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M.Tech

DATA SCIENCE & ENGINEERING

BITS Pilani
Pilani | Dubai | Goa | Hyderabad
Work Integrated Learning Programmes

HCL

WHO SHOULD APPLY?

Prepare for career in Data Science with the most comprehensive Master's degree programme in Data Science & Engineering without taking a break from your career.

M.Tech. Data Science and Engineering is a four-semester programme designed for working professionals that helps learners build mathematical and engineering skills required to advance their career as a Data Scientist or Data Engineer.

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WHAT ARE THE MAIN HIGHLIGHTS OF THE PROGRAMME?

- The programme is offered by BITS Pilani, a top-ranked institution, recently announced as an Institution of Eminence by MHRD, Govt. of India.
- The programme is of four semesters, and can be pursued without a career break.
- Classes will be conducted by BITS Pilani faculty over weekends through live online sessions.
- The curriculum covers areas that prepare you for most lucrative careers in the space of Data Science, Data Engineering and Advanced Analytics. It helps learners master critical skills such as Mathematical modeling, Machine learning, Artificial Intelligence, Product development and scripting languages.
- Tools & Technologies covered include Apache Spark, Apache Storm for Big Data Systems/ Real time Processing, Tableau for data visualization, Tensorflow for Deep Learning and various packages within Python for data processing, machine learning and data visualization.
- The programme emphasizes on experiential learning through Simulations, Online Labs, Case Studies, Group Discussions, Assignments and Project work.
- Dissertation/ Project Work in the final semester enables learners to apply concepts and techniques learnt during the programme.

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WHAT IS THE EDUCATION DELIVERY METHODOLOGY?

CLASSROOM SESSIONS

- Classroom sessions in this programme will be conducted through live online sessions which can be accessed by the learners from any location using a computer and a high-speed internet connection.
- Classes will be conducted by BITS Pilani faculty over weekends. A typical weekend classroom session per subject is of 1.5-2 hours duration. Since students typically pursue 4 courses in a semester, they will be expected to attend approximately 4 classroom sessions over a weekend.
- These classroom sessions will be typically scheduled over 16 weekends per semester.
- The schedule of the classroom sessions, will be announced at the beginning of each semester.

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EXPERIENTIAL LEARNING & LABS

The programme emphasises on Experiential Learning that allows learners to apply concepts learnt in classroom in simulated and real work situations. This is achieved through Simulations, Online Labs, Case Studies, Group Discussions, and Assignments, etc.

Some or all of the following would be utilised across the programme:

Apache Spark, Apache Storm for Big Data Systems/ Real time Processing; Tableau for data visualisation; Tensorflow for Deep Learning; Various Packages within Python for data processing, machine learning, data visualization etc.

PROJECT WORK

During the final semester participants carryout a semester-long intensive project work applying the various concepts learnt throughout the program guided by the organisation mentor and supervisor. Participants are provided access to virtual labs where applicable, and faculty expertise to support the project work.

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EXAMINATIONS & CONTINUOUS ASSESSMENT

The learners' performance is assessed continuously throughout the semester using various tools such as quiz, assignments, mid-semester and comprehensive exams. The assessment results are shared with the learners to improve their performance.

Each course will entail a minimum of 1 Assignment/ Quiz, a Mid-semester exam and a final Comprehensive exam. Your semester calendar will clearly indicate the dates of the Mid-semester and Comprehensive exam. Typically, a Mid-semester or Comprehensive examination for a course is for 2-3 hours duration. The examinations are typically conducted over a weekend, i.e. Saturday and Sunday. These exams will be conducted either at the learners' office premises, or at another suitable location. Details regarding the exam location will be communicated at the beginning of the semester.

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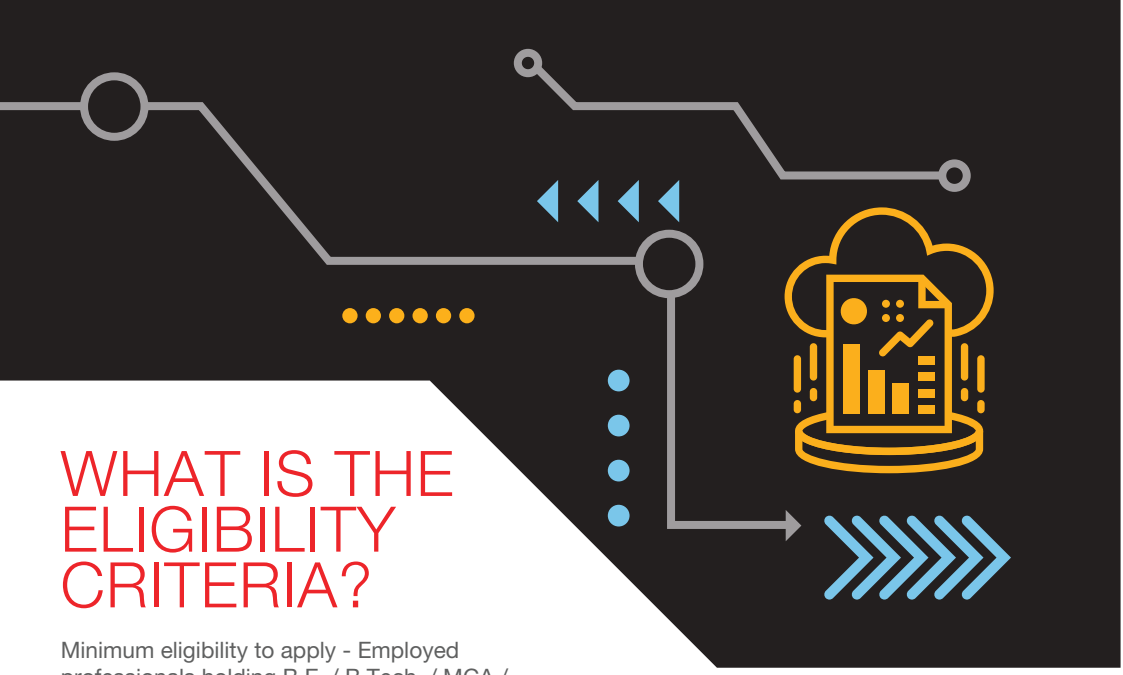

WHAT IS THE ELIGIBILITY CRITERIA?

Minimum eligibility to apply - Employed professionals holding B.E. / B.Tech. / MCA / M.Sc. or equivalent with at least 60% aggregate marks or more in their qualifying exam, and minimum two years of relevant work experience within HCL are eligible to apply.

Applicants should possess basic programming knowledge and adequate background in Mathematics.

FEE STRUCTURE

The following fees schedule is applicable for candidates seeking new admission during the academic year 2022-23

Application Fees (one time)	:INR	1,500
Admission Fees (one time)	:INR	16,500
Semester Fees (per semester)	:INR	60,500

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SEMESTER-WISE PATTERN

The programme features 12 courses between Semester 1-3, and a Dissertation in Semester 4. All the courses will be offered using live online mode.

First Semester

- Mathematical foundations for Data Science
- Introduction to Data Science
- Computer Organization and Software Systems
- Data Structures and Algorithm Design

Second Semester

- Introduction to Statistical Methods
- Elective - I
- Elective - II
- Elective - III

Third Semester

- Big Data Systems
- Elective - IV
- Elective - V
- Elective - VI

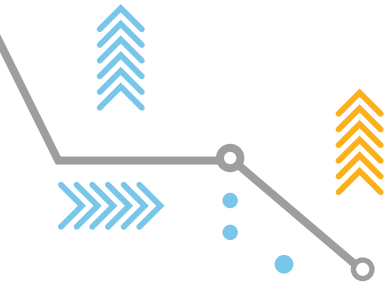
Fourth Semester

- Dissertation

Electives

- Data Warehousing
- Graphs – Algorithms and Mining
- Deep Learning
- Probabilistic Graphical Models
- Ethics for Data Science
- Optimization Techniques for Analytics
- Data Management for Machine Learning
- Natural Language Processing
- Design of Experiments for Data Science
- Information Retrieval
- Data Visualization and Interpretation
- Stream Processing and Analytics
- Artificial and Computational Intelligence
- Machine Learning #*
- Applied Machine Learning

Note: #*Machine Learning course is a prerequisite for Deep Learning elective course.



Electives finally offered will be at the discretion of the BITS Pilani, and will be decided in consultation with HCL. Offered electives will be made available to enrolled students at the beginning of each semester.

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DETAILED COURSE CURRICULUM

- **Mathematical Foundations for Data Science**

  Vector and matrix algebra, systems of linear algebraic equations and their solutions; Eigenvalues, eigenvectors and diagonalization of matrices; multivariate calculus, vector calculus, Jacobian and Hessian, multivariate Taylor series, gradient descent, unconstrained optimization, constrained optimization, nonlinear optimization, stochastic gradient descent, dimensionality reduction and PCA, optimization for support vector machines.

- **Introduction to Data Science**

  Data Analytics, Data and Data Models, Data wrangling, Feature Engineering, Classification and Prediction, Association Analysis, Clustering, Anomaly Detection, exploratory / explanatory data analysis with visual storytelling, Ethics for Data Science.

- **Computer Organization and Software Systems**

  Learn about:

  - Computer organization, architecture aspects and operating system concepts
  - Advanced systems and techniques used for data processing

  Topics

  - Introduction to computer organization, architecture; Introduction to operating systems; ISA - RISC etc. Processes and Threads; Scheduling, Concurrency; Memory Management

- **Data Structures and Algorithm Design**

  Learn about:

  - Applications of basic and advanced data structures & algorithms
  - How to determine the space and time complexities of various algorithms
  - Identifying and choosing the relevant data structures and algorithms for a given problem and justifying the time and space complexities involved

  Topics

  - Stack, Queue, Hash Tables, Graphs, Bloom Filters, Trees, Sets, Dictionary, Dynamic Graphs; Divide-and-conquer, Dynamic Programming, Graph Algorithms, Greedy Algorithms - Spanning
    Tree, Amortized Analysis, Huffman encoding; Page Rank, Map Reduce (map, fork, join etc); Complexity analysis

- **Introduction to Statistical Methods**

  Basic probability concepts, Conditional probability, Bayes Theorem, Probability distributions, Continuous and discrete distributions, Transformation of random variables, estimating mean, variance, covariance, Hypothesis Testing, Maximum likelihood, ANOVA – single factor, dual factor, time series analysis: AR, MA, ARIMA, SARIMA, sampling based on distribution, statistical significance, Gaussian Mixture Model, Expectation Maximization.

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- **Big Data Systems**

  Learn about:

  - Concepts related to big data and its processing
  - Applying the concepts of storage, retrieval, interfaces and processing frameworks to a given problem and design solutions for the same by choosing the relevant ones

  Topics

  - What is big data - are existing systems sufficient; Data Warehouse v/s Data Lakes; Hadoop - Components; Storage - Relational DBs/ NoSQL dbs / HDFS / HBase / Object Data stores - S3; Serialization; Interfaces - Hive/ Pig; Stream Processing; Spark; Mahout Advanced Topics in Data Processing

- **Data Management for Machine Learning**

  Data Models and Query Languages: Relational, Object-Relational, NoSQL data models; Declarative (SQL) and Imperative (Map Reduce) Querying; Data Encoding: Evolution, Formats, Models of dataflow; Machine learning workflow; Data management challenges in ML workflow; Data Pipelines and patterns; Data Pipeline Stages: Data extraction, ingestion, cleaning, wrangling, versioning, transformation, exploration, feature management; Modern Data Infrastructure: Diverse data sources, Cloud data warehouses and lakes, Data Ingestion tools, Data transformation and modelling tools, Workflow orchestration platforms; ML model metadata and Registry, ML Observability, Data privacy and anonymity.

- **Design of Experiments for Data Science**

  Introduction and importance of Experimental Design, Testing of Hypothesis, Designs with One Source of Variation, Multiple Comparison Testing, Interaction Effect, Factorial Experiment, Fractional Factorial Designs & Confounding, Latin Squares and Graeco-Latin Squares, Fractional-Factorial Designs, Taguchi Design, Designs with Random Effects, Optimal Designs and Model Uncertainty, Design for Nonlinear Model, Sequential Designs.

- **Ethics for Data Science**

  Nature of data - data as a by-product of computing, operations data (e.g., sales/marketing), surveillance data (business or government), data collected for research; Ethics - What are ethics, need for ethics, Ethical concerns in computing and analytics; Why data science needs ethics?; Issues -political/social, liberty and justice, fairness and equality, business competitiveness, privacy, anonymity, and security; Data Ownership, Informed Consent, Security Risks (Privacy, Anonymity, Integrity, and Provenance); Ethical methods for sourcing/collecting data, and for storage/ distribution of data. Data validation. Algorithmic Fairness and Case Studies; Solutions to address ethical issues for government, corporations/organizations, research, public use of data, social norms, legal compliance, and case studies. Data ethics in specific domains - e.g. health care, finance, and social studies/research.

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- **Optimization Techniques for Analytics**

  Role of optimization in different types of analytics, Introduction to Linear Programming, LP Model and graphical solution, Primal Simplex method, Dual Simplex and Post Optimality Analysis, Revised Simplex method with examples, Application of linear programming in transportation, assignment problems, Integer linear programming, mixed integer programming, complexity analysis, branch and bound techniques, goal programming, Network models - critical path method and PERT, Dynamic programming, game theory, additional meta heuristic techniques, 2-3 case studies from relevant industry domains.

- **Natural Language Processing**

  Natural Language Understanding and Generation, N-gram and Neural Language Models, Word to Vectors / Word Embedding (Skip gram/CBOW, Glove, BERT/ XLM, MURIL), Part of Speech Tagging, Hidden Markov Models, Parsing - Syntactic, Statistical, Dependency, Word Sense Disambiguation, Semantic Web Ontology.

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HOW TO APPLY

- Click here to visit the Online Application Center. Create your login at the Online Application Center by entering your official HCL Email ID only and create a password of your choice. Once your login has been created, you can anytime access the Online Application Center using your official email ID and password
- Begin by clicking on Step 1 - 'Fill/ Edit and Submit Application Form'. This will enable you to select the programme of your choice. After you have chosen your programme, you will be asked to fill your details in an online form. You must fill all details and press 'Submit' button given at the bottom of the form
- Now, click on 'Pay Application Fee' to pay INR 1,500/- using Netbanking/ Debit Card/ Credit Card
- Finally, click on 'Upload & Submit All Required Documents'. This will allow you to upload one-by-one all the mandatory supporting documents such academic certificates and transcripts, photograph, etc. and complete the application process. Acceptable file formats for uploading these documents are .DOC, .DOCX, .PDF, .ZIP and .JPEG
- Upon receipt of your Application Form and all other enclosures, the Admissions Cell will scrutinise them for completeness, accuracy and eligibility
- Admission Cell will intimate selected candidates by email within two weeks of submission of application with all supporting documents. The selection status can also be checked by logging in to the Online Application Centre

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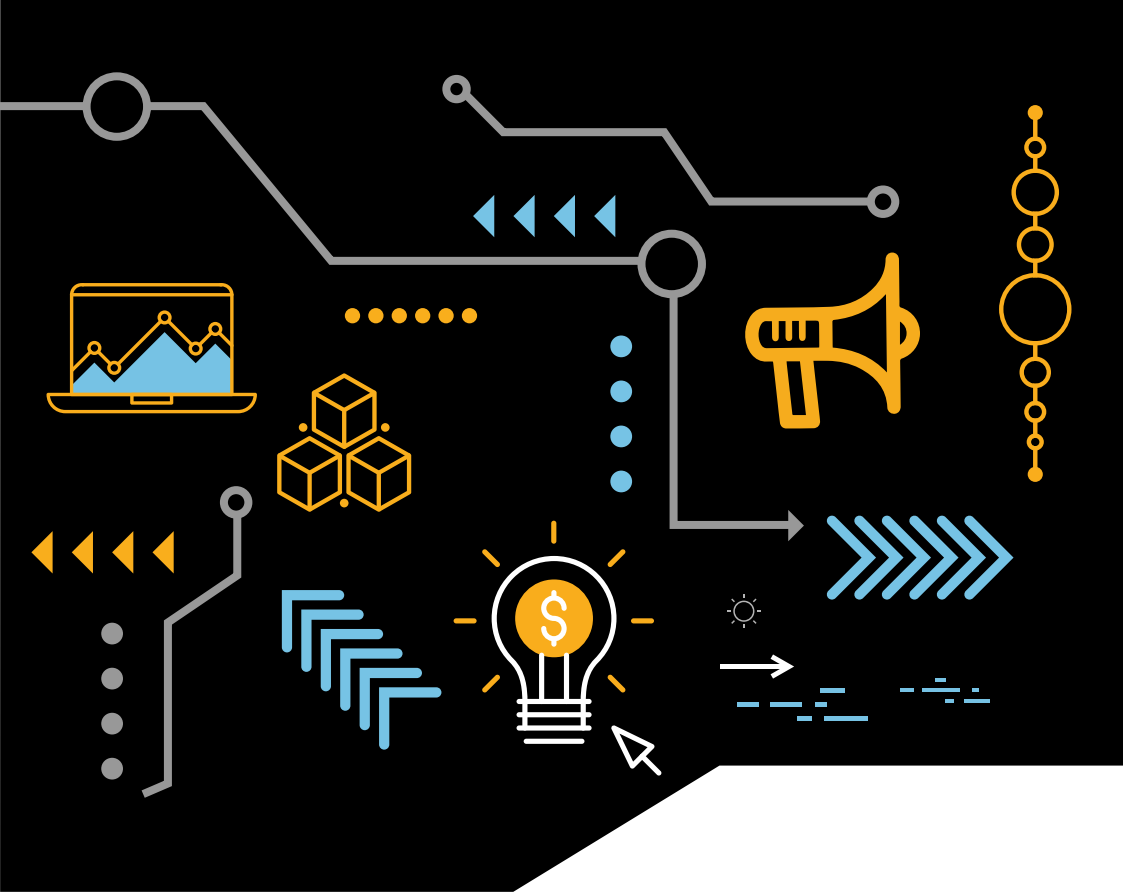

DISCLAIMER

Ever since it was declared as a Deemed to be University in 1964, BITS Pilani has been offering higher education programmes in science and technology, and has earned an enviable reputation for its innovations in this sphere. The Work Integrated Learning Programmes (WILP) of BITS Pilani constitutes a unique set of educational offerings for working professionals. These programmes, which BITS began to offer in 1979, have, over the years, evolved along the lines envisaged in the National Policy on Education, 1986.

The WILP are rigorous higher education programmes in technology areas, designed keeping the evolving needs of industry in view, and meant for working professionals in their respective domains. The very intent is to deliver the education at the workplace, in order that the greatest degree of work integration of the education is achieved, and thus the WILP are very distinct in philosophy and pedagogy from open, distance learning programmes. Though it is incorrect and improper, at times the WILP are compared to ODL programmes. Accordingly, it has been our constant endeavor to engage with the regulator, and provide all necessary information about these programmes.

The WILP have been well received, and accepted by industry, because of the high quality of the programmes in terms of the curriculum and the instruction, and also because of the high degree of work integration, which results not only in up gradation of knowledge, but also in up skilling, and productivity increase.

HCL_10/11/2022