Department of Electrical and Computer Science Engineering

PhD Admissions Spring Semester AY 2025-26 | Syllabus for written test

Discipline: Electrical Engineering

Part-I: This section is compulsory.

Research Methodology: Concepts and methods of engineering research, use of ICT and soft tools in research, research ethics, formulating the research problem, literature review, research design, collection-processing-analysis of data, reasoning, documentation-presentation-dissemination of research, intellectual property rights and scholarly publishing.

Part-II: ANY ONE of the following nine sections to be attempted as per the choice of the candidate

Faculty	Research Area	Section	Syllabus
Dr. Kshitij Bhargava Dr. Rahul Kumar	MOSFETs, Thin Film Transistors, Solar PVs, VLSI Design, Semiconductor Devices, Device fabrication, Sensors & Detectors, AI/ML in Healthcare	**A**	• Electronic Devices: Energy bands in intrinsic and extrinsic semiconductors, equilibrium carrier concentration, direct and indirect band-gap semiconductors; Carrier Transport: diffusion current, drift current, mobility and resistivity, generation and recombination of carriers, Poisson and continuity equations; P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell. • Analog Circuits: Diode circuits: clipping, clamping and rectifiers; BJT and MOSFET amplifiers: biasing, ac coupling, small signal analysis, frequency response. Current mirrors and differential amplifiers; Op-amp circuits: Amplifiers, summers, differentiators, integrators, active filters, Schmitt triggers and oscillators.
Dr. Manjunath K. Dr. Priyesh Chauhan	Power Systems, Renewable Energy, Grid connected VSCs to provide ancillary services, Power Electronics, Electric Transport, Microgrids, Decarbonization	**B**	• Fundamentals of Power Systems - electrical power generation-transmission-distribution-utilization, voltage-frequency-power control, line compensation, power system analysis, switchgear & protection, power system stability concepts. • Fundamentals of Power Electronics - Power semiconductor devices operation and characteristics, Operation-control-applications of dc-dc, ac-dc, and dc-ac converters
Dr. Dharmendra Sadhwani	Wireless Commⁿ Systems, Active reconfigurable intelligent surfaces, Approximation theory in Commⁿ Systems, Machine learning in commⁿ theory	**C**	• Amplitude modulation and demodulation, angle modulation and demodulation, Random variables and random process, autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems. PCM, DPCM, digital modulation schemes (ASK, PSK, FSK), matched filter receiver. Fundamentals of error probability in digital communication systems.
Dr. Abhishek Rawat	Drones, Robotics	**D**	• Drones: Basics of Drones, Assembly, Calibrations and Different types of sensors, Regulations.

	Satellite navigation, Antenna		• Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, super heterodyne receivers. • Information theory: entropy, mutual information and channel capacity theorem. • Digital communications: PCM, DPCM, digital modulation schemes (ASK, PSK, FSK, QAM), bandwidth, inter-symbol interference, MAP, ML detection, matched filter receiver, SNR and BER. Fundamentals of error.

Prof. Axaykumar Mehta	Control of Autonomous Aerial Vehicles, Control of Multi-Agent Systems, Networked Control System	**E**	• Engineering Mathematics: o Linear Algebra: Vector space, basis, linear dependence and independence, matrix algebra, eigenvalues and eigenvectors, rank, solution of linear equations- existence and uniqueness. o Calculus: Mean value theorems, theorems of integral calculus, evaluation of definite and improper integrals, partial derivatives, maxima and minima, multiple integrals, line, surface and volume integrals, Taylor series. o Differential Equations: First order equations (linear and nonlinear), higher order linear differential equations, Cauchy's and Euler's equations, methods of solution using variation of parameters, complementary function and particular integral, partial differential equations, variable separable method, initial and boundary value problems. o Vector Analysis: Vectors in plane and space, vector operations, gradient, divergence and curl, Gauss's, Green's and Stokes' theorems. o Complex Analysis: Analytic functions, Cauchy's integral theorem, Cauchy's integral formula, sequences, series, convergence tests, Taylor and Laurent series, residue theorem. o Probability and Statistics: Mean, median, mode, standard deviation, combinatorial probability, probability distributions, binomial distribution, Poisson distribution, exponential distribution, normal distribution, joint and conditional probability • Control Systems: Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag lead compensation; State variable model and solution of state equation of LTI systems.
Dr. Krupa Shah	Artificial Intelligence and Machine Learning for various applications such as power systems, drones, EVs, healthcare IoT for industry applications and edge-cloud computing	**F**	• Module 1: Introduction to Artificial Intelligence and Machine Learning; Applications; Search Algorithms: introduction, breadth first search, depth first search, bidirectional search, A*; Basics of Machine learning: Supervised learning, Unsupervised learning, Semi Supervised learning, Reinforcement learning, etc., Model evaluation and error measures; • Module 2: Regression: Single variable and multivariate Linear Regression, model representation, cost function; Non-linear regression – polynomial regression; Classic algorithms: support vector regression, decision tree regression, random forest regression etc.; Error metrics and measures; • Module 3: Classification: Hypothesis representation, decision boundary, cost function, gradient descent algorithm, overfitting and regularization etc.; Classic algorithms: Logistic regression, Naïve bayes, Decision Tree, Ensemble learning, K Nearest Neighbour, Support Vector Machine; Multiclass classification; Error metrics and measures: precision, recall, scores etc., skewed classes scenario; • Module 4: Artificial Neural Networks: Neurons and brain, Non-linear hypothesis, Model representation, Back Propagation algorithm, ANN for Regression and Classification, Loss function, Hyper parameter tuning; Unsupervised

			Learning: Clustering algorithms: K-means clustering, Dendrograms and Hierarchical clustering, DBSCAN; Error measures; Dimensionality reduction: Motivation, Principal Component Analysis • Module 5: Power system protection: Principles of Over-Current, Differential, Directional And Distance Protection
Dr. Raghavendra Bhalerao	Digital Image Processing, Computer vision, Biomedical Instrumentation	**G**	• Linear Algebra: Vector space, basis, linear dependence and independence, matrix algebra, eigen values and eigenvectors, rank, solution of linear equations- existence and uniqueness. • Calculus: Mean value theorems, theorems of integral calculus, evaluation of definite and improper integrals, partial derivatives, maxima and minima, multiple integrals, line, surface and volume integrals, Taylor series. • Differential Equations: First order equations (linear and nonlinear), higher order linear differential equations, Cauchy's and Euler's equations, methods of solution using variation of parameters, complementary function and particular integral, partial differential equations, variable separable method, initial and boundary value problems. • Vector Analysis: Vectors in plane and space, vector operations, gradient, divergence and curl, Gauss's, Green's and Stokes' theorems. • Complex Analysis: Analytic functions, Cauchy's integral theorem, Cauchy's integral formula, sequences, series, convergence tests, Taylor and Laurent series, residue theorem. • Probability and Statistics: Mean, median, mode, standard deviation, combinatorial probability, probability distributions, binomial distribution, Poisson distribution, exponential distribution, normal distribution, joint and conditional probability