Teaching and Research

~10,069 students on roll (Sept. 2017)
3283 Bach., 895 (2) DD, 3006 (39) Masters, 2885 (22) PhD

130+ Post-doctoral fellows; 1250+ Project staff (Technical)

27 Academic Units; 23 Research Centres

~630 full-time faculty; ~50 part time (adjunct & visiting) June 2017

External research funding (receipts in FY 2016-17) ₹392 crores
Academic units @ IIT Bombay

- Department of Aerospace Engineering
- Department of Biosciences & Bioengineering
- Department of Chemical Engineering
- Department of Chemistry
- Department of Civil Engineering
- Department of Computer Science & Engineering
- Department of Earth Sciences
- Department of Electrical Engineering
- Department of Energy Science and Engineering
- Department of Humanities and Social Sciences
- Department of Mathematics
- Department of Mechanical Engineering
- Department of Metallurgical Engg. & Materials Sci.
- Department of Physics
- Center for Environmental Science & Engineering
- Center for Policy Studies (IDP)
- Center for Research in Nanotechnology & Science
- Center for Technology Alternatives to Rural Areas
- Center for Urban Science and Engineering
- Center of Studies in Resources Engineering
- IDP in Climate Studies
- IDP in Education Technology
- IDP in Industrial Engg. & Operations Research
- IDP in Systems & Control Engineering
- IITB Desai Sethi Centre for Entrepreneurship (IDP)
- Industrial Design Center
- Shailesh J. Mehta School of Management
<table>
<thead>
<tr>
<th>Academic programs and degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applied Statistics &amp; Informatics</strong></td>
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<tr>
<td><strong>Chemistry</strong></td>
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<tr>
<td><strong>Economics</strong></td>
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<td><strong>Geology</strong></td>
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<td><strong>Geophysics</strong></td>
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<td><strong>Mathematics</strong></td>
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<td><strong>Physics</strong></td>
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<td><strong>Design</strong></td>
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<tr>
<td><strong>Education Technology</strong></td>
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<tr>
<td><strong>Entrepreneurship (minor)</strong></td>
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<tr>
<td><strong>Humanities &amp; Social Sciences</strong></td>
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<td><strong>Management</strong></td>
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<td><strong>Policy Studies</strong></td>
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<tr>
<td><strong>Biotechnology</strong></td>
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<td><strong>Climate Studies</strong></td>
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<tr>
<td><strong>Computer Science &amp; Engineering</strong></td>
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<td><strong>Energy Science &amp; Engineering</strong></td>
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<td><strong>Environment Science &amp; Engineering</strong></td>
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<td><strong>Geoinformatics &amp; Natural Resources Eng.</strong></td>
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</table>

**BTech, BDes, BS, PhD, MTech, MSc, MDes, MMgmt, MPhil,Dual degree programs (BTech+MTech, MTech+PhD, MTech+MSc, MSc+PhD,)**

**Minors and Honors for BTech students**
Research & Development @ IIT Bombay

- Number of research publications in 2016: 1982 (1374 Journals + 608 Conference proceedings)
- Number of companies incubated so far: 105
- Number of patent applications filed up to June 2017: 834 (710 Indian + 124 Foreign)
- Number of patent applications granted up to June 2017: 181 (127 Indian + 54 Foreign)
- Number of PhD degrees awarded in 2017: 357
- Number of other degrees awarded in 2017: 857 Bachelors + 1398 Masters
Representative examples
Gram Marg Solution for Rural Broadband

Open source low cost hardware prototype utilising television white spectrum

- Indigenous and ingenious technology that utilises unused white space on the TV spectrum to backhaul data from village wifi clusters to provide broadband access (frugal 5G)

- Rolled out in 25 villages on a pilot basis so far

- Won 1st prize in the Mozilla Innovation Challenge

Prof. Abhay Karandikar, Electrical Engineering
Solar Urja Lamps (SoUL)

Localization of solar energy through local assembly, sale and usage

- Provided to students in 7903 remote rural villages in Maharashtra, Madhya Pradesh, Rajasthan and Odisha through support by the National Clean Energy Fund, MNRE

- The project as implemented by the District Collector in Dungarpur, Rajasthan received the prestigious Prime Minister's Award under the Innovation Category in April 2017

- ~40,000 lamps distributed in Dungarpur

Prof. Chetan Singh Solanki, Energy Science & Engineering
Wearable Health Monitoring

Technologies to monitor ECG, EMG, EOG and SpO₂

Heart-Sense
(Multi Channel ECG recorder)
Light weight portable device for continuous monitoring of ECG and heart rate

Oxi-Sense
(Pulse Oximeter)
Non-invasive, fast and accurate measurement of blood oxygen saturation level and heart rate

Life-Sense
(Android Application and Desktop GUI)
Real-time monitoring of ECG/PPG data on any Android mobile or desktop

Prof. Maryam Baghini, Electrical Engineering
Low Cost Soil Monitoring System for Irrigation Control

- Solar powered system
- Completely automated system
- System will sustain for 3-4 days without solar energy
- Modular design
- Ease for use
- Designed according to Indian farmers condition
- Low power signal processing unit
- Wireless communication
- Data displayed on mobile
- Soil moisture sensor
- Soil temperature sensor
- Ambient humidity sensor
- Ambient temperature sensor

Prof. Maryam Baghini, Electrical Engineering
Energy Conservation Systems

**Tube Tube Heat Exchanger**
- Low cost double vented wall heat exchanger
- Compact and cost effective
- Easy to modify

**Multi-Utility Heat Pump**
- Integrated easy to operate, compact design system
- Novel tubular exchangers
- On-demand supply of hot/cold water
- Low operating costs

**Diabetic Contacting Device**
- Air humidifier
- Indirect evaporative cooler
- Evaporative condenser/de-superheater/sub-cooler
- Fresh air dehumidifier
- Hybrid air conditioning system

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*Prof. M. V. Rane, Mechanical Engineering*
Arsenic Removal from Water

- Water treatment for removal of arsenic, pesticides, herbicides, etc.
- Hand-pump attachable filters developed using indigenous material
- Each unit caters to around 200 families

- 50+ units - Assam, Bihar, UP, West Bengal
- Each unit costs around ₹ 70K
- Low maintenance (₹ 1000/year)

Prof. Sanjeev Chaudhari, Centre for Environmental Science and Engineering (CESE)
Mathematical Model for Lifestyle Management

- Reliable disease diagnosis & therapeutic strategies for holistic disease management
- Hypothesis generation for various lifestyle and environmental properties
- Determining drug targets rationally
- Personalised analysis
- Toxicology & drug safety assessment
- Whole body dynamics including body weight, fat mass, plasma metabolite dynamics
- Strategies for adaptive weight loss & muscle mass gain for individuals
- Lifestyle intervention (optimal diet & physical activity chart) for reduced disease risk and management overall health

Prof. K. V. Venkatesh, Chemical Engineering
Detection of sickle cell disease by microscopy

Paperfluidics for affordable diagnostics

Prof. Debjani Paul, Biosciences and Bioengineering
Point of care diagnostics

**UCHEK**
Mobile-based urine & blood glucose analyzer

**SUCHEK**
Low-cost blood glucometer

Prof. Rohit Srivastava, Biosciences and Bioengineering
Hollow Fibre Membrane for Kidney Dialyses

- Economically viable technology for haemodialysers
- High performance: 10 times greater urea clearance per given area than commercial haemodialysers
- Superior bio-compatibility & improved quality of life for renal patients
- Manufacturers of haemodialysers with end users being patients, nephrologists, industry, dialysis centres and hospitals

Other Potential Applications
(Immediate and unmodified)

- Blood plasma separation in autoimmune diseases
- Bioreactor for stem cells expansion
- Hollow fibre for bioreactor in waste water treatment
- Membranes for bio-artificial organs
- Water purification: removal of bacteria
- Immuno-isolation and encapsulation devices

Prof. Jayesh Bellare, Chemical Engineering
Nutrient Enriched Cosmetics

- Low-cost drug delivery system developed to deliver nutrient supplements through skin of pregnant women
- Aim: To reduce infant mortality
To investigate biomarkers in brain tumours (gliomas & meningiomas) and infectious diseases like malaria & dengue.
Biomedical Engineering and Technology (incubator) Center

- BETiC – started in 2014, a translational research center
- Catalyzes indigenous medical device innovation
- Brings together doctors, researchers and manufacturers.
- Develop a range of diagnostic devices, surgical instruments and patient aids covering medical specialties like orthopedics, internal medicine, cardiology and rehabilitation.
- Funding: RGSTC and DST
- Have developed over 100 medical devices, filed 20 Indian patents, and transferred 3 technologies to industry

Prof. B. Ravi, Mechanical Engineering
Biomedical Engineering and Technology (incubator) Center

Ideas room of BETiC

Surgeon testing laparoscopic device

Medical Device Innovation Conclave

Indian Medical Device Exhibition in Dervan

Prof. B. Ravi, Mechanical Engineering
Cloud based software platform
To perform 3D surgery planning
Designing patient specific instruments
Will assist surgeon to take accurate surgical decisions and to order correct implant from implant manufacturers

Prof. B. Ravi, Mechanical Engineering
Novel laparoscopic instrument

- Enables safe and reliable manipulation of tissue and organs
- Stress-free dexterity for surgical procedures
- Provides seven or more degrees of freedom,
- Additional maneuverability, thereby reducing the risk of tissue damage and surgeon fatigue.
- Accuracy and reliability are maintained

Prof. B. Ravi, Mechanical Engineering
Bone tumor in children: cancer can be treated but limb is amputated

Limb saving surgery: Resect tumour bone, reconstruct gap using prosthesis (imported)

Low Cost Tumour Knee Mega Prosthesis

Prof. B. Ravi, Mechanical Engineering
Diabetic Foot Screening Device

- Handy and compact design to measure stiffness of sole
- Sensitive sensor to measure force accurately
- Reduces cost burden
- 5-wire connection
- 5V DC, 100 Hz
- Operating force: 0-1.5 lb
- Operating temperature: 0-70°C
Features of the module
- Volume control
- Recording and playback option
- Bluetooth connectivity
- Traditional look
- Detachable chestpiece
- Provision for simultaneous auscultation

Transforming any stethoscope into a digital stethoscope

Prof. B. Ravi, Mechanical Engineering
Low Cost Vein Tracer

- Convenient, light weight and affordable
- Ergonomic and user friendly
- LED lights deflected by deoxygenated blood giving a clear silhouette of veins
- Used in busy & frugally run blood camps; blood banks; small and medium sized hospitals

Prof. B. K. Chakravarthy, Industrial Design Centre
Gynae Cam: Preliminary Screening Device For Cervical Cancer

- Affordable with high accuracy/sensitivity
- On-the-spot results
- Minimal training required for device handling
- Reusable, no need of sterilisation
- Rechargeable and portable
- Recordable results - Image captured can be stored on SD Card
- 3x optical zoom and upto 12x digital zoom
- Focal distance of 30 cm, hence need not be too close to body
- Yellow light for better visualization

Prof. Santosh Noronha, Chemical Engineering
SelfCervi: Realtime Self Screening Device for Cervical Cancer

- Clear distinction between normal and cancer cells
- Affordable & simple to use, even self screening
- Real-time, within minutes screening
- Early detection of cancer (CIN)
- Integrated data organizer

One of the University Challenge winners of DST – Lockheed Martin – Tata Trusts India Innovation Growth Programme (IIGP) 2.0 for 2017

Prof. Rohit Srivastava, Biosciences and Bioengineering
Vestibulator

- Therapeutic device to stimulate vestibular system of cerebral palsy children
- Also serves physiotherapy needs
- Stimulates the vestibular canals by generating vertical, horizontal and rotary motions
- The motions to stimulate the semicircular canals of the vestibular organ
- This will develop reflex actions which will enable the development of neuro-muscular coordinated responses

Prof. G. G. Ray, Industrial Design Centre
RoVer – remotely operated vehicle

- Wireless control
- Climb steps
- Remote inspection and removal of suspicious objects
- Remote disposal of IEDs

Prof. Anirban Guha, Mechanical Engineering
Broadband Public Protection and Disaster Relief (BPPDR) Communication System

- Designing and development of high speed Broadband Wireless Communication System for Public Safety and Emergency Communication purposes

- Demonstrated one-to-one audio as well as video call using 4G LTE technology on the first prototype

- Design and fabrication of components completed both on the network side as well as the User Equipment side

Prof. Abhay Karandikar, Electrical Engineering
- Remotely operated vehicle for handling and disposing Improvised Explosive Devices (IEDs) that can be carried by one man.
A low cost long range transceiver being developed using off the shelf components

With encrypted messages, the boat should be able to identify itself using the transceiver and provide its location
Polymer micro cantilever based technology

- Can be functionalised as sensor for various applications like healthcare, defence, etc.
- Framework developed by IITB, manufacturing and testing under progress at SCL, Chandigarh

Prof. Ramgopal Rao, Electrical Engineering

Pulse tube cryocoolers

- Imaging equipment for night vision and heat-seeking missile guidance; cooling electronic devices and sensors
- Ready for commercialization

Prof. Milind Atrey, Mechanical Engineering
Innovation by Design

Design Innovation Center Collaborative Projects

- **Maintenance free post box for India Post** by Prof. B K Chakravarthy, India Post Chair Professor
- **Seat attachment for police lathi (stick)** for support during long standing hours
- **Collapsible helmet for two wheeler ease of use and storage**
- **Solar Rice Cooker** with Prof. M V Rane, Mechanical Engineering
- **Stainless steel lightweight Puuki for Sri Mata Vaishno Devi** with Prof. Yogesh Desai Civil Engineering, NITIE, PSA Office
- **Balloon-Kite hybrid system**, a stable aerial platform for applications such as precision agriculture, crowd surveillance, defense surveillance & weather analysis
- **Lightweight Postal Trolley** for India Post for bag handling at railway stations with Prof. Ramesh Singh, Mechanical Engineering
- **Low cost vein tracer for blood extraction**
- **Easy to carry light weight Puuki for Ayanta Caves**
- **The Solar Cooker window mounted easy to use**
- **Solar Dryer for preservation of vegetables** for farmers in rural areas support from Prof. N G Shah, CTARA
- **Drumstick Plucker** for harvesting matured drumsticks selectively
- **Easy to carry light weight Bag for Postman**
- **Support of details for Jalpur Post with Shri D. R Mehta, BMSS, Jalpur**
- **Domestic water filter for arsenic removal with Prof. Chaudhri, CESE**
- **Smokeless stove which produces coal as by-product support from Prof. Sanjay Mahajan, Chemical Engineering**
- **Heritage Lighting using LEDs to preserve ambience**
Societal relevance

- Ascender: climbing wheelchair
- Bed for the Elderly
- Online Farmer Knowledge Exchange
- Super Critical Fluid extraction
- Riding Type Power Tiller

- Communicator for children with cerebral palsy
- Education & Creativity based Board Games
- Technologies and Tools for Cane and Bamboo Craft
- Solar Urja Lamp
- LPG Stove for Visually Impaired
- Indian Rupee symbol
Industry + IITB to pool resources to set up a consortium

Pilot jaggery plant
1 ton per day

Rajiv Gandhi Sci. Tech. Center, Maharashtra Govt.
Tata Center for Technology and Design

Enable research in emerging areas
IMPRINT, UAY, ...

Advanced Machining Excellence Cell, NCAIR

National Centre for Aerospace Innovation and Research
IITB, DST, NAL, HAL, Boeing, DMG Mori, Sandvik
Partnership with Industry

- Seek help to solve specific problems
- Sponsor laboratories, students
- Deploy IPs
- Support basic research for knowledge creation
- Form Consortia
- Visits of Scientists and Engineers
- Exploit complementarity
- Carry out industry relevant research
- Human resource development
- Train industry personnel
- Seed high-tech spin offs
Modes of Industry Interaction

- Consultancy - Short term projects to solve specific problems
- Sponsored Research - Long term research for knowledge generation & manpower development
- Student Sponsorship - Promotion of research & manpower development
- Sponsored Lab/ Facilities - Support for research / lab infrastructure
- Customized Continuing Education Programme for industry personnel
- Endowment Chair Professorship
- Faculty Visit
- Consortia / CoE - to pool resources & enable research in emerging areas
Request for proposal received from Industry

Faculty members identified; Meeting and initial discussions on expectations

Scoping, budgeting of project between faculty and industry

Agreement finalization

Project initiated
- Long term
- Broad areas by Industry
- Fixed funding commitment
- On-the-fly access to data
- Project cycles
- IP: Joint ownership
- Licensing: mutually agreed T&C
Continuing Education Program

Through Professor-in-Charge, CEP

- Widen knowledge base, improve skills of working professionals
- Provide training in critical areas
- Can be short term or long term
- Slow paced to accommodate other commitments
- Can be in-house or @ IITB
- Towards making the Indian industry globally competitive
- Foster learning as a vehicle for innovation and growth
- Open new areas of cooperation & collaborations
- Strengthen industry – IITB interactions
Faculty Visit & Sabbatical

Visits facilitate formulation of R&D projects
Research Centers @ IIT Bombay

GISE
Advanced Research Lab

Healthcare Research Consortium

Tata Centre
Technology and Design, IIT Bombay

National Solar Thermal Research, Testing and Simulation Facility

BETiC

FIC-TT

Forbes Marshall Energy Efficiency Laboratory

CA/DDE

CEN

NATIONAL CENTRE FOR AEROSPACE INNOVATION AND RESEARCH

NCAIR

National Centre for Mathematics
A joint center of TIFR and IIT Bombay

WADHWANI FOUNDATION

IITB-TTSI
Center for Excellence in Telecom

GEP

National Mission on Education Through ICT

Shenoy Innovation Studio
Humanizing Technology

CoPT

CCES

Centre for Formal Design and Verification of Software

SERIUS

NCETIS
National Center of Excellence in Technology for Internal Security

Indian Institute of Technology Bombay
Research Centers @ IIT Bombay

- Biomedical Engineering and Technology Incubation Centre [RGSTC, Maharashtra Govt + DST]
- Centre for Aerospace System Design & Engineering [ARDB + MoD]
- Centre for Formal Design and Verification of Software [DAE]
- Centre for Computational Engineering and Science [DAE]
- Centre of Excellence in Nanoelectronics [MCIT]
- Centre of Excellence in Steel Technology [MoSteel]
- Focus Incubation Centre in Technical Textiles
- Forbes Marshall Energy Efficiency Laboratory [Industry]
- Geospatial Information Science and Engineering (@CSE) [DST]
- Healthcare Research Consortium
- National Centre for Aerospace Innovation and Research [DST, NAL, HAL, Boeing, DMG Mori, Sandvik]
- National Centre for Mathematics (with TIFR) [NBHM, DAE]
- National Centre for Photovoltaic Research and Education [MNRE]
- National Centre of Excellence in Technology for Internal Security [MEITy]
- National Mission on Education through ICT [MHRD]
- National Solar Thermal Research, Testing and Simulation Facility [MNRE]
- Power Anser Laboratory [TCS + TCE]
- Shenoy Innovation Studio
- Solar Energy Research Institute for India and the United States
- Tata Center for Technology Development [Tata Trusts]
- Tata Teleservices - IIT Bombay Centre of Excellence in Telecommunication [Tata Teleservices]
- Wadhwani Research Center for Bioengineering [Alumnus]
Sponsored Research Laboratory Facility

- Sponsor a research facility in an area of interest
- Help in building the research infrastructure @IITB
- Shared facility – access control as decided by RPG

By PRAJ industries: Parimal and Pramod Chaudhari Laboratory for Cell Culture
Chair Professorships

- Sponsor “{Industry} Chair Professor”, a distinguished academic position in the Institute
- Selection of IITB faculty as per IITB norms
- Industry representation in the selection committee
- Currently there are around 20 chairs established with donations from alumni and industries
Sponsor student fellowships

- Jointly promote research and manpower development
- Areas of research to be chosen by the Industry
- PhD, MTech, MSc, Dual degree students
- Monthly fellowship + contingency + {travel}
- PM Fellowship: 50% from GoI + 50% from Industry
- IP, acknowledgements, etc. - mutually agreeable T&C

Jointly with the office of the Dean (Academic Programs)
Collaborative development and licensing
- Joint ownership of IP
- First option for exclusive licensing
- IP ownership to industry on mutually agreed terms

Licensing of IP generated in the Institute
- IP generated through academic / unrestricted sponsored research
- Can be exclusive or non-exclusive license
- Assign IP on mutually agreeable terms

Incubation / entrepreneurship
- Technology business incubator for commercializing IITB IP (SINE)
- Faculty, students and alumni as incubatees
- License to use IITB IP
Society for Innovation and Entrepreneurship (SINE)

- Technology Business Incubator of IIT Bombay set up in 2004; a not-for-profit entity
- Facilitates conversion of IIT Bombay R&D into commercial entities
- Helps in building business models / plans, fund raising, approaching clients
- Governing Board members includes IIT Bombay faculty and industry experts
- Incubate companies that have a potential to create economic growth and/or have a strategic or social value
- Intellectual property created by IIT Bombay faculty, students, staff, alumnus

Through Professor-in-Charge, SINE
## Impact

<table>
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<tr>
<th>Total</th>
<th>Incubated and accelerated</th>
<th>Graduated/ exited/ acquired</th>
<th>Folded</th>
<th>Jobs created during incubation</th>
</tr>
</thead>
<tbody>
<tr>
<td>112</td>
<td>Current: 47</td>
<td>44</td>
<td>21</td>
<td>3,000+</td>
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<tr>
<th>Funded</th>
<th>Cos. Funded by Angels/ VCs.</th>
<th>Total funding raised by SINE companies: 500 crore+</th>
<th>SINE investment vs externally raised: 1:150+</th>
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<tr>
<td>36</td>
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<td>18</td>
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</tbody>
</table>

- IITB IP commercialized: 28
- Faculty involved startups: 23
- Companies with social innovation: 26
- Equity liquidation (partial exits in 18 companies): 3 crores+

Policies and procedures emulated in many other colleges

Data as on October 2017
Vision
Achieve recognition for innovation, entrepreneurship and research excellence through industry-academia collaboration

Mission
- Establish an innovation hub via industry-academia collaboration
- Enable two-way flow of knowledge and resources
- Create joint IITB-industry R&D groups for stronger impact
- Provide a platform for fostering entrepreneurship

Members
Applied Materials, Bharat Forge, Suzlon, NanoSniff Technologies, TATA Power SED, Cummins

Through the office of the Professor-in-Charge, IIT Bombay Research Park
Student initiatives

- IITB Racing
- Pratham satellite
- Mars Rover, Land Robot
- Intelligent ground vehicle
- Shunya at Solar Decathlon
- Rakshak: Unmanned Aerial Vehicle
- Matsya: Autonomous Underwater Vehicle
- ASME: Fast, strong & agile multi-functional robot
- Drishti: Auto-tunable lens for universal eye glasses
Thank You
High-End Research Facilities at IITB

- Bio-Atomic Force Microscope
- Central Surface Analytical Facility
- Fluorescence Activated Cell Sorting
- High Resolution Mass Spectrometer
- High Resolution XRD System
- Environmental Scanning Electron Microscope