BITS Pilani
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WORK INTEGRATED
LEARNING PROGRAMMES

M.Tech.
Data Science & Engineering
for Working
Professionals

innovate achieve lead

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Program Introduction

Data Science ranks as the fastest-growing global job, with a remarkable growth rate exceeding 650% since 2012, as per LinkedIn's Emerging Jobs report.

The Global Data Science Platform market size is projected to rise at a **CAGR of 27.7%** to an anticipated **USD 322.80 billion by 2026,** indicating a significant upward trend.

Join **BITS Pilani WILP's M.Tech. Data Science & Engineering Programme,** a comprehensive four-semester course designed for Software and IT professionals.

This program empowers professionals to specialize in roles like Data Analyst, Data Engineer, Data Architect, and Data Scientist, offering an opportunity to enhance career prospects without the need for a career break.

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Who Should Apply?

Software and IT professionals in roles like Software Engineer, Programmer, Software Test Engineer, Support Engineer, Data Analyst, or Business Analyst seeking to transition to Data Scientist or Data Engineer roles should consider applying to this program.

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Programme Highlights

M.Tech. Data Science and Engineering is a BITS Pilani Work Integrated Learning Programme (WILP). BITS Pilani Work Integrated Learning Programmes are UGC approved.

The curriculum covers key areas for popular Data Science roles like Analyst, Engineer, Architect, and Scientist.

Pursue the four-semester programme without any career break. Contact classes over a technology enabled platform are conducted mostly on weekends and after business hours.

The program includes core and elective courses such as Data Management for Machine Learning, Big Data Systems, Optimization Techniques for Analytics, Natural Language Processing, etc.

Offers the most comprehensive Data Science Curriculum for working professionals.

The program utilizes various Tools and Technologies like Apache Spark, Apache Storm for Big Data Systems/Real-time Processing, Tableau for data visualization, Tensorflow for Deep Learning, and various Python packages for data processing, machine learning, and visualization.

Covers fundamental to advanced skill sets and comprehensive knowledge in Data Science.

Aimed at transitioning software & IT professionals into Data Science careers tracks closest to their interest/passion.

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The final-semester Dissertation (Project Work) allows students to apply learned concepts and techniques.

Participants who successfully complete the programme will become members of an elite & global community of BITS Pilani Alumni.

The Continuous Evaluation System assesses learners at regular intervals, providing timely feedback to busy professionals.

Option to submit fee using easy-EMI with 0% interest and 0 down payment

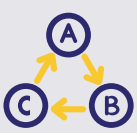
The program combines classroom and experiential learning through labs, assignments, case studies, and work-integrated activities.

Programme Objectives

The program focuses on essential skills required for lucrative roles in Data Science, Data Engineering, and Advanced Analytics, covering:

Mathematical and Statistical modeling for problem-solving.

Data structures, algorithms, and complexity management.



Computer organization, architecture, and advanced data processing techniques.

Data Mining involving preprocessing, classification, and engineering through distributed and cloud computing.

Advanced skills in Machine Learning, Artificial Intelligence, Deep Learning, and Natural Language Processing.

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Key Benefits of BITS Pilani WILP

- Can pursue the programme without any career break and along with the job.
- The programme curriculum is highly relevant to sectors, industries and organisations they work for
- In addition to the institute, the learning experience of working professionals in the programme is also supported by the employer organisation and Industry Mentors.
- Effective use of technology to deliver a range of learning interventions at the location of the working professional such as faculty contact sessions, asynchronous learning materials, remote, virtual and cloud labs, Learner support, peer to peer collaboration etc.
- Contact sessions with faculty take place mostly over weekends or after business hours and are conducted over a technology platform that can be accessed from anywhere.
- Mid semester and End semester examinations for every semester are conducted mostly at designated examination centres distributed across the country. For details, click here.
- Learners can access engaging learning material which includes recorded lectures from BITS Pilani faculty members, course handouts and recorded lab content where applicable.

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Experiential Learning

The programme emphasizes on Experiential Learning that allows learners to apply concepts learnt in classroom in simulated and real work situations. This is achieved through:

Tools & Technologies covered

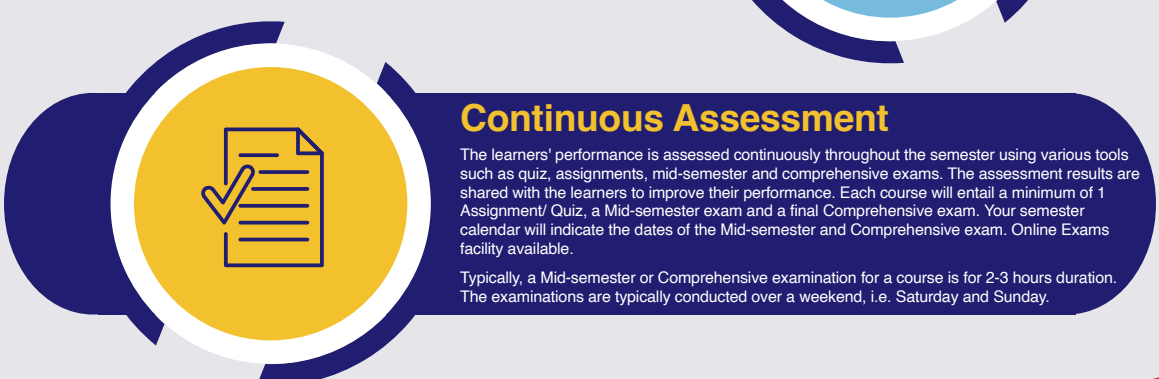
Spark, kafka, Apache Storm, tableau, TensorFlow, python

Case studies & Assignments

Carefully chosen real-world cases & assignments are both discussed and used as problem-solving exercises during the programme.

Project Work

The fourth semester offers an opportunity for learners to apply their knowledge gained during the programme to a real-world like complex project. The learner is expected to demonstrate understanding of vital principles learnt across semesters and their ability to successfully apply these concepts



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 indicate the dates of the Mid-semester and Comprehensive exam. Online Exams facility available.

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.

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Programme Curriculum

The programme features 12 courses between Semester 1-3, and a Dissertation in Semester 4. All the courses will be offered using contact sessions over a technology enabled platform.

First Semester

- Mathematical foundations for Data Science
- Introduction to Data Science
- Computer Organization and System Software
- 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

General Pool of Electives

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

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

Note: Choice of Electives is made available to enrolled students at the beginning of each semester. Students' choice will be taken a s one of the factors while deciding on the Electives offered. However, Electives finally offered will be at the discretion of the Institute.

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Eligibility Criteria

- Employed professionals holding B.E. / B.Tech. with at least 60% aggregate marks and minimum one-year relevant work experience after the completion of the degree are eligible to apply.
- Employed professionals holding MCA / M.Sc. or equivalent with at least 60% aggregate marks with university level mathematics / statistics as mandatory subjects and minimum one-year relevant work experience after the completion of the degree are also eligible to apply.
- Applicants should possess basic programming knowledge and adequate background in Mathematics.

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Fee Structure

Fee Structure for students admitted in Academic Year 2024-2025 is as follows:

Application Fees (one time)	Admission Fees (one time)	Semester Fees (per semester)
₹1500	₹16,500	₹71,750

Easy Monthly Payment Option with 0% Interest and 0 Down Payment

Instant EMI option with 0% interest and 0 Down Payment is now available that allows you to pay programme fee in an easy and convenient way.

- Instant online approval in seconds
- No Credit Cards/ CIBIL score required
- Easy and secure online process using Aadhaar and PAN number
- Anyone with a Salary Account with Netbanking can apply the Option to submit fee using easy- EMI with 0% interest and 0 down payment

Admissions open. Orientation begins on November 9th, 2024.

Click here to learn more

All the above fees are non-refundable.

Important: For every course in the programme, institute will recommend textbooks, students would need to procure these textbooks on their own.

Course-wise Syllabus

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 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

Data Warehousing

- Introduction, evolution of data warehousing
- decision support systems

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- Goals, benefit, and challenges of data warehousing
- Architecture
- Aata warehouse information flows
- Software and hardware requirements
- Approaches to data warehouse design
- Creating and maintaining a data warehouse
- Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling
- View materialization
- Data marts
- Data warehouse metadata
- Data mining

Computer Organization & Software Systems

- Programmer model of CPU
- Basic concept of buses and interrupts
- Memory subsystem organization
- I/O organization
- Concept of assembler, linker & loader
- Types of operating systems
- Concept of process
- OS functions: Process scheduling, Memory management, I/O management and related issues

Graphs - Algorithms and Mining

- Basic concepts of graphs and digraphs connectivity, reachability and vulnerability
- Trees, tournaments and matroids
- Planarity
- Routing and matching problems
- Representations
- Various algorithms Applications
- Introduction to graph mining, Graph Pattern Mining, Graph Classification, Graph Compression, graph model, graph dynamics, social network analysis, visualization, summarization, graph clustering, link analysis, applications of graph patterns

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Big Data Systems

- 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

Deep Learning

- Common Architectural Principles of Deep Networks
- Building Blocks of Deep Networks
- Convolutional Neural Networks (CNNs)
- Recurrent Neural Networks
- Recursive Neural Networks
- Building Deep Networks with ND4J
- Applications to Sequence Data
- Anomaly Detection
- Tuning Deep Networks
- Vectorization

Probabilistic Graphical Models

- HMM, Markov Random Field, Bayesian networks, Representation, Learning, Inference
- Dynamic Bayesian Networks and Temporal Bayesian networks, applications

Optimization Techniques for Analytics

- Role of optimization in different types of analytics
- Introduction to Linear Programming
- LP Model and graphical solution
- Primal Simplex method

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- 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

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

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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

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

Information Retrieval

- Organization, representation, and access to information
- Categorization, indexing, and content analysis
- Data structures for unstructured data
- Design and maintenance of such data structures, indexing and indexes, retrieval, and classification schemes
- Use of codes, formats, and standards
- Analysis, construction and evaluation of search and navigation techniques
- Search engines and how they relate to the above. Multimedia data and their representation and search

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Data visualization and Interpretation

- Visualization as a Discovery tool
- Visualization skills for the masses
- The Visualization methodology
- Visualization design objectives
- Exploratory vs. explanatory analysis
- Understanding the context for data presentations, 3-minute story, Effective Visuals
- Gestalt principles of visual perception, Visual Ordering, Decluttering, Story Telling, Visualization Design

Stream Processing and Analytics

- Real Time, Streaming Data & Sources, Real time streaming system architecture, Characteristics of a Real Time Architecture and Processing
- Configuration and Coordination Systems: Distributed State and Issues, Coordination and Configuration using Apache ZooKeeper
- Data Flow Management: Distributed Data Flows, Various Data Delivery and Processing Requirements, N+1 Problem, Apache Kafka (High-Throughput Distributed Messaging)
- Processing Stream Data with Storm
- Overview of Data Storage – Requirements: Need for long-term storage for a real time processing framework, In-memory Storage, No-Sql Storage Systems, Choosing a right storage solution
- Visualizing Data: Requirements, Principles and tools
- Bounds of Random variables, Poisson Processors, Maintaining Simple Statistics from Data Streams, Sliding Windows and computing statistics over sliding windows, Data Synopsis (Sampling, Histograms, Wavelets, DFT), Exact Aggregation, Timed Counting and Summation, Multi Resolution Time Series Aggregation, Stochastic Optimization

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- Statistical Approximation to Streaming Data: Probabilities and Distributions, Sampling Procedures for Streaming Data, Approximating Streaming Data with Sketching, Registers and Hash Functions, Working with Sets, The Bloom Filter, Distinct Value Sketches, The Count-Min Sketch
- Clustering techniques for Streaming Data; Classification methods: Decision Tree (VFDT) Evaluating stream processing algorithms
- Case Studies in Designing solutions to streaming data

Artificial and Computational Intelligence

- Agents and environments, Task Environments, Working of agents
- Uninformed Search Algorithms: Informed Search
- Local Search Algorithms & Optimization Problems: Genetic Algorithm
- Searching with Non-Deterministic Actions, Partial Information and Online search agents, Game Playing, Constraint Satisfaction Problem, Knowledge Representation using Logics: TT-Entail for inference from truth table, Proof by resolution, Forward Chaining and Backward Chaining, Inference in FOL, Unification & Lifting, Forward chaining, Backward Chaining, Resolution
- Probabilistic Representation and Reasoning: Inference using full joint distribution, Representation of Conditional Independence using BN, Reinforcement Learning
- Difference between crisp and fuzzy logic, shapes of membership function, Fuzzification and defuzzification, fuzzy logic reasoning
- Decision making with fuzzy information, Fuzzy Classification
- Connectionist Models: Introduction to Neural Networks, Hopfield Networks, Perceptron Learning, Backpropagation & Competitive Learning
- Applications of Neural Net: Speech, Vision, Traveling Salesman
- Genetic Algorithms - Chromosomes, fitness functions, and selection mechanisms
- Genetic algorithms: crossover and mutation, Genetic programming

Machine Learning

- Introduction to Machine Learning, Various kinds of learning, Supervised Learning, Unsupervised Learning, Model Selection
- Bayesian Learning
- MAP Hypothesis, MDL Principle, Bias Variance Decomposition, Bayes Optimal Classifier, Naive Bayes Classifier
- Linear Models for Regression, Linear Models for Classification
- Non-Linear models, Decision trees

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- Instance Based Learning, KNN Algorithm, CBR Learning
- Support Vector Machines, VC Dimension; Neural Networks, Perceptron Learning, Back Propagation Algorithm
- Introduction to Genetic Algorithms

Applied Machine Learning

- Need for machine learning
- Prediction and classification methods
- Use cases in application domains
- Interpretation of results
- Limitations of various techniques
- End to end Machine learning - data collection, data preparation, model selection

Dissertation

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

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Mode of Examination

Mode of Examinations applicable for students admitted in

Batch starting in Oct / Nov 2024.

Semester 1, 2 and 3 have Mid-Semester Examinations and Comprehensive Examinations for each course.

These examinations are mostly scheduled on Friday, Saturday or Sunday. Students need to **appear in person for taking the examinations at the institution's designated examination centres** as per the examination schedule, Instructions, rules and guidelines announced before every examination.

During these semesters, in addition to the above mentioned Mid-Semester and Comprehensive examinations, there will also be Quizzes/Assignments conducted online on the Learning Management System (LMS) as per the course plan in which the students need to participate.

In Semester 4 (Final Semester), the student will be doing Dissertation/Project Work as per the Institution's guidelines.

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For Indian Students:

Students can take their examination at any of our **33 designated** examination centres in India at the following locations:

- **South Zone:** Bangalore - North, Bangalore - Central, Bangalore - South, Bangalore - East, Chennai - North, Chennai - Central, Chennai - South, Hyderabad, Secunderabad, Vijayawada, Visakhapatnam, Kochi, Thiruvananthapuram and Coimbatore.
- **North Zone:** Delhi, Gurugram, Noida, Jaipur, Chandigarh, Lucknow and Pilani.
- **West Zone:** Mumbai, Navi-Mumbai, Pune, Pune - Pimpri Chinchwad, Goa, Ahmedabad, Indore and Nagpur.
- **East Zone:** Kolkata, Bhubaneswar, Guwahati and Jamshedpur.

  In addition to these locations, the Institution also has a designated examination centre in **Dubai.**

For International Students:

- In addition to the above locations, the institution also has a designated international examination centre, located in **Dubai.**
- To facilitate the learning of international students, applying from any other location except India and Dubai, the mode of examinations will be online, which can be availed by meeting the requirements of the institute.

  Requirements for online examinations

  - Scanned copy of the visa for the country in which you are currently residing. The visa should be currently valid. No expired visas shall be considered,

    (OR)
  - Scanned copy of government-issued ID from the residing country,

    (And)
  - HR recommendation or endorsement letter from the employer, stating the location of your work.
- Indian students, who are temporarily based out of India, can also avail of online examinations on request by meeting the above-mentioned requirements of the institute.

How to Apply

Click here to apply now

Create your login at the Application Center by entering your unique Email id and create a password of your choice.

Once logged in, follow four essential steps:

Step 1
Fill and submit your application form for your chosen program.

Step 2
Download a PDF copy of the application form.

Step 3
Pay the application fee of INR 1,500 using Net banking/Debit Card/Credit Card.

Step 4
Print the downloaded Application Form and note your Application Form Number.

In the printout of the downloaded Application Form, you will notice on page no. 3 a section called the Employer Consent Form. Complete the Employer Consent Form. This form needs to be signed and stamped by your organisation's HR or any other authorised signatory of the company.

Important: In view of work-from-home policies mandated by many organisations, a few candidates may not be able to get the physical forms signed by their HR/other authorised organisational representative. Such candidates may instead request an email approval to be sent to their official email ID by the HR using the format available **through this link.**

On page 4, complete the Mentor Consent Form, which needs to be signed by your Mentor.

Due to remote work policies, some candidates may struggle to get physical mentor signatures. They can request email approval using a **provided format**.

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Role of a Mentor:

The basic role of the mentor will be to ensure that the student remains aligned with the academic objectives and the key academic milestones while pursuing the programme. The mentor's valuable guidance and professional expertise would also be leveraged to maximise work-integrated learning and make the education experience highly relevant for the job role and pursuit of the long-term career goals of the student. Following are the expected responsibilities of the mentor:

1. Periodically monitor student's study schedules and submission deadlines for the programme.
2. Provide guidance towards integrating learning from the programme with job role/long-term career goals, especially while the student pursues their learning assignments and project work.
3. Monitor the student's progress throughout the duration of the programme. If required by BITS Pilani, also try to be available to engage with the faculty to collaboratively assess the student's academic performance and recommend any learning improvement plan.
4. Emphasise the importance of self-study and self-learning throughout the programme to the student.

Qualifications for a Mentor:

The mentor chosen should be a senior professional with at least 5 years of relevant work experience, holding a B.E./ B.Tech./ M.Sc./ M.B.A./ M.B.B.S./ First Degree at BITS Pilani or its equivalent. If the mentor has less than 5 years of relevant work experience, then the minimum educational qualification for the mentor should be M.E./ M.Tech./ M.S./ M.Phil./ Higher Degree of BITS Pilani or its equivalent is required.

Page 5 of the downloaded Application Form includes a Checklist of Enclosures/Attachments.

Photocopies of these documents should be made, and applicants need to self-attest academic mark sheets and certificates.

In the final step (Step 4), upload your printed Application Form, Mentor Consent Form, Employer Consent Form, and mandatory documents one by one.

Accepted file formats for uploads include .DOC, .DOCX, .PDF, .ZIP, and .JPEG.

The Admissions Cell will review your application for completeness, accuracy, and eligibility.

Selected candidates will receive email notifications within two weeks of submitting their application with all required documents.

You can also check your selection status by logging in to the Online Application Centre.

UGC Approval

BITS Pilani is an Institution of Eminence under UGC (Institution of Eminence Deemed to be Universities) Regulations, 2017. The Work Integrated Learning Programmes (WILP) of BITS Pilani constitutes a unique set of educational offerings for working professionals. WILP are an extension of programmes offered at the BITSPilani Campuses and are comparable to our regular programmes both in terms of unit/credit requirements as well as academic rigour. In addition, it capitalises and further builds on practical experience of students through high degree of integration, which results not only in upgradation of knowledge, but also in up skilling, and productivity increase. The programme may lead to award of degree, diploma, and certificate in science, technology/engineering, management, and humanities and social sciences.

On the recommendation of the Empowered Expert Committee, UGC in its 548th Meeting held on 09.09.20 has approved the continued offering of BITS Pilani's Work Integrated Learning programmes.

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Students Speak

I was looking for an upskilling programme that meets my career aspirations without any career break and BITS Pilani WILP was exactly what I needed. My experience with the faculty was great and the concepts I learnt here are relevant in real-time situations as well.

C R Bhargavi
Software Engineer, Ford Motor Pvt Ltd

I was looking for a program where I could learn multiple things relevant to my work profile. I then heard of BITS Pilani WILP. My overall journey with WILP has been amazing. I've learned a lot and now I am more confident at my workplace. I am able to explain complex things to people easily, which is ultimately helping my entire team to perform better.

Prashant Thakre
Technical Architect, GE Healthcare

I truly see my decision of pursuing a degree programme from BITS Pilani WILP as the best career move so far. This programme equipped me with world-class skills, technologies and in-depth knowledge in this field that helped me to become the leader. Learning without a career break from the best faculty to weekend classes, recorded lectures, everything was just perfect!

Abhishek Kumar Mishra
Leader, Data Science, Brilio Technologies

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WORK INTEGRATED
LEARNING PROGRAMMES

Let's start a conversation to ignite the change you desire

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admission@wilp.bits-pilani.ac.in