

## Areas of Research for Doctor of Philosophy (July 2023 Admissions)

Department/ Centre/ School	Specialization	Areas of Research	Link to Dept./ Centre/ School
Computer Science and Engineering	Computer Science and Engineering	Artificial Intelligence, Interpretability of AI and ML Models, Online Learning, Evolving and Adaptive Intelligent Systems, Data Mining, NLP, Speech processing, Computer Vision and Deep Learning, Nature-inspired Algorithms, Intelligent and Networked Robotics, Augmented/Virtual reality, Human-Computer Interaction, Distributed Systems, Edge and Cloud Computing, Wireless Networks, Software-defined Networking, IoT, Smart Grid, Intelligent Transportation Systems, Network Security, Controller Synthesis and Games, Formal Verification, Logic in Computer Science, High-level Synthesis, Electronic Design Automation, Hardware Acceleration, Embedded and Cyber-physical Systems, System-on-chip validation, Multicore Architecture, Memory Systems, Near-memory Computing, Disaggregated Compute Systems, Approximate Computing, Autonomous Vehicles, Hardware Security, Data Structures, Algorithms, Distributed Algorithms, Randomization and Approximation Algorithms, Optimization, Computational Geometry.	<a href="#">CSE Department</a>
	Communication Engineering	Wireless Communications; Information Theory and Coding; Communication Networks; Computer Networks; Computational Photography; Data Compression; and Cryptography; Quantum error correction; Quantum computation and communication; Waveform design for wireless communications; Vehicular communications; 5G/6G Wireless communication; AI/ML application in communications; Adversarial machine learning.	
Electronics and Electrical Engineering	Power Engineering	Power Systems; Power Electronics; Power Quality; Power electronics application in power system; Micro grid and renewable energy resources; Power distribution system planning; Custom power devices; Electrical Machines; Control of Electrical Drives; Smart Grids and Electric Vehicles; High Voltage Engineering; High Voltage Engineering and Applied Electromagnetics; Condition Monitoring of Power Apparatuses; High voltage and Pulse power; High power density motor design; Inductive charging for EVs; Vector Control of Motors; Power system Monitoring and Control; Power System Cyber-Security, Decentralized Control for the Smart Grid.	<a href="#">EEE Department</a>

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	Microelectronics, Photonics and RF Engineering	Antenna; Microwave Engineering; Electromagnetics; Computational Electromagnetics. Fiber Optic Communication; Optoelectronics; Photonics Integrated Circuits, Optical Communication, Optical Networks; Optical Sensors; Microwave and Photonics; Optical Instrumentation; Plasmonics and metamaterials and smart electrotuneable plasmonic metasystems; Silicon photonics, Structural Health Monitoring Using fiber Optics, Distributed Acoustic Sensors, Optical Signal Processing, Digital Holography, Phase Imaging; Vacuum Electronics; Millimeter-wave Communication; Integrated photonic devices; Photonics and Metamaterial device design using AI.	
	Signal Processing and Machine Learning	Data Sciences, Biomedical Signal and Medical Image Processing; Speech and Handwriting Processing; Image/Video Processing and Computer Vision; Pattern Recognition; Multimedia Analytics; Biometrics; Counter-spoofing; Security and Privacy; Biometrics and Biometric counter-spoofing; Privacy preserving analysis for secure computation; Secure key distribution and management in wireless sensor networks; Video Analytics; Vision and Language; Natural Language Processing; Deep Learning.	
	Systems, Control and Automation	Systems Theory; Control Theory and Applications; Control of Nonlinear Uncertain Systems; Artificial Intelligence based Control; Identification and Control of Nonlinear Systems; Relay Based Identification and Autotuning; Adaptive Control; Optimal Control; Robotics and Automation; Cryptography; Robust Control; Cooperative Control of Multi-agent Systems, Decentralized Control for Smart Power Grid Applications, Model Predictive Control, Reinforcement Learning, Vibration control of flexible structures, Modelling and control of mechatronic and robotic systems, Multi-agent systems and Cooperative control, Group-coordinated control of UAVs, UGVs and AUVs, Connected Vehicle Platooning, Passivity-based control and Dissipativity, Negative-imaginary systems theory, Robust control of missiles, spacecraft and rockets, Smart and Microgrid control using a multi-agent framework.	
	VLSI and Nanoelectronics	Solid-State Devices; Analog and RF Integrated Circuits; Digital Systems; DSP Architectures; CAD for VLSI; High Performance Computing; MEMS; Organic Electronics; Flexible Electronics; Instrumentation; Quantum Computing; Hardware	

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		Security; Sensors; Non-volatile memory technologies; Spintronics; Power Semiconductor Devices; Photodetectors, VLSI System Design, Embedded System Design, Computer Architecture, Neuromorphic Computing, In-Memory Computing, Hardware Realization of Machine Learning Algorithms, Magnetic random-access memory (MRAM), Magnetic Tunnel Junctions (MTJ), Advanced data storage technologies, Neuromorphic devices, Wearable Sensors, Electronic Nose, Papertronic Sensing Systems, and Sensor Interface Electronics.	
Mechanical Engineering	Machine Design	Isogeometric analysis computational contact mechanics; Nonlinear Dynamics; Robotics and Control; Hydrodynamic Bearings; Tribology; Smart Materials & Smart Structures; Composite Materials and Structures; Noise; Vibration and Harshness in Electric Vehicles; Machine/Deep Learning in Finite Element; Finite element analysis in Multiphysics: Acoustics; Electromagnetics; Electromagnetic Forming; Applications of Robotics and Artificial Intelligence for Underwater Exploration; Rotor Dynamics; Application of Artificial Intelligence and Biomechanics for Ocular Disease Detection; Isogeometric analysis for contact-impact problems; Machine learning in computational mechanics; Impact response of 3D printed components; machine learning in computational contact mechanics; large deformation isogeometric analysis of thin structures; Experimental and Numerical analysis of Electromagnetic Forming and Crimping Mixed formulation in Isogeometric Analysis for Nonlinear Elasticity; functionality graded piezoelectric materials	<a href="#">ME Department</a>
	Fluids & Thermal	Computational fluid dynamics (CFD); Hydrodynamics of Complex Fluids; Hydrodynamics of Active Soft Matter; Experimental Microfluidics; fluid-structure interaction; Vortex induced vibration; Large eddy simulation; Computational Gas Dynamics; Rarefied Gas Dynamics; Porous medium combustion; Thermal Energy Storage; Artificial intelligence in CFD (AI-CFD); Multiphase flow; Hydrogen storage and thermal energy storage; Aeroacoustics	
	Manufacturing and Materials	Additive manufacturing; Data-Driven Manufacturing & Industry 4.0; Structural Topology Optimization; Molecular Dynamics; Materials Engineering; Smart Materials & Smart Structure; CAD CAM; Biomechanics and gait analysis; Welding and joining; Laser based manufacturing; Smart Manufacturing; Manufacturing of	

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		hydrogen energy system; Biomedical Devices and systems; Traditional medicine manufacturing systems; Metal Forming; Powder Metallurgy & its Fatigue Performance; Characterization and modeling of chatter in high speed micromilling by considering process nonlinearities; Advanced machining process; Micromanufacturing process; Metal Additive Manufacturing; Hybrid Additive Manufacturing	
Civil Engineering	Environment Engineering Geotechnical Engineering Infrastructure Engineering & Management Structural Engineering Transportation Engineering Water Resources and Hydraulic Engineering Earth System Science and Engineering.	(For Civil Engineering Department, Sub-Area is not required to be filled in the application form)	<a href="#">Civil Engineering Department</a>
Biosciences and Bioengineering	Biosciences and Bioengineering	All Areas of Biosciences and Bioengineering.	<a href="#">BSBE Department</a>
Chemical Engineering	Chemical Engineering	All areas of Chemical Engineering (including Materials Science and Engineering, Petroleum Science and Engineering, and Computer Aided Process Engineering)	<a href="#">Chemical Engineering Department</a>
Design	Design	Visual Communication (Including Art & Visual Culture, Semiotics, Colour, Typography, Grids, Signage Design, Graphic Design, Illustration, Animation,	<a href="#">Design Department</a>

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		<p>Multimedia, Film &amp; Video, Visual Narratives); New Media; Design Management, Design Strategy, Product-Service-Systems (PSS); Service Design; Design For Sustainability; Design for Social Innovation; System Design; Product Design and Development; Product Aesthetics; Form Design; Human Centered Design of Emerging-Technology-Based Products; Design Cognition; Understanding/Supporting Design Processes in Various Disciplines; Design and Culture; Makerspaces; Participatory Design; Co-creation; Frugal Design and Engineering; Frugal Innovation; Inclusive Design; Design For Health and Well-Being; Human Computer Interaction (HCI); Interaction and Usability Engineering; Virtual Reality (VR); Voice And Conversational User Interfaces; Assistive Interfaces; User Interaction On Flexible Displays; Deformation Based Input Methods; Information Communication Technology For Development (ICTD); Input Methods for Digital Interfaces; Ergonomics (Including Occupational Health And Safety); Design Creativity and Innovation Studies; Design Education and Pedagogy; Design for Smart Cities; Design for Children; Toy Design; Electronic Product Design; Sound Design and Sonic Studies; Speculative Design; Furniture Design; Packaging Design; Automotive Design; Advanced Product Design with Additive Manufacturing.</p>	
Physics	Physics	<p>Condensed Matter Physics - materials physics, materials for energy and environmental applications, ferroelectric and oxide materials, graphene and analogue atomic thin materials, organic semiconductors, semiconducting materials, thin film semiconductor devices, solar cells, smart magnetic materials, multiferroics, Luttinger liquids, soft condensed matter, spintronics, statistical physics, random walk, percolation, porous media, climate physics, network, self-organization, active matters and collective motion, nonequilibrium statistical mechanics, hydrodynamics, quantum turbulence and nonlinear instabilities in BEC, strongly correlated systems, superconductivity, topological insulators, skyrmions, quantum turbulence, quantum phase transitions, ultracold atoms in optical lattices, nanomaterials and nanotechnology, polymer physics, AdS/CMT, magnetohydrodynamics, Luttinger and non-Fermi liquids, Bosonization, Machine learning in Physics.</p>	<p><a href="#">Physics Department</a></p>

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		<p>Gravity, Astrophysics, and Cosmology – classical &amp; quantum aspects of gravity, cosmology, and astrophysics – black hole physics, theoretical cosmology, phenomenology of AdS/CFT, astrophysical flows, ultra high energy cosmic rays, black hole thermodynamics, quantum field theory on curved spacetime.</p> <p>High Energy Physics – Theory and Phenomenology: dark matter phenomenology, neutrino physics, heavy flavor physics, collider phenomenology, QCD, precision calculations in the Standard Model and beyond, aspects of CP violation, matter-antimatter asymmetry, astro-particle physics/cosmological connections, inflation, effective field theory in particle and nuclear physics, physics of exotic hadrons.</p> <p>Experimental Particle Physics: B-physics at Belle and Belle II and neutrino physics at NoVA and DUNE.</p> <p>Laser and Photonics – fiber optics, laser-Matter interaction, nonlinear optics, quantum optics, free space optical communication, advanced optical imaging, terahertz plasmonics and metamaterials, plasmonics materials, laser-induced breakdown spectroscopy, and plasma spectroscopy.</p> <p>Quantum Optics and Quantum Technology - cavity quantum electrodynamics, circuit QED and quantum optomechanics, cold atoms for quantum computation and simulation.</p>	
Chemistry	Chemistry	All Areas of Chemistry.	<a href="#">Chemistry Department</a>
Mathematics	Mathematics	Geometry and Topology, Algebra, Numerical Analysis and Differential Equations, Fluid Dynamics, Multiscale Modeling and Simulations, Mathematical Modeling, Machine Learning in Fluid Dynamics.	<a href="#">Mathematics Department</a>
	Probability, Statistics and Finance	Mathematical Finance, Financial Risk Management, Sustainable Finance, Computational Finance, Algorithmic and High Frequency Trading, Statistics, Biostatistics, Machine Learning, and Health Data Science, Statistical Application of Survival analysis and Reliability.	
	Computer Science	Algorithms, Graph theory, Network Security and Computer Networks.	
Humanities and Social Sciences	Archaeology	<ol style="list-style-type: none"> <li>1. All areas of archaeology</li> <li>2. Indigenous trade and indigenous agriculture</li> </ol>	<a href="#">HSS Department</a>
	Development Studies	Health and Education Public Policy	

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	Economics	Macroeconomics, Public Economics, Industrial Organization, Economic Growth, Agricultural Economics, Environmental Economics, Energy Economics	
	History	Contemporary History of India, Environmental History of India, History of Assam	
	Linguistics	1. Phonology of Tibeto-Burman languages and South Asian languages, tone and intonation in Tibeto-Burman and South Asian languages 2. Acoustic phonetics, phonetics of tone languages, phonetics of Tibeto-Burman languages 3. Language acquisition, bilingualism	
Agro and Rural Technology	Agro and Rural Technology	Waste water treatment, Solid Waste management, Food Biotechnology, Isothermal drying of agricultural products, Waste heat recovery, Nano-fertilizer optimization, Crop & Soil Quality Management, Soil and Water Microbiology, Crop and soil modelling, Climate smart agriculture, and Agricultural Biotechnology.	<a href="#">School of Agro and Rural Technology</a>
Energy Science and Engineering	Energy Science and Engineering	All the areas related to renewable energy, clean coal technology, biofuels, bio lubricants, gasification, biomass pyrolysis, microalgae, internal combustion engine, energy efficiency and advanced energy storage systems, hydrogen production and storage, CO2 to methanol, bio oil via CTL, solar thermal, energy material synthesis, batteries and supercapacitors, smart grid, distributed energy resources and microgrids and EV charging infrastructure, electronic design, energy computation and simulation, device fabrication, integrated energy systems, and multigeneration energy systems, energy modelling, AI and energy optimization.	<a href="#">School of Energy Science and Engineering</a>
Mehta Family School of Data Science and Artificial Intelligence	Data Science and Artificial Intelligence	<ul style="list-style-type: none"> <li>• Optimization and control of stochastic systems, Resource allocation in next-generation wireless communication networks (5G/6G), Reinforcement learning, Application of machine learning in wireless communication, Markov decision process, Multi-armed bandit</li> <li>• Machine learning in cyber security</li> <li>• Image processing: Biomedical image processing, Computer vision: Classification, segmentation, and tracking of the human eye, face, and hand, Computer graphics: Animation of human eye and face</li> <li>• Computational biology</li> </ul>	<a href="#">Mehta Family School of Data Science and Artificial Intelligence</a>

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		<ul style="list-style-type: none"> <li>• Machine learning for signal processing, Data science for spoken conversation modeling, Neuro-informed signal processing for speech and audio processing</li> <li>• Deep learning, Computer vision</li> <li>• Statistics, Statistical signal processing, Non-linear regression, Time series analysis</li> </ul>	
Jyoti and Bhupat Mehta School of Health Sciences and Technology	Health Sciences and Technology	<ul style="list-style-type: none"> <li>• Biomedical Devices and Sensors; Disease Diagnostics; Biomedical Imaging and Analysis; Development of MRI Contrast Agents; Microfluidics; Nanoelectronics; Nanobiotechnology.</li> <li>• Tissue Engineering; In-vitro Disease Models for Drug Screening; Cancer Biology and Stem Cells; Regenerative Medicine and Stem Cells; Expanded Genetic Code.</li> <li>• Molecular Biophysics; Chemical Biology; Tox Screening of Phytochemicals/Drugs; Site-specific Protein Modification, Mathematical modeling and simulations of Biomolecules.</li> <li>• Health Data Science and Analytics; Preserving Privacy in Health Data Sharing; Ergonomics and Design for Healthcare; Quantum Technology for Healthcare Applications.</li> <li>• Biomaterials; Artificial Limbs and Prosthetics; Biomechanics; Transport Processes in Physiological Systems; Medical Waste Disposal and Degradation.</li> <li>• Bioorganic, Bioinorganic and Medicinal Chemistry; Drug Delivery; Environmental Health and Toxicology.</li> <li>• Molecular Neuroscience and Cancer Neuroscience, Pharmacology and Toxicology, Large-Scale Genomics and Transcriptomic Data Analysis, Cheminformatics, Protein Engineering.</li> </ul>	<a href="#">Jyoti and Bhupat Mehta School of Health Sciences and Technology</a>
School of Business	Business	Marketing, Organizational Behaviour and Human Resource Management, Finance, Economics, Operations Research, Operations Management, and Project Management	<a href="#">School of Business</a>
Environment	Environment	Environmental Organic and Inorganic Chemistry/ Biotechnology/ Economics/ Engineering; Bioengineering; Biopolymers and Biomacromolecules; Environmental	<a href="#">Centre for the Environment</a>



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		Chemical Biology; Waste Water Treatment and supply; Solid Waste Management; Environmental process system; Oil recovery; CO2 Capture/storage; Atmospheric Chemistry; Air Quality monitoring; Environmental Hydraulics; Environmental Genomics; Environmental aspects of Algal Biotechnology; and Other emerging areas of environment with interdisciplinary application of science, technology, arts and humanities.	
Nanotechnology	Nanotechnology	Nano/Bio Materials Science and Engineering; NanoTheranostic Devices; Nano/Bio-Electronics and Sensors; Experimental and Computational studies of micro- and nano-fluidics, Molecular Simulations; Polymer self-assembly; Polymer Nanocomposites; Nano Devices and Applications; Flow Chemistry; Catalysis for Energy; Energy Applications; All areas of Chemistry and Physics including Nanoscale Materials, Polymers, Optoelectronics, and Photonic applications; Nanoelectronic Devices: Non-Volatile Memory Devices and Technologies, Plasmonic Devices, Neuromorphic Devices, Low-Dimensional Semiconductors and Devices, Spintronic Devices, Photovoltaics and Photodetectors; Green Hydrogen Generation: Organic, Hybrid, Flexible, and Printable Electronics; Bio-Inspired Wettability and Design of Water Repellent and Conductive Interfaces.	<a href="#">Centre for Nanotechnology</a>
Linguistic Science and Technology	Linguistic Science and Technology	Language Processing, Computational Phonology, Speech Analysis, Spoken Language Resources, Neuroimaging of Language disorders. Language and Cognition, Quantitative Phonetics, User Interface, Script Processing, Type Design and Typography, Language Acquisition and Visual Attention.	<a href="#">Centre for Linguistic Science &amp; Technology</a>
Disaster Management and Research	Disaster Management and Research	Climate change: Health, Climate-smart agriculture; Structural health monitoring, Service Life Assessment of Structures, Low-cost housing; Sustainable construction materials; Vulnerability, adaptation and DDR in urban cluster; Transport (accessibility and disaster resilience); Earthquake ground motion characterization; Seismic resilience of structures; Seismic and blast-induced disasters; Design for disaster risk reduction; Landslide prediction and mitigation, mudflow/debris-flow; Frugal technologies for disaster risk reduction; Sustainable development and disaster risk reduction; Disaster modeling using AI and Machine Learning; Deformation of metallic structures under crash loading conditions; Gender Perspectives in DRR; Non-equilibrium transport of pollutants in soil	<a href="#">Centre for Disaster Management and Research</a>

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Sustainable Polymers	Sustainable Polymers	All areas of Polymer Science and Engineering (including Organic electronics, Polymer liquid crystal, Polymer nanocomposites, Implant materials), Solid Waste Management, Agriculture, Biotechnology with Emphasis on Biopolymers, Monomers, Biocatalysis, Toxicology, Migration Studies, Polymer Ecology, Life Cycle Assessment, Polymer Product Design and Development, Orgnocatalyst, Organometallic catalysis, Green Chemistry.	<a href="#">Centre for Sustainable Polymers</a>
Indian Knowledge Systems	Indian Knowledge Systems	<ul style="list-style-type: none"> <li>• History of Science, Technology, and Engineering in India;</li> <li>• Water conservation systems;</li> <li>• Home Construction Materials;</li> <li>• Vastu and Sidhanta/Samhita-Jyotisha</li> <li>• Temple Architecture;</li> <li>• Study of Instruments from Indian texts;</li> <li>• Science and Technology of Ksheerapaka extracts;</li> <li>• Ontological design;</li> <li>• Herbal/Ayurvedic Medicinal Products;</li> <li>• Integrative Medicine;</li> <li>• Psychology and Consciousness studies;</li> <li>• Meditation and Health;</li> <li>• Indigenous cultivation systems and Indigenous trade</li> </ul>	<a href="#">Centre for Indian Knowledge Systems</a>
Intelligent Cyber Physical Systems	Intelligent Cyber Physical Systems	Research work related to underwater exploration; computer vision, underwater communication, underwater structural analysis.	<a href="#">Centre for Intelligent Cyber Physical Systems</a>
Centre for Sustainable Water Research	Sustainable Water Research	Hydrology and Water Resources Engineering (Surface Water; Groundwater; Atmospheric Water); Hydraulics; Socio-economic aspects of water; Water Economics; Water governance and policy; Transboundary water management; Sustainable Development of Water Resources; Remote Sensing and GIS application in Water Resources; Contaminant Transport; Water Filtration; Pipe Networks; and allied areas related to sustainable water research	<a href="#">Centre for Sustainable Water Research</a>