

M.Tech. **Artificial Intelligence and Machine Learning** for Working Professionals



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Program Introduction

With a surge of job opportunities in the fields of Artificial intelligence and Machine Learning, the world is indeed standing on the threshold of massive transformation.

According to the World Economic Forum's Future of Jobs Report, **85 million jobs** will be replaced by machines with AI **by 2025**. While that might make you uneasy, the same report states that 97 million new jobs will be created **by 2025 due to AI**. Are you prepared?

Prepare for a career with infinite possibilities in AI and ML with India's most comprehensive and world-class M.Tech. Artificial Intelligence and Machine Learning programme without taking any career break.

This four-semester program equips IT professionals and software developers with a diverse skill set, paving the way for career growth in high-demand roles like ML Engineers and AI Scientists.



Who Should Apply?



IT and Software professionals working as Software Engineer, Software Developer, Programmer, Software Test Engineer, Support Engineer, Data Analyst, Business Analyst, who wish to transition to roles such as ML Engineers & AI Scientists, etc. should consider applying to this programme



Programme Highlights



M.Tech. Artificial Intelligence and Machine Learning is a BITS Pilani Work Integrated Learning Programme (WILP). BITS Pilani Work Integrated Learning Programmes are UGC approved.



Meant for IT professionals and Software developers aiming to become expert Machine Learning Engineers & AI Scientists.



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 programme offers a set of core courses and elective courses, allowing students to gain expertise in Advanced Deep learning, Natural Language Processing, etc.



Offers the most comprehensive AI & ML Curriculum for working professionals.



The programme makes use of Tools and Technologies such as Tensorflow for Deep Learning and various Python libraries for data processing, machine learning, OpenCV for computer vision, NLTK for NLP etc.



The programme has an unmatched range & depth and covers the widest variety of skill & knowledge areas required to develop advanced AI solutions.



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.



Opportunity to become a member of an elite & global community of BITS Pilani Alumni.



The education delivery methodology is a blend of classroom and experiential learning.



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



Experiential learning consists of Virtual lab exercises, assignments, case studies and work-integrated activities.



Programme Objectives



Abundance of user-generated data, easy access to computing and storage in the cloud, open-source libraries and algorithmic advancement have led to the deployment of artificial intelligence and machine learning techniques across industries.



This in turn has fuelled significant job opportunities in the IT products and services sector in India and across the globe.



This program is geared towards the professional development of employees who are working in the area of IT products and services industry or who aspire for a career in the applications of AI and ML techniques in traditional industries.



Student

Learning Outcomes

At the end of the programme, the students will be able to:



Demonstrate conceptual understanding and hands-on knowledge of traditional and contemporary AI and machine learning techniques, including deep learning, and reinforcement learning.



Demonstrate conceptual understanding and hands-on knowledge of AI application areas such as natural language processing, computer vision, robotics or cyber security.



Understand the system and software engineering requirements for implementing machine learning systems on large datasets and in resource-constrained environments.



Understand the underlying ethical issues in applying AI and machine learning.



Mode of Learning

The Mode of Learning used in this programme is called - Work Integrated Learning. Internationally, Work Integrated Learning (WIL) is defined as "An educational approach involving three parties - the student, educational institution, and employer organization(s) - consisting of authentic work-focused experiences as an intentional component of the curriculum. Students learn through active engagement in purposeful work tasks, which enable the integration of theory with meaningful practice that is relevant to the students' discipline of study and/or professional development*.

An education model can be considered as WIL if and only if:

1. The programs are designed and developed by the institute in collaboration with industry.
2. Work-focused experiences form an active part of the curriculum.
3. The program structure, pedagogy and assessment enable integration of theory-with relevant practice.

The innovative Work Integrated Learning Programs (WILP) of BITS Pilani are quite aligned with the above definition and requirements. The programs are designed in collaboration with its industry partners, subject matter experts from industry and academia that enable the students to remain relevant in their chosen profession, grow in their career and retain the habit of lifelong learning. The continued availability of workplace related experiences along with the weekly instruction sessions promote integration of theory with practice. An active participation of the organization mentor in the learning process of the student plays a key role. Case studies, simulation exercises, labs and projects further strengthen this integration.

The WILP of BITS Pilani is comparable to its campus-based programs in terms of structure, rigor, instruction, labs, assessment, faculty profile and learning support. The pervasive adoption of technology in all its academic processes makes the same high-quality education of BITS Pilani available to the aspirants at scale with the required flexibility.





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.



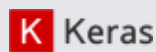
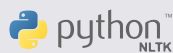
Experiential Learning

The programme emphasises on Experiential Learning that allows learners to apply concepts learnt in the classroom in simulated, and real work situations.

This is achieved through: Simulation Tools, Platforms & Environments: Some or all of the following would be utilised across the programme.

Tensorflow for Deep Learning and various Python libraries for data processing, machine learning, OpenCV for computer vision, NLTK for NLP etc.

Tools & Technologies covered



Supplementary Learning

In addition to contact classes over a technology enabled platform, supplementary sessions will be organised periodically comprising of tutorials, doubt-clearing interactions, and industry talks (18-20 hours per semester).





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 assessment includes graded assignments/quizzes, mid-semester and comprehensive exam



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 Machine Learning.
- Machine Learning
- Introduction to Statistical Methods
- Artificial and Computational Intelligence

Second Semester

- Deep Neural Networks
- Deep Reinforcement Learning
- Elective 1
- Elective 2

Third Semester

- Elective 3
- Elective 4
- Elective 5
- Elective 6

Fourth Semester

- Dissertation

Pool of Electives for Deep Learning Specialization

- Advanced Deep learning #
- Graph Neural Networks
- ML System Optimization
- Fair, Accountable, Transparent Machine Learning

Pool of Electives for NLP Specialization

- NLP Applications
- Social Media Analytics
- Natural Language Processing#
- Information Retrieval

Note: 3 courses are required including the course marked in #

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General Pool of Electives

- MLOps
- Design of Algorithms
- Computer Vision
- Probabilistic Graphical Models

- Data Management for Machine Learning
- Video Analytics
- Advanced Data Mining AI and ML techniques for Cyber Security

Note: 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.



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.



Fee Structure

Fee Structure for students admitted in Academic Year 2023-2024 is as follows:



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

Application Deadline: 18th March 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

Deep Neural Networks

- Introduction to neural networks
- Approximation properties
- Back propagation
- Deep network training
- Regularization and optimization
- Convolution neural networks
- Recurrent neural networks
- Attention models
- Transformers



- Neural architecture search, federated learning, meta-learning, applications in time series modelling and forecasting, online (incremental) learning

Deep Reinforcement Learning

- Introduction and applications
- Markov decision processes (MDP)
- Tabular MDP planning
- Tabular RL policy evaluation
- Q-learning, model-based RL,
- Deep RL with function approximation
- Policy search, policy gradient, fast learning, applications in game playing, imitation learning, RL for neural architecture search, batch RL

Advanced Deep Learning

- Introduction to Representation Learning
- PCA and variants, likelihood-based models, flow models, autoregressive models latent variables
- Deep autoencoders, Boltzmann Machines, Generative Adversarial learning, Variants of GAN and applications
- DeepDream, neural style transfer, self-supervised learning, semi-supervised learning, language model learning, applications in time series modelling, representation learning for reinforcement learning, deep clustering

Graph Neural Networks

- Basics of graph theory
- Machine learning on graphs, node embeddings, link analysis, representation learning for graphs
- Label propagation for node classification, empirical risk minimization, graph convolutional filters
- Composition with pointwise nonlinearities, permutations, dilation and stability, transferability, graph RNN, algebraic neural networks, applications of graph NN in subgraph mining
- Recommendation systems, community structures in networks, deep generative models, knowledge graph embeddings and reasoning



ML System Optimization

- Review of parallel and distributed systems
- System Performance Trade-offs
- Distributed machine learning for large models and datasets
- General-purpose distributed computing frameworks - Hadoop, map reduce and Apache Spark
- Deep Learning frameworks and runtimes, deep learning hardware, Deep learning compilers with optimizations, scalable training and Inference Serving, parameter serving, Federated Learning, model compression for optimizing communication and resource-constrained devices
- Case studies of machine learning on single GPU systems, on GPU Clusters

Fair, Accountable, Transparent Machine Learning

- Biases and fairness
- Fair representation learning, Interpretability and Transparency
- Example and Visualization Based Methods for Interpretability
- Interpreting deep neural networks, Fairness Through Input Manipulation, Fair NLP/Vision, Robustness and adversarial attacks/defence, ML auditing, privacy

NLP Applications

- Sentiment Analysis
- Grammar and Spelling Checkers
- Cross Lingual Language Models,
- Machine Translation including Indic Languages
- Question answering and Chatbots
- Information extraction (named entity recognition, relation extraction)
- Knowledge graph



Social Media Analytics

- Social Media Platforms
- NLP in SMA
- Text Summarization
- Opinion Science and dynamics
- ML/DL in SMA- Community detection
- Ethical Social Media
- Case Studies- Role of social media in disaster management
- SM driven mental health and behaviour Analysis

MLOps

- Adaptation of DevOps for building and deploying machine learning systems,
- Model Deployment: Infrastructure requirements
- Deployment patterns, Model CI/CD (Build, Test, Integration and Delivery of model),
- Model Serving tools and technologies
- Model life cycle management, ML pipelines with data management support, model assessment, evolution, and management in production
- MLOps infrastructure and tools
- Trends in Model deployment: ML on the Cloud / Edge / Browsers; VMs, Containers, Docker, Kubernetes (K8S), FaSS, ML-as-a-Service

Design of Algorithms

- Review of important data structures
- Design techniques such as divide-and-conquer, greedy, recursion, backtracking, branch-and-bound, simulation
- Dynamic Programming (Examples, Analysis, General Structure of Solutions Limitations and Applicability)
- Illustrations dealing with problems in AI and machine learning
- Computational complexity and bounds, NP-hard and NP-complete problems
- Introduction to Approximation algorithms; Randomized algorithms

Computer Vision

- Image formation, structure, and transformations
- Low-level (filters, features, texture)
- Mid-level(segmentation, tracking, morphology) and High-Level Vision (registration contour geometry
- Object detection and classification, segmentation)
- Deep learning for object detection
- Recognition



- Face detection and face recognition
- Facial key point recognition
- Optical Character Recognition
- Visual annotation
- Activity recognition
- Applications for autonomous cars – Landmark detection and tracking, track pedestrians
- 3D projection
- Image search and retrieval
- Edge devices for computer vision

Probabilistic Graphical Models

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

Data Management for Machine Learning

- Data Models and Query Languages: Relational, Object-Relational, NoSQL data models; Declarative (SQL) and Imperative (MapReduce) 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

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



Video Analytics

- Digital Video
- Spatio temporal sampling
- Low-Level Features to High-Level Semantics
- Video enhancement technologies (denoising, stabilization, unsharp masking, super-resolution)
- Background modelling and Foreground Detection, ML techniques for Video Motion Detection
- Tracking
- Compression
- Indexing and Retrieval
- Browsing and Summarization
- Applications in License plate detection on moving vehicles, monitoring traffic jams, Activity recognition
- Crowd management and gesture recognition

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

Advanced Data Mining

- Topics beyond conventional record data mining
- Mining complex data structures
- Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining
- Mining multivariate time series data, high-dimensional data clustering and mining social networking sites
- Mining data from multiple relations (Multirelational Data Mining)
- Privacy-preserving Data Mining
- Distributed computing solutions for data-intensive data mining



Artificial and Computational Intelligence

- Introduction to Intelligent Agents
- Search-based agents - Informed and Uninformed searches
- Local Search Algorithms - Hill Climbing, Simulated Annealing, Local Beam Search, Genetic Algorithms, ACO, PSO
- Minimax Algorithm, Alpha Beta Pruning
- Knowledge Representation and Reasoning: Logical Agents - Representation and reasoning using propositional and predicate logic
- Resolution, forward and backward chaining, DPLL
- Probabilistic Reasoning - Knowledge representation using Bayesian networks, exact and approximate inference from bayesian networks
- Hidden Markov Models
- Ethics in AI: Explainable AI

Machine Learning

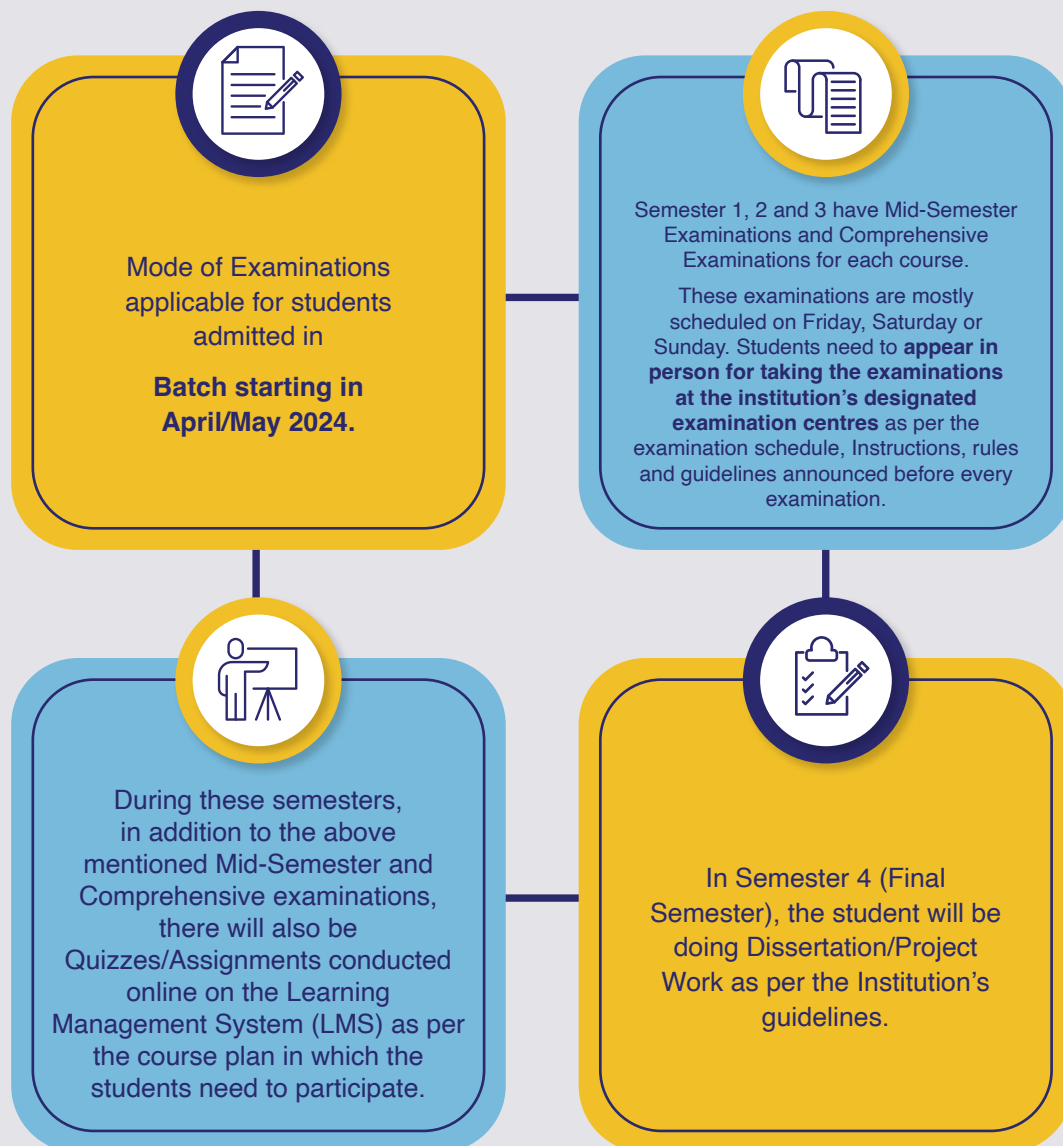
- Introduction to Machine Learning
- Various kinds of learning
- Supervised Learning
- Unsupervised Learning
- Model Selection, Bayesian Learning, MAP Hypothesis, MDL Principle, Bias Variance
- Decomposition
- Bayes Optimal Classifier
- Naive Bayes Classifier, Linear Models for Regression,
- Linear Models for Classification; Non-Linear models, Decision trees, Instance Based Learning, KNN Algorithm, Support Vector Machines, Ensemble methods: Random Forest, Bagging, Boostin

AI and ML Techniques for Cyber Security

- Introduction to Cyber-Security
- Supervised Learning for Misuse/Signature Detection
- Machine Learning for Anomaly Detection
- Malware detection and classification, Network Intrusion detection and classification
- Detection and categorization of domain names, Profiling Network Traffic, Adversarial Machine Learning for Malware detectiong



Mode of Examination



- Students can take their examination at any of our 23 designated examination centres in India at the following locations:
- **South Zone:** Bangalore, Chennai, Hyderabad, Vijayawada, Visakhapatnam, Kochi, Thiruvananthapuram and Coimbatore.
North Zone: Delhi NCR, Jaipur, Chandigadh, Lucknow and Pilani.
West Zone: Mumbai, Pune, Goa, Ahmedabad, Indore and Nagpur.
East Zone: Kolkata, Bhubaneshwar, Guwahati and Jamshedpur.
In addition to these locations, the Institution also has a designated examination centre in **Dubai**.



How to Apply



Click here to apply now
through the BITS
Pilani online
application centre.



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**.

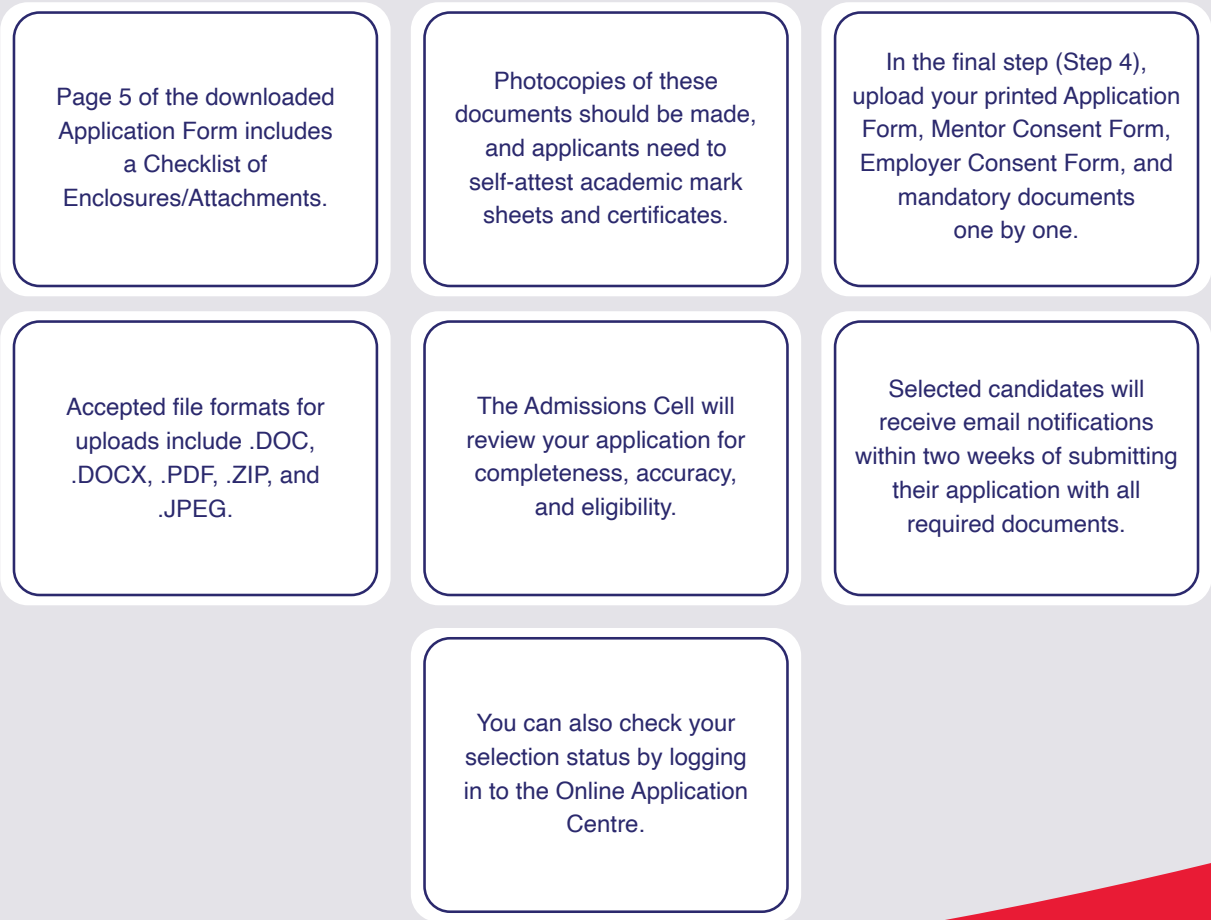


Who is a mentor:

- 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.
- 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.



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.

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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



Pursuing masters, learning more about Data Science and how could I apply it to my work was something that I always wanted to do. BITS Pilani WILP helped me pursue my dream without taking a career break. The group assignments, last-minute preparations and discussions for exams felt like I am back in college.

Chaithanya Rai K

Product Manager, Microsoft Corporation



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





WORK INTEGRATED LEARNING PROGRAMMES

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



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



Call: 080-48767777



admission@wilp.bits-pilani.ac.in