Detailed Syllabus

Lecture-wise Breakup

Subject Code	17M11CS111	**Semester (specify Odd/Even)**	**Semester Odd Session 2022-2023 Month from July 22 to December 22**
Subject Name	Data structure & Algorithms for Big Data		
Credits	**3**	**Contact Hours**	**3(L)**

Faculty (Names)	**Coordinator(s)**	Indu Chawla
	Teacher(s) (Alphabetically)	Indu Chawla

COURSE OUTCOMES		**COGNITIVE LEVELS**
C110.1	Define basic concepts of Big Data and relating them to them with various Big Data technologies (e.g., Hadoop, Spark)	Remember Level (Level 1)
C110.2	Explain Hadoop cluster architecture and its components and Differentiate Hadoop Distributed File System (HDFS) from other storage techniques, e.g., NFS and UNIX file system	Understand Level (Level 2)
C110.3	Construct data structure and algorithms for HDFS and MapReduce and further applying them to different Big Data problems.	Apply Level (Level 6)
C110.4	Apply hashing on large scale multi-dimensional data sets using Locality Sensitive Hashing.	Apply Level (Level 3)
C110.5	Analyze and apply advance data structures and algorithms (e.g., B and B+ Tree, R and R+ Tree, Matrix multiplication) for solving big data problems	Analyze Level (Level 4)
C110.6	Evaluate Streaming Algorithms, Sublinear optimization, Machine Learning, Hadoop systems	Evaluate Level (Level 5)

S.N.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**	**Remarks**
1.	Introduction to Big Data	Motivation, Application, Domains for Big Data, Various tools and services	2	
2.	Basics of Hadoop	Introduction to hadoop. Introduction to HDFS, Read and write operation, Fault Tolerance-Failures and Recovery,:	3	
3.	MapReduce	Introduction to MapReduce, Mapreduce Job scheduling	3	
4.	Basic data structures	Array: searching, sorting,	4	

	concepts	aggregation on BIG DATA		
5.	Basic Statistics	Various types of parametric and non-parametric test	2	
6.	Matrix Multiplication	Matrix Multiplication for BIG DATA	2	
7.	Concurrency Control	Concurrency-control mechanisms, Multithreading, Transactions, logging, ACID compliant, crash recovery	5	
7.	Graphs	Spanning Tree (Min/Max), Searching (BFS), Shortest Path etc.	6	
8.	Indexing strategies Trees	large Arrays, Hashing, AVL, B-tree, Tries, R and R+ Trees, Prefix Trees, Accumulo, Bigtable, bLSM, Cassandra, HBase,Hypertable, LevelDB are LSM trees, divide & conquer, mapreduce	6	
9.	Bloom filters	Bloom filters, HyperLogLog, Count–2 min sketch	4	
10	Applications (may use spark)	Streaming Algorithms, Sublinear optimization, Machine Learning Problems, Hadoop systems	2	
11	Mathematical Foundation	Sparse: Vector Spaces, Matrix algebra, LSI,SVD, PSD	3	
Total number of Lectures			**42**	

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25Attendance (10 Marks), Assignment/Quiz/Mini-project (15 Marks)
Total	**100**

Project based learning: Students in group of 3 to 4 students are required to develop mini-project based on the concepts taught in this course. In mini-project, students need to create the distributed environment either using Hadoop framework or multithreading using OpenMP. Problem statements need to be formulated in various applications domains of big data, proposing the solution approach and implemented over the created distributed environment.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Journals: IEEE Transactions on Knowledge and Data Engineering, ACM Transactions on Intelligent Systems and

	Technology (TIST), ACM Transactions on Knowledge Discovery from Data (TKDD)
2.	2. Tier-1 Conferences: SIGKDD, ICDE - International Conference on Data Engineering, CIKM - International Conference on Information and Knowledge Management, ICDM - IEEE International Conference on Data Mining, SDM - SIAM International Conference on Data Mining, PKDD - Principles of Data Mining and Knowledge Discovery, IEEE Big Data
3.	https://journalofbigdata.springeropen.com/ https://www.springer.com/journal/41060
4.	4. Book: Mahmoud Parsian, "Data Algorithms: Recipes for Scaling Up with Hadoop and Spark", O'Reilly Media
5.	Probabilistic Data Structures and Algorithms in Big Data Applications by Andrii Gakhov
6.	Algorithms and Data Structures for Massive Datasets by Dzejla Medjedovic, Emin Tahirovic, and Ines Dedovic, MEAP began July 2020

Detailed Syllabus
Lecture-wise
Breakup

Subject Code	17M11CS112	**Semester (specify Odd/ Even):** Odd	**Semester:** Odd **Session** 2022-2023 **Month from** July to December
Subject Name	Machine Learning and Data Mining		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Anita Sahoo
	Teacher(s)	Anita Sahoo

COURSE OUTCOMES		**COGNITIVE LEVELS**
C112.1	Differentiate between Classification, Clustering and Association Rules techniques.	Level 4 (Analyze)
C112.2	Understand working of classification techniques, e.g., k-Nearest Neighbours, Naïve Bayes, ID3 Decision Trees, Support Vector Machine, Ensemble methods.	Level-2- (Understanding)
C112.3	Apply and compare different clustering techniques, e.g., k-means, k-mediods, etc.	Level-3 (Apply)
C112.4	Evaluate different dimensionality reduction techniques e.g. PCA, SVD, Factor Analysis, Linear Discriminant Analysis, etc., in big data scenarios.	Level-5 (Evaluate)
C112.5	Apply various Artificial Neural Network Models for classification and clustering	Level-3 (Apply)

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1	Introduction	Introduction to Machine Learning, Data Mining and Knowledge Discovery in Data Bases, Data Types	2
2	Classification	Introduction to classification, k-Nearest Neighbours, Naïve Bayes, Decision Trees, Advanced classification techniques	6
3	Regression	Linear Regression with One Variable, Linear Regression with Multiple Variables, Logistic Regression	4
4.	Clustering	Introduction, Different type of Clustering Methods, Partitioning Clustering Methods, Hierarchical Clustering Methods, k-means, k-medoids, density based clustering, cluster validation	8
5.	Association Rules	Support, Confidence, Lift, Conviction; Apriori algorithm, Eclat algorithm, FP-growth algorithm	4
6.	Dimensionality Reduction	Introduction, Subset Selection, PCA, SVD, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis	6
7.	Artificial Neural Methods	Cost Function, Back propagation, Feed forward Network, Gradient Descent, Network training, Error Propagation, Application of Neural Networks, Introduction to quantum neural network	8
8.	Ensemble Methods	Ensemble methods of classification-Bagging, Boosting, and Random Forest	4
		Total number of Lectures	42

Evaluation Criteria	
Components	**Maximum**
Marks T1	**20**
T2	**20**
End Semester Examination	**35**
TA	**25 (Attendance (10), Mini-project/Assignment (15))**
Total	**100**

Project based learning: Each student in a group of 3-4 will have to develop a mini project based on association mining, classification and clustering approaches. The students can choose any real-world application that requires some decision-making. The students have to implement the mini-project using any open-source programming language. Project development will enhance the knowledge and employability of the students in IT sector.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc.)

1	Han, Jiawei, Jian Pei, and Micheline Kamber. Data mining: concepts and techniques. Elsevier, 3rd edition ,2012
2	Kimball R. and Ross M ,The Data Warehouse Toolkit", Wiley, 3rd edition,2013
3	Pujari, Arun K, Data mining techniques , Universities press, 3rd edition , 2013
4	Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, second edition, 2019
5	Soumen Chakrabarti, Mining the Web: Discovering knowledge from hypertext data", Morgan Kaufmann, Elsevier
6	Mitchell, Tom, and Machine Learning McGraw-Hill. "Edition." (1997).
7	Wittek, Peter. Quantum machine learning: what quantum computing means to data mining. Academic Press, 2014.
8	Anahory S. and Murray D, Data Warehousing in the Real World, Addison- Wesley
9	Dunham, Margaret H. Data mining: Introductory and advanced topics. Pearson Education India, 2006.
10	Mattison R. ,Web Warehousing and Knowledge Management", Tata McGraw- Hill.
11	David Hand, Heikki Mannila and Padhraic Smyth ,Principles of Data Mining,PHI
12	Transactions on Database Systems (ACM)
13	IEEE Transactions on Knowledge & Data Engineering
14	The VLDB Journal The International Journal on Very Large Data Bases

Course Description with COs

Detailed Syllabus

Subject Code	19M12CS111	**Semester odd**	**Semester: First Session: 2022- 2023 Month from July to December**
Subject Name	Web Intelligence		
Credits	**3**	**Contact Hours**	**3**
Faculty (Names)	**Coordinator(s)**	1. Dr. Anuja Arora	
	Teacher(s) (Alphabetically)	Dr. Anuja Arora	

Course Outcomes:

At the completion of the course, students will be able to,

CO#	CO Description	COGNITIVE LEVELS
C121.1	Outline the various web technologies, methods, and models used to design an intelligent web.	Understand (Level-2)
C121.2	Make use of web caching strategies at varied level: user, web server, and gateway server.	Apply Level (Level-3)
C121.3	Analyze and Model the users' browsing behavior on web.	Analyze (Level-4)
C121.4	Evaluate various Web content mining algorithms, Web language models and learning to rank models to handle complex Web.	Evaluate Level (Level-5)
C121.5	Design and develop the computational intelligent web algorithms to handle complex real problems	Create Level (Level-6)

Module No.	Subtitle of the Module	Topics in the module	No. of Lectures for the module
1.	Web Content Feature Engineering	Frequency Filter, POS Tag, Unigram, Ngram, Collocation, Levenstein Distance, KL-Divergence, T-Test.	4
2	Web Language Models	Vector Space Models: TF-IDF, SGRank, SGRank-IDF,	8

		Single Rank, Word-Word occurrence matrix; Word Embedding with GloVe, Word2Vec, CBoW, Skip Gram Model Probabilistic models: Bayes model, BM25 Ranking model;	
3	Web Content Searching	Link Based Search Algorithm, Power Iteration Method for ranking nodes on web, Handling Spider Traps and Dead ends, Topic Sensitive Page Ranking.	4
4	Ranking Algorithm and performance measures	Point wise ranking, Pair wise Ranking, Listwise ranking, Metrics for Learning to rank : CG, DCG, NDCG, P@K, MAP, AP	4
5	Web caching Algorithm	LRV, FIFO, LRU, Random, OPT, Size based, PSS	4
6	Matrix Factorization Techniques	Matrix decomposition, Eigenvalue decomposition, Non-Negative matrix factorization, Singular value decomposition, objective functions , UV decomposition, CUR decomposition	5
7	Tensor Factorization	Multidimensional Matrix, Matricization, Tucker decomposition, High Order SVD, clustHOSVD, other methods	4
10	Collective Intelligence	Crowd Sourcing, Local-Global Behavioral Interactions, Self-Organizing Systems, Self-Adaptive Evolutionary Systems, Information Extraction from Deep Web, Decision Making Under Uncertainty	4
11	Graph Structure in the Web	Social Network Analysis, Google Patent Algorithm, News Feed Algorithm, Edge Rank Algorithm, Web of Things, Situational Awareness	5
		Total number of Lectures	**40**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1 Web Intelligence Journal: https://www.iospress.nl/journal/web-intelligence-and-agent-systems/

2. Soumen Chakrabarti,. Mining the Web: Discovering knowledge from hypertext data. Morgan Kaufmann, 2003.

3. Scime, Anthony, ed. Web mining: applications and techniques. IGI Global, 2005.

4. Hitzler, Pascal, Markus Krotzsch, and Sebastian Rudolph. Foundations of semantic web technologies. CRC Press, 2011.

5. Sponder, M., & Khan, G. F. (2017). Advanced Web Analytics and Web Intelligence. In Digital Analytics for Marketing (pp. 115-144). Routledge.

6. Symeonidis, P., & Zioupos, A. (2016). Matrix and Tensor Factorization Techniques for Recommender Systems (Vol. 1). New York: Springer International Publishing.

7. Aggarwal Charu.C, Social Network Data Analytics, Springer Science+Business Media, LLC 2011

8. Velásquez, J. D. (2010). Advanced techniques in web intelligence (Vol. 311). L. C. Jain (Ed.). Springer.

9. Zhong, N., Liu, J., & Yao, Y. (2003). Web intelligence. Springer Science & Business Media.

10 Borgatti Stephon. P., Everett Martin G and Johnson Jeffery C , Analyzing Social Networks, Sage Publications, 2013

Detailed Syllabus
Lecture-wise Breakup

Course Code	19M12CS113	**Semester** Odd **(specify Odd/Even)**	**Semester** I sem (M.TechCSE)/DD **Session** 2022 -2023 **Month** from **Jul'22** to **Dec'22**
Course Name	ADVANCED WIRELESS NETWORKS		
Credits	3	**Contact Hours**	3-0-0

Faculty (Names)	**Coordinator(s)**	Dr K. RAJALAKSHMI
	Teacher(s) (Alphabetically)	Dr K. RAJALAKSHMI

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Understand the fundamentals of Wireless Transmission Technology, and media access Technologies.	Understand (C2)
CO2	Network design, simulate and analysis of various protocols in wireless networks such as WLAN, Bluetooth.	Create (C6)
CO3	Analyse the GSM & UMTS Telecommunication Systems	Analyze (C4)
CO4	Discuss the features of 4G and 5G networks	Apply (C3)
CO5	Demonstrate the features of SDN framework	Apply (C3)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Introduction	Applications of Wireless Networks, history of wireless communication, open research topics, simplified reference model	**4**
2.	Wireless Transmission	Frequency for radio transmission, regulation, signals, antennas, signal propagation, multiplexing, modulation, spread spectrum, cellular systems	**6**
3.	Medium Access Control	Specialized MAC, Hidden and exposed terminals, near and far terminals, SDMA, FDMA, TDMA, CDMA., comparison of S/T/F/CDMA	**4**
4.	Wireless LAN	Infra-red vs. radio transmission, Infrastructure and ad-hoc network, IEEE802.11: System architecture, protocol architecture, Physical Layer, Medium access control layer, MAC management, 802.11b, 802.11a, Bluetooth.	**6**
5	WiMAX	IEEE802.16 and WiMAX – Security – Advanced 802.16 Functionalities – Mobile WiMAX - 802.16e – Network Infrastructure	**3**
6.	Telecommunication Systems	GSM: Mobile Services, System Architecture, Radio Interface, Protocols, Localization and calling, Handover, Security, Data Services, GPRS,EDGE, UMTS and IMT-2000: UMTS releases and standardization, UMTS system architecture, UMTS radio interface, UTRAN, Core Network, Handover	**5**

7.	LTE, 4G, 5G	LTE – Network Architecture and Interfaces – Air Interface and Radio Networks – Mobility Management - Interconnection with UMTS and GSM – LTE Advanced (3GPPP Release 10) - Physical Layer and Multiple Access - OFDMA - Channel Modelling for 4G – Introduction to 5G - 3GPP 5G-NR Standards, usage scenarios, 5G Architecture, Next Gen Core (NGC) Network Function , 5G Non Standalone Options (NSA), 5G Advance Networks, mmWave Systems	8
8.	Software Defined Networks	Introduction – Centralized and Distributed Control and Data Planes – Open Flow – SDN Controllers – General Concepts – VLANs – NVGRE – Network Overlays – Types – Virtualization – Data Plane – I/O – Design of SDN Framework	6
		Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Attendance = 10, Quizzes /Assignments /Mini-Project = 15)
Total	**100**

Students form group of size 2-3 members. Each group will identify several wireless network issues in distributed applications in various thrust areas like healthcare, industrial, education, smart city, logistics, environment, governance and etc. Once problem has been identified, the group will analyze the problem and synthesize wireless network based solutions to the identified problem. Each group will apply different wireless network technology and concepts such as WIFI, Bluetooth, WiMAX, 4G/5G, and SDN. This approach will enhance skills of each student and increase the understanding of incorporating wireless networks in recent distributed applications. Moreover, candidate will gain the enough knowledge to provide the wireless network based solutions to enhance the scalability, mobility and coverage issues of any organization/company. After this course, a student will able to undertake any work in this area in the industry or research.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

	Reference Books
1.	Jochen Schiller, “Mobile Communications”, second edition, Addison-Wesley, 2004.
2.	Martin Sauter, From GSM to LTE, An Introduction to Mobile Networks and Mobile Broadband, Wiley, 2014.
3.	Savo G Glisic, Advanced Wireless Networks – 4G Technologies, John Wiley & Sons, 2007.
4.	Jonathan Rodriguez, Fundamentals of 5G Mobile Networks, Wiley, 2015.
5	Paul Goransson, Chuck Black, ―Software Defined Networks: A Comprehensive Approach, Morgan Kauffman, 2014.
6.	Naveen Chilamkurti, SheraliZeadally, HakimaChaouchi, Next-Generation Wireless Technologies‖, Springer, 2013.
7.	IEEE, ACM Transactions, Journals and Conference papers on “Advance Wireless Network”

Detailed Syllabus

Subject Code	21M71CS112	**Semester Even**	**Semester M.Tech I** **Session 2022- 2023** **Month from July - December**
Subject Name	Advances in AI		
Credits	**3**	**Contact Hours**	**3**
Faculty (Names)	**Coordinator(s)**	Dr. Ankit Vidyarthi	
	Teacher(s) (Alphabetically)	Dr. Ankit Vidyarthi	

S.No.	**Description**	**Cognitive Level (Blooms Taxonomy)**
C161.1	Understand the characteristics & significance of AI	Understanding Level (Level III)
C161.2	Analyze several AI/ML techniques to yield and process information from open real-world data sources	Analyzing Level (Level II)
C161.3	Apply the concept of Machine Learning for industrial applications	Applying Level (Level IV)
C161.4	Evaluate the use of the Machine Learning algorithms towards pattern mining	Evaluating Level (Level V)
C161.5	Design algorithmic frameworks for solving time series data patterns	Creating Level (Level VI)

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1	Introduction	Introduction of AI, introduction of Machine Learning, Significance of AI and ML, Application areas, model pipelining	3
2	Mathematical Formulation	Matrices and its operations, Overview of probability theory, Bayes networks, Independece, I-Maps, Undirected graphical models, Bayesian and Markov networks	5
3	Models and Learning	Learning, Types of learning, Local models; Exact inference, Clique trees, Belief propagation, Tree construction, applications solving problems	6

4	Optimization and Inference	Introduction to optimization, Approximate inference: sampling, Markov chains, MAP inference, Inference in temporal models; Learning graphical models	6
5	Estimation	Parameter estimation, Bayesian networks and shared parameters, structure learning, Partially observed data, Dimension reduction: PCA, LDA	8
6	Decision making	Gradient descent, Expected Maximization, Hidden variables, HMM, Undirected models, Undirected structure learning, Causalty, Utility functions, Decision problem, Expected utility	8
7	Classification and Segmentation	KNN, SVM, NN and its types, K-means, FCM, Introduction to Deep learning for classification and segmentation	6
Total number of Lectures			**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	Attendance (15Marks), Assignment/Quiz/Mini-project (10Marks)
Total	**100**

Project based learning: Each student in a group of 2-3 will extract data from real-world domains using data from standard repositories that are globally recognized. For conducting application-based research, the students are encouraged to analyze social/political/financial/disease related data and generate underlying networked structure based on the algorithms of AI.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Michael Negnevitsky, *Artificial Intelligence*, Person Publication, Third Edition, 2011
2.	Toshinori Munakata, *Fundamentals of the New Artificial Intelligence*, Springer, Second Edition, 2008
3.	Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong. *Mathematics for machine learning*. Cambridge University Press, 2020
4.	Valliappa Lakshmanan, Martin Görner, Ryan Gillard - *Practical Machine Learning for Computer Vision_ End-to-End Machine Learning for Images*, O'Reilly Media, Inc., 2021
5.	Laurence Moroney - *AI and Machine Learning for On-Device Development_ A Programmer's Guide*, O'Reilly Media, Inc., 2021

Detailed Syllabus

Course Code	17M15CS112	**Semester: July-December 2022-23**	**Semester: I Session** 2022 -2023 Month from: July
Course Name	Machine Learning and Data Mining Lab		
Credits	1	**Contact Hours**	**2**

Faculty (Names)	**Coordinator(s)**	Dr.Amit Mishra
	Teacher(s) (Alphabetically)	Dr.Amit Mishra

COURSE OUTCOMES		**COGNITIVE LEVELS**
C173.1	Identify the programming languages for machine learning and data mining	Understanding (Level-2)
C173.2	Use Python to apply and evaluate Linear regression, Logistic regression, kNN , k Means, SVM and ID3 on different datasets	Apply Level-3)
C173.3	Implement apiori algorithm and Eclat algorithm in R	Apply (Level-3)
C173.4	Apply Neural networks to model object detection, video tagging, music genre detection etc.	Apply (Level-3)
C173.5	Evaluate different machine learning models on the basis of their performances	Evaluate (Level-5)

Module No.	**Title of the Module**	**List of Experiments**	**CO**
1.	Python for data sampling and Visualization	a. To write a program for writing the pixel values of an image b. Write programs for Data Sampling (given dataset).	1
2.	Python for text processing	Use IPython (a web version provided by Jupyter nootbook) to write a word count program. Your program should read a text document (download from https://raw.githubusercontent.com/python/cpython/master/	1
3.	Classification-1	Implement kNN algorithm using Python. Consider iris dataset and report the accuracy of classification. [May take help from : https://machinelearningmastery.com/tutorial-to-implement-k-nearest-neighbors-in-python-from-scratch/]	2

4.	Clustering	Clustering: Implement kMeans Algorithm	2
5.	Classification-2	Classify the wine dataset of UCI Repository by ID3.	2
6.	Data Mining-1	Implement Logistic Regression on a sample dataset	2
7.	Data Mining-2	Implement apriori and Eclat algorithm for association rule mining in R	3
8.	SVM-1	Apply Support Vector Machine on the dataset of question the Parkinson dataset given in https://archive.ics.uci.edu/ml/datasets/Parkinson+Dataset+with+replicated+acoustic+features+.	2
9.	Comparison of Classification algorithms	Compare the classification of Iris dataset by different algorithms namely kNN, ID3 and SVM. Report accuracy and other performance measures.Implement neural networks for Classification of *four* character patterns	5
10.	ANN	Apply Multi Layer Percepron for supervised learning (problem statement to be given individually)	4
11.	BPN	Use back propagation for supervised learning . For the data based on 1990 census data from California.Evaluate the accuracy of a model's predictions using RMSE.	4
12.	CNN	Implement CNN using TensorFlow for classifying MNIST images	4

Evaluation Criteria

Components	**Maximum Marks**
Lab Test1	20
Lab Test2	20
PBL/Miniproject /Assignment	45
Attendance	15
Total	100

PBL- Students in a group of 4-5 will be designing an efficient solution to a given problem / case-studies using appropriate Machine Learning and Data mining Technique studies in the course.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Jiawei Han, Micheline Kamber, Data Mining, Morgan Kaufmann Publishers,Elsevier,2005
2.	Kimball R. and Ross M ,The Data Warehouse Toolkit", Wiley
3.	Pujari, Arun K,Data mining and statistical analysis using SQL, Universities press
4.	Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining
5.	Soumen Chakrabarti, Mining the Web: Discovering knowledge from hypertext data", Morgan Kaufmann, Elsevier

6.	Margaret H. Dunham, Data Mining: Introductory and Advanced Topics, Prentice Hall,2003
7.	Mattison R. ,Web Warehousing and Knowledge Management", Tata McGraw-Hill.
8.	David Hand, Heikki Mannila and Padhraic Smyth ,Principles of Data Mining,PHI
9.	Transactions on Database Systems (ACM)
10.	IEEE Transactions on Knowledge & Data Engineering
11.	The VLDB Journal The International Journal on Very Large Data Bases

Detailed Syllabus
Lab-wise Breakup

NOTE: All the entries (…) must be in Times New Roman 11.

Course Code	17M15CS113	**Semester** **Odd 2022**	**Semester** ... **Session** 2022-23 **Month from** July to Dec, 2022
Course Name	**Cloud Technology Lab**		
Credits	1	**Contact Hours**	2 Hours

Faculty (Names)	**Coordinator(s)**	Dr Prakash Kumar
	Teacher(s) (Alphabetically)	Dr. Prakash Kumar

COURSE OUTCOMES		**COGNITIVE LEVELS**
C171.1	Demonstrate the architecture and layers of Cloud Service Models, Deployment models etc.	Understand (level 2)
C171.2	Understand the working of CloudSim and run different scheduling algorithms.	Apply (level 3)
C171.3	Analyze various Scheduling algorithms and compare their performances on Virtual Machines, Containers and Dockers.	Analyze (level 4)
C171.4	Apply and evaluate the energy aware algorithms for using DVFS techniques.	Evaluate (level 5)

Module No.	**Title of the Module**	**List of Experiments**	**CO**
1.	CloudSim installations and Use	Create Virtual Machines (VMs) on CloudSim.	CO1
2.		Allocate different Cloudlets to VMs and Data Centers using different scheduling algorithms	CO2
3.	Analyze various Scheduling algorithms in different scenarios on cloudsim	Create different Data Centers and allocate the VMs to them and analyze the outcomes	CO3
4.		Assign the cloudlets and change the scheduling techniques for various scenarios Creating and Running applications using Containers and Dockers in Cloud Environments.	CO3
5.	Evaluate Energy Aware Simulations using DVFS	Apply and evaluate energy aware algorithms using DVFS techniques.	CO4

Evaluation Criteria

Components	**Maximum Marks**
Lab Test# 1	20
Lab Test# 2	20
D2D work	60 (D2D: 30 marks, PBL: 20 marks, Attendance: 10 marks)
Total	**100**

Project Based Learning: A group of maximum 2 students are to be formed. Each group shall choose a Cloud based project. The project shall be designed and/or modeled based on any Cloud Platform like AWS, Google cloud, Eucalyptus, CloudSim, iFogSim or any simulation tools. The project shall function and run as per the objective of the project. Live demonstration of the project shall be shown during their presentation. The project evaluation shall be done based on the quality, innovation, relevance and creativity involved.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	K. Hwang, Geoffrey C. Fox, Jack J. Dongarra, "Distributed and Cloud Computing- From Parallel Processing to the Internet of Things", Morgan Kauffman Publishers, Elsevier.
2	George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud" O'REILLY publication.
3	"Virtualization Overview", White paper, VM Ware.
4.	Rodrigo N. Calheiros, Rajiv Ranjan, Anton Beloglazov, Cesar A. F. De Rose, and Rajkumar Buyya, CloudSim: A Toolkit for Modeling and Simulation of Cloud Computing Environments and Evaluation of Resource Provisioning Algorithms, Software: Practice and Experience, Volume 41, Number 1, Pages: 23-50, ISSN: 0038-0644, Wiley Press, New York, USA, January 2011.
5.	Tom Guérout, Thierry Monteil, Georges Da Costa, Rodrigo Neves Calheiros, Rajkumar Buyya, Mihai Alexandru, Energy-aware Simulation with DVFS, Simulation Modelling Practice and Theory, Volume 39, No. 1, Pages: 76-91, ISSN: 1569-190X, Elsevier Science, Amsterdam, The Netherlands, November 2013.
6.	Rajkumar Buyya, Rajiv Ranjan and Rodrigo N. Calheiros, Modeling and Simulation of Scalable Cloud Computing Environments and the CloudSim Toolkit: Challenges and Opportunities, Proceedings of the 7th High Performance Computing and Simulation Conference (HPCS 2009, ISBN: 978-1-4244-4907-1, IEEE Press, New York, USA), Leipzig, Germany, June 21 - 24, 2009. **- Keynote Paper.**
7.	https://www.docker.com
***m*.**	…

Detailed Syllabus
Lecture-wise Breakup

Course Code	19M12CS112	**Semester** Odd **(specify Odd/Even)**	**Session** 2022 -2023 **Month** from July to Dec
Course Name	Metaheuristics in Modelling and Optimization		
Credits	3	**Contact Hours**	3-0-0

Faculty (Names)	**Coordinator(s)**	Dr. Parul Agarwal
	Teacher(s) (Alphabetically)	Dr. Parul Agarwal

COURSE OUTCOMES At the completion of the course, Students will be able to		**COGNITIVE LEVELS**
C131.1	Interpret and explain the concepts of Metaheuristics based optimization and it's application in a diverse range of applications.	Understand Level (C2)
C131.2	Model single solution and population based Metaheuristic algorithms to solve a given optimization problem.	Apply Level (C3)
C131.3	Model Metaheuristic algorithms to solve Multi-objective optimization problems.	Apply Level (C3)
C131.4	Model hybrid Metaheuristic algorithms to solve a given optimization problem.	Apply Level (C3)
C131.5	Explain algorithms and architectures for parallel implementation of Metaheuristics.	Understand Level (C2)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Introduction	Optimization Models, Approximate Algorithms, When to use Metaheuristics?, Methods and Application	4
2.	Fundamentals of Metaheuristics	Representation, Objective Functions; Constraint Handling; Parameter Tuning; Performance Analysis.	5
3.	Single-Solution Based Metaheuristics	Basic Concepts, Fitness Landscape Analysis; Local Search; Tabu Search; Iterated and Guided Local search; Variable Neighborhood Search; Smoothing Methods; Noisy Methods	6
4.	Population-Based Metaheuristics Methods	Basic Concepts; Evolutionary Algorithms, Swarm Intelligence, Stochastic diffusion search, Social cognitive optimization	6
5.	Metaheuristics for Multi-objective Optimization	Basic concepts; Multi-objective Continuous and Combinatorial Problems, Multi-criteria Decision Making; Design Issues	3
6.	Fitness Assignment Strategies and Evaluation of Multi-objective Optimization	Scalar approach, Criterion-Based Methods; Dominance-Based Approaches; Indicator based Approaches; Diversity Preservation; Performance Evaluation	7
7.	Hybrid Metaheuristics	Design and Implementation Issues; Mathematical Programming Approaches; Classical Hybrid Approaches;	7

		Hybrid Metaheuristics with Machine Learning and Data Mining; Hybrid Metaheuristics for Multi-objective Optimization	
8.	Parallel Metaheuristics	Parallel Design and Implementation of Metaheuristics; Parallel Metaheuristics for Multi-objective Optimization	4
		Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Attendance(10), Assignments/Mini-project/Tutorials/Quiz (15)
Total	**100**

Project based learning: Each group of 3-4 students will be assigned an optimization problem at the beginning. They are required to apply the metaheuristic methods they study on the given problem.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Metaheuristics: From Design to Implementation by El-Ghazali Talbi, Wiley, June 2009.
2.	Sean Luke, 2013, Essentials of Metaheuristics, Lulu, second edition, available athttp://cs.gmu.edu/←sean/book/metaheuristics.
3.	Gandomi, Amir; Yang, Xin-She; Talatahari, Siamak; Alavi, Amir; "Metaheuristic Algorithms in Modeling and Optimization", Metaheuristic Applications in Structures and Infrastructures, Dec 2013.
4.	Kalyanmoy Deb; "Multi-Objective Optimization Using Evolutionary Algorithms:An Introduction"; https://www.egr.msu.edu/~kdeb/papers/k2011003.pdf
5.	Kalyanmoy Deb; "Single and Multi-Objective Optimization Using Evolutionary Algorithms"; https://www.iitk.ac.in/kangal/papers/2004002.pdf
6.	Paulo Cortez, Modern Optimization with R, Use R! series, Springer, September 2014, ISBN 978-3-319-08262-2.

Research Methodology and Intellectual Property Rights (18M11GE111)

Basic idea of research, types of research, methods to write report and research papers, use of Mendeley in report writing, problem identification and solving, research ethics, patents, intellectual property rights, plagiarism regulation 2018, steps in research process and common methodologies to attempt solution to research paper, basic statistical concepts, handling of raw data, Some common probability distributions, hypothesis testing, parametric and non-parametric data, introduction to regression analysis.

Course Description

Course Code	**18M11GE111**	**Semester** Odd	**Semester** I **Session** 2022-23 **Month from** Aug - Dec 2022	
Course Name	Research Methodology and Intellectual Property Rights			
Credits	2	**Contact Hours**	2-0-0	
Faculty (Names)	**Coordinator(s)**	Dr. Shikha Pandey		
	Teacher(s) (Alphabetically)	Dr. Shikha Pandey		

COURSE OUTCOMES:		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
C101.1	explain the basic concepts and types of research	Understanding Level (C2)
C101.2	define a research problem, its formulation, methodologies and analyze research related information	Analyzing Level (C4)
C101.3	explain research ethics, understand IPR, patents and their filing related to their innovative works.	Understanding Level (C2)
C101.4	explain and analyze the statistical data and apply the relevant test of hypothesis in their research problems	Analyzing Level (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Research	What is research? Types of research. What is not research? How to read a Journal paper?	3
2.	Report writing	How to write report? Use of Mendeley in report writing. How to write a research paper? Problem identification and solving.	4
3.	Ethics, IPR and Research methodologies	Research ethics, patents, intellectual property rights, plagiarism regulation 2018. Steps in research process and common methodologies to attempt solution to research paper.	8

4.	Basics of statistics and probability distributions	Basic statistical concepts. Handling of raw data, Some common probability distributions.	7
5.	Test of hypothesis and regression analysis	Hypothesis testing. Parametric and non-parametric data, Introduction to regression analysis.	8
		Total number of Lectures (Course delivery method: open ended discussion, guided self-study, lectures)	**30**

Evaluation Criteria

Components	**Maximum Marks**
Mid Term Examination	30
End Semester Examination	40
Assignments	30 (Quiz, Assignments)
Total	**100**

Project based learning: Students divided in small groups will be assigned topics related to patents, intellectual property rights, plagiarism, and statistics. Students can write a report/review paper and find its similarity through plagiarism software available online. Students may collect data and test the relevant hypothesis. They may study some data set and do its regression analysis. The main purpose is to expose students to a wider arena of applicable knowledge of the subject.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

Stuart Melville and Wayne Goddard, Research Methodology: An Introduction for Science & Engineering Students, Kenwyn, South Africa: Juta & Co. Ltd., 1996.

Kothari, C.R., Research Methodology: Methods and Techniques, New Age International, New Delhi, 2009.

Kumar, Ranjit, Research Methodology: A Step by Step Guide for Beginners, 2nd Edition, Sage Publications Ltd., 2005.

Ramappa, T., Intellectual Property Rights Under WTO, S. Chand, New Delhi, 2008.

Wayne Goddard and Stuart Melville, Research Methodology: An Introduction, Kenwyn, South Africa: Juta & Co, 2001.

Detailed Syllabus
Lecture-wise Breakup

Course Code	21M71CS111	**Semester:** ODD	**Semester:** I **Session:** 2022 -2023 **Month from:** Aug 2022-Dec 2022
Course Name	Data Science using Python		
Credits	3-0-0	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Dr. Adwitiya Sinha
	Teacher(s) (Alphabetically)	Dr. Adwitiya Sinha

COURSE OUTCOMES		**COGNITIVE LEVELS**
C183.1	Understand the data analysis techniques	Understand (Level 2)
C183.2	Understand the concepts behind the descriptive analytics	Understand (Level 2)
C183.3	Apply predictive analytics of data	Apply (Level 3)
C183.4	Analyze data using Python programming	Analyze (Level 4)
C183.5	Evaluate strategies for data science with measures of correlation, association, and learning using Python modules and packages	Evaluate (Level 5)

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	Introduction	Introduction to Data Science - Evolution of Analytics, analytic processes and tools, Analysis vs reporting - Modern data analytic tools. Statistical concepts: Sampling distributions, re-sampling, statistical inference, prediction error.	8
2.	Predictive Analytics	Predictive Analytics – Regression, Decision Tree, Neural Networks. Dimensionality Reduction - Principal component analysis	9
3.	Descriptive Analytics	Mining Frequent item-sets - Market based model – Association and Sequential Rule Mining - Clustering Techniques – Hierarchical – K- Means	9
4.	Data Analysis Using Python	Introduction to Python, Python Application Programming Interfaces & Libraries, File handling, Data Types, Descriptive Statistics, Data Preprocessing, Dirty Data, Examining Single/Multiple Variables, Statistical Methods	10
5.	Exploratory Data Analysis	Exploring univariate and multivariate data: Heat Map, Box and Whisker plot, Scatter plots with histograms, Bubble charts, Geo-plots	6
		Total number of Lectures	**42**

Evaluation Criteria	
Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA (Tutorials, regularity & Marco	Assignments) 25 (Assignments & Attendance) (**Class Presence & Performance = 05 Internal Assessment & Assignment in PBL mode = 20**)
Total	**100**

Project based learning: Each student in a group of 2-3 will use Python to extract data from real-world domains using data streaming, web crawling, application programming interfaces (APIs), or from standard repositories that are globally recognized. The students will be encouraged to analyze social/political/financial/healthcare related data and perform data science using Python libraries and packages. Project work will focus on developing models to analyze the real-world data by performing statistical, probabilistic and exploratory analysis. The students will also explore learning techniques on variety of datasets and perform case studies using Python programming.

Recommended Reading material: Text Books/ Reference Books	
1.	Dietrich, David (2015). Data Science & Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data. EMC Education Services, Wiley**.**
2.	Jaiwei Han, Micheline Kamber. (2006) Data Mining Concepts and Technique. Elsevier.
3.	Ross, Sheldon (2019). A First Course in Probability. 9th Edition, Pearson.
4.	Michael Berthold, David J. Hand (2007). Intelligent Data Analysis, Springer.
5.	Michael Minelli, Michele Chambers, Ambiga Dhiraj. (2013). Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends", John Wiley & Sons.
6.	Bart Baesens. (2014) Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", John Wiley & Sons.
7.	Min Chen, Shiwen Mao, Yin Zhang, Victor CM Leung. (2014), Big Data: Related Technologies, Challenges and Future Prospects, Springer.
8.	Zelle, J. (2016). Python Programming: An Introduction to Computer Science. Franklin, Beedle & Associates, Inc..
9.	Jaworski, M. and Ziadé, T. (2019). Expert Python Programming: Become a master in Python by learning coding best practices and advanced programming concepts in Python 3.7. Packt Publishing Ltd.

Detailed Syllabus
Lab-wise Breakup

Course Code	**17M15CS111**	**Semester:** ODD	**Semester: I** **Session** 2022 -2023 **Month from** July to Dec 2022
Course Name	Advanced Algorithms Lab		
Credits	1	**Contact Hours**	2

Faculty (Names)	**Coordinator(s)**	Manish Kumar Thakur
	Teacher(s) (Alphabetically)	Manish Kumar Thakur

COURSE OUTCOMES		**COGNITIVE LEVELS**
C170.1	Implement algorithms and use appropriate advanced data structures for solving computing problems.	Level 3: Apply
C170.2	Design algorithms using divide-and-conquer, greedy and dynamic programming strategies, and further recite algorithms that employ these strategies.	Level 3: Apply Level 5: Evaluate
C170.3	Illustrate the mathematical foundation of network flows and some important flow algorithms.	Level 2: Understand Level 3: Apply
C170.4	Implement randomized algorithms to solve various problems, and validate their correctness and complexity.	Level 3: Apply Level 4: Analyze
C170.5	Understand P, NP, polynomial reduction, NP-hardness, and NP-Completeness.	Level 2: Understand Level 4: Analyze
C170.6	Comprehend and select algorithm design approaches in a problem specific manner.	Level 6: Create

Module No.	**Title of the Module**	**List of Experiments**	**CO**
1.	Fundamentals of data structures and algorithmic problem solving	Searching, Sorting, time complexity, Heaps, Arrays, Linked List, Trees, Fibonacci heaps, splay trees, dynamic trees.	CO1
2.	Divide and Conquer Technique	Solving Matrix multiplication problem and subset- sum problem using divide-and-conquer approach	CO2
3.	Greedy Algorithms	Greedy Approximation algorithms- Set Cover Problem, K Centers Problem, Fractional and 0/1 Knapsack, Coinage problem; Bin packing; Job scheduling, Graph coloring; and Text compression using Huffman coding and Shannon-Fanon coding.	CO2
4.	Dynamic Programming Technique	Fundamentals of Dynamic programming-based solution approach, Printing Shortest Common Super sequence, Dynamic Programming on Trees, Maximum sum rectangle in a 2D matrix.	CO2
5.	Graph Algorithms	Solve and analyze Graph problems, Algorithms. All Pair Shortest Problem, Subset-sum problem. Minimum Spanning Trees (Prim's and Kruskal algorithms); Shortest Path using Dijkstra's algorithm, K-clique problem, Graph Coloring problem.	CO1, CO2
6.	Flows in Network	Network flows - max flow and min-cost flow/circulation, Edmonds-Karp algorithm	CO3
7.	Tractable and Non- Tractable	One Way of Coping with NP-Hardness. Randomized	CO4,

	Problems	Rounding. Vertex Cover and Travelling Salesman Problem.	CO5
8.	Mini-Project	Mini-Project	CO6

Evaluation Criteria

Components	**Maximum Marks**
Lab Test# 1	20
Lab Test# 2	20
D2D work	60
Total	**100**

Project based learning: Students in group of 3 to 4 students are required to develop mini-project based on the concepts taught in this course like Greedy algorithms, dynamic programming, network flow, etc. The solution approach for the identified problem statements should include the usages of advanced data structures including string data structures. The problem statements may be a puzzle-based games, graph-based problems, string-based problems, etc. The developed mini project will enhance the algorithmic thinking and problem-solving approaches of students which are highly desirable to excel in software industries.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, Introduction to Algorithms, MIT Press, 4th Edition, 2022
2.	Steven Skiena, The Algorithm Design Manual, Springer; 3rd Edition, 2020
3.	Tim Roughgarden, Algorithms Illuminated: Part 1: The Basics, Sound like yourself Publishing, September 27, 2017
4.	Tim Roughgarden, Algorithms Illuminated: Part 2: Graph Algorithms and Data Structures, Sound like yourself Publishing, First Edition, 2018.
5.	Tim Roughgarden, Algorithms Illuminated: Part3: Greedy Algorithms and Dynamic Programming, Sound like yourself Publishing, First Edition, 2019.

Detailed Syllabus
Lecture-wise
Breakup

Subject Code	17M11CS112	**Semester (specify Odd/ Even):** Odd	**Semester:** Odd **Session** 2022-2023 **Month from** July to December
Subject Name	Machine Learning and Data Mining		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Anita Sahoo
	Teacher(s)	Anita Sahoo

COURSE OUTCOMES		**COGNITIVE LEVELS**
C112.1	Differentiate between Classification, Clustering and Association Rules techniques.	Level 4 (Analyze)
C112.2	Understand working of classification techniques, e.g., k-Nearest Neighbours, Naïve Bayes, ID3 Decision Trees, Support Vector Machine, Ensemble methods.	Level-2- (Understanding)
C112.3	Apply and compare different clustering techniques, e.g., k-means, k-mediods, etc.	Level-3 (Apply)
C112.4	Evaluate different dimensionality reduction techniques e.g. PCA, SVD, Factor Analysis, Linear Discriminant Analysis, etc., in big data scenarios.	Level-5 (Evaluate)
C112.5	Apply various Artificial Neural Network Models for classification and clustering	Level-3 (Apply)

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1	Introduction	Introduction to Machine Learning, Data Mining and Knowledge Discovery in Data Bases, Data Types	2
2	Classification	Introduction to classification, k-Nearest Neighbours, Naïve Bayes, Decision Trees, Advanced classification techniques	6
3	Regression	Linear Regression with One Variable, Linear Regression with Multiple Variables, Logistic Regression	4
4.	Clustering	Introduction, Different type of Clustering Methods, Partitioning Clustering Methods, Hierarchical Clustering Methods, k-means, k-medoids, density based clustering, cluster validation	8
5.	Association Rules	Support, Confidence, Lift, Conviction; Apriori algorithm, Eclat algorithm, FP-growth algorithm	4
6.	Dimensionality Reduction	Introduction, Subset Selection, PCA, SVD, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis	6
7.	Artificial Neural Methods	Cost Function, Back propagation, Feed forward Network, Gradient Descent, Network training, Error Propagation, Application of Neural Networks, Introduction to quantum neural network	8
8.	Ensemble Methods	Ensemble methods of classification-Bagging, Boosting, and Random Forest	4
		Total number of Lectures	42

Evaluation Criteria	
Components	**Maximum**
Marks T1	**20**
T2	**20**
End Semester Examination	**35**
TA	**25 (Attendance (10), Mini-project/Assignment (15))**
Total	**100**

Project based learning: Each student in a group of 3-4 will have to develop a mini project based on association mining, classification and clustering approaches. The students can choose any real-world application that requires some decision-making. The students have to implement the mini-project using any open-source programming language. Project development will enhance the knowledge and employability of the students in IT sector.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc.)

1	Han, Jiawei, Jian Pei, and Micheline Kamber. Data mining: concepts and techniques. Elsevier, 3rd edition ,2012
2	Kimball R. and Ross M ,The Data Warehouse Toolkit", Wiley, 3rd edition,2013
3	Pujari, Arun K, Data mining techniques , Universities press, 3rd edition , 2013
4	Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, second edition, 2019
5	Soumen Chakrabarti, Mining the Web: Discovering knowledge from hypertext data", Morgan Kaufmann, Elsevier
6	Mitchell, Tom, and Machine Learning McGraw-Hill. "Edition." (1997).
7	Wittek, Peter. Quantum machine learning: what quantum computing means to data mining. Academic Press, 2014.
8	Anahory S. and Murray D, Data Warehousing in the Real World, Addison- Wesley
9	Dunham, Margaret H. Data mining: Introductory and advanced topics. Pearson Education India, 2006.
10	Mattison R. ,Web Warehousing and Knowledge Management", Tata McGraw- Hill.
11	David Hand, Heikki Mannila and Padhraic Smyth ,Principles of Data Mining,PHI
12	Transactions on Database Systems (ACM)
13	IEEE Transactions on Knowledge & Data Engineering
14	The VLDB Journal The International Journal on Very Large Data Bases

Course Description with COs

Detailed Syllabus

Subject Code	19M12CS111	**Semester odd**	**Semester: First Session: 2022- 2023 Month from July to December**
Subject Name	Web Intelligence		
Credits	**3**	**Contact Hours**	**3**
Faculty (Names)	**Coordinator(s)**	1. Dr. Anuja Arora	
	Teacher(s) (Alphabetically)	Dr. Anuja Arora	

Course Outcomes:

At the completion of the course, students will be able to,

CO#	CO Description	COGNITIVE LEVELS
C121.1	Outline the various web technologies, methods, and models used to design an intelligent web.	Understand (Level-2)
C121.2	Make use of web caching strategies at varied level: user, web server, and gateway server.	Apply Level (Level-3)
C121.3	Analyze and Model the users' browsing behavior on web.	Analyze (Level-4)
C121.4	Evaluate various Web content mining algorithms, Web language models and learning to rank models to handle complex Web.	Evaluate Level (Level-5)
C121.5	Design and develop the computational intelligent web algorithms to handle complex real problems	Create Level (Level-6)

Module No.	Subtitle of the Module	Topics in the module	No. of Lectures for the module
1.	Web Content Feature Engineering	Frequency Filter, POS Tag, Unigram, Ngram, Collocation, Levenstein Distance, KL-Divergence, T-Test.	4
2	Web Language Models	Vector Space Models: TF-IDF, SGRank, SGRank-IDF,	8

		Single Rank, Word-Word occurrence matrix; Word Embedding with GloVe, Word2Vec, CBoW, Skip Gram Model Probabilistic models: Bayes model, BM25 Ranking model;	
3	Web Content Searching	Link Based Search Algorithm, Power Iteration Method for ranking nodes on web, Handling Spider Traps and Dead ends, Topic Sensitive Page Ranking.	4
4	Ranking Algorithm and performance measures	Point wise ranking, Pair wise Ranking, Listwise ranking, Metrics for Learning to rank : CG, DCG, NDCG, P@K, MAP, AP	4
5	Web caching Algorithm	LRV, FIFO, LRU, Random, OPT, Size based, PSS	4
6	Matrix Factorization Techniques	Matrix decomposition, Eigenvalue decomposition, Non-Negative matrix factorization, Singular value decomposition, objective functions , UV decomposition, CUR decomposition	5
7	Tensor Factorization	Multidimensional Matrix, Matricization, Tucker decomposition, High Order SVD, clustHOSVD, other methods	4
10	Collective Intelligence	Crowd Sourcing, Local-Global Behavioral Interactions, Self-Organizing Systems, Self-Adaptive Evolutionary Systems, Information Extraction from Deep Web, Decision Making Under Uncertainty	4
11	Graph Structure in the Web	Social Network Analysis, Google Patent Algorithm, News Feed Algorithm, Edge Rank Algorithm, Web of Things, Situational Awareness	5
		Total number of Lectures	**40**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1 Web Intelligence Journal: https://www.iospress.nl/journal/web-intelligence-and-agent-systems/

2. Soumen Chakrabarti,. Mining the Web: Discovering knowledge from hypertext data. Morgan Kaufmann, 2003.

3. Scime, Anthony, ed. Web mining: applications and techniques. IGI Global, 2005.

4. Hitzler, Pascal, Markus Krotzsch, and Sebastian Rudolph. Foundations of semantic web technologies. CRC Press, 2011.

5. Sponder, M., & Khan, G. F. (2017). Advanced Web Analytics and Web Intelligence. In Digital Analytics for Marketing (pp. 115-144). Routledge.

6. Symeonidis, P., & Zioupos, A. (2016). Matrix and Tensor Factorization Techniques for Recommender Systems (Vol. 1). New York: Springer International Publishing.

7. Aggarwal Charu.C, Social Network Data Analytics, Springer Science+Business Media, LLC 2011

8. Velásquez, J. D. (2010). Advanced techniques in web intelligence (Vol. 311). L. C. Jain (Ed.). Springer.

9. Zhong, N., Liu, J., & Yao, Y. (2003). Web intelligence. Springer Science & Business Media.

10 Borgatti Stephon. P., Everett Martin G and Johnson Jeffery C , Analyzing Social Networks, Sage Publications, 2013

Detailed Syllabus
Lecture-wise Breakup

Course Code	19M12CS113	**Semester** Odd **(specify Odd/Even)**	**Semester** I sem (M.TechCSE)/DD **Session** 2022 -2023 **Month** from **Jul'22** to **Dec'22**
Course Name	ADVANCED WIRELESS NETWORKS		
Credits	3	**Contact Hours**	3-0-0

Faculty (Names)	**Coordinator(s)**	Dr K. RAJALAKSHMI
	Teacher(s) (Alphabetically)	Dr K. RAJALAKSHMI

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Understand the fundamentals of Wireless Transmission Technology, and media access Technologies.	Understand (C2)
CO2	Network design, simulate and analysis of various protocols in wireless networks such as WLAN, Bluetooth.	Create (C6)
CO3	Analyse the GSM & UMTS Telecommunication Systems	Analyze (C4)
CO4	Discuss the features of 4G and 5G networks	Apply (C3)
CO5	Demonstrate the features of SDN framework	Apply (C3)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Introduction	Applications of Wireless Networks, history of wireless communication, open research topics, simplified reference model	**4**
2.	Wireless Transmission	Frequency for radio transmission, regulation, signals, antennas, signal propagation, multiplexing, modulation, spread spectrum, cellular systems	**6**
3.	Medium Access Control	Specialized MAC, Hidden and exposed terminals, near and far terminals, SDMA, FDMA, TDMA, CDMA., comparison of S/T/F/CDMA	**4**
4.	Wireless LAN	Infra-red vs. radio transmission, Infrastructure and ad-hoc network, IEEE802.11: System architecture, protocol architecture, Physical Layer, Medium access control layer, MAC management, 802.11b, 802.11a, Bluetooth.	**6**
5	WiMAX	IEEE802.16 and WiMAX – Security – Advanced 802.16 Functionalities – Mobile WiMAX - 802.16e – Network Infrastructure	**3**
6.	Telecommunication Systems	GSM: Mobile Services, System Architecture, Radio Interface, Protocols, Localization and calling, Handover, Security, Data Services, GPRS,EDGE, UMTS and IMT-2000: UMTS releases and standardization, UMTS system architecture, UMTS radio interface, UTRAN, Core Network, Handover	**5**

7.	LTE, 4G, 5G	LTE – Network Architecture and Interfaces – Air Interface and Radio Networks – Mobility Management - Interconnection with UMTS and GSM – LTE Advanced (3GPPP Release 10) - Physical Layer and Multiple Access - OFDMA - Channel Modelling for 4G – Introduction to 5G - 3GPP 5G-NR Standards, usage scenarios, 5G Architecture, Next Gen Core (NGC) Network Function , 5G Non Standalone Options (NSA), 5G Advance Networks, mmWave Systems	8
8.	Software Defined Networks	Introduction – Centralized and Distributed Control and Data Planes – Open Flow – SDN Controllers – General Concepts – VLANs – NVGRE – Network Overlays – Types – Virtualization – Data Plane – I/O – Design of SDN Framework	6
		Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Attendance = 10, Quizzes /Assignments /Mini-Project = 15)
Total	**100**

Students form group of size 2-3 members. Each group will identify several wireless network issues in distributed applications in various thrust areas like healthcare, industrial, education, smart city, logistics, environment, governance and etc. Once problem has been identified, the group will analyze the problem and synthesize wireless network based solutions to the identified problem. Each group will apply different wireless network technology and concepts such as WIFI, Bluetooth, WiMAX, 4G/5G, and SDN. This approach will enhance skills of each student and increase the understanding of incorporating wireless networks in recent distributed applications. Moreover, candidate will gain the enough knowledge to provide the wireless network based solutions to enhance the scalability, mobility and coverage issues of any organization/company. After this course, a student will able to undertake any work in this area in the industry or research.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

	Reference Books
1.	Jochen Schiller, “Mobile Communications”, second edition, Addison-Wesley, 2004.
2.	Martin Sauter, From GSM to LTE, An Introduction to Mobile Networks and Mobile Broadband, Wiley, 2014.
3.	Savo G Glisic, Advanced Wireless Networks – 4G Technologies, John Wiley & Sons, 2007.
4.	Jonathan Rodriguez, Fundamentals of 5G Mobile Networks, Wiley, 2015.
5	Paul Goransson, Chuck Black, ―Software Defined Networks: A Comprehensive Approach, Morgan Kauffman, 2014.
6.	Naveen Chilamkurti, SheraliZeadally, HakimaChaouchi, Next-Generation Wireless Technologies‖, Springer, 2013.
7.	IEEE, ACM Transactions, Journals and Conference papers on “Advance Wireless Network”

Detailed Syllabus

Subject Code	21M71CS112	**Semester Even**	**Semester M.Tech I** **Session 2022- 2023** **Month from July - December**
Subject Name	Advances in AI		
Credits	**3**	**Contact Hours**	**3**
Faculty (Names)	**Coordinator(s)**	Dr. Ankit Vidyarthi	
	Teacher(s) (Alphabetically)	Dr. Ankit Vidyarthi	

S.No.	**Description**	**Cognitive Level (Blooms Taxonomy)**
C161.1	Understand the characteristics & significance of AI	Understanding Level (Level III)
C161.2	Analyze several AI/ML techniques to yield and process information from open real-world data sources	Analyzing Level (Level II)
C161.3	Apply the concept of Machine Learning for industrial applications	Applying Level (Level IV)
C161.4	Evaluate the use of the Machine Learning algorithms towards pattern mining	Evaluating Level (Level V)
C161.5	Design algorithmic frameworks for solving time series data patterns	Creating Level (Level VI)

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1	Introduction	Introduction of AI, introduction of Machine Learning, Significance of AI and ML, Application areas, model pipelining	3
2	Mathematical Formulation	Matrices and its operations, Overview of probability theory, Bayes networks, Independece, I-Maps, Undirected graphical models, Bayesian and Markov networks	5
3	Models and Learning	Learning, Types of learning, Local models; Exact inference, Clique trees, Belief propagation, Tree construction, applications solving problems	6

4	Optimization and Inference	Introduction to optimization, Approximate inference: sampling, Markov chains, MAP inference, Inference in temporal models; Learning graphical models	6
5	Estimation	Parameter estimation, Bayesian networks and shared parameters, structure learning, Partially observed data, Dimension reduction: PCA, LDA	8
6	Decision making	Gradient descent, Expected Maximization, Hidden variables, HMM, Undirected models, Undirected structure learning, Causalty, Utility functions, Decision problem, Expected utility	8
7	Classification and Segmentation	KNN, SVM, NN and its types, K-means, FCM, Introduction to Deep learning for classification and segmentation	6
Total number of Lectures			**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	Attendance (15Marks), Assignment/Quiz/Mini-project (10Marks)
Total	**100**

Project based learning: Each student in a group of 2-3 will extract data from real-world domains using data from standard repositories that are globally recognized. For conducting application-based research, the students are encouraged to analyze social/political/financial/disease related data and generate underlying networked structure based on the algorithms of AI.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Michael Negnevitsky, *Artificial Intelligence*, Person Publication, Third Edition, 2011
2.	Toshinori Munakata, *Fundamentals of the New Artificial Intelligence*, Springer, Second Edition, 2008
3.	Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong. *Mathematics for machine learning*. Cambridge University Press, 2020
4.	Valliappa Lakshmanan, Martin Görner, Ryan Gillard - *Practical Machine Learning for Computer Vision_ End-to-End Machine Learning for Images*, O'Reilly Media, Inc., 2021
5.	Laurence Moroney - *AI and Machine Learning for On-Device Development_ A Programmer's Guide*, O'Reilly Media, Inc., 2021

Detailed Syllabus

Course Code	17M15CS112	**Semester: July-December 2022-23**	**Semester: I Session** 2022 -2023 Month from: July
Course Name	Machine Learning and Data Mining Lab		
Credits	1	**Contact Hours**	**2**

Faculty (Names)	**Coordinator(s)**	Dr.Amit Mishra
	Teacher(s) (Alphabetically)	Dr.Amit Mishra

COURSE OUTCOMES		**COGNITIVE LEVELS**
C173.1	Identify the programming languages for machine learning and data mining	Understanding (Level-2)
C173.2	Use Python to apply and evaluate Linear regression, Logistic regression, kNN , k Means, SVM and ID3 on different datasets	Apply Level-3)
C173.3	Implement apiori algorithm and Eclat algorithm in R	Apply (Level-3)
C173.4	Apply Neural networks to model object detection, video tagging, music genre detection etc.	Apply (Level-3)
C173.5	Evaluate different machine learning models on the basis of their performances	Evaluate (Level-5)

Module No.	**Title of the Module**	**List of Experiments**	**CO**
1.	Python for data sampling and Visualization	a. To write a program for writing the pixel values of an image b. Write programs for Data Sampling (given dataset).	1
2.	Python for text processing	Use IPython (a web version provided by Jupyter nootbook) to write a word count program. Your program should read a text document (download from https://raw.githubusercontent.com/python/cpython/master/	1
3.	Classification-1	Implement kNN algorithm using Python. Consider iris dataset and report the accuracy of classification. [May take help from : https://machinelearningmastery.com/tutorial-to-implement-k-nearest-neighbors-in-python-from-scratch/]	2

4.	Clustering	Clustering: Implement kMeans Algorithm	2
5.	Classification-2	Classify the wine dataset of UCI Repository by ID3.	2
6.	Data Mining-1	Implement Logistic Regression on a sample dataset	2
7.	Data Mining-2	Implement apriori and Eclat algorithm for association rule mining in R	3
8.	SVM-1	Apply Support Vector Machine on the dataset of question the Parkinson dataset given in https://archive.ics.uci.edu/ml/datasets/Parkinson+Dataset+with+replicated+acoustic+features+.	2
9.	Comparison of Classification algorithms	Compare the classification of Iris dataset by different algorithms namely kNN, ID3 and SVM. Report accuracy and other performance measures.Implement neural networks for Classification of *four* character patterns	5
10.	ANN	Apply Multi Layer Percepron for supervised learning (problem statement to be given individually)	4
11.	BPN	Use back propagation for supervised learning . For the data based on 1990 census data from California.Evaluate the accuracy of a model's predictions using RMSE.	4
12.	CNN	Implement CNN using TensorFlow for classifying MNIST images	4

Evaluation Criteria

Components	**Maximum Marks**
Lab Test1	20
Lab Test2	20
PBL/Miniproject /Assignment	45
Attendance	15
Total	100

PBL- Students in a group of 4-5 will be designing an efficient solution to a given problem / case-studies using appropriate Machine Learning and Data mining Technique studies in the course.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Jiawei Han, Micheline Kamber, Data Mining, Morgan Kaufmann Publishers,Elsevier,2005
2.	Kimball R. and Ross M ,The Data Warehouse Toolkit", Wiley
3.	Pujari, Arun K,Data mining and statistical analysis using SQL, Universities press
4.	Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining
5.	Soumen Chakrabarti, Mining the Web: Discovering knowledge from hypertext data", Morgan Kaufmann, Elsevier

6.	Margaret H. Dunham, Data Mining: Introductory and Advanced Topics, Prentice Hall,2003
7.	Mattison R. ,Web Warehousing and Knowledge Management", Tata McGraw-Hill.
8.	David Hand, Heikki Mannila and Padhraic Smyth ,Principles of Data Mining,PHI
9.	Transactions on Database Systems (ACM)
10.	IEEE Transactions on Knowledge & Data Engineering
11.	The VLDB Journal The International Journal on Very Large Data Bases

Detailed Syllabus
Lab-wise Breakup

NOTE: All the entries (…) must be in Times New Roman 11.

Course Code	17M15CS113	**Semester** **Odd 2022**	**Semester** ... **Session** 2022-23 **Month from** July to Dec, 2022
Course Name	**Cloud Technology Lab**		
Credits	1	**Contact Hours**	2 Hours

Faculty (Names)	**Coordinator(s)**	Dr Prakash Kumar
	Teacher(s) (Alphabetically)	Dr. Prakash Kumar

COURSE OUTCOMES		**COGNITIVE LEVELS**
C171.1	Demonstrate the architecture and layers of Cloud Service Models, Deployment models etc.	Understand (level 2)
C171.2	Understand the working of CloudSim and run different scheduling algorithms.	Apply (level 3)
C171.3	Analyze various Scheduling algorithms and compare their performances on Virtual Machines, Containers and Dockers.	Analyze (level 4)
C171.4	Apply and evaluate the energy aware algorithms for using DVFS techniques.	Evaluate (level 5)

Module No.	**Title of the Module**	**List of Experiments**	**CO**
1.	CloudSim installations and Use	Create Virtual Machines (VMs) on CloudSim.	CO1
2.		Allocate different Cloudlets to VMs and Data Centers using different scheduling algorithms	CO2
3.	Analyze various Scheduling algorithms in different scenarios on cloudsim	Create different Data Centers and allocate the VMs to them and analyze the outcomes	CO3
4.		Assign the cloudlets and change the scheduling techniques for various scenarios Creating and Running applications using Containers and Dockers in Cloud Environments.	CO3
5.	Evaluate Energy Aware Simulations using DVFS	Apply and evaluate energy aware algorithms using DVFS techniques.	CO4

Evaluation Criteria

Components	**Maximum Marks**
Lab Test# 1	20
Lab Test# 2	20
D2D work	60 (D2D: 30 marks, PBL: 20 marks, Attendance: 10 marks)
Total	**100**

Project Based Learning: A group of maximum 2 students are to be formed. Each group shall choose a Cloud based project. The project shall be designed and/or modeled based on any Cloud Platform like AWS, Google cloud, Eucalyptus, CloudSim, iFogSim or any simulation tools. The project shall function and run as per the objective of the project. Live demonstration of the project shall be shown during their presentation. The project evaluation shall be done based on the quality, innovation, relevance and creativity involved.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	K. Hwang, Geoffrey C. Fox, Jack J. Dongarra, "Distributed and Cloud Computing- From Parallel Processing to the Internet of Things", Morgan Kauffman Publishers, Elsevier.
2	George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud" O'REILLY publication.
3	"Virtualization Overview", White paper, VM Ware.
4.	Rodrigo N. Calheiros, Rajiv Ranjan, Anton Beloglazov, Cesar A. F. De Rose, and Rajkumar Buyya, CloudSim: A Toolkit for Modeling and Simulation of Cloud Computing Environments and Evaluation of Resource Provisioning Algorithms, Software: Practice and Experience, Volume 41, Number 1, Pages: 23-50, ISSN: 0038-0644, Wiley Press, New York, USA, January 2011.
5.	Tom Guérout, Thierry Monteil, Georges Da Costa, Rodrigo Neves Calheiros, Rajkumar Buyya, Mihai Alexandru, Energy-aware Simulation with DVFS, Simulation Modelling Practice and Theory, Volume 39, No. 1, Pages: 76-91, ISSN: 1569-190X, Elsevier Science, Amsterdam, The Netherlands, November 2013.
6.	Rajkumar Buyya, Rajiv Ranjan and Rodrigo N. Calheiros, Modeling and Simulation of Scalable Cloud Computing Environments and the CloudSim Toolkit: Challenges and Opportunities, Proceedings of the 7th High Performance Computing and Simulation Conference (HPCS 2009, ISBN: 978-1-4244-4907-1, IEEE Press, New York, USA), Leipzig, Germany, June 21 - 24, 2009. **- Keynote Paper.**
7.	https://www.docker.com
***m*.**	…

Detailed Syllabus
Lecture-wise Breakup

Course Code	19M12CS112	**Semester** Odd **(specify Odd/Even)**	**Session** 2022 -2023 **Month** from July to Dec
Course Name	Metaheuristics in Modelling and Optimization		
Credits	3	**Contact Hours**	3-0-0

Faculty (Names)	**Coordinator(s)**	Dr. Parul Agarwal
	Teacher(s) (Alphabetically)	Dr. Parul Agarwal

COURSE OUTCOMES At the completion of the course, Students will be able to		**COGNITIVE LEVELS**
C131.1	Interpret and explain the concepts of Metaheuristics based optimization and it's application in a diverse range of applications.	Understand Level (C2)
C131.2	Model single solution and population based Metaheuristic algorithms to solve a given optimization problem.	Apply Level (C3)
C131.3	Model Metaheuristic algorithms to solve Multi-objective optimization problems.	Apply Level (C3)
C131.4	Model hybrid Metaheuristic algorithms to solve a given optimization problem.	Apply Level (C3)
C131.5	Explain algorithms and architectures for parallel implementation of Metaheuristics.	Understand Level (C2)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Introduction	Optimization Models, Approximate Algorithms, When to use Metaheuristics?, Methods and Application	4
2.	Fundamentals of Metaheuristics	Representation, Objective Functions; Constraint Handling; Parameter Tuning; Performance Analysis.	5
3.	Single-Solution Based Metaheuristics	Basic Concepts, Fitness Landscape Analysis; Local Search; Tabu Search; Iterated and Guided Local search; Variable Neighborhood Search; Smoothing Methods; Noisy Methods	6
4.	Population-Based Metaheuristics Methods	Basic Concepts; Evolutionary Algorithms, Swarm Intelligence, Stochastic diffusion search, Social cognitive optimization	6
5.	Metaheuristics for Multi-objective Optimization	Basic concepts; Multi-objective Continuous and Combinatorial Problems, Multi-criteria Decision Making; Design Issues	3
6.	Fitness Assignment Strategies and Evaluation of Multi-objective Optimization	Scalar approach, Criterion-Based Methods; Dominance-Based Approaches; Indicator based Approaches; Diversity Preservation; Performance Evaluation	7
7.	Hybrid Metaheuristics	Design and Implementation Issues; Mathematical Programming Approaches; Classical Hybrid Approaches;	7

		Hybrid Metaheuristics with Machine Learning and Data Mining; Hybrid Metaheuristics for Multi-objective Optimization	
8.	Parallel Metaheuristics	Parallel Design and Implementation of Metaheuristics; Parallel Metaheuristics for Multi-objective Optimization	4
		Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Attendance(10), Assignments/Mini-project/Tutorials/Quiz (15)
Total	**100**

Project based learning: Each group of 3-4 students will be assigned an optimization problem at the beginning. They are required to apply the metaheuristic methods they study on the given problem.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Metaheuristics: From Design to Implementation by El-Ghazali Talbi, Wiley, June 2009.
2.	Sean Luke, 2013, Essentials of Metaheuristics, Lulu, second edition, available athttp://cs.gmu.edu/←sean/book/metaheuristics.
3.	Gandomi, Amir; Yang, Xin-She; Talatahari, Siamak; Alavi, Amir; "Metaheuristic Algorithms in Modeling and Optimization", Metaheuristic Applications in Structures and Infrastructures, Dec 2013.
4.	Kalyanmoy Deb; "Multi-Objective Optimization Using Evolutionary Algorithms:An Introduction"; https://www.egr.msu.edu/~kdeb/papers/k2011003.pdf
5.	Kalyanmoy Deb; "Single and Multi-Objective Optimization Using Evolutionary Algorithms"; https://www.iitk.ac.in/kangal/papers/2004002.pdf
6.	Paulo Cortez, Modern Optimization with R, Use R! series, Springer, September 2014, ISBN 978-3-319-08262-2.

Research Methodology and Intellectual Property Rights (18M11GE111)

Basic idea of research, types of research, methods to write report and research papers, use of Mendeley in report writing, problem identification and solving, research ethics, patents, intellectual property rights, plagiarism regulation 2018, steps in research process and common methodologies to attempt solution to research paper, basic statistical concepts, handling of raw data, Some common probability distributions, hypothesis testing, parametric and non-parametric data, introduction to regression analysis.

Course Description

Course Code	**18M11GE111**	**Semester** Odd	**Semester** I **Session** 2022-23 **Month from** Aug - Dec 2022	
Course Name	Research Methodology and Intellectual Property Rights			
Credits	2	**Contact Hours**	2-0-0	
Faculty (Names)	**Coordinator(s)**	Dr. Shikha Pandey		
	Teacher(s) (Alphabetically)	Dr. Shikha Pandey		

COURSE OUTCOMES:		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
C101.1	explain the basic concepts and types of research	Understanding Level (C2)
C101.2	define a research problem, its formulation, methodologies and analyze research related information	Analyzing Level (C4)
C101.3	explain research ethics, understand IPR, patents and their filing related to their innovative works.	Understanding Level (C2)
C101.4	explain and analyze the statistical data and apply the relevant test of hypothesis in their research problems	Analyzing Level (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Research	What is research? Types of research. What is not research? How to read a Journal paper?	3
2.	Report writing	How to write report? Use of Mendeley in report writing. How to write a research paper? Problem identification and solving.	4
3.	Ethics, IPR and Research methodologies	Research ethics, patents, intellectual property rights, plagiarism regulation 2018. Steps in research process and common methodologies to attempt solution to research paper.	8

4.	Basics of statistics and probability distributions	Basic statistical concepts. Handling of raw data, Some common probability distributions.	7
5.	Test of hypothesis and regression analysis	Hypothesis testing. Parametric and non-parametric data, Introduction to regression analysis.	8
		Total number of Lectures (Course delivery method: open ended discussion, guided self-study, lectures)	**30**

Evaluation Criteria

Components	**Maximum Marks**
Mid Term Examination	30
End Semester Examination	40
Assignments	30 (Quiz, Assignments)
Total	**100**

Project based learning: Students divided in small groups will be assigned topics related to patents, intellectual property rights, plagiarism, and statistics. Students can write a report/review paper and find its similarity through plagiarism software available online. Students may collect data and test the relevant hypothesis. They may study some data set and do its regression analysis. The main purpose is to expose students to a wider arena of applicable knowledge of the subject.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

Stuart Melville and Wayne Goddard, Research Methodology: An Introduction for Science & Engineering Students, Kenwyn, South Africa: Juta & Co. Ltd., 1996.

Kothari, C.R., Research Methodology: Methods and Techniques, New Age International, New Delhi, 2009.

Kumar, Ranjit, Research Methodology: A Step by Step Guide for Beginners, 2nd Edition, Sage Publications Ltd., 2005.

Ramappa, T., Intellectual Property Rights Under WTO, S. Chand, New Delhi, 2008.

Wayne Goddard and Stuart Melville, Research Methodology: An Introduction, Kenwyn, South Africa: Juta & Co, 2001.

Detailed Syllabus
Lecture-wise Breakup

Course Code	21M71CS111	**Semester:** ODD	**Semester:** I **Session:** 2022 -2023 **Month from:** Aug 2022-Dec 2022
Course Name	Data Science using Python		
Credits	3-0-0	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Dr. Adwitiya Sinha
	Teacher(s) (Alphabetically)	Dr. Adwitiya Sinha

COURSE OUTCOMES		**COGNITIVE LEVELS**
C183.1	Understand the data analysis techniques	Understand (Level 2)
C183.2	Understand the concepts behind the descriptive analytics	Understand (Level 2)
C183.3	Apply predictive analytics of data	Apply (Level 3)
C183.4	Analyze data using Python programming	Analyze (Level 4)
C183.5	Evaluate strategies for data science with measures of correlation, association, and learning using Python modules and packages	Evaluate (Level 5)

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	Introduction	Introduction to Data Science - Evolution of Analytics, analytic processes and tools, Analysis vs reporting - Modern data analytic tools. Statistical concepts: Sampling distributions, re-sampling, statistical inference, prediction error.	8
2.	Predictive Analytics	Predictive Analytics – Regression, Decision Tree, Neural Networks. Dimensionality Reduction - Principal component analysis	9
3.	Descriptive Analytics	Mining Frequent item-sets - Market based model – Association and Sequential Rule Mining - Clustering Techniques – Hierarchical – K- Means	9
4.	Data Analysis Using Python	Introduction to Python, Python Application Programming Interfaces & Libraries, File handling, Data Types, Descriptive Statistics, Data Preprocessing, Dirty Data, Examining Single/Multiple Variables, Statistical Methods	10
5.	Exploratory Data Analysis	Exploring univariate and multivariate data: Heat Map, Box and Whisker plot, Scatter plots with histograms, Bubble charts, Geo-plots	6
		Total number of Lectures	**42**

Evaluation Criteria	
Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA (Tutorials, regularity & Marco	Assignments) 25 (Assignments & Attendance) (**Class Presence & Performance = 05 Internal Assessment & Assignment in PBL mode = 20**)
Total	**100**

Project based learning: Each student in a group of 2-3 will use Python to extract data from real-world domains using data streaming, web crawling, application programming interfaces (APIs), or from standard repositories that are globally recognized. The students will be encouraged to analyze social/political/financial/healthcare related data and perform data science using Python libraries and packages. Project work will focus on developing models to analyze the real-world data by performing statistical, probabilistic and exploratory analysis. The students will also explore learning techniques on variety of datasets and perform case studies using Python programming.

Recommended Reading material: Text Books/ Reference Books	
1.	Dietrich, David (2015). Data Science & Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data. EMC Education Services, Wiley**.**
2.	Jaiwei Han, Micheline Kamber. (2006) Data Mining Concepts and Technique. Elsevier.
3.	Ross, Sheldon (2019). A First Course in Probability. 9th Edition, Pearson.
4.	Michael Berthold, David J. Hand (2007). Intelligent Data Analysis, Springer.
5.	Michael Minelli, Michele Chambers, Ambiga Dhiraj. (2013). Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends", John Wiley & Sons.
6.	Bart Baesens. (2014) Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", John Wiley & Sons.
7.	Min Chen, Shiwen Mao, Yin Zhang, Victor CM Leung. (2014), Big Data: Related Technologies, Challenges and Future Prospects, Springer.
8.	Zelle, J. (2016). Python Programming: An Introduction to Computer Science. Franklin, Beedle & Associates, Inc..
9.	Jaworski, M. and Ziadé, T. (2019). Expert Python Programming: Become a master in Python by learning coding best practices and advanced programming concepts in Python 3.7. Packt Publishing Ltd.

Detailed Syllabus
Lab-wise Breakup

Course Code	**17M15CS111**	**Semester:** ODD	**Semester: I** **Session** 2022 -2023 **Month from** July to Dec 2022
Course Name	Advanced Algorithms Lab		
Credits	1	**Contact Hours**	2

Faculty (Names)	**Coordinator(s)**	Manish Kumar Thakur
	Teacher(s) (Alphabetically)	Manish Kumar Thakur

COURSE OUTCOMES		**COGNITIVE LEVELS**
C170.1	Implement algorithms and use appropriate advanced data structures for solving computing problems.	Level 3: Apply
C170.2	Design algorithms using divide-and-conquer, greedy and dynamic programming strategies, and further recite algorithms that employ these strategies.	Level 3: Apply Level 5: Evaluate
C170.3	Illustrate the mathematical foundation of network flows and some important flow algorithms.	Level 2: Understand Level 3: Apply
C170.4	Implement randomized algorithms to solve various problems, and validate their correctness and complexity.	Level 3: Apply Level 4: Analyze
C170.5	Understand P, NP, polynomial reduction, NP-hardness, and NP-Completeness.	Level 2: Understand Level 4: Analyze
C170.6	Comprehend and select algorithm design approaches in a problem specific manner.	Level 6: Create

Module No.	**Title of the Module**	**List of Experiments**	**CO**
1.	Fundamentals of data structures and algorithmic problem solving	Searching, Sorting, time complexity, Heaps, Arrays, Linked List, Trees, Fibonacci heaps, splay trees, dynamic trees.	CO1
2.	Divide and Conquer Technique	Solving Matrix multiplication problem and subset- sum problem using divide-and-conquer approach	CO2
3.	Greedy Algorithms	Greedy Approximation algorithms- Set Cover Problem, K Centers Problem, Fractional and 0/1 Knapsack, Coinage problem; Bin packing; Job scheduling, Graph coloring; and Text compression using Huffman coding and Shannon-Fanon coding.	CO2
4.	Dynamic Programming Technique	Fundamentals of Dynamic programming-based solution approach, Printing Shortest Common Super sequence, Dynamic Programming on Trees, Maximum sum rectangle in a 2D matrix.	CO2
5.	Graph Algorithms	Solve and analyze Graph problems, Algorithms. All Pair Shortest Problem, Subset-sum problem. Minimum Spanning Trees (Prim's and Kruskal algorithms); Shortest Path using Dijkstra's algorithm, K-clique problem, Graph Coloring problem.	CO1, CO2
6.	Flows in Network	Network flows - max flow and min-cost flow/circulation, Edmonds-Karp algorithm	CO3
7.	Tractable and Non- Tractable	One Way of Coping with NP-Hardness. Randomized	CO4,

	Problems	Rounding. Vertex Cover and Travelling Salesman Problem.	CO5
8.	Mini-Project	Mini-Project	CO6

Evaluation Criteria

Components	**Maximum Marks**
Lab Test# 1	20
Lab Test# 2	20
D2D work	60
Total	**100**

Project based learning: Students in group of 3 to 4 students are required to develop mini-project based on the concepts taught in this course like Greedy algorithms, dynamic programming, network flow, etc. The solution approach for the identified problem statements should include the usages of advanced data structures including string data structures. The problem statements may be a puzzle-based games, graph-based problems, string-based problems, etc. The developed mini project will enhance the algorithmic thinking and problem-solving approaches of students which are highly desirable to excel in software industries.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, Introduction to Algorithms, MIT Press, 4th Edition, 2022
2.	Steven Skiena, The Algorithm Design Manual, Springer; 3rd Edition, 2020
3.	Tim Roughgarden, Algorithms Illuminated: Part 1: The Basics, Sound like yourself Publishing, September 27, 2017
4.	Tim Roughgarden, Algorithms Illuminated: Part 2: Graph Algorithms and Data Structures, Sound like yourself Publishing, First Edition, 2018.
5.	Tim Roughgarden, Algorithms Illuminated: Part3: Greedy Algorithms and Dynamic Programming, Sound like yourself Publishing, First Edition, 2019.