Tulsiramji Gaikwad Patil College of Engineering & Technology, Nagpur

SCHEME OF INSTRUCTION & SYLLABI

Programme: Data Science

Scheme of Instructions: Final Year B.Tech.in Data Science

Semester – VII

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs./Wk	Credits	EXAM SCHEME				
									CT1	CT2	TA/CA	ESE	TOTAL
1	PCC	BDS4701	Cryptography and Network Security	3	-	-	3	3	15	15	10	60	100
2	PCC	BDS4702	Deep Learning	3	-	-	3	3	15	15	10	60	100
3	PCC	BDS4703	Cryptography and Network Security-Lab	-	-	2	2	1	-	-	25	25	50
4	PCC	BDS4704	Data Visualization using Tableau- Lab	-	-	2	2	1	-	-	25	25	50
5	PROJ	BDS4705	Seminar based on Emerging Courses@	-	-	4	4	2	-	-	25	25	50
6	PEC	BDS4706-09*	Program Elective-V	3	-	-	3	3	15	15	10	60	100
7	PEC	BDS47010-13*	Program Elective-VI	3	-	-	3	3	15	15	10	60	100
8	OEC	B$$XX01-19#	Open Elective-III	4	-	-	4	4	15	15	10	60	100
9	OEC	B$$XX01-19#	Open Elective-IV	4	-	-	4	4	15	15	10	60	100
10	MCC	BAU4707	Behavioral and Interpersonal skills	2	-	-	2	Audit	-	-	-	-	-
			Total	**22**	**-**	**8**	**30**	**24**	**90**	**90**	**135**	**435**	**750**

L- Lecture T-Tutorial P-Practical CT1- Class Test 1 CT2- Class Test 2 TA/CA- Teacher Assessment/Continuous Assessment ESE- End Semester Examination (For Laboratory End Semester performance)

*** Indicates out of the four course codes each student has to select any one PEC from the list provided at the end of structure.**

 # Indicates out of the 19 course codes each student has to select any one OEC except BDSXX17, BDSXX18 & BDSXX19 from the list provided at the end of structure. @ There will be two presentations, based on seminar topic to be selected in consultation with guide preferably based on emerging trends.

Course Category	HSMC (Hum., Soc. Sc, Mgmt.)	BSC (Basic Sc.)	ESC (Engg. Sc.)	PCC (Programme Core courses)	PEC (Programme Elective courses)	OEC (Open Elective courses from other discipline)	Project / Seminar / Industrial Training	MCC (Mandatory Courses)
Credits	--	--	--	08	06	08	02	Yes
Cumulative Sum	12	26	23	49	18	16	05	--

PROGRESSIVE TOTAL CREDITS: 124+24=148

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Dr. Premanand Naktode
Principal
TGPCET, Nagpur

List of Electives offered by Department of Data Science

Professional Elective Courses								
Sr. No	**Domain wise Cluster**		**PEC-I**	**PEC-II**	**PEC-III**	**PEC-IV**	**PEC-V**	**PEC-VI**
			Semester-V		Semester-VI		Semester-VII	
1	Domain -1	**Course Code**	**BDS3507**	**BDS3511**	**BDS3606**	**BDS3610**	**BDS4706**	**BDS4710**
		Data visualization and system Design	Computer Graphics	Digital Image Processing	Computer Vision	Design patterns	Compiler Design	Data Warehousing & ETL
2	Domain -2	**Course Code**	**BDS3508**	**BDS3512**	**BDS3607**	**BDS3611**	**BDS4707**	**BDS4711**
		Network Security	Wireless Security	Ethical hacking	Security in Wireless Ad Hoc Networks	Cyber Law in India	Block chain Security	Business Intelligence
3	Domain -3	**Course Code**	**BDS3509**	**BDS3513**	**BDS3608**	**BDS3612**	**BDS4708**	**BDS4712**
		Neural Network and Computing Techniques	Soft Computing	Mobile Computing	Convolution Neural network	Quantum Computing	Natural Language Processing	Artificial Neural Network
4	Domain -4	**Course Code**	**BDS35010**	**BDS3514**	**BDS3609**	**BDS3613**	**BDS4709**	**BDS4713**
		Programming Languages	Python for Data Science	Client Side Scripting-Java Script	Server Side Scripting-PHP	R Programming	No SQL	Data Mining

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Semester	Course Code	Name of Course
VII	BDS4701	Cryptography and Network Security

Teaching Scheme		Examination Scheme	
Lectures	3	**CT-1**	15
Tutorial	-	**CT-2**	15
Total Credit	3	**TA**	10
		ESE	60
		Total	100
		DurationofESE:03 Hrs 00 Min.	

Course Objective:

1	Understand basic concepts of cryptography and its role in network security.
2	Learn classical and modern encryption techniques.
3	Analyze and compare symmetric and asymmetric cryptographic systems.
4	Study message authentication and integrity mechanisms.
5	Understand key management, digital signatures, and certificate authorities.

Course Contents

Unit I	**Introduction to Cryptography:** Security goals (confidentiality, integrity, availability, etc.), Attacks: passive and active, Security services and mechanisms, Introduction to cryptography, Substitution and transposition techniques
Unit II	**Symmetric Key Cryptography:** Block ciphers and the Data Encryption Standard (DES), Advanced Encryption Standard (AES), Modes of operation (ECB, CBC, CFB, OFB, CTR), Modern symmetric algorithms (e.g., Blowfish, RC4)
Unit III	**Asymmetric Key Cryptography:** Principles of public key cryptosystems, RSA algorithm, Key distribution and management, Diffie-Hellman key exchange, ElGamal cryptosystem
Unit IV	**Cryptographic Hash Functions and Digital Signatures:** Hash functions: SHA-1, SHA-2, MD5, Message Authentication Codes (MAC), Digital signatures and authentication protocols, Digital Signature Standard (DSS)
Unit V	**Network Security Applications:** Authentication applications (Kerberos), IP security (IPSec), Secure Socket Layer (SSL) and Transport Layer Security (TLS), Email security (PGP, S/MIME), Firewalls and intrusion detection systems (IDS)

Text Books

T.1	William Stallings, *Cryptography and Network Security: Principles and Practice*
T.2	Behrouz A. Forouzan, *Cryptography and Network Security*

Reference Books

R.1	Charlie Kaufman, Network Security: Private Communication in a Public World
R.2	Atul Kahate, Cryptography and Network Security

Useful Links

1	https://onlinecourses.nptel.ac.in/noc22_cs90/preview
2	https://archive.nptel.ac.in/courses/106/105/106105162/

Course Outcomes		CL	Class Session
After the completion of this course, students will be able to-			
BDS4701.1	**Understand** fundamental concepts of cryptography, security goals, attack types, and classical encryption techniques.	2	9
BDS4701.2	**Apply** symmetric key cryptographic techniques including DES, AES, and various cipher modes in securing data.	3	9
BDS4701.3	**Analyze** and implement public key cryptography techniques such as RSA, Diffie-Hellman, and ElGamal for secure communication.	4	9
BDS4701.4	**Evaluate** cryptographic hash functions, message authentication codes, and digital signature algorithms for data integrity and authentication.	5	9
BDS4701.5	**Explore** network security applications and protocols like IPSec, SSL/TLS, Kerberos, email security, and firewalls for system protection.	4	9

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Semester	**Course Code**	**Name of Course**
VII	BDS4702	Deep Learning

Teaching Scheme		**Examination Scheme**	
Lectures	3	**CT-1**	15
Tutorial	-	**CT-2**	15
Total Credit	3	**TA**	10
		ESE	60
		Total	100
		Duration of ESE: 03 Hrs 00 Min.	

Course Objective:

1	To understand the evaluation of deep architectures.
2	To apply deep learning Principles to Natural Language Processing
3	To assess the challenges of multimodality and reinforcement learning.

Course Contents

Unit I	**Introduction to Deep Learning**: Deep Learning, Difference between Machine Learning and Deep Learning **Neural network**: Layers in neural network, evolution of neural networks **perceptron**: Types of perceptron, working of perceptron, building and training single layer perceptron model, limitations of perceptron.
Unit II	**Neural Networks**: Types of neural networks, Applications of Deep Learning, advantages and disadvantages of Deep Learning, Neural Networks in Deep Learning, Biological Neuron, Neuron in Artificial Neural Net **Working of Neural Network**: Forward Propagation, Backpropagation, Neuron Process Data in Neural Network, Learning of a Neural Network, Implementation of Neural Network using TensorFlow, Advantages and Disadvantages of Neural Networks, Applications of Neural Networks.
Unit III	**Feed-forward Neural Networks**: Introduction, Structure of Feed Forward Neural Network, Linear Neurons and Limitations, sigmoid, Tanh and ReLU neurons, Training Feed-Forward Neural Networks, Delta Rule and Learning Rates **Gradient Descent**: Introduction to Gradient Descent, Working of Gradient Descent, Batch Gradient Descent, Stochastic Gradient Descent, Mini-Batch Gradient Descent, Backpropagation Algorithm,
Unit IV	**Autoencoder**: Understanding Autoencoder, architecture, loss function in Autoencoder training **Convolutional Neural Networks (CNN):** Working of convolutional layers, mathematical overview of convolution, layers used to build ConvNets, Advantages and Disadvantages of CNNs **LeNet**: Significance of LeNet in Deep Learning, architecture, applications of LeNet **VGGNet**: VGG-Net architecture, Detailed Layer-by-Layer Architecture of VGG-Net 19, architectural Design Principles
Unit V	**Object Detection**: Key components of Object Detection, Working of Object Detection, Technique in Object Detection, R-CNN, Fast R-CNN, Faster R-CNN, You Only Look Once (YOLO) **Recurrent Neural Networks**: Introduction, Architecture **Long Short Term Memory Cells (LSTMs):** Introduction, Architecture, Working with LSTM, Applications of LSTM **Gated Recurrent Units (GRUs)**: introduction, equations for GRU operations, how GRUs solve the vanish Gradient Problem, GRU vs LSTM **Generative Adversarial Networks (GANs):** Introduction, architecture, working of GAN, Types of GAN

Text Books	
T.1	https://webfiles.amrita.edu/2025/02/deep-learning-material-dept-ece-ase-blr-1.pdf
T.2	Goodfellow, I., Bengio, Y., and Aaron Courville, A Deep Learning, MIT Press, 2016.
T.3	Introduction to Artificial Neural Systems BY Jacek M. Zurada
Reference Books	
R.1	François Chollet, "Deep Learning with Python", Manning Publications, 2nd edition, 2021
R.2	Magnus Ekman, "Learning Deep Learning", Addison-Wesley Professional, 2021
R.3	Charu C. Aggarwal, "Neural Networks and Deep Learning", Springer, 2nd edition, 2021
Useful Links	
1	https://www.geeksforgeeks.org/
2	https://onlinecourses.nptel.ac.in/noc20_cs62/preview
3	https://archive.nptel.ac.in/courses/106/106/106106184/

Course Outcomes		**CL**	**Class Session**
After the completion of this course, students will be able to-			
BDS4702.1	Understand architecture, training methods, and functioning of deep neural networks including implementation of perceptron	2	9
BDS4702.2	Analyze neural networks and working of neural networks	4	9
BDS4702.3	Explore feedforward network and Gradient Descent	4	9
BDS4702.4	Evaluate the functionality and various deep learning algorithms including autoencoder, Convolutional Neural Networks CNN, LeNet, VGGNet	5	9
BDS4702.5	Distinguish various Object Detection techniques, Recurrent Neural Networks, Long Short Term Memory Cells (LSTMs) and Gated Recurrent Units (GRUs)	2	9

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Semester	**Course Code**	**Name of Course**
VII	BDS4703	Cryptography and Network Security - Lab

Teaching Scheme		**Examination Scheme**	
Practical	2	**CA**	25
Total Credit	1	**ESE**	25
		Total	50
		Duration of ESE: 02 Hrs 00 Min.	

Sr. No.	**List of Experiment**	**COs**
1	Implement Caesar Cipher and Vigenère Cipher (in Python, Java, or C++)	CO1
2	Design a simple substitution cipher tool with encryption and decryption functionality	CO1
3	Implement DES and AES using a crypto library	CO2
4	Compare different AES modes of operation with sample plaintexts and visualize ciphertext differences	CO2
5	Generate RSA key pairs and implement RSA encryption/decryption	CO3
6	Implement Diffie-Hellman Key Exchange to securely share a secret key over a network.	CO3
7	Packet Sniffing and Analysis using Wireshark to examine secure vs. insecure data transmission.	CO4
8	Simulate Digital Signature Algorithm for message authentication and integrity.	CO4
9	Create PGP keys and send encrypted emails.	CO5
10	Setup and analyze SSL/TLS communication using Wireshark	CO5

Text Books	
T.1	William Stallings, *Cryptography and Network Security: Principles and Practice*
T.2	Behrouz A. Forouzan, *Cryptography and Network Security*

Reference Books	
R.1	Charlie Kaufman, Network Security: Private Communication in a Public World
R.2	Atul Kahate, Cryptography and Network Security

Useful Links	
1	https://onlinecourses.nptel.ac.in/noc22_cs90/preview
2	https://archive.nptel.ac.in/courses/106/105/106105162/

Course Outcomes After the completion of this course, students will be able to-		**CL**	**Class Session**
BDS4703.1	**Implement** classical encryption algorithms like Caesar and Vigenère ciphers to understand the foundational principles of cryptography.	3	4
BDS4703.2	**Apply** modern symmetric and asymmetric encryption techniques such as DES, AES, RSA, and ElGamal for secure data transmission.	3	4
BDS4703.3	**Analyze** and compare different AES modes of operation by visualizing encryption differences on sample plaintexts.	4	4
BDS4703.4	**Demonstrate** the creation and verification of digital signatures and secure	3	4

	message authentication using tools like OpenSSL and HMAC.		
BDS4703.5	**Utilize** PGP for secure email communication and analyze SSL/TLS traffic using tools like Wireshark to understand secure communication protocols.	3	4

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Semester	**Course Code**	**Name of Course**
VII	BDS4704	Data Visualization using Tableau- Lab

Pre-Requisites:

Teaching Scheme			**Examination Scheme**	
Practical	2		**CA**	25
Total Credit	1		**ESE**	25
			Total	50
			Duration of ESE: 02 Hrs 00 Min.	

Sr. No.	**List of Experiment**	**COs**
1	Introduction to various Data Visualization tools.	CO1
2	Introduction to Tableau and Installation	CO1
3	Demonstration on connecting to Data and preparing data for visualization in Tableau	CO2
4	Demonstrate to creating a View - formatting charts, adding filters, creating calculated fields and defining parameters.	CO2
5	Implementation of data Aggregation and Statistical functions in Tableau.	CO3
6	Demonstration on data Visualizations in Tableau.	CO3
7	Implementation of basic Dashboards in Tableau	CO4
8	Demonstrate to display calculated fields in visualizations (e.g., Profit Ratio = Profit/Sales).	CO4
9	Demonstrate to create a parameter to control the chart (e.g., select measure: Sales or Profit).	CO5
10	Dashboard Design and Storytelling – Components of Dashboard, Understanding how to place worksheets in Containers, Action filters and its types.	CO5

Text Books

T.1	Practical Tableau: 100 Tips, Tutorials, and Strategies from a Tableau Zen Master, Ryan Sleeper, Oreilly Publications, 2018
T.2	"Learning Tableau" by Joshua N. Milligan

Reference Books

R.1	Mamta Mittal, Abhishek Raheja, "Data Visualization and Storytelling with Tableau", CRC Press, 2023
R.2	Ramesh Joshi, N. Mahalle, "Data Storytelling and Visualization with Tableau: A Hands-on Approach", CRC Press, 2023

Useful Links

1	https://elearn.nptel.ac.in/shop/iit-workshops/completed/data-to-dashboard-mastering-visual-storytelling-with-tableau-batch-2/?v=c86ee0d9d7ed
2	https://elearn.nptel.ac.in/shop/completed-courses/short-term-programs-completed/data-to-dashboard-mastering-visual-storytelling-with-tableau/?v=c86ee0d9d7ed

Course Outcomes		**CL**	**Class Session**
After the completion of this course, students will be able to-			
BDS4704.1	**Apply** data preprocessing techniques to prepare raw data for data mining tasks.	3	4
BDS4704.2	**Implement** association rule mining algorithms to find meaningful patterns.	3	4

BDS4704.3	**Apply** advanced classification techniques such as Support Vector Machines.	3	4
BDS4704.4	**Perform** data summarization and statistical analysis using Tableau features.	4	4
BDS4704.5	**Build** dashboards for interactive data exploration and presentation.	5	4

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Semester	**Course Code**	**Name of Course**
VII	**BDS4706**	PEC – V (Compiler Design**)**

Teaching Scheme		**Examination Scheme**	
Lectures	3Hrs/Week	**CT-1**	15
Tutorial	-	**CT-2**	15
Total Credit	3	**TA**	10
		ESE	60
		Total	100
		Duration of ESE:03 Hrs 00 Min.	

Course Objective:	
1	To understand the fundamental concepts and tools involved in compiler construction.
2	To provide a comprehensive understanding of syntax analysis in compiler design.
3	To explore the principles of semantic analysis in compiler design.
4	To study key code optimization techniques in compiler design.
5	To understand the challenges and techniques in code generation.

Course Contents	
Unit I	Introduction to Compiler Interpreter, Assembler, Compiler, Types of compiler, Analysis of Source Program, Phases of Compiler, Grouping of phases, Compiler Construction tools, Lexical Analysis: The role of the Lexical analyzer, Input buffering, Specification of Tokens, A Language for Specifying Lexical Analyzers, Design of a Lexical Analyzer generator.
Unit II	Syntax Analysis The role of the Parser, Context-free grammars, Writing a Grammar, Top-Down Parsing, Bottom-Up Parsing, Operator-precedence Parsing, LR Parsers, Using Ambiguous Grammars, Parser Generators.
Unit III	Semantic Analysis Definitions, Construction of Syntax Trees, Bottom-Up Evaluation of S- Attributed definitions, Top-Down Translation, Intermediate Languages, Declarations, Assignment Statements, Boolean Expressions, Case Statements, Back patching, Procedure Calls.
Unit IV	Code optimization Sources of optimization, loop optimization, control flow analysis, data flow analysis, setting up data flow equations to compute reaching definitions, available expressions, Live variables, Induction Variable, Common sub expression elimination
Unit V	Code Generation problems in the Design of a Code Generator, The target Machine, Run-Time Storage Management, Basic Blocks and Flow Graphs, Next-Use information, Simple Code Generator, Register allocation and Assignment, The DAG Representation of Basic Blocks, Generating Code from DAGs, Dynamic Programming, Code- Generation Algorithm, Code-Generators.

Text Books	
T.1	Compilers – Principles, Techniques and Tools; Aho, Sethi, and Ullman; Second Edition, Pearson Education, 2008
T.2	Principles of Compiler Design; Alfred V. Aho and Jeffery D. Ullman; Narosa Publishing House, 1977
T.3	Compiler Design, O. G. Kakde, Laxmi Publication

Reference Books	
R.1	Principles of Compiler Design, V. Raghavan, Tata McGraw Hill, 2009.
R.2	Compiler Design using Flex and Yacc; Vinu V. Das; PHI Publication, 2008.

Useful Links	
1	https://archive.nptel.ac.in/courses/106/105/106105190/
2	https://nptel.ac.in/courses/106104123

Course Outcomes		CL	Class Session
After the completion of this course, students will be able to-			
BDS4706.1	**Understand** compiler phases, tools, and lexical analyzer design.	2	9
BDS4706.2	**Analyze** parsing techniques using grammars and parser generators.	4	9
BDS4706.3	**Apply** semantic analysis and generate intermediate code.	3	9
BDS4706.4	**Evaluate** code optimization techniques and flow analysis.	3	9
BDS4706.5	**Design** code generation strategies with register allocation and DAGs.	5	9

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Semester	**Course Code**	**Name of Course**
VII	**BDS4707**	PEC – V (Block chain Security**)**

Teaching Scheme		**Examination Scheme**	
Lectures	3Hrs/Week	**CT-1**	15
Tutorial	-	**CT-2**	15
Total Credit	3	**TA**	10
		ESE	60
		Total	100
		Duration of ESE:03 Hrs 00 Min.	

Course Objective:

1	To provide a comprehensive understanding of block chain technology, its historical evolution, types, consensus mechanisms.
2	To equip students with foundational and practical knowledge of symmetric and asymmetric cryptography.
3	To provide in-depth knowledge of Bitcoin's architecture along with hands-on experience using Bitcoin clients.
4	To explore the theoretical foundations and limitations of Bitcoin and understand alternative cryptocurrencies and their features.
5	To examine alternative block chain platforms and frameworks, and explore block chain applications.

Course Contents

Unit I	**Blockchain:** Introduction, distributed systems, history and evolution of blockchain and bitcoin, types of blockchain, consensus, CAP theorem. Decentralization: Decentralization using blockchain, methods of decentralization, blockchain and full ecosystem of decentralization, smart contracts, decentralized organizations, platforms for decentralization.
Unit II	**Symmetric and Asymmetric Cryptography:** Working with OpenSSL command line, Introduction, Mathematics behind Cryptography, Confidentiality, Integrity, Authentication, Non-repudiation, Accountability, Cryptographic primitives, Symmetric cryptography, Data Encryption Standard, Advanced Encryption Standard. Public Key Cryptography: Asymmetric cryptography, Public and Private keys, RSA, Discrete logarithm problem in ECC, Hash functions, RSA digital signature algorithm, Elliptic Curve Digital Signature Algorithm.
Unit III	**Bitcoin:** Introduction, definition, digital keys and addresses, transactions, blockchain, mining, Bitcoin network and payments: Bitcoin network, Wallets, payments, innovation, Bitcoin Clients and APIs: Bitcoin installation, Types of Bitcoin core clients, steps in setting up a Bitcoin node.
Unit IV	**Alternative coins:** Experiment with CLI, Bitcoin programming, and CLI. Theoretical foundations, Bitcoin limitations, Other crypto coins, Z-cash. Smart contracts: History, definition, Ricardian contracts.
Unit V	**Alternative Blockchains:** Blockchains, platforms, and frameworks. Use cases of Blockchain other than the currencies: Use case of IoT blockchain, Government, Health, Finance, and media.

Text Books

T.1	"Mastering Blockchain" by Imran Bashir
T.2	"Bitcoin and Cryptocurrency Technologies" by Arvind Narayanan et al.
T.3	"Cryptography and Network Security: Principles and Practice" by WilliamStallings
Reference Books	
R.1	"Blockchain Basics: A Non-Technical Introduction in 25 Steps" by Daniel Drescher.
R.2	"The Bitcoin Standard: The Decentralized Alternative to Central Banking" by Saifedean Ammous.

Useful Links	
1	https://onlinecourses.nptel.ac.in/noc22_cs44
2	https://onlinecourses.nptel.ac.in/noc20_cs01

Course Outcomes		**CL**	**Class Session**
After the completion of this course, students will be able to-			
BDS4707.1	**Demonstrate** an understanding of blockchain technology by explaining its historical evolution, structure, and consensus mechanisms.	3	11
BDS4707.2	**Apply** symmetric and asymmetric cryptographic techniques to ensure data confidentiality and integrity.	3	11
BDS4707.3	**Analyze** the structure and functioning of Bitcoin, including digital keys, transactions, mining, wallets, and client setups.	4	11
BDS4707.4	**Explore** and experiment with alternative cryptocurrencies and understand their unique features and limitations compared to Bitcoin.	4	11
BDS4707.5	**Evaluate** their applications across diverse domains such as IoT, government, healthcare, finance, and media.	5	11

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Semester	**Course Code**	**Name of Course**
VII	**BDS4708**	PEC – V (Natural language Processing**)**

Teaching Scheme		**Examination Scheme**	
Lectures	3Hrs/Week	**CT-1**	15
Tutorial	-	**CT-2**	15
Total Credit	3	**TA**	10
		ESE	60
		Total	100
		Duration of ESE:03 Hrs 00 Min.	

Course Objective:

1	To provide a comprehensive view of building real-world natural language processing (NLP) Applications.
2	The diverse applications of NLP are based on a common set of ideas, drawing on algorithms, Linguistics, logic, statistics, and more.

Course Contents

Unit I	**OVERVIEW AND MORPHOLOGY:** Introduction – Models -and Algorithms, Regular Expressions, Basic Regular Expression Patterns, Finite State Automata Understand the wireless sensor network principles. Morphology, Inflectional Morphology, Derivational Morphology, Finite-State Morphological Parsing, Porter Stemmer.
Unit II	**WORD LEVEL AND SYNTACTIC ANALYSIS:** N-grams Models of Syntax ,Counting Words , L T P C 3 0 0 3 Unsmoothed N-grams .Smoothing- Back-off Deleted Interpolation ,Entropy - English Word Classes - Tag sets for English Part of Speech Tagging, Rule Based Part of Speech Tagging ,Stochastic Part of Speech Tagging, Transformation, Based Tagging.
Unit III	**CONTEXT FREE GRAMMARS**: Context Free Grammars for English Syntax- Context, Free Rules and Trees, -Understand the network simulation tools. Sentence, Level Constructions–Agreement, Sub Categorization .Parsing, Top-down – Early Parsing, feature Structures, Probabilistic Context-Free Grammars.
Unit IV	**SEMANTIC ANALYSIS:** Representing Meaning, Meaning Structure of Language-First Order Predicate Calculus Representing Linguistically Relevant Concepts, Syntax-Driven Semantic Analysis, Semantic Attachments, and Syntax-Driven Analyzer. Robust Analysis, Lexemes and Their Senses, Internal Structure - Word Sense Disambiguation, Information Retrieval.
Unit V	**LANGUAGE GENERATION AND DISCOURSE ANALYSIS:** Discourse, Reference Resolution, Text Coherence, Discourse Structure, Coherence. Dialog and Conversational Agents, Dialog Acts, Interpretation -Conversational Agents. Language Generation, Architecture-Surface Realizations ,Discourse Planning .Machine Translation, Transfer Metaphor, Interlingua – Statistical Approaches.

Text Books

T.1	Daniel Jurafsky and James H Martin, ”Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition”, Prentice Hall, 2nd Edition, 2008.
T.2	C. Manning and H. Schutze, “Foundations of Statistical Natural Language Processing”, MIT Press. Cambridge, MA:,1999.

Reference Books	
R.1	C. Manning and H. Schutze, "Foundations of Statistical Natural Language Processing", MIT Press. Cambridge, MA:,1999.
R.2	Bharati A., Sangal R., ChaitanyaV.. Natural language processing: a Paninian perspective, PHI, 2000.
Useful Links	
1	https://nptel.ac.in/courses/106105158
2	https://archive.nptel.ac.in/courses/106/106/106106211/

Course Outcomes		**CL**	**Class Session**
After the completion of this course, students will be able to-			
BDS4708.1	**Understand** NLP fundamentals, regular expressions, and morphological analysis.	2	9
BDS4708.2	**Apply** N-gram models and POS tagging for syntactic analysis.	3	9
BDS4708.3	**Analyze** syntax using CFGs and probabilistic parsing techniques.	4	9
BDS4708.4	**Interpret** semantics with predicate logic and disambiguation methods.	2	9
BDS4708.5	**Evaluate** discourse analysis, dialog agents, and machine translation.	5	9

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Semester	**Course Code**	**Name of Course**
VII	BDS4709	PEC – V (No SQL**)**

Teaching Scheme		**Examination Scheme**	
Lectures	3Hrs/Week	**CT-1**	15
Tutorial	-	**CT-2**	15
Total Credit	3	**TA**	10
		ESE	60
		Total	100
		DurationofESE:03 Hrs 00 Min.	

Course Objective:

1	The ability to manipulate, analyze and draw insights from data using SQL provides a major advantage in many industries.
2	No SQL databases are purpose-built for specific data models and stores data in flexible schemas that scale easily for modern applications.

Course Contents

Unit I	Overview and History of NoSQL Databases. Definition of the Four Types of NoSQL Database, The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL,
Unit II	Comparison of relational databases to new NoSQL stores, MongoDB, Cassandra, HBASE, Neo4j use and deployment, Application, RDBMS approach, Challenges NoSQL approach, Key-Value and Document Data Models, Column-Family Stores, Aggregate-Oriented Databases. Replication and sharding, Map Reduce on databases. Distribution Models, Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication
Unit III	NoSQL Key/Value databases using MongoDB, Document Databases, Document oriented Database Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, E-Commerce Applications, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure.
Unit IV	Column- oriented NoSQL databases using Apache HBASE, Column-oriented NoSQL databases using Apache Cassandra, Architecture of HBASE, Column-Family Data Store Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Counters, Expiring Usage.
Unit V	NoSQL Key/Value databases using Riak, Key-Value Databases,Key-Value Store, Key-Value Store Features, Consistency, Transactions, Query Features, Structure of Data, Scaling, Suitable Use Cases, Storing Session Information, User Profiles, Preferences, Shopping Cart Data,Relationships among Data, Multi operation Transactions, Query by Data, Operations by Sets. Graph NoSQL databases using Neo4 ,NoSQL database

	development tools and programming languages, Graph Databases, Graph Database. Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases.
Text Books	
T.1	Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Wiley Publications,1st Edition ,2019
T.2	NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence" by Pramod J. Sadalage and Martin Fowler
Reference Books	
R.1	"NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence" by Pramod J. Sadalage and Martin Fowler
R.2	Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement" by Eric Redmond and Jim R. Wilson
Useful Links	
1	https://nptel.ac.in/courses/106104135
2	https://archive.nptel.ac.in/courses/106/104/106104135/

Course Outcomes		**CL**	**Class Session**
After the completion of this course, students will be able to-			
BDS4709.1	**Understand** the key differences between SQL and NoSQL databases.	2	9
BDS4709.2	**Design** Data Models: Design appropriate data models for NoSQL databases based on application requirements	6	9
BDS4709.3	**Evaluate** NoSQL Solutions: Assess and select suitable NoSQL databases for specific use cases.	5	9
BDS4709.4	**Implement** CRUD Operations: Perform create, read, update, and delete operations in NoSQL databases	2	9
BDS4709.5	**Evaluate** suitable NoSQL databases for specific use cases.	5	9

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Semester	Course Code	Name of Course
VII	BDS4710	PEC - VI (Data Warehousing & ETL)

Teaching Scheme		Examination Scheme	
Lectures	3Hrs/Week	**CT-1**	15
Tutorial	-	**CT-2**	15
Total Credit	3	**TA**	10
		ESE	60
		Total	100
		Duration of ESE:03 Hrs 00 Min.	

Course Objective:

1	Understand the fundamental concepts of data warehousing and its role in decision support systems.
2	Explore data modeling techniques for designing efficient data warehouse structures.
3	Learn the principles and techniques of data extraction, transformation, and loading (ETL) processes.
4	Examine data quality, cleansing methods, and metadata management in ETL pipelines.
5	Implement performance optimization, indexing, and scheduling strategies in data warehousing and ETL systems.

Course Contents

Unit I	**Introduction:** Definition and characteristics of Data Warehouses, Differences between OLTP and OLAP, Components of a Data Warehouse, Data Warehouse architecture (Basic, Two-tier, Three-tier), Types of Data Warehouses: Enterprise DW, Data Marts, ODS, Advantages and challenges of data warehousing.
Unit II	**Dimensional Modeling Concepts:** Fact and Dimension tables**,** Star Schema vs Snowflake Schema**,** Galaxy Schema (Fact Constellation)**,** Types of Facts: Additive, Semi-additive, Non-additive**,** Dimension Types: Conformed, Junk, Degenerate, Role-playing**.**
Unit III	**Introduction to ETL concepts, Data Extraction**: Types of source systems, Full vs Incremental extraction, Data Transformation: Cleaning, Filtering, Deduplication, Data Standardization and Aggregation, Data Loading: Loading strategies, Error handling and data validation.
Unit IV	**Overview of ETL tools:** Open-source: Talend, Apache NiFi, Airbyte, Commercial: Informatics Power Center, Job scheduling and automation, Logging, monitoring, and debugging ETL jobs.
Unit V	**Data Quality and Data Governance:** Data Profiling**,** Metadata Management**,** Data Lineage and Audit**,** Introduction to Big Data ETL (Hadoop-based ETL)**,** Cloud Data Warehousing**.**

Text Books

T.1	Understanding Etl and Data Warehousing authored by Ralph Kimball and Joe Caserta.
T.2	Mastering Data Warehousing: A Comprehensive Guide to Learn Data Warehousing by

	by Cybellium Ltd (Author), Kris Hermans(Author) Kindle Edition
Reference Books	
R.1	Mastering SAS Programming for Data Warehousing authored by Monika Wahi
R.2	The Data Warehouse ETL Toolkit: Practical Techniques for Extracting, Cleaning, Conforming, and Delivering Data" by Ralph Kimball and Joe Caserta
R.3	The Data Warehouse Lifecycle Toolkit: Practical Techniques for Building Data Warehouse and Business Intelligence Systems" by Ralph Kimball
Useful Links	
1	https://docs.oracle.com/en/database/oracle/oracle-database/19/dwhsg/index.html
2	https://www.geeksforgeeks.org/etl-extract-transform-and-load/
3	https://www.w3schools.com/sql/sql_intro.asp (Intro to SQL used in ETL)

Course Outcomes		**CL**	**Class Session**
After the completion of this course, students will be able to-			
BDS4710.1	**Describe** the architecture and components of data warehousing systems.	3	9
BDS4710.2	**Design** data warehouse schemas using appropriate data modeling techniques.	6	9
BDS4710.3	**Develop** ETL workflows to extract, transform, and load data from heterogeneous sources.	6	9
BDS4710.4	**Apply** data cleansing techniques and manage metadata to ensure data quality in ETL processes.	3	9
BDS4710.5	**Optimize** data warehouse performance using indexing, partitioning, and ETL job scheduling strategies.	5	9

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Semester	**Course Code**	**Name of Course**
VII	BDS4711	PEC - VI (Business Intelligence)

Teaching Scheme		**Examination Scheme**	
Lectures	3Hrs/Week	**CT-1**	15
Tutorial	-	**CT-2**	15
Total Credit	3	**TA**	10
		ESE	60
		Total	100
		Duration of ESE:03 Hrs 00 Min.	

Course Objective:

1	To introduce the fundamentals and significance of Business Intelligence in supporting business decisions.
2	To provide an understanding of data warehousing architecture and basic data mining techniques.
3	To familiarize students with BI tools for data visualization and interactive reporting.
4	To develop the ability to apply predictive analytics and build data models for business forecasting.
5	To explore real-world BI applications and understand the process of implementing BI solutions in organizations.

Course Contents

Unit I	**Introduction:** Definition and scope of Business Intelligence, Evolution of BI: From MIS to BI, Components of BI Systems, Data, Information, and Knowledge concepts, Role of BI in decision-making.
Unit II	**Fundamentals of BI:** Types of BI users: Operational, Tactical, Strategic, BI architecture and lifecycle, Data Warehouse architecture, Data modeling for BI: Star, Snowflake, Fact Constellation schemas, Concepts of ETL in BI, Metadata and its importance in BI.
Unit III	**Business Analytics and Reporting:** Introduction to Business Analytics, Types of Analytics: Descriptive, Predictive, Prescriptive, Reporting and querying tools, Dashboards and Scorecards, KPIs and performance metrics.
Unit IV	**Data Mining and Predictive Analytics:** Data Mining in BI, Data preprocessing and preparation, Classification, Clustering, Association rules, Predictive modeling techniques: Decision Trees, Regression, Time Series, Applications of Predictive Analytics in Business.
Unit V	**BI Implementation Framework:** Success factors and challenges in BI projects, BI project lifecycle and management, BI in different domains: Finance, Retail, Healthcare, Self-Service BI and Mobile BI.

Text Books

T.1	Data Mining And Business Intelligence , Shinde S.K., Chandrasekhar Uddagiri, Dreamtech
T.2	**Competing on Analytics: The New Science of Winning"** *By Thomas H. Davenport and Jeanne G. Harris*

Reference Books

R.1	**Business Intelligence Guidebook: From Data Integration to Analytics** By Rick Sherman
R.2	**Data Science for Business** By Foster Provost and Tom Fawcett
Useful Links	
1	https://learn.microsoft.com/en-us/power-bi/fundamentals/business-intelligence-overview
2	https://learn.microsoft.com/en-us/power-bi/
3	https://mopinion.com/business-intelligence-bi-tools-overview/

Course Outcomes		**CL**	**Class Session**
After the completion of this course, students will be able to-			
BDS4711.1	**Understand** the fundamental of Business Intelligence in organizational decision-making.	2	9
BDS4711.2	**Apply** basic data mining techniques to extract business insights.	3	9
BDS4711.3	**Utilize** popular BI tools (e.g., Power BI, Tableau) to create visual reports and dashboards for data analysis.	4	9
BDS4711.4	**Apply** predictive analytics and data modeling techniques to forecast business trends and behaviors.	3	9
BDS4711.5	**Analyze** real-world BI applications, challenges.	4	9

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Semester	**Course Code**	**Name of Course**
VII	**BDS4712**	PEC - VI (Artificial Neural Network)

Teaching Scheme		**Examination Scheme**	
Lectures	3 Hours/Week	**CT-1**	15 Marks
Tutorial	-	**CT-2**	15 Marks
Total Credit	3	**TA**	10 Marks
		ESE	60 Marks
		Total	100 Marks
		Duration of ESE: 03 Hrs 00 Min.	

Course Objective:

1	To introduce students to the fundamental concepts, architectures, and learning algorithms of artificial neural networks.
2	To enable students to design, implement, and evaluate neural network models for real-world data science applications.
3	To familiarize students with advanced neural network paradigms and their applications in fields like computer vision and natural language processing.
4	To develop practical skills in using modern deep learning frameworks for building neural network models.

Course Contents

Unit I	**Introduction to Artificial Neural Networks:** Biological neuron vs. artificial neuron, perceptron model, activation functions (sigmoid, ReLU, tanh). Multilayer perceptrons (MLPs), feedforward neural networks, backpropagation algorithm. Learning process: supervised vs. unsupervised learning, gradient descent, loss functions. Applications of ANNs in data science.
Unit II	**Neural Network Architectures:** Deep neural networks (DNNs), convolutional neural networks (CNNs) for image processing. Recurrent neural networks (RNNs), Long Short-Term Memory (LSTM), and Gated Recurrent Units (GRU) for sequential data. Autoencoders for unsupervised learning, generative adversarial networks (GANs) basics. Network design considerations: depth, width, and regularization techniques (dropout, batch normalization).
Unit III	**Training and Optimization of Neural Networks:** Challenges in training: vanishing/exploding gradients, overfitting, underfitting. Optimization techniques: Stochastic Gradient Descent (SGD), Adam, RMSprop. Hyperparameter tuning: learning rate, batch size, number of epochs. Data preprocessing for neural networks: normalization, augmentation, handling imbalanced datasets.
Unit IV	**Advanced Neural Network Applications:** Computer vision applications: image classification, object detection, image segmentation. Natural language processing applications: sentiment analysis, text generation, machine translation. Time-series analysis using RNNs and LSTMs. Case studies: Neural networks in healthcare, finance, and autonomous systems.
Unit V	**Tools and Emerging Trends in Neural Networks:** Deep learning frameworks: TensorFlow, PyTorch, Keras. Deployment of neural networks: cloud platforms (AWS, Google Cloud), edge devices. Emerging trends: Transformers, self-supervised learning,

	neural architecture search (NAS). Ethical considerations: Bias in neural networks, explainability, and fairness.
Text Books	
T.1	Simon Haykin, "Neural Networks and Learning Machines," 3rd Edition, Pearson Education, 2016.
T.2	Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learning," MIT Press, 2016.
Reference Books	
R.1	Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow," 3rd Edition, O'Reilly Media, 2022.
R.2	Michael Nielsen, "Neural Networks and Deep Learning," Determination Press, 2015 (Available online: http://neuralnetworksanddeeplearning.com/).

Useful Links	
1	https://www.coursera.org/specializations/deep-learning
2	https://pytorch.org/tutorials/

Course Outcomes		**CL**	**Class Session**
After the completion of this course, students will be able to-			
BDS4712.1	**Explain** the fundamental concepts and architectures of artificial neural networks.	2	9
BDS4712.2	**Apply** backpropagation and optimization techniques to train neural network models.	3	9
BDS4712.3	**Design** neural network models for specific applications using modern frameworks.	6	10
BDS4712.4	**Evaluate** the performance of neural networks and address challenges like overfitting and bias.	5	9
BDS4712.5	**Analyze** emerging trends and ethical considerations in neural network applications.	4	8

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Semester	**Course Code**	**Name of Course**
VII	**BDS4713**	PEC - VI (Data Mining)

Teaching Scheme		**Examination Scheme**	
Lectures	3 Hours/ Week	**CT-1**	15 Marks
Tutorial	-	**CT-2**	15 Marks
Total Credit	3	**TA**	10 Marks
		ESE	60 Marks
		Total	100 Marks
		Duration of ESE: 03 Hrs 00 Min.	

Course Objective:

1	To introduce students to the principles, processes, and techniques of data mining for extracting actionable insights from large datasets.
2	To equip students with the ability to apply data mining algorithms for classification, clustering, association rule mining, and anomaly detection.
3	To develop proficiency in using data mining tools and frameworks for real-world data science applications.
4	To foster an understanding of advanced data mining trends and ethical considerations in data-driven decision-making.

Course Contents

Unit I	**Introduction to Data Mining:** Overview of data mining: definition, scope, and applications in data science. Data mining process: CRISP-DM framework (Business Understanding, Data Understanding, Data Preparation, Modeling, Evaluation, Deployment). Data preprocessing: handling missing values, normalization, discretization, feature selection. Types of data: structured, semi-structured, unstructured, and time-series data. Challenges: scalability, high dimensionality, data quality, and noise.
Unit II	**Classification and Prediction:** Classification techniques: Decision Trees, Naive Bayes, k-Nearest Neighbors (k-NN), Support Vector Machines (SVM). Regression techniques: Linear Regression, Logistic Regression. Evaluation metrics: Accuracy, Precision, Recall, F1-Score, ROC-AUC. Techniques to address overfitting: Cross-validation, regularization. Applications: Credit scoring, medical diagnosis, customer churn prediction.
Unit III	**Clustering and Anomaly Detection:** Clustering concepts: K-Means, Hierarchical Clustering, DBSCAN. Evaluation of clustering: Silhouette Coefficient, Within-Cluster Sum of Squares. Anomaly detection: Statistical approaches, Isolation Forest, One-Class SVM. Applications: Customer segmentation, fraud detection, network intrusion detection.
Unit IV	**Association Rule Mining and Sequential Patterns:** Association rule mining: Apriori Algorithm, FP-Growth Algorithm. Rule evaluation metrics: Support, Confidence, Lift, Conviction. Sequential pattern mining: GSP (Generalized Sequential Patterns), PrefixSpan. Applications: Market basket analysis, recommendation systems, web usage mining.
Unit V	**Advanced Data Mining and Tools:** Text mining: Bag-of-Words, TF-IDF, Topic Modeling (LDA). Big data mining: Integration with Hadoop, Spark, MapReduce. Data mining tools: Weka, RapidMiner, Python (Scikit-learn, Pandas), R. Emerging trends:

	Graph mining, stream mining, federated data mining. Ethical considerations: Data privacy, bias mitigation, fairness in mining.
Text Books	
T.1	Jiawei Han, Micheline Kamber, and Jian Pei, “Data Mining: Concepts and Techniques,” 3rd Edition, Morgan Kaufmann, 2011.
T.2	Pang-Ning Tan, Michael Steinbach, and Vipin Kumar, “Introduction to Data Mining,” 2nd Edition, Pearson Education, 2018.
Reference Books	
R.1	Ian H. Witten, Eibe Frank, and Mark A. Hall, “Data Mining: Practical Machine Learning Tools and Techniques,” 4th Edition, Morgan Kaufmann, 2016.
R.2	Charu C. Aggarwal, “Data Mining: The Textbook,” Springer, 2015.

Useful Links	
1	https://www.kaggle.com/competitions
2	https://www.coursera.org/specializations/data-mining

Course Outcomes		**CL**	**Class Session**
After the completion of this course, students will be able to-			
BDS4713.1	**Describe** the principles, processes, and applications of data mining in extracting patterns from data.	5	9
BDS4713.2	**Apply** classification and regression algorithms to solve predictive modeling problems.	3	9
BDS4713.3	**Implement** clustering and anomaly detection techniques for unsupervised learning tasks.	4	10
BDS4713.4	**Evaluate** the effectiveness of association rule mining and sequential pattern mining for pattern discovery.	5	9
BDS4713.5	**Analyze** advanced data mining techniques and tools, addressing ethical issues in real-world applications.	4	8

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Semester	Course Code	Name of Course
VII	BDSXX19	OE III - Introduction of Data Science

Pre-Requisites:

Teaching Scheme	
Lectures	4
Tutorial	0
Total Credit	4

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
TA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03Hrs 00Min.	

Course Objective:

1	Building the fundamentals of data science.
2	Gaining practical experience in programming tools for data sciences
3	Empowering students with tools and techniques used in data science

Course Contents

Unit I	Introduction to Data Science Evolution of Data Science, Data Science Roles, Stages in a Data Science Project, Applications of Data Science in various fields, Data Security Issues. Architecture of data, data acquisition.
Unit II	Data Collection and Data Pre-Processing Data Collection Strategies, Data Pre-Processing Overview, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization.
Unit III	Exploratory Data Analytics Descriptive Statistics, Mean, Standard Deviation, Skewness and Kurtosis, Box Plots, PivotTable, Heat Map, Correlation Statistics, ANOVA
Unit IV	Regression: Linear Regression, Simple Linear Regression, Multiple & Polynomial Regression. Unsupervised Learning, Clustering, Similarity and Distances, Quality Measures of Clustering.
Unit V	Network Analysis, Graphs, Social networks, centrality, drawing centrality of Graphs, PageRank, ego-networks, Community Detection

Text Books

1	Data Science from Scratch-Joel Grus
2	Introduction to Data Structures With Applications, 2nd Edition by Jean-Paul Tremblay Paul Sorenson, McGraw Hill Education India Pvt Ltd.
3	Data Science for Business- Tom Fawcett

Reference Books

1	Designing data-Intensive Applications-Martin Kleppmann
2	Data Science and Big Data Analytics- EMC Education Services

3	The Data Science Handbook- Field Cady
Useful Links	
1	https://archive.nptel.ac.in/courses/110/106/110106072/
2	https://www.youtube.com/playlist?list=PLw5h0DiJ-9PCn4shW4X43FSjEqdBwc1Cn
3	https://www.youtube.com/watch?v=W01tIRP_Rqs

Course Outcomes		**CL**	**Class Session**
After the completion of this course, students will be able to-			
BDSXX19.1	**Understand** data science evolution, roles, architecture, and security.	2	9
BDSXX19.2	**Apply** data collection and preprocessing techniques.	3	9
BDSXX19.3	**Analyze** data using descriptive statistics and ANOVA.	4	9
BDSXX19.4	**Implement** regression and clustering techniques.	3	9
BDSXX19.5	**Perform** network analysis using graph-based methods.	5	9

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Semester	Course Code	Name of Course
VII	BDSXX19	OE IV - Introduction of Data Science

Pre-Requisites:

Teaching Scheme	
Lectures	4
Tutorial	0
Total Credit	4

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
TA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03Hrs 00Min.	

Course Objective:

1	Building the fundamentals of data science.
2	Gaining practical experience in programming tools for data sciences
3	Empowering students with tools and techniques used in data science

Course Contents

Unit I	Introduction to Data Science Evolution of Data Science, Data Science Roles, Stages in a Data Science Project, Applications of Data Science in various fields, Data Security Issues. Architecture of data, data acquisition.
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Unit IV	Regression: Linear Regression, Simple Linear Regression, Multiple & Polynomial Regression. Unsupervised Learning, Clustering, Similarity and Distances, Quality Measures of Clustering.
Unit V	Network Analysis, Graphs, Social networks, centrality, drawing centrality of Graphs, PageRank, ego-networks, Community Detection

Text Books

1	Data Science from Scratch-Joel Grus
2	Introduction to Data Structures With Applications, 2nd Edition by Jean-Paul Tremblay Paul Sorenson, McGraw Hill Education India Pvt Ltd.
3	Data Science for Business- Tom Fawcett

Reference Books

1	Designing data-Intensive Applications-Martin Kleppmann
2	Data Science and Big Data Analytics- EMC Education Services
3	The Data Science Handbook- Field Cady

Useful Links

1	https://archive.nptel.ac.in/courses/110/106/110106072/
2	https://www.youtube.com/playlist?list=PLw5h0DiJ-9PCn4shW4X43FSjEqdBwc1Cn
3	https://www.youtube.com/watch?v=W01tIRP_Rqs

Course Outcomes		CL	Class Session
After the completion of this course, students will be able to-			
BDSXX19.1	**Understand** data science evolution, roles, architecture, and security.	2	9
BDSXX19.2	**Apply** data collection and preprocessing techniques.	3	9
BDSXX19.3	**Analyze** data using descriptive statistics and ANOVA.	4	9
BDSXX19.4	**Implement** regression and clustering techniques.	3	9
BDSXX19.5	**Perform** network analysis using graph-based methods.	5	9

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