Centre for Machine Intelligence

and Data Science [CMInDS]

Indian institute of Technology Bombay

MS by Research and PhD Program Admissions

ONLINE TEST

SYLLABUS

April 19, 2022

www.minds.iitb.ac.in

Test Structure

All selected candidates for the MS by Research and PhD programs will have to complete an online admissions test. The test will assess the candidate's foundations and knowledge in AI/ML related topics.

The **MS by Research candidates** will have a **2-hour test** comprising questions that will cover topics listed only under the **FOUNDATIONS** section.

The **PhD candidates** will have a **3-hour test** comprising the same **FOUNDATIONS** questions as above; and additionally, questions from the **COMMON CORE** section and the **DOMAIN SPECIFIC** section. Candidates will be able to choose a subset of questions from the three Domain Specific modules.

The test (for both MS and PhD candidates) will be of **objective type only (i.e. Multiple-Choice-Qs and Fill-in-the-blanks)**.

Test Syllabus

The syllabus includes the following topics:

FOUNDATIONS (Common for MS by Research and PhD applicants)

MODULE	TOPICS	STUDY MATERIAL
Calculus	Differentiation, Integration, Partial derivatives, Nested integration, Polar coordinates, etc.	*Calculus*, Gilbert Strang, 2nd edition (2010): Chapters 1-15. Companion web resource.
Linear algebra	Vectors, Linear equations, Vector spaces and subspaces, Orthogonality, Determinants, Eigenvalues and eigenvectors.	*Introduction to Linear Algebra*, Gilbert Strang, 3rd edition (2003): Chapters 1-6. Related web resource.
Probability	Basic probability, Random variables, Sampling, Parameter estimation, Regression.	*Introduction to Probability and Statistics for Engineers and Scientists*, Sheldon M. Ross, 5th edition (2014): Chapters 3, 4, 6, 7, 9.
Algorithms	Algorithms, Asymptotic notation, Divide and conquer, Sorting, Searching.	*Introduction to Algorithms*, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, 3rd edition (2009): Chapters 1, 2, 3, 4, 6, 7, 12.

COMMON-CORE (Only for PhD candidates)

MODULE	TOPICS	STUDY MATERIAL
Machine Learning basics	Machine learning tasks, Overfitting, Parameter estimation, Gradient descent, etc.	Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, 2016: Chapter 5. On-line version.

DOMAIN-SPECIFIC (Only for PhD candidates)
(Candidates will be able to choose a subset of questions from the 3 modules)

MODULE	TOPICS	STUDY MATERIAL
Speech and Natural Language Processing	N-gram language models, Naive Bayes and sentiment classification, Logistic regression, Hidden Markov Models, Word Sense and Wordnet, Automatic Speech Recognition and Text-to-Speech, Word vector representations, Recurrent neural networks and language models), Gated recurrent units and further topics in NMT.	*Speech and Language Processing*, Daniel Jurafsky and James H. Martin, 3rd edition (2020): Chapters/sections: 3, 4, 5, 18, 26.1, 26.2, 26.3, Appendix A. On-line version. *Natural Language Processing with Deep Learning,* Winter 2017 course offered by Chris Manning at Stanford University: Lectures 2, 8, 11, 16. Videos of course lectures.
Stochastic Multi-armed Bandits and Multi-agent systems	Bandits, Regret, Sampling algorithms (epsilon-greedy, UCB, Thompson Sampling), Hoeffding's Inequality. General tenets of game theory, Normal form games, Perfect information extensive form games.	*Foundations of Intelligent and Learning Agents*, Autumn 2021 course at IIT Bombay: Lectures from weeks 1 (video, slides), 2 (video, slides), 3 (video, slides). Solved questions based on the material are provided in exam papers and assignments linked from the course pages from the 2017, 2018, 2019, 2020, and 2021 offerings. Lecture notes: Lectures 2-8.3. Modules 1-22 from this video playlist provide detailed explanations of the concepts along with the boardwork.

Image Processing	Fourier transforms (discrete and continuous, 1D and 2D), Image filtering in the spatial and frequency domains, Image restoration, Convolution and correlation, Image enhancement, histogram equalization, Image derivatives and edge detection, Basic image compression: steps of the JPEG standard, discrete cosine transforms.	*Digital Image Processing*, Rafael C. Gonzalez and Richard E. Woods, 3rd edition (2007): Chapters/sections 3, 4, 5.1-5.8, 8.2.1, 8.2.8.

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