॥ सा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड – ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with'B++' grade

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

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विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरण २०२० नुसार पदव्युत्ती द्वितीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२५–२६ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, दिनांक २७ मे २०२५ रोजी संपन्न झालेल्या मा. विद्यापरिषद बैठकीतील विषय क्रमांक ४२/६१–२०२५ च्या ठरावानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील राष्ट्रीय शैक्षणिक धोरण–२०२० नुसारचे पदव्युत्तर द्वितीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२५–२६ पासून लागू करण्यास मा. विद्यापरिषदेने मान्यता प्रदान केली आहे. त्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील एम. एस्सी द्वितीय वर्षाचे खालील विषयाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२५–२६ पासून लागू करण्यात येत आहेत.

01	M. Sc. II year Data Science (Affiliated College)
02	M. Sc. II year Computer Application (Affiliated College)

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी, ही विनंती.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.:शै–१/एनइपी/विवत्रंविपदवी/२०२५–२६/194
दिनांक २९.०७.२०२५

सहाय्यक कुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत : माहितीस्तव तथा कार्यवाहीस्तव.

१) मा. कुलगुरू महोदयांचे कार्यलय, प्रस्तुत विद्यापीठ.
२) मा. प्र. कुलगुरू महोदयांचे कार्यलय, प्रस्तुत विद्यापीठ.
३) मा. आधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
४) मा. संचालक, परीक्षा व मुंल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
५) मा. प्राचार्य, सर्व संबधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
६) सिस्टीम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. याना देवून कळविण्यात येते की, परिपत्रक अभ्यासक्रम संकेतस्थळावर प्रसिध्द करण्यात यावेत.

SWAMI RAMANAND TEERTH

MARATHWADA UNIVERSITY, NANDED - 431 606

(Structure and Syllabus of Two Years PG Degree Program with Multiple Entry and Exit Option)

TWO YEAR MASTERS PROGRAMME IN SCIENCE

Subject Data Science

Under the Faculty of

Science and Technology

Effective from Academic year 2024 – 2025

(As per NEP-2020)

Swami Ramanand Teerth Marathwada University

Nanded

Affiliated Colleges

Faculty of Science and Technology

NEP-2020 Oriented Structure of Post Graduate Programs

(as per Govt. of Maharashtra GR dated 16-05-2023)

M.Sc. Data Science (Affiliated Colleges)

(Second Year)

Introduced from Academic Year 2025-2026

Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science and Technology

NEP-2020 oriented Structure of Two Years Post Graduate Program

Subject: Data Science (Affiliated Colleges) Second Year

Introduced from Academic Year 2025-2026 **(as per Govt. of Maha. GR dated 16-05-2023)**

Program Year and Sem	**Level**	**Semester**		**Faculty**			**Other courses**				
Second Year is program for PG programs in the affiliated colleges			**Major / Mandatory / SDSC**		**Electives / SDSC**		**RM /others**	**OJT/FP/**	**RP**	**Total Sem. credits**	**Cumu. Credits**
			Theory	**Practical**	**Theory**	**Practical**					
			(04 credits)	**(01credits)**	**(04 credits) (03+01)**		**(02 credits)**	**(04 credits)**	**(04 credits)**		
M.Sc. DS	6.5	Third Semester	SDATSC-501 SDATSC-502 SDATSC-503	SDATSP-501 SDATSP-502	SDATSE-501 (FROM SAME SCHOOL/DEPT)	---------	---------	---------	SDATSR-501	**22**	**66**
M.Sc. DS	6.5	Fourth Semester	SDATSC-551 SDATSAC-552	SDATSP-551 SDATSP-552	SDATSE-551 (FROM SAME SCHOOL/DEPT)	--------	SVECP -551 Publication ethics	---------	SDATSR-551 (06 credits)	**22**	**88**
Exit Option: After completion of Second year as above with cumulative 88 credits, student will be awarded M.Sc. in Data Science Degree depending upon enrollment and completion of program specific core and electives courses ** ****(for students who have done 03 years UG program)**											

Program Specific Syllabus: Third Semester
Data Science

Core Courses Code	Title	Remarks Credits
SDATSC-501	Computer Vision and Image Analytics	04
SDATSC-502	Machine Learning with Python	04
SDATSC-503	Mathematical and Statistical foundation for Data Science	04
SDATSCP-501	Lab 7:IP Using Python Lab	01
SDATSCP-502	Lab 8: Machine Learning Lab	01
SDATSE-501	**Chose any one** A. Introduction to Artificial Intelligence B. Internet of Things C. Database Administration	03 Theory and 01 Lab
SDATSR-501	Research Project	04

Program Specific Syllabus: Fourth Semester
Data Science

Core Courses Code	Title	Remarks Credits
SDATSC-551	Natural Language Processing	04
SDATSC-552	Deep Learning	04
SDATSCP-551	Lab 9: NLP Lab	01
SCDATSCP-552	Lab 10: Deep Learning Lab	01
SDATSE-551	**Chose any one** A. NoSQL Databases B. DevOps Fundamental C. Block Chain and Cryptography	03 Theory and 01 Lab
SVECP -551	Publication Ethics	02
SDATSR-551	Research Project	06

M. Sc. Second Year, Semester III (*Level 6.5):* Teaching Scheme

	Course Code	Course Name	Credits Assigned per course			Teaching Scheme (Hrs./ week) per course	
			Theory	Practical	Total	Theory	Practical
Major	SDATS-501 to SDATSC-503	All Core Course	12	--	12	12	--
Elective	SDATSE-501 and SDATSE-551	All Elective Courses	03	--	03	03	--
Special Courses	SDATSR-501	Research Project	--	04	04	--	02
Major Practical	SDATSCP-501 to SDATSCP-502	All Core labs	--	02	02	--	02
Elective Practical	SDATSE-501	Elective lab	--	01	01	--	01
Total Credits per semester			**15**	**07**	**22**	**15**	**05**

M. Sc. Second Year, Semester IV (*Level 6.5):* Teaching Scheme

	Course Code	Course Name	Credits Assigned per course			Teaching Scheme (Hrs./ week) per course	
			Theory	Practical	Total	Theory	Practical
Major	SDATSC-551 to SDATSC-552	All Core Course	08	--	08	08	--
Elective	SDATSE-551	All Elective Courses	03	--	03	03	--
Special Courses	SDATSR-551	Research Project	--	06	06	--	04
Special Courses	SVECP -C551	Publication ethics	02	--	02	02	--
Major Practical	SDATSCP -551 and SDATSCP -552	All Core labs	--	02	02	--	02
Elective Practical	SDATSE-551	Elective lab	--	01	01	--	01
Total Credits per semester			**13**	**09**	**22**	**13**	**07**

M. Sc. Second Year, Semester III and IV (Level 6.5): Examination Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
		Continuous Assessment (CA)			ESA			
		Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
SDATSC-501 to SDATSC-503 and SCMPDATSSC-551 to SDATSC-552	All core courses	20	20	20	80	--	--	100
SDATSE-501 and SDATSE-551	All elective courses	15	15	15	60	--	--	75
Special Courses	SDATSR-501	--	--	--	--	25	75	100
Special Courses	SDATSR-551	--	--	--	--	50	100	150
Special Courses	SVECP -C551	10	10	10	40	--	--	50
SDATSCP-501 to SDATSCP-502 SDATSCP -551 and SDATSCP -552	All Core Labs	--	--	--	--	05	20	25
SDATSE-501and SDATSE-551	All Elective labs	--	--	--	--	05	20	25

Guidelines for Course Assessment:

A. **Continuous Assessment (DS) (20% of the Maximum Marks):** This will form 20% of the Maximum Marks and will be carried out throughout the semester. It may be done by conducting **Two Tests** (Test I on 40% curriculum) and **Test II** (remaining 40% syllabus). Average of the marks scored by a student in these two tests of the theory paper will make his **C**A score (col. 6).

B. **End Semester Assessment (80% of the Maximum Marks): (*For illustration we have considered a paper of 04 credits, 100 marks and need to be modified depending upon credits of an individual paper)***

1. **ESA Question paper will consist of 6 questions, each of 20 marks.**
2. **Students are required to solve a total of 4 Questions.**
3. **Question No.1 will be compulsory and shall be based on entire syllabus.**
4. Students need to solve **ANY THREE** of the remaining Five Questions (Q.2 to Q.6) and shall be based on entire syllabus.

C. **Question paper of campus and affiliated colleges shall be different**

Note: **Number of lectures required to cover syllabus of a course depends on the number of credits assigned to a particular course. One credit of theory corresponds to 15 Hours lecturing and for practical course one credit corresponds to 30 Hours. For example, for a course of two credits 30 lectures of one-hour duration are assigned, while that for a three credit course 45 lectures.**

%%%%%

M.Sc. Data Science

M.Sc.(CS) S. Y. (Semester III)

SDATSC-501 Computer Vision and Image Analytics

Learning Objectives:

i. To understand digital image processing principles.
ii. To apply image processing techniques and to implement image enhancement and restoration.
iii. Perform image segmentation and object detection.
iv. To extract features for analysis and classification.
v. To develop Python applications for image processing tasks

Course Outcomes:

Upon successful completion of this course, students will be able to:

- Acquire proficiency in digital image processing fundamentals.
- Demonstrate competence in utilizing Python for image processing.
- Execute techniques for image enhancement and restoration effectively.
- Successfully perform image segmentation and object detection.
- Employ feature extraction methods for analysis and classification tasks.
- Create functional Python applications tailored for image processing purposes.

Unit I: Introduction to Digital Image Processing **8 Hrs.**

Basics of digital images, Image representation (grayscale, RGB, etc.), Image acquisition and sampling, Histogram equalization, Spatial domain methods (e.g., filtering), Frequency domain methods (e.g., Fourier transform)

Unit II: Image Restoration **8 Hrs.**

Image degradation models, Noise reduction techniques, Image Blurring and sharpening, Thresholding techniques, Edge detection of Image, Region-based segmentation, Texture analysis, Shape descriptors, Corner detection

Unit III: Introduction to Python Libraries for Image Processing **8 Hrs.**

Overview of OpenCV, scikit-image, and NumPy, Installation and setup

Unit IV: Image Processing with OpenCV and scikit-image **8 Hrs.**

Loading and displaying images, Basic image operations, Filtering and convolution, Image manipulation and transformation, Segmentation algorithms, Feature extraction

Unit V: Feature Extraction **8 Hrs.**

Introduction to feature extraction, Texture analysis using gray-level co-occurrence matrix (GLCM), Shape descriptors: Hu moments, Fourier descriptors

Unit VI: Applications of Image Processing **8 Hrs.**

Medical image processing: MRI and CT image analysis, Remote sensing applications: satellite image processing, Computer vision applications: object detection and recognition

References:

1. Gonzalez, R.C., Woods, R.E., & Eddins, S.L. (2018). Digital Image Processing Using MATLAB.
2. Szeliski, R. (2010). Computer Vision: Algorithms and Applications.
3. Burger, W., & Burge, M.J. (2016). Digital Image Processing: An Algorithmic Approach with MATLAB.
4. Sonka, M., Hlavac, V., & Boyle, R. (2014). Image Processing, Analysis, and Machine Vision.

M.Sc. Data Science

M.Sc. (DS) S. Y. (Semester III)

SDATSC-501 Computer Vision and Image Analytics

Note: Conduct at least 15 practical based on given syllabus.

M.Sc. Data Science

M.Sc. (DS) S. Y. (Semester III)

SDATSC-502- Machine Learning with Python

Learning Objectives:

i. Understand Core Machine Learning Concepts
ii. Preprocess and Analyze Data Using Python
iii. Implement ML Algorithms in Python
iv. Evaluate and Optimize Model Performance
v. Build Complete ML Pipelines
vi. Solve Real-World Problems Using ML.

Course Outcomes:
After successful completion of this course, students should be able to:

- Understand and explain fundamental concepts of machine learning, including types, algorithms, and real-world applications.
- Preprocess and analyze datasets using Python libraries such as NumPy, Pandas, and Matplotlib for effective machine learning.
- Implement supervised and unsupervised machine learning algorithms using Python and scikit-learn.
- Evaluate the performance of machine learning models using appropriate metrics like accuracy, precision, recall, and F1-score.
- Optimize models through techniques like cross-validation and hyperparameter tuning.
- Apply machine learning techniques to solve real-world problems through hands-on projects using Python.

Unit I: Introduction to Machin Learning **05 Hrs.**

Why Machine Learning?, Problems Machine Learning Can Solve, Knowing Your Task and Knowing Your Data, Why Python?

Unit II: Supervised Learning **8 Hrs.**

Classification and Regression, Generalization, Overfitting, and Under fitting, Supervised Machine Learning Algorithms, k-Nearest Neighbors, Linear Models, Naive Bayes Classifiers, Decision Trees, Ensembles of Decision Trees, Kernelized Support Vector Machines.

Unit III: Unsupervised Learning and Preprocessing **10 Hrs**.

Types of Unsupervised Learning, Challenges in Unsupervised Learning, Preprocessing and Scaling, Different Kinds of Preprocessing, Applying Data Transformations, Scaling Training and Test Data the Same Way, The Effect of Preprocessing on Supervised Learning, Dimensionality Reduction, Feature Extraction, and Manifold Learning

Unit IV: Unsupervised Learning Algorithm **8 Hrs.**

Principal Component Analysis (PCA), Non-Negative Matrix Factorization (NMF), Manifold Learning with t-SNE, Clustering, k-Means Clustering, Agglomerative Clustering DBSCAN, Comparing and Evaluating Clustering Algorithms

Unit V: Representing Data and Engineering Features **6 Hrs**.

Categorical Variables, One-Hot-Encoding (Dummy Variables), Numbers Can Encode Categorical, Binning, Discretization, Linear Models, and Trees, Interactions and Polynomials

Unit VI: Model Evaluation and Improvement **9 Hrs**.

Cross-Validation, Cross-Validation in scikit-learn, Benefits of Cross-Validation, Stratified k-Fold Cross-Validation and Other Strategies, Grid Search, Simple Grid Search

References:

1. Introduction to Machine Learning with Python by Andreas C. Müller and Sarah Guido.

M.Sc. Data Science

M.Sc. (DS) S. Y. (Semester III)

SDATSC-502- Machine Learning with Python

Note: Conduct at least 15 practical based on given syllabus.

M.Sc. Data Science

M.Sc. (DS) S. Y. (Semester III)

SDATSC-503- Mathematical and Statistical foundation for Data Science

Objectives:

i. Formulating and solving complex problems using mathematical and data science principles.
ii. Developing mathematical models for real-life data science problems.
iii. Applying ethical considerations in data science practice.
.

Outcomes:

- Students are able to Use Python for data processing, analysis, and visualization.
- Apply logical thinking to problem-solving in context.
- Use appropriate technology to aid problem-solving and data analysis

Unit I: Measures of Dispersion **8Hrs.**

Introduction, Measures of Dispersion: Range, Standard deviation, Variance and coefficient of variance, formulae and examples.

Unit II: Determinant **10Hrs.**

Find value of a determinant, simplify determinant, and solve linear equations in 2 variables.

Unit III: Matrices **8Hrs.**

Definition & Types, Equality & transpose of matrices, Algebra of matrices, Definition of determinant, Ad-joint of matrices, Inverse of matrices.

Unit IV: Correlation & Regression **8Hrs.**

Introduction, Correlation, types of correlation, Karl Pearsons coefficient of correlation, Examples, Regression, types of lines, examples.

Unit V: Relation & function **8Hrs.**

Cartesian products, Relation, Function, Domain, Range, Type of function, Examples

Unit VI: Graph theory **8Hrs.**

Definition & types of graphs, incidences & degree of vertices, Isomorphism of graphs, Walks, Paths & circuits, Tree, Centre of tree, Binary tree.

References:

1. Elements of discrete mathematics, C. L. Liu
2. Discrete mathematics, Olympia Nicodemi
3. Graph theory, Narsing Deo
4. Basic mathematics, Mittal & Agrawal
5. Statistical Methods–S. P. Gupta 9th Edition, S. Chand Publication

M.Sc. Data Science

M.Sc. (DS) S. Y. (Semester III)

SDATSC-503- Mathematical and Statistical foundation for Data Science

Note: Conduct at least 15 practical based on given syllabus.

M.Sc. Data Science

M.Sc. (DS) S. Y. (Semester III)

SDATSE-501 A- Introduction to Artificial Intelligence

Course Objectives:

i. To introduce the fundamental concepts and techniques of Artificial Intelligence, including problem-solving, knowledge representation, reasoning, and learning.
ii. To familiarize students with the applications of AI in real-world scenarios, enabling them to understand how intelligent systems are designed and implemented.

Course Outcome:

- Students will be able to describe key concepts of Artificial Intelligence, including types of AI, intelligent agents, and core problem-solving techniques.
- Students will be able to implement basic AI algorithms such as uninformed and informed search to solve simple computational problems.

Unit I: Introduction to Artificial Intelligence **8 Hrs.**

Definition and history of AI, Types of AI: Narrow, General, and Super AI, Applications of AI in various domains, AI Techniques: Search, Knowledge Representation, Reasoning, Agents and Environments: Types of agents, PEAS representation

Unit II: Problem Solving and Search Techniques **8 Hrs.**

Problem formulation, Uninformed search strategies: BFS, DFS, Depth-limited search, Informed search strategies: Best-first, A*, Greedy search, Heuristics and evaluation functions, Constraint Satisfaction Problems (CSPs)

Unit III: Knowledge Representation and Reasoning **8 Hrs.**

Propositional and Predicate Logic, Forward and Backward chaining, Rule-based systems and semantic networks, Ontologies, Uncertainty in AI: Bayesian reasoning and fuzzy logic

Unit IV: Introduction to Neural Networks and Deep Learning **8 Hrs.**

Biological vs. Artificial Neural Networks, Perceptron model and Multilayer Perceptron, Activation Functions, Backpropagation algorithm, Introduction to Convolutional Neural Networks and Applications:

Unit V: Introduction to Fuzzy logic and sets **10 Hr**

Notion of Fuzziness, Membership Functions, Fuzzification and Defuzzification; Operations on Fuzzy Sets, Fuzzy Functions and Linguistic Variables; Fuzzy Relations, Fuzzy Rules and Fuzzy Inference; Fuzzy Control System and Fuzzy Rule Based Systems.

Unit VI: Genetic Algorithms **8 hrs**

Genetic Algorithms (GA): Encoding Strategies, Genetic Operators, Fitness Functions and GA Cycle; Problem Solving using GA.

References:

1. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig 4th Edition (or latest) Pearson Education
2. *Fuzzy Logic with Engineering Applications*, Timothy J. Ross, Wiley
3. *Genetic Algorithms in Search, Optimization, and Machine Learning, David E. Goldberg, Addison-Wesley, **ISBN**: 978-0201157673, **Edition**: 1st Edition (1989)*

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M.Sc. Data Science

M.Sc. (DS) S. Y. (Semester III)

SDATSE-501A- Introduction to Artificial Intelligence

Note: Conduct at least 15 practical based on given syllabus.

M.Sc. Data Science

M.Sc. (DS) S. Y. (Semester III)

SDATSE-501B- Internet of Things (IoT)

Learning Objectives:

i. To study the fundamentals about IoT
ii. To study about IoT Access technologies
iii. To study the design methodology and different IoT hardware platforms.
iv. To study the basics of IoT supporting services.
v. To study about various IoT case studies and industrial applications.

Course Outcomes:

After successful completion of this course, students should be able to:

- Understand the basics of IoT.
- Implement the state of the Architecture of an IoT.
- Understand design methodology and hardware platforms involved in IoT.

Unit I: Basics of IoT Networking **8 Hrs.**

Overview of Internet of Things, Wireless Sensor Networks, Machine-to-Machine Communications Cyber Physical Systems

Unit II: Introduction to Internet of Things **8 Hrs.**

Evolution of IoT, Enabling IoT and the Complex Interdependence of Technologies, IoT Networking Components, Addressing Strategies in IoT

Unit III: IoT Sensors, Actuators and Microcontroller devices **8 Hrs.**

Sensors, Sensor Characteristics, Sensing Types, Actuators, Actuator Characteristics, Actuator Types, Arduino, Raspberry Pi

Unit IV: Processing in IoT **8 Hrs.**

Data Format, Importance of Processing in IoT, Processing Topologies, IoT Device Design and Selection Considerations

Unit V: IoT Connectivity Technologies **8 Hrs.**

IEEE 802.15.4, Zigbee, RFID, DASH7, NFC, Z-Wave, Cloud Computing, Virtualization, Cloud Models, Sensor-Cloud: Sensors-as-a-Service, Fog Computing and Its Applications

Unit VI: Application Areas and Futures of IoT **10 Hrs.**

Agricultural IoT, Components of an agricultural IoT, Advantages of IoT in agriculture, Smart irrigation management system, Vehicular IoT, Components of vehicular IoT, Advantages of

vehicular IoT, Healthcare IoT, Components of healthcare IoT, Advantages and risk of healthcare IoT, Evolution of New IoT Paradigms, Challenges Associated with IoT, Emerging Pillars of IoT

References:

1. Introduction to IoT by Sudip Misra, Anandarup Mukherjee, Arijit Roy | Publication Cambridge University Press | ISBN 9781108842952, ISBN 9781108959742.
2. The Internet of things_ do-it-yourself projects with Arduino, Raspberry Pi, and BeagleBone Black | ISBN: 978-0-07-183521-3
3. The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012.| ISBN 978-1-11999435-0

M.Sc. Data Science

M.Sc. (DS) S. Y. (Semester III)

SDATSE-501B- Internet of Things (IoT)

Note: Conduct at least 15 practical based on given syllabus.

M.Sc. Data Science

M.Sc. (DS) S. Y. (Semester III)

SDATSE-501 C Database Administration

Learning Objectives:

i. To Introduce the students physical and Logical Structure of database
ii. To aware the students the role of the database administrator

Course Outcomes:

After successful completion of this course, students should be able to:

- Explain and evaluate the fundamental theories and requirements that influence the design of modern database systems.
- Analyze the background processes involved in queries and transactions, and explain how these impact on database operation and design

Unit I: Database Architecture **8 Hrs.**

Overview of database, pfile, spfile, Instance, Tablespaces, Datafiles, Other files, Oracle managed Files, Users, Schemas, Indexes, View, Sequences, Synonyms, Privileges, Roles, Clusters, Hash Clusters, Internal memory structure, SGA, PGA, Background processes, External structure, Redo logs, Control files, Trace files, Alert logs, Creating database manually.

Unit II: Hardware configuration and consideration **8 Hrs.**

Architectural overview, Standalone hosts, Standalone hosts with disk array, Standalone, Hosts with disk shadowing, Multiple databases, Networked hosts, Networks of databases, Remote updates, Remote application options, Real application, Clusters, Multiple processors, The parallel query and parallel load options, Client/server databases application, Standby databases

Unit III: Physical databases layouts **10 Hrs.**

Database file layouts, I/O connections among data files, I/O bottlenecks among all data files, Concurrent I/O among background processes, Defining recoverability and performance goals for the system, Defining the system hardware and mirroring architecture, Database space using overview, Implementation of the storage clause, Locally managed Tablespaces, Dictionary managed Tablespaces, Table segments, Index segments, Rollback segments, Temporary, Free space, Resizing Datafiles, Control files, Online redo log Files Deallocate space from segments, Shrinking Datafiles, Shrinking Tables, Clusters and indexes, Oracle managed files(OFA)

Unit IV: Logical Database Layouts **08 Hrs.**

Describe logical structure of a database, Different types of Tablespaces, Changing the Tablespaces size, allocating segments for temporary segments, Temporary segments in permanents Tablespaces, changing tablespace status, changing tablespace storage settings, Oracle Managed

Files (OMFs), Oracle Flexible Architecture (OFA), Different segments types and relationships, Extent usages, Block space utilization.

Unit V: Backup and Recovery **8 Hrs.**

Types of Logical and Physical backups, Implementations, Integrations of backup procedures, NOARCHIVELOG Mode, ARCHIVELOG Mode, Backup Methods –Closed Database Backup, Open Database Backup, Recovery in NOARCHIVELOG Mode, Recovery in ARCHIVELOG Mode, Recovery manager architecture, Recovery Manager Features, Using Recovery manager & RMAN, Using OEM backup manager, Generating lists and reports.

Unit V: Networked ORACLE **8 Hrs.**

Overview of SQL *Net and Net8, connect descriptors, Service names and Listeners, Net8 assistants, the multi-protocol interchange, Dedicated Server Processes, Oracle Shared Server, Benefits of Oracle Shared Server, Client Server application, Database links.

Reference Books:

1. Oracle 9i DBA Handbook, Eighth Reprint - Kevin Lonely, Marlene Theriault Oracle Press, Tata McGraw Hill Publication ISBN-0- 07-048674-3.
2. OCA Oracle 9i Associate DBA Certification Exam Guide, Sixth Reprint, Jason Couchman, Sudheer N. Marish Oracle Press,Tata McGraw Hill Publication,2005, ISBN-0-07-049893-8

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SDATSE-501 C **Database Administration**

Note: Conduct at least 15 practical based on given syllabus.

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M.Sc. (DS) S. Y. (Semester III)

SDATSR-501 Research Project

Note:

Students have to complete the research project under the guidance of a research guide.

M.Sc. Data Science

M.Sc. (DS) S. Y. (Semester IV)

SDATSC-551 Natural Language Processing

Learning Objectives:

i. Understand the benefits of MVC design over traditional ASP.NET Web Forms.
ii. Acquiring sufficient knowledge on role of Model, View and Controller in integrating them to developcomplete web application
iii. Understand how Routing API maps requests to action methods in controller.
iv. Learn how to reuse code rendering HTML using custom HTML Helper methods and Tag Helpers.
v. Building Custom Model Binders for typical conditions in which built-in default binders are not usable

Course Outcomes:

After successful completion of this course, students should be able to:

- Understanding and applying validation framework for both client and server validations.
- Access databases and performing CRUD operations using LINQ and Entity Framework
- Implement security in ASP.Net Core applications.
- Develop Service Oriented RESTful services using Web API feature of ASP.NET Core.
- Build and deploy ASP.NET Core application to the production server.

Unit I: Introduction to Regular Expressions, Tokenization, Edit Distance 8 Hrs.

Regular Expressions, Words, Corpora, Simple Unix Tools for Word Tokenization, Word and Subword Tokenization, Sentence Segmentation, Minimum Edit Distance.

Unit II: N-gram Language Models 8 Hrs

N-Grams, Evaluating Language Models: Training and Test Sets, Evaluating Language Models: Perplexity, Sampling sentences from a language model, Generalizing vs. overfitting the training set, 3.6 Smoothing, Interpolation, and Backoff , Advanced: Perplexity's Relation to Entropy.

Unit III: Naive Bayes, Text Classification, and Sentiment 8 Hrs

Naive Bayes Classifiers, Training the Naive Bayes Classifier, worked example, optimizing for Sentiment Analysis, Naive Bayes for other text classification tasks, Naive Bayes as a Language

Model, Evaluation: Precision, Recall, F-measure, Test sets and Cross-validation, Statistical Significance Testing, Avoiding Harms in Classification

Unit IV: Logistic Regression **8 Hrs**

The sigmoid function, Classification with Logistic Regression, Multinomial logistic regression, learning in Logistic Regression, the cross-entropy loss function, Gradient Descent, Regularization, learning in Multinomial Logistic Regression, interpreting models, Advanced: Deriving the Gradient Equation.

Unit V: Vector Semantics and Embedding's **10 Hrs**

Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF: Weighing terms in the vector, Pointwise Mutual Information (PMI), Applications of the tf-idf or PPMI vector models, Word2vec, Visualizing Embedding's, Semantic properties of embedding's, Bias and Embedding's, Evaluating Vector Models

Unit VI: Large Language Models **08 Hrs**

Large Language Models with Transformers, Sampling for LLM Generation, Pretraining Large Language Models, Evaluating Large Language Models, Dealing with Scale, Potential Harms from Language Models

References:

1. An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with Language Models. Third Edition draft, Daniel Jurafsky, Stanford University and James H. Martin, University of Colorado at BoulderASP.NET Core in Action, Second Edition , Andrew Lock, March 2021

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SDATSC-551 Natural Language Processing

Note: Conduct at least 15 practical based on given syllabus.

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SDATSC-552 Deep Learning

Learning Objectives:

i. The objective of this course is to provide advance knowledge of machine learning techniques.
ii. This course mainly focused on Regression and Neural network based Machine learning algorithms.
iii. This aim to make students aware of various recent developments in the field of neural network such as deep learning.

Course Outcomes:

After successful completion of this course, students should be able to:

1. Perform regression analysis
2. Use to use Neural Network based model for classification and other task
3. Use to train and test deep learning based model for various tasks.
4. Use Python for building Deep learning based applications

Unit I: Linear Regression **8 Hrs**

Prediction using Linear Regression, Gradient Descent, Linear Regression with one variable, Linear Regression with multiple variables, Polynomial Regression, Feature Scaling/Selection.

Unit II: Logistic Regression **8 Hrs**

Classification using Logistic Regression, Logistic Regression vs. Linear Regression, Logistic Regression with one variable and with multiple variables.

Unit III: Regularization **8 Hrs**

Regularization and its utility: The problem of Overfitting, Application of Regularization in Linear and Logistic Regression, Regularization and Bias/Variance.

Unit IV: Neural Networks **8 Hrs**

Introduction, Model Representation, Gradient Descent vs. Perceptron Training, Stochastic Gradient Descent, Multilayer Perceptron's, Multiclass Representation, Backpropagation Algorithm.

Unit V: Deep Learning **8 Hrs**

History, Scope and specification, why deep learning now, building block of neural network, neural networks, Deep learning hardware. Feedforward neural networks, XOR model, cost function estimation (maximum likelihood)

Unit VI: Advanced Deep Learning **10 Hrs**

Activation functions, layers, normalization, hyper-parameter tuning, Convolution neural networks, architecture, recurrent neural networks, architecture, types and overview, GAN (Generative Adversarial Networks).

Deep learning applications and implementation: Computer vision, sentiment analysis, music generation, text generation, neural style transfer, image captioning

References:

1. Ethem Alpaydin, "Introduction to Machine Learning" 2nd Edition, The MIT Press, 2009.
2. Tom M. Mitchell, "Machine Learning", First Edition by Tata McGraw-Hill Education, 2013.
3. Christopher M. Bishop, "Pattern Recognition and Machine Learning" by Springer, 2007.
4. Mevin P. Murphy, "Machine Learning: A Probabilistic Perspective" by The MIT Press, 2012.

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SDATSC-552 Deep Learning

Note: Conduct at least 15 practical based on given syllabus.

M.Sc. Data Science

M.Sc. (DS) S. Y. (Semester IV)

SDATSE-551 A -NoSQL Databases

Learning Objectives:

i. Understand the fundamental concepts and types of NoSQL databases, including key-value, document, column-family, and graph-based systems.
ii. Develop the ability to model, store, and retrieve data using NoSQL systems like MongoDB, Redis, Cassandra, and Neo4j.
iii. Analyze the strengths and limitations of NoSQL databases in comparison to traditional relational databases, particularly in the context of big data and real-time applications.

Course Outcomes:
After successful completion of this course:

- Students will be able to differentiate between relational and NoSQL databases based on data models, scalability, and use cases.
- Students will be able to design and implement basic data models using NoSQL databases such as MongoDB, Redis, or Cassandra.
- Students will be able to apply NoSQL database solutions to solve real-world problems involving large-scale or unstructured data.

Unit I: Introduction to NoSQL **10 Hrs.**

Why NoSQL? The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, A (Mostly) Standard Model, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL, Aggregate Data Models; Aggregates, Example of Relations and Aggregates, Consequences of Aggregate Orientation,

Unit II: Key-Value and Document Data Models **10 Hrs.**

Key-Value and Document Data Models, Column-Family Stores, Summarizing Aggregate-Oriented Databases. More Details on Data Models; Relationships, Graph Databases, Schemaless Databases, Materialized Views, Modelling for Data Access

Unit III: Distribution Models **10 Hrs.**

Distribution Models; Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication. Consistency, Update Consistency, Read Consistency, Relaxing Consistency, The CAP Theorem, Relaxing Durability, Quorums. Version Stamps, Business and System Transactions, Version Stamps on Multiple Nodes

Unit IV: Map-Reduce **10 Hrs.**

Map-Reduce, Basic Map-Reduce, Partitioning and Combining, Composing Map-Reduce Calculations, A Two Stage Map-Reduce Example, Incremental Map-Reduce Key-Value Databases, What Is a Key-Value Store, Key-Value Store Features, Consistency, Transactions, Query Features, Structure of Data, Scaling, Suitable Use Cases, Storing Session Information, User Profiles, Preference, Shopping Cart Data, When Not to Use, Relationships among Data, Multioperation Transactions, Query by Data, Operations by Sets

Unit V: Document Databases **10 Hrs.**

Document Databases, What Is a Document Database? Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, ECommerce Applications, When Not to Use, Complex Transactions Spanning Dif erent Operations, Queries against Varying Aggregate Structure

Unit VI: Graph Databases **10 Hrs.**

Graph Databases, What Is a Graph Database?, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Connected Data, Routing, Dispatch, and Location-Based Services, Recommendation Engines, When Not to Use.

Reference Books:

1. Dan Sullivan, "NoSQL For Mere Mortals", 1st Edition, Pearson Education India, 2015. (ISBN13: 978-9332557338)
2. Dan McCreary and Ann Kelly, "Making Sense of NoSQL: A guide for Managers and the Rest of us", 1st Edition, Manning Publication/Dreamtech Press, 2013. (ISBN-13: 978-9351192022)
3. Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pearson Addision Wesley, 2012

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SDATSE-551 A -NoSQL Databases

Note: Conduct at least 15 practical based on given syllabus.

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SDATSE-551 B- DevOps Fundamental

Learning Objectives:

i. DevOps Fundamental course would enable the students in understanding Basics of DevOps, Its Life Cycle, Integration and Deployments.
ii. To Introduces Cloud Infrastructure with Terraform and Deployment with Packer
iii. Understanding DevOps CI/DI Pipeline Version Control with Git, Git, Jenkins & Maven Integration
iv. To Introduce the process of Continuous Integration and Continuous Delivery
v. To Introduces the tools Docker and Kubernetes
vi. Understands the tools for testing applications

Course Outcomes:
After successful completion of this course, students should be able to:

- Understand the basics of DevOps and its Operations
- Learn Terraform and Deployment with Packer
- Understand the different Tools: Git, Jenkins & Mave
- Learn NuGet, Docker and Kubernetes
- Understand the use of Postmans

Unit I: Introduction to Devops

What Is Devops, Benefits of working in a DevOps environment, History of Devops, DevOps Main Objectives, DevOps and Software Development Life Cycle: Waterfall Model, Agile Model, DevOps Stages, Continuous Integration & Deployment: Jenkins Containers and Virtual Development: Docker, Vagrant, Configuration Management Tools: Ansible, Puppet, Chef, DevOps Delivery Pipeline, Understanding IAC Practices

Unit II: Provisioning Cloud Infrastructure with Terraform and Deployment with Packer

Technical Requirements, Installing Terraform, Configuring Terraform for Azure, writing a Terraform scripts to deploy Azure Infrastructure, Deploying the Insfracture with Terraform, Terraform Command Line and Life Cycle, Overview of Packer, creating packer Template for Azure VMs with Scripts, Executing Packer

Unit III: DevOps CI/DI Pipeline Version Control with Git, Git, Jenkins & Maven Integration

Version Control Preview, Git Introduction Preview, Git Installation, commonly used commands in Git, working with Remote repository, Branching and merging in Git Preview, Merge Conflicts, Stashing, Rebasing, Reverting and Resetting, Git Workflows

UNIT IV Continuous Integration and Continuous Delivery

CI/CD Principles, Using Package Manger- NuGet and npm, Introduction to Maven, Maven Architecture, Introduction to Continuous Integration, Introduction to Jenkin, Jenkins Architecture, Plugin Management in Jenkins Preview, Jenkins Security Management, Notification in Jenkins, Jenkins Master-slave architecture, Jenkins Delivery Pipeline, Jenkins Declarative pipeline, Using Azure Pipelines

Unit V: Containerized Application with Docker and Kubernetes

Installing Docker, Creating Dockerfile, Building and Running Container on a Local Machine, pushing an Image to Docker Hub, deploying a Container to ACI with a CI/CD Pipeline, Managing Containers Effectively with Kubernetes- Installing Kubernetes, Kubernetes Architecture Overview, Installing Kubernetes Dashboard, First Example of Kubernetes Application Deployments

Unit VI: Testing Your Applications

Creating Postman Collection with Requests, Installing Postman, Creating Collections, Creating Our First Request, Using Environments and Variables to Dynamize requests, Writing postman tests, Executing's Postman request tests locally, Understanding the Newman Concepts, Preparing Postman Collection for Newman, Running the Newman Command Line, Integration of Newman in the CI/CD pipeline process.

Reference Books:

1. Learning DevOps: The complete guide to accelerate collaboration with Jenkins By Mikael Krief
2. The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations Kindle Edition
3. DevOps: A Complete Beginner's Guide to DevOps Best Practices
4. Volume 1 of 1 Series, Jim Lewis, Publisher: Independently Published, 2019, ISBN 1673259146, 9781673259148
5. Effective DevOps: Building a Culture of Collaboration, Affinity, and Tooling at Scale 1st Edition, Kindle Edition

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SDATSE-551 B- DevOps Fundamental

Note: Conduct at least 15 practical based on given syllabus.

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M.Sc. (DS) S. Y. (Semester III)

SDATSE-551 C- Block Chain and Cryptography

Learning Objectives:

i. This course is intended to study the basics of Block chain technology.
ii. During this course student will explore various aspects of Block chain technology like application in various domains.
iii. Students will able to understands Bitcoin, Ethereum, Hyper ledger, Solidity Programming
iv. By implementing learner will have idea about private and public Blockchain, and smart contract.

Course Outcomes:

After the completion of this course, student will be able to

- Understand and explore the working of Block chain technology (Understanding)
- Analyze the working of Smart Contracts (Analyze)
- Understand and analyze the working of Hyperledger (Analyze).
- Apply the learning of solidity and de-centralized apps on Ethereum (Apply).

Unit I: Introduction of Cryptography and Blockchain 10 Hrs.

Model of decentralization, What is Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions And Blocks, P2P Systems, Basics of Cryptography, Keys As Identity, Digital Signatures, Hashing, and public key cryptosystems, Private vs. public Blockchain.

Unit II: BitCoin and Cryptocurrency 12 Hrs.

What is Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain And Digital Currency, Transactional Blocks, Impact Of Blockchain Technology On Cryptocurrency

Unit III: Introduction to Ethereum 10 Hrs.

What is Ethereum, Introduction to Ethereum, Consensus Mechanisms, How Smart Contracts Work, Metamask Setup, Ethereum Accounts, Receiving Ether's What is a Transaction? Smart Contracts.

Unit IV Introduction to Hyperledger 12 Hrs.

Permission less model and Open Consensus, Proof or Work(PoW) and its Limitation, Beyond PoW, Introduction to Hyperledger: What is Hyperledger? Distributed Ledger Technology & its

Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer, Enterprise Block-Chain

Unit V: Solidity Programming: 08 Hrs.

Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types (Int, Real, String, Bytes, Arrays, Mapping, Enum, address)

Unit VI: Blockchain Security and Applications 08 Hrs.

Hyper ledger Aries, Blockchain Security, Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins

References:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction Antonopoulos and G. Wood, Mastering Ethereum.
2. D. Drescher, Blockchain Basics. Apress, 2017.
3. Hyperledger Tutorials - https://www.hyperledger.org/use/tutorials
4. Ethereum Development Resources - https://ethereum.org/en/developers

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SDATSE-551 C- **Block Chain and Cryptography**

Note**:**

Conduct at least 15 practical's based on given syllabus.

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SVECP -551-Publication Ethics

The syllabus of this paper is available on the university website as a common syllabus for PG SY students

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SDATSR-551 Research Project

Note:

Students have to complete the research project under the guidance of a research guide.