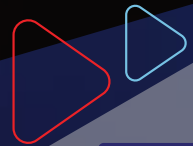




**BITS Pilani**

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Work Integrated  
Learning Programmes



# M.Tech. Data Science & Engineering



<https://bits-pilani-wilp.ac.in>



Call:+91-80-48767777



[admission@wilp.bits-pilani.ac.in](mailto:admission@wilp.bits-pilani.ac.in)



innovate

achieve

lead



The global Data Science Market is estimated to grow at a CAGR of 30% to reach USD 140 billion by 2024, according to a Markets and Markets report.

Prepare for a career in Data Science with India's most comprehensive & world class M.Tech. Data Science & Engineering Programme without taking a career break. The programme covers fundamentals to advanced skill & knowledge areas, and is a four-semester programme that helps software & IT professionals build skillset required to advance their career as a Data Analyst, Data Engineer, Data Architect, and Data Scientist, etc.

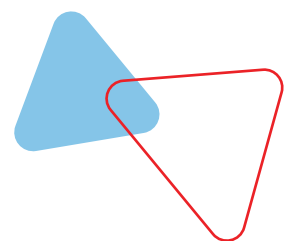
## Who Should Apply?

Software and IT professionals working as Software Engineer, Programmer, Software Test Engineer, Support Engineer, Data Analyst, Business Analyst, who wish to transition to roles such as Data Scientist or Data Engineer should consider applying to this programme.

# What are the Highlights of the Programme?



- 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 programme is of four semesters, with online classes conducted mostly on weekends or after business hours. You can pursue the programme without any career break.
- Offers the most comprehensive Data Science Curriculum for working professionals.
- The programme has an unmatched range & depth, and covers fundamentals to advanced skill & knowledge areas associated with the domain of Data Science.
- Aimed at transitioning software & IT professionals into Data Science careers tracks closest to their interest/passion.
- Curriculum maps knowledge and skill areas required to perform popular Data Science job roles such as Data Analyst, Data Engineer, Data Architect, and Data Scientist, etc.
- The programme offers a set of core courses and elective courses, allowing students to specialize in Data Management for Machine Learning, Ethics for Data Science, Optimization Techniques for Analytics, Natural Language Processing, etc.
- The programme makes use of Tools and Technologies. These include 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.
- The Dissertation (Project Work) in the final semester enables students to apply concepts and techniques learned during the programme.
- The programme uses a Continuous Evaluation System that assesses the learners over convenient and regular intervals. Such a system provides timely and frequent feedback and helps busy working professionals stay on course with the programme.
- The education delivery methodology is a blend of classroom and experiential learning. Experiential learning consists of lab exercises, assignments, case studies and work-integrated activities.
- Participants who successfully complete the programme will become members of an elite & global community of BITS Pilani Alumni
- Option to submit fee using easy-EMI with 0% interest.



**M.Tech.  
Data Science & Engineering**

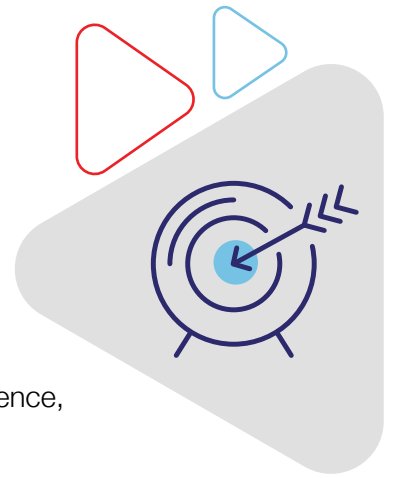
**Apply Now** 

# What are the programme objectives?

The most lucrative jobs in the areas of Data Science, Data Engineering and Advanced Analytics go to professionals who have mastered a combinations of critical skills such as Mathematical modeling, Machine learning, Artificial Intelligence, Product development and Scripting languages.

The programme aims to help participants build a solid foundation in these areas by developing skills in:

- ★ Mathematical and Statistical modelling using concepts such as linear algebra and probability to model and solve physical problems.
- ★ Data structures and algorithms and managing time and space-related complexities.
- ★ Computer organisation, architecture and Operating systems and advanced techniques for data processing.
- ★ Data Mining aspects including preprocessing, cleaning & classification, and Data engineering & processing through distributed computing and cloud computing.
- ★ Advanced computing and analytical skills in areas such as Machine Learning, Artificial Intelligence, Deep Learning and Natural Learning Processing.



# Learning methodology



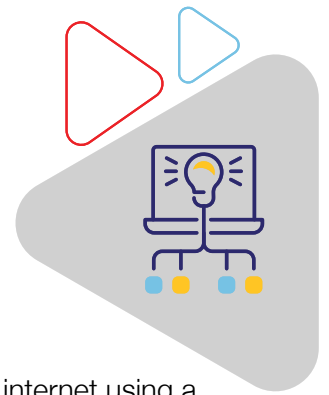
## Attend online lectures over weekends

Lectures are conducted live via online classes. These lectures can be attended via the internet using a computer from any location. These online classrooms offer similar levels of interactivity as regular classrooms at the BITS Pilani campus.

Classes for students admitted during the period Aug-Oct 2022 will begin in Oct 2022. The class schedule is announced within 1 week of completion of the admission process.

The online lectures are conducted usually over weekends for a total of 7-8 hours per week. If you miss a lecture, you can also access the recorded lecture on the internet.

Lectures are conducted on Sat/Sun as per Indian Standard Time.



## Experiential learning

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:

### Tools & Technologies covered



## Case studies and assignments

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



## Dissertation

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.

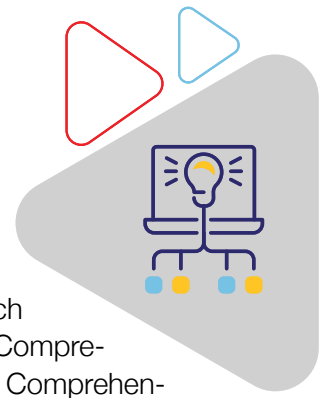
## CONTINUOUS ASSESSMENT

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.

## SUPPLEMENTARY LEARNING

In addition to live weekly online lectures, supplementary live online sessions will be organised periodically comprising of tutorials, doubt-clearing interactions, and industry talks (18-20 hours per semester).



# Mode of Examinations

## Examinations Mode Options applicable for students admitted in Batch starting in October 2022.



Semester 1, 2 and 3 have Mid-semester Examinations and Comprehensive Examinations for each of the course. These examinations are mostly scheduled over weekends. During these semesters, In addition to the mid-semester and comprehensive examinations, there will also be quizzes/assignments conducted online as per course plan which the students need to participate. In the Semester 4 (Final Semester), Student will be doing a dissertation (project work) as per Institution's guidelines.

### Two Options on Mode of Examinations during Semester 1 & 2:

Institution offers a choice between taking the examination online or taking them at a designated examination centre. The student will choose one of the option depending on his or her own preference and circumstances. Both options are explained below:

#### ★ Online Examinations:

Students choosing this option can take the examinations online from any location e.g. office or home. To take an online examination, student must possess a laptop or desktop **with two web cams (One Web Cam for students frontal face view and second Web Cam for student's full side profile view)**, a smart phone and good internet connectivity. As per the examination schedule, the student is expected to login to the institution's online examination platform and take the examinations in compliance with institution's defined guidelines and rules announced before the examinations. For full details about hardware, software and connectivity requirements to take online examination, [Click here](#).

#### ★ Examinations at Designated Examination Centers:

Students choosing this option will need to appear in person for taking the examinations at institution's designated examination centers. These designated examination centers are at the following locations: **Bangalore, Chennai, Hyderabad, Pune, Mumbai, Goa, Delhi NCR, Pilani and Kolkata**. In addition to these location, Institution also has a designated examination center at **Dubai**.

Please note that offering of examinations at designated examination centers is subject to institution's assessment of the safety conditions as per prevailing pandemic conditions and also subject to a required minimum number of students preferring this option. The institution may choose to not offer this option, if as per its own assessment the safety situation due to pandemic conditions is not conducive to conduct examinations at designated examination centers or if as per its assessment, adequate no of students have not preferred for this option. In circumstances as explained, Institute will then conduct the examinations only in the online mode.



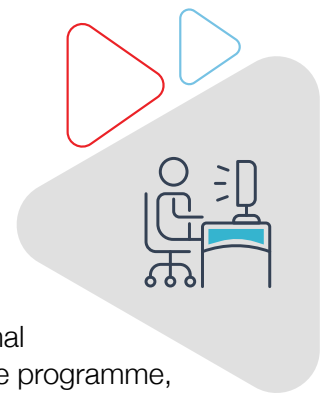


### Important:

The option of taking Online Exams for Semester 1, 2 & 3 will remain available for normal duration of the programme. However, in case a student chooses to take a break in the programme, the options on the mode of examination available will be as prevailing at the time the student resumes the programme. Also, if a student has backlog course/s to successfully complete and due to which he/she needs to register in additional semester/s over and above the normal duration of the programmes, the options on the mode of examination available will be as prevailing at the time when student registers for an additional semester.

### Mode of Evaluation for Semester 4 (Final Semester):

During Semester 4, students will be required to register for a full semester Dissertation (Project work). Each submission required for Dissertation as per institution's guidelines can be made **ONLINE** on a BITS Pilani's approved and managed online assessment platform.





# What is the Eligibility Criteria?

Minimum eligibility to apply - Employed professionals holding B.E. / B.Tech. with at least 60% aggregate marks, and minimum one-year relevant work experience are eligible to apply.

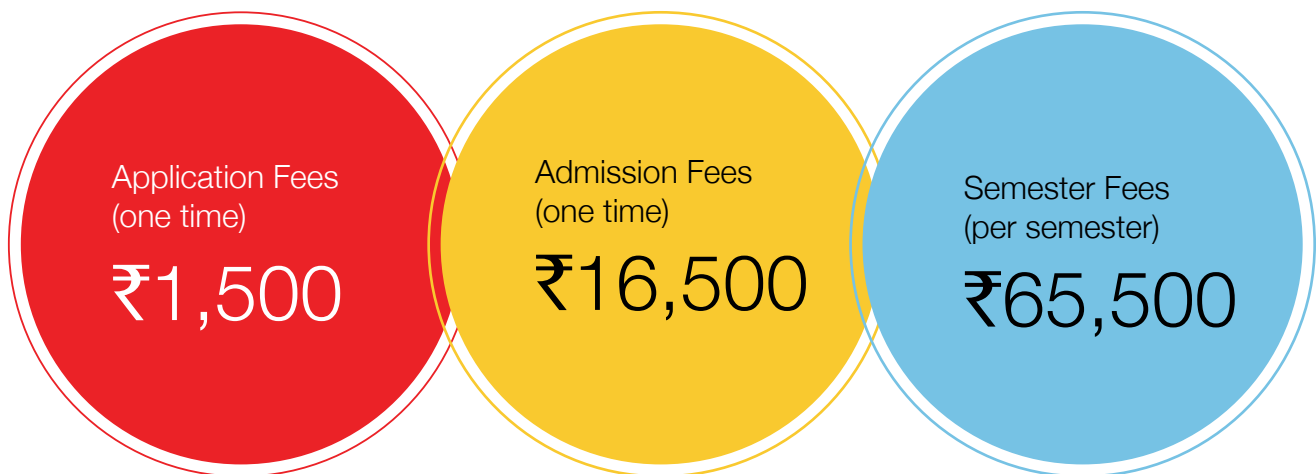
Employed professionals holding MCA / M.Sc. or equivalent with mathematics as a mandatory subject, and with at least 60% aggregate marks or more in their qualifying exam, and minimum one-year relevant work experience are eligible to apply.

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



## Fee Structure

Fee Structure for students admitted in Academic Year 2022-23 in the Cluster and Certification Programmes is as follows:



## 0% Easy-EMI Option

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

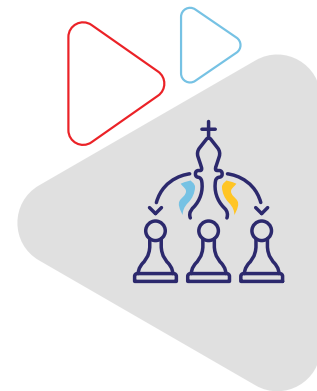
- ★ Instant online approval in seconds
- ★ No Credit Cards/ CIBIL score required
- ★ Easy & Secure online process using Aadhaar and PAN number
- ★ Anyone with a Salary Account with Netbanking can apply
- ★ Option to submit fee using easy-EMI with 0% interest.

[Click here](#) to learn more



**M.Tech.  
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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 live online mode.

## 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

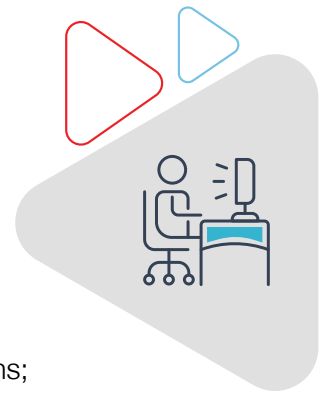
## General Pool of Electives

- ★ Data Warehousing
- ★ Graphs – Algorithms and Mining
- ★ Deep Learning
- ★ Probabilistic Graphical Models
- ★ 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 #\*

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

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

# COURSE WISE SYLLABUS



## Introduction to 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 System Software

### 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

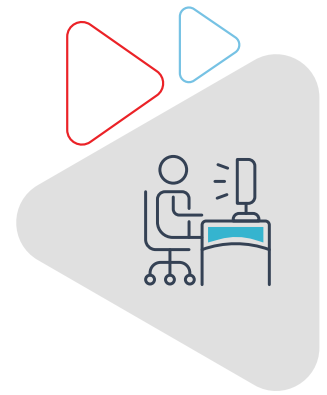
## Data Structures and Algorithm Design

### 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.

## 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.

## 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.

# How to apply



- ★ [Click here](#) to visit the BITS Pilani Online Application Center. Create your login at the Application Center by entering your unique Email id and create a password of your choice.
- ★ Once your login has been created, you can anytime access the online Application Center using your email ID and password. Once you have logged in, you will see a screen showing 4 essential steps to be completed to apply for the programme of your choice.
- ★ 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.
- ★ Take the next step by clicking on Step 2 - 'Download Application PDF Copy'. This will download a pdf copy of the application form on your computer.
- ★ Now, click on Step 3 - 'Pay Application Fee' to pay INR 1,500/- using Net banking/ Debit Card/ Credit Card.
- ★ Take a printout of the downloaded Application Form and note down the Application Form Number that appear on the top-right corner of the first page. This Application Form Number should be referred in all future correspondence with BITS Pilani.
- ★ 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](#).

- ★ Further on page no. 4 of the printed Application Form is a section called the Mentor Consent Form. The Mentor Consent Form needs to be signed by the Mentor.

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 Mentor. Such candidates may instead request an email approval to be sent to their official email ID by the Mentor using the format available through this [link](#).

## Who is a mentor:

Candidates applying to Work Integrated Learning Programmes must choose a Mentor, who will monitor the academic progress of the candidate, and act as an advisor & coach for successful completion of the programme.



# How to apply

Candidates should ideally choose the immediate supervisor or another senior person from the same organisation. In case a suitable mentor is not available in the same organisation, a candidate could approach a senior person in another organisation who has the required qualifications. Wherever the proposed Mentor is not from the same employing organization as that of the candidate, a supporting document giving justification for the same should be provided by the candidate's employer.

Candidates applying to B.Tech. programmes should choose a Mentor who is an employed professional with B.E./ B.S./ B.Tech./ M.Sc./ A.M.I.E./ Integrated First Degree of BITS or equivalent. Candidates applying to M.Tech., M.Sc., MBA, M.Phil programme should choose a Mentor who is an employed professional with:

- B.E./ M.Sc./ M.B.A./ M.C.A./ M.B.B.S. etc. and with a minimum of five years of relevant work experience

OR

- M.E./ M.S./ M.Tech./ M.Phil./ M.D./ Higher Degree of BITS or equivalent

★ Further on page no. 5 of the downloaded Application Form, is a Checklist of Enclosures/ Attachments.

- Make photocopies of the documents mentioned in this Checklist
- Applicants are required to self-attest all academic mark sheets and certificates

★ Finally, click on Step 4 - 'Upload & Submit All Required Documents'. This will allow you to upload one-by-one the printed Application Form, Mentor Consent Form, Employer Consent Form, and all mandatory supporting documents 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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**Work Integrated  
Learning Programmes**



## **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 BITS Pilani 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.

 <https://bits-pilani-wilp.ac.in>

 Call: +91-80-48767777

 [admission@wilp.bits-pilani.ac.in](mailto:admission@wilp.bits-pilani.ac.in)

