# Programme Specific Orientation Session

## M.Tech. in Artificial Intelligence and Machine Learning

**22nd October 2023**

**BITS** Pilani

Pilani | Dubai | Goa | Hyderabad

# Welcome to

# BITS Pilani and

# Work Integrated Learning Programmes (WILP)

# Agenda

- Academic Guidelines for M.Tech. AIML Programme
- M.Tech. AIML - Programme Overview
- M.Tech. AIML - Programme Operations
- Operations Support
- Question & Answer

# Academic Guidelines for M.Tech. AIML

# Academic Guidelines for M.Tech. AIML Programme

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2 Years, 4 Semesters programme

| Year | First Semester | | | Second Semester | | |
|---|---|---|---|---|---|---|
| | Course No. | Course Title | Units | Course No. | Course Title | Units |
| I | AIML* ZC416 | Mathematical Foundations for Machine Learning | 4 | AIML* ZG511 | Deep Neural Networks | 4 |
| | AIML* ZC418 | Introduction to Statistical Methods | 4 | AIML* ZG512 | Deep Reinforcement Learning | 4 |
| | AIML* ZG557 | Artificial and Computational Intelligence | 5 | | Elective 1 | |
| | AIML* ZG565 | Machine Learning | 4 | | Elective 2 | |
| | | Total | 17 | | Total | 16 |
| II | | Elective 3 | | AIML* ZG628T | Dissertation | 16 |
| | | Elective 4 | | | | |
| | | Elective 5 | | | | |
| | | Elective 6 | | | | |
| | | Total | 16 | | Total | 16 |

- Minimum units required for graduation is 48 (course work)
- Dissertation is of 16 units, standalone
- Each unit corresponds to about 30 hours of effort

# Sample Course Handout

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**WORK INTEGRATED LEARNING PROGRAMMES**

**COURSE HANDOUT**

**Part A: Content Design**

| | |
|---|---|
| **Course Title** | Mathematical Foundations for Data Science |
| **Course No(s)** | |
| **Credit Units** | 4 |
| **Course Author** | G Venkiteswaran |
| **Version No** | 2 |
| **Date** | 15.09.2019 |
| | |

**Course Description**

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions;

**Course Objectives**

| No | Objective- The course aims to |
|---|---|
| CO1 | Introduce concepts in linear algebra and to use it as a platform to model physical problems. |
| CO2 | Provide techniques for analytical and numerical solutions of linear equations and introduce the concept of convergence. |
| CO3 | Utilize concepts of linear algebra and calculus in solving optimization problems. |
| CO4 | Introduce some of the mathematical structures, concepts and notations used in discrete mathematics. |
| CO5 | Introduce some concepts from graph theory, partially ordered sets, Boolean algebras. |

**Text Book(s)**

| No | Author(s), Title, Edition, Publishing House |
|---|---|
| T1 | Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India, 9 th Edition, 2011 |
| T2 | Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata McGraw Hill, 7th Ed., 2011. |

**Reference Book(s) & other resources**

| No | Author(s), Title, Edition, Publishing House |
|---|---|
| R1 | K Hoffman and R Kunze, Linear Algebra, Pearson Education, 2nd Edition, 2005. |
| R2 | Kolman, Busby, Ross and Rehman, Discrete Mathematical Structures for Computer Science, Pearson Education, 6th Edition, 2017 |

**Content Structure**

| No | Title of the module | References |
|---|---|---|
| M1 | 1. Matrices, System of equations, determinants and inverse of a matrix<br><br>1.1. Matrix Algebra-Row-reduced echelon form of a matrix, inverse of a matrix<br>1.2. System of linear equations, Consistency and inconsistency of system of linear equations | T1: Sec 7.1 – 7.3, 7.5, 7.8 |
| M2 | 2. Vector spaces and Linear transformations<br><br>2.1 Vector space, subspace and span of a set, Linear dependence and independence of a set of vectors, basis and dimension<br>2.2. Linear transformation, rank and nullity | T1: Sec 7.4, 7.9, R1: Sec 3.2 |
| M3 | 3. Eigenvalues, Eigenvectors and singular values<br><br>3.1. Eigenvalues<br>3.2. Eigenvectors<br>3.3. Singular value decomposition | T1: Sec 8.2, 8.3 and class notes |
| M4 | 4. Numerical linear algebra<br><br>4.1. Gauss elimination with partial pivoting and scaling<br>4.2. Iterative methods for solving linear system of equations | T1: Sec 20.1 |
| M5 | 5. Matrix Eigenvalue Problems<br><br>5.1. Eigenvalue problems in linear system of equations<br>5.2. Power method for finding the dominant eigenvalue | T1: Sec 20.3, 20.8 |
| M6 | 6. Linear and non-linear optimization<br><br>6.1 Basics of calculus<br>6.2 Linear optimization using simplex method and sensitivity<br>6.3 Non-linear optimization | Class notes |
| | | |
| M7 | 6. Sets, Functions and Relations, Boolean Algebra<br><br>6.1 Introduction to set theory, set relations, set operators, cardinality of sets, Cartesian product of sets<br>6.2 Fundamentals of functions – range, domain, injection, surjection, bijection of functions<br>6.3 Fundamentals of relations, reflexive, symmetric and transitive properties in relations, representing relations, applications of relations, equivalence relations, partial order relations, lattices.<br>6.4 Boolean functions, representing Boolean functions | T2: Sec 2.1, 2.2, 2.3, 7.1 – 7.6, 10.1, 10.2 |
| M8 | 7. Graph Theory<br><br>7.1 Introduction to graph theory, directed and undirected graphs, handshaking theorem, special graph structures, graph representations and isomorphism of graphs, connectedness, components, Euler, Hamilton paths and cycles | T2: Sec 8.1-8.5 |

# Sample Course Handout

## Part B: Contact Session Plan

| | |
|---|---|
| **Academic Term** | I semester 2018-2019 |
| **Course Title** | Mathematical Foundations for Data Science |
| **Course No** | |
| **Lead Instructor** | |

### *Course Contents*

| Contact Hours | List of Topic Title | Text/Ref Book/external resource |
|---|---|---|
| 1 | Introduction to matrices, row-reduced echelon form of a matrix, Consistency of linear systems and matrix inversion<br>• Unary and binary operations and special matrices (orthogonal matrix, upper and lower triangular, diagonal and sparse)<br>• Row reduction and determination of rank. Comparison to computation using determinants<br>• Use of rank in determining the consistency and inconsistency of linear systems<br>• Row reduction to determine the inverse of the matrix (the Gauss Jordan method) (this is to be used in Simplex method later on) | T1: Sec 7.1 – 7.3, 7.5, 7.8 |
| 2 | Vector space, subspace and span, Linear dependence and independence, basis and dimension, Linear transformation, rank and nullity and the rank nullity theorem<br>• Definition and examples of vector space (R^n, space of polynomials of finite degree, n x m matrices etc.,)<br>• Determination of whether a non-empty set of a vector space is a subspace or not<br>• Span of a finite set<br>• Linear dependence and independence (theory and couple of examples)<br>• Basis and dimension of a finite dimensional vector space | T1: Sec 7.4, 7.9<br>R1: Sec 3.2 |
| | • Linear transformation T: V → W (definition and a couple of examples)<br>• Range(T) and Ker(T) as subspaces of W and V respectively<br>• Rank Nullity Theorem (statement without proof) with examples | |
| 3 | Eigenvalues and eigenvectors of a matrix with applications<br>• Eigenvalues – definition and method of determination of eigenvalues<br>• Eigenvectors – definition and methods of finding the eigenvectors | T1: Sec 8.2 – 8.4 |
| 4 | Singular value decomposition with examples (using MATLAB) and applications (Face recognition with SVD)<br>• SVD of a matrix (derivation)<br>• Exemplify using matlab for a couple of matrices and also show that the singular values are arranged in descending order.<br>• Face recognition example. | Class notes |
| 5 | Gauss elimination with scaling and partial pivoting; LU factorization and related methods<br>• Gauss elimination (with and without scaling and partial pivoting). Take an example to shown the role played by precision.<br>• LU factorization, Cholesky and Crout's methods with examples | T1: Sec 20.1, 20.2 |
| 6 | Iterative methods of solving linear systems; Matrix eigenvalue problems and Power method for finding the dominant eigenvalue<br>• Write Ax = b in the form (L+D+U) x = b and work out the iterative scheme for Gauss Jacobi and Gauss Seidel iterations.<br>• Introduce vector and matrix norms (row sum, column sum and Frobenius norms) and work out a few problems in Excel / Matlab<br>• Explain the power method and work out a couple of problems. | T1: Sec 20.3, 20.8 |
| 7 -8 | Application of linear algebra in optimization. Modelling linear programming problem and the basics of Simplex algorithm and sensitivity analysis.<br>• Model a LPP in construction of buildings.<br>• Model the currency conversion optimization problem.<br>• Work out the graphical method of solution in the case of 2 variable case<br>• Simplex method for simple cases<br>• Outline how Gauss Jordan produces the inverse matrix.<br>• Graphical sensitivity analysis (Change in objective value coefficients and rhs of constraints) | Class notes |
| 9 | Calculus of one and several variables; Limits, continuity and differentiability; Maxima and minima of functions; Steepest gradient method for finding the maximum. Constrained optimization (Lagrange multipliers)<br>• Review limits, continuity and differentiability (graphically and algebraically)<br>• Maxima and minima in one variable<br>• Steepest gradient method<br>• Lagrange multipliers (for more number of constraints) | Class notes |

# Evaluation Components

- Evaluation Component 1 (EC1) - Quizzes and Assignments
  - Minimum weightage 20%
  - Individual or group assignments
  - Quizzes administered through LMS
- Evaluation Component 2 (EC2) - Mid-Semester Examination
  - Minimum weightage 30%
  - **Closed** Book Exam, 120 minutes
- Evaluation Component 3 (EC 3) - Comprehensive Examination
  - Minimum weightage 40%
  - **Open** Book Exam, 150 minutes

# Programme Overview

# M.Tech. AIML Programme Overview

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An Inter-disciplinary field comprising Computer Science and Engineering & Statistics

Machine Learning algorithms and AI applications are the focus

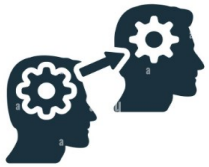
Topics would span:

- Contemporary AIML techniques that drives the application applications in Natural Language Processing & other application areas
- Algorithmic and computational techniques for AI system design, model building using curated data, implement machine learning techniques for handling large datasets and in resource constrained environments and applications

**Curriculum :**

- Strong foundation in mathematics, necessary statistical techniques
- Computing techniques and algorithms for machine learning
- Model development for a AI-driven application pipeline

# M.Tech. AIML Specializations



**Natural Language Processing**

**Deep Learning**

**General**

# M.Tech. AIML
# Programme Overview

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## Programme Structure

| Year | First Semester | | | Second Semester | | |
|---|---|---|---|---|---|---|
| | Course No. | Course Title | Units | Course No. | Course Title | Units |
| I | AIML* ZC416 | Mathematical Foundations for Machine Learning | 4 | AIML* ZG511 | Deep Neural Networks | 4 |
| | AIML* ZC418 | Introduction to Statistical Methods | 4 | AIML* ZG512 | Deep Reinforcement Learning | 4 |
| | AIML* ZG557 | Artificial and Computational Intelligence | 5 | | Elective 1 | |
| | AIML* ZG565 | Machine Learning | 4 | | Elective 2 | |
| | | Total | 17 | | Total | 16 |
| II | | Elective 3 | | AIML* ZG628T | Dissertation | 16 |
| | | Elective 4 | | | | |
| | | Elective 5 | | | | |
| | | Elective 6 | | | | |
| | | Total | 16 | | Total | 16 |

| **Please note:** | | | |
|---|---|---|---|
| Elective I | AIML* ZG530 | Natural Language Processing ** # | 4U |
| Elective III | AIML* ZG513 | Advanced Deep Learning *** ## | 4U |

# M.Tech. AIML
# Programme Overview for Natural Language Processing Specialization

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| Electives on the offer – Semester 2 | | | |
|---|---|---|---|
| Mandatory Elective | AIML* ZG530 | Natural Language Processing | 4U |
| 1 Electives must be chosen among the ones offered below so that minimum 16 unit requirements are met | | | |
| AIML* ZG537 | Information Retrieval (course under NLP) | | 4U |
| AIML* ZG517 | Fair Accountable Transparent Machine Learning | | 4U |
| AIML* ZG529 | Data Management for Machine Learning | | 4U |
| AIML* ZG526 | Probabilistic Graphical Models | | 4U |
| AIML* ZG567 | AI and ML Techniques for Cyber Security | | 5U |
| AIML**ZG516 | ML System Optimization | | 4U |

# M.Tech. AIML
# Programme Overview for Natural Language Processing Specialization

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| Electives on the offer – Semester 3 | | |
|---|---|---|
| 4 Electives must be chosen among the ones offered below so that minimum 16 unit requirements are met | | |
| AIML* ZG519 | NLP Applications (course under NLP) | 4U |
| AIML* ZG522 | Social Media Analytics (course under NLP) | 4U |
| AIML* ZG513 | Advanced Deep Learning | 4U |
| AIML* ZG514 | Graph Neural Networks | 4U |
| AIML* ZG523 | MLOps | 4U |
| AIML* ZG525 | Computer Vision | 4U |
| AIML* ZG531 | Video Analytics | 4U |
| Note : At least 3 courses under NLP are **required** to be completed in semester 2 & 3 including the mandatory elective for NLP specialization. | | |

# M.Tech. AIML
# Programme Overview for
# Deep Learning Specialization

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| Electives on the offer – Semester 2 | | |
|---|---|---|
| 2 Electives must be chosen among the ones offered below so that minimum 16 unit requirements are met | | |
| AIML* ZG537 | Information Retrieval | 4U |
| AIML* ZG517 | Fair Accountable Transparent Machine Learning (course under DL) | 4U |
| AIML* ZG529 | Data Management for Machine Learning | 4U |
| AIML* ZG526 | Probabilistic Graphical Models | 4U |
| AIML* ZG567 | AI and ML Techniques for Cyber Security | 5U |
| **AIML**ZG516** | **ML System Optimization** | **4U** |
| AIML* ZG530 | Natural Language Processing | 4U |

# M.Tech. AIML
# Programme Overview for Deep Learning Specialization

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| Electives on the offer – Semester 3 | | | |
|---|---|---|---|
| Mandatory Elective | AIML* ZG513 | Advanced Deep Learning | 4U |
| 3 Electives must be chosen among the ones offered below so that minimum 16 unit requirements are met | | | |
| AIML* ZG519 | NLP Applications | | 4U |
| AIML* ZG522 | Social Media Analytics | | 4U |
| AIML* ZG514 | Graph Neural Networks (course under DL) | | 4U |
| AIML* ZG523 | MLOps | | 4U |
| AIML* ZG525 | Computer Vision | | 4U |
| AIML* ZG531 | Video Analytics | | 4U |
| Note : At least 3 courses under DL are required to be completed in semester 2 & 3 including the mandatory elective for DL specialization. | | | |

# M.Tech. AIML
# Programme Overview – General Specialization

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| Electives on the offer – Semester 2 | | |
|---|---|---|
| 2 Electives must be chosen among the ones offered below so that minimum 16 unit requirements are met | | |
| AIML* ZG537 | Information Retrieval | 4U |
| AIML* ZG517 | Fair Accountable Transparent Machine Learning | 4U |
| AIML* ZG529 | Data Management for Machine Learning | 4U |
| AIML* ZG526 | Probabilistic Graphical Models | 4U |
| AIML* ZG567 | AI and ML Techniques for Cyber Security | 5U |
| AIML**ZG516 | ML System Optimization | 4U |
| AIML* ZG530 | Natural Language Processing | 4U |

# M.Tech. AIML
# Programme Overview for General Specialization

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| Electives on the offer – Semester 3 | | |
|---|---|---|
| 4 Electives must be chosen among the ones offered below so that minimum 16 unit requirements are met | | |
| AIML* ZG519 | NLP Applications | 4U |
| AIML* ZG522 | Social Media Analytics | 4U |
| AIML* ZG513 | Advanced Deep Learning | 4U |
| AIML* ZG514 | Graph Neural Networks | 4U |
| AIML* ZG523 | MLOps | 4U |
| AIML* ZG525 | Computer Vision | 4U |
| AIML* ZG531 | Video Analytics | 4U |

# M.Tech. AIML
# Programme Overview

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| Electives on the offer – Semester 2 | | |
|---|---|---|
| AIML* ZG530 | Natural Language Processing ** # | 4U |
| AIML* ZG537 | Information Retrieval ** | 4U |
| AIML* ZG517 | Fair Accountable Transparent Machine Learning *** | 4U |
| AIML* ZG529 | Data Management for Machine Learning | 4U |
| AIML* ZG526 | Probabilistic Graphical Models | 4U |
| AIML* ZG567 | AI and ML Techniques for Cyber Security | 5U |
| AIML**ZG516 | ML System Optimization*** | 4U |

| Electives on the offer – Semester 3 | | |
|---|---|---|
| AIML* ZG519 | NLP Applications ** | 4U |
| AIML* ZG522 | Social Media Analytics ** | 4U |
| AIML* ZG513 | Advanced Deep Learning *** ## | 4U |
| AIML* ZG514 | Graph Neural Networks *** | 4U |
| AIML* ZG531 | Video Analytics | 4U |
| AIML* ZG523 | MLOps | 4U |
| AIML* ZG525 | Computer Vision | 4U |

** Courses under NLP ,

*** Courses under DL

# Mandatory Elective for NLP Specialization

## Mandatory Elective for DL Specialization

Note: Atleast 3 courses from respective category are **required** to be completed including the mandatory elective for the opted specialization. The elective list is tentative and subject to change depending on the availability in the academic year

# M.Tech. AIML
# Programme Overview

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| Faculty | Pedagogical Tools/Techniques | Evaluation |
|---|---|---|
| • Experts drawn from industry and academia | • Experiential learning<br>  • Assignments, case studies, lab exercises<br>• Collaborative learning<br>  • Group activities & exercises | • Quiz<br>• Lab, Assignments, Projects<br>• Mid semester exam<br>• End semester exam |

# M.Tech. AIML
# Programme Overview

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- Assignments
  - Students will work in a virtual group of three, as assigned by the backend using some constraints.
- Quizzes
  - Quizzes are online for all the courses. Each quiz will be evaluated for 5%.
  - Timelines for quizzes and assignments to be announced by the IC for each courses.

| Units and Courses | Quiz | Assignment | Mid Sem Exam (Open Book) | End Semester Exam (Open Book) | Total |
|---|---|---|---|---|---|
| 4 Unit Courses | 10 | 20 | 30 | 40 | 100 |
| 5 Unit Courses | 5 | 25 | 30 | 40 | 100 |

# M.Tech. AIML Programme Overview

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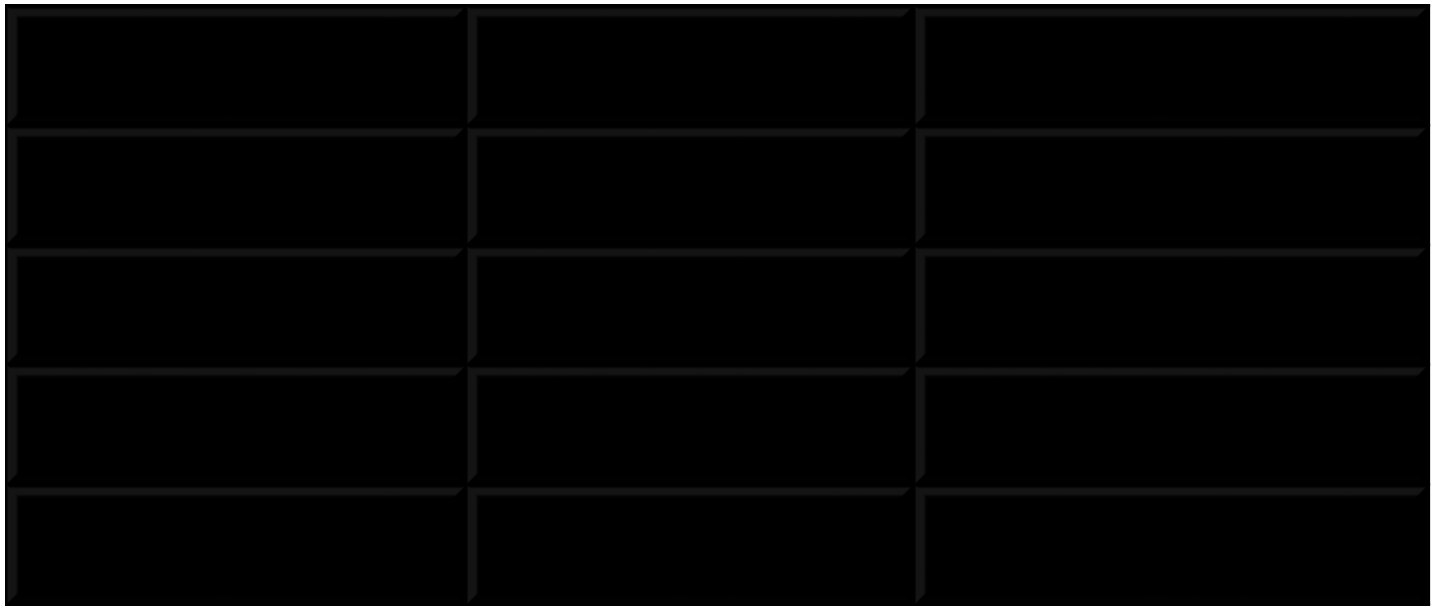
- Python, programming language of choice for all the courses
- Optional Course on ‘ Introduction to Python for Data Science ’
  - Designed to give an overview of Python and some of python libraries used in courses
  - Recorded sessions are shared through the canvas for your personal reference.
  - No evaluation for this course - not a part of formal course package
  - Python will not be taught as programming language as a part of any other course
  - No evaluation components. Exercises will be given for practice purposes.

# Programme Operations

# Schedules
# Program Timelines - [November 2023]



# Schedule - Lecture Sessions

- Classes will be held over weekends through online mode
- **Tentative Schedule :** 4 Sessions / Day **or** 5 Sessions/ Day
  - Class #1:  8:30 AM to 10:30 AM
  - Class #2: 10:40 AM to 12:40 PM
  - Class #3: 1:40 PM to 3:40 PM
  - Class #4: 3:50 PM to 5:50 PM
  - Class #5: 6:00 PM to 8:00 PM
- Each course will be offered in multiple sections. Students will be allotted a section for a course. Sections will be allotted in such a way that a student attends all the classes either on Saturday or Sunday. (If needed, One
- session on Friday evening)
- Sessions will be recorded and automatically made available in Microsoft Teams account for streaming

# People involved in the Course Delivery

- Instructor - in - Charge (IC)
  - Leads the course delivery
- Instructors
- Teaching Assistants

| **Led by IC** | | | |
|---|---|---|---|
| Sec: Sat #1 | Sec: Sat #2 | Sec: Sun #1 | Sec: Sun #2 |
| Instructor #1 | Instructor #2 | Instructor #3 | Instructor #4 |
| **Supported by Teaching Assistants** | | | |

# Course Delivery

- Semester #2

| Session | Saturday | Sunday |
|---|---|---|
| 1 | Core Course | Core Course |
| 2 | Core Course | Core Course |
| 3 | Electives | Electives |
| 4 | Electives | Electives |

**Note:**
Desirable to plan for the specialization before the start of second semester course selections.
Only ONE Specialization must be chosen by the students after the end of fourth semester course selections.
No change request for consideration of both specializations or change in specialization is allowed after this process.

# Course Delivery

- Semester #3
  - 7 electives
  - We do not guarantee that all four courses/sections of their choice can be taken on the same day.

| Code | Title | Saturday Slot #1<br>Saturday Slot #2 | Sunday Slot #1 |
|---|---|---|---|
| AIML* ZG514 | Graph Neural Networks *** | 2:00 PM [ **GNN #1** ] | No Sunday Section |
| AIML* ZG522 | Social Media Analytics ** | 4:15 PM [ **SMA #1** ] | 2:00 PM [ **SMA #2** ] |
| AIML* ZG519 | NLP Applications ** | No Sunday Section | 2:00 PM [ **NLPA #1** ] |
| AIML* ZG523 | MLOps | 2:00 PM [ **MLOP #1** ] | 4:15 PM [ **MLOP #2** ] |
| AIML* ZG525 | Computer Vision | 2:00 PM [ **CV #1** ] | 4:15 PM [ **CV #2** ] |
| AIML* ZG513 | Advanced Deep Learning *** ## | 2:00 PM [ **ADL #1** ] | 8:45 AM [ **ADL #2** ] |
| AIML* ZG515 | Video Analytics | 4:15 PM [ **VA #1** ] | No Sunday Section |

**This table is only for representation. Actual schedule & the list of electives may be different from this subject to the availability in that academic semester.**

# Course Delivery

- Semester #4
- Dissertation
- No. of units: 16
- 3 Interactions between Student and BITS Examiners

# Schedules -Tutorial, evaluation components

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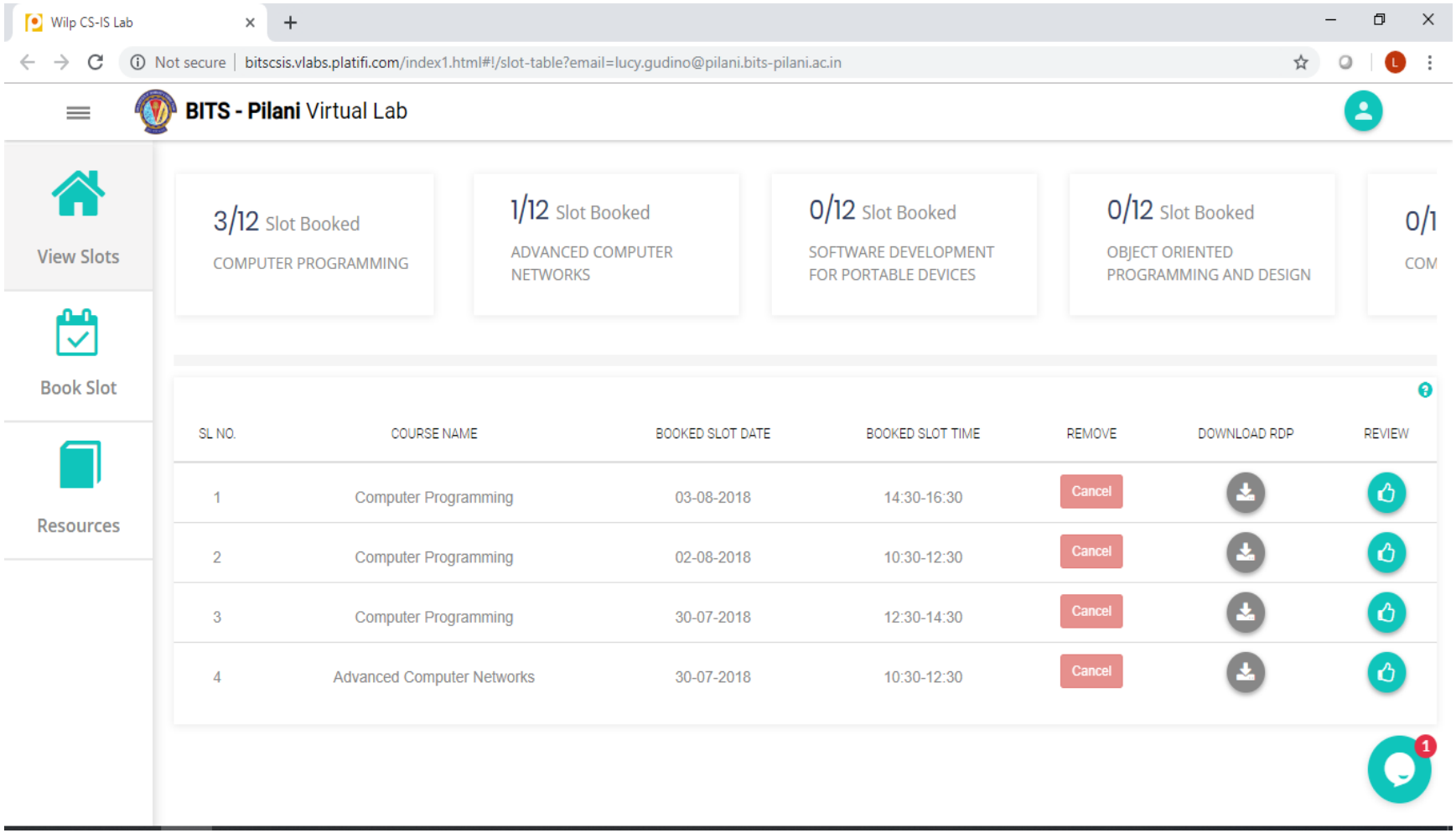
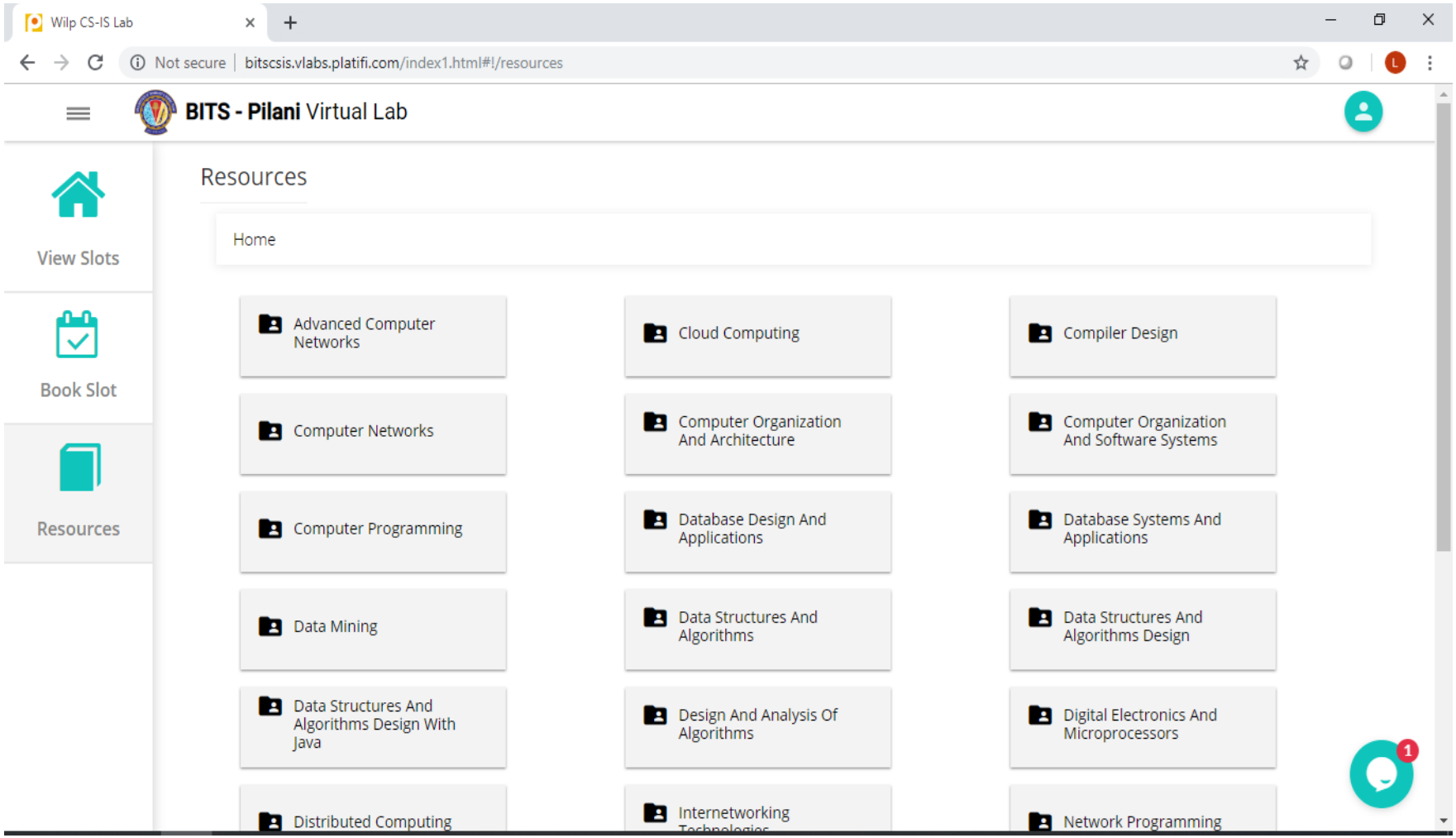
- Tutorials / Webinar Sessions
  - 4 sessions of 90 mins for each course
    - Recitation of topics, problem solving will be the focus of the sessions
    - Typically delivered by Teaching Assistants, attached to the course
    - On Tuesday / Thursday from 7:00 PM to 8:30 PM
    - Sessions will be recorded and posted for later reference.
- Mid Semester (120 Mins / course), Comprehensive Exams (150 Mins / course)
  - Schedules to be announced at the beginning of semester
  - Exam may fall on **Friday**/Saturday/Sunday
- Assignments & Quizzes
  - To be announced through canvas for each courses. **No make-ups**.

# Virtual Lab/ Remote Lab



# Virtual Lab/ Remote Lab



# Formal Communication

- Formal BITS Notices will be delivered through Canvas Announcements and Emails in BITS ID.
- Configure your BITS email signature to carry the following details

  [Your Name as it appears on University Records]

  [Your Student ID - All Caps]

  M.Tech (AIML)[ 2023 October Batch]

- Include relevant details when you initiate a email communications with instructors / IC's / and others in BITS.

  - For Ex: your section #, when you write to your IC.

- Always use BITS Email ID for all official communication

# Operations Support

# Formal Communication

- Communicate with the appropriate ones for quick resolutions. For Ex:
  - Raise all queries on course contents, clarifications in the **canvas** discussion forums, messages to TA's, instructors or IC's
  - Other course related concerns as emails to your instructor / IC by email
  - Issues with canvas, matters related to access etc, issue with hall tickets, exam venues etc as tickets in student care help desk - Queries raised here will be typically resolved in 48 hours - You will find options to escalate your queries in the student care help desk in canvas.

# Whom to Contact for support?

- **Student Care Helpdesk Portal:**
  - https://wilpqueries.bits-pilani.ac.in/
- **Programme Coordinators Contact:**
  - pc.aiml@wilp.bits-pilani.ac.in
- **Operations Team Contact:**
  - ops.aiml@wilp.bits-pilani.ac.in

# Questions ?

**Programme Specific Orientation Session - M.Tech. in AIML**

**22nd October, 2023**

**BITS** Pilani

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# Thank you