# Project for Future Researchers at Indian Institute of Technology, Hyderabad (IIT-H) to Enhance Network Development with Scholarship of Japan (FRIENDSHIP project)

**Supported by Japan International Cooperation Agency (JICA)**

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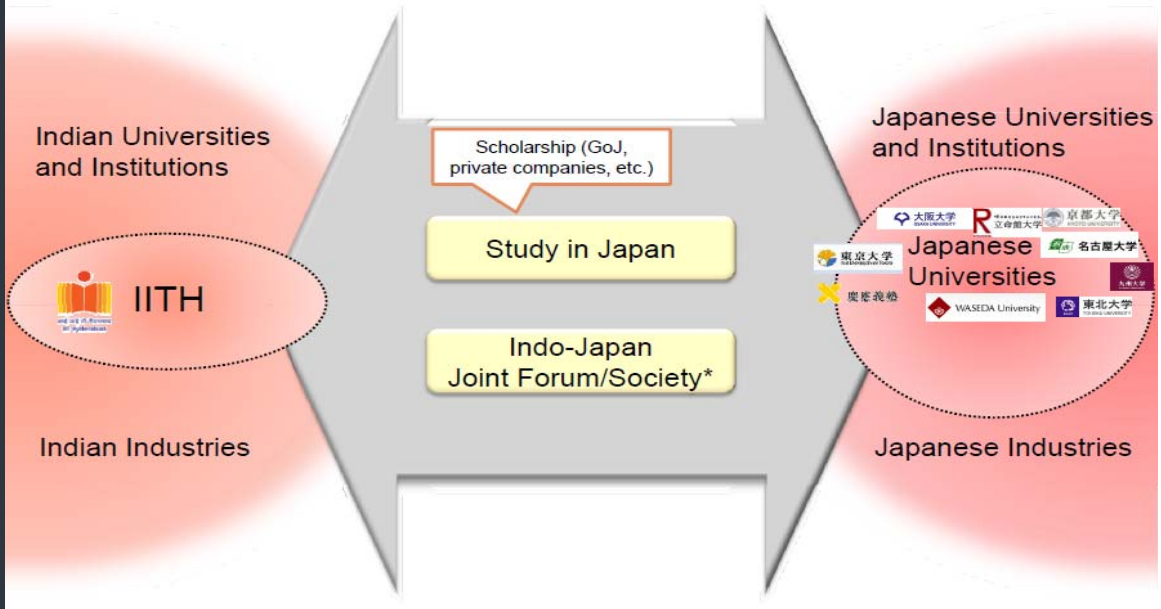



## BRIEF PROFILE OF FRIENDSHIP

### GOAL

To enhance world-class research network between Higher Education Institutions/ Industrial clusters of Japan and IITH.

### PURPOSE

To promote exchange of human resource between IITH and Japan at various levels.

### DURATION

Jan. 2012 to Mar. 2020

## I. BACKGROUND

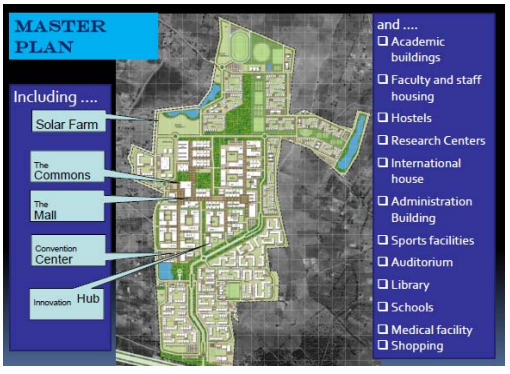
India is realizing tremendous economic growth in recent years with more than 8% annually. Human resources particularly in science and technology is key to sustain and accelerate Indian development. Establishment of first Indian Institute of Technology (IIT) at Kharagpur in 1951 made a historical beginning of high quality institution of technology, followed by six other IITs, at Bombay, Madras, Kanpur, Delhi, Guwahati and Roorkee.

Encouraged by the success story of IITs, and in order to meet the pressing need of more high quality graduates, the Government of India (GOI) has established from 2008-09, eight new IITs, at Hyderabad, Indore, Gandhinagar, Patna, Bhubaneshwar, Jodhpur, Ropar and Mandi with aiming at further socioeconomic development and meeting expectation from industrial sectors.

Based on the commitment in August 2007 between both Prime Ministers of India and Japan, collaboration between IIT Hyderabad (IITH) and Japan has started. IITH greatly values this collaboration for assistance for research and studies in identified areas, Construction of certain buildings and purchase of identified equipment for high-end research. There shall be intensive exchange of human resource at various levels by receiving guest lecturers and scholarships for the students.

Besides the ODA Loan, it is proposed that the Government of Japan (GOJ) consider a grant for faculties and students for pursuing joint research by receiving Scholarship for Japanese Universities.

It is envisaged that this grant is crucial to develop innovative technologies and do cutting edge research at the frontiers of science and technology. Moreover, personal interaction at various levels of faculties, industry experts and students, shall cooperatively help develop tremendous intellectual capital.




(Site plan of IITH new campus)

# Project for Future Researchers at Indian Institute of Technology, Hyderabad (IIT-H) to Enhance Network Development with Scholarship of Japan (FRIENDSHIP project)

Supported by Japan International Cooperation Agency (JICA)

**ACTIVITIES**

(1) Scholarship program
(2) Academic Exchange Program
(3) Academic-Industry Collaboration
(4) Logistics and Public Relation

**CONTACT (in Hyderabad)**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Mr.R.S.Sreekanth
Program Officer
E-mail: sreekanth@friendship.iith.ac.in


## II. OUTLINE OF THE PROJECT

### 1. Overall Goal

The overall goal of the Project is to contribute to the further development in the educational and research activities of **IITH** through the world-class research network between IITH and higher education institutions & industrial clusters of Japan, whereby both can establish educational and research excellence in the field of science, technology and engineering in the future.

### 2. Purposes

The purpose of the Project is to enhance research network between IITH and first rate higher education institutions & industrial clusters of Japan through the interaction of human resource in educational and research activities between IITH and Japan.

### 3. Output

(1) IITH graduates with Japanese PhD degree, faculties and researchers who contribute to educational and research activities

(2) Establishment of interactive relationship between the first rate higher education Institutions of Japan and IITH

(3) Establishment of interactive relationship between industrial clusters of Japan and IITH

### 4. Main Activities

(1) To offer the scholarship programme for IITH graduates to study for PhD degree (Including Master's, if necessary) in Japanese universities, in the field of science, technology and engineering.

(2) To promote the interaction in human resource of educational and research activities between IITH and Japanese first rate higher education institutions through the fellowship programme.

(3) To promote the interaction in human resource of educational and research activities between IITH and Japanese industrial clusters through the fellowship programme.

### 5. Inputs from Japanese Side

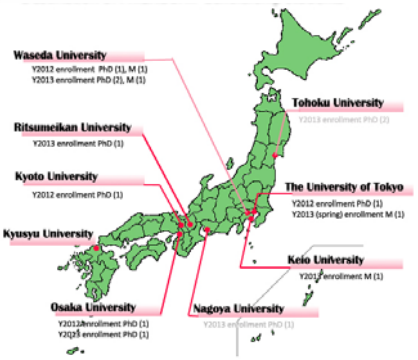
1) Scholarship programme of PhD study (including Master's, if necessary) in Japanese university for IITH graduates
2) Fellowship programme for IITH faculties and researchers to come to Japan
3) Faculties and researchers from Japanese Universities and Industry
4) Coordinator(s) to promote the Project
5) Support programs for IITH graduates before *I during* the study in Japan
6) Equipment for experts; if necessary

### 6. Project Site(s)

IIT Hyderabad and Japanese universities

### 7. Duration

2 January, 2011 ~ 31 March, 2020




(9supporting universities in Japan for Scholarship/Academic Exchange)

* Figure shows the detail of scholarship students in 2012 and 2013

## III. AREAS OF COOPERATION

Academic experts from both countries identified the following five areas where India's needs match Japan's strengths. More areas can be added later by mutual consent. In each of these fields, both sides nominated **group leaders** who are to further develop the modalities of cooperation that would be beneficial for both sides.

(1) Next Generation Communication Technology
(former "Digital Communication")
(2) Environment & Energy
(3) Nano-technology & Nano-science
(4) Design & Manufacturing
(5) Sustainable Development
(former "Civil Engineering")

# Academic Field
## Supported by FRIENDSHIP PROJECT

# NEXT GENERATION COMMUNICATION TECHNOLOGIES

FRIENDSHIP PROJECT

### CONCEPT

The proliferation of smart phones combined with wide spread deployment of sensor networks, Machine-to-Machine (M2M) communication devices and services is expected to have profound impact on global economy. In order to meet the exponential growth in the number of devices and the high data rates needs demanded by both human and M2M communications, internet-of-things (IoT), a converged communication network composed of heterogeneous cloud radio access technologies (including cellular, WiFi, ZigBee, and sensor networks) is required.
IITH in collaboration with our Japanese counterparts will develop a prototype product for the next generation converged network that includes a cloud radio network that seamlessly integrates sensor networks, communication systems for cellular, M2M, IoT along with secure cloud computing.
The project will also contribute to development converged IoT based chipsets will help us realize smart healthcare systems that will have significant impact on society and economy, both in urban and rural context. Converged cloud communications along with cloud data analytics will play a significant role in delivering smart health care solutions.
Specifically, the project will develop low-cost equipment for

- Converged sensor based cloud networks
- Cloud radio base stations
- User equipment and next generation modems
- Sensors with various combinations of cellular/WiFi/ZigBee modems
- Develop technologies for sustainable development. This includes a sensor networked smart city prototype implemented at IITH campus
- Smart healthcare delivery using converged cloud communications, IoT and cloud data analytics

In addition to research publications, the project will have technology transfer to industry, IPR generation through international patents. It is expected that the project will spin-off startup companies that lead to commercialization of the technologies developed as part of collaborative effort.

### DEPARTMENT INVOLVED IN IIT-H

Department of Electrical Engineering
Department of Computer Science and Engineering

### PERSON IN-CHARGE IN IIT-H

**Uday B. Desai, Professor & Director**
Department : Department of Electrical Engineering
Areas of Interest : wireless communication, cognitive radio, wireless sensor networks and statistical signal processing, multimedia, image and video processing, artificial neural networks, computer vision, and wavelet analysis.

**Mohammed Zafar Ali Khan, Associate Professor & Head of Department**
Department : Department of Electrical Engineering
Areas of Interest : space-time coding, distributed space-time coding and cooperative communication, coding for multiple-access and relay channels, network coding, space-time signal processing, joint Baseband-RF optimization, software defined radio, cognitive radio.

**Kotaro Kataoka, Visiting Assistant Professor**
Department : Department of Computer Science and Engineering
Areas of Interest : Internet over Broadcast Media, IPv6 Multicast, Post-disaster Networking

### PROFESSOR-IN-CHARGE FROM JAPAN

**Jun Murai (村井純), Professor, Keio University**
Faculty of Environment and Information Studies
Area of Interest : Computer science, computer network and computer communication.

### COLLABORATION WITH INDUSTRIAL CLUSTERS

We are having few collaborative projects with KDDI, Urmi, Samsung, Hitachi, etc. We are looking for more industrial projects in this area to direct our resources toward applied research.

# Academic Field
## Supported by FRIENDSHIP PROJECT

# SUSTAINABLE DEVELOPMENT

I

FRIENDSHIP PROJECT

### CONCEPT

The challenge of sustainable development is to ensure that every living being on earth will have equal opportunity to utilize the natural and man-made resource for healthy living and to develop for mutual benefits for all time to come. In the context of rapid urbanization and growth this entails several Engineering challenges arising from infrastructure, water and energy demands. The following areas were identified for future potential collaboration considering the available expertise at IIT Hyderabad and the interest from researchers in Japan:

Sustainable Infrastructure Materials Development of sustainable structural materials and minimizing the environmental impact of materials through a reduction in the demand for new/virgin materials.

Urban Infrastructure Systems: Developing quality infrastructure systems for an assured performance of new infrastructure and enhancing performance of existing low-strength, un-engineered construction.

Water and Social Public System: Development of an integrated approach to urban water supply and urban land-use, which is required to improve the economic efficiency and security of urban water infrastructure and to ensure the quantity and quality of water supply.

ICT in infrastructure: developing solutions for achieving energy efficiency and reduction of energy demand through the use of Information and Communication Technology.

Key Words: Infrastructure, water, ICT

### DEPARTMENT INVOLVED IN IIT-H

Department of Civil Engineering
Department of Liberal Arts
Department of Electrical Engineering
Department of Chemistry

### PERSON IN-CHARGE IN IIT-H

**Kolluru V.L. Subramaniam, Professor & Head of Department**
Department : Department of Civil Engineering
Areas of Interest : Condition Assessment and Rehabilitation of Structures; Nondestructive testing of Concrete Structures; Sensor development for Infrastructure monitoring; Blast analysis and mitigation; Microstructure of Cement and Concrete; Durability of Concrete; Corrosion of Reinforcement

### PROFESSOR-IN-CHARGE FROM JAPAN

**Yozo Fujino (藤野陽三), Professor, The University of Tokyo**
Dept. of Civil Engineering, the University of Tokyo
Areas of Interest : Dynamics, control and monitoring of bridges and structures, earthquake- and wind-effects on structures

### COLLABORATION WITH INDUSTRIAL CLUSTERS

Shimizu Corporation (potential collaborator)
Kajima Corporation (potential collaborator)

# Academic Field
## Supported by FRIENDSHIP PROJECT

# ENVIRONEMNT AND ENERGY

**CONCEPT**

**I. Environmental research**

During the last forty years, the continuous growth of population and industrial activities contributed to a large increase of pollutants concentration in the atmosphere. The World Health Organization states that 2.4 million people die each year from causes directly attributable to air pollution, with 1.5 million of these deaths attributable to indoor air pollution. SOx, NOx, VOCs, Particulate matter, CFCs, etc are the primary pollutants emitted directly mainly due the human activities, whereas, secondary pollutants like photochemical smog, acid rain are a result of indirect reactions of the primary pollutants. Exposure to many of these, especially to VOCs, SOx has implications in a number of human diseases, including cancer, cardiovascular and several insusceptible diseases. As some of the VOCs are carcinogenic more rigorous environmental regulations have to be followed in order to reduce their emission. There are many conventional methods for VOCs reduction, including adsorption, absorption, catalytic oxidation and thermal incineration. However, under highly dilute indoor concentrations these techniques may not be environmental friendly.

In a similar context, discharge water/waste water from various industries is highly contaminated due to the presence of physical, chemical compounds and pathogens. For treatment of water from these industries, various physico-chemical treatments, such as membrane filtration, ion exchange, activated carbon adsorptions etc. have been proposed. But these techniques, at best, transfer the pollutants from one phase to other, whereas mineralization is the desired way of removing the organic contaminant. Bio-treatment of organic dyes is not effective due to their resistance to aerobic degradation, whereas, in anaerobic degradation, carcinogenic aromatic compounds may be formed as the by-products. Bacterial contamination of potable water is another threat to living organisms. Even though advanced oxidation processes have the potential to mineralize the pollutants in aqueous media, quantification of the oxidants and conditions favoring their formation are largely unknown.

Faculty of IITH are engaged in the following research activities in environmental science

- ***Green chemical technologies to control the emission of air and water pollutants***
- ***Air quality assessment, modeling and abatement of air pollutants***
- ***Surface and Groundwater Quality Modeling, physico-chemical methods of water treatment***
- ***Solid and Hazardous Waste Management***
- ***Bacteria inactivation in aqueous medium***

**II. Energy**

Utilization of renewable energy sources such as solar energy, water, biomass, etc may offer a solution to the increasing global energy demand. Solar cells, the perceptive idea of converting solar energy into electricity is gaining paramount interest in the field of energy conversion. Solar power is a sustainable green approach capable of providing clean and affordable electricity compared to conventional and harmful methods of energy production. It does not contribute to pollution or global warming and does not require any fuel. It offers flexibility as it can be adapted easily to both portable and stationary applications. It is therefore desirable to develop low cost solar cells with long term cyclability and to this end; significant improvements in manufacturing technology and assembly techniques are needed as green solar power can play a definitive role in preserving our environment. Even though increasing number of materials has been developed for the conversion, there is an urgent need to reduce the processing cost and simple methods for the fabrication.
In a similar way, methane is the predominant component of natural gas and has formed a major part of the energy market for many years. Traditionally methane has been used for the production of syngas ($CO+H_2$) in steam methane reforming and extraction of hydrogen in water gas shift reaction.

# Academic Field
## Supported by FRIENDSHIP PROJECT

# ENVIRONEMNT AND ENERGY
## (continued)

However, this approach may no longer be environmental friendly due to release of CO2 and may be replaced with more environmental friendly dry reforming, where two potential greenhouse gases carbon dioxide ($CO_2$) and methane ($CH_4$) will be converted to useful chemicals/feed stocks. Like-wise, for transport applications, Lithium ion batteries have been in the news recently, due to their high energy density, whereas for stationary applications, fuel cells have shown promise.

Active areas of research in Energy and Power

- ***Steam/Dry reforming, Methanol, Ammonia production and de-NOx, SCR***
- ***Conversion of greenhouse gases for value addition***
- ***Harnessing solar energy- Materials for photocatalytic and photovoltaic applications***
- ***Fuel cells and batteries***
- ***Biodiesel***
- ***Power electronics***

### DEPARTMENT INVOLVED IN IIT-H

Departments involved in IITH:
Department of Chemistry
Department of Electrical Engineering
Department of Civil Engineering
Department of Chemical Engineering and others

### PERSON IN-CHARGE IN IIT-H

**Faiz Ahmed Khan, Professor & Head of Department**
Department : Department of Chemistry
Areas of Interest : Transition Metal-mediated reactions in organic synthesis, Discovery of New Methodologies and Control of Stereochemistry in organic synthesis, Chemical Synthesis in Ionic Liquids, and Supported Catalysts, Synthesis of Natural and aesthetically pleasing.

**Ch.Subramanyam, Associate Professor**
Department : Department of Chemistry
Areas of Interest : Nonthermal plasma for abatement of air and water pollutants, NTPs for bacteria inactivation in aqueous medium, Hydrogen, ammonia and methanol production, Dry reforming, Adsorption, Nanomaterials **Photocatalysis,** and Heterogeneous catalysis

**Siva Kumar Keerthipati, Assistant Professor**
Department : Department of Electrical Engineering
Areas of Interest : Multilevel inverters, open-end winding induction motor drives, Switched Mode Power Conversion, micro grids, Power quality and control.

### PROFESSOR-IN-CHARGE FROM JAPAN

**Professor Toshifumi Ise (伊瀬敏史）, Osaka University**
Division of Electrical, Electronic and Information Engineering Graduate School of Engineering
Areas of Interest : Power electronics and applied superconductivity in power systems including superconducting magnetic energy storage (SMES), new distribution systems with distributed generations and power quality.

# Academic Field
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# DESIGN AND MANUFACTURING

FRIENDSHIP PROJECT

### CONCEPT

Societal changes impacted manufacturing including other engineering fields. Earlier industrialized economies were on mass production however a combination of advances in technology and information is making it increasingly possible to mass-customize the manufacturing. Worldwide, many new manufacturing technologies capable of producing customized products are being researched. Emerging miniaturization technologies are perceived by many as potentially key technologies for producing high quality products in healthcare, communication and transportation industries. In addition, Distributive Manufacturing is viewed as an emerging manufacturing paradigm that will enhance the quality of life in situations when the precise product character cannot be pre-specified, when access to disposable/consumable commodities is limited, e.g., in remote/rural locations, when replacement parts are unavailable or an innovative solution is immediately required, or when mass customization requires production in small quantities tailored to local or individual needs. Stringent restrictions on environmental effects and energy and material consumption is guiding the innovation in manufacturing processes leading to hybridization at multi-scales. To address both Mass Customization and Distributive Manufacturing at Multi-scales, one has to design and develop sustainable products and processes. Hence, Mass Customization and Distributive Manufacturing in Design and Manufacturing at Multi-scales has been identified as one of the focus areas for the IITH-Japan collaboration.

This collaborative activity between IIT Hyderabad and Japanese Academia & Industry will emphasize on (a) Fundamental studies, (b) Knowledge transfer to Industries and scaling up to industry level and (c) Development of Human Resource. This will result in the advancement of technologies necessary for both the countries.

Key Word : Design & Manufacturing, Manufacturing at Multi-scales

### DEPARTMENT INVOLVED IN IIT-H

Department of Mechanical and Aerospace Engineering
Department of Material Science and Engineering
Department of Physics

### PERSONS INVOLVED FROM IIT-H

**N. V. Reddy**
*Professor In-charge, Interests: Design & Manufacturing*

**Abhay Sharma**
*Interests: Joining & Welding*

**P.P.Bhattacharjee**
*Interests: SPD, Crystallographic texture*

**S. Suryakumar**
*Interests: Additive Manufacturing*

**Vandana Sharma**
*Interests: Laser Physics*

**B. Venkatesham**
*Interests: Condition monitoring & control*

### PROFESSOR-IN-CHARGE FROM JAPAN

**Takahiro Ono (大野高裕), Professor, Waseda University**
Faculty of Science and Engineering, Waseda University
Areas of Interest : Research for Profit and Design: Development of Strategic Decision-making Tool, Mathematical Management Analysis, Real Options, Game Theory Development of Strategic Operating Decision making Tool: Cost Management, price-fixing, Marketing Science, Financial Engineering

# Academic Field
## Supported by FRIENDSHIP PROJECT

# NANO-TECHNOLOGY AND NANO-SCIENCE

### CONCEPT

Nano science and nanotechnology refers to developing understanding to control and manipulate the atomic scale followed by engineering them to use for various applications. The amazingly different behavior of matter at atomic scale is what leads to great interest of scientific community in this area. The ongoing research in this vast area is driven by the fact that Nanotechnology has immense potential across the various fields to serve the humanity better than ever before.

At IIT Hyderabad, there are 18 faculty members who are working in the different areas of Nanoscience and Nanotechnology. In order to be more focused and conclusive, we aim to strengthen the following areas based on our research interest and expertise:

1. **Micro and Nanofabrication Technologies**: We focus on the development of micro and nanofabrication of different materials such as silicon, polymer, carbon, metals, etc. We have in-house facilities for carrying out different kinds of micro/nano-fabrication processes.
2. **Nanoelectronics, Photonics and Phononics**: It involves the development of novel device and interconnect technologies aimed at achieving 3D CMOS-MEMS integration.
3. **Synthesis and Characterization of Functional thin film materials**: It involves development of thin films followed by surface functionalization for different application in the area of energy, biology, and automotive.
4. **Nanomagnetism and NanoSpintronics:** It involves the synthesis of different magnetic materials and development of ultrafast and nanoscale sensors and actuators.
5. **Micro and Nanointegration and Smart Packaging**: It is one of the highly focused areas of our group. We are focusing on smart circuit design as well as wafer bonding to achieve complete system integration.
6. **MEMS, NEMS, BioMEMS, QNEMS, CMEMS, Lab-on-Chip, Microfluidics devices, etc**: We are focusing on developing different sensors and actuators such as temperature sensors, pressure sensors, carbon based mass sensors, carbon fabric gas sensors, etc.
7. **Computational Micro/Nano Mechanics and Fluidics**. It involves multiscale modeling of nanomaterials and micro/nanofluids using extended continuum hypothesis, Molecular dynamics simulation and Direct Monte Carlo Simulation.

Key Words: Micro/Nanofabrication, Micro/Nanointegration, Functional Thin-films, MEMS, NEMS, Micro/Nano Mechanics and Fluidics, Nanomagnetism and Nanospintronics.

### DEPARTMENT INVOLVED IN IIT-H

Department of Biomedical Engineering and Biotechnology; Department of Chemistry; Department of Chemical Engineering; Department of Civil Engineering; Department of Electrical Engineering, Department of Material Science and Engineering, Department of Mechanical Engineering, Department of Physics.

### PERSON IN-CHARGE IN IIT-H

**Ashok Kumar Pandey, Assistant Professor, Email: ashok@iith.ac.in**
Department : Department of Mechanical Engineering
Areas of Interest: Vehicle Dynamics, Nonlinear Dynamics, Sensors and Actuators in Automobile Application, Surface Elasticity.

### PROFESSOR-IN-CHARGE FROM JAPAN

**Yasuhiko Arakawa (荒川泰彦), Professor, The University of Tokyo**
Institute of Industrial Science, the University of Tokyo
Area of Interest : Fabrication Technologies of Quantum Dots, Fabrication Technologies of Photonic Nanostructures, Manipulation of Electrons and Photons in Nanostructures, and Development of Nano-Photonic and Electron Devices

### COLLABORATION WITH INDUSTRIAL CLUSTERS

We are having few collaborative projects with DRDO, DST, MCIT, etc. We are looking for more industrial projects in the area of developing sensors and actuators to direct our resources toward the applied research.