2025
International Summer School
June 23-28 & June 30-July 5

Experience Excellence @ IIT Bombay

Office of International Relations
Indian Institute of Technology Bombay

BRIEF ABOUT IIT BOMBAY

Established in 1958, IIT Bombay is one of India's premier public technical and research institutions, located in Powai, Mumbai. Spanning 550 acres, it consistently ranks among the top engineering institutions globally, including the QS World University Rankings 2025 (top 120 overall, top 50 in engineering & technology). With 14,000+ students and 750+ faculty members, IIT Bombay maintains a student-faculty ratio of 17:1. The institute houses 17 academic departments, 27 research centers, and 3 Schools. Through SINE (Society for Innovation and Entrepreneurship), the institute has incubated 235+ deep-tech, biotech, and digital startups. IIT Bombay boasts world-class labs, libraries, sports facilities, and 16+ hostels. With over 200+ international partnerships, it fosters global collaborations and student exchange programs. Vibrant campus life includes flagship events like Mood Indigo (cultural festival) and Techfest (technical festival), attracting global participation. Combining academic excellence, innovation, and entrepreneurship, IIT Bombay continues to shape the future of technology and research

BRIEF ABOUT PROGRAM

The 2025 International Summer School at IIT Bombay is an exclusive, in-person program designed for international undergraduate, postgraduate, and PhD students. Taught by our esteemed faculty, the program offers a diverse selection of courses across two flexible weeks: allowing participants to attend either one or both weeks based on their course interests and availability. Week 1 will run from June 23-28, 2025, and Week 2 from June 30-July 5, 2025. Participants may select up to two courses per week during the application process; however, upon selection, they will be enrolled in only one course per week. As some courses have prerequisites, students are advised to review course requirements carefully before applying. All courses will be conducted in English, and participants who successfully complete the program will receive a certificate.

IIT Bombay will provide complimentary on-campus accommodation along with free airport pick-up and drop-off services.

Week 1 (June 23-28, 2025)

1) Unmanned Aerial Vehicles - A Technological Perspective

Department	Aerospace Engineering
Eligibility	Senior UG (3rd & 4th Year) from Aerospace, Mechanical, Physics
Prerequisite	None
Course Overview	In the last two to three decades, Unmanned Aerial Vehicles (UAVs) have established themselves as important technological tools for many military and civilian applications. These include; aerial attacks, aerial package delivery, crop monitoring and spraying, surveillance in outdoor and indoor spaces, assistance in disaster relief efforts as part of overall search and rescue missions, aerial photography/videography of public and private gatherings including sporting events, etc. This has also led to the evolution of an ecosystem that includes government agencies, large, medium, and small industries, including startups, that are currently engaged in the design, development, and deployment of different types of UAVs. The proposed course aims to expose students to the various technological inputs that contribute to the design, development and deployment of UAVs and aims to prepare them for taking up further studies / challenges in this critical field of aerospace engineering

2) Application of Biostatistics in Medical Research and Health Care

Department	Biosciences and Bioengineering
Eligibility	Only PG and PhDs. Students from any engineering/medicine department engaged in biomedical/clinical research
Prerequisite	Knowledge of mathematics at 10+2 level
Course Overview	Proposed course would cover how biostatistics help answer pressing research questions in medicine, biology, and public health. This would cover various diverse examples from healthcare sector to emphasize how biostatistics principles/tools are deeply involved in the design, analysis, and interpretation of data for research in public health and medicine.

3) Continuous Process Intensification: Flow, Electro and Mechano Organic Chemistry

Department	Chemistry
Eligibility	UG Students from Chemistry, Chemical Engineering, Materials Science, Nanomaterials
Prerequisite	Basic understanding of chemistry and passion for chemical/materials manufacturing
Course Overview	Continuous process intensification is the future of chemicals and materials manufacturing. It provides sustainable, economical and safe alternative to batch production which has been in practice for last 200 years. Continuous process enables synthetic processes which are reproducible, small and modular footprints, allow on demand production, chemistry in new space. In fact, these processes allow one to carry out synthesis without chemicals (Electro organic synthesis) and also without solvents (Mechano chemistry). Therefore, it is important for everyone working in the domain of chemical and materials synthesis to learn and art and science of continuous process intensification.

4) Strategic Multi-agent Artificial Intelligence

Department	Computer Science and Engineering
Eligibility	UG Students from Computer Science, Mathematics, Operations Research, Electrical Engineering, Economics
Prerequisite	formal mathematical reasoning, a fair amount of probability theory, basic calculus! experience in programming will be useful.
Course Overview	This course explores Algorithmic Mechanism Design, the reverse engineering of Game Theory, focusing on strategic interactions among multiple self-interested agents. The course starts with desired social objectives—such as efficiency, fairness, and stability—and examines whether they can be achieved through algorithmic methods. It also addresses algorithmic challenges in designing such mechanisms efficiently or approximating them when exact solutions are impossible. To ensure a solid foundation, the course begins with game theory fundamentals before delving into mechanism design. Key areas discussed will include auctions, fair division, and stable matching, with applications to sponsored search advertisements, resource allocation, crowdsourcing, and internet-based trade. This course will be valuable for students across Computer Science, Economics, Mathematics, Operations Research, Management Science, and Electrical Engineering, equipping them with essential tools to model, analyse, and design strategic interactions in multi-agent environments.

5) High-frequency Magnetics for Power Electronics

Department	Electrical Engineering
Eligibility	Senior UG (3rd & 4th Year) from Electrical Engineering
Prerequisite	None
Course Overview	Modern power electronic converters, driven by wide-bandgap semiconductor switches, operate at increasingly higher switching frequencies, potentially enabling compact converters with smaller magnetic components. However, leveraging these benefits requires a deep understanding of high-frequency magnetics, loss mechanisms, and parasitic effects. This course will cover both the fundamental and advanced aspects of high-frequency magnetics. A tentative schedule is as follows: Day 1: Explanation of fundamental loss mechanisms in high-frequency windings (skin, proximity effects) and cores (hysteresis, eddy currents) and principles behind the origin of leakage and magnetizing inductance, capacitance, etc., leading to magnetic equivalent circuits. Day 2: Analytical formulations like Dowell's equations, aiding in designing low-loss windings (foil, Litz wire). Day 3: State-of-the-art empirical core loss models, including Steinmetz-derived formulations. Day 4: 2D FEA simulations for estimation of losses and magnetic circuit parameter values. Day 5: Overview of advanced technologies such as planar and integrated magnetics, magnetic cooling.

6) Financial Derivatives Pricing

Department	Mathematics
Eligibility	Senior UG (3rd & 4th Year) with mathematical background
Prerequisite	Linear Algebra, Real Analysis or a good level of Calculus, and Probability.
Course Overview	This course provides a mathematically rigorous introduction to the pricing of financial derivatives, focusing on risk-neutral valuation, the binomial model, and the Black-Scholes framework. Participants will learn fundamental concepts of derivatives markets, arbitrage pricing, and stochastic models used in financial engineering. The course balances theoretical foundations with practical applications, including computational techniques for pricing options. By the end of the course, participants will have a strong understanding of core pricing models and the ability to apply them in various financial contexts.

7) Foundations of Mechatronics: Hands-on

Department	Mechanical Engineering
Eligibility	Senior UG (3rd & 4th Year), PG & PhD from All engineering and technology branches permitted
Prerequisite	background in binary, hexadecimal number representation and arithmetic, basic C programming, basic electricity,
Course Overview	This course focuses on-hands on activities pertaining to foundations of mechatronics. Students will learn basic constituents of mechatronics system: Sensors, Actuators, Controller and plant. 70% of the course will have laboratory activity where students will learn to sense encoder, to actuate motor, and finally to closed loop control (P, PD) a DC servo motor using a microcontroller (XEP 100). The course would be useful for students interested in robotics, automation, mechatronics, and related areas. Background in digital electronics, and microprocessors could be useful but not required.

8) Introduction to Observational Astrophysics

Department	Physics
Eligibility	UG students from Any science or engineering departments
Prerequisite	Knowledge of 1st year physics, basic calculus, familiarity with computers
Course Overview	This course provides a comprehensive introduction to observational astronomy for undergraduate and graduate students. The course delivers a structured curriculum covering fundamental astronomical concepts including life cycle of stars, stellar classification, transient and variable astronomical phenomena, as well as technical concepts of coordinate systems, photometry, optical telescopes, cameras. The five-day program consists of daily three-hour lectures supplemented by one-hour hands-on tutorials designed to reinforce theoretical concepts through practical application. Participants will gain proficiency in essential astronomical techniques including observations, image processing, and photometric analysis. A notable component of the course includes scheduled sessions utilizing the GROWTH-India Telescope, providing students with exposure to robotic telescope operations within a controlled educational environment. This practical experience enables students to apply classroom knowledge to actual observational procedures.

Week 2 (June 30-July 5, 2025)

1) Climate intelligence: Data Science for Sustainable Solutions

Department	Centre for Climate Studies
Eligibility	Senior UG (3rd & 4th Yr), PG & PhD from All branches of science and engineering
Prerequisite	Basic Knowledge on Climate Science or equivalent, Computation course or equivalent; Statistics course or equivalent
Course Overview	This course, led by Profs. Subimal, Subhankar, Jaideep, and Vishal, offers a comprehensive exploration of data science applications in climate studies. The program follows a structured format, with morning sessions (2 hours) dedicated to lectures and afternoon sessions (3 hours) focused on hands-on exercises. The curriculum covers key topics, including an introduction to data science (Subimal), monsoon modelling (Vishal), ecosystem modelling (Jaideep), and risk assessment (Subhankar). Additionally, real-world applications are explored through case studies such as rainfall and heatwave prediction (Vishal), urban flooding analysis (Subimal), agricultural water optimization ("More Crop per Drop"), vulnerability and risk mapping (Subhankar), and ecosystem modelling (Jaideep). This course aims to equip participants with the skills to leverage data science for sustainable climate solutions.

2) Group Testing: An Important Tool for Data Science

Department	Computer Science and Engineering
Eligibility	Senior UG (3rd & 4th Yr) from CSE, EE, ECE, Statistics
Prerequisite	None
Course Overview	Consider a set of n items that need to get tested for a certain defect. Group testing is a technique that replaces tests on the n individual by a set on m < n groups of items, where each group consists of a subset of the n items. The aim is to save testing resources, (eg: time) due to the reduced number of tests (m instead of n). In the popular Dorfman's technique, the n items (e.g., one blood sample per subject) are divided into m disjoint groups, and each group is tested for a disease. Different groups are created from different subsets. The groups that tested negative for the disease are discarded. For those that tested positive, each participant of the group is then tested individually in the second round of tests. Apart from biological testing, there are many data science applications of group testing as well.

3) Waste to Wealth: Circular Economy and Sustainability

Department	Centre for Technology Alternatives for Rural Areas
Eligibility	UG, PG, PhD, Open to All branches
Prerequisite	None
Course Overview	This capsule course is designed to empower students with a comprehension of waste generation and innovative pathways for upcycling. Throughout the week, participants will delve into the intricacies of the circular economy model, exploring how waste materials can be reintegrated into the production cycle to minimize environmental impact. The course will also include the concept of value chain analysis, examining how different crops contribute to waste generation and identifying opportunities for value addition at every stage. By understanding the interconnectedness of various industries and the potential for synergy, participants will unravel avenues for creating new markets and driving economic growth sustainably. By harnessing the latent potential of waste materials, circular thinking, turning challenges into opportunities for creating a parallel billion-dollar industry while simultaneously promoting environmental sustainability.

4) Sustainability of Distributed Renewable Energy (DRE) Systems in Global South

Department	Centre for Technology Alternatives for Rural Areas
Eligibility	Senior UG (3rd & 4th Yr), PG & PhD, Open to All
Prerequisite	A basic understanding of energy units is beneficial (Not Mandatory)
Course Overview	This course is designed to introduce the participants to the critical role of the Distributed Renewable Energy (DRE) systems in fostering sustainable development within the Global South, simultaneously addressing the climate challenge. The course covers the fundamental concepts of the DRE systems, including their relevance, techno-economics, as well as the barriers and challenges in field implementation. The course will focus on solar PV and bioenergy applications in agriculture, residential and MSME sectors, and the issues related to their long-term sustainability in the developing countries. Through case studies and interactive sessions with stakeholders, the participants will be exposed to real-world situations and will also be introduced to various sustainability assessment tools. This course aims to develop better understanding regarding the potential role of DRE systems and equip the participants with the knowledge and skills necessary to contribute to the advancement of greener and cleaner energy solutions in the Global South.

5) Becoming" an Entrepreneur: Leveraging Your University and local ecosystems

Department	Desai Sethi School of Entrepreneurship
Eligibility	UG, PG, PhD: Open to All
Prerequisite	None
Course Overview	Entrepreneurship goes beyond the idea of establishing a VC backed scalable startup, to roles like a social innovator or an intrapreneur in a large organization. It is now understood that the seeds of entrepreneurship have to be sown early on, for individuals to harvest its benefits as they progress in their respective careers. Students can leverage entrepreneurship support systems existing in their institutes, even as they continue their mainstream studies, to activate their entrepreneurial cognition and identity. This course would provide inputs in form of practices and frameworks which students can adopt towards building an entrepreneurial identity independent of whether they wish to create a new venture during the period of their education. Having an entrepreneurial identity and related skill sets is known to create opportunities for the individual across domains and across time, apart from the possibility of creating a new venture should the circumstances afford such a possibility.

6) Energy Data Analytics

Department	Electrical Engineering
Eligibility	UG, Open to All Branches
Prerequisite	None
Course Overview	This course explores the intersection of energy systems, data science, and machine learning. It begins with an overview of energy systems, with focus on electric grids and the critical role of data in this sector. Students will examine diurnal and seasonal variations in electricity demand and renewable generation and learn key concepts in energy markets, economics, and the transition toward smart grids and cities. The role of IoT and ICT in modern energy systems will also be discussed. The course will cover essential data analytics techniques, including time series analysis, data cleaning, preprocessing, and statistical analysis, all within the context of contemporary energy data. A wide range of data-driven applications in the energy sector will be explored through real-world case studies. These include forecasting electricity demand, renewable generation, and market prices, as well as developing decision support systems for demand-side management, home energy scheduling, industrial and commercial load monitoring.

7) Waste to Energy

Department	Energy Science & Engineering
Eligibility	UG; Open to All Branches
Prerequisite	None
Course Overview	'Waste-to-Energy' technologies are not only relevant in generating green energy and fuel for various power, transport and industrial/thermal application, but also features as sustainable way in managing the animal, agricultural, industrial and municipal waste towards cleaner environment. The course will discuss about waste categorization and various waste to energy technologies, including biological, chemical and thermochemical conversion processes, and it's underlying principles. Course will have lectures and interactive lab session and demonstration of few wastes to energy conversion systems.

8) Immersive Arts in Virtual Reality

Department	IDC School of Design
Eligibility	UG, Preferably Design and Art (paint or sculpture) disciplines
Prerequisite	Good sketching ability and ability to think complex forms in 3D
Course Overview	The course is designed for students eager to explore art in a new dimension. It introduces participants to industry-leading VR creative tools, allowing them to experiment with painting, sculpting, animation, and calligraphy in a fully immersive environment. Students will learn how to harness the boundless potential of VR as an artistic medium, pushing the limits of imagination, interaction, and expression. Throughout the course, students will: Learn the fundamentals of VR art creation using industry-leading tools. Get exposure to diverse artistic styles in VR, from dynamic 3D painting to virtual sculpting. Confidently use VR-based artistic tools to create digital artwork. Collaborate on group VR art installations to push creative and technical boundaries. This program delivers a transformative learning experience by leveraging VR's unique capabilities, fostering creativity, innovation, and emotional expression. Additionally, the course incorporates creative art therapy principles, acknowledging the power of art as a means for enhancing emotional well-being and cognitive development.

9) Network & Cyber Security

Department	Industrial Engineering and Operations Research
Eligibility	PG, PhD from Computer Science, Electrical, Electronics and Communications, Information Technology
Prerequisite	Knowledge of programming in Python is preferred.
Course Overview	The course will cover basic aspects network security like firewalls, Intrusion Detection, Intrusion Protection, DNS poisoning, Distributed Denial of Service Attacks. ARP cache poisoning. Vulnerability Scanning and Penetration testing. We will delve in into Transport Layer Security and IPSec algorithms. On the Cybersecurity, we will discussion attack kill chain, various type of malware attacks, malware analysis, malware detection, SQL injection attacks. We will also explore use of AI/ML algorithms for detection of various cyber-attacks.