

January 2016

# R&D PROFILE

at a glance

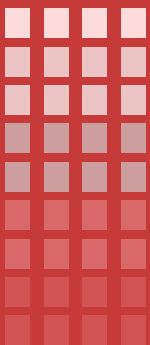
INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Basic Research

Industrial Research

Technology Transfer

Innovation



Nano

Energy

UAV

Traffic

Synthesis

Solar

Dynamics

Materials

Power Grid

Optimization

Environment

Air Quality

Data Analysis

Healthcare

Ganga Cleaning

Infrastructure

Computational

Rural Technology

Manufacturing

Telecommunication

Flexible Electronics

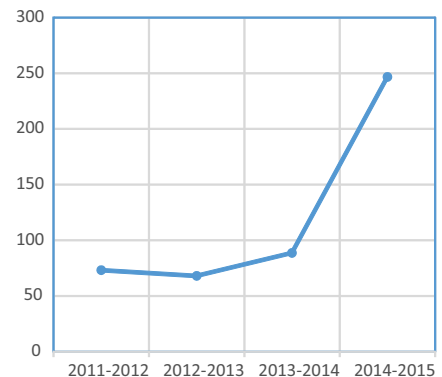
[www.iitk.ac.in/dord](http://www.iitk.ac.in/dord)

# RESEARCH & DEVELOPMENT

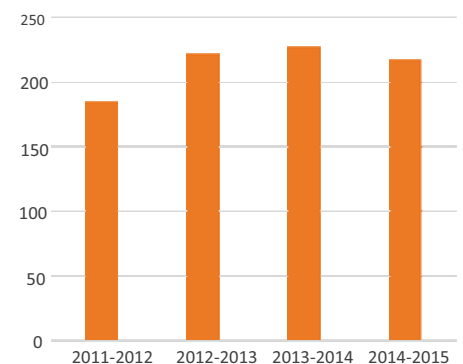
IT Kanpur has demonstrated its excellence of research in many areas. To cite few areas: Finite Element Methods Using Domain Decomposition, Flow Induced Vibrations, Wind Tunnel Testing of Large Scale Prototypes, Computational Chemistry, Nano-materials and Nanotechnology, Geometric Optimization of Large Organic Systems, Genomics and Bio-Informatics, Electronic Structure Calculations, Aggregation and Etching, Molecular Dynamics, Thin Film Dynamics, Optical / EM Field Calculations, Computational Fluid Dynamics and Heat Transfer, Computer Aided Design and Rapid Prototyping, Tomography, Robotics, Multi-Body Dynamics, Geo-seismic Prospecting, Stress Analysis and Composite Materials, Vibration and Control, Semiconductor Physics, Photonics, Neural Networks and Genetic Algorithms, Earthquake Engineering, Impurities in Anti-Ferro Magnet, Raman Scattering, Particle Physics, Spin Fluctuation in Quantum Magnets, Quantum Computation and so on. The most recent initiative of IIT Kanpur has been the Formation of a Strong Research Group in the areas of Nanoscience and Nanotechnology, Aerosol and Flexible Electronics.

## Statistical Data

Externally Funded Ongoing Projects	<ul style="list-style-type: none"><li>Total Number: 518</li><li>Sanctioned Amount: ~ Rs 535 Crore</li><li>Number of Project Staff: 546</li></ul>
Externally Funded Research Fellowships	<ul style="list-style-type: none"><li>Total Number: 116</li></ul>
New Projects (2014-2015)	<ul style="list-style-type: none"><li>Total Number: 217</li></ul>
Patents Filed (2014-2015)	<ul style="list-style-type: none"><li>Total Number: 56</li></ul>
Technology Licensed (2014-2015)	<ul style="list-style-type: none"><li>Total Number: 20</li></ul>
Research Papers (2014-2015)	<ul style="list-style-type: none"><li>Total Number of Journal Papers: ~ 1015</li></ul>



Amount (Rs in crore) of Projects over last 4 years



Number of Projects over last 4 years



For developing a long term framework for research collaboration, IIT Kanpur signed MOU with Ministry of Railways, New Delhi on 22<sup>nd</sup> December, 2015.

An MOU was signed between IIT Kanpur and TCS on 15<sup>th</sup> October, 2015 for strengthening and developing the link between them through the formation of IITK-TCS Program.

For intensifying academic and research cooperation, a joint collaboration agreement signed between IIT Kanpur and Sterlite Technology Limited on 12<sup>th</sup> May, 2015.

An MOU was signed between IIT Kanpur and Steel Authority of India Limited, New Delhi to explore and identify joint research programs on topic of mutual interest.

To collaborate in the areas of commercialization, evaluation and enhancement of technologies, products and services developed by IIT Kanpur; an MOU was signed with IKAN Innovations and Technologies Pvt. Ltd, Lucknow.

BHEL, one of the Navratnas in the public sector, and a premier electrical engineering company & IIT Kanpur have signed industry-academia agreement for collaborating and pursuing industrial application oriented research programmes through BHEL funding.

Professor Indranil Manna, Director IIT Kanpur signed MOUs with Dow Chemical International Pvt. Ltd. (DCIPL) and with Emerson Network Power in the Rashtrapati Bhawan in the presence of the President, Shri Pranab Mukherjee.

Selected MOUs

## Selected Government Funding Agencies

- Department of Science & Technology
- Science and Engineering Research Board
- Department of Biotechnology
- Ministry of Earth Sciences
- Council of Scientific & Industrial Research
- Ministry of Communications & Information Technology
- Board of Research & Nuclear Sciences
- Ministry of Environment & Forests
- Ministry of Power
- Indian Space Research Organisation
- Defence Research & Development Organisation
- Aeronautics Research & Development Board

## Selected Industrial Partners

### Indian Partners

- Samsung India Operations Ltd
- Manipal Press Ltd
- Larsen & Toubro Ltd
- Tata Consultancy Services
- Rashtriya Ispat Nigam
- Power Grid Corporation of India Ltd
- CEAT Ltd
- Housing & Urban Development Corporation Ltd
- Bharat Heavy Electrical Ltd
- Sahasra Electronics Private
- Tata Steel Ltd
- Hindustan Aeronautics Ltd
- United Phosphorus Ltd
- Hindustan Petroleum Corporation Ltd

### International Partners

- Boeing International
- Tata Steel Nederland Technology BV
- Procter & Gamble Company
- Eaton Corporation
- Chevron Corporation
- Pratt & Whitney Canada Corporation
- ETI Dynamics
- Earth Systems
- Instalaciones Inabensa
- Intel Corporation
- Samsung Electronics Co Ltd
- SAP
- Unilever
- General Electric

SIDBI Innovation & Incubation Centre  
 DST Technology Business Incubator  
 DIT Technology Incubation & Development Entrepreneurship  
 DSTI TePP Outreach Centre  
 MSME Centre

# INNOVATION & INCUBATION

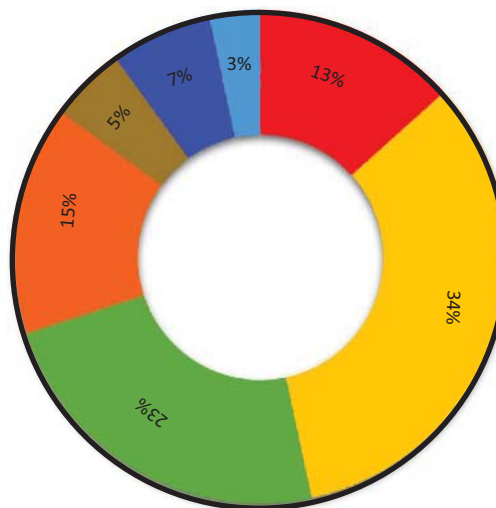
SIDBI Innovation and Incubation Center (SIIC) fosters innovation, research, and entrepreneurial activities in technology-based areas. SIIC provides a platform for start-ups by budding entrepreneurs and intrapreneurs to convert their innovative ideas into commercially viable products. SIIC also provides services related to patenting and commercialization.

During the year 2014-15, 8 patents were granted and 20 technologies were licensed for commercialization. Till date, 294 Indian Patents have been filed of which 41 are international, 10 are design patents, over 40 technologies have been licensed for commercialization and 40 patents have been granted. .

Incubation  
 Portfolio

Currently Incubated  
 Companies: 25

Companies  
 Graduated: 35



- Bioscience/Drug
- Electronics & ICT
- Automation & Mechanical
- Software
- Materials & Chemicals
- Design
- Others

## Currently Incubated Companies

- Apcegen Technologies Pvt. Ltd.
- InvivoD Solutions Pvt. Ltd.
- GenPro Therapeutix
- Ortho Regenics
- Kanopy Techno Solutions
- Cenogen Material Pvt. Ltd.
- E-Spin Nanotech Pvt. Ltd.
- Innosium Technologies Pvt. Ltd.
- Orane Infosystems Pvt. Ltd.
- Arnium Technologies Pvt. Ltd.
- Trident Analytical Solutions
- Singhal Labs Pvt. Ltd.
- Cloudshell Technologies Pvt. Ltd.
- Robust Results Pvt. Ltd.
- Promorph Techno Solutions
- Kaleidoscope Control Robotics and Automation
- Rotavio Labs Pvt. Ltd.
- Taral Engineering Solutions Pvt. Ltd.
- Aarav Unmanned Systems Pvt. Ltd.
- Srashta Automation Labs Pvt. Ltd.
- Adwik Mobility Solutions Pvt. Ltd.
- Objectify Technologies Pvt. Ltd.
- G T Silicon Pvt. Ltd.
- Prosoc Innovators Pvt. Ltd.
- NURBS 3D Solutions Pvt. Ltd.



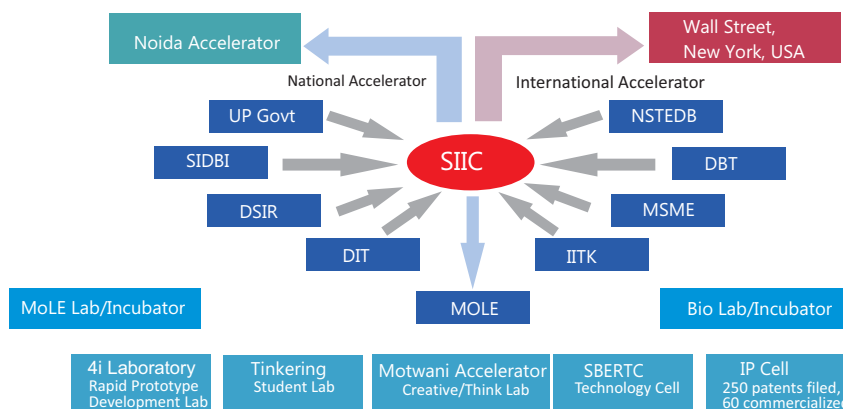
## Recently Granted Patents

- A process for generating micro and sub macro patterns on the surfaces or layers of polymers
- New duplex adsorption process for fractionation of gas mixture
- A Carbon nanotubes coated long fiber and a process for preparation thereof
- A process for preparation of nanoparticles of higher molecular weight of polyethylene polypropylene and polystyrene
- Design of an integrated system for using straight vegetable oils as fuels for diesel engines
- Recuperative Liquefied Petroleum Gas (LPG) Vortex Burner System
- Conversion of vegetable oils to biodiesel
- A Novel viscoelastic media used for a nano-finishing of materials through abrasive flow machining process and a method of manufacture thereof
- Functionally graded magnetic materials and a method for preparation of the same
- A Process for Preparation of Micron Sized High Molecular Weight Polymer
- A Wind turbine device
- A Twin- fluid Internally Mixed Swirl Atomizer

## Recently Licensed Technologies

- An Organic Device with Thin Film Transistor Merged with Light Emitting Diode through Use of an Accumulation Layer in TFT as an Electrode
- Multiple criteria decision analysis in distributed databases
- Polymeric nanocomposite films with embedded channels and Methods of their preparation and use
- Nanobrushes and methods of manufacture and use
- Microfluidic Devices and Methods for their Preparation Use
- Hierarchically Porous Polymer, Carbon, Silica and Composite Carbon/Silica Monoliths with Ultra High BET Surface Area Synthesized by Combined Templated Sol-gel and Micro-phase separation for applications in Supported Metal Catalysis
- Multiple Criteria Decision Analysis
- Metamaterial Structures for Q-Switching in Lasers
- Systems and methods for dry processing fabrication of binary masks with arbitrary shapes for ultra-violet laser micromachining
- Thin Film Transistor with A Current- Induced Channel
- Smart Card Operating System (SCOSTA)
- A Coronary stent with nano coating of drug free polymer and a process for preparation thereof

**T**he Innovation Ecosystem at IIT Kanpur is a unique experimental and incubation space fostering innovation and entrepreneurship in the whole country. The ecosystem is driven by a set of laboratories and testing facilities encompassing the entire gamut of engineering disciplines from Bio-Engineering, Mechanical, Electronics and Electrical to IT & ITES and is open to anyone with an innovative idea. These facilities provide the students, innovators and entrepreneurs both within the institute and outside a unique environment to fructify their ideas into viable high technology intensive products thus helping them in building a successful entrepreneurial venture with minimum cost. SIIC along with the Innovation Council is at the epicentre of this ecosystem fostering, facilitating and funding these nascent entrepreneurial ventures. IIT Kanpur faculty plays an important role in this ecosystem in providing knowledge and technical expertise as mentors to make them globally competitive.





# RESEARCH CENTERS

The Institute has 10 research centers/units in interdisciplinary areas endowed with state-of-the-art facilities.

- Center for Environmental Science and Engineering  
<http://www.iitk.ac.in/cese/>
- National Information Center of Earthquake Engineering  
<http://www.nicee.org/>
- Thematic Unit of Excellence  
<http://www.iitk.ac.in/nanoscience/>
- SAMTEL Center for Display Technologies  
<http://www.iitk.ac.in/scdt/>
- Syndicate Bank Entrepreneurship Research and Training Centre  
<http://www.iitk.ac.in/siic/d/sbertc>
- BSNL-IITK Telecom Center of Excellence  
<http://www.iitk.ac.in/dord/bitcoe/>
- Center for Laser Technology  
<http://www.iitk.ac.in/celt/>
- Center for Mechatronics  
<http://www.iitk.ac.in/robotics/>
- Advanced Center for Materials Science  
<http://www.iitk.ac.in/acms/>
- Advanced Center for Electronic Systems  
<http://www.iitk.ac.in/ee/>

## Major achievements of a few Centers/Units

### Thematic Unit of Excellence

- Nanolens and nanolens array fabrication by self-assembly
- Non-fouling and reusable pressure-sensitive adhesive
- Micro/nano functional carbon fiber webs for environmental remediation
- Technology for large area, ultra-fast micro-patterning of coatings

### BSNL IITK Telecom Center of Excellence

- Digital Mandi for the Indian Kisan
- Power Supply for telecom applications
- Strategies for telecom operators to switch to IPv6 from IPv4

### Center for Lasers and Photonics

- Design and development of broadband, tunable fiber laser
- Hand held probe for cervical cancer detection
- Real-time vein visualization tool
- Solar cell defect characterization tool

### Samtel Center for Display Technologies

- 1.0 and 1.5 inch full colour OLED display
- Organic Solar cell module
- A method for printing micron size width of nano gold ink



## Advanced Imaging Center

Advanced Imaging at IIT Kanpur was started with a generous internal grant from the Institute to procure high-resolution transmission electron microscope for researchers engaged cutting-edge materials research. The building houses microscopes, sample preparation and wet laboratory facility, and conference rooms. The following machines are located in the facility: FEI Titan G2 60-300 TEM and FEI TECHNAI G2 12 Twin TEM; ultramicrotome for room and cryo-temperature sectioning and a Vitrobot for vitrification process.



## National centre for Flexible Electronics



The Launch and Foundation Stone Laying ceremony of National Center for Flexible Electronics took place on July 1st, 2015 at Outreach Auditorium of IIT Kanpur. This event was a part of the 'Digital India' initiative of Government of India which was held in the Indira Gandhi Indoor stadium, Delhi. Honourable Prime Minister, Shri Narendra Modi launched the National Center for Flexible Electronics which is established jointly by the Department of Electronics and Information Technology (DeitY) and IIT Kanpur. Owing to use of new materials and methods of manufacturing, Flexible Electronics represents a break from the past and provides a fresh opportunity to become a significant manufacturer of electronics. The aim of this Centre is to act as a catalyst for

the development of the flexible electronics industry in the country. Its objectives include development of a national technology roadmap in coordination with other academic and industrial partners, establishment of a broad research program that leads to development of a critical set of electronic components and partner with industry to develop unique prototypes. The Center will function as a National Resource Center functioning closely with the industry.

## Advanced Center for Materials Science

The Advanced Center for Materials Science has been completely rejuvenated with augmentation of research equipment worth more than 70 crore in the last 2 years. Some of the sophisticated characterization instruments are: Laser confocal optical microscopy for life cell imaging; XPS-AES system for surface characterization of entire range of materials metals, semi-conductors, ceramics, polymers; X-ray facility for thin film, high temperature XRD, texture and residual stresses. Chemical analysis is enhanced with EPMA and Optical emission spectroscopy. The newly added equipment are the state-of-art in their category and provided the much needed research infrastructure to do cutting edge, high quality research.





# STUDENTS' CORNER

## Formula Racing Car

The students of SAE Club, IIT Kanpur have designed and manufactured an off-road racing vehicle using institute's in-house facility. The car is powered by a Briggs and Stratton 305cc engine coupled with a Continuously Variable Transmission (CVT) and a FNR gearbox. The car has ergonomically designed pedal assembly to facilitate driver comfort and has large traction forces for a safe and thrilling ride in off-road conditions. The most recent Formula Student and BAJA Student cars- F16 and B16 from SAE club were unveiled on 19th January in an official launch event organized in the campus in the presence of Professor Indranil Manna, Director IIT Kanpur.



## Pushpak



Team Pushpak is a group of students pioneering from Aeromodelling Club under the Science and Technology Council, IIT Kanpur. Over the years the team has participated in three SAE Aero design chapter in 2013, 14 and 15. They are known for their expertise in designing UAV based solutions to modern day problems from baseline designs developed for SAE Aero Design. The expertise developed at this platform has allowed the Team's Alumni to setup their own start-up in UAV based imaging and analysis Aaruv Unmanned Systems.

## AUV

'Varun' is the Autonomous Underwater Vehicle currently being developed by a team of undergraduate students under the Science and Technology Council, IIT Kanpur. After a year of designing and building several experimental based prototypes, the vehicle is now on its verge of completion to participate in the 5<sup>th</sup> NIOT-SAVE organized by the National Institute of Ocean Technology, Chennai.



## Abhyast

A team of 8 undergraduates designed an Unmanned Ground Vehicle (UGV) that could successfully perform simple path planning and obstacle avoidance. Body engineering aspects of the vehicle were also factored in to make it suitable for unstructured landscape. After successfully navigating in an arena filled with randomly moving obstacles, complexities were introduced into the objectives for Phase II of the project. Phase II mainly aimed at developing gas sensors for detection and monitoring of gases in a chemically hostile environment. The endeavour is supported by The Boeing, USA.

## NERD

NERD is a campus magazine meant for providing students a platform to share the excitement of science and technology. The magazine is created by students - be it their research work, hobby projects, interviews with scientists, or book reviews.

## POWER

Promotion of Work Experience and Research (POWER) is a student body aiming at promoting student ideas and a culture of student led technical projects by providing work-experience opportunities.





## National Wind Tunnel Facility

It was established to meet the national needs in aeronautical and non-aeronautical activities. It houses the most versatile and efficient wind tunnel in India and is capable of testing at wind speed up to 80 m/sec.

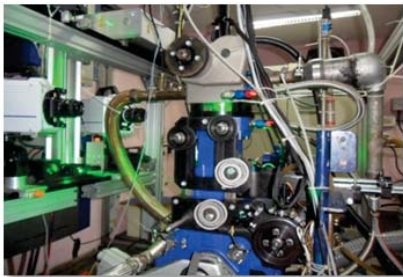


## Real Time Digital Simulator (RTDS)

A 6-rack Real Time Digital Simulation (RTDS) Facility carries out advanced research on power systems. The facility is the biggest amongst Asian universities and can simulate the transient behaviour of practical systems using a time step of upto two microseconds. It will be used for Synchrophasor Applications in Power Systems and Grid Integration of Wind Farm/Solar Photovoltaic using DC micro grids.

## Nanoscale Imaging Facility

The Institute is in the process of commissioning this facility for materials and biological science at a cost of about INR 15 crores. It houses a HRTEM and a cryo-TEM along with all the complete infrastructure/accessories requirements for materials and biological sample preparation. The HRTEM is FEI make Titan G2 60-300 model, the world's most powerful commercially available STEM/TEM.



## Engine Research Lab

It houses a flexible internal combustion system with provision to vary fuel injection strategies and timing, supercharging boost pressure, control and measurement of fuel pressure and injection pattern. It is equipped with an AC dynamometer, state of art intake air measurement system and gravimetric fuel flow meter. The engine also has provision for installation of endoscope for visualization of combustion at higher engine operating load.

## Focused Ion Beam (FIB) System

It allows milling, imaging and deposition at nanometer scales. The FIB is a product of FEI Company (Nova 600 Nano Lab) and has a dual beam facility. The two beams are :

(i) An electron beam which has a spot size of 2—10 nm, beam current of 1—35 nA and energy varying from 500 eV to 30 keV. The electron beam is primarily utilized for scanning electron microscopy (SEM)

(ii) A Gallium (Ga) ion beam which has a spot size of 10—15 nm, beam current of 1—35 nA and energy varying from 5—30 keV. The Ga ion is utilized for machining of samples and fabrication of nanostructures





# RECENT PROJECTS

Department of Atomic Energy has sanctioned a project titled '[Bi-functional Approach to Small Molecule Activation: Towards Sustainable Processes and Products](#)'. The central objective of this project is to design and develop catalytic systems for the conversion of cheap and earth-abundant molecules to value-added compounds. The concept of metal-ligand cooperativity would be exploited to engineer new generation catalysts. Alternative pathways to elementary organometallic reactions will be developed. Some of the reactions that will be examined include 'green' synthesis of industrial chemicals, valorization of biomass, hydrogen production and more. This project is being carried out in the Department of Chemistry.

The newly created Department of Earth Sciences has received a new project on '[Establishing a Critical Zone Observatory \(CZO\) in the Ganga Basin: Focus on Water Balance, Water Quality, and Hydro-Meteorological Information System](#)'. The critical zone is defined as "the external terrestrial layer extending from the outer limits of vegetation down to and including the zone of groundwater". The goal of this project is to set up a Critical Zone Observatory (CZO) in a watershed of the Pandu River basin (catchment area ~2270 km<sup>2</sup>) in the Gangetic plains. An array of field instruments will be set up to monitor hydro-meteorological parameters, partitioning of different components of water balance, determine soil characteristics and chemistry, and geochemical fluxes. Data generated will quantify various climatic, hydrological and geochemical parameters related to the critical zone, and contribute towards understanding of physiochemical (and biological) processes responsible for sustenance of the critical zone.

The Prime Minister has launched the [National Air Quality Index \(AQI\)](#) on April 6, 2015, developed at IIT Kanpur. An AQI translates individual air pollutant concentrations into a single number that reflects the status of air quality in simple terms. The scientific basis of developed AQI is the attainment of air quality standards and pollutant dose-response relationships. A website ([aqi.iitk.ac.in:9000](http://aqi.iitk.ac.in:9000)) is developed for a quick dissemination of AQI to citizens. The AQI has six categories Good (0-50), Satisfactory (51-100), Moderate (101-200), Poor (201-300), Very Poor (301-400) and Severe (401-500) with health statements for each category. The AQI is available for ten cities and in future more cities will be covered. The project is funded by Central Pollution Control Board.

A Pan-IIT initiative of MHRD, called [IMPRINT \(IMpacting Research, Innovation and Technology\)](#) is being led by IIT Kanpur. It involves developing an education policy and research plan in Health care, Energy, Sustainable urban design, Water resources and Manufacturing.

Ministry of Earth Sciences has sanctioned another major project, '[Monsoon Dynamics and thermodynamics from the land surface through convection to the continental-scale](#)' under Indo-UK joint program. The monsoon is the primary driver of the agriculture and industry in South Asia, and is thus significant in the lives of more than a billion people residing in the region. Unfortunately, our capability to forecast monsoon is limited by large, rapidly developing errors. To quantify the land surface properties and fluxes, which interact with the monsoon on different temporal and spatial scales, an eddy covariance flux tower will be set up in Kanpur. The tower will directly measure the sensible and latent heat fluxes and help us understand the land-atmosphere feedback processes and how they relate to monsoon pattern of the region.

# RECENT PROJECTS



The Ministry of Communication and Information Technology (MCIT) funded a major project to set up [Electronics and ICT Academics](#). The project aims at the development and delivery of a high technology platform using cloud computing and other state of the art storage and delivery mechanisms for delivery of courses in the Information and Communication Technology. The platform would build upon, improve and scale existing technology platforms in the education domain already developed and tested at IIT Kanpur like intelligent tutor and Mini MOOC platforms for capacity building of sixteen thousand faculty members across four states of Uttar Pradesh, Haryana, Delhi and Chandigarh. The platform will have facility for forward integration with last mile or end user delivery using current future ubiquitous portable devices. The project will also build upon, improve and scale highly interactive course content compatible for delivery across various platforms and operating systems. The platform once developed and field tested will also have the capability of delivering courses from other domains of engineering, science, humanities and management.

IIT Kanpur has successfully procured the project of setting up an Incubator in the area of [Power Generation, Transmission, Distribution, Wiring and Electrical equipment](#) with generous funding of Rs. 5 crore from the Ministry of Labour and Employment (MoLE). The objective of the project is to allow selected ITI students access to the existing Incubation Centre facilities to incubate their original ideas.

The Department of Civil Engineering received generous equipment grants of Rs. 6.60 crore of FIST funding to procure 2500 kN servo-hydraulic four column loading frame and controller of Universal Testing Machine (UTM), 600 lpm Hydraulic Power Unit, Cyclic Simple Shear Apparatus, Instrumentation and Data Acquisition system for the Pseudo Dynamic testing facility, Water Isotope Analyzer, Short range laser scanner.

Department of Biological Sciences and Bioengineering received FIST funding to augment its research infrastructure and also to initiate new lines of investigations. Under the current funding an high-end Fluorescence-Activated Cell Sorting (FACS) and a Next-generation sequencing system, a robotic device for crystallisation membrane proteins are to be added to augment the molecular biology and structural biology core facilities. As a new initiative, an high-resolution micro-computed tomography (micro-CT) system is being added for imaging small animals. These facilities are expected to address the the state-of-the-art instrumentation needs of the faculty members, students of the department and the institute.

Department of Science and Technology (DST) India, under the FIST program (Level-II), has sanctioned a new project titled 'Structure, Interfacial Phenomena and Cell-Molecule Interactions of Complex Chemical Systems' in the Department of Chemistry. The central objective of this proposal is to modernise existing characterization facilities and establish new capabilities in the chemistry department. The sanction amount is Rs. 520 lacs, and IITK Chemistry is the only department in the country to receive grant of this magnitude in this cycle.

MHRD has funded a project to set up [Teaching and Learning Center](#) at IIT Kanpur. The center will basically work on transformation of higher education, concentrating on STEM topics.

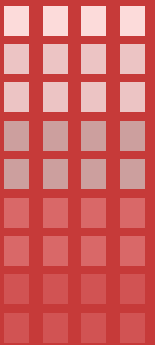
The project Titled '[Target-Specific Nanomaterials as Contrast Agents for High Precision Multimodal Bioimaging Applications](#)' sponsored by Department of Science and Technology aims to focus on designing of a novel class of monodisperse, target specific multimodal nanoparticles-loaded (e.g. metal, magnetic, semiconductor, and lanthanide-doped nanoparticles) carbon nanocapsules for variety of bioimaging applications such as magnetic resonance imaging (MRI), positron emission tomography (PET), and optical imaging. Additionally, these nanoparticles-loaded carbon capsules can have molecular functionality on their surfaces, such as catalytic centres, fluorescent markers, and DNA or organic ligands for biorecognition.



## Contact

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