BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
WORK INTEGRATED LEARNING PROGRAMMES

COURSE HANDOUT

Part A: Content Design

Course Title	Mathematical Foundations for Data Science
Course No(s)	SE ZC416
Credit Units	3
Course Author	Padma Murali
Version No	
Date	19.07.2018

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	Introduce some of the mathematical structures, concepts and notations used in discrete mathematics.
CO4	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 1.1. Matrix Algebra-Row-reduced echelon form of a matrix, Inverse of a matrix 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 2.1 Vector space, subspace and span of a set, Linear dependence and independence of a set of vectors, basis and dimension 2.2. Linear transformation, rank and nullity	T1: Sec 7.4, 7.9, R1: Sec 3.2
M3	3. Eigenvalues and Eigenvectors 3.1. Eigenvalues 3.2. Eigenvectors	T1: Sec 8.2, 8.3
M4	4. Numerical linear algebra 4.1. Gauss elimination with partial pivoting and scaling 4.2. Iterative methods for solving linear system of equations	T1: Sec 20.1
M5	5. Matrix Eigenvalue Problems 5.1. Eigenvalue problems in linear system of equations 5.2. Power method for finding the dominant eigenvalue	T1: Sec 20.3, 20.8
M6	6. Sets, Functions and Relations, Boolean Algebra 6.1 Introduction to set theory, set relations, set operators, cardinality of sets, Cartesian product of sets 6.2 Fundamentals of functions – range, domain, injection, surjection, bijection of functions 6.3 Fundamentals of relations, reflexive, symmetric and transitive properties in relations, representing relations, applications of relations, equivalence relations, partial order relations, lattices. 6.4 Boolean functions, representing Boolean functions	T2: Sec 2.1, 2.2, 2.3, 7.1 – 7.6, 10.1, 10.2
M7	7. Graph Theory 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 7.2 Trees, binary trees, binary search tree, spanning trees, minimum spanning trees – Prim's and Kruskal's algorithms.	T2: Sec 8.1-8.5, 9.1-9.5

Learning Outcomes:

No	Learning Outcomes
LO1	Students will be able to effectively use matrix algebra tools to analyse and solve systems of linear equations.
L02	Students will be able to use some numerical methods to solve linear systems of equations
LO3	Students will be able to work with some of the mathematical structures, concepts and notations used in discrete mathematics
LO4	Students will be able to apply the concepts of sets, functions, relations and graph theoretic concepts to problems in computer science

Part B: Contact Session Plan

Academic Term	First Semester 2020-2021
Course Title	Mathematical Foundations for Data Science
Course No	SE ZC416
Lead Instructor	K.VENKATA RATNAM

Course Contents

Contact Hours	List of Topic Title	Text/Ref Book/external resource
1	Introduction to matrices, row-reduced echelon form of a matrix	T1: Sec 7.1 – 7.3
2	Consistency of linear systems, matrix inversion	T1: Sec 7.5, 7.8
3	Vector space, subspace and span, Linear dependence and independence, basis and dimension	T1: Sec 7.4
4	Linear transformation, rank and nullity	T1: Sec 7.9, R1: Sec 3.2
5	Eigenvalues of a matrix	T1: Sec 8.2
6	Eigenvectors of a matrix	T1: Sec 8.3
7	Gauss elimination with scaling and partial pivoting	T1: Sec 20.1
8	Iterative methods of solving linear systems; Matrix eigenvalue problems and Power method for finding the dominant eigenvalue	T1: Sec 20.3, 20.8

9	Introduction to set theory, set relations, set operators, cardinality of sets, Cartesian product of sets	T2: Sec 2.1, 2.2
10	Fundamentals of functions – range, domain, injection, surjection, bijection of functions	T2: Sec 2.3
11	Fundamentals of relations, reflexive, symmetric and transitive properties in relations	T2: Sec 7.1, 7.2
12	Representing relations, applications of relations, equivalence relations, partial order relations, lattices.	T2: Sec 7.3, 7.4, 7.5, 7.6
13	Introduction to graph theory, directed and undirected graphs, handshaking theorem, special graph structures, graph representations	T2: Sec 8.1, 8.2
14	Isomorphism of graphs, connectedness, components, Euler, Hamilton paths and cycles	T2: Sec 8.3, 8.4, 8.5
15	Trees, binary trees, binary search tree, Spanning trees, minimum spanning trees – Prim's and Kruskal's algorithms.	T2: Sec 9.1, 9.2, 9.3, Sec 9.4, 9.5
16	Boolean Algebra- Boolean Functions, Representing Boolean functions	T2: Sec 10.1, 10.2

 # The above contact hours and topics can be adapted for non-specific and specific WILP programs depending on the requirements and class interests.

Lab Details

Title	Access URL
Lab Setup Instructions	Not applicable
Lab Capsules	Not applicable
Additional References	Not applicable

Select Topics and Case Studies from business for experiential learning

Topic No.	Select Topics in Syllabus for experiential learning	Access URL
1	Assignment - linear algebra topics	
2	Assignment- discrete structures topics	

Evaluation Scheme:

Legend: EC = Evaluation Component; AN = After Noon Session; FN = Fore Noon Session

No	Name	Type	Duration	Weight	Day, Date, Session, Time
EC-1	Quiz-I	Online	-	5%	September 10-20, 2020
	Quiz-II	Online		5%	October 20-30, 2020
	Quiz - III	Online		5%	November 10-20, 2020
EC-2	Mid-Semester Test	Closed Book	2 hours	35%	Sunday, 11/10/2020 (FN) 10 AM - 12 Noon
EC-3	Comprehensive Exam	Open Book	3 hours	50%	Sunday, 13/12/2020 (FN) 9 AM – 12 Noon

Important Instructions:

Syllabus for Mid-Semester Test (Closed Book): Topics in Session Nos. 1 TO 8

Syllabus for Comprehensive Exam (Open Book): All topics

Important links and information:

Elearn portal: https://elearn.bits-pilani.ac.in

Students are expected to visit the Elearn portal on a regular basis and stay up to date with the latest announcements and deadlines.

Contact sessions: Students should attend the online lectures as per the schedule provided on the Elearn portal.

Evaluation Guidelines:

1. EC-1 consists of either three Assignments. Students will attempt them through the course pages on the Elearn portal. Announcements will be made on the portal, in a timely manner.
2. For Closed Book tests: No books or reference material of any kind will be permitted.
3. For Open Book exams: Use of books and any printed / written reference material (filed or bound) is permitted. However, loose sheets of paper will not be allowed. Use of calculators is permitted in all exams. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
4. If a student is unable to appear for the Regular Test/Exam due to genuine exigencies, the student should follow the procedure to apply for the Make-Up Test/Exam which will be made available on the Elearn portal. The Make-Up Test/Exam will be conducted only at selected exam centres on the dates to be announced later.

It shall be the responsibility of the individual student to be regular in maintaining the self study schedule as given in the course handout, attend the online lectures, and take all the prescribed evaluation components such as Assignment , Mid-Semester Test and Comprehensive Exam according to the evaluation scheme provided in the handout.