir Leszek Borysiewicz (University of Cambridge), Prof Sir Tejinder Singh Virdee (Imperial College, London) and Prof Robin Franklin (University of Cambridge).

- Delegation from Nanyang Technological University, Singapore: Prof B.V.R. Chowdari, Senior Executive Director, School of Materials Science & Engineering.
- Delegation from the French Alternative Energies and Atomic Energy Commission (CEA): Dr Claire Giry, Deputy Director of CEA Sciences Division.
- Prof Jean Pierre Bourguignon, President, European Research Council.
- Delegation from Centre National de la Recherche Scientifique (CNRS), International Associated Laboratory (LAI), France.
- Dr Nakita Vodjdani, Head, European and International Partnerships of (ANR) to IFCWS.
- Mr Kris Browne, Manager, Australia India Strategic Research Fund (AISRF) & Mr Bruce Murphy, Science & Innovation Counsellor, the Australian High Commission, New Delhi.
- Delegation from University of Alberta, Canada: Ms Cen Huang, Associate Vice President, University of Alberta, Canada, Mr Sudhiranjan Banerjee, Commercial Officer, Government of Alberta at the High Commission of India and Ms Maria Mathai, Advisor.
- Ms Candace B Matha, Asst. Director, Brandeis Led Study Programs, Brandeis University.
- Delegation from Hokkaido University, Japan: Prof Ichiro Uyedea, Executive, President, Hokkaido University.
- Mr Ajai Singh Sirohi, Head, Strategic Planning & Corp Dev, Dr Masahiro Kimura, General Manager and Mr Shigekazu Suenaga, MD, Toray Industries, Japan.
- Delegation from Flinders University, Australia: Mr Michael Davis, Chairperson, Space Industry Association of Australia and Dr Alice Gorman, Space Archaeologist at Flinders University.
- Delegation from University of Cambridge, UK: Professor Sir Leszek Borysiewicz, Vice-chancellor, University of Cambridge.
- Prof Roy L Sutliff, Faculty, Associate for International Programs Emory University Atlanta, Georgia, USA
- Delegation from Technical University of Delft, Netherlands: Dr Krista Knopper, International Relationships, Industry Cooperation.
- Delegation from Technical University of Delft, Netherlands: Prof Rob Fastenau, dean of EEMCS and Prof Inald Lagendijk, department head Intelligent.
- Delegation from University of Nottingham, UK: Dr Nagamani Bora, Director, Biotechnology, School of Science.
- Delegation from University of Strasbourg, France: Prof F. Kern, Vice President, International Relations, Faculty of Economics & Management.
- Delegation from Wellcome Trust, MRC Cambridge Stem Cell Institute, UK: Prof Robin Franklin.
- Delegation from Sheffield University, UK: Prof Sir Keith Burnett, Vice President & Mrs Ruth Arnold, Director of Strategic Projects and Communications.
- Delegation from University of Washington, USA: Prof Julian Marshall.
- Delegation from University of Alberta, Canada: Dr David Turpin, the President and Vice-Chancellor.
- 12-membered Senior Group of Delegation from Thales, France.
- Delegation from Moscow Aviation Institute, Russia: A team headed by Mr Mikhail Pogosyan, Rector (President).
- Delegation from Cardiff University, UK: Professor Dylan Jones, Pro Vice-Chancellor along with an academic group.
- Delegation from University of Southern California, USA: Prof Yannis C. Yortsos, the Dean and an academic team.
- Delegation from Volvo group, Sweden: Prof Jan Ove Ostensen, the Vice President, Advanced Technology & Research along with his group in India.
- Delegation from Tel Aviv University, Israel: A team led by Prof Joseph Klafter, the President.
- Delegation from Mitacs, Canada: Ms Lissa Matyas, Director for International Affairs.

- Delegation from University of Westminster, UK: A team led by Prof Alexandra Hughes, Vice-Chancellor, Global engagement.
- Delegation from University of Twente, The Netherlands: A team of faculties, strategy & policy and marketing department.
- Delegation from Australian National University: Prof Kieran Kirk, Dean, College of Medicine, Biology and Environment.
- Delegation from Iran: A team of the representatives from various biomedical colleges.
- Delegation from Queensland University of Technology, Australia: A team led by Prof Peter Coaldrake, the Vice Chancellor.
- Delegation from Purdue University, USA: Prof David Janes, Faculty coordinator for Institutional partnerships.
- Delegation from Yokohama National University, Japan: A team led by Prof Atsushi Suzuki.
- Delegation from CNRS-INSIS, France: A team of faculty members from various streams.
- Delegation from Tel Aviv University, Israel: A team led by Prof Raanan Rein, the Vice-president.
- Delegation from University College of Dublin, Ireland: An academic team of Prof Jeremy Simpson and Prof Ravi Thampi.

COURTESY VISITS OF DIPLOMATIC STAFF AND COUNSELLORS

- Prof Adele Martial, French Embassy, Attaché for Scientific and University Co-operation.
- Ms Yael Hashavit, Consul General, Consulate General of Israel, Bengaluru.
- Mr Frank Rose, Assistant Secretary, U.S Consulate, Chennai, Department of State, USA.
- Ms Maria Teresita C Daza, Ambassador Philippine Embassy, New Delhi.
- A team led by Mr Ofir Akunis, Science & Technology minister of Israel.

- A team of Chinese journalists, organised in association with Foreign Ce, New Delhi.

MoU/AGREEMENTS WITH ACADEMIC/INDUSTRIAL PARTNERS

To enhance the international cooperation, the Office of International Relations coordinated 7 MoUs/agreements with various foreign Universities/Institutes and Industries. Based on our existing agreements, 2 nomination-based fellowship programmes coordinated/facilitated annually through our office were IISc-DAAD fellowship and Larvol fellowship for women PhD students in science at the Institute. A noteworthy new initiative in this period is the implication of bilateral joint supervision of PhD students. Two such academic agreements provide jointly supervised collaborative research problems to be taken up by students of IISc and the partner institution. During the current period, such activities with Technical University of Delft, Netherlands and University of Southern California, USA were activated. This model is anticipated to be expanded to include other leading institutions in the coming years. Another new venture is a trilateral partnership wherein academic partners, specifically IISc and CNRS laboratory, secured funding support from the industry partner, Thales. These funds account for supporting two doctoral level students. Whilst most of the partnerships are aimed at increasing academic cooperation, the OIR will explore increasing the number of industrial partnerships in the coming years.

- Agreement between Centre National de la Recherche Scientifique (CNRS)- International Associated Laboratory (LIA) and Indian Institute of Science: Signed on 4th May, 2016.
- MoU between University of Ulsan, Republic of Korea and Indian Institute of Science: Signed on 8th July 2016.
- Letter of Intent between University of Strasbourg and Indian Institute of Science: Signed on 26th October 2016.
- MoU between University of Southern California and Indian Institute of Science: Signed on 10th Dec. 2016.
- MoU between Volvo Group and Indian Institute of Science: Signed on 12th December 2016.
- MoU between Clausthal University of Technology, Germany and Indian Institute of Science: Signed on 13th December 2016.
- Renewal of the MoU with Queensland University of Technology, Australia: Signed on February 14, 2017

INTERNATIONAL STUDENTS AT IISc

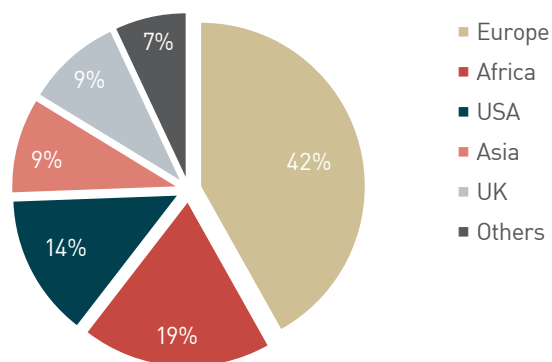
The Institute welcomed 35 international students, including 4 full-time and 43 short-term students/visitors, from many Institutes around the world.

FULL-TIME INTERNATIONAL STUDENTS

As of March 2017, IISc has 39 full-time foreign students from different parts of the world who are pursuing their MTech (Res) or PhD studies. Most of the international students come from Asia (23) and Africa (14). A large number of students applied to the Institute seeking admissions for the academic year 2016; 49 candidates amongst them were shortlisted and interviewed by the admissions committees at various departments. Based on the recommendations of these committees, 5 applicants were offered positions for PhD (2 students) and MTech (Research)-Engg. (3 students). We hope that a more active advertisement of the Institute programs will enhance the pool of full time International students at IISc from other parts of the world.

SHORT-TERM STUDENTS/VISITORS

A majority of the short-term students and visitors at the Institute performed collaborative work under an agreement with a partner university or for semester long course study. A total of 43 students/research scholars visited the Institute for course studies or conducting collaborative research from several countries that includes Europe (18), Africa (8), USA (6), Asia (4), UK (4) and others (3). The number has increased from past year, which was 31. Among incoming students, few came with their own fellowships from bilateral funding programmes like Newton-Bhabha, S N Bose or others.



In the face of rapid technological advancement taking place in globe, continuing education of working professionals to new technologies is in need of the day to update their knowledge. The Centre for Continuing Education has completed more than 40 years & is a pioneering centre in the area of continuing education in the country by organising refresher/specialized courses for working professionals from different target groups ranging from high school science teachers to research scientists/engineers of the industries/institutions and we justified to take pride in the fact that it is one of the profound Continuing Education Centre in the Country.

Summary of Programmes

Sl.No.	Programme Type	Details	Students/Participants benefited
1	National Programmes	a. QIP: Degree Programme (PhD/ME/MTech)	15
		b. QIP Short Term Courses: 12 (Engineering College Teachers)	400
2	Industry Oriented Programmes	a. CCE - Proficiency: 37 Semester long courses	551
		b. Industry sponsored short term/full term courses: 10	400

Details

1. NATIONAL PROGRAMMES

a) QIP (Quality Improvement Programme): Programmes Leading to Award of Degrees: During the current year, under this programme, 6 teachers were admitted for PhD and 1 for ME/MTech. Apart from this, 4 persons were given advance admission for PhD during 2016.

	PhD	ME/MTech
Students admitted	6	1
On Roll	13	2

CHAIRPERSON

G L SIVAKUMAR BABU | Professor, Civil Engineering

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CENTRE FOR CONTINUING EDUCATION

b) QIP – Short Term Courses: These courses are sponsored by Government agencies such as AICTE- QIP, ISTE, UGC etc. and are primarily for teachers from engineering/science colleges. During the year 12 short-term courses were organised with a total participation of 400 faculty members from Engineering colleges.

2. INDUSTRY PROGRAMMES

a) CCE – Proficiency Program: The programme is first of its kind in India. Under the CCE - PROFICIENCE programme in 2 semesters during the year 2016, 37 evening courses were conducted and 849 students/professionals attended and 551 successfully completed the program. Under this programme a sum of ₹ 69 lakhs has been received, towards application and course fee.

b) Self-supporting Intensive Courses: The CCE promotes various refresher/extension programmes to enable the participation of Scientists and engineers working in different organisations. During the year, 10 such courses were organised for different organisations with a total participation of 400. Under this programme a total sum of ₹ 77.00 lakhs has been received as Overhead to the Institute.

c) Curriculum Development Cell: The Curriculum Development Cell (CDC), sponsored by the AICTE, Government of India, has been functioning at the Institute since 1979. The Curriculum Development Cell provides financial assistance for book writing, Preparation of Laboratory Manuals, Holding of Conference, Workshops, Seminars, Special Lectures and Panel Discussions, for the preparation of monographs and audio-visual aids for teaching etc. Since 1979, the Centre has provided financial assistance for 94 faculty members for Book Writing, out of which, 52 books have been published/completed. Since the scheme is discontinued by AICTE from 2016, the CCE is continuing the said facilities from using CCE- FACE funds.

3. EXTENSION LECTURE PROGRAMME

This programme is also first of its kind in the Country. It has now been restarted from 2016 keeping in view the future objectives. The progress, prosperity and material welfare of the country depend very much on the scientific and technological base of its citizens. With this in view, the Institute, under the Continuing Education Program has been organising Extension Lectures by its faculty since 1990 in institutions of higher learning at the technical level, in Engineering and science colleges and in schools, public/

cultural organisations, Doordarshan and All India Radio at the popular level. This program is first of its kind in the Country. These extension lectures are expected to be of great help in the transfer of information on the latest scientific developments in this Institute and other organisation in India and abroad. They are intended to popularize Science and through science bring about a transformation in the basic thinking from the traditional fatalistic attitude to a daring confidence in facing scientifically the challengers of the modern times.

These lectures are arranged not only in Bangalore, but also in centres in the entire state of Karnataka and sometimes even outside the state. Even though the majority of these are in English, lectures are also arranged in regional languages like Kannada, if specific requests are received. Many of these lectures are supported by demonstration, slides, transparencies and models.

4. HOYSALA GUEST HOUSE

CCE runs a Guest house, named after the famous Hoysala Dynasty, which ruled ancient Karnataka. It has 60 self-contained and fully furnished single rooms. These are mainly intended for accommodating the participants of the programmes conducted under CCE, like short term courses and invitees to the Institute. However, subject to availability, accommodation is made available to other categories of participants in seminars, symposia and conferences, and persons visiting the Institute for academic work. During the year 305 faculty from other universities/ research laboratories/colleges who visited the Institute, 758 participants for Short Term Courses and Work Shops/ Seminars. Revenue of about ₹ 17.00 lakhs is received through Hoysala Guest House.



Most of the research contributions come from research and development sponsored by over a hundred agencies, comprising a total of 975 projects with an outlay of ₹ 1400.64 Crores and an annual cash in-flow of ₹ 334 Crores during 2016-2017.

The primary sponsors are the Department of Science and Technology, Aeronautical Research and Development Board, Department of Biotechnology, Indian Space Research Organization, Space Technology Cell, Council of Scientific and Industrial Research, Department of Atomic Energy, Ministry of Information Technology, Defence Research Development Organisation, Ministry of Human Resources and Development, UK-India Education and Research Initiative and Ministry of Non-Conventional Energy Source.

The International Sponsors include Boeing Company, European Union, Welcome Trust, IBM, Asian Office of Aerospace Research and Development, Indo-French Centre for Promotion of Advanced Research, Korea Institute of

Science and Technology, European Union, Tokyo Electron Limited.

The Private Sponsoring Agencies include Robert Bosch Centre for Cyber Physical Systems, Jamshetji Tata Trust, Shakti Sustainable Energy Foundation, Sonata Software Limited, St. Johns Research Institute.

In the past year, the Science Departments received a total of 482 Projects with a total outlay of ₹ 674.03 Crores. The Engineering Departments received 493 Projects with a total outlay of ₹ 726.61 Crores. There has been a changing trend in recent times in terms of the industrial relevance of the projects. In a few projects, industries are involved from the initial stages, are partially funded, identify technology transfer terms and mutually agree on when the research should mature. The table (1) below shows the Division-wise breakup of projects and the financial outlay and the table (2) shows the details of each sponsored schemes.

Division	No. of Schemes	Outlay (₹ in Lakhs)
Division of Biological Sciences	220	322.07
Division of Chemical Sciences	147	221.90
Division of Electrical Sciences	139	92.62
Division of Mechanical Sciences	242	271.41
Division of Physical & Mathematical Sciences	110	83.24
Division of Interdisciplinary Research	112	362.58
Centres under the Director	5	46.82
GRAND TOTAL	975	1,400.64

ADVISOR

R MOHAN DAS

3.7.5 CENTRE FOR SPONSORED SCHEMES AND PROJECTS

Sl. No.	Code	Funding Agency	No of Schemes	Total Budget (Crores)
1	AITP	ASIAN TECHNOLOGY PROGRAMME	1	0.02
2	AMDO	ADVANCED MICRO DEVICES	1	0.44
3	AOAD	ASIAN OFFICE OF AEROSPACE RESEARCH & DEVELOPMENT	2	0.61
4	ARCI	INTERNATIONAL ADVANCED RESEARCH CENTRE FOR POWDER METALLURGY AND NEW MATERIALS, BALAPUR	1	1.53
5	ARDB	AERONAUTICS RESEARCH & DEVELOPMENT BOARD	7	10.71
6	ARGO	ARGHYAM	1	0.53
7	AU00	ANNA UNIVERSITY	1	1.34
8	BC00	BRITISH COUNCIL	1	0.01
9	BOCO	BOEING COMPANY	2	7.04
10	CDAC	CENTRE FOR DEVELOPMENT OF ADVANCED COMPUTING	1	1.91
11	CIST	CENTRE FOR INFRASTRUCTURE TRANSPORTATION & URBAN PLANNING	16	18.02
12	COLO	THE COMMONWEALTH OF LEARNING	1	0.15
13	CPRI	CENTRAL POWER RESEARCH INSTITUTE	1	3.36
14	CSBO	CENTRAL SILK BOARD	1	0.13
15	CSIR	COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH	31	6.56
16	DAEO	DEPARTMENT OF ATOMIC ENERGY	21	8.92
17	DBTO	DEPARTMENT OF BIOTECHNOLOGY	106	148.5
18	DE00	DEPARTMENT OF ENVIRONMENT	2	1.8
19	DRDL	DEFENCE RESEARCH & DEVELOPMENT LAB	3	1.18
20	DRDO	DEFENCE RESEARCH & DEVELOPMENT ORGANISATION	49	123.59
21	DSTO	DEPARTMENT OF SCIENCE & TECHNOLOGY	441	483.25
22	EDNO	ELECTRON DEVICE NEWS	1	0.05
23	EPFO	ECOLE POLYTECHNIQUE DE FEDERAL	1	0.21
24	EU00	EUROPEON UNION	2	0.18
25	EW00	EARTH WATCH INSTITUTE	1	0.05
26	FSIP	FREESCALE SEMICONDUCTOR INDIA PVT. LTD.	1	0.29
27	GEIT	GE INDIA TECHNOLOGY CENTRE	3	0.45
28	GFPE	THE GRANTHAM FOUNDATION FOR THE PROTECTION OF THE ENVIRONMENT	1	31.82
29	GK00	GOVERNMENT OF KARNATAKA, DEPARTMENT OF SCIENCE	1	8.5
30	GTRE	GAS TURBINE RESEARCH ESTABLISHMENT	5	5.39

Sl. No.	Code	Funding Agency	No of Schemes	Total Budget (Crores)
31	HALO	HINDUSTAN AERONAUTICS LIMITED	1	0.36
32	IBMC	INTERNATIONAL BUSINESS MACHINE CORPORATION	6	0.57
33	ICAR	INDIAN COUNCIL OF AGRICULTURAL RESEARCH	3	1.56
34	ICMR	INDIAN COUNCIL OF MEDICAL RESEARCH	2	0.25
35	IFCP	INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH(IFCPAR)	15	6.65
36	IGCA	INDIRA GANDHI CENTRE FOR ATOMIC RESEARCH	1	0.37
37	IIIS	INDIAN INSTITUTE OF SCIENCE	3	0.65
38	IMPR	IMPRINT MINISTRY OF HUMAN RESOURCE DEVELOPMENT	16	41.96
39	INCO	INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES	3	2.55
40	INSA	INDIAN NATIONAL SCIENCE ACADEMY	1	0.15
41	INTL	INTEL TECHNOLOGIES INDIA PVT., LTD.	1	0.52
42	IRDO	INSTITUT DE RECHERCHE POUR LE DEVELOPMENT, FRANCE	4	4.54
43	ISRO	INDIAN SPACE RESEARCH ORGANISATION	7	7.13
44	ISTC	ISRO-IISc SPACE TECHNOLOGY CELL	48	8.71
45	IUCR	INTERNATIONAL UNION OF CRYSTALLOGRAPHY	1	0.03
46	IUSF	INDO-US SCIENCE & TECHNOLOGY FORUM	5	51.37
47	JATP	JOINT ADVANCED TECHNOLOGY PROGRAMME	9	0.63
48	JTTO	JAMSETJI TATA TRUST	1	77.87
49	KFEE	KARNATAKA STATE FOREST ECOLOGY & ENVIRONMENT	1	0.01
50	KIST	KOREA INSTITUTE OF SCIENCE & TECHNOLOGY	1	0.17
51	LANS	LOS ALAMOS NATIONAL LABORATORY	1	1.94
52	LTMT	LADY TATA MEMORIAL TRUST	1	0.4
53	MDWS	MINISTRY OF DRINKING WATER AND SANITATION	1	2.79
54	MEFO	MINISTRY OF ENVIRONMENT & FORESTS	3	0.71
55	MERK	MERCK & Co., INC.	2	1.29
56	MESO	MINISTRY OF EARTH SCIENCES	7	19.72
57	MHRD	MINISTRY OF HUMAN RESOURCE DEVELOPMENT	1	0.01
58	MITO	MINISTRY OF INFORMATION TECHNOLOGY	23	157.52
59	MNRE	MINISTRY OF NEW & RENEWABLE ENERGY	3	11.65
60	MRIL	MICROSOFT RESEARCH INDIA LTD.	1	0.07

Sl. No.	Code	Funding Agency	No of Schemes	Total Budget (Crores)
61	MSCI	MICROSOFT CORPORATION INDIA (P) LTD.	1	0.26
62	MSME	MICRO SMALL MEDIUM ENTERPRISES	1	5
63	NBRC	NATIONAL BRAIN RESEARCH CENTRE	1	0.88
64	NIHO	NATIONAL INSTITUTES OF HEALTH, USA	1	1.22
65	NKIO	NOKIA	1	0.24
66	NRBO	NAVAL RESEARCH BOARD	2	0.79
67	NSTL	NAVAL SCIENCE & TECHNOLOGICAL LAB	1	0.26
68	OPSA	OFFICE OF THE PRINCIPAL SCIENTIFIC ADVISER	2	3.27
69	RBCO	ROBERT BOSCH ENGINEERING & BUSINESS SOLUTIONS LIMITED	45	44.85
70	RNTB	RENAULT NISSAN TECHNOLOGY & BUSINESS CENTRE INDIA PVT. LTD.	1	0.69
71	RR00	ROLLS ROYCE	1	0.41
72	RSGF	RUFFORD SMALL GRANTS FOUNDATION	1	0.05
73	SDCO	THE SWISS AGENCY FOR DEVELOPMENT & COOPERATION	1	0.57
74	TIPL	TEXAS INSTRUMENTS PVT. LTD.	1	0.56
75	TOEL	TOKYO ELECTRON LIMITED	3	1.96
76	UGCO	UNIVERSITY GRANTS COMMISSION	11	10.37
77	USCO	UNIVERSITY OF SOUTHERN CALIFORNIA	1	0.17
78	UU00	UPPSALA UNIVERSITY	1	0.09
79	VSSC	VIKRAM SARABHAI SPACE CENTRE	1	0.15
80	VTSK	VETENSKAPSRADDET	1	0.04
81	WELT	THE WELLCOME TRUST, UK	19	60.15
GRAND TOTAL			975	1,400.64

The Office of Development and Alumni Affairs (ODAA) was established at the Indian Institute of Science in 2015 to build a vibrant Industry-Institute-Alumni ecosystem, and raise funds for various special projects from corporates, philanthropists and alumni. In addition, the ODAA provides support for alumni-related activities and engagement programmes at the Institute. In March 2017, the ODAA along with the Office of International Relations moved into a newly renovated bungalow on Gulmohar Marg.

PROJECTS

Some major projects that the ODAA pursued for fundraising during 2016-17 include:

- Endowed Young Investigator positions supporting young Assistant Professors or new faculty candidates
- Endowed Chair Professorships supporting senior faculty members at the Professor level
- New women's hostel blocks
- Sustainability projects at IISc Bangalore and Challakere campuses
- Digital "Library of Life" (museum/conservation facility)
- Teachers' training programme at IISc, Challakere
- Student travel funds for international conferences
- PhD scholarships

CORPORATE PARTNERSHIPS

In addition to ongoing projects, several organisations and individuals have come forward this year to support new projects and initiatives under Corporate Social Responsibility (CSR) and philanthropy.

PROJECTS AND ACTIVITIES SUPPORTED UNDER CSR

- HT Parekh Foundation: A 3-year grant to support the dissemination of sustainable technologies (developed by CST, IISc) in rural and peri-urban habitats. Project activities include constructing a new training centre, developing training programmes/workshops and establishing model demonstration projects.
- Rural Electrification Corporation: Establishment of 279 KWp solar PV panels on building rooftops to generate power for institutional grid, and the installation of 2200 LED lights at various locations on the IISc Bangalore campus.
- Bharat Dynamics Limited: Implementation of solar PV and CSP based training for unemployed youth, as well as setting up of laboratories and procuring relevant equipment and instruments at the IISc Challakere campus.
- Sonata Software Limited: Education infrastructure development, research and outreach activities at the Department of Computer Science and Automation.
- Tata Motors Limited: PhD scholarships in areas of sustainable technologies benefiting the bottom of the pyramid

DIVISIONAL CHAIRPERSON IN-CHARGE

GOVINDAN RANGARAJAN | Professor, Mathematics

3.7.6 OFFICE OF DEVELOPMENT AND ALUMNI AFFAIRS

- Triveni Turbine Limited: Research equipment in the area of turbomachinery at the Interdisciplinary Centre for Energy Research
- Covidien Engineering Services: Research equipment in BioSystems Science and Engineering
- Hewlett-Packard: Support for Education
- Adventz Finance Private Limited: Endowed Young Investigator position
- Accel Partners: Research activities at the Department of Computer Science and Automation

PHILANTHROPY/GRANTS

- Tata Trusts: 3 endowed Chairs (JN Tata Chair, JRD Tata Chair and Homi Bhabha Chair)
- Dr Kiran Mazumdar Shaw: R I Mazumdar Young Investigator position
- Estate of Dr Krishna Kaikini: Endowed scholarships in science and engineering

ALUMNI RELATIONS

Since 2015, the ODAA has maintained an exclusive alumni portal to help alumni connect with each other and with the Institute (www.alumni.iisc.ernet.in). About 3750 alumni have currently registered for this free portal. The ODAA sends periodic newsletters and announcements to alumni through the portal. The ODAA has also built a large network of alumni and corporates through LinkedIn (~6000).

The Institute has been receiving generous funding from alumni towards several projects. Major contributions were made by alumni for the following initiatives:

- Dr Vijaya & Rajagopal Rao fund for Biomedical Research
- Bio Engineering Summer Training programme (BEST)
- D Nagarajachar Fund for supporting student travel to international conferences
- PV Lakshmi Narayana Grant for supporting student travel to international conferences
- ERC Shekar scholarship in Materials Engineering
- ECE Alumni Research Fund for students
- CSA Research Endowment Fund

ANNUAL ALUMNI REUNION

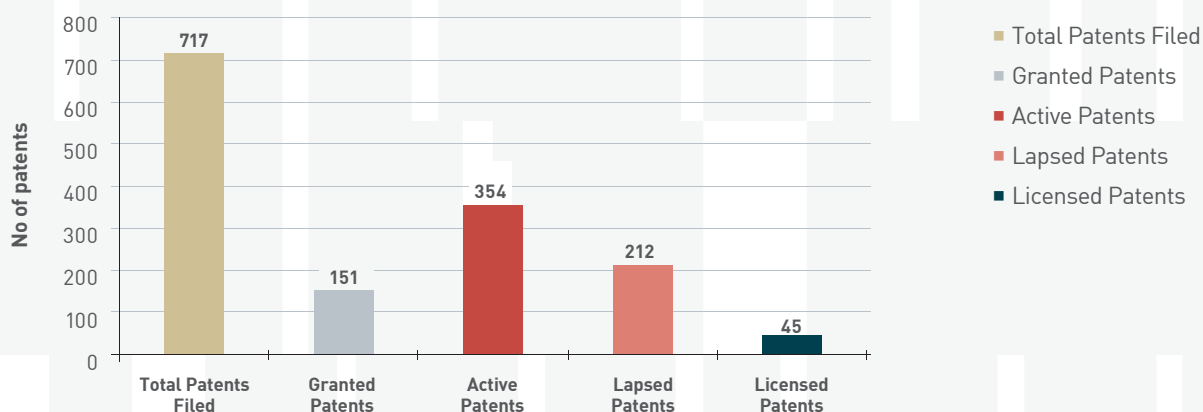
The ODAA, with support from IIScAA and IIScAANA, will be organising an annual reunion to encourage alumni to return to campus, and connect with the Institute and their departments.

The first alumni reunion was organised during December 16-18, 2016. More than 400 alumni registered for the 3-day event, which began with a special dinner hosted by the Director. The event also included a talk by the Director, panel discussions on "Partnering for IISc's future" and "Entrepreneurship & Innovation", get-together at the departments, a cultural programme, a Sunday morning campus walk and breakfast at the mess. The next alumni reunion will be held on December 16 & 17, 2017.

The office of IPTeL acting as the gateway to filing for intellectual property protection and technology licensing, also ensures that the value of the knowledge being generated at the Institute is leveraged, by responsible licensing, for the benefit of the Institute and thereby to the society at large. IPTeL strives to enable rapid filing of IP, so that it does not unduly delay the submission of results to academic journals.

BASIC PORTFOLIO INDEX (1996-2016)

- **Total number of patents filed: 717**
 - a. Active patents: 475
 - b. Granted patents: 70 (Indian) + 81 (Foreign)
 - c. Lapsed patents: 242



- **Total number of patents filed: 717**
 - a. Indian: 440
 - b. Foreign: 277

CHAIRPERSON

SRINIVASAN RAGHAVAN | Associate Professor, CeNSE

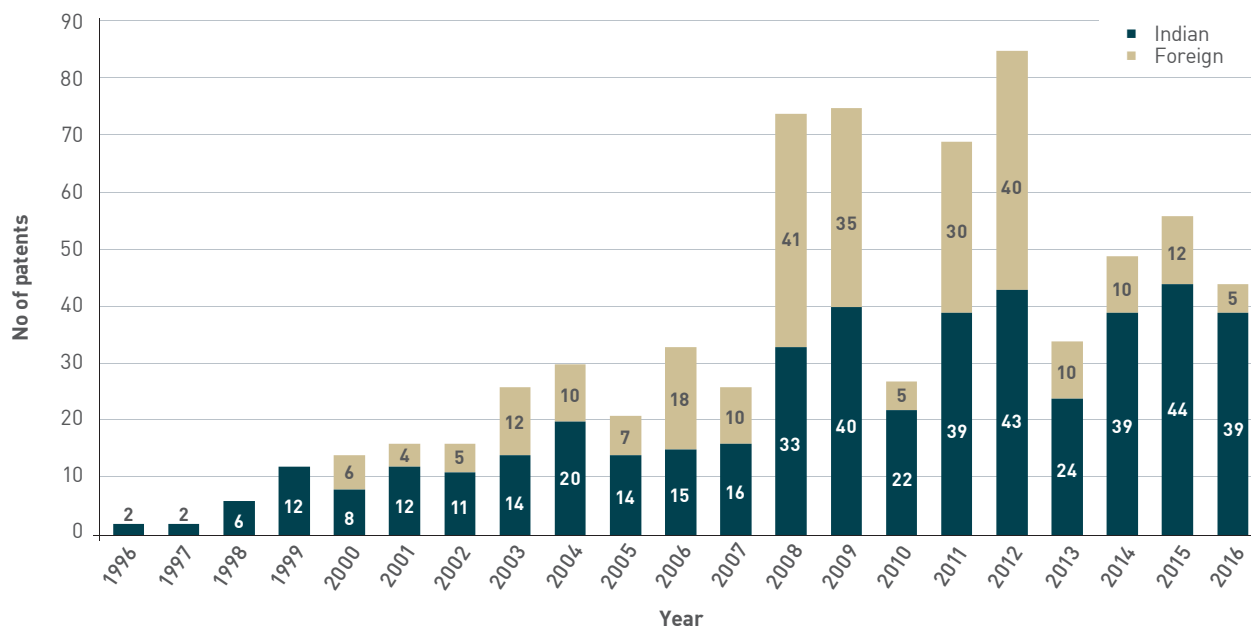
3.7.7

OFFICE OF

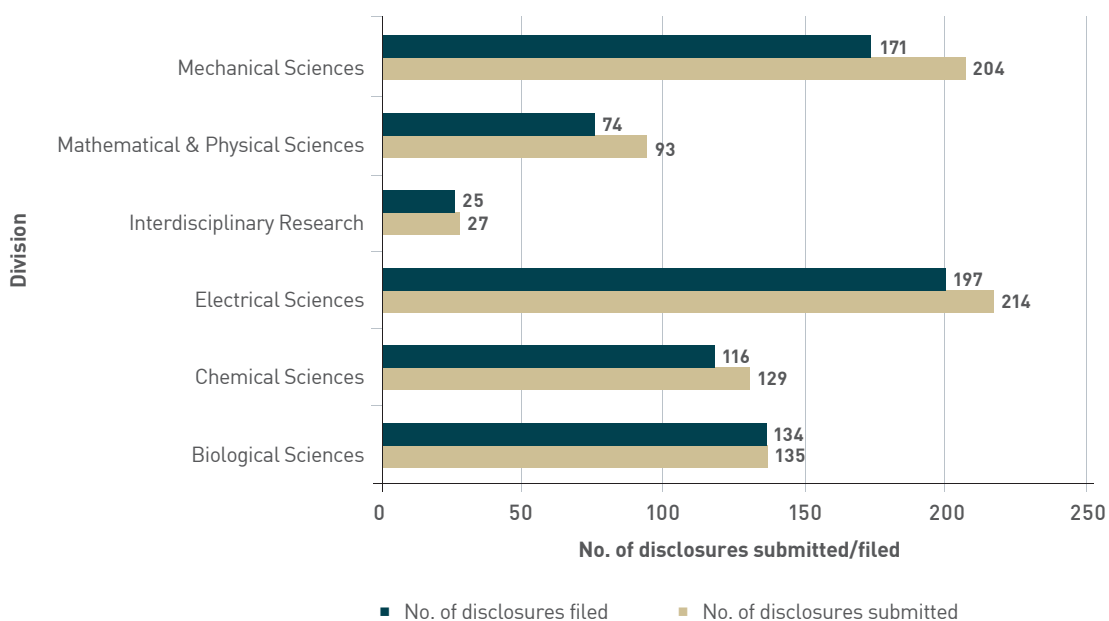
INTELLECTUAL PROPERTY

AND **TECHNOLOGY LICENSING**

• Total number of patents filed: Year wise break-up (1996-2016)



• Division wise break-up of number of disclosures filed & submitted (1996-2016)



The Institute is in possession of 1500 acres of land allotted by the Government of Karnataka during 2009 in Challakere Taluk of Chitradurga District. This second campus of IISc being set up in Kudapura village is officially known as "Challakere Campus". It is 220 km from Bangalore and takes about 4 hours to reach the campus. Development of infrastructure in the new campus has been a challenge given the geo-climatic conditions.

The first step was to secure the boundaries by construction of 10 Km long peripheral road and the compound. This work along with an imposing entrance was completed two years ago. This was followed by construction of two check dams for harvesting rain water which were also completed last year. These are expected to serve as the major water bodies for vegetation and the fauna. These will also enhance the ground water level in the region, thus may serve as a step-in-aid for agriculture and allied activities in the surrounding region.

The construction of buildings for Solar Power Generation and Research Centre and the Climate Research Centre has also been completed and the activities of these Centres are in the initial phase. The Centre for Sustainable Technologies (CST) has commenced its activities under the project "C-BELT" i.e., the Centre for Bio-energy and Low-Carbon Technologies. The proposed project work aims at dissemination and capacity building towards adapting and promoting low-C and biomass centric technologies developed by Centre for Sustainable Technologies (CST). Under this project funded by the State, a few training programmes for surrounding villagers as well as to those from a neighbouring state have been completed. The project is at present funded by the Government of Karnataka. The training and exhibition centres for this activity are nearing completion. A major fillip to this activity has just been received from HDFC under CSR funding.

The Talent Development Centre is vigorously pursuing its popular programme of providing training to High School Science Teachers, supported by the Government of Karnataka. In the past six years nearly 9000 teachers have been trained at the Centre and the impact assessment has shown very promising results.

The Ministry of Human Resource Development, Government of India has identified the IISc Challakere Campus as the Centre of Excellence in Science and Mathematics under the scheme "Pandit Madan Mohan Malaviya National Mission on Teachers & Teaching (PMMNMTT)". Under this scheme, science teachers in high schools as well as the UG/PG lecturers across the country are to be provided training. A lecture-hall and a large laboratory to augment the present facility at the Talent Development Centre have been constructed for this purpose and experimental facilities have been established. A few training sessions for UG teachers and some for high school teachers outside Karnataka have been successfully completed.

The CPWD has started the construction of Skill Development Centre and Hostel Blocks and the work in all respects would be completed by the end of October 2018. The entire project is being funded by HAL under CSR Act for which the Institute has entered in to an MOU with HAL. The Skill Development Centre will extend the training to many different levels including some of the engineering disciplines of importance to manufacturing sector. Activities pertaining to drinking water supply, power distribution and greening of the campus are being addressed and the necessary works are expected to begin shortly.

ADVISOR OF CHALLEKERE EMPOWERED COMMITTEE

B N RAGHUNANDAN | Professor (Retired), Aerospace Engineering

TALENT DEVELOPMENT CENTRE CONVENOR

M S HEGDE | CSIR Emeritus Scientist, Solid State and Structural Chemistry Unit

3.7.8

CHALLAKERE CAMPUS/ TALENT DEVELOPMENT CENTRE, KUDAPURA

During the year under review, the Centre for Scientific and Industrial Consultancy (CSIC) has strengthened the faculty-industry interactions in the form of informal discussions and advice to formal projects, involving design, development and transfer of technology. The Centre has strived to enhance, qualitatively and quantitatively, the nature of Institute - Industry linkages. The Centre has undertaken major consultancy projects of national significance involving scientific and technological challenges, with the ultimate goal of technology transfer for industrial development.

The range of professional consultancy services offered by the Institute faculty through CSIC include: Systems design/analysis; Software development; Product design/development; Process design/development; Model investigations; Advice on R & D; Transfer of technology; Evaluation/overview; Diagnostics.

The above services have been utilised by a wide range of clientele, comprising of educational/research institutions, health/pharmaceuticals industries, department of space, defence laboratories/organisations, irrigation departments, electricity boards, electronics/telecom industries, engineering industries and chemical industries from both public and the private sector.

During the financial year starting from April 01, 2016 to March 31, 2017, 205 consultancy project proposals costing ₹ 2,378.77 lakhs were communicated to the clients. In the above said period 102 consultancy projects with an outlay of ₹ 1,681.52 lakhs were materialised. Receipts from consultancy projects and consultancy test projects amounted to ₹ 1,751.61 lakhs.

Some of the Consultancy projects undertaken during the period April 1, 2016 to March 31, 2017 are as follows:

Department	Projects	Amount (₹ in Lakhs)
Inorganic and Physical Chemistry	2	28.5
Organic Chemistry	1	3.39
Computer Science and Automation	5	40.7
Electrical Communication Engineering	1	1.25
Electrical Engineering	6	26.38
Aerospace Engineering	11	103.78
Chemical Engineering	2	27.12
Civil Engineering	51	1176.32
Earth Sciences	1	29.64
Mechanical Engineering	8	40.96
Materials Engineering	4	14.04
Instrumentation and Applied Physics	2	4.18
Management Studies	3	68.31
Sustainable Technologies	3	49.1
Cryogenic Technology	1	25.99
Physics	1	17.25

CHAIRPERSON

J M CHANDRA KISHEN | Professor, Civil Engineering

3.7.9

CENTRE FOR SCIENTIFIC AND INDUSTRIAL CONSULTANCY

DIGITS (Digital Campus and Information Technology Services) Office is a unit set up by the Institute to conceive, plan, and create a best-in-class information technology (IT) and networking system, and implement agile IT and networking services for operational excellence in the Institute. The DIGITS office has the mandate of consolidating and coordinating all digital campus activities and services for better execution of the following earlier initiatives in IISc:

- OPERA (Operational Excellence for Research Advancement)
- CCIT (Committee on Computerisation and Information Technology)
- TINA (Telecom, Internet, and Network Access)
- VISE (Video Security Equipment for IISc)
- MMCR (Multimedia Class Rooms Initiative)
- Video archives and streaming
- IISc webpage maintenance and enhancement
- Campus infrastructure data acquisition and analytics (including the Challakere Campus)

- Provide an interface between vendors and IISc administrative units, addressing short-term and long-term measures

During April 2016-March 2017, the activities of DIGITS have resulted in the following outcomes.

ERP EVALUATION

In preparation for selecting a highly performance ERP (Enterprise Resource Planning) system to be implemented in the Institute, the DIGITS team has commissioned the services of an ERP evaluation team from Infosys to help with the selection of an ERP platform. Through an ERP and competitive techno-commercial bidding process, an ERP platform is set to be finalized to be identified by July 2017. Following this, an implementation partner for the selected ERP platform will be identified through a competitive bidding process.

CHAIRPERSON

Y NARAHARI, CSA

CHAIR, OPERA

K V S HARI, ECE

CHAIR, TINA

JOY KURI, ESE

CHIEF INFORMATION TECHNOLOGIST

GANESH GOPALAKRISHNAN, DIGITS

INFORMATION TECHNOLOGY CONSULTANT

AMIT C CHAKRABORTY, DIGITS

3.7.10

DIGITAL CAMPUS AND INFORMATION TECHNOLOGY SERVICES OFFICE

MAINTENANCE OF THE CURRENT IT AND NETWORKING OPERATIONS

Since it would take 18 – 24 months for a fully operational implementation of a new ERP system at the Institute, there is a need to strengthen and maintain the current IT and network services. DIGITS had commissioned the services of a team from an IT services company Integra Micro Systems since September 2016 for this purpose. This team is helping DIGITS to run the existing operations in a more reliable and robust way, and in implementing additional applications.

ENHANCEMENTS TO IT SERVICES

DIGITS, with the help of its staff and outsourced team, designed and implemented an Online Course Evaluation Platform for obtaining feedback on courses and instructors corresponding to the August-December 2016 and January-April 2017 semesters. A completely automated online PhD thesis processing system is being implemented through the Scholar One platform of Clarivate Analytics (formerly Thomson Reuters). This is expected to be deployed by July 2017. A course registration module has been implemented as well and has been successfully used in course registrations during August 2016 and January 2017 in several Departments.

DEVELOPING A UNIFIED DATABASE ARCHITECTURE

Currently, the existing IT applications in the campus invoke as many as 12 different databases leading to wasted redundancy and causing inconsistency of data across databases. A team from Integra Micro Systems is working on integrating all data in the campus to be organised into a single unified logical architecture. This ongoing exercise will have significant value for data migration phase of ERP implementation.

ACTIVE DIRECTORY IMPLEMENTATION AND CENTRALIZED EMAIL SERVICES

Office 365 and Active Directory implementations are currently in progress and are expected to be completed by August 2017. Following this, the Institute will move to centralized cloud-based email services (this activity involves migrating user mailboxes to the cloud).

EQUIPMENT FOR NEXT GENERATION NETWORK INFRASTRUCTURE

A detailed plan has been drawn up for procuring equipment for a modern networked campus. The equipment is being

procured through NICS, a subsidiary of NIC and a Govt. of India company.

CELLULAR COVERAGE

AirTel operations (from four roof top towers) have stabilized and improved cellular coverage. BSNL has also set up roof top towers and will start radiating soon. Reliance Jio and Vodafone are also expected to set up their infrastructure soon.

WISE (VIDEO SECURITY EQUIPMENT)

Phase I of WISE, deployed in 2015, covers 26 locations. The RFP for Phase II of WISE covering 40 additional locations is ready and the open tender will be released by the end of August 2017.

WEBSITE

The Institute website has metamorphosed into a more contemporary and content rich platform. It will migrate to the cloud in July 2017.

RECRUITMENT

Mr Amit Kumar Chakraborty (with 20+ years IT experience in BHEL and IBM) joined in February 2017 as IT Consultant, to help Mr Ganesh Gopalakrishnan, Chief Information Technologist. Recruitment of personnel for manager and programmer positions is being pursued actively.

BUILDING

DIGITS has been allotted the building space currently occupied by the F & A Section which has moved to a newly created facility (Old Aerospace Building). Renovation work is in progress and it is expected that DIGITS will move into the new building by October 2017.

Going forward, the plan of action for the forthcoming year includes commencement and completion of a part of ERP implementation; completion of email migration to Azure cloud; aggressive recruitment; and initiating a variety of other value added IT services at the Institute. It will be an exciting year ahead for DIGITS.

The mission of the Society for Innovation and Development (SID) is to enable India's innovations in science and technology by creating a purposeful and effective channel to help and assist industries and business establishments to compete and prosper in the face of global competition, turbulent market conditions and fast-moving technologies. SID strives to bring the leading intellectuals of IISc and the fruits of their research and development efforts closer to industries and business establishments in a cordial atmosphere with prosperity of the Nation as the ultimate goal.

PROJECTS SANCTIONED

During the period under review SID got **21 projects sanctioned** covering different departments of the Institute involving the participation of more number of faculty.

INDUSTRY R&D CENTRES IN SID/IISc CAMPUS:

- Pratt and Whitney – Aerospace
- Tata Motors – Automotive
- Robert Bosch Centre – Cyberphysical Systems
- Gubbi Labs LLP – Science Media
- i2n Technologies Private Limited – Nanotech

OTHER CENTRES:

- SATF (Spectroscopy Analytical Test Facility)
- CiSTUP
- ESSI (Energy Storage Systems Initiative)
- Centre for Brain Research

COMPANIES/INDUSTRIES WITH WHICH AGREEMENTS/ MOU'S SIGNED DURING 2016-17

The following organisations have entered into agreements and project proposals have been submitted. In some cases projects have been funded/and in others they are in process.

- NI Systems (India) Pvt. Ltd
- Mymo Wireless Technology Private Limited
- Tata Consultancy Services

AGREEMENT SIGNED UNDER UCHHATAR AVISHKAR YOJANA

- Tata Motors Limited
- Tata Consultancy Services
- Triveni Turbines

CHIEF EXECUTIVE

B GURUMOORTHY | Professor, Mechanical Engineering

3.7.11

SOCIETY FOR
INNOVATION

AND **DEVELOPMENT**

INTERACTION MEETINGS

SID has regularly been receiving number of enquiries on the modalities to be followed in sponsoring of projects and for establishment of R&D Centres. SID continues to organise the Interact sessions between the scientists/technologists from industries and faculty of IISc to showcase the capabilities of the Institute that would provide in the growth of applied research. The following are the details of the interact sessions.

Sl No.	Company	Areas of Interest
1	Siemens	Combustion, Design Optimisation, Machine learning
2	WIPRO 3D	Metal Additive Manufacturing
3	Faurecia	Connected Automobile, Ergonomics, Energy harvesting
4	Wipro Tech	Autonomous Vehicle
5	Mtuity	Smart City
6	All State Insurance	Machine Learning, Sensors
7	TESCO Labs	Machine Learning, Sensor based tracking, Learning from legacy designs

ENTREPRENEURSHIP AT SID

B1. Companies currently being incubated:

Company	Incubatee	Technology Area	Status	Impact Area
Pratimesh Labs	Mr. Prakhar Jain	Low- Cost Medical Devices	Developmental phase	Rural Health
Sickle innovation	Mr. Vinay Reddy	Agrotools	Developmental phase	Agriculture
Azooka Life Sciences	Ms.Fatima Benazir	DNA Stains	Developmental phase	Societal
Astrome Technologies	Ms. Neha Satak	Satelite Based Internet Services	Developmental phase	Digital India
General Aeronautics	Dr. Kota Harinarayana	Aerospace	Developmental phase	Aerospace Industry
Bellatrix Aerospace	Mr. Rohan M Ganapathy	Orbital launch vehicles	Developmental phase	Aerospace Industry
Lab to market innovations	Prof. S K Sinha	lol based applications	Developmental phase	Transportation Industry (Railways)
SIAMAF Healthcare Pvt. Ltd.	Dr. Subhasis Sarangi	Nano technology based diagnostics	Product development	Health care

B2. Companies incubated under the Faculty entrepreneurship programme

Company	Faculty Promoters	Technology Area	Status	Impact Area
Superwave Technology Pvt. Ltd.	Prof. K P J Reddy/ Prof Jagadeesh	Shock Wave Dynamics	Revenues	Petroleum, Tea Industry and Healthcare
Equine Biotech Pvt. Ltd.	Prof. Utpal Tatu	Veterinary Diagnostics	Field Testing	Animal Health
Pathshodh Healthcare Pvt. Ltd.	Prof. Navakanta Bhat	Diabetes Diagnostics	Product Testing	Societal
Bio-Synth	Prof. B Gopal	Enzyme Engineering	Product Development	Biotechnology, Chemicals, Pharma
Shanmukha Innovations Pvt Ltd	Dr. Sai Siva Gorthi	Optics and Microfluidics Instrumentation	Developmental Phase	Medical Diagnostics
Simyog	Prof. Dipanjan Gope	Computational tool for modelling and simulation in electromagnetics	Product Development; Strategic investor on board	Electric vehicle

SID has received new proposals on faculty entrepreneurship and these are in various stages of evaluation and processing.

INCUBATION PIPELINE

Domain	Product / Initial Offering
Renewable Energy	Wind Energy at High Altitudes
Healthcare / Education	Laparoscopy Simulator
Healthcare (Diagnostics)	Hearing Test
Education	3D Models
Environment (Solid Waste Management)	Compost and Bio-Fuel

UCHHATAR AVISHKAR YOJANA

Uchhatar Avishkar Yojana (UAY) has been launched for promoting research that is socially relevant and is of use to the end users like the Industry. The UAY promotes industry sponsored, outcome-oriented research projects. The main aim of launching the UAY scheme is to make faculty more accustomed with the outer world and give them a market oriented mindset. The Scheme is to be implemented first in premier institutes like IITs & IISc only.

IISc had sent around 19 project proposals, out of which 10 projects proposals have been approved. We have had to drop one project as the Industry partner could not provide the industry share of the project cost despite signing the MOU. Of the remaining 9, financial closure has been achieved for six of them and these are underway. MOUs have been signed for two more and funds from the industry is expected shortly. For the last project, we hope to sign the MOU first week of April.

Centre for Brain Research (CBR) is an autonomous centre of the Indian Institute of Science established under the Karnataka Societies Act 1960, with a goal to discover, how to preserve cognitive functions during aging and how to reduce the burden of dementia through early diagnosis and innovative interventions.

Towards this goal, CBR has started the Srinivaspura Aging Neuro Senescence and Cognition (SANSCOG) study, with the objective to identify risk and protective factors in a large-scale prospective community based cohort study with long term follow-up. This will include comprehensive evaluation of risk and protective factors associated with cognitive changes due to normal ageing, Alzheimer's disease and other related disorders. This study will generate a database comprising of genetic, biochemical, clinical, neuroimaging and neurocognitive data that can help in further exploration of the pathophysiology of normal and pathological cognitive aging using systems biology based approaches. National Institute of Mental Health and Neurosciences (NIMHANS) and Shri Devraj Urs Medical College, Kolar are collaborative partners in this project. CBR has also embarked on a project to complete the whole genome sequencing of 1000 individuals from Southern India with the aim of mapping the haplotype structure and genetic variation in this Indian population that will help perform genetic studies for SANSCOG as well as other researchers across the country.

Since its inception, two new faculty members Ganesh Chauhan, PhD and Bratati Kahali, PhD have joined the centre.

The society has organised twelve lectures by eminent scientists as part of the CBR lecture series since its formation. A few of them being:

- Lecture on "Using Machine Learning to Study Neural Representations of Language Meaning" by Prof Tom M. Mitchell, Fredkin University Professor at Carnegie Mellon University, USA.
- Lecture on "Enjoying a three-way marriage: A story of Maths, Biology, and Medicine" by Prof ANURAG AGRAWAL Principal Scientist at CSIR-Institute of Genomics & Integrative Biology, New Delhi.
- Ms SHARWARE GOKHALE MEMORIAL LECTURE on "Cardiovascular disease in India: pathways and paradoxes" by Prof K. Srinath Reddy, President, Public Health Foundation of India, New Delhi.
- Lecture on Dementia and insights into brain cognitive functions" by Dr Ratnavalli Ellajosyula, Senior Consultant Neurologist & Specialist in Cognitive Neurology, Manipal Hospital & Annaswamy Mudaliar General Hospital, Bangalore.

The construction process of the building for CBR has been initiated in IISc campus as well. CBR has been established with a generous gift of ₹ 225 crores to be given over a period of ten years by Mr Kris Gopalakrishnan, co-founder of Infosys, a global leader in consulting, technology and outsourcing solutions. Late Ms Sharwaree Gokhale, an IAS officer of Maharashtra cadre, has also bequeathed a flat in Mumbai to CBR, IISc as she strongly believed that human progress requires investment in scientific research.

CONVENOR

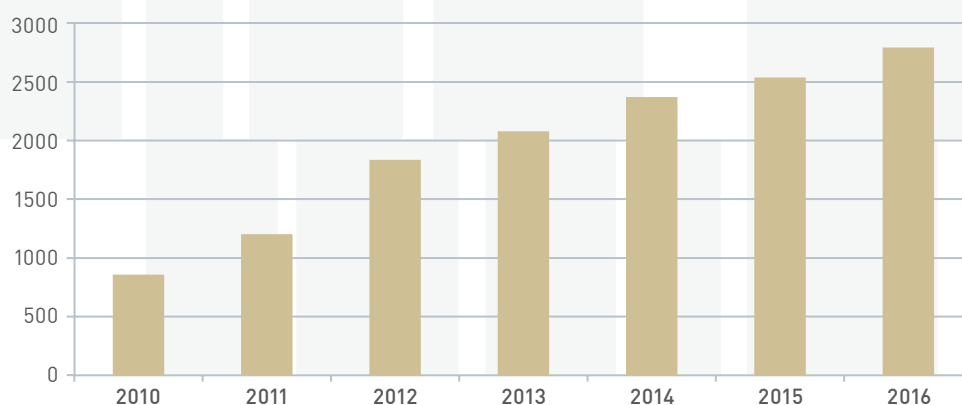
VIJAYALAKSHMI RAVINDRANATH | Professor, Centre for Neuroscience

3.7.12 CENTRE FOR BRAIN RESEARCH

The Kishore Vaigyanik Protsahan Yojana (KVPY) is a programme established in 1999 by the Department of Science and Technology, Government of India to encourage students to take up research career in Basic/Natural Sciences. The Department of Science and Technology, the nodal agency of the Government has entrusted the overall responsibility for organising and running the KVPY Program to the Indian Institute of Science, Bangalore and set up a KVPY Management Committee which oversees all the aspects of implementing KVPY program including declaration of results. The National Advisory Committee (NAC) oversees proper implementation of the program and a Core Committee looks after both the day-to-day and academic aspects of the KVPY Program. The aim of the programme is to identify and encourage talented students with an aptitude for research. This programme strives to assist the students to realise their potential and ensure that the best scientific talent is tapped for research and development in the country.

KVPY programme is open to Indian Nationals studying in India. Students enrolled in an undergraduate course in Basic Science subjects such as Chemistry, Physics, Mathematics, Statistics, Biochemistry, Microbiology, Cell Biology, Ecology, Molecular Biology, Botany, Zoology, Physiology, Biotechnology, Neurosciences, Bioinformatics, Marine Biology, Geology, Human Biology, Genetics, Biomedical Sciences, Applied Physics, Geophysics, Materials Science or Environmental Science, in their degree courses leading to BSc/BS/BStat/BMath/Int. MSc/Int. MS, during the academic year in which the fellows awarded are made, are eligible to apply for the KVPY fellowship under various streams – SA, SX and SB. Since 2010 there is more than 200% increase in the number of KVPY Fellowships offered under various categories as depicted in the bar chart.

NUMBER OF KVPY FELLOWSHIPS AWARDED DURING 2010 – 2016



CONVENOR

G MUGESH | Professor, Inorganic and Physical Chemistry

3.7.13

KISHORE VAIGYANIK PROTSAHAN YOJANA

EMPOWERMENT INITIATIVE IN THE KVPY PROGRAM

- i. A certain number of fellowships under the various streams as stated above are available for the students belonging to SC/ST community.
- ii. A certain number of fellowships under various streams as stated above are available for the students under the category of Person with Disability (Physically and Visually Challenged).

Application fee: General Category is ₹ 1,000/- and SC/ST & PWD is ₹ 500/-.

Fellowships (₹ 5,000 - ₹ 7,000 p.m and a contingency grant equal to 4 months of fellowship per year) are given up to the Pre-PhD level or for a period of five years whichever is earlier to the selected students.

FELLOWSHIP DETAILS

Fellowship Value	Qualifications
₹ 5,000/- p.m.	I to III year BSc/BS/BStat/BMath/Int. MSc/Int. MS
₹ 7,000/- p.m.	I/II year MSc; IV/V year BS/Int MSc/Int. MS
Contingency Grant	Equivalent to four months of Fellowship per year

KVPY Fellows SA/SB/SX are eligible to attend the Interview/Counselling for admission to the five year Integrated BS/MS Programme conducted by the Indian Institute of Science Education and Research (IISER) Kolkata/Pune/Mohali/Bhopal/Thiruvananthapuram.

KVPY fellows SA/SX/SB are also eligible to apply for Undergraduate degree programme conducted by IISc Bangalore.

NATIONAL SCIENCE (VIJYOSHI) CAMP

The aim of the annual National Science (Vijyoshi) Camps is to provide a forum for interactions between bright young students and leading researchers in various branches of science and Mathematics. With boundaries between disciplines fast disappearing, these camps serve as an ideal platform for the young participants to get an exciting global viewpoint of questions relating to Basic Sciences as well as application oriented themes.

As in the previous meetings, a comprehensive programme has been designed for the participants. This includes thought provoking lectures followed by a round of discussion at the end of each day's programme. In addition, the previous meetings have ultimately served to motivate and inspire the participants by bringing them together, in what is hoped will be their first step towards a career in research in the Basic Sciences and Mathematics.

During 2016 the National Science (Vijyoshi) Camp was held at Bangalore and Kolkata, the details of the camp along with number of students called and attended are as specified below:

Sl.No.	Place	Date	Venue	No. of students called	No. of students attended
1	Bangalore	3rd-5th Dec 2016	JN Tata Auditorium, IISc, Bangalore	622	538
2	Kolkata	5th-7th Dec 2016	IISER-Kolkata	963	625

Karnataka State Council for Science and Technology (KSCST) an autonomous S&T organisation under Department of Science & Technology, Government of Karnataka established in the year 1975 is one of the first State S&T Councils to be set up in the country.

During the last 40 years of its existence, KSCST has been pro-actively engaging itself to identify, propose and implement S&T based solutions to locale specific needs / problems in the broad areas of Agriculture, Water, Education, Energy, Ecology and Environment, Habitat, Health, Solid and Electronic waste and Infrastructure. In co-operation with the Indian Institute of Science and several other premier R&D institutions, KSCST has been executing many projects and programmes aimed at improving socio-economic conditions of the people of the state.

Over the years, a number of technologies have been translated, from research and demonstration phase to the implementation and operational phase. KSCST provides support to the State Government in formulation of S&T based policies and to both Central and State Governments in scientific surveys, project implementation, evaluation, co-ordination & monitoring, organisation of scientific meets and awareness campaigns.

Vision: Application of Science & Technology for the management of resources, improvement of environment, quality of life and socio-economic conditions of the people of Karnataka.

Mission: Co-ordinate R & D activities for generation of knowledge for scientifically based interventions, development and popularization of appropriate technologies for adaptation

by the civil society to overcome local-specific problems and, inspire and improve human resources of the S&T sector in the state.

MAJOR PROGRAMMES

- Natural Resources Data Management System (NRDMS) - A Repository of Natural Resources and Socio-economic database to support local level development, planning.
- Karnataka State Spatial Data Infrastructure (KSSDI) - Karnataka Geoportal is a web portal to find and access spatial information, metadata and associated geographic services/applications via the Internet.
- Student Project Programme (SPP) - Support to undergraduate and post-graduate engineering students for nurturing innovation and development of new technology.
- Rainwater Harvesting (RWH) - Awareness and technical support for implementation of rooftop Rainwater Harvesting.
- Biofuel Programme - Demonstration and dissemination of technology and process for biofuel production and use in rural setup.
- State Science and Technology Conference - To discuss, deliberate and generate public opinion on a contemporary theme in S&T.
- National Science Day Celebration - In order to expose, encourage, strengthen scientific temper amongst school children.

SECRETARY

S SUBRAMANIAN | Professor, Materials Engineering

3.7.14

KARNATAKA

STATE COUNCIL

FOR SCIENCE AND TECHNOLOGY

- State Awards for Scientists and Engineers - Provide support to state government to recognise and reward eminence in S&T.
- Patent Information Centre - Awareness creation in Intellectual Property Rights and provision of technical support for securing IPR.
- Sir M. Visvesvaraya Geospatial Chair - To promote and encourage R&D in Spatial Data Techniques / Technology.
- Digital Geospatial Data Generation and Terrestrial Scanning for 3D Reconstruction of Heritage Site at Hampi.
- Assessing the Status of Kalyanis & Measures for Rejuvenation in different Zones of Karnataka State using Geospatial Technologies.
- Karnataka –Israel Industrial Research & Development Programme (KIRD) to promote industrial research leading to product development.

ONGOING PROJECTS (SUPPORTED BY DST - GoK AND GoI)

- Implementation of Virtual Laboratory to Improve the quality of education in the backward taluks of Karnataka.



The Indian Institute of Science Alumni Association (IIScAA) was formed in the year 1976 to provide a common platform for the alumni of the institute to reach out to other alumni across various batches, branches, and interests. Following report summarizes the activities of IIScAA during the financial year 2016-17.

WiSER Conclave

The IISc Alumni Association and IISc Family and Friends Forum under the able guidance of Prof Rohini Godbole came together to celebrate **'Women in Science, Engineering and Research'** in IISc. The first WiSER Conclave, organised on 2nd April, 2016 at Faculty Hall, Main Building IISc, brought together the women faculty, women students & alumni of IISc along with eminent women from both industry and academia. The intent of this conclave was to bring together achievers from women community, identify concerns on campus, deliberate on possible solutions and provide a roadmap for the future WiSER events. The idea was to awaken the society and impact policy changes at the Institutional level.

Dr Madhurima Das, Joint Secretary, IIScAA gave the welcome address. Prof Rohini Godbole highlighted the thought behind WiSER and its mission. Prof Anurag Kumar, Director of IISc and Patron of IIScAA delivered the opening remarks and introduced the Chief Guest & Key note speaker for the day, Dr Kiran Mazumdar Shaw, Chairperson and MD, BIOCON.

Panel Discussion

IIScAA in collaboration with Students Council, IISc and Entrepreneurship and Innovation in IISc (EntIISc), organised Panel Discussion on the topic – **"Entrepreneurship or Employment - What governs the choice?"** on 9th April 2016, at the Faculty Hall, IISc. The five Panelists were:

1. Ms Shradha Sharma, Founder and Chief Editor, YourStory.com
2. Mr Abhinay Choudhari - Co-founder and Head, of New Initiatives, Bigbasket.com
3. Prof Swami Manohar - Senior Researcher, Microsoft Research Centre (MSR) India
4. Mr Pavan Sriram - Founder and CEO, ITTIGE Learning
5. Ms Vandana Suri – CEO and Founder, TaxShe

The session was moderated by: Mr C. S. Murali, Chairman, Entrepreneurship Cell, IISc, Bangalore.

Alumni Network Meetings

1. ALUMNI NETWORK MEETING – AUGUST 7, 2016

IIScAA organised the alumni networking meeting over breakfast on August 7, 2015 at the Lawns of the Main Guest House, IISc. The intent was to develop closer interaction among members, spread membership awareness and notify new initiatives of IIScAA. Quite many senior members, family and children participated.

PRESIDENT

L N SATAPATHY | Deputy General Manager, BHEL R&D

3.7.15

IISc ALUMNI
ASSOCIATION

Honours and Award Functions

1. HONOURING SENIOR GURUS FUNCTION – OCTOBER 15, 2016

IIScAA organised Honouring Senior Gurus on October 15, 2016 at the Faculty Hall, IISc. Prof Anurag Kumar, Director, IISc, honoured the following Senior Gurus:

1. Prof V G Tikekar, Mathematics, IISc
2. Prof M Sathyam, ECE, IISc
3. Prof D P Sengupta, Electrical Engineering, IISc
4. Prof K Parthasarathy, Electrical Engineering, IISc

2. DISTINGUISHED ALUMNUS AWARDS – SEPTEMBER 11, 2016

Prof Anurag Kumar, Director, IISc, presented the Distinguished Alumnus Awards-2016 to the following awardees on September 11, 2016 at the Faculty Hall, IISc.

1. Prof N Balakrishnan, Honorary Professor, Department of Aerospace Engineering and Supercomputer Education and Research Centre, Indian Institute of Science
2. Prof Ajay K Sood, Honorary Professor, Department of Physics, Indian Institute of Science
3. Prof Ramalingam Chellappa, Chair, Department of Electrical and Computer Engineering, University of Maryland, College Park, Maryland, USA

On this occasion, Prof S K Chatterjee Award for the year 2016 was awarded to two people, Prof Parbati Biswas, Dept. of Chemistry, Delhi University, New Delhi and Dr Suja Elizabeth, Chief Research Scientist, Dept. of Physics, IISc. Dr Suja Elizabeth could not attend the function and on her behalf, the chairman of the Physics dept. Prof V V Venkatraman received the award.

IISc Alumni Association website was launched by IISc Director Prof Anurag Kumar on 11th September 2016 after the Distinguished Alumni Awards ceremony.

Lecture Series

1. IIScAA SCIENCE FORUM - POPULAR LECTURE SERIES

a) Prof Tarun Khanna, Jorge Paulo Lemann Professor, Harvard Business School, USA, delivered the 53rd Lecture on the topic - **“Science and Start-Ups”** on July 23, 2016 at the Faculty Hall, IISc.

b) Dr Kartik Shanker, Director, Ashoka Trust for Research in Ecology and the Environment (ATREE), Bangalore, delivered the 54th Lecture on the topic - **“From soup to superstar: the making of a marine conservation icon in India”** on August 25, 2016 at the Faculty Hall, IISc.

c) Prof R L Kashyap, Honorary Director, Sakshi Trust, Bengaluru, delivered the 55th Lecture on the topic **“Knowledge of the four vedas and its relevance”** on November 19, 2016 at the Faculty Hall, IISc.

d) Dr Murthy S Gudipati, Principal Scientist, Science Division, NASA Jet Propulsion Laboratory, California Institute of Technology, USA, delivered the 56th Lecture on the topic - **“Astrophysics, Astrochemistry, and Astrobiology Exploring the Universe in Search of Life Beyond Earth”** on March 11, 2017 at the Faculty Hall, IISc.

2. SPECIAL LECTURE BY NOBEL LAUREATE PROF MUHAMMAD YUNUS

IIScAA organised the Special Lecture by Nobel Laureate Prof Muhammad Yunus, on the topic - **“The Zero Effects of Social Entrepreneurship”** on February 6, 2017 at the Faculty Hall, IISc.

IIScAA NEWSLETTERS

The IIScAA Newsletters of Issues - April 2016, July 2016, October 2016 and January 2017 were released. Dr H Saroja Devi, Dr H K Anasuya Devi and Dr S Ramachandra are the Editorial Committee Members.

ALUMNI DAY (DECEMBER 16 – 18, 2016)

IISc has produced nearly 30000 graduates over 107 years, who have been successful as academicians, scientists and technologist world over. To bring these Alumni together, the function of the Alumni Day of IISc was held with active support of IIScAA from 16th December evening till 18th December forenoon. The events were a great success and exhibited grandeur.

With a mandate given by the Director of IISc to organise the Alumni Day on 17th day or 3rd week of December of every year, the ODAA organising committee, under the chairmanship of Prof S Mohan and President-Elect of IIScAA Dr M P Ravindra, together with other representatives of IIScAA took initiative to conduct the Alumni day of this year.

On 16th evening, the Director received the Alumni with a grand dinner on the lawns of the Main Guest House. On the

second day, 17th, the Director addressed the gathering and appraised them of the academic growth IISc has achieved both in terms of number of programs and number of students graduating, awards and recognitions won by faculty of IISc and in brief some of the significant contributions made by the scientists and technologists highlighting social impact. He also explained the needs for expanding the overall capacity and called upon the alumni to take active part in making it happen.

On the 18th morning, IIScAA in partnership with Student Council organised a Campus Walkathon ending with a sumptuous breakfast in the A mess. 200 enthusiastic alumni participated in a 5km Walkathon (also called Science & Technology run- SnT run) to celebrate the 2016 Alumni meet organised by the Institute. The IIScAA was entrusted with organising this walk. Dr M P Ravindra, President Elect and Mr BNN Prasad, EC member, who led the initiative, with the commendable support of the Student Council Chairman Mr Naveen and Mr Vikram, Gymkhana Secretary and their team ensured a successful event.

7TH IIScAA SPORTS MEET 2017 – JANUARY 29, 2017

The 7th IIScAA Sports Meet among IISc Alumni was held on 29th January 2017 at IISc Gymkhana ground. The convenor of the event was Dr L N Satapathy. About 100 members including alumni and family members participated in the event which was kick started with breakfast in the Gymkhana ground. The cricket match was played among 30 alumni participants.

FLORAL TRIBUTES TO THE FOUNDER – MARCH 3, 2017

Dr L N Satapathy, President, IIScAA, paid the floral tributes to the founder, J N Tata, on the occasion of Founder's Day on March 3, 2017.

GREEN OPEN DAY

Trash Free Green open day was held on 4th March 2017, with a focus on waste management & segregation, treatment and recycling. IFF (IISc Families and Friends) together with IIScAA and Student volunteers conducted this event. IIScAA, apart from volunteering in all the above activities, also sponsored T-shirts for more than 50 green volunteers (faculty, students, alumni and families) with an intention to spread the message: Reduce-Reuse-Recycle.

MEMBERSHIP STATUS

IIScAA has Members as on 31st March 2017: **9541**
Total number of members enrolled during the period 2016-2017: **232**.

EQUIPMENT DEVELOPMENT

INLINE CHARACTERISATION



The Office of Career Counselling and Placement (OCCaP) was established in 2016 to support students graduating from IISc secure a job of their interest. In addition to managing campus placement activities (primarily for Masters and Undergraduate Students), OCCaP has organised events to facilitate interaction between students and industries through special meetings in IISc or enabling internship visits for our students. In addition, OCCaP plans to support graduating students secure teaching and research jobs as well. Presently this office is managed by a committee of four Faculty Members and a Placement Officer.

OCCaP has incorporated some major changes in the functionality of the Placement department. A brand new Placement Portal was launched to automate all administrative aspects of the recruitment process. OCCaP has held continuous activities throughout the year to associate with more Companies and the Alumni of the Institute.

A. IISconnect

OCCaP organised a first of its kind research career fair at IISc on October 3, 2016. Graduating doctoral students presented their work to representatives of interested industries. Firms got an opportunity to advertise and interact via stalls and also make presentations with regard to the nature of employment opportunities available in their industries. The event included presentations from the director and IISc faculty on the various ways in which industry could interact and engage with IISc. Over 100 graduating doctoral students presented their work. A large number of other students from the institute, in various stages of their undergraduate, masters and doctoral degrees, also participated and interacted with industry delegates. Over 100 delegates representing industries from a host of sectors in science and engineering visited IISc for the event. The event was sponsored by Qualcomm and Media.net. Based on information available, several industries are interacting with students to finalize employment offers.

B. Highlights of other placement activities

1. PLACEMENT BROCHURE

An attractive Placement Brochure was prepared by OCCaP to be circulated with potential recruiters. A large number of potential recruiters were contacted with an intent for Campus Association for recruiting the students. Brochures were shared, and many responded positively with good number of work opportunities for our students for Final placements. This has added on to the list of our Eminent Recruiters those visited last year on Campus. On Campus and Off Campus interest to hire our students was shared by the companies.

2. PLACEMENT PORTAL

A modern and fully functional Placement Portal has been set up for students and recruiters. The portal enables companies to register and post their hiring requirements. Students can register, apply for jobs, and manage interface with recruiters. The portal facilitates Emails and SMS alerts to selected set of student, and to disseminate information quickly. Around 709 students (233 Research, 403 Masters and 73 Undergraduate) students have registered for placements in the portal. More than 130 Companies have shared their interest to recruit our students for final placements and internship and have registered on the placement portal.

3. ALUMNI CONNECT

Alumni, the valuable ambassadors of our Institution were approached and connected to get their insights and requested to contribute toward enhancing placement numbers and emoluments. They were invited to connect with our graduating students and impart their knowledge and work experiences to keep them abreast of the expectations

3.7.16

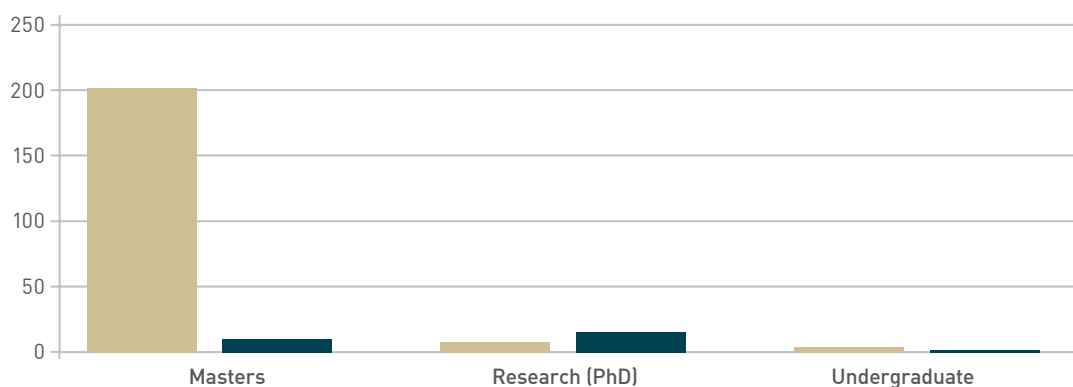
OFFICE OF
CAREER COUNSELLING
AND PLACEMENT

from industries and improve competencies. OCCaP aims to facilitate alumni and student interactions by campus visits, video-conferencing and online mode. Details of our graduating research students seeking employment in the form of a small booklet was shared with several industry contacts including alumni. This has provided the industries with a ready reference guide to areas where talent is available and has resulted in numerous queries for recruitment.

4. PLACEMENT STATISTICS FOR BATCH 2016-2017

A total of 212 students from Master Program (ME/ MTech/ MDes/ MMgmt), 24 from Research(PhD in Science or Engineering/ MTech in Research) and 6 students from Undergraduate program(BSc/ MSc Research) expressed their interest for placement support this year. 10 students from Master Program, 16 from Research and 2 from the UG program are yet to be placed. The recruitment for this batch is still in a phase of continuation.

PLACEMENTS - BATCH 2016-17



Placement Statistics-Batch 2016-17: 2015-16 figures in brackets

Highest annual salary (CTC) offered: ₹ 30 Lakhs [27.6 from India; 75 from abroad]

Number of offers with CTC above 20 LPA: 32 [17]

Number of offers with CTC in the range 15-20 LPA: 78 [60]

Number of recruits in top (first) 10 companies: 51

Total offers till date: 225 [150]

Number of companies visited till date: 83 (+ off campus) [total in 2015: ~55]

Overall, we have noted a 50% improvement in most of the parameters above. This list does not contain information on off-campus placements, many of which were facilitated using the initial contact established during our first flagship event IISconnect held on October 3, 2016.



4.

UNDERGRA PROGRAMME

The undergraduate programme in science which began in 2011 has seen two batches of students who graduated with a Four-year Bachelor of Science (Research) degree and one batch of students who graduated with a Master of Science degree. In the first two batches, roughly 50% of the students in each batch opted to continue for a fifth year to pursue a Master of Science program.

BSc (RESEARCH) AND MSc PROGRAMMES

DEAN: **ANJALI KARANDE** | PROFESSOR, BIOCHEMISTRY

ASSOCIATE DEAN: **BALAJI R JAGIRDAR** | PROFESSOR, INORGANIC AND PHYSICAL CHEMISTRY

ASSOCIATE DEAN: **PS ANIL KUMAR** | ASSOCIATE PROFESSOR, PHYSICS

CAREER PATHS OF OUTGOING STUDENTS

Batch 2012 (2nd batch): 57 students opted to continue for the Master's program; A total of 39 graduating Bachelor's students secured admission to PhD and other programs.

BATCH 2011 (1st BATCH)

42 graduating Master's students secured admission to PhD and other programs. Universities/institutes in which these students (Bachelor's and Master's) secured admission: Caltech, Columbia, Cornell, Harvard, Oxford, Princeton, Purdue, Rockefeller, Univ of California (Berkeley), Erasmus Mundus FAME program in Europe, Max Planck Institute (Dresden), National Univ of Singapore, Peking Univ, Univ of Bordeaux, Weizmann Institute of Science, National Centre for Biological Sciences, London School of Economics, IIM (Ahmedabad, Kozhikode), Indian School of Business, and others.

NEW ACADEMIC INITIATIVES

UG special lectures: Recent speakers include Prof Martin Gruebele (University of Illinois, Urbana-Champaign), Prof Alan Goldman (Rutgers – The State University of New Jersey), and Prof Richard Zare (Stanford University).

CURRENT BATCHES OF STUDENTS

Batch 2012: 57 Students continuing for Masters;
Batch 2013: 111 students; Batch 2014: 102 students;
Batch 2015: 108 students; Batch 2016: 94 students.

Breakup of 2015 batch of student discipline-wise:
Biology (20), Chemistry (17), Materials (12),
Mathematics (21), Physics (36).

DUATE



5.

AWARDS/ DISTINCTIONS

DISTINCTIONS

NATIONAL ACADEMY OF MEDICAL SCIENCES

PN Rangarajan, BC

NATIONAL ACADEMY OF SCIENCES (NASI)

AK Nandakumaran, MATHS

KN Balaji, MCB

Utpal Nath, MCB

Other Fellowships

J C BOSE NATIONAL FELLOWSHIP

KN Balaji, MCB

SK Satheesh, CAOS

Rene M Borges, CES

R Narasimhan, ME

Pradip Dutta, ME

G Mugesh, IPC

AMERICAN HELICOPTER SOCIETY VERTICAL FLIGHT FELLOWSHIP 2016, USA

Dineshkumar Harursampath, AE

DBT-WELLCOME TRUST INTERMEDIATE FELLOWSHIP

Aravind Penmatsa, MBU

DST SERB EARLY CAREER FELLOWSHIP

Pradipta Biswas, CPDM

FELLOW OF AMERICAN CERAMIC SOCIETY

KT Jacob, MT

FELLOW OF ANDHRAPRADESH ACADEMIC OF SCIENCES

Kavirayani R Prasad, OC

FELLOW OF AMERICAN INSTITUTE FOR MEDICAL AND BIOLOGICAL ENGINEERING

Bikramjit Basu, MRC

FELLOW OF 'INTERNATIONAL ASSOCIATION (IA-FRAMCOS)

Chandra Kishen J M, CiE

FELLOW OF ISRAEL INSTITUTE OF ADVANCED STUDIES

Thaker M, CES

FELLOW OF THE WORLD ACADEMY OF SCIENCES

U Ramamurty, MT

RAMALINGASWAMI FELLOWSHIP

D Nair, CNS

Sangram Keshari Samal, MRC

RAMANUJAN FELLOWSHIP

Aravind Penmatsa, MBU

Somnath Dutta, MBU

Sangram Keshari Samal, MRC

Siddharth Barman, CSA

Siddharth Jhunjhunwala, BSSE

SAE FELLOW MEMBER

Anindya Deb, CPDM

SWARNAJAYANTI FELLOWSHIP, DST

Vijay Natarajan, CSA

WELLCOME-DBT INDIA ALLIANCE "MARGADARSHI" FELLOWSHIP

Sandhya S Visweswariah, BSSE

WELLCOME-DBT INDIA ALLIANCE SENIOR FELLOWSHIP

Rishikesh Narayanan, MBU

Amit Singh, CIDR

WELLCOME-DBT INDIA INTERMEDIATE FELLOWSHIP

Prerna Sharma, PHY

YOUNG FACULTY FELLOWSHIP (2016-2020)

Mayank Shivastava, ESE

YOUNG FACULTY RESEARCH FELLOWSHIP

Shankar Kumar Selvaraja & Sushobhan Avasthi, CeNSE

Awards and Honours

K MUNIYAPPA, BC

Karnataka Rajyotsava Award

PATRICK D'SILVA, BC

Central Drug Research Institute (CDRI) Awards (2015-2016) for Excellence in Drug Research under Biological Sciences

SATHEES C RAGHAVAN, BC

4th Kobayashi Foundation Award (KFA)

GANESH NAGARAJU, BC

National Bioscience Award from DBT

RAVINDRANATH H ALADAKATTI, CAF

Best Poster Presentation Award at International Conference on "Advances in Laboratory Animal Science for Modeling Human Diseases"

RAMACHANDRA TV, CES

- Best Paper Award (Hydrological regime dependence on catchment vegetation dynamics, Authors: Ramachandra TV, Vinay S, Subash Chandran MD, Bharath SA) International Symposium Water Urbanization and Infrastructure Development in eco-Sensitive Regions, Organized by IIT Kharagpur, 6-7 Jan 2017

- Best Poster Award (Landscape Dynamics: National Parks of Karnataka, India), Authors: Ramachandra TV, Bharath S, Nimish Gupta) - International Symposium Water Urbanization and Infrastructure Development in Eco-Sensitive Regions, Organised by IIT Kharagpur, 6-7 Jan 2017

AMIT SINGH, CIDR

NASI-SCOPUS AWARD-2016, Biological Science

V RAVINDRANATH, CNS

Jawaharlal Nehru Birth Centenary Lecture Award, INSA

ARAVIND PENMATSA, MBU

DBT-Innovative Young Biotechnologist Award

SOMNATH DUTTA, MBU

Early Career Research Award

G MUGESH, IPC

Received the ISCB Award for Excellence – 2016 from the Indian Society of Chemists and Biologists

PK DAS, IPC

JC Ghosh Memorial Award of the Indian Chemical Society, 2015

ED JEMMIS, IPC

- PC Ray Memorial Award, awarded by the Prime Minister at Indian Science Congress, Mysore University, Indian Science Congress Association

- Linus Pauling Lecture Award, Mahatma Gandhi University, Kottayam, Nov, 2016

PRABEERBARPANDA, MRC

- NASI-Young Scientist Platinum Jubilee Award - 2016, by National Academy of Sciences, India

- Energy Technology Division Supramaniam Srinivasan Young Investigator Award- 2016, by the Electrochemical Society (ECS), USA

- Ross Coffin Purdy Award- 2016, by the American Ceramic Society (ACerS), USA

HANUDATTA S ATREYA, NMR

PK Bose Memorial Award from Indian Chemical Society

N SURYAPRAKASH, NMR

GV Bakore Memorial Award from Indian Chemical Society

SANTANU MUKHERJEE, OC

Basudev Banerjee Memorial Award for the year 2015 by Indian Chemical Society

CHANDAN SAHA, CSA

- INAE Young Engineer Award 2016

- Best paper award, ICALP

MURALI KRISHNA RAMANATHAN, CSA

ACM SIGSOFT Distinguished Paper Award, ISSTA 2016

SANJIT CHATTERJEE, CSA

IBM Faculty Award 2016

UDAY KUMAR REDDY B, CSA

INAE Young Engineer Award 2016

ANURAG KUMAR, ECE

IIT Kanpur Distinguished Alumnus Award 2016

Systems Society of India Lifetime Achievement Award 2016

NEELESH MEHTA, ECE

Vikram Sarabhai Research Award

RAJIV SOUNDARARAJAN, ECE

2016 IEEE Circuits and Systems for Video Technology Best Paper Award

GURUNATH GURRALA, EE

2nd Best Poster Award, IEEE PES T&D Conference and Exposition 2016 in Dallas, USA, May 2-5

PARTHA TALUKDAR, CDS

- IBM Faculty Award 2016

- Google Focused Research Award

S GOPALAKRISHNAN, AE

Structural Health Monitoring, Person of the year award 2016

G JAGADEESH, AE

Eminent Engineering Award 2016, Institution of Engineers, Karnataka State, India

DINESHKUMAR HARURSAMPATH, AE

AHS Best Paper Award, Bell Helicopters Textron/Concordia University/IISc/CRIAQ/ NSERC's International Workshop on Mechanical Behavior of Thick Composites, March 14-15, 2016, Montreal, Canada

GIRIDHAR MADRAS, CH

Santappa Award for outstanding contributions in the field of polymer science

GL SIVAKUMAR BABU, CiE

American Society of Civil Engineers Wesley W. Horner Award (2017) for the paper titled "Risk and Reliability Analysis of Multibarrier System for Near-Surface Disposal Facilities

SRINIVAS VV, CiE

Distinguished Alumni Professional Achievement Award, NIT Warangal

MADHAVI LATHA G, CiE

- Best Paper award at the Eighth Asian Young Geotechnical Engineers conference (8AYGEC) for the paper "Strength and deformation characteristics of sand-geosynthetic interfaces through digital image analysis" by Prashanth Vangla and G Madhavi Latha, presented at Astana, Kazakhstan
- IGS-MD Desai Memorial Award for the best paper on "Geosynthetics and Natural Fibers" during 2014-2016 for the paper "Characterization of Soil Geosynthetic Interaction Based on Surface Roughness Studies" by Prashanth Vangla and Madhavi Latha Gali by Indian Geotechnical Society
- Editor-in-Chief of Indian Geotechnical Journal published by Springer

AMARESH CHAKRABARTI, CPDM

- Best Paper Award at the 13th IFIP International Conference on Product Lifecycle Management (PLM16), Columbia, South Carolina, USA, July 2016 for the paper: Kumari MC
- Acted as a member of the Jury for India Design Excellence Awards, CII, India, 2016

MONTO MANI, CST

Best Paper Award at the 13th IFIP International Conference on Product Lifecycle Management (PLM16), Columbia, South Carolina, USA, July 2016

R NARASIMHAN, ME

Distinguished Alumnus award of IIT, Madras, April 2016

PRADIP DUTTA, ME

IIT Madras Distinguished Alumnus Award

TA ABINANDANAN, MT

Distinguished Alumnus Award of BHUMET

PRAVEEN KUMAR, MT

NASI Young Scientist Platinum Jubilee Award 2016, Young Member 2016

KA NATARAJAN, MT

NIGIS Lifetime Achievement Award-2016

DIPANKAR BANERJEE, MT

National Metallurgical Award for Research and Academia-2016

PRASAD HEGDE, CHEP

DST SERB Early Career Research Award

ROHINI M GODBOLE, CHEP

Archana Sharma Memorial Lecture Award (2016) of the National Academy of Sciences, India

SANJIV SAMBANDAN, IAP

- Cambridge Lectureship Award
- Award by Spinoff: F6S Top 10
- Award by Spinoff: GEN Top 10

SAI SIVA GORTHI, IAP

INAE's Young Engineer Award

ABHISHEK BANERJEE, MA

AK Agarwal Award for best paper from the Indian Mathematical Society

SUJA ELIZABETH, PHY

SK Chatterjee Award for the year 2016

AK SOOD, PHY

- Distinguished Alumni Award 2016 of IISc jointly with IIScAA-2016
- Life time achievement award by Optical Society of India (2016)
- MRSI Distinguished Materials Scientist of the year award-2016

V NAGARAJA, MCB

G N Ramachandran Gold Medal for Excellence in Biological Sciences & Technology

UTPAL NATH, MCB

RB Ekbote Prize, Maharashtra Association for Cultivation of Science, Pune

ED JEMMIS, IPC

Fukui Medal, Asia Pacific Association of Theoretical and Computational Chemists, Asia Pacific Conference on Theoretical and Computational Chemistry, Taiwan

PRABEER BARPANDA, MRC

- INSA Medal for Young Scientist - 2016, by Indian National Science Academy (INSA)
- ISE Prize for Applied Electrochemistry- 2015, by International Society of Electrochemistry (ISE), HQ: Switzerland

ANSHU PANDEY, SSCU

Young Scientist's Medal (2016) by Indian National Science Academy

CHANDAN SAHA, CSA

INSA Medal for Young Scientists 2016

DINESHKUMARHARURSAMPATH, AE

2nd Prize, Christ University's Technical Conference Magnovite 2016

U RAMAMURTY, MT

The World Academy of Sciences Prize-2015

PRAVEEN KUMAR, MT

INSA Medal for Young Scientists

ANINDA SINHA, CHEP

ICTP prize 2016 in honor of Kenneth Wilson given by the International Centre for Theoretical Physics, Trieste Italy

SAI SIVA GORTHI, IAP

INSA's Young Scientist Medal

UTPALTATU, BC

Elected President of Proteomics Society of India

SUKUMAR R, CES

Honorary Professor, Jawaharlal Nehru Centre for Advanced Scientific Research

RAGHAVENDRA GADAGKAR, CES

Year of Science Chair Professorship, Department of Science and Technology 2017-2021

BORGES RM, CES

Chairperson, DST-PAC, Animal Sciences (2016-2019)

V RAVINDRANATH, CNS

Elected Member Dana Alliance for Brain Initiatives, USA

SK SIKDAR, MBU

Kamla BK Anand Oration, AIIMS, New Delhi

SUROLIA A, MBU

Prof VSR Rao Endowment Lecture, University of Madras

RAGHAVAN VARADARAJAN, MBU

Council Member, Indian Academy of Sciences (2016-18)

UMESH VARSHNEY, MCB

- Outstanding alumnus of College of Basic Sciences and Humanities, G B Pant University of Agriculture and Technology, Pantnagar
- JV Bhat Endowment Oration 2016, Manipal University, Manipal

ARUN KUMAR, MRDG

- Member, Academic Council, JNU, New Delhi
- Adjunct Professor, Rajiv Gandhi Centre for Biotechnology, Thiruvanthapura

SANDHYA S VISWESWARIAH, MRDG

Royal Society Collaborative Grant for Research Professors with Gad Frankel, Imperial College, London, UK

A BHATTACHARYA, IPC

Elected as Young Associate, Indian Academy of Sciences

PS MUKHERJEE, IPC

- Appointed as an Editorial Advisory Board Member of Inorganic Inorganic Chemistry Frontiers, a journal published by the Royal Society of Chemistry, UK
- Appointed as an Associate Editor of Inorganic Chemistry, a journal published by the American Chemical Society

G MUGESH, IPC

- Elected as Vice-President of the Asian Chemical Editorial Society (ACES)
- Appointed as an Editorial Board Member of Organic & Biomolecular Chemistry, Royal Society of Chemistry
- Appointed as a Member of the inaugural Editorial Advisory Board of ACS Omega, American Chemical Society
- Appointed as an Editorial Board Member of the Current Science
- Member, Editorial Board of Biological Chemistry
- Elected as a Member of the Executive Council of Society for Materials Chemistry
- Elected as a Member of the Executive Council of Indian Peptide Society

BIKRAMJI TBASU, MRC

Invited member, National Institution for Transforming India, NitiAyyog (earlier, Planning Commission), the Government of India, 2016

N JAYARAMAN, OC

- President, International Carbohydrate Organization (ICO) (2014-2016)
- Associate Editor, Glycoconjugate Journal, Springer Nature Publications

S BHATTACHARYA, OC

Director, Indian Institute of Cultivation of Science, Kolkata (on deputation)

S CHANDRASEKARAN, OC

Chairman, National Organic Symposium Trust (2015-2018)

DD SARMA, SSCU

- Acharya PC Ray memorial lecture, CSIR – National Institute for Interdisciplinary Science and Technology (NIIST)
- CNR Rao Distinguished Lecture on “Nanoscience and Nano technology”, IIT Bombay
- 4th Annual Lecture Series of CEFIPRA delivered at College du France, Paris; Ecole Polytechnique, Paris; and Laboratoire CRISMAT, Caen
- Scientific Evening Talk, Magnus-Haus, Berlin, 2016
- Lecture under Saint Gobain Chair program at Ecole Polytechnique, Palaiseau, France

UDAY KUMAR REDDY B, CSA

IASc Young Associate 2016

NAVIN KASHYAP, ECE

Joined the editorial board of the SIAM Journal on Discrete Mathematics, January 2017

PRASANTA KUMAR GHOSH, ECE

Team ‘Vidyut’ has been selected as the second runner-up in Signal Processing Cup 2016 held in Shanghai as a part of ICASSP March 2016

B SUBBA REDDY, EE

Honorary Distinguished Member Engineers welfare forum, West Bengal Power Development Corporation Limited, Kolkata, India

SHAYAN S GARANI, EE

- Senior Member, OSA, Vice Chairman (Academics) for IEEE DSTC, Chairman for IEEE ICC 2018 (Data Storage Track)
- Invited by All India Radio for a lecture on Prapatti as Envisaged by Tyagaraja. 2 Hour episode broadcast over DTH Raagam channel

SIDDHARTH JHUNJHUNWALA, BSSE

RI Mazumdar Young Investigator

NAVAKANTA BHAT, CeNSE

Elected as member of Board of Governors of IEEE Electron Devices Society

P BALACHANDRA, MGS

Ranked among the top 10 management researchers in India, and ranked Number ONE researcher in the “Strategic Management” domain in India

RADHAKANTPADHI, AE

- Associate Editor of IFAC Mechatronics journal
- Member of IFAC Council
- Aerospace Technical Committee

SWETAPROVO CHAUDHURI, AE

- Editorial Board Member of the Journal of Energy and Environmental Sustainability
- Associate of the Indian Academy of Sciences, July 2016
- Outstanding Contribution in Reviewing, Proceedings of the Combustion Institute, Elsevier, January 2016

DINESHKUMAR HARURSAMPATH, AE

- Academic Mentor, Team ROW, Winner, 2016 Airbus Innovation Showdown, USA
- Editor, International Journal of Mechanical Engineering and Materials Science, Serials Publications, ISSN: 0974-584X
- ISBN-13: 978-8126556502 book listed amongst the top sellers of GATE books in 25 online stores, including Flipkart and Amazon
- Awardee, Airbus BizLab Accelerator Program 2016-17

SK SATHEESH, CAOS

- Elected Member, Governing Council of INDIAN NATIONAL SCIENCE ACADEMY (INSA)
- Co-Editor, CURRENT SCIENCE, Interdisciplinary journal of India
- Executive Director, South Asia regional office of the international “Future Earth” programme

PN VINAYACHANDRAN, CAOS

Co-chair, IIOE-2, Science Theme-2, IOC, UNESOC Member, Editorial Board, Current Sciences

D NAGESH KUMAR, CEaS

Editor-in-Chief, Open Water Journal, IWA Publishing, UK

SAJEEV K, CEaS

- Associate Editor, Gondwana Research
- Associate Editor, Geological Journal
- Editorial Board, Lithosphere

NARENDRA M DIXIT, CH

- RA Mashelkar Endowment Lectureship, NCL Pune
- CV Seshadri Distinguished Lectureship, IIT Kanpur

ASHISH VERMA, CiE

- Elected President, Transportation Research Group of India
- Nominated Member of Project Team of United Nations Economic Commission for Europe (UNECE) for development of PPP Standards for Airports
- Member of the steering Committee of World Conference on Transport Research society (WCTRS) for a period of 3 years w.e.f. 13th July 2016
- Vice-Chair (Conference) of the Scientific committee of WCTRS, for a period of years w.e.f. 13th July 2016

MANOHAR CS, CiE

Delivered the Prof G S Ramaswamy Memorial Lecture at the CSIR-Structural Engineering Research Centre, Chennai on the occasion of the CSIR-SERC Foundation Day, 10th June 2016

GL SIVAKUMAR BABU, CiE

President, Indian Geotechnical Society for 2017-18

NANJUNDA RAO KS, CiE

- Chairman, Works Advisory Committee, Indian Statistical Institute Bangalore centre. Term of Appointment is 2016-18
- Member, Advisory committee, Sir M Visveswaraiyah National Construction Academy, Govt. of Karnataka
- Member, Building and Works Committee of Centre for Nano and Soft Matter Sciences, Bangalore (An autonomous Institute under DST, Govt of India)

VENKATARAMA REDDY BV, CiE

Member TC-RILEM committee on Earthen materials for buildings

VV SRINIVAS, CiE

Certificate of Outstanding Contribution in Reviewing from the Editors of Journal of Hydrology, Elsevier, in Recognition of the contributions made to the quality of the Journal

MONTO MANI, CST

A spatio-temporal product lifecycle network representation, 13th IFIP International Conference on Product Lifecycle Management (PLM16), Columbia, South Carolina, USA, July 2016

AMARESH CHAKRABARTI, CPDM

- Acted as the member of the Jury for the India Design Mark 2016 organised by the India Design Council, Gol

- Acted as a member of National Committee on Design, CII, India, 2016

- A spatio-temporal product lifecycle network representation, 13th IFIP International Conference on Product Lifecycle Management (PLM16), Columbia, South Carolina, USA, July 2016

- Initiated as Editor-in-Chief a new book Series called 'Design Science and Innovation', by Springer, 2016

PUNIT SINGH, CST

Habilitation Degree from Karlsruhe Institute of Technology, Germany

SK SATHEESH, DCCC

- Elected Member, Governing Council of INDIAN NATIONAL SCIENCE ACADEMY (INSA)
- Co-Editor, CURRENT SCIENCE, Interdisciplinary journal of India
- Executive Director, South Asia regional office of the international "Future Earth" programme

SAPTARSHI BASU, ME

Editor, Advanced Powder Technology [Elsevier]

PRAVEEN KUMAR, MT

Associate of the Indian Academy of Sciences (2016-19)

SAI SIVA GORTHI, IAP

Serving as Honorable General Secretary of Instrument Society of India (ISOI)

ROHINI M GODBOLE, CHEP

Elected Vice President of National Academy of Sciences, India

HR KRISHNAMURTHY, PHY

CNR Rao Vijnana Puraskara" by the "Swadeshi Vijnana Andolana, Karnataka", Sept. 2016

CHANDA J JOG, PHY

- Elected as a Council member for the Indian Academy of Sciences, Bangalore, for the three-year term 2016-18
- Appointed as Chair of the Indian National Committee for Astrophysics for the International Astronomical Union (IAU) for the four-year term 2016-2019 appointed by INSA-ICSU, New Delhi

AK SOOD, PHY

Doctor of Science, Honoris Causa, Indian Institute of Science Education and Research, Bhopal (2016)



6.

STUDENTS

6.1 Admissions and On Roll

During the year, 879 students (403 for research, 65 for Integrated PhD, 316 for course programmes and 95 under graduate programme) joined the Institute taking the number "On Roll" to 3595 (2,077 students in research, 296 in Int. PhD, 709 in post graduate and 513 in under graduate course programme).

6.2 SC/ST Students

68 students belonging to SC/ST in research, 55 in the course programme and 22 in the under graduate programme joined the Institute in the current year and, in all 249 research students, 49 Int. PhD and 129 course students, 119 under graduate students were "On Roll" during the year.

ADMISSIONS

Research: Out of 879 applicants, 686 were called for an interview; 58 were offered admission and 53 joined.

Integrated PhD: Since 2013, admission is through JAM (Joint Admission Test for MSc), 35 of them were short-listed and called for an interview, 12 were offered admission and 12 joined.

COURSES

ME/MTech/MMgt/MDes: Out of 828 applicants, 188 were offered admission and 71 joined.

BS: Out of 653 applicants, 61 were offered admission and 23 joined.

6.3 Scholarships/Fellowships

The students participating in research and course programmes are granted scholarships at the Institute ranging from ₹ 12,000/- to ₹ 40,000/- depending on the programme. Those students who are granted fellowships by agencies like UGC/CSIR and other bodies are not eligible for scholarships awarded by the Institute.

6.4 Students Assistance Programme

Needy students have offered their services in selected Institute activities and have secured additional finances under the "earn-while-you-learn" scheme.

Students Aid Fund: This is a co-operative scheme (every student subscribes ₹ 100/- per annum) to assist needy and deserving students through loans, to meet tuition fees, study tour expenses, cost of books, thesis expenses and maintenance at the Institute.

During the period 2016-17, 219 students availed themselves of the loan to the extent of ₹ 45,57,000/-.

6.5 Students Council

The Students Council (an elected body from among the student community) provides an effective channel of communication between the Director, faculty and students. Through dialogue and discussion on various student matters, problems relating to the students are resolved by initiating appropriate action. The Students Council is also responsible for certain welfare measures initiated by the student community. The publication of 'SCAMPUS', a campus magazine and News Letter of the students is one of its main activities.

6.6 Hostels

The Students' Hostel consists of 11 Gents and 4 ladies hostel blocks. Students, research associates and Short-term workers totaling 2,904 (2129 gents and 775 ladies) are provided accommodation in the Hostel Blocks.

Four Dining halls (Two Vegetarian and Two Composite) provide a variety of food items in clean and hygienic conditions for all the boarders. The Hostel and Dining halls are managed by the Council of Wardens headed by the Chairman and team.

6.7 Award of Medals

The Institute awards medals every year in recognition of the best thesis (both at the Doctoral and Master's levels) in various fields and for excellence in course programmes and projects.

The following tables give the names of the medal and the recipient for the current year:

SL No	Name of the Medal	Awardee	Dept / Centre
FOR THE BEST PhD THESIS			
1	Prof AK Rao Medal	Dr Visakh Vaikuntanathan	AE
2	Prof NR Kuloor Memorial Medal	Dr Pranesh Padmanabhan	CH
3	Prof BK Subba Rao Medal	Dr Ankur Miglani	ME
4	Prof KP Abraham Medal	Dr Badari Narayana Aroor Rao	MT
5	The Alumni Medal (Research)	Dr Nithin Shivashankar	CS
6	The Seshagiri Kaikini Medal	Dr Shilpa D Rao	EC
7	Prof DJ Badkas Medal	Dr Mohammad Hassan Hedayati	EE
8	Prof NS Govinda Rao Medal	Dr Bidroha Basu	CE
9	Prof Giri Memorial Medal	Dr Praveen Anand	BC
10	The M Sreenivasaya Medal	Dr Sunil Kumar Shetty	MC
11	Prof BH Iyer Medal	Dr V Vamsee Aditya	MB
12	Dr JC Ghosh Medal (Physical Chemistry)	Dr Anil Kumar Tummanapelli	IP
13	Prof S Soundarajan Medal (Inorganic Chemistry)	Dr Uttara Basu	IP
14	The Guha Research Medal	Dr Madhusudan Manna	OC
15	The Toulouse Medal	Dr Abhijit Hazarika	SS
16	The Martin Forster Medal	Dr Arpan Kabiraj	MA
17	Prof Anil Kumar Memorial Medal	Dr Gokhale Shreyas Shashank	PH
18	Kumari LA Meera Memorial Medal (For Research)	Dr Upasana Das	PH

19	The Indian Economic Association Medal	Dr Amrutha AA	MG
20	The Sudborough Medal	Dr B Sunil Kumar	MR
21	Dr Srinivasa Rao Krishnamurthy Medal	Dr Shilpa Dilip Kumar	IN
22	Amulya and Vimala Reddy Medal	Dr Jagmohan Sharma	ST
23	The Roddam Family Medal	Dr Joy Merwin Monteiro	AS
24	Tag Corporation Medal	Dr Kundan Kandhway	ED
25	The Institute Medal	Dr Tania Guha	CEaS

FOR THE BEST INTEGRATED PhD STUDENT (MS LEVEL)

26	Dr RK Maller Memorial Medal	Mr Soumyanetra Chandra	Biological Scs.
27	Dr A Nagaraja Rao Medal	Mr Rajeew Kumar Rai	Chemical Scs.
28	Kumari LA Meera Memorial Medal	Ms Ramya Nagarajan	Physical Scs.

FOR THE BEST MSc (ENGG) THESIS

29	Mrs Sabita Chaudhuri Memorial Medal (research)	Mr Sai Krishna Venkeswaram	AE
30	ME Department Alumni Medal	Mr Khivsara Sagar Deepak	ME
31	Dr MNS Swamy Medal	Mr Ravi Teja Mullapudi	CS

FOR THE BEST INTEGRATED ME/MTech/MDes/MMgt STUDENT

32	Dr N Narayanamurti Medal	Mr Sreenath Bhat	-
33	Prof NS Lakshmana Rao Medal	Mr Abhishek	CE
34	The Computer Society of India (Bangalore Chapter) Medal	Mr Shreyas S	CS
35	The KK Malik Medal	Mr Supriyo Chakraborty	MT
36	SV Sastry Memorial Medal	Mr Ayush Saraswath	ME
37	The Alumni Medal	Mr Akash Kumar Agrawal	EC/ED
38	Prof ISN Murthy Medal	Mr Vishal Jain	EE/EC
39	The NR Khambhati Memorial Medal	Mr Sagar Gupta	EE
40	The NR Khambhati Memorial Medal	Mr Debabrata Mahapatra	EE
41	Prof SVC Aiyra Medal	Ms Anjana AM	EC
42	Motorola Medal	Mr Abhijith J	CDS
43	The CEDT Design Medal	Mr Shah Nimish Shirish	ESE
44	HR Babu Seetharam Medal	Ms Priyanka Gupta	IN
45	Nikhil Memorial Medal	Mr Farhan Jamil	AS
46	The Institute Medal	Mr Patil Neepun Prashant	PD
47	Prof BG Raghavendra Memorial Medal	Mr P Rajesh Bhat	MG

FOR THE BEST BACHELOR OF SCIENCE (RESEARCH)

48	The Institute Medal	Ms Harsha Gurnani	Biological Scs.
49	The Institute Medal	Mr Deepak V	Chemical Scs.
50	The Institute Medal	Mr Shashank HR	Materials Scs.
51	The Institute Medal	Mr Sandip Sinha	Mathematics Scs.
52	The Institute Medal	Mr Kishalay De	Physical Scs.

6.8 Awards & Distinctions

FELLOWSHIPS

Praveen Prakhar, MCB
ProdipHowlader, IPC
Bristol-Myers-Squibb Fellowship

Vijaya Kumar BR, ECE
Sireesha Madabushi, ECE
Nihesh Rathod, ECE
CISCO Fellowship

Swati Gupta, CDS
DBT Junior Research Fellowship

Karthikeyan L, CiE
Fullbright Fellowship to do part of PhD work in Princeton Univ., USA

Arpita Biswas, CSA
Google PhD Fellowship

Kruthika Eswaran, DCCC
Arushi PV, DCCC
Nirupam Karmakar, DCCC
Angshuman Modak, DCCC
Govardhan Gaurav Rajabhau, DCCC
Phadtare Jayesh Anand, DCCC
Surajit Das, DCCC
Shubhi Agrawal, DCCC
Suhas DL, DCCC
Kala Nair K, DCCC
Ashutosh Pandey, DCCC
Deepankar Pacheria, DCCC
Anand N, DCCC
Jalihal Chetankumar Adappa, DCCC
Dixit Vishal Vijay, DCCC
Farhan Jamil, DCCC
Prashant Kumar, DCCC
Sheo Mishra, DCCC
Grantham fellowship

Ankur Miglani, ME
Indo-US Post-Doctoral Fellowship

Pardeep Garg, ME
ASME KCORC Award

Hassain M, MA
Shree Chaitranjali Yadla, MRDG
Shyama Prasad Mukherjee Fellowship

Srikanth Raju, ECE
Jagannath Venkatesan, CDS

Sreedevi Gutta, CDS
TCS Doctoral Fellowship

Ravi Kumar V, IPC
The Newton-Bhabha International fellowship (2016) co-funded by Royal Society (UK) and SERB (INDIA) to carry out his post-doctoral work with Prof Andrew J Orr-Ewing, School of Chemistry, University of Bristol

BEST PAPER AWARDS

Rahul Chakraborty, EE
Best paper award at IEEE Joint Electrostatics conference held at Univ of PURDUE, USA, June 2016

JB George, GM Abraham, B Amrutur, S Sikdar and AK Choudhury, ECE
Best Paper Award @ Intl VLSI Design&Embedded System Design Conference, Bangalore

Alok R Verma, EE
Shakthi Prasad D, EE
Best paper award at IEEE Joint Electrostatics conference held at Univ of PURDUE, USA, June 2016

Ms Narmada Sambaturu, BC
Best paper presentation award – IEEE international conference on bioinformatics and biomedicine

Akshay Datey, BSSE
Best Paper Presentation Award - National Symposium on Shock Waves 2016

Gowdham Prabahakar and J Rajesh, CPDM
IEEE ICCICT 2016 Best Paper Award

Prashanth Vangla, CiE
IGS-MD Desai Memorial Award for the best paper on “Geosynthetics and Natural Fibers” during 2014-2016 for the paper “Characterization of Soil Geosynthetic Interaction Based on Surface Roughness Studies” by PrashanthVangla and Madhavi Latha Gali by Indian Geotechnical Society

Prashanth Vangla, CiE
The Best Paper award at the Eighth Asian Young Geotechnical Engineers Conference (8AYGEC) for the paper “Strength and deformation characteristics of sand-geosynthetic interfaces through digital image analysis” by Prashanth Vangla and G Madhavi Latha, presented at Astana, Kazakhstan

BEST POSTER AWARDS**Shaikbepari Mohamed Khajamoinuddin, AE**

ARSS Best Poster Award, Shaikbepari Khajamoinuddin and Dineshkumar Harursampath, July 11–13, 2016, IISc, Bengaluru, India

Isha Verma, MRDG

Awarded Best Poster award at SCSS symposium Singapore

Ms Mihika Bose, BC

Best Poster Award - "Small Molecule inhibitors for the management of HCV infection", presented in "Biology and Molecular Pathogenesis of Viruses 2016", June 21-23, 2016, Department of Microbiology and Cell Biology, Indian Institute of Science, Bangalore

Lalit Sharma, MRC

Best Poster Award at Biennial ACSSI-2016 meeting

Sharmistha (CDS PhD), CDS

Best Poster Award at Grace Hopper Conference India 2016

Pramod Ravindra, CeNSE

Best Poster Award at MRS Spring Meeting 2016, Phoenix AZ, USA for his poster titled, "Electron-blocking properties of crystalline-Si/Cu₂O heterojunctions for photovoltaics"

Priyanka Tyagi (Dr Amit Singh), CIDR

Best Poster Award, National Virology Symposium-2016, IISc

AN Muttathukattil, SSCU

Best Poster Award, The 15th Theoretical Chemistry Symposium, University of Hyderabad, Hyderabad, 14th Dec 2016

Geetika Sharma, MCB**Pratik Dave, MCB**

Best Poster Awards, Symposium on Biology and molecular pathogenesis of viruses 2016, IISc. Bangalore

Satyapaul Singh, CH

Hindustan Platinum award for the best poster on a topic of "Pt, Ru substituted TiO₂ catalysts for dry reforming of methane" in 17th National Workshop on Challenges in Catalysis Science and Technology – 2016, Hyderabad, India

Prakhar Ojha, CSA

IBM ICARE 2016 Best Poster Award

Debasmita Mondal, PHY

Outstanding Poster Prize in 'Hands-On Research in Complex Systems School', at The Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy

Ms Anindita Brahma, CES

Student Poster Award during the 16th Congress of the International Society for Behavioral Ecology on the 30th anniversary of its founding, University of Exeter, UK, 18th July – 3rd August 2016. Title of Poster: Lose or retain: nest initiation potential of a eusocial wasp

Santanu Mondal, IPC

The ACS Chemical Biology Best Poster Prize at the International Symposium on Chemical Biology and Drug Discovery (ISCBDD-2016)

Surajit Kayal, IPC

The best poster presentation award at International Conference on Perspective in Vibrational Spectroscopy-2016 held at Lucknow

Tandriila Das, IPC

The best poster prize at the 6th International Conference on Metals in Genetics, Chemical Biology and Therapeutics (ICMG-16), Bangalore

BEST ORAL PRESENTATION AWARDS**Abhishek Sharma, MT**

1st Prize, Oral Presentation: Materials for Strategic Applications, NMD ATM 2016, IIT KANPUR

Saurabh Dixit, MT

2nd prize, oral presentation: Advance in Manufacturing, NMD ATM 2016, IIT KANPUR

Arka Lahiri, MT

3rd prize: ICME, Oral presentation, NMD ATM 2016, IIT KANPUR

Marsha Parmar, CeNSE

Best Oral Presentation Award, 13th International Workshop on Nanomechanical Sensing, 22-24 June 2016, Delft Netherlands

Ms Supriya V Vartak, BC

ICRR-HHE 2016 Best Oral Presentation Award

Ravi Kumar V, IPC

The best oral presentation award at International Conference on Perspective in Vibrational Spectroscopy-2016 held between 5th to 7th November at Lucknow

BEST RESEARCH / THESIS AWARDS**Upasana Das, PHY**

Best Physics PhD Thesis under Theory

Sandeep Mishra, NMR

CBMR-NMRS Award for best research work

Subhash Joshi TG, EE

CDAC-Director General Research and Development Award 2016

Dr Madhu Sudan Manna, OC

Eli Lilly and Company Asia Outstanding Thesis Award 2016

Abhinav Dubey, NMR

Jharana Rani Samal Award for Best Research Work

Sahana Holla, MCB

M Sreenivasaya medal for Best PhD Thesis

Indu J, CiE

Prof U C Kothiyari Best PhD Thesis Award

Divyaprakash Gnanadhas, MCB

T Ramakrishna best thesis award from MCB Society

Amit A Vernekar, IPC

The best thesis award in Inorganic Chemistry for the year 2015-16

Mr Kondalarao Bankapalli, BC

Young Scientist Award - Winner in Biology (16th Annual Research Awards – 2015-16) conducted by Dr KV Rao Scientific Society, Hyderabad

TRAVEL AWARDS

Yograj Banerjee, CEaS

AGU-2016 Student Travel grant

G Eluru, IAP

Awarded DST Travel Grant for presenting a paper in Micro-TAS 2016 held at Dublin, Ireland

Ms Supriya V Vartak, BC

D Nagarajachar Fund for travel support to Germany

Vikas Singh, MCB

DST International Travel Support

Surajit Mondal, CEaS

Elsevier travel grant to attend Goldschmidt 2016 Yokoyama, Japan

Debalina Chaudhury, MCB

EMBO travel grant for attending EMBO workshop, Italy, 2016

Sarmistha Guha, MCB

Gordon Travel award to attend Gordon Research Seminar on "DNA Topoisomerases" as an invited speaker, Newry, ME, USA

Chaitanya Matcha, ESE

IEEE ISIT Travel award. Sarkkai Jagannathan award

Revathy, CEaS

SSA Travel Grant (international Kanamori Fund)

Satyapaul Singh

DST travel grant for young scientist to attend an international conference of advanced energy materials (AEM -2016, September 12 - 14, 2016), University of Surrey, London, United Kingdom

Ravikant Dindokar, CDS

Student Travel Award, IEEE Big Data Conference

Abhilash Sharma, CDS

Shilpa Chaturvedi, CDS

Prateeksha Varshney, CDS

Aakash Kochare, CDS

Student Travel Award, IEEE HiPC Conference, India

Anshu Shukla, CDS

Abhilash Sharma, CDS

Student Travel Award, VLDB Conference, India

Swathi Suran, RBC

The Newport Research Excellence Travel Award at SPIE Photonics West 2016, San Francisco

Agrita Dubey, CNS

Travel Award, CSIR

Murty Dinavahi, CNS

Travel Award, DBT-CTEP

N Apurva Ratan Murty, CNS

Travel Award, International Brain Research Organization

Aditi Verma, CNS

Travel Award, Society of Free Radical Biology & Medicine

Chandan Samanta, CeNSE

Travel grant from DST

GPR Yasasvi, CeNSE

Travel grant from DST and IEEE

Marsha Parmar, CeNSE

• Travel grant from International Union of Pure and Applied Physics (IUPAP) Women in Physics to attend 13th

International Workshop on Nanomechanical Sensing, 22-24 June 2016, Delft Netherlands

- Travel grant from SERB-DST to attend 13th International Workshop on Nanomechanical Sensing, 22-24 June 2016, Delft Netherlands

Srabanti Rakshit, CIDR

Asma Ahmed, CIDR

Srabanti Rakshit, CIDR

Bharath Sunderaraj, CIDR

Young Investigator Travel Award

AWARDS AND MEDALS

Nagendra GD, SERC

ACM India Doctoral Dissertation Honorable Mention Award

Arunachalam Ramiah, CIDR

Best Abstract and Young Investigator Award

Talha Bin Masood, CSA

Best Doctoral Symposium Award, ICVGIP 2016

VK Jaganadh and team, IAP

Gandhian Young Technological Innovation (GYTI) Award

Dr Praveen Anand, BC

GIRI MEMORIAL AWARD for the year 2015-16

Milova Paul (PhD) and Sampath B (PhD), ESE

Honourable Mention Award for presenting one of the best technical papers titled "Physics of Current Filamentation in ggNMOS: was our understanding scientifically complete", VSLID, 2016-17

Avanish Mishra, MRC

Kawazoe Award" at ACCMS TM 2016

Damayanthi Jesudas, CPDM

Nominated for the best doctoral presentation award in PLM 2016 international conference Doctoral workshop held at University of South Carolina, Columbia

MV Vamsee Aditya, MBU

Prof B H Iyer Medal award, a former PhD student at MBU

OTHERS

Abhishek Sharma, MT

1st Prize, Metallograph: Light Microscopy, NMD ATM 2016, IIT KANPUR

VK Jaganadh, IAP

BIRAC-GYTI-SRISTI Award and Funding

Awarded Full Scholarship for participating in the UK-India Anti-Microbial Drug Resistance Diagnostics School, held at the University of Edinburgh

Santanu Talukder, CeNSE

Best Innovative PhD Project Award, 2016 from Indian National Academy of Engineers (INAE)

Subhash Joshi TG, EE

Best Project of the year 2016 of CDAC Thiruvananthapuram, 2016

Abhinav Dubey (IMI PhD), CDS

Best Student Award at ENC 2016 - 57th Experimental Nuclear Magnetic Resonance Conference, Pittsburg, USA

Srinivas Karthik V, CSA

Best Student Paper, ICDE 2016 conference

Dr G Srividya Varma, IAP

Dr Srinivasa Rao Krishnamurthy Medal

Indu J, CiE

DST INSPIRE Faculty Award

Suvam Mukherjee, CSA

First prize (joint) at IDRBT doctoral colloquium

Manish Kumar, CPDM

Indo-US dissemination Workshop - Member (Winner Team) for Sustainable Product Service System Design

Saurabh Umrao, CH

Newton Bhabha PhD Scholar placement grant, 2016: Sponsored research visit for six months to University of Glasgow

Srividya Kumar, IPC

Newton-Bhabha Fund for short term PhD placement programme with Prof Ted Hupp at Edinburgh Cancer Research Centre, University of Edinburgh, UK

Abhinav Dubey, NMR

Outstanding Presentation at the Experimental NMR Conference, USA

Mr Rishav Mallick, CEaS

Prof K N Krishnaswamy Medal

Lavanya S Tekumalla, CSA

Runner up India Research Colloquium organised by Xerox Research Centre 2016

R Harisankar and Chaitanya Karwa, ME

Second prize-winning mechanism in ASME Mechanisms and Robotics Design Contest, 2016. [A Compliant Mechanism for Grasping and Rolling Rigid and Elastic Objects]

Melamine sensing work done in Lab, IAP

Selected among Best Ten Innovations for Indo-Swiss AIT Camp held in EPFL and ETH Zurich, Switzerland in April 2016

Palash Dey, CSA

Selected for ACM India Research Symposium

Vivek Vanmane, CPDM

Selected for Hacking Elderly Care; Hackathon organised by the City of The Hague, The Netherlands and GoK

Pokharel SS, MRDG

Selected in Japanese Society for Promotion of Science (JSPS)

Dr Ankana Tiwari, MRDG

Mrs CV Hanumantha Rao Medal

Abhijit Hazarika, SSCU

Toulouse Medal – 2016

Deval Karia, CPDM

Rohit S Nambiar, CPDM

Ansuman Sahu, CPDM

R Vinodh Kumar, CPDM

TATA Wearables Challenge Finalist

Sarmistha Guha, MCB

UKIERI grant to attend the 2nd meeting on “DNA Topoisomerases in Biology and Medicine”, Gordon Research Conference 2016, USA

Sarmistha Guha, MCB

Rajiv Kumar Jha, MCB

Kakade Pallavi Anil, MCB

E Nagamalleswari, MCB

Shweta Karambelkar, MCB

Phoolwanti Rani, MCB

UKIERI grant for collaborative research work at John Innes Centre, Norwich, UK

Mohammadi Zaki, ECE

Pushtivardhan Soni, ECE

Myna Vajha, ECE

Lekshmi Ramesh, ECE

Shubham Sharma, ECE

Rama Kiran, ECE

Archana K, ECE

Bharath S, ECE

Krishna M, ECE

Sashasrananda KR, ECE

Vaddi Mahesh Babu, ECE

Rohit KR, ECE

Sagar GV, ECE

Nikhil Krishna M, ECE

Ritesh Kumar, ECE

Visvesvaraya PhD Scheme for Electronics and IT

Akash Agrawal and Prof Gaurab Banerjee

Won First prize in the All India Cadence Design Contest 2016

Manish Kumar, CPDM

Govind Sharma, CPDM

Govindaprasath E, CPDM

Waste Hackathon Winner

R Srinivasan and team, IAP

Winner of BIRAC Hackathon 2016 on improved point-of-care devices conducted in June 2016

6.9 Placement

An attractive Placement Brochure was prepared by OCCaP to be circulated with potential recruiters. A large number of potential recruiters were contacted with an intent for Campus Association for recruiting the students. Brochures were shared, and many responded positively with good number of work opportunities for our students for Final placements. This has added on to the list of our Eminent Recruiters those visited last year on Campus. On Campus and Off Campus interest to hire our students was shared by the companies.

A modern and fully functional Placement Portal has been set up for students and recruiters. The portal enables companies to register and post their hiring requirements. Students can register, apply for jobs, and manage interface with recruiters. The portal facilitates Emails and SMS alerts to selected set of students, and to disseminate information quickly. Around 709 students (233 Research, 403 Masters and 73 Undergraduate) students have registered for placements in the portal. More than 130 Companies have shared their interest to recruit our students for final placements and internship and have registered on the placement portal.

6.10 External Registration Programme

An attractive Placement Brochure was prepared by OCCaP to be circulated

Sl. No.	Sponsors	No. on Roll
1	24 - 7 Customer Private Limited	1
2	3M India Limited	1
3	ABB Corporate Research Centre	1
4	Accenture Technology Labs	1
5	Aeronautical Development Agency	4
6	Amrita School of Engineering	1
7	Atomic Mineral Directorate for Exploration and Research	1
8	Bangalore Integrated Systems Solutions P Ltd.	1
9	BHEL Corporate R and D Division	1
10	Bloom Energy I Pvt Ltd	1
11	Centre for Study of Science Technology and Policy	2
12	Central Research Laboratory	1
13	Centre for Development of Advanced Computing	2
14	CSIR- National Aerospace Laboratories	2
15	Defence Metallurgical Research Laboratory	3
16	Defence Research and Development Organisation	9
17	Defense Research and Development Laboratory	2
18	Electronics and Radar Development Establishment	1
19	Faurecia Emission Control Technologies	1
20	Gas Turbine Research Establishment	5
21	GE Power Systems	1
22	General Motor Technical Centre India Pvt Ltd	1
23	Generl Electric India Technology Centre	1
24	HAL	1
25	Hemwati Nandan Bahuguna Garhwal University	1
26	Hewlett Packard	1
27	Hindustan Aeronautics Limited	4
28	Hindustan University	1
29	Honeywell Technology Solutions Pvt. Ltd.	6
30	HP Indian Software Operations	1
31	IBM	3
32	Indian Space Research Organisation	27
33	Indira Gandhi Centre for Atomic Research (IGCAR) , Kalpakkam	1
34	Infosys Ltd.	1

35	Institute of Ayurveda and Integrative Medicine Foundation of Revitalization of Local Health Traditions	1
36	Intel Technology India Pvt Ltd	1
37	ISRO Telemetry, Tracking and Command Network	1
38	John F Welch Technology Centre	1
39	Laboratory for Electro Optics Systems, Bangalore	1
40	Liquid Propulsion Systems Centre	3
41	LPSC, ISRO, Bangalore	1
42	LRDE, Bangalore	1
43	M S Ramaiah Institute of Technology	1
44	Microwave Tube Research and Development Centre	4
45	Nagarjuna Fertilizers and Chemicals Ltd	1
46	National Aerospace Laboratories	13
47	Naval Science and Technological Laboratory	1
48	NSTL. DRDO. Ministry of Defence	1
49	Nuclear Fuel Complex	1
50	Programme AD - Research Centre Imarat	1
51	R and DE -Engrs DRDO	2
52	Research and Development Division, Tata Steel,Jamshedpur	1
53	Research Center Imarat (RCI), DRDO	1
54	Robert Bosch Engineering and Business Solutions Ltd	4
55	Samatvam Science and Research Centre	1
56	Samsung R and D Institute India Bangalore Pvt Ltd	2
57	Siddaganga Institute of Technology	2
58	Solid State Physics Laboratory	1
59	Space Applications Centre - ISRO	1
60	Tata Consultancy services limited	1
61	Tata Motors Limited	2
62	Texas Instruments India Pvt Ltd	3
63	Triveni Turbine Limited	1
64	Vikram Sarabhai Space Centre - Indian Space Research Organisation	1
65	Visveswaraya College of Engg, Bangalore	1
66	Vittal Mallya Scientific Research Foundation	1
67	WEBFIL Limited - Digital Systems Division	1
68	Wipro Technologies Ltd	1
69	Xerox Research	1
TOTAL		152

6.11 Research Conferments PhD, MSc (Engg), Int. PhD

6.11.1. PhD

BIOCHEMISTRY

Mr Roshan Singh Thakur: Role of *Mycobacterium tuberculosis* *RecG* helicase in DNA repair, recombination and in the remodeling of stalled replication forks

Mr Kohal Das: Evaluation of Alternate DNA Structures at c-MYC Fragile Region Associated with t (8;14) Translocation and Role of GNG Motifs during G-quadruplex Formation

Ms B Chetana: Elucidating the roles of Lon protease and its substrate, MarA, in response to salicylate and other compounds in *Escherichia coli*

Ms Mihika Bose: Characterisation of monoclonal antibodies and small molecule inhibitors as Hepatitis C Virus entry inhibitors

Ms Shubhi Srivastava: Uncovering the role of mitochondrial co-chaperones and artificial antioxidants in cellular redox homeostasis

Ms Rupa Kumari: Mechanism of RAG Regulation During its Physiological and Pathological Functions in Lymphoid Cells

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Ms Rutuja Chitra Tarak: Eco-Hydrology of a Seasonally Dry Tropical Forest: Tree Growth, Belowground Water Dynamics and Drought-Vulnerability

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Ms Eisha Shaw: Evaluation of early pathogenic mechanisms of synaptic dysfunction in Alzheimer's disease

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Ms Grace Lhainekim: Delineating the Role of OsMADS1 in Auxin Distribution, Floret Identity and Floret Meristem Determinacy

Ms Drisya V: Functional insights into the canonical and non-canonical roles of the fission yeast splicing factor SpPrp16

Mr Arjun Balakrishnan: Unravelling the Mechanism of Bactericidal/ Permeability-Increasing Protein Expression During Bacterial Pathogenesis

Mr Vikas Singh: Delineating the roles for WNT signaling during PRRs driven inflammatory responses: Implications for Host-Pathogen interaction

Ms B Vijayalakshmi: Molecular Genetic Analysis of Trichome Development in *Arabidopsis thaliana*

Mr Souvik Bhattacharyya: Fidelity of translation initiation in *E. coli*: roles of the transcription-recycling factor RapA, 23S rRNA modifications, and evolutionary origin of initiator tRNA

Mr Sushil Kumar: Role of VILAMBIT genes in controlling flowering time and jasmonic acid signaling in *Arabidopsis*

Ms Easa Naga Malleswari: Exploring the unusual properties and non-canonical roles of promiscuous restriction endonuclease KpnI

Ms Baisakhi Mondal: DNA methylation landscape of astrocytoma: Role of Fibromodulin (FMOD), a hypomethylated and upregulated gene, in glioblastoma cell migration

MOLECULAR BIOPHYSICS UNIT

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Mr Prasun Kumar: Secondary Structures in Proteins: Identification & Analyses

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Ms Priyanka Dinesh Baloni: A systems biology approach towards understanding host response and Pathogen adaptation in latent tuberculosis infection

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Ms Khadija Kanwal Khanum: Morphological Architecturing of Electroactive Materials in Organic Electronics

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Mr Shanoob B: Effect of Thermomechanical processing on microstructure and microtexture evolution in Titanium alloys

Mr Amit Sharma: Evolution of Crystallographic Texture and Microstructure in Sputter Deposited NiMnGa Thin Films and Their Influence on Magnetic Properties

Mr Krishna Yaddanapudi GR: Effect Process Parameters on the Growth N-polar GaN on Sapphire by MOCVD

Ms Priti Xavier: Mapping the transient morphologies and demixing behavior of Polystyrene/ Poly (vinyl methyl ether) blend in the presence of multiwall carbon nanotubes

Mr Vimalnath S: Bioremediation of Lead from Aqueous Solutions using Pseudomonas species-Mechanisms & Biosensor Applications

Ms Sangeeta Santra: Diffusion-controlled growth of A15-based Nb₃Sn and V₃Ga intermetallic compounds

MECHANICAL ENGINEERING

Mr Vijesh V Joshi: Thermal Performance of Various Roof Elements under Different Weather Conditions

Mr Indrasen Singh: Continuum Analysis of Cavitation Induced Failure and Tensile Deformation Response of Metallic Glasses and Nanoglasses

Mr NVR Vikram G: Influence of Contact Stresses on Shape Recovery in Sputter Deposited NiTiCu Thin Films

Mr Dalal Swapnil Arun: A Numerical Study of Droplet Dynamics in Viscoelastic Flows

Mr Sunil Kumar Pandey: Exploration and Assessment of HCCI Strategies for a Multi-Cylinder Heavy – Duty Diesel Engine

Mr Sanjay Kumar Shukla: Experimental study of flow past a circular cylinder with a flexible splitter plate

Mr Muthu Kumar M: Effect of Surface Texture on Friction under Dry Reciprocating Contacts

Mr Arup Kumar Nandy: Robust Finite Element Strategies for Structures, Acoustics, Electromagnetics and Magneto-hydrodynamics

Mr Tejas Prakash Gotkhindi: Generalized circular and elliptical honeycomb structures / bundled tubes: L Effective transverse elastic moduli

Mr VN Surendra Kamadi: Novel Compression Fracture Specimens and Analysis of Photoelastic Isotropic Points

Mr Prosenjit Das: Rheo Processing of Al Alloys using Cooling Slope Technique

Mr Pawar Shashikant Sampatrao: Axially homogeneous turbulent convection at high Rayleigh numbers: scaling laws for flux and spectra

Mr Vijaya Prakash S: Analytical investigation on linear and nonlinear wave propagation in structural-acoustic waveguides

Mr Nagendra Pratap Singh: Growth and Characterization of ZnO Nanostructures for Device Applications: Field Emission, Memristor and Gas Sensors

Mr Narsing Kumar Jha: Interaction of bubbles with vortical structures

Mr Basireddy Sandeep Reddy: A Study of Two Problems in Nonlinear Dynamics Using Method of Multiple Scales

Mr Anish Roychowdhury: Numerical Modelling and Software Development for Analysing Squeeze Film Effect in MEMS

Mr Pritam Giri: Power loss minimization for drag reduction and self-propulsion using surface mass transpiration

Mr Jasvanth VS: Experimental and Numerical Investigation of an Evaporating Meniscus in a capillary slot: Microscale and pore scale studies

Mr Prashant Das: Unsteady two dimensional jet with flexible flaps at the exit

Mr Shrikanth V: A non resonant piezoelectric sensor for mass, force and stiffness measurements

Mr Shanthanu Chakravarthy: A Haptic Simulator for Gastrointestinal Endoscopy: Design, Development And Experiments

Mr Sourav Mitra: Development and Investigation of Two-Stage Silica gel + Water Adsorption Cooling cum Desalination System

Mr Pradeep Garg: Thermodynamics of Distributed Solar Thermal Power Systems with Storage

CIVIL ENGINEERING

Ms Keerthy M Simon: 6110-120-101-08032: Studies on Fracture and Fatigue Behavior of Cementitious Materials- Effects of aggregate Bridging, Interfacial Transition Zone and Microcracking

Ms Achu Catherine Cherian: Effect of Cycle Strain Path and Vibration Cycles on Shear Modulus and Damping of Sand

Ms Gouri R Laxmeshwar: A Fuzzy approach to Reliability based design of urban storm water drain network considering changes in Land Use/ Land cover and Climate

Mr Devaraj G: Schemes for Smooth Discretization and Inverse Problems-Case Study on Recovery of Tsunami Source Parameters

Mr Deendayal: Analysis of Laterally Loaded Piles in Clayey Soils with Sloping Ground

Mr Harshad Rameshwar Parate: Field Investigations and Modeling of Flow in Vadose Zone in a Forested Watershed

Mr Suryakanth Biswal: Uncertainty based damage identification and prediction of long-time deformation in concrete structures

Mr Abhinav S: Stochastic modelling of vehicle-structure interactions: dynamic state and parameter estimation, and global response sensitivity analysis

Mr Deepak GB: Influence of Chemo-Mechanical Factors on Compression and Undrained Strengths of Soft Kaolinites prepared using Synthetic Seawater

Mr Prashanth Vangla: Shear behaviour of sand-geosynthetic interfaces based on size and morphology of sand particles and surface roughness of geosynthetics

Mr Shwetabh Yadav: Mechanics of drilling in porous brittle solids

Ms J Sumaltha: Studies on Transport Rates of Heavy Metals in the Design of Liner Thickness and Remediation of Soils

Ms Sangeeta Kumari: Fuzzy State Reservoir Operation Models for Irrigation

Mr Somayya Ammanagi: Vibration Testing of Structures under Random Support Excitations

Mr Ramesh Kannan K: Experimental Studies on the Mechanical behavior of cohesive frictional granular materials

Mr Chavan Sagar Rohidas: Design Flood Estimation at Ungauged Locations using Geomorphological Characteristics

Ms Seetha N: Multi-Scale Modeling of Nanoparticle Transport in Porous Media: Pore Scale to Darcy Scale

Mr Devaraj H: A Framework to Measure the Socio-Economic impact of Development Programs using Malmquist Index

Mr Gourav K: Studies on Flexural Behaviour of Fly Ash-Lime-Gypsum BrickMasonry

Mr Naveen BP: Assessment of Leachate Characteristics and Geotechnical Properties of Municipal Solid Waste Land Fill

Mr Arvind Kumar Jha: Role of Gypsum in Stabilisation of Expansive Soil with Lime Fly Ash-A Micro-Mechanistic Study

CENTRE FOR EARTH SCIENCES

Mr Thulasiraman N: Seismic Site Response Evaluation Using Ambient Vibrations and Earthquakes: Applications in Active and Vulnerable Regions with Emphasis on the 2001 Bhuj(India) Earthquake

Ms Ramya Bala P: Evaluating Geochemical Proxies for Paleoclimate Reconstruction in Tropical montane peat: a case study from the Nilgiris, southern India

Mr Prasanna K: CO₂ Ventilation, Hydrological Cycle Over Southern Ocean and Clumped Isotope Thermometry in Biogenic Carbonates

Mr Rahul P: Study of the seasonal water cycle over the Indian subcontinent and the Southern Ocean using stable isotopes in rainwater and water vapor

CENTRE FOR ATMOSPHERIC AND OCEANIC SCIENCES

Mr Shailendra Kumar: Vertical Structure of Convective clouds using the TRMM PR data

Mr Ram Ratan: Temporal Persistence and Spatial Coherence of Tropical Rainfall

Ms Anwesa Bhattacharya: Role of Aerosols in Modulating the Intraseasonal Oscillations of Indian Summer Monsoon

Mr Joy Merwin Monteiro: A Tale of Two Gradients: Atmospheric dynamics in an inhomogeneous background

CENTRE FOR SUSTAINABLE TECHNOLOGIES

Mr Sadhan Mahapatra: Experiments and Analysis on Wood Gasification in an Open Top Downdraft Gasifier

Mr Snehesh Shivananda Ail: Combustion Synthesized Cobalt Catalysts for Liquid Fuel Generation Via Fischer Tropsch Reaction

Mr Sandeep Kumar: Experimental and Modeling Studies on the Generation of Hydrogen Rich Syngas Through Oxy-Steam Gasification of Biomass

Ms Gayathri Aaditya Ghatty: Integrability Evaluation Methodology for Building Integrated Photovoltaic's (BIPV): A Study in Indian Climatic Conditions

Ms Shwetmala: Assessment of Environmental Issues and Biodegradation Aspects of Current MSW Practices of Developing Country Metropolises – A case study of Bangalore

Ms Abitha R: Agriculture- A novel algae cultivation technique for sustainable Algal Biofuel Production and capture of Green House Gases

INSTRUMENTATION AND APPLIED PHYSICS

Mr Abhay Singh Gour: Design and Development of linear moving magnet synchronous motor based twin PTC and HTS level sensors for LOX recondenser

Mr Vinaya Kumar KB: Design, Development and Performance Study of Microneedle & Micropump- based Transdermal Drug Delivery System

Mr Maligi Anantha Sunil: Studies on AgInS₂ films as Absorber Layer for Heterojunction Solar cells

Mr Prakash Kodali: Large Area Electronics with Fluids: Field Effect on 2-D Fluid Ribbons for Desalination and Energy Harvesting

Mr Sriram Chandran R: Ultrasound –Assisted Diffuse Correlation Spectroscopy: Recovery of Local Dynamics and Mechanical Properties in Soft Condensed Matter Materials

Mr S Balachandar: Optical interrogation of the Transient heat conduction in dielectric solids – A few Investigations

Mr Venkateswarlu Gaddam: Synthesis and Characterization of 1D & 2D Nanostructures: Performance Study for Nano generators and Sensors

MATHEMATICS (IMI)

Ms Gayatri Ramakrishnan: Recognition of structures, functions and interactions of proteins of pathogens: Implications in drug discovery

Mr Sudipto Chowdhury: Finite Element Analysis of Interior and Boundary Control Problems

Mr Abhinav Dubey: Development of NMR Methods for Metabolomics and Protein Resonance Assignments

Mr Manish Bhatt: Toward Computationally efficient models for near-infrared and photoacoustic tomographic imaging

PHYSICS

Mr Akshay Bhatnagar: Direct Numerical Simulations of Fluid Turbulence: (A) Statistical Properties of Tracer and Inertial Particles (B) Cauchy- Lagrange Studies of the Three-Dimensional Euler Equations

Mr Khare Siddharth Madhav (Sunita): Micro-Newton Force Measurement and Actuation – applied to Genetic Model organisms

Mr Jagtap Amardeep Manikrao (Ranjana): Investigations on Photophysical Properties of Semiconductor Quantum Dots (Cd_xHg_{1-x}Te, Ag₂S) and their Interaction with Graphene Oxide, Organic Polymer Composites

Mr Aditya Narayan Roy Choudhury: DIRECT MEASUREMENT OF Itinerant Magnetism & Interface States in Semiconductors using time-varying Magnetic Fields

Mr Apurba Paul: Optical tweezers and its use in studying red blood cells – healthy and infected

Ms Sreetama Das: Insights into substrate specificity in sortase enzymes from structural studies on a novel class of housekeeping sortase (SrtE) Identifying functionally important cis-peptide containing segments in proteins and their utility in molecular function annotation

Ms Praveena Mullapudi: Study of Optical Properties of Semiconductor Quantum Dot Based Hybrid Nano Assemblies

Mr SRK Chaitanya Indukuri: Study of Light-Matter Interaction at the Nanoscale with Quantum Dots in Photonic and Plasmonic Metamaterials

Ms Nafisa Begam: Study of dynamics, thermal and rheological properties of polymer grafted nanoparticle-polymer blend

Ms Nairita Pal: Cahn-Hilliard-Navier-Stokes Investigations of Binary-Fluid Turbulence and Droplet Dynamics

Ms Marsha Mary Parmar: Investigation of Nonlinearities in Graphene based NEMS

Mr Pranjal Mahanta: Crystal structure analysis of a (β/α)8-TIM barrel enzyme and its mutants: Insights into the role of interactions between termini in influencing protein stability. Experimental and computational study of protein-surface-pockets occluded by Tryptophan side-chains

Mr Honnavar Gajanan Venkataraman: Mixed Alkali Effect in Oxyfluoro Vanadate Glasses and The Effect of Rare Earth Ions On Oxyfluoro Tellurite Glasses – A Spectroscopic Study

Mr Hariharan N: Magnetic and dielectric properties of half doped RMnO₃ (R=Y, Tb)

Mr Ranjan Krishna Modak: Thermalization and its relation to localization, conservation laws and integrability in quantum systems

PHYSICS (ASTRONOMY AND ASTROPHYSICS)

Mr Sujit Kumar Nath: Origin of Instability and Plausible Turbulence in Astrophysical Accretion Disks and Rayleigh-stable flows

Ms Syeda Nazma Islam: The many facets of variabilities in X-ray binaries

Mr Iyer Nirmalkumar Ramesh: Studies of X-ray Transients and a Future X-ray Sky Monitor

6.11.2. INT. PhD

BIOCHEMISTRY

Ms Naik Tanushree Sanjeev: Isolation and Identification of Tropane Alkaloid Producing Endophytic Fungi from *Datura metel* L., and Studies on *Colletotrichum boninense* Recombinant Putrescine N-methyltransferase

Ms Meetali Singh: Novel facets of Heat Shock Protein 90 in neglected protozoan parasites

Mr Sumith Kumar: Exploring the Roles of Phase Variable HpyAll Restriction-Modification System in the Human Pathogen *Helicobacter pylori*

Ms Ambily Abraham: Chimeric virus like particles as nanocarriers for antibody delivery in mammalian cells & Role of Groundnut bud necrosis virus NSs in viral life cycle

Mr Robin Sebastian: Physiological and exogenous means of regulation DNA damage response: insights into mechanisms of DNA repair and genomic instability

CENTRE FOR ECOLOGICAL SCIENCES

Mr Diptarup Nandi: Acoustic signals, mate choice and mate sampling strategies in a field cricket

Ms Monisha Bhattacharya: Investigating pattern recognition and bi-coordinate sound localization in the tree cricket species *Oecanthus henryi*

MICROBIOLOGY AND CELL BIOLOGY

Ms Geetha M: Understanding functions for fission yeast pre-mRNA splicing factors SpPrp18 and SpSlu7 in constitutive and alternative splicing

Ms Shipra Goel: Studies on Molecular Targets and Pathways Regulated by Rice RFL for Flowering Transition and Panicle Development

Mr Godbole Adwait Anand: Topoisomerase I from *Mycobacterium tuberculosis*: dynamics of enzyme function and inhibitor development

MOLECULAR BIOPHYSICS UNIT

Mr Ujjwal Rathore: HIV-1 immunogen design: Envelope protein minimization, stabilization and glycan removal

Mr Pankaj Chandraprakash Jain: Structural and functional insights derived from saturation Mutagenesis of CcdB and DgkA

Ms Vidhi Pareek: Structure-function studies on triosephosphate isomerase Some old Questions, Some new insights

Mr Gupta Kuldeepkumar Ramnaresh Indravati: (p)ppGpp and c-di-GMP: a tale of two second messengers in *Mycobacterium smegmatis*

Mr Sufyan Ashhad: Physiological Interactions between Neuronal Active Conductances and Inositol Trisphosphate Receptors in Neurons and Astrocytes

Mr Ashutosh Gulati: Structural Studies on SeMV chimeras and TSV: Insights into capsid assembly

MOLECULAR REPRODUCTION, DEVELOPMENT AND GENETICS

Ms Smrithi Murthy Devi: Role of CG9650 in neuronal development and function of *Drosophila melanogaster*

Ms Aditi Madan: Developmental and functional roles of Troponin-T isoforms, and exploring genome-wide alterations in *Drosophila* Indirect flight muscle mutants

INORGANIC AND PHYSICAL CHEMISTRY

Mr Rahul Kumar: Mechanistic Insights into Small Molecule (Amine- Boranes, Hydrogen, Methane, Formic acid and Carbon dioxide) Activation using Electrophilic Ru(II)-Complexes

Mr Santanu Mondal: Halogen Bonding in the Structure and Biomimetic Dehalogenation of Thyroid Hormones and Halogenated Nucleosides

Mr Sourav Ghosh: Synthesis of metal and metal oxide nanosponges for hydrogen storage and catalytic applications

Ms Koushambi Mitra: Platinum(II) Complexes as Dual Action DNA Crosslinking & Photochemotherapeutic Agents

MATERIALS RESEARCH CENTRE

Mr Barun Kumar Barman: Rational Design of Advanced Hybrid Nanostructures for Catalysis and Electrocatalysis

Ms Aakanksha: Titania Nanostructures for Photocatalytic and Photovoltaic applications

ORGANIC CHEMISTRY

Mr Balaji P V: Studies on the Stereoselective Geminal and Vicinal Heterodifunctionalization of Alkenes

Mr Abhijnan Ray Choudhury: Enantioselective Carbon-Carbon and Carbon-Heteroatom Bond Formation: from Bifunctional to Anion-Binding Catalysis

Mr Parikshit Moitra: Syntheses and Characterization of Novel Materials for Efficacious Anticancer Drug Delivery and Selective Sensing of Bioanalytes

SOLID STATE AND STRUCTURAL CHEMISTRY UNIT

Mr Sourav Laha: Exploring transition metal oxides towards development of new functional materials: lithium-ion battery cathodes, inorganic pigments and frustrated magnetic perovskite oxides

CENTRE FOR HIGH ENERGY PHYSICS

Mr Arunprasad V: Issues in Phenomenology of Heavy Quarks and Leptons

Mr Kallol Sen: Lessons for Conformal Field theories from bootstrap and holography

Mr Gaurav Mendiratta: Probing the Beyond Standard Model Physics in Top Quark and Dark Matter Sectors

MATHEMATICS

Mr Bidhan Chandra Sardar: Study of Optimal Control Problems in a Domain with Rugose Boundary and Homogenization

Mr Kartick Adhikari: Hole probabilities for determinantal point processes in the complex plane

Mr Md. Ramiz Reza: Curvature Inequalities for Operators in the Cowen-Douglas Class of a Planer Domain

Mr Arpan Kabiraj: Goldman bracket: center, geometric intersection number & length equivalent curves

Mr Haripada Sau: Operator theory on symmetrized bidisc and tetrablock-some explicit constructions

PHYSICS

Mr Amit Kumar Majhi: Investigations of electroporation physics using optically transparent polymer devices and molecular dynamics simulations

Ms Semonti Bhattacharyya: A study of electrical transport and $1/f$ noise in topological insulators

Mr Vaisakh V: Experimental Investigation of Multielectron Bubbles in Liquid Helium

Ms Anindita Sahoo: Electrical Transport in the Hybrid Structures of 2D van der Waals Materials and Perovskite Oxide

Mr Sudeep Kumar Ghosh: UltraCold Fermions: Dimensional Crossovers, Synthetic Gauge Fields and Synthetic Dimensions

6.11.3. MASTER OF SCIENCE (ENGINEERING)

COMPUTER SCIENCE AND AUTOMATION

Mr Jagdeep Pani: Provable methods for Non-Negative Matrix Factorization

Ms Pallavi Chugh: Identifying Method Memoization Opportunities in Java Programs

Ms Anusha Posinasetty: Multi-label classification with multiple label correlation orders and structures

Mr Patel Naman Jagdishchandra: A Case of Protecting Huge Pages from the Kernel

Mr Chetan Gupta: On algebraic and analytic properties of polynomials over finite fields

Ms Mudduluru Rashmi: Efficient Instrumentation for Object Flow Profiling

Mr Siddharth P Watwe: Efficient Schemes for Improving the Performance of Clock Synchronization Protocols in Wireless Sensor Networks using TDMA-based MAC Protocols

Mr Shrikant H Talwar: Efficient Key Management Protocols for Secure Routing and End-to End Key Establishment with Enhanced Security in Mobile Ad hoc Networks

Mr Ashish Panwar: A Memory Allocation Framework for Optimizing Power Consumption and Controlling Fragmentation

Mr Nithish Pai B: A GPU Accelerated Tensor Spectral method for Subspace Clustering

Mr Ameet Gadekar: On Learning K-Parities and the complexity of K-Vector-SUM

Ms Rangnani Soniya Deepak: Retweet Profiling – Study of Dissemination of Twitter Messages

Mr Kirankumar Shiragur: Variants of Hegselmann-Krause model

ELECTRICAL COMMUNICATION ENGINEERING

Mr Rupesh Kumar Kona: Performance Analysis of Opportunistic Selection and Rate Adaption in Time-Varying Channels

Mr Prateek Jha: Conformal Active Sheets

ELECTRICAL ENGINEERING

Ms Ann G Sarah: Discharge Plasma Supported Mariculture and Lignite Waste for NO_x Cleaning in Biodiesel Exhaust: Direct and Indirect Methods

Mr Deepak G Skariah: Image Restoration Improved Regularization and Potimization

Mr S Navin: New Algorithms for Some Economic Dispatch Problems

Mr Chennakeshava K: Adaptive Sampling Pattern Design Methods for MR Imaging

Mr Daniel Sanju Antony: Performance Analysis of Non local Means Algorithm using Hardware Accelerators

Mr A Santosh Kumar: Voltage Stability Analysis of Unbalanced Power Systems

Mr Ganapathineedi Manoj Kumar: Accurate Estimation of Frequency and Phasor for Wide Area Monitoring and Control

COMPUTATIONAL AND DATA SCIENCES

Ms Narayanan Vidya K V Narayanan: Similarity between scalar Fields

Ms Kruthiventi SS Srinivas: Visual Flow Analysis and Saliency Prediction

Ms Nikita Prabhu: Image Representation using Attribute-Graphs

Mr Ashirbad Mishra: Efficient Betweenness Centrality Computations on Hybrid CPU-GPU Systems

Ms Rafia Sabih: Balancing Money and Time for OLAP Queries on Cloud Databases

Mr Vishesh Garg: Towards Designing PCM-Conscious Database Systems

AEROSPACE ENGINEERING

Mr Jobin Joseph Unnupatt: Novel fully Implicit Collocated Grid Incompressible flow solver on unstructured meshes

Mr Maqsood Mohammed Ameen: Analysis of Thick Laminated Composite Beams Using Variational Asymptotic Method

Ms Sunitha M: Modeling and Simulation of Biomolecular Flow in Microchannel

Mr Joel Varghese: Linear Instability and Transition of Incompressible Plane Wall Jet

Mr Vinay Nathan: Analysis of unsteady incompressible potential flow over a swimming slender fish and a swept wing tail

Ms Megha TV: Asymptotically-correct Computational Models for Tapered Composite Structures with Matrix-rich Regions

CENTRE FOR PRODUCT DESIGN AND MANUFACTURING

Mr G Kalyan Ramana: Towards Automated Design of Toggle Switch Mechanisms

MATERIALS ENGINEERING

Mr KS Vinay: Micro structural Evolution of Directionally Solidified Ni-Al-Re/Ru Alloys

MECHANICAL ENGINEERING

Mr Suhas Bannur: Design and Development of a Novel Solar Thermal Receiver

Mr Eeshitw Kaushal Singh: A Numerical Implementation of An Artery Model Using Hybrid Fem

Mr Gaurav Saluja: Experimental study of Patterns in hydro dynamically deposited dispersed phase of CaCO₃ on surfaces of straight cylindrical silica tubing

CIVIL ENGINEERING

Mr Satish Kumar D: Partial Slip Contacts in Linear Viscoelasticity

CENTRE FOR EARTH SCIENCES

Mrs Nayela Zeba: Lab Experiment Documenting Growth of Microbes in an Extreme Condition

CENTRE FOR ATMOSPHERIC AND OCEANIC SCIENCES

Mr Roshan R Rao: A method to derive an aerosol composition from downward solar spectral fluxes at the surface

Mr Subham Rath: Dynamics of Summer Monsoon Current around Sri Lanka

INSTRUMENTATION AND APPLIED PHYSICS

Ms Swetha M: Automation of Microscopic Tests for Cyto-diagnostics using Custom-built Slide Scanner



7.

EVENTS

7.1 Institute Lectures

The Institute has organised the following Centenary, Memorial, Endowment, Institute lectures during the year:

IISc CENTENARY LECTURE

- IISc Centenary Lecture by Prof Martin Gruebele, James R. Eiszner Chair in Chemistry, University of Illinois, Urbana Campaign, USA, 15th December 2016.
- IISc Centenary Lecture by Prof K C Nicolaou, PhD, Harry C and Olga K. Wiess Professor of Chemistry, Department of Chemistry, Rice University, 27th March 2017.

J N TATA LECTURE

J N Tata Lecture by Prof Sir Tejinder Singh Virdee, FRS, Faculty of Natural Sciences, Dept. of Physics, Imperial College, London, 11th November 2016.

PROF CNR RAO ENDOWMENT LECTURE

Prof CN Rao Endowment Lecture by Prof Richard N. Zare, Department of Chemistry, Stanford University, Stanford, California 94305, USA, 8th February 2017.

INSTITUTE SPECIAL LECTURE

- Dr V Ramaswami, VP Strategy & Research, Color EyeQ, Inc., NJ, USA, Institute Lecture, 16th May 2016.
- Special Lecture by Prof David J Gross, the Nobel Laureate in Physics 2004, hosted by the IISc. 13th January 2017.

GOLDEN JUBILEE LECTURE

Prof B Jayant Baliga, Distinguished University Professor, North Carolina State University, Raleigh, NC 27613, Golden Jubilee Lecture, 26th July 2016.

SIR VITHAL N CHANDAVARKAR MEMORIAL LECTURE

Sri MJ Akbar, Honourable Minister of State for External Affairs and Member of Parliament, Rajya Sabha, Sir Vithal N Chandavarkar Memorial Lecture, 9th September 2016.

PROF S RAMASESHAN MEMORIAL LECTURE

Prof Chennupati Jagadish, Research School of Physics and Engineering, Australian National University - Canberra, ACT 2601, Prof S Ramasesha Memorial Lecture, 27th October 2016.

MORRIES TRAVERS MEMORIAL LECTURE

Morris Travers Memorial Lecture by Prof W.E. Moerner, a Noble Laureate and the Harry S. Mosher Professor of Chemistry, Stanford University on 5th January 2017.

INSTITUTE COLLOQUIUM

- Prof S Gopalakrishnan, Chairman, Department of Aerospace Engineering (Divn. of Mechanical Sciences), 6th April 2016.
- Prof C Jayabaskaran, Chairman, Department of Biochemistry, (Divn. of Biological Sciences), 24th October 2016.
- Prof Shalabh Bhatnagar, Dept. of Computer Science & Automation Divn. of Electrical Sciences), 21st November 2016.
- Prof Navakanta Bhat, Chairperson, Centre for Nano Science & Engineering (CeNSE) (Divn. of Interdisciplinary Research), 20th January 2017.
- Prof Mrinal K Ghosh, Department of Mathematics (Divn. of Physical & Mathematical Sciences), 22nd February 2017.
- Prof AG Samuelson, Dept of Inorganic & Physical Chemistry, (IPC) (Divn. of Chemical Sciences), 30th March 2017.

7.2 Conference/Symposia/Seminars/Workshops

A number of conferences, workshops, seminars and symposia are regularly organised at the Institute. A large number of scientists, engineers, educationists take advantage of these. The programmes conducted during the year were:

A. BIOLOGICAL SCIENCES

- New Horizons in Biology, 16-17 June 2016 (BC)
- Application of Laser Flow Cytometry in Biomedical Research, 14-18 March 2016 (BC)
- Experiences shaping current research careers, 28-29 November 2016 (BC)
- School of Oriental and African Studies (SOAS), University of London, Elephant Conference, 4-6 Apr 2016 (CES)
- Workshop on Molecular phylogenetics, 1-5 Aug 2016 (CES)
- Course in Herpetology, 1-6 Nov 2016 (CES)

- Student Conference on Conservation Science – Bengaluru, 21-24 Sep 2016 (CES)
- India-Behavior, Ecology and Evolution (I-BEE), 10-12 Mar 2016 (CES)
- The Xth Biennial Lake Conference – Lake 2016: Conference on Conservation and Sustainable Management of Ecologically Sensitive Regions in Western Ghats, 28-31 Dec 2016 (CES)
- Internet based Course – Environment Management (XIVth Session), Aug-Dec 2016 (CES)
- Workshops on Municipal Solid Waste Management (MSWM 2016), 20th Aug, 29th Oct, 26th Nov of 2016 (CES)
- Workshop on Documenting Biodiversity in the Neighbourhood – Western Ghats, 19 Nov 2016 (CES)
- Workshop on Environment Education, 7 Nov 2016 (CES)
- Brainstorming session on Geo-visualization of Land Cover Dynamics, 10-14 Oct 2016 (CES)
- Workshop on 'Inventorying and Mapping of Biodiversity at village level' for School Students and Teachers, 7-8 Oct 2016 (CES)
- Workshops on Green Kitchen and Municipal Solid Waste Management (MSWM 2016), 24 Sep 2016 (CES)
- Village Biodiversity Mapping: Orientation programme for College Students and School Teachers, 23-25 Jul 2016 (CES)
- Brainstorming Session on Action Plan for Effective Dissemination of Environmental Information, 20 May 2016 (CES)
- Workshop on Free and Open Source GIS, 12-14 May 2016 (CES)
- Workshop on Wetland Ecosystems, 12-14 May 2016 (CES)
- Workshop on Terrestrial Ecosystems, 11-12 May 2016 (CES)
- Workshop on Coastal Ecosystems, 9 -10 May 2016 (CES)
- Workshop on Role of Students in Coastal Ecosystem Management, 9th, 13th, 28th Jan of 2016 (CES)
- Workshop on Role of Students in Coastal Ecosystem Management", 16 th, 20 th, 24 th of Feb 2016 (CES)

- Conference MSWM 2016: Municipal Solid Waste Management, 23-24 Feb 2016 (CES)
- IISc-CIDR National Tuberculosis conference, 19 Feb 2016 (CIDR)
- Computational mechanisms underlying the control of simple and complex movements. Understanding, 18-21 Nov (CNS)
- Simultaneous analysis of local field potential and spikes to understand the visuo-motor transformation in monkey frontal eye field, 12-16 Nov (CNS)
- Asian Science Camp, 21-27 Aug (CNS)
- 4th Bangalore Cognition Workshop, June 19-July 2 (CNS)
- Practical aspects of membrane protein crystallization, Dec 15-16th, 2016 (MBU)
- Annual one day symposium of MBU, 08 Aug 2016 (MBU)
- Immunology and human diseases, Biotechnology- Present and Future, 29-30th Jan 2016 (MCB)
- The many faces of host immune system, Internship Programme, DST, 9-13th Mar 2016 (MCB)
- 17th Indo-US Cytometry Workshop, 14-18 March 2016 (MCB)
- Symposium on Bioggy & Molecular Pathogenesis of Viruses, 20-21 June 2016 (MCB)
- Indian Academy of Sciences, 4-6th Nov 2016 (MCB)
- IISc-CIDR National Tuberculosis, 19th Dec 2016 (MCB)
- Popular talk to the 'Chetana Scholars', 21 Oct 2016 (MCB)
- National Conference on Molecular Virology, (MCB)

B. CHEMICAL SCIENCES

- Recent advances in theoretical chemistry conference, 8-9 July 2016 (IPC)
- IISc-JAIST (JAPAN) Joint workshop on Functional Inorganic and Organic materials, 7 Mar 2016 (IPC)
- International Discussion Meeting on Chemical Kinetics for Aerospace Applications, 7-10 Dec 2016 (IPC)
- 6th International Conference on Metals in Genetics, Chemical Biology and Therapeutics (ICMG-16), 17-20 Feb 2016 (IPC)

- International Conference of Young Researchers on Advanced Materials, 11-15 Dec 2016 (MRC)
- Conference on Emerging Materials (CEMAT-2016), 18-19 July 2016 (MRC)
- Excitements in Physics and Chemistry, 16-17 Mar 2016 (OC)
- DK Banerjee Memorial Endowment Lecture, 19-20 Jan 2016 (OC)
- Pfizer Endowment Symposium in Organic Chemistry, 19-20 Jan 2016 (OC)
- Prof A Srikrishna Memorial Endowment Lecture, 7 Mar 2016 (OC)
- Minigrid energy generation, storage and transmission technology in India for the next 10 years, 21-22 July 2016 (OC)
- Magnetic and Optical Properties of Molecular Materials, Principles and Applications, 19-22 Oct 2016 (OC)
- Works shop on Density Functional Theory, Mar 2016 (OC)
- Workshop on School on Optics, Microscopy and Spectroscopy, 18-22 Jul 2016 (OC)

C. ELECTRICAL SCIENCES

- Workshop on Education for Data-Science, 18 Jan 2016 (CSA)
- NMI Workshop on Game Theory and Mechanism Design, 11-15 Jan 2016 (CSA)
- Workshop on Analysis and Inference from UGC, 28 Mar 2016 (CSA)
- EECS Doctoral Symposium, 29-30 Apr 2016 (CSA)
- Fostering Innovations in Data Science, 27 May 2016 (CSA)
- NMI Summer School on Machine Learning, 1-8 Jul 2016 (CSA)
- Formal Methods Update Meeting, 21-22 Jul 2016 (CSA)
- 42nd Intl. Conf. on Very Large Data Bases (VLDB), 5-9 Sep 2016 (CSA)
- DRDO-IISc Workshop on Verification of System Software, 24-25 Nov 2016 (CSA)
- International Conference on ICVGIP, 18-22 Dec 2016 (CSA)

- IEEE International Conference on Advanced Networks and Telecommunication Systems, Nov 2016 (ECE)
- IEEE International Conference on Advanced Networks and Telecommunication Systems, Nov 2016 (ECE)
- Technical Program Committee Member for 2016 IEEE International Symposium on Information Theory (ISIT 2016), Jul 2016 (ECE)
- JTG / IEEE Information Theory Society Summer School 2016, Jun 2016 (ECE)
- General Co-Chair for 2016 International Conference on Signal Processing and Communications (SPCOM 2016), Jun 2016 (ECE)
- SPCOM 2016 - Publications Chair, Jun 2016 (ECE)
- Tutorial chair, International Conference on Signal Processing and Communication, Jun 2016 (ECE)
- Workshop on Game Theory and Mechanism Design, Jan 2016 (ECE)
- Advanced Training in Mathematics, Workshop on Applied Probability, Jan 2016 (ECE)
- Intelligent Transportation Systems Workshop at COMSNETS 2017, Jan 2017 (ECE)
- Conference on SPCOM, IISc, 2016, 12-15, June 2016 (EE)
- Conference on ICGVIP, IIT Gawahati, 2016, 18-22, Dec 2016 (EE)
- 4th Bangalore Cognition Workshop, Jun 19 to July 2, 2016 (EE)
- QIP Short Term Course on Stability, Protection and Power Conversion Concepts for Modern Power Grid, (Co-Organizer), 22-26 Feb 2016 (EE)
- Technical session organiser, IEEE PES Bangalore section, Annual workshop on Energy Analytics for Smart Cities, 23-24 Sep 2016 (EE)
- International Summer workshop on Music Science and Technology Workshop, May 2016 (ESE)
- 1st India ESD Workshop, 16 Feb 2016 (ESE)
- International Workshop on 3 day ESD course, 3 Mar 2016 (ESE)
- Poster Session in the conference "COMSNETS 2016", 12-15 Jun 2016 (ESE)
- PhD Forum in the Conference "IEEE ANTS 2016", 6-9 Nov 2016 (ESE)

D. INTERDISCIPLINARY RESEARCH

- Joint Symposium between BSSE and Mazumder-Shaw Centre for Translational Research, 20 Aug 2016 (BSSE)
- National Workshop on Systems Engineering, 9 Aug 2016 (BSSE)
- 42nd Intl. Conf. on Very Large Data Bases (VLDB), Sep 5-9, 2016 (CDS)
- Indo-US Symposium on Central Nervous System Viral Infection and its Therapy, Nov 14-17, 2016 (CDS)
- Summer School on Internet of Things, June 20-25, 2016 (CDS)
- National Symposium on Think Nano 2016, 31 Mar – 1 Apr (CeNSE)
- INUP Hands-on Training (SIX Workshops during Calendar 2016) (CeNSE)
- IEEE International Conference on Recent Advances in Lightwave Technology, CRALT 2016, 21-23 Sep 2016 (CeNSE)
- Seminar - Advances in Magnetic Sector Secondary Ion Mass Spectrometry, 26th July (CeNSE)
- Workshop - Thin Film applications using XRD. Organised by Rigaku, Japan, 14th-15th Nov (CeNSE)
- Workshop - Zeta PALS Organized by Inventys Research Company, Mumbai, 15th July (CeNSE)
- Continuing Education Programme on DC and RF Probe Stations by Mr Francis and Mr Desmond of Cascade Technologies, 11th May (CeNSE)
- First National Seminar on Nanoscience and Nanotechnology, Jun 2016 (CeNSE)
- Eighth Biennial INSEE Conference on "Urbanization and the Environment", 04-06 Jan 2016 (MGS)
- On studying development as an evolutionary process of catch-up with illustrations from the WASH sectors, Feb 17th 2016 (MGS)
- The 16th Consortium of Students in Management Research-COSMAR 2016 Conference, Nov 11th-12th 2016 (MGS)
- Panel Discussion On "Demonetization: Boon or Bane?", Nov 25, 2016 (MGS)
- The 4th International Conference on Business Analytics and Intelligence (ICBAI), Dec 12th-21st 2016 (MGS)

- Next-generation transportation systems analysis tools and technologies for Indian cities, 16 Dec 2016 (RBCCPS)
- JTG / IEEE Information Theory Society Summer School 2016, 27/06/2016 to 01/07/2016 (RBCCPS)
- Workshop on Game Theory and Mechanism Design, 11-15 Jan 2016 (RBCCPS)
- Advanced Training in Mathematics, Workshop on Applied Probability, 04-08. Jan 2016 (RBCCPS)

E. MECHANICAL SCIENCES

- Nonlinear, Adaptive, Optimal and Embedded Control, 18-23 July 2016 (AE)
- 8th International Symposium on NDT in Aerospace, November 3-5th, 2016 (AE)
- Indo-US Workshop on Essential Algorithms for Integrated Vehicle Health Management for Aerospace Applications, 23-26 May 2016 (AE)
- National Shock wave symposium, 25-26th Feb 2016 (AE)
- International Discussion Meeting on Chemical Kinetics for Aerospace Applications, 7-9th Dec 2016 (AE)
- Bell Helicopters Textron / Concordia University / IISc / CRIAQ / NSERC's International Workshop on Mechanical Behavior of Thick Composites, Montreal, Canada, March 14-15, 2016 (AE)
- Airbus Link the Top Season-2, NUS, Airbus Helicopters and Singapore Air Show, Singapore, 14-18 Feb 2016 (AE)
- Airbus Link the Top Season-3, ISAE-SUPAERO, Airbus Head Quarters, A330 Final Assembly Line, A380 Final Assembly Line, Toulouse Space Show, Aeroscopia and Cité de l'Espace, Toulouse, France, June 24th to July 3rd, 2016 (AE)
- Symposium on CTCZ Clouds and Aerosol group meeting, 20 Jan 2016 (CAOS)
- CTCZ Results Workshop, 05-07 May 2016 (CAOS)
- Impact of Climate Change on Intraseasonal Variability of the Indian Summer Monsoon, 5-7 Dec 2016 (CAOS)
- Urban Meteorology, 22 -27 Aug 2016 (CAOS)
- Local and Remote influences on Rainfall over India (LORRI), 18-19 July 2016 (CAOS)
- Bay of Bengal Science and Analysis, 20-30 June 2016 (CAOS)
- Climate Change quiz, Sep 2016 (CAOS)
- Historical climate change and future climate change projections to Bangladesh Forest officers in 4 batches, Oct 2016 (CAOS)
- Historical climate change, future climate change projections and impacts of climate change on the forestry sectors to delegates from ASEAN countries, Aug 2016 (CAOS)
- historical climate change and future climate change projections to forestry officials from EMPRI, Karnataka State government. Aug 2016 (CAOS)
- Geodynamic processes and evolution of geophysical fields, tectonics and climate, 19-23 Sep 2016 (CEaS)
- Research Outreach for Young Chemical Engineering Students, 27 Feb 2016 (CH)
- Soil and Environment, 30-31 July 2016 (CiE)
- Modelling and Analysing Sustainable Transport for Scientific Decision Support, 26-30 Dec 2016 (CiE)
- Surge analysis and design of surge protection systems, 14-16 July 2016 (CiE)
- National Design Show on Ripples 2016, 4 - 6 Mar 2016 (CPDM)
- National Hackathon Reimagine Waste, Mar 26th to Apr 3rd 2016 (CPDM)
- Indo-US Workshop on Design of Sustainable Products, Services and Manufacturing Systems, 20-22 June 2016 (CPDM)
- First CII-IISc Design Workshop DCODE, 27-29 July 2016 (CPDM)
- 3rd SIAM Automotive Workshop 2016 – Two-Wheeler Mobility Solutions, 19-20 March 2016 (CPDM)
- Medical Device Hackathon, MeDHa 2016, 3-6 Nov 2016 (CPDM)
- Indo-UK Future of Manufacturing Roundtable Meeting, Nov & Dec 2016 (CPDM)
- Annual 'Research into Product Development' Symposium (RPD 2016), 7 Apr 2016 (CPDM)

- IISc-JAIST Workshop, 29 Feb 2016 (CPDM)
- Research in Design, 20-24 June 2016 (CPDM)
- Product Design 2016, 20 June - 8 July 2016 (CPDM)
- CPDM Research Seminar Series, 2016 (CPDM)
- CPDM Alumni Meet, 17 Dec 2016 (CPDM)
- CPDM-Sweden Research Interaction Workshop, 7 Nov 2016 (CPDM)
- Climate Resilient Participatory Afforestation and Reforestation Project (CRPARP), 11-24 Jan 2016 (CST)
- Climate change projection and Assessments of Impacts: Modelling and Capacity building program - Indian-ASEAN Region, 22 -28 Feb 2016 (CST)
- Climate change projection and Assessments of Impacts: Modelling and Capacity building program - Indian-ASEAN Region, 3-8 Oct 2016 (CST)
- Climate Resilient Participatory Afforestation and Reforestation Project (CRPARP), 1-10 Mar 2016 (CST)
- International Training Workshop on Climate Projection Modeling, 22-28 Feb 2016 (DCCC)
- Workshop on Solar Photovoltaics and Micro-Grid in collaboration with Flux Gen Engineering Technologies, 21 Mar 2016 (DCCC)
- Short Course on Forecast Error Correction using Data Assimilation, 4-15 July 2016 (DCCC)
- Brainstorming session on 'Future Earth', 9 Jul 2016 (DCCC)
- Second Workshop on Local and Remote influences on Rainfall over India (LORRI), 18 -19 July 2016 (DCCC)
- Training on Glacier, Climate Change and Remote Sensing, 18 -29 July 2016 (DCCC)
- Ninth Jeremy Grantham Lecture - Will Climate Change Lead to an abrupt Cessation of the Indian monsoon - by Prof William R. Boos, 25 Jul 2016 (DCCC)
- Seminar on Energy budget control of the regional ITCZ: a predictive theory applied to mid-Holocene rainfall, by Prof William R. Boos., 26 Jul 2016 (DCCC)
- Seminar on Topography and monsoons: elevated heating, orographic insulation, and runaway greenhouse states, by Prof William R. Boos, 28 Jul 2016 (DCCC)
- Towards a new understanding of monsoon depressions by Prof William R. Boos, 29 Jul 2016 (DCCC)
- Global Water, the Anthropocene and the Transformation of a Science towards a Sustainable Water Future - Prof Anik Bhadur, Executive Director, "Sustainable Water Future Programme" and Professor, Australian River Institute, Griffith University, Brisbane, Australia., 14 Sep 2016 (DCCC)
- The benefits of connecting science to policy makers - Prof Alyssa Gilbert, Head of "Policy and Translation", The Grantham Institute for Climate Change, Imperial College, London, UK., 12 Sep 2016 (DCCC)
- 8th Climate Science Quiz, 27 Sep 2016 (DCCC)
- NASA Earth Science Satellite Missions with a Focus on the Global Precipitation Measurement (GPM) Mission- Dr. Gail Jackson and Dr. Carlos Castillo, NASA GSFC, Greenbelt, Maryland, USA, 16 Nov 2016 (DCCC)
- Seminar on Rising seas causes and consequences, by Prof Stefan Rahmstorf., 22 Nov 2016 (DCCC)
- Tenth Jeremy Grantham Lecture - New Insights from Climate Science and the future of the Paris agreement by Prof Stefan Rahmstorf., 23 Nov 2016 (DCCC)
- Extreme weather events and the role of planetary waves by Prof Stefan Rahmstorf., 25 Nov 2016 (DCCC)
- A conclave of Young Scientists in Central & South Asian Region in collaboration with Twas Rocasa, JNCASR, 5-7 Dec 2016 (DCCC)
- Research Integrity: Avoiding Plagiarism, 26 Oct 2016 (DCCC)
- Cavitation in brittle bulk metallic glasses, 25 Apr 2016 (ME)
- Finite element simulations of void growth and coalescence in ductile single crystals, Sixth International Congress on Computational Mechanics and Simulation, 27th June - 1st July 2016 (ME)
- Brittle-ductile transition in notched nanoscale metallic glass specimens, 24th International Congress of Theoretical and Applied Mechanics (ICTAM 2016), 21-26 Aug 2016 (ME)

- Role of tensile twinning on fracture behavior of magnesium, 16-17 Sep 2016 (ME)
- Fracture behavior of brittle bulk metallic glasses, 15 Sep 2016 (ME)
- Cavitation induced failure in brittle bulk metallic glasses, 21 Sep 2016 (ME)
- International conference on Metals and Materials, 20-22 June 2016 (MT)

F. PHYSICAL & MATHEMATICAL SCIENCES

- In House symposium, 23 - 24 Jan 2016 (CHEP)
- Workshop on Quantum Physics Foundations and Applications, 1-12 Feb 2016 (CHEP)
- Quantum Physics: Foundations and Applications, 1-12 Feb 2016 (CHEP)
- Indo French Network Project in High Energy Physics (INFRE-HEPNET) Kick off workshop, 2-5 May 2016 (CHEP)
- Looking for BSM Physics, 20 - 22 Dec 2016 (CHEP)
- The 750 GeV Excess, 6 May 2016 (CHEP)
- India's Associate membership of CERN, 26 Feb 2016 (CHEP)
- The visit to IISc of Japanese delegation to explore scientific collaboration, 11 Mar 2016 (CHEP)
- Chetana - Empowering Girls with Technology ' of the DEPARTMENT OF IT, BT AND S&T, Govt. of Karnataka, 16 - 27 Oct 2016 (CHEP)
- Diversity and Inclusion' at the ICHEP2016: 38th International Conference on High Energy Physics, 3 - 10 Aug 2016 (CHEP)
- 'SUSY Models' at the 24th International Conference on Supersymmetry and Unification of Fundamental Interactions (SUSY2016), Univ. of Melbourne, Australia, 3 - 8 July 2016 (CHEP)
- International Organising Committee, AEPSHEP (Asia-Europe-Pacific School of High-Energy Physics) School held in Beijing, China, 12 - 25 Oct 2016 (CHEP)
- International Advisory Committee, International Meeting on 'Higgs Couplings' held in SLAC, Stanford, USA, 9 - 12 Nov 2016 (CHEP)
- Indo-Japan Seminar on Emerging Trend in Science and Technology, 10 Aug 2016 (IAP)
- NCM Workshop on Probability and Representation Theory, 7-12 Mar 2016 (MA)
- Conference on Zero and Related Topics in Number Theory, 25-26 Jul 2016 (MA)
- 10th Asian Science Camp, 21-27 Aug 2016 (MA)
- Investigation of protein and Nanoparticle Interactions with supported Bilayer Membranes, 3-5 Nov 2016 (PHY)
- Quantum plasmonics of hybrid Nano-assemblies, 5-8 July & 17-18 Nov 2016 (PHY)
- International Conference on IUMRS-ICYRAM 2016, 11-15 Dec 2016 (PHY)
- Contemporary Issues in Condensed Matter Systems, 13-15 June 2016 (PHY)



8. Other

INSTITUTE UNITS

8.1 Centre for Campus Management and Development – Buildings

PROJECTS COMPLETED DURING THE YEAR

Sl No.	Description of Works	Cost (₹ in lakhs)	Area in Sq. Mtrs.
1.	Construction of laboratories, classrooms, conference hall and office space in Material Engineering Department	513.83	2265.00
2.	Construction of dining facility and parking at Main Guest House	43.00	300.90
3.	Construction of second floor to Department of Electronic Systems Engineering (ESE) Building	312.63	1705.00
4.	Acoustic treatment and connected Civil and Electrical works at Raja Ramanna Auditorium in Gymkhana Campus	66.24	-
5.	Renovation and improvement to "E" Block Hostel	162.61	-
6.	Proposed Development and Alumni Affairs and International Cell Department	51.95	-
7.	Repairs and Painting to Gymkhana Building	30.00	-
8.	Providing chain link fencing to all round runway at Aerospace department	23.49	-
9.	Formation of hockey ground & improvements to foot ball ground in Gymkhana, IISc	50.58	-
10.	Raising of existing compound wall for a stretch of C V Raman Avenue from Main Gate to Health Centre, IISc	15.94	-
11.	Director's Office Renovation & Interior works.	65.00	-

PROJECTS IN-PROGRESS DURING THE YEAR

Sl No.	Description of Works	Cost (₹ in lakhs)	Area in Sq. Mtrs.
1.	Construction of New Block for Electronics and Communication Engineering Department	643.93	3206.00
2.	Construction & renovation of centre for Neuroscience in old TIFR Building, IISc	626.64	2692.00
3.	Additional constructions for Divecha Centre for Climate Change at CAOS premises	368.77	1840.00
4.	Establishment of 0.5 MLD domestic STP	294.00	-
5.	Modification of 'C' Mess including adding new patio and annexe	275.57	-

6.	Conversion of class rooms, renovation of students Laboratory and other renovation works to Management Studies building at IISc	106.08	-
7.	Providing new sanitary line from NNE Quarters/New 8 storeyed quarters under construction upto the proposed STP behind swimming Pool	51.75	-
8.	Construction of new Hydraulics building for Civil Engineering Department	823.65	4875.00
9.	Proposed construction of new Animal facilities building to CAF department	589.55	3794.00
10.	Proposed extension to second floor of Aerospace Engineering department building, IISc	328.08	1400.00
12.	Supply, erection, testing and commissioning of one transformer bay with 66/11 KV 12.5 MVA transformer by extending the existing 66 KV switch yard adding two Nos. of 11 KV VCB panels to existing 11 KV switchgear and SCADA system including all civil works.	297.90	-
13.	Electrical renovation works at Civil Engineering Department	18.96	-

NEW PROJECTS COMMENCED DURING THE YEAR

Sl No.	Description of Works	Cost (₹ in lakhs)	Area in Sq. Mtrs.
1.	Construction of CIDR (Annexe) Building	65.00	232
2.	Supply, erection, testing and commissioning of 2 Nos. of 2000KVA – 11KV D.G. Sets	4,47,60,785	-
3.	Supply, Erection, Testing and Commissioning of 11kv underground cable Ring Main including 2 nos. compact substations at Chemical Science (1250kVA) and E-Type Quarters (500kVA), extension of existing 11kV Switchgear Panel at 66kV MUSS by adding 4 Nos. of 11kV VCB Panels, Replacement of existing 11kV Load Break Switch Unit by adding 1 no. of 11kV Compact RMU at SS-14, Addition of 1 no. of 11/0.415kV, 1.0mva Transformer and Extension of 415V Panel by Adding 3 nos. of 415V panel at Physical Science and associated 11kV BUSDUCT, 11kV & 415V cabling work including all Civil Works at IISc campus	4,43,59,595	-

8.2 Official Language Unit

Chairperson: **ANJULA GURTOO**

HINDI WORKSHOP

The Institute regularly organises Hindi Workshops on various aspects of the use of Hindi in Central Government Offices and conversation sessions for the benefit of the Institute staff. Staff from different sections/units of the Institute take part in these workshops and are utilizing the same in their offices. During 13-3-2016 to 17-03-2017 a special training programme on "Technical Translation was organised under the auspices of Central Translation Bureau, Bangalore. Dr V Rajarajan, Registrar, Indian Institute of Science, Bangalore delivered keynote address after inaugurating the workshop. About 17 participants had taken part in the five-day training workshop. Several subject experts and Hindi Officers were invited to address various sessions.

DARSHINI MAGAZINE

Published Hindi Quarterly Magazine "Darshini" regularly. For the year 2016-17, January –March 2016, April- June 2016, July-September 2016 and October-December 2016 issues had been published.

HINDI LECTURE SERIES

- Ms. Amrita Shah, a journalist, social theorist, writer and is currently visiting faculty at the Centre for Contemporary Studies, Indian Institute of Science, Bangalore. She delivered a lecture in Hindi on “Shabdon ki Rachna” on 09-06-2016.
- Lt. General Vishnu Kanth Chaturvedi (Retd), is an alumni of National Defence Academy and Indian Military Academy. He is recipient of Param Vishisht Seva Medal (PVSM), the Ati Vishisht Seva Medal (AVSM) and the Sena Medal gallantry. He delivered a technical lecture in Hindi on “Aadhunikta, Parampara aur Naitikta” on 18-08-2016.
- Shri. Brijesh Kumar Dikshit, IFS, Additional Principal Chief Conservator of Forest (Forest Resource Management) delivered a lecture on “Prakruti aur Vigyan ke yudh mein vijayi kaun” on 16-12-2016.

TOLIC COMPETITIONS

Many participants from various Central Government offices participated in different competitions conducted by TOLIC office, Bangalore. Institute organised Vividha Competition for the Hindi Officers and Hindi staff on November 15, 2016 under the auspices of TOLIC. For the first time TOLIC celebrated the World Hindi Day on 11-01-2016. Members of the Hindi Samiti of the Indian Institute of Science, Bangalore participated actively in the celebration which was highly appreciated by all the members.

TRANSLATION

- Translation of Institute Annual Report into Hindi
- Translation of Annual Accounts into Hindi
- Translation of other administrative manuals, forms and day-to-day correspondence
- Translation of Hindi materials from KVPY, IISc, Bangalore

8.3 SC/ST Cell

Liaison Officer In Charge: **PUTTABASAVIAIH**

The Governing Council of the Institute has decided to follow Government of India directives/orders regarding reservations, concessions, relaxation, etc., in favour of Scheduled Castes and Scheduled tribes.

The SC/ST Cell monitors “Registers of Roster” pertaining to direct recruitments and promotions maintained for both teaching and non-teaching staff. The Cell strictly ensures the Institute’s adherence to Government of India directives/orders

regarding reservations, concessions, relaxation etc., for Scheduled Castes and Scheduled Tribes.

The Cell furnishes statistical information regarding the representation of SCs & STs in the service of the Institute to the Ministry of Human Resource Development, the University Grants Commission and the National Commission for Scheduled Castes and Scheduled Tribes as and when called for.

The Cell also looks after the implementation of welfare measures such as the reimbursement of tuition and other fees, etc. for SC/ST staff wards.

8.4 Counselling and Support Centre

Chairperson: **N C SHIVAPRAKASH**

The Centre for Counselling & Support (CCS) provides professional support to employees in various kinds of distress, especially those related to debts, alcoholism, absenteeism, family, health & personal matters. The Centre extends educational support to the children of the employees of the Institute through Guidance programmes. The Centre also runs training programmes for family members of the staff who are assessed to be in need of them. A small library for school-going children is also maintained.

Also, the Centre raises awareness amongst the Institute community about social problems through (i) arranging lectures, film shows, (ii) disseminating information through pamphlets. Posters, (iii) house to house visits by social workers.

During the year the Centre conducted the following programme:

- Yoga, Pranayama, Mudra & Meditation and Clapping and Laughter Therapy classes for Faculty / Students / Employees and their dependents.
- Drawing and painting classes for employees and their dependents.
- Organized interaction with Students (Student support network committee, Students Council) for Counselling.
- Organized Lectures / Seminars by eminent personalities on various topics to help employees, their families & children.
- Organized Tailoring & Embroidery courses for the employees and their dependents.
- Organized interaction with Departments for Counselling

WOMEN'S CELL

The Women's Cell was established in the year 2004 under Centre for Counseling and Support with the objective of addressing matters relating to women in the Institute. This Committee was reconstituted by the Director and Ms. Indumati Srinivasan, Financial Controller of the Institute is the present Chairperson and Dr. V Thilagam is the Convenor of the committee.

As the women employees are generally prone to depressions, due to circumstances, it was decided to engage services of a counselor (Psychologist) to counsel them.

To facilitate the Committee to prepare an agenda, several meetings were organised with each category of women, viz., faculty, students and administrative staff to understand the needs of each group.

SEXUAL HARASSMENT COMPLAINTS COMMITTEE

The Hon'ble Supreme Court has laid down certain guidelines and norms to be observed in institutions to ensure the prevention of sexual harassment of women in the work place. Sexual harassment of any kind constitutes an action unbecoming of an employee of the Institute and therefore constitutes misconduct in employment and will attract appropriate disciplinary action. Any complaint of sexual harassment would be examined by a complaints committee for redressal of the complaints. The committee would broadly be as follow:

- Redressal of complaints of women employees on sexual harassment while on duty and recommend suitable action wherever necessary

- Suggest steps to ensure that there is no hostile environment towards women at work place

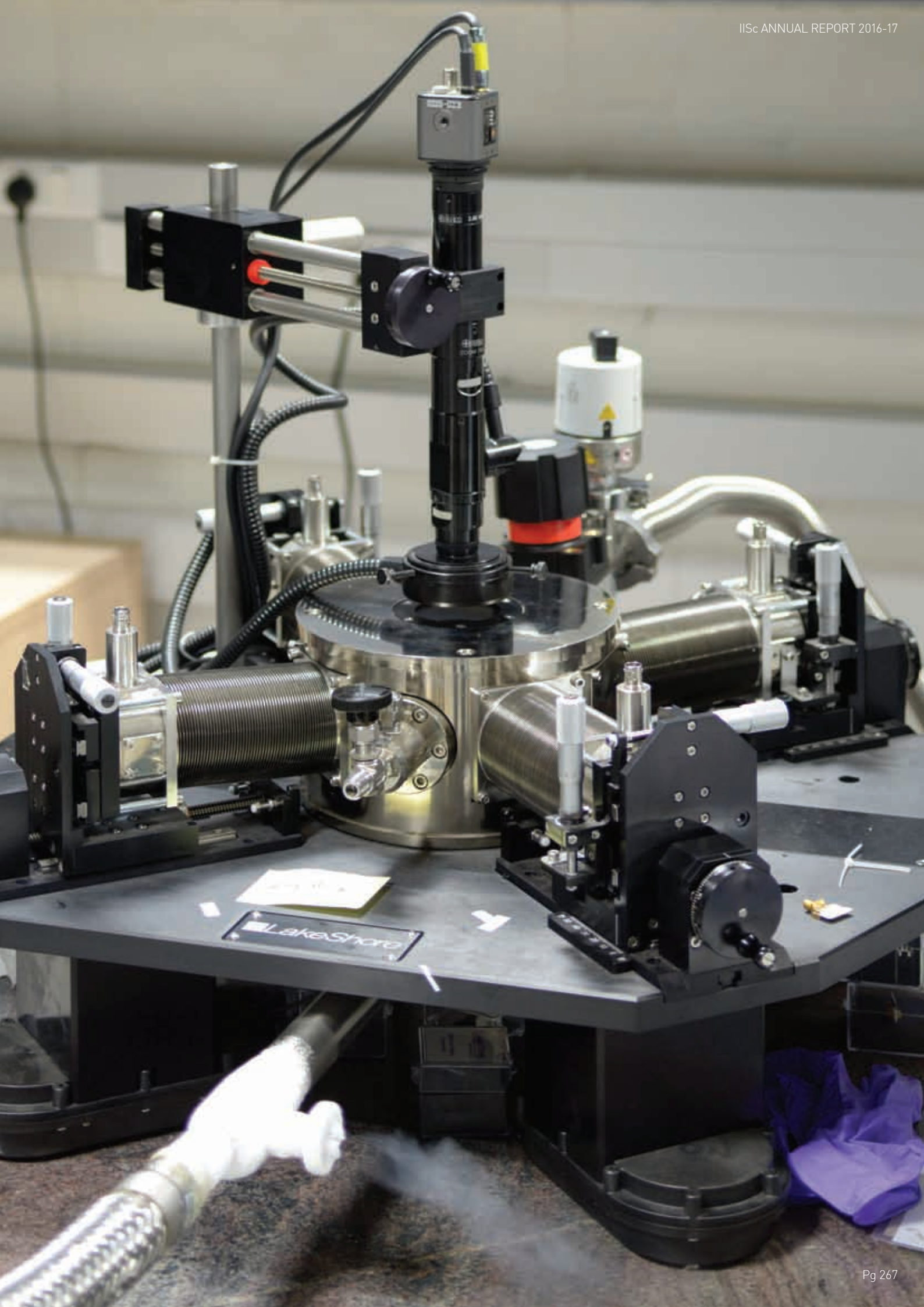
- Counselling the staff concerned

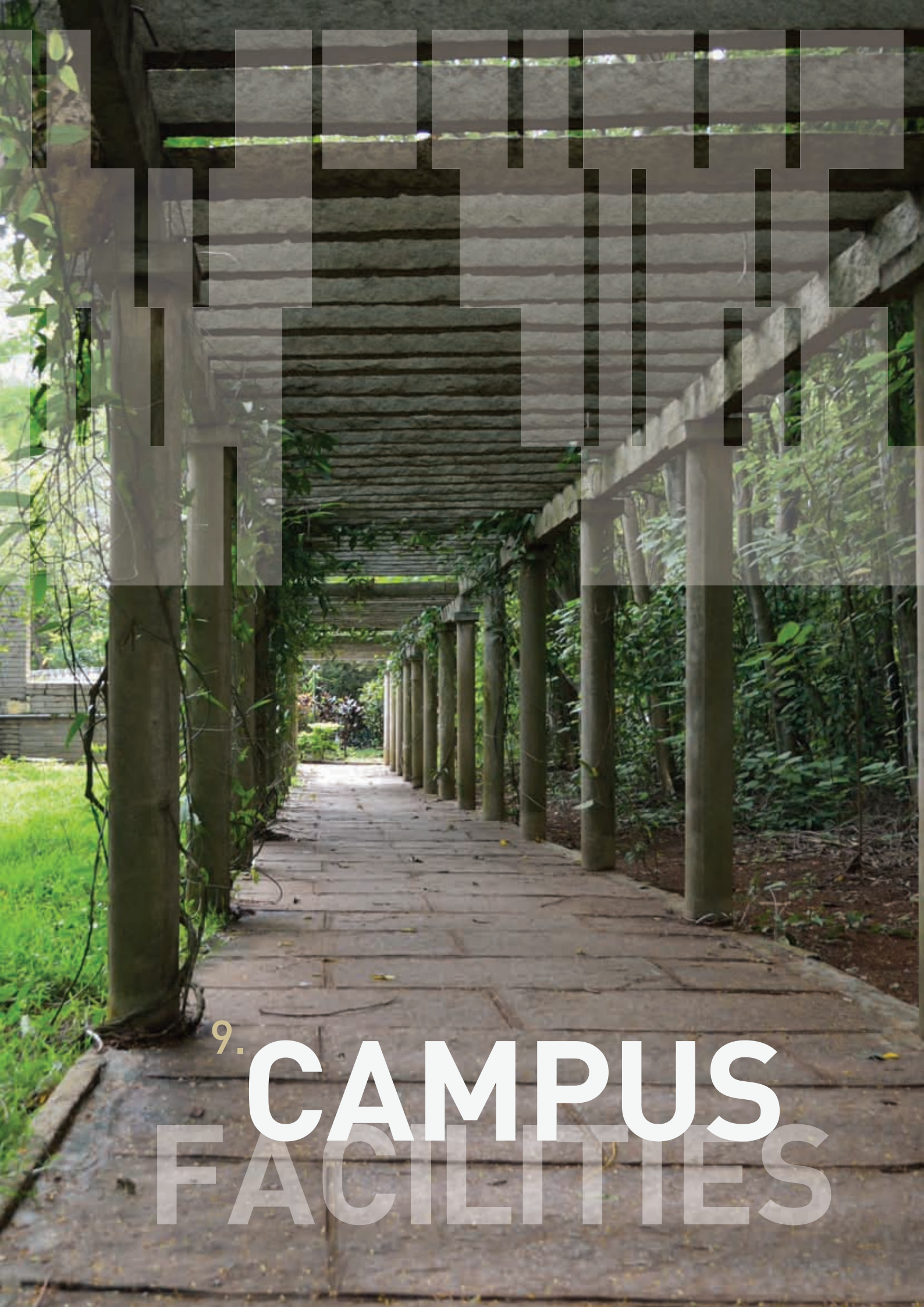
- Any other work as entrusted to the Committee regarding welfare of women employees at the Institute

The sexual harassment complaints committee was constituted during 2003 and functioning under the Centre for Counseling and Support. During this year the committee received four (4) complaints and all of them were dealt with appropriately. Also fifteen work shop on awareness programme against sexual harassment were conducted during this year, which include two Administration and Training for SHCC members.

8.5 Public Information Office

Right to Information Act, 2005: The Institute adopted the Right to Information Act, 2005 in the year 2006. The Institute has disseminated certain information through its website, which is accessible to the public. During the year, the public have made 160 requests seeking information and prompt action has been taken and the applicants have been informed accordingly.





9.

CAMPUS FACILITIES

9.1 Health Centre

PROJECTS COMPLETED DURING THE YEAR

The Health Centre extends primary health care to the staff, their family members, pensioners and their spouses, family pensioners and students. The Centre offers round-the-clock out-patient and in-patient treatment.

- A fully equipped Clinical Laboratory, Digital X-ray, Ultrasonography, ECG, fully equipped Physiotherapy Unit services are available.
- Specialist consultants in General Medicine, Gynecology, ENT, Ophthalmology, Dermatology, Dentistry and Psychiatry are available on appointment basis
- It has a Pharmacy, which stores most of the required medicines.
- It has an Operation Theater where minor surgical procedure can be carried out efficiently.
- For cases requiring hospitalization for major illness, patients are referred to external hospitals for admission and treatment. All the permanent Employees and their Family Members and Retired Employees and their Spouses and Family Pensioners are covered by Group Medclaim Insurance Policy under the Contributory Health Service Scheme (CHSS).
- The Health Centre provides OPD consultation for students residing in the campus.
- The Health Centre has experienced doctors residing in the campus and Area Medical Officers catering the institute population residing outside the campus in the city.
- The Health Centre also provides Ayurvedic Health Care by a recognized Ayurvedic Practitioners.
- Emergency care is given round the clock at the Health Centre.
- The Health Centre has a fully equipped Ambulance to transfer Critically ill patients round the clock.
- The Health Centre in collaboration with CCS department provides counseling by a recognized psychologist.

9.2 Recreational Facilities

9.2.1 GYMKHANA

The spacious and well-designed Gymkhana is the nodal centre for sports and cultural activities of the students and faculty. It offers facilities for many outdoor and indoor games and has a well-equipped gymnasium and a swimming pool. In addition, the Gymkhana houses the Nature club, Dance club, Dramatic club, Literary, Fine Arts and Photographic club and a well-equipped modern music room. The Ranade Library in Gymkhana offers light

reading material in English and in many Indian languages. Other features include periodic coaching classes in games and athletics such as Basketball, Tennis, Swimming, Kung Fu, Archery, Athletics, Aerobics and Dance. The Football/ Hockey and Tennis grounds are fitted with floodlights. The Raja Ramanna Student's Activity Centre (SAC) is open for cultural activities.

The Gymkhana conducted a number of sports and games competitions during the year in connection with Founder's Day, Independence Day, Republic Day and Gandhi Jayanthi. The indoor and outdoor game clubs held annual tournaments throughout the year. The Institute's Cricket team, Football team, Hockey team, Billiards team, Lawn Tennis team and Volleyball team participated in Club Tournaments, League matches and Inter Collegiate Tournaments. The Gymkhana has also conducted Inter Departmental / Open matches for the students, faculty, staff, spouses and their children.

9.2.2 FACULTY CLUB

The Faculty Club is a place for recreational, social and cultural activities.

Some of the salient activities of the club are: Indoor Games (Billiards/Snooker, Carrom, Table Tennis and Chess); Outdoor Games (Tennis); Fine Arts; Library & Reading Room (subscribes to dailies, weeklies and popular magazines); T V Lounge; Ladies Section; Snack Parlour and Pastry Shop and a Mini Gym. Classical music concerts are organised regularly on the campus.

During the year dining and gym facilities were improved. Science learning activity for school kids is arranged through science club.

9.2.3 TATA MEMORIAL CLUB

This Club provides the space and facilities for various games and cultural activities for the supporting staff of the Institute.

In addition to organising outdoor and indoor games, its activities cover swimming coaching, computer training, Abacus class, creative camps, dance training, musical instrument training, Yoga / Meditation classes, and Sloka classes for members, students & their dependents. Tuition classes are conducted with the support of student volunteers for needy dependents children. The club also can borrow Engineering and Medicine text books for needy children of the Institute community. The mini multi gym facility is open to the Institute community. The club also maintains a Library. A Regular Blood Donation camp is organised on Independence and Republic day in co-ordination with the Students Council / Lions club (Aishwarya).

The Tata Memorial science quiz was organised on National Science Day. The club organised Badminton / Carrom / Table Tennis tournaments for students, faculty and staff. The club also organised the Karnataka Rajayotsava in co-ordination with the Kannada Sangha.

9.3 Auditoria

9.3.1 NATIONAL SCIENCE SEMINAR COMPLEX

The magnificent National Science Seminar Complex situated in the IISc Campus is the first of its kind in India. The complex is open for seminars, symposia and conferences organised by recognized scientific societies, educational institutions and professional bodies. The total built up area measures around 5750 sq. metres.

This fully air condition complex houses the JN Tata Auditorium with a seating capacity of 750 and 3 mini auditoria to seat 120, 90 and 60 people respectively. Interactive concourses at the basement and ground level with excellent light and sound facilities are part of the seminar complex. The business centre at the complex has facilities for photo copying, FAX, STD/ISD phone booths and secretarial assistance.

9.3.2 PROF SATISH DHAWAN AUDITORIUM

Located on the first floor of the Centre for Scientific and Industrial Consultancy, this medium sized auditorium has a seating capacity of 265. It has fixed seats and a dais suitable for conferences and chamber music. It is fully air-conditioned and is adequately equipped with sound, lighting and projection equipment.

9.3.3 RUSTUM CHOKSI HALL

Located close to the entrance of the Institute, with a seating capacity of 120, the interior of the hall and its surroundings provide the right environment for intellectual inquiry and cultural activities.

9.3.4. FACULTY AND RECEPTION HALL

The Faculty Hall with a seating capacity of 275 is located in the east wing, on the first floor of the tower building. The Reception Hall is in the west wing. These are used for formal events.

9.4 Amenities

The following amenities located in different parts of the campus make day-to-day life smoother and more comfortable. In fact, these facilities have made IISc a totally self-contained Campus.

- Travel Agencies (Domestic & International Travel)
- Photo copying and DTP Centres
- Stationery/Book Shop
- Laundries/Dry cleaners
- Tailoring Shops
- Restaurants
- Juice Shop
- Provision and General Stores
- Vegetable Shop
- Bakery & Pastry Shop
- Hair Dressing Saloons
- Baby Care Centre
- Ladies Boutique
- Cycle Shop
- Cable Facility
- Milk Parlour
- STD/ISD, Courier & Mobile Services

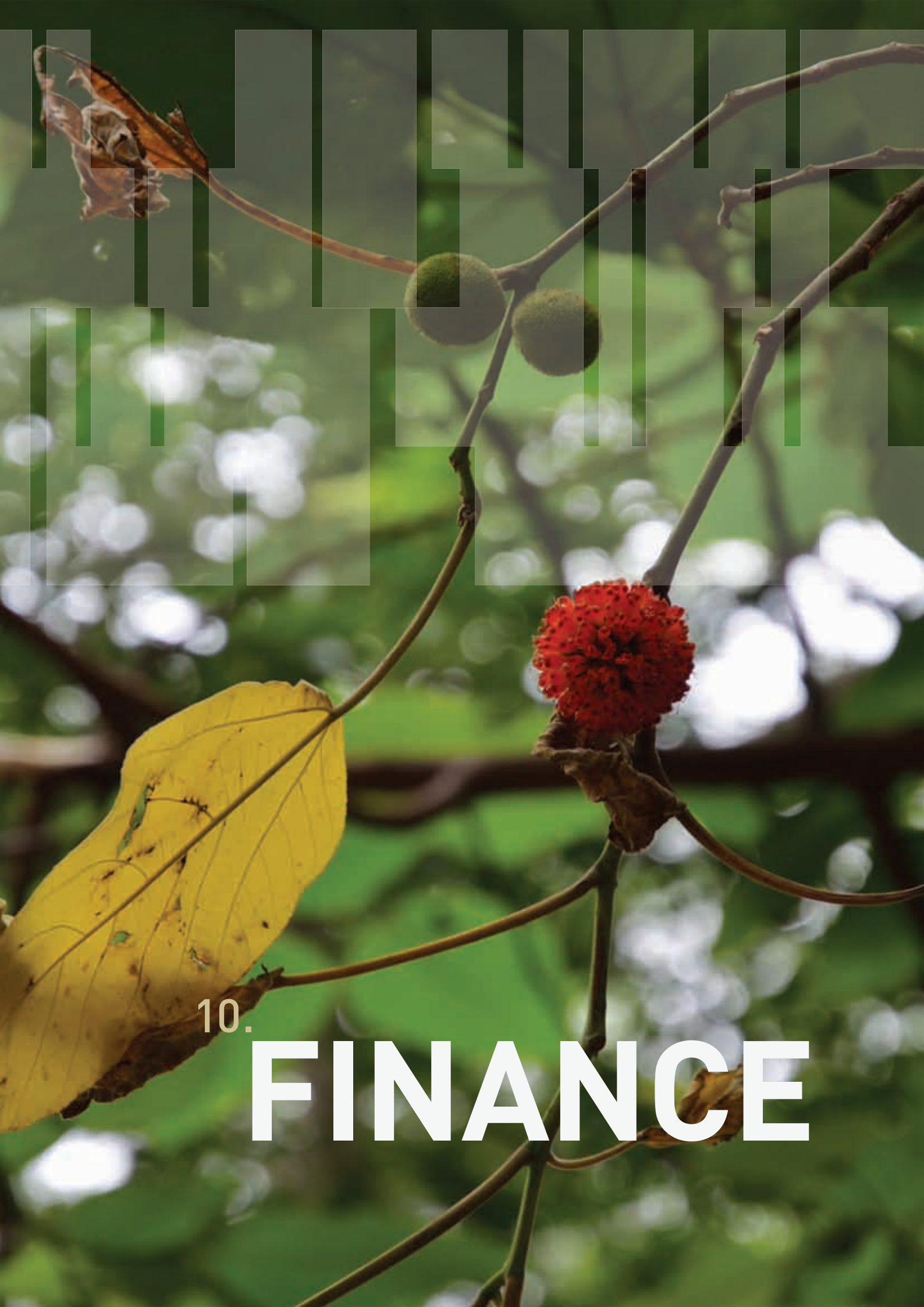
COMMUNICATIONS

Post Office (Science Institute, Bangalore – 560 012), Telecom Centre and STD booths. The Institute is connected by the Centrex Exchange from M/s.BSNL with 1200 extensions. In addition, there are nearly 250 direct lines to different department and centres.

Centralized electronic franking takes care of outward postage and is supported by a centralized FAX facility. The Transport section maintains a fleet of service vehicles through approved travel agencies.

Help Desk: The Help Desk facility has been reactivated at the Reception Counter at the main gate of the Institute to assist visitors. This facility functions from 8.00 am to 8.00 pm.

Banks: Canara Bank and State Bank of India have fully computerized branches with many facilities including foreign exchange transactions and ATM machines



10.

FINANCE

The Ministry of Human Resource Development provides Non-Plan and Plan Grants to the Institute for meeting Recurring expenditure & for creation of Capital assets, respectively. The Institute also receives funds from other Government agencies like DST/DBT/CSIR etc, for Extra Mural Research. The UGC/DST also release grants for research in emerging areas & for expansion of Infrastructure under Centre for Advanced Study/ FIST Programmes, respectively.

The total receipts covering all major areas for the year 2016-17 was ₹ 1.01,816.76 lakhs and the payments for various activities of the Institute was ₹ 91,880.33 lakhs.

THE DETAILS OF RECEIPTS AND PAYMENTS FOR THE YEAR 2016-17 ARE AS FOLLOWS

Sl No.	Particulars	Receipts	Payments
1	Non-Plan Grant - Recurring	30,252.00	29,382.25
2	Plan Grants	12,054.00	13,755.46
3	Developmental Projects	13,985.74	12,438.50
4	Sponsored Research Schemes	35,576.00	26,851.23
5	Scientific & Industrial Consultancy	1,205.15	1,078.77
6	ODAA Projects	1,070.38	1,186.17
7	Continuing Education Programme	479.64	405.65
8	Sponsored Scholarships (CSIR/UGC/AICTE etc)	2,134.31	1,722.76
9	Academic/Other Income	1,559.97	1,559.97
10	Interest earnings/Project Overheads	3,525.15	3,525.15
	TOTAL	1,01,842.34	91,905.91
	Salaries & Allowances	23,740.09	
	Research Associateship	636.34	
	Working Expenses	6,565.79	
	TOTAL	30,942.22	



11. **ENDOWED**
CHAIRS

11.1 Endowed Chairs for Faculty

A number of Endowed Chairs have been instituted in recent years to recognize the outstanding contribution of Institute faculty members.

Year	Name	Department
ABB		
2012-15	Prof PS Sastry	EE
2015-18	Prof K Gopakumar	ESE
AMRUT MODY		
2015-18	Prof Binny J Cherayil	IPC
ASTRA		
2012-15	Prof Sandhya S Visweswariah	MRDG
2015-18	Prof C Jayabaskaran	BC
MSIL		
2012-15	Prof Chanda J Jog	PHY
2015-18	Prof B Ananthanarayan	CHEP
2015-18	Prof Vasant Natarajan	PHY
KSIIDC		
2012-15	Prof PP Mujumdar	CIVIL
2015-18	Prof TG Sitharam	CIVIL
PROF SATISH DHAWAN		
2012-15	Prof KPJ Reddy	AE
2015-18	Prof Ranjan Ganguli	AE
TATACHEM		
2012-15	Prof P Vijay Kumar	ECE
2015-18	Prof N Surya Prakash	NMRC

RAMAKRISHNA RAO

2014-17	Prof Srinivasan Raghavan	CeNSE
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PRAT & WHITNEY

2016-18	Prof Gopalan Jagadeesh	AE
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11.2 Endowed Visiting Chairs

A number of Endowed Visiting Chairs have been instituted to facilitate the visits of celebrated researchers from all over the world.

Year	Name	Department
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BRAHM PRAKASH

2015	Prof Tamas Ungar	Eotvos University, Budapest, Hungary
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2015-16	Prof Kannan M Krishnan	University of Washington, Seattle, USA
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2016	Prof Jiang-Zhong Jiang	Zhejiang University, Hangzhou, PR China,
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2016	Prof Tamas Ungar	Eotyos University, Budapest, Hungary
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2016	Prof David P Field	Washington State University, Pullman, USA
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2016	Prof Surya R Kalidindi	George W. Woodruff School of Mechanical Engineering, Atlanta, USA,
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2017	Prof Jerzy Antoni Szpunar	Univ. of Saskatchewan, Saskatoon, Canada
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2017	Prof David P Field	Washington State Univ., Pullman, USA
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PROF SATISH DHAWAN

2015	Prof Tribrikram Kundu	University of Arizona, Tucson, AZ
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2016	Prof P Guruswamy	Ames Research Centre, California, USA
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2016-17	Prof DS Naidu	University of Minnesota, USA
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SUNDARARAJAN

2015	Prof Uma Das Gupta	Kolkata
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PRATT & WHITNEY

2015-16	Prof Ravi N Banavar	IIT Bombay
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Year	Name	Department
DST-IISc CENTENARY CHAIR		
2015	Prof Ramesh Narayan	Harvard University, USA
2015	Prof Jainendra K Jain	Pennsylvania State University, USA
2015	Prof William A Goddard	Caltech, California, USA
2017	Prof Allan Peter Young	Univ. of California, USA
2017	Prof Richard N Zare	Stanford University, Stanford, CA
BHARAT ELECTRONICS CHAIR PROFESSORSHIP		
2016	Dr Goutam Chattopadhyay	Jet Propulsion Lab, USA
SMT RUKMINI – SHRI GOPALAKRISHNACHAR DISTINGUISHED CHAIR PROFESSORSHIP		
2015	Prof Michael L Norman	University of California, San Diego, USA
2016	Prof Rakesh Agrawal	Microsoft Research, Redmond, USA
K VAIDYANATHAN DISTINGUISHED VISITING CHAIR		
2015-2020	Prof Shihab Shamma	University of Maryland, USA
SMT SUDHA MURTY DISTINGUISHED VISITING CHAIR		
2016-2019	Prof Vasant Honavar	Pennsylvania State University, USA
INFOSYS VISITING CHAIR		
2016-2020	Prof Jainendra K Jain	Pennsylvania State University, USA
	Prof Susanne C Brenner	Louisiana State University, USA
	Prof Aneesh V Manohar	University of California, USA

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