

Areas of Research for Doctor of Philosophy (December 2023 Admissions)

Academic Division (Department/School/ Centre)	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 (EDA), ML for EDA, ML for Security, 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	CSE Department
Electronics and Electrical Engineering	Communication Engineering	Wireless Communications; Information Theory and Coding, Network Coding, Codes for Distributed Computing; Communication Networks; Computer Networks; Computational Photography; Data Compression; and Cryptography, Blockchains, Cryptocurrencies, Decentralized Applications; 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.	EEE Department
	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	

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		design; Inductive charging for EVs; Vector Control of Motors; Power system Monitoring and Control; Power System Cyber-Security, Decentralized Control for the Smart Grid.	
	Microelectronics, Photonics and RF Engineering	Silicon photonics, Programmable Photonics, Microelectronics Circuits, III-V Compound Semiconductors, Integrated photonic devices, Fiber Optic Communication, Optoelectronics, Photonics Integrated Circuits, Optical Communication, Structural Health Monitoring Using fiber Optics, Distributed Acoustic Sensors, Optical Networks; Optical Sensors, Microwave and Photonics, Optical Instrumentation, Plasmonics and metamaterials and smart electrotuneable plasmonic metasystems, Optical Signal Processing, Digital Holography, Phase Imaging, Photonics and Metamaterial device design using AI, Reconfigurable Metasurfaces, TeraHertz Photonic Topological Insulators, Metamaterials and Metasurfaces for Advanced photovoltaics and Light emitting diodes, Antenna; Microwave Engineering; Electromagnetics; Computational Electromagnetics.; Vacuum Electronics; Millimeter-wave Communication.	
	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	

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		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 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	Mechanical Engineering	Machine Design; Vibrations; Fluid Mechanics; Solid Mechanics; Thermal Engineering; Heat Transfer; Manufacturing Engineering; Rehabilitation Robotics; Predictive Maintenance; Generative Design; Digital Twin in Machine Design; Digital Twin in Manufacturing; Operations Research; AI And ML in Machining Processes; Composite Machining; Modelling of Manufacturing Processes; Multiscale Modelling of Composites; Micromechanics and Homogenization; Application of Machine Learning in Material Modelling; Rotor Dynamics; Condition Monitoring of Machinery; Polymer Composites; Natural Fiber Reinforced Composites; Additive Manufacturing of Composites; Modelling of Manufacturing Process Using Machine Learning; Fluid Flow and Heat Transfer; Multiphase Flows; Biomicrofluidics; Finite Element Analysis in Multiphysics; Structure; Acoustics; Electromagnetics; Electromagnetic Forming; Mixed Formulation in Isogeometric Analysis for Nonlinear Elasticity; Experimental and Numerical Analysis of Electromagnetic Forming and Crimping; Biomicrofluidics; Magnetofluidics; Magnetohydrodynamics (MHD); Turbulence; Direct Numerical Simulations (DNS) and Large Eddy Simulations (LES); Fusion Energy Generation;	ME Department

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		Micromechanics and Homogenization; Application of Machine Learning in Material Modelling; Multiscale Modelling of Composites for Underwater Applications; Additive Manufacturing (3D Printing); Computational Fluid Dynamics (CFD); Fluid-Structure Interaction; Flow-Induced Vibration; Experimental Fluid Dynamics; Functionally Graded Material Fabrication.	
Civil Engineering	Environment Engineering	(For Civil Engineering Department, Sub-Area is not required to be filled in the application form)	Civil Engineering Department
	Geotechnical Engineering		
	Infrastructure Engineering & Management		
	Structural Engineering		
	Transportation Engineering		
	Water Resources and Hydraulic Engineering		
	Earth System Science and Engineering.		
Biosciences and Bioengineering	Biosciences and Bioengineering	All Areas of Biosciences and Bioengineering.	BSBE Department
Chemical Engineering	Chemical Engineering	All areas of Chemical Engineering (including Materials Science and Engineering, Petroleum Science and Engineering, and Computer Aided Process Engineering)	Chemical Engineering Department
Design	Design	Visual Communication (Including Art & Visual Culture, Semiotics, Colour, Typography, Grids, Signage Design, Graphic Design, Illustration, Animation,	Design Department

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		Multimedia, Film & 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.	
Physics	Physics	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, metal halide perovskite materials, photo-physics, thin film semiconductor devices, solar cells, LEDs, flexible devices, imaging, 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,	Physics Department

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		<p>magnetohydrodynamics, Luttinger and non-Fermi liquids, Bosonization, Machine learning in Physics.</p> <p>Gravity, Astrophysics, and Cosmology – classical & quantum aspects of gravity, cosmology, and astrophysics – black hole physics, theoretical cosmology, phenomenology of AdS/CFT, astrophysical flows around compact objects, X-ray astronomy of black hole X-ray Binaries, 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. Experimental Particle Physics: B-physics at Belle and Belle II and neutrino physics at NoVA and DUNE.</p> <p>Laser and Photonics – fiber Optics, localized surface plasmon resonance, optical fiber sensors for structural health monitoring and environmental engineering, laser-Matter interaction, nonlinear optics, quantum optics, holographic optical tweezers, optical super-resolution microscopy, terahertz plasmonics and metamaterials, plasmonics materials, laser-induced breakdown spectroscopy, and plasma spectroscopy, Integrated photonic devices, Quantum optoelectronics, Non-volatile photonic memory, Near-field optical microscopy</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.	Chemistry Department

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Mathematics	Mathematics	Algebra, Linear Algebra, Fluid Dynamics, Geometry and Topology, Harmonic Analysis.	Mathematics Department
	Probability, Statistics and Finance	Stochastic Models and Queues, Biostatistics, Mathematical Finance, Computational Finance, Portfolio Theory, Financial Risk Management, Sustainable Finance, Algorithmic and High Frequency Trading, FinTech.	
	Computer Science	Graph Theory, Algorithms, Graph Algorithms, Distributed Algorithms, Security and privacy in networks, Social network security.	
Humanities and Social Sciences	Economics	Industrial organization, economic growth, and development economics	HSS Department
	Linguistics	1. Language processing, psycholinguistics of bi/multilingualism 2. Phonetics and phonology of tone and intonation in Tibeto-Burman/South Asian languages; atypical phonological development 3. Acoustic phonetics, Phonetics of tone languages, Phonetics of Tibeto-Burman languages	
	Political Science	Indian politics, theory, and thought	
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.	School of Agro and Rural Technology
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, CO ₂ to methanol, bio oil via CTL, solar thermal, energy material synthesis, batteries and supercapacitors. Power electronics application in power system; Power system monitoring and Control; Control of Power Electronics Interfaces for Distributed Energy Resources and Microgrids. EV charging infrastructure, electronic design, energy computation	School of Energy Science and Engineering

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		and simulation, device fabrication, integrated energy systems, and multigeneration energy systems, energy modelling, AI and energy optimization. Power Systems.	
Mehta Family School of Data Science and Artificial Intelligence	Data Science and Artificial Intelligence	<ul style="list-style-type: none"> Artificial Intelligence, Machine Learning, and Deep Learning Algorithms and their applications to Computer Vision: Object detection, Classification, Identification, Recognition, Image enhancement, Image matching; Equitable Precision Medicine: Transfer learning, Meta-learning, Few-shot learning; and Condition-based Monitoring: Fault diagnosis and Remaining useful life prediction. Computer Vision using Deep Learning and Machine Learning, Adverse Weather Image/Video Restoration, Object Detection and Tracking, Scene Perception/Understanding 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, Internet of Things (IoT), Federated Learning, Quantum Machine Learning. 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 Machine Learning in Robotic Neurorehabilitation Machine learning for signal processing, Data science for spoken conversation modeling, Neuro-informed signal processing for speech and audio processing Network security and Security in social networks. Reliability, Statistical Inferences, Transfer Learning, Applications of AI and ML Statistical Signal Processing and Machine Learning, Non-linear regression, Time series analysis; Bayesian Inference in Signal Processing 	Mehta Family School of Data Science and Artificial Intelligence

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

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		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.	Centre for Nanotechnology
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, Virtual / Augmented / Mixed Reality, Natural User Interfaces, Vision and language, Vision and Speech, Document Image Processing	Centre for Linguistic Science & Technology
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	Centre for Disaster Management and Research

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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.	Centre for Sustainable Polymers
Indian Knowledge Systems	Indian Knowledge Systems	<ul style="list-style-type: none"> History of Science, Technology, and Engineering in India; Water conservation systems; Home Construction Materials; Vastu and Sidhanta/Samhita-Jyotisha Temple Architecture; Study of Instruments from Indian texts; Science and Technology of Ksheerapaka extracts; Ontological design; Herbal/Ayurvedic Medicinal Products; Integrative Medicine; Psychology and Consciousness studies; Meditation and Health; Indigenous cultivation systems and Indigenous trade 	Centre for Indian Knowledge Systems
Intelligent Cyber Physical Systems	Intelligent Cyber Physical Systems	Cyber-Physical Systems: Internet-of-Things (IoT), Sensors, Embedded Systems; Robotics, Control and Sensing: Modelling, Analysis and Design of Robotic Systems, Intelligent Sensing and Control for Autonomous Vehicles, Control of Swarm Systems, Sensor and Actuator Design; Artificial Intelligence: Machine Learning, Computer Vision, Natural Language Processing, Speech Processing, Biomedical Signal & Image Processing; Underwater Systems: Underwater Systems Design and Development, Underwater Exploration, Underwater Structural Analysis, Sonar and Underwater Acoustics, Compressed Air Energy Storage, Power Electronics for Underwater Systems	Centre for Intelligent Cyber Physical Systems

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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; Chemistry of nanomaterials for sustainable water; Pipe Networks; and allied areas related to sustainable water research	Centre for Sustainable Water Research
Centre for Drone Technology	Drone Technology	Autonomous Vehicles: Sensors, Embedded Systems, Control and Sensing, Design and development of Drones; Artificial Intelligence: Machine Learning, Computer Vision, Signal Processing, Image Processing; Underground Exploration, Remote Sensing and Geoinformatics (Geomatics), Geodesy, Atmospheric Science, Societal problems and mitigation.	Centre for Drone Technology