Department of Computer Science Engineering

M.Tech. Data Science
Curriculum and Syllabus

(Applicable to the students admitted from AY: 2023 onwards)

School of Engineering and Sciences
SRM University *AP*, Andhra Pradesh

Department Vision

To create technology innovators and leaders who can shape the future of society through technical, research, and entrepreneurial skills with a strong emphasis on interdisciplinary learning and collaborations.

Department Mission

1. Use effective teaching and learning pedagogies to enhance technical competency with a focus on computer science and engineering fundamentals.
2. Encourage interdisciplinary education and research by promoting the exchange of ideas among a varied community of researchers, educators, and learners.
3. Develop a substantial body of knowledge for industrial applications.
4. Create an outstanding interdisciplinary research atmosphere.
5. Instil students with effective managerial skills, fostering their development into competitive and visionary entrepreneurs.

Program Educational Objectives (PEO)

1. To produce the most employable graduates who are problem solvers, team players and lifelong learners with exceptional analytical & effective communication skills, leadership abilities and ethical values with significant opportunities in various domains and sectors both nationally and internationally.
2. To develop proficiency in advanced data analysis, mathematics, and statistical inference of the data to create solutions for various problems in the data analytical industry for a better society.
3. To emerge as strong data science researchers using world-class research facilities focusing on interdisciplinary and multidisciplinary research and learning.

Mission of the Department to Program Educational Objectives (PEO) Mapping

	PEO 1	PEO 2	PEO 3
Mission Statement 1	3	1	2
Mission Statement 2	3	3	2
Mission Statement 3	2	1	3
Mission Statement 4	3	2	3
Mission Statement 5	2	3	2

Program Specific Outcomes (PSO)

1. Develop efficient and effective mathematical and statistical models and applications in the field of Data Science.
2. Design and develop advanced techniques and algorithms in Data Sciences to analyze data and solve real-world problems.
3. Conduct exceptional research in the emerging areas of Data Science to develop solutions and acquire skills in the field of data mining, prediction of data based on the AI, Computer Networks, Signal & Image Processing.

Mapping Program Educational Objectives (PEO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)													
PEOs	POs										PSOs		
	Engineering Knowledge	Design Development of Solutions	Conduct Investigations of Complex Problems	Modern Tools and ICT Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork Skills	Communication Skills	Lifelong Learning	PSO 1	PSO 2	PSO 3
PEO 1	3	3	3	3	2	1	3	2	2	2	3	2	2
PEO 2	3	3	3	3	3	1	3	1	2	2	3	2	3
PEO 3	3	3	3	3	2	3	3	3	3	3	2	3	3

Category Wise Credit Distribution			
Course Sub-Category	**Sub-Category Credits**	**Category Credits**	**Learning Hours**
Ability Enhancement Courses (AEC)		1	30
University AEC	0		
School AEC	1		
Value Added Courses (VAC)		1	30
University VAC	1		
School VAC	0		
Skill Enhancement Courses (SEC)		4	120
School SEC	4		
Department SEC	0		
SEC Elective	0		
Foundation / Interdisciplinary courses (FIC)		3	90
School FIC	0		
Department FIC	3		
Core + Core Elective including Specialization (CC)		36	1080
Core	30		
Core Elective (Inc Specialization)	6		
Minor (MC) + Open Elective (OE)	0	0	0
Research / Design / Internship/ Project (RDIP)		35	1050
Internship / Design Project / Startup / NGO	3		
Internship / Research / Thesis	32		
Total		**80**	**2400**

Semester wise Course Credit Distribution Under Various Categories						
Category	**Semester**					
	I	**II**	**III**	**IV**	**Total**	**%**
Ability Enhancement Courses - AEC	0	1	0	0	1	**1**
Value Added Courses - VAC	0	1	0	0	1	**1**
Skill Enhancement Courses - SEC	2	2	0	0	4	**5**
Foundation / Interdisciplinary Courses - FIC	3	0	0	0	3	**4**
CC / SE / CE / TE / DE / HSS	18	18	0	0	36	**45**
Minor / Open Elective - OE	0	0	0	0	0	**0**
(Research/ Design/ Industrial Practice/Project/Thesis/Internship) -RDIP	0	3	17	15	35	**44**
Grand Total	**23**	**25**	**17**	**15**	**80**	**100**

Note: L-T/D-P/Pr and the class allocation is as follows.

a) Learning Hours : 30 learning hours are equal to 1 credit.

b) Lecture/Tutorial : 15 contact hours (60 minutes each) per semester are equal to 1 credit.

c) Discussion : 30 contact hours (60 minutes each) per semester are equal to 1 credit.

d) Practical : 30 contact hours (60 minutes each) per semester are equal to 1 credit.

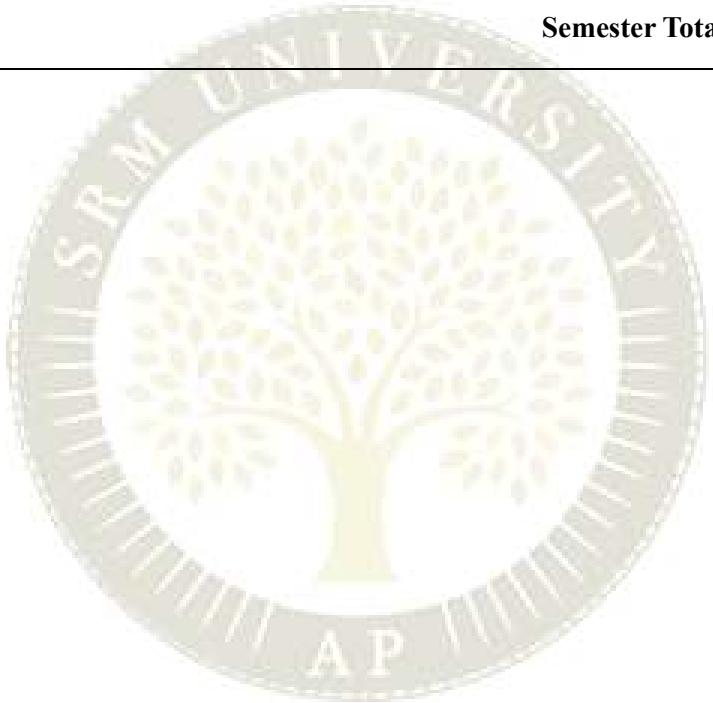
e) Project : 30 project hours (60 minutes each) per semester are equal to 1 credit.

SEMESTER - I								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 501	Community Engagement and Social Responsibility	0	0	1	1*
2	AEC	S AEC	AEC 502	Research Seminar	0	0	1	1*
3	SEC	S SEC	SEC 502	Design Thinking	1	0	1	2
4	FIC	D FIC	FIC 504	Advanced Probability, Linear Algebra and Optimization Techniques	3	0	0	3
5	Core	CC	DSC 501	Computational Essentials for Data Science	3	0	1	4
6	Core	CC	DSC 502	Big Data Analytics	3	0	1	4
7	Core	CC	DSC 503	Advanced Algorithms and Analysis	3	0	1	4
8	Core	CC	DSC 504	Machine Learning Techniques	3	0	1	4
9	Core	CC	DSC 505	Advanced Python Programming Lab	0	0	2	2
				Semester Total	**16**	**0**	**9**	**23**

SEMESTER - II								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 501	Community Engagement and Social Responsibility	0	0	1	1
2	AEC	S AEC	AEC 502	Research Seminar	0	0	1	1
3	SEC	S SEC	SEC 103	Entrepreneurial Mindset	1	0	1	2
4	Core	CC	DSC 506	Advanced Tools and Techniques for Big Data Analytics	3	0	1	4
5	Core	CC	DSC 507	Deep Learning: Methodologies and Techniques	3	0	1	4
6	Core	CC	DSC 508	Data Warehousing and Pattern Mining	3	0	1	4
7	Elective	CE	CE	Core Elective	3	0	0	3
8	Elective	CE	CE	Core Elective	3	0	0	3
9	RDIP	RDIP	DSC 509	Project Management	0	0	3	3
				Semester Total	**16**	**0**	**9**	**25**

SEMESTER - III								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	RDIP	RDIP	DSC 510	Thesis – I	0	0	**14**	14
2	RDIP	RDIP	DSC 511	Industrial Practice	0	0	**3**	3
				Semester Total	**0**	**0**	**3**	**17**

SEMESTER - IV								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	RDIP	RDIP	DSC 512	Thesis - II	**0**	0	**15**	15
				Semester Total	**0**	**0**	**15**	**15**



List of Core Electives								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE	AML 552	Knowledge Engineering and Expert Systems	3	0	0	3
2	Elective	CE	AML 553	Information Retrieval	3	0	0	3
3	Elective	CE	AML 561	Artificial Intelligence and Neural Networks	3	0	0	3
4	Elective	CE	AML 566	Optimization Paradigms: Exploring Methods and Strategic Frameworks	3	0	0	3
5	Elective	CE	AML 567	Soft Computing	3	0	0	3

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Design Thinking

Course Code	SEC 502	**Course Category**	SEC	**L**	**T**	**P**	**C**
				1	0	1	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Management	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Familiarize with the principles of Design Thinking
2. Learn to apply the principles of Design Thinking
3. Apply Design Thinking to solve problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Grasp the Concepts and process of Design Thinking	2	85%	90%
Outcome 2	Learn the process of Design Thinking	2	85%	90%
Outcome 3	Solve a problem using Design Thinking Principles	5	75%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3									1	3	1	3
Outcome 2	3							3		2	3	2	3
Outcome 3	3	3	3	3				3	3	3	3	3	3
Average	3	3	3	3				3	3	2	3	2	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Incubation and understanding**			1,2
	Understanding of Design Thinking & its Importance	4	1	1,2
	Importance of Design Thinking	3	1	1,2
	Pillars of Design Thinking	3	1	1,2
Unit 2	**Process – Understanding the Stages of Design Thinking**			1,2
	Stage 1- Empathy	2	2	1,2
	Stage 2 - Define	2		
	Stage 3 – Ideate	2		
	Stage 4 – Prototype	2	2	1,2
	Stage 5 – Test & Implement	2	2	1,2
Unit 3	**Application**			
	Project Work	7	3	1,2
	Viva	3	3	1,2
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (100%)**	
		CLA-1 (50%)	**CLA-2 (50%)**
Level 1	Remember	20	40
	Understand		
Level 2	Apply	30	30
	Analyse		
Level 3	Evaluate	50	30
	Create		
Total		**100%**	**100%**

Recommended Resources

1. Design Thinking – Techniques and Approaches, N. Siva Prasad

Other Resources

1. HBS – Online – Design Thinking & Innovation – course material
2. Case studies
3. Nigel Cross , Design Thinking, BERG Publishing, (2011)
4. Thomas Lockwood , Design Thinking- Integrating Innovation, Customer Experience and Brand Value, , Design Management Institute, (2009)

Course Designers

1. Satyanarayana Duvvuri, Visiting Faculty, Paari school of business, SRM University AP.

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Advanced Probability, Linear Algebra and Optimization Techniques

Course Code	FIC 504	**Course Category**	FIC	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Calculus, Linear Algebra, and Preliminary knowledge of MATLAB or Python	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Introduction of mathematical tools that are useful in developing new algorithm for machine learning.
2. Introduce the matrix method and optimization process.
3. Data analysis using the least squares classification and regression.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Analyse and analyse the large-scale computational complexity of various matrix factorization.	2	70%	75%
Outcome 2	How machine learning builds on numerical linear algebra, Optimization, and statistics.	5	70%	75%
Outcome 3	Apply the basic statistics and probability concepts.	4	70	75%
Outcome 4	Implementing the numerical methods using MATLAB/Python and analysing the numerical complexity.	6	75%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	**Program Learning Outcomes (PLO)**												
	POs										**PSOs**		
	Engineering Knowledge	Design Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2						3		2			
Outcome 2	3	3	3					3		2			
Outcome 3	3	2	3	3				3		2			
Outcome 4	3	3		3				3		3			
Average	3	2	2	3				3		2			

Course Unitization Plan

Session	Description of Topic	Contact Hours Required	CLOs Addressed	References Used
	UNIT-1 (Probability)	**6**		
1	Classical, relative frequency and axiomatic definitions of probability.	2	**CO 3**	2
2	Addition rule, multiplication rule and conditional probability.	1	**CO 3**	2
3	Total probability, Bayes' Theorem, and independence.	2	**CO 3**	2
4	Tutorial	1	**CO 3**	2
	UNIT-2 (Random Variables)	**7**		
5	Discrete, continuous, and mixed random variables, probability mass, probability density and cumulative distribution functions.	3	**CO 3**	2
6	Mathematical expectation, moments, moment generating function, Chebyshev's inequality.	3	**CO 3**	2
7	Tutorial	1	**CO 3**	2
	UNIT-3 (Linear Algebra)	**12**		
8	Finite dimensional vector spaces over a field, linear combination, linear dependence, and independence, basis, and dimension.	4	**CO 1**	1
9	Inner-product spaces, linear transformations; matrix representation of linear transformations, Projection.	3	**CO 1**	1
10	Eigen values and eigenvectors (Matrix and Transformations)	2	**CO 1**	1,3
11	Rank and nullity, inverse and linear transformation, Cayley-Hamilton Theorem.	2	**CO 1**	1,3
12	Tutorial (Python/MATLAB)	1	**CO 4**	
	UNIT-4 (Matrix Decompositions)	**10**		1,3
13	Determinant and Trace, LU-Decomposition, QR-Decomposition.	3	**CO 1, CO 2**	1,3
14	Cholesky Decomposition, Eigen decomposition and Diagonalization.	2	**CO 1, CO 2**	1,3
15	Singular Value Decomposition, Matrix Approximation and Jordan Canonical Form.	4	**CO 1, CO 2**	1,3
16	Tutorial (Python/MATLAB)	1	**CO 4**	
	UNIT-5 (Continuous Optimization)	**10**		
17	Foundations of Optimizations (Basic terminology and Definitions).	2	**CO 1, CO 2**	1
18	Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers.	4	**CO 1, CO 2**	1
19	Convex optimization and linear regression.	4	**CO 1, CO 2**	1

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Assessments (50%)
		CLA-1 (10%)	Mid-1 (20%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember	30%	40%	30%	30%	40%
	Understand					
Level 2	Apply	40%	30%	30%	30%	30%
	Analyse					
Level 3	Evaluate	30%	30%	40%	40%	30%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Deisenroth, M. P., Faisal, A. A, & Ong, C. S (2020). Mathematics for Machine Learning, Cambridge University Press.
2. Ross, S. (2006). A First Course in Probability, 7th Edition, Pearson Publication.
3. Hoffman, K. M & Kunze, R. (2015) Linear Algebra, 2nd Edition, Pearson Publication.

Other Resources

1. Medhi, J. (2009). Stochastic Processes, 3rd Edition, New Age International.
2. Ross, S. M (1996). Stochastic Processes, 2nd Edition, Wiley Publication.
3. Friedberg, S. H, Insel, A. J., & Spence, L.E. (2006). Linear Algebra. 4th Edition, Pearson Publication

Course Designers

1. Dr. Tapan Kumar Hota

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Computational Essentials for Data Science

Course Code	DSC 501	Course Category	CC	L	T	P	C
				3	0	1	4
Pre-Requisite Course(s)	Statistics	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	CSE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the importance of data science.
2. Learn data collection and pre-processing techniques.
3. To learn data classification techniques.
4. To learn data visualization techniques.
5. To learn some tools to work on data science (such as Numpy, Scipy, pandas, Scikit-learn, IPyhotn, Matplotlib, NetworkX).

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	To understand various data collection techniques and their importance.	1	70 %	65%
Outcome 2	To apply data pre-processing techniques	3	70 %	65%
Outcome 3	Manage huge amount of data and to apply classification algorithms.	4	70 %	65%
Outcome 4	Manage huge amount of data and to visualize their diversity and importance.	5	70 %	65%
Outcome 5	Able to draw graphs in different formats and transform one data format to other format.	2	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	3		1		1		3	2	1
Outcome 2	3	3	3	3	3		1		1		2	2	2
Outcome 3	3	3	3	3	3		1		1		3	3	3
Outcome 4	3	3	3	3	3		1		1		2	3	2
Outcome 5	3	3	3	3	3				1		3	3	3
Average	3	3	3	3	3		1		1		3	3	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Data Science**	**9**		
1	Overview of Data Science	1	1	1
2	Data Ingestion, Data Review	1	1	1
3	Variable Roles,	1	1	1
4	Missing Data and its management	1	1	1
5	Data Cleaning	1	1	1
6	Feature Creation	1	1	1
7	Preparing for Model Building	1	1	1
8	Preparing the Metadata	1	1	1
9	Feature Selection	1	1	1
Unit 2	**Data Collection, Pre-Processing and Analytics**	**9**		
10	Data Collection Strategies	1	2	1
11	Data Cleaning	1	2	1
12	Data Integration and Transformation	1	2	1
13	Data Reduction	1	2	1
14	Data Discretization	1	2	1
15	Descriptive Statistics – Mean, Standard Deviation, Skewness and Kurtosis	1	2	1
16	Box Plots	1	2	1
17	Pivot Table	1	2	1
18	Heat Map – Correlation Statistics	1	2	1
Unit 3	**Data Classification**	**9**		
19	Loading the Dataset	1	3	1,2
20	Building a Decision Tree Model	1	3	1,2
21	K nearest neighbor	1	3	1,2
22	Model Performance	1	3	1,2
23	Decision Tree	1	3	1,2
24	Evaluating Model Generality	1	3	1,2
25	Comparison of Performance Measures	1	3	1,2
26	Model Tuning	1	3	1,2
27	Python exercise on Decision Tree, KNN	1	3	1,2
Unit 4	**Data Visualization**	**9**		
28	Basic principles, ideas and tools for data visualization	1	4	1,2
29	Basic principles, ideas and tools for data visualization	1	4	1,2
30	Case Study 1 on industry projects	1	4	1,2
31	Case Study 2: Create Complex visualization dataset	1	4	1,2
32	Preparing the Dataset, Scatter Plot, Bar Charts, Saving Plots to File.	1	4	1,2
33	Preparing the Dataset, Scatter Plot, Bar Charts, Saving Plots to File.	1	4	1,2
34	Adding Spice to the Bar Chart, Alternative Bar Charts, Box Plots.	1	4	1,2
35	Adding Spice to the Bar Chart, Alternative Bar Charts, Box Plots.	1	4	1,2
36	Analysis on graphs	1	4	1,2
Unit 5	**Advances in Data Science**	**9**		
37	Data loading and preprocessing with pandas	1	5	1,2
38	Working with categorical and textual data	1	5	1,2
39	Data preprocessing with NumPy, Creating NumPy arrays	1	5	1,2
40	NumPy Operations	1	5	1,2
41	Data Analytics using R	1	5	1,2
42	Getting started with graphs	1	5	1,2
43	Introduction to R	1	5	1,2
44	Basic data management	1	5	1,2
45	Advanced data management.	1	5	1,2
	Total contact hours	**45**		

List of practical experiments

SL.No	Lab assignment title	Contact Hours	CLOs	Ref.Used
1	Python basics, creating and manipulating a List, and dictionaries.	2	1,2	1
2	Basic exercises on Python Packages such as Numpy, SciPy, Pandas, Scikit-learn, Matplotlib, NetworkX	2	5	2
3	Basic exercises on IPython Notebook	2	2	2
4	Write a program using Datasets and code used in the book	2	2,3	2
5	Creating a Data Frame and Matrix-like Operations on a Data Frame from CSV or text files and Applying functions to Data Frames	2	2,3,4	2
6	Write a program to implement how to structurally load, manipulate, preprocess, and polish data with pandas and NumPy	2	2	2
7	Write a program to implement working with categorical and textual data	2	2,3	1
8	Write a program to implement creating NumPy arrays, Unidimensional and Multidimensional arrays	2	2	1
9	Write a program to demonstrate the Introducing EDA (Exploratory Data Analysis), Feature creation	2	2	2
10	Write a program to demonstrate the different Scoring functions (binary, multilabel classification)	2	2	2
11	Write a program to implement the building custom scoring functions	2	2,4	2
12	Write a program to demonstrate the different feature selection methods	2	2	1,2
13	Implement different data structures in R	2	1,2	1,2
14	Simple Linear Regression – Fitting, Evaluation and Visualization and Multiple Linear Regression, Lasso and Ridge Regression in Python and R	2	3,5	1,2
15	Project Discussion and presentation	2	1-5	1,2
	Total contact hours	**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%	50%	60%	40%	50%	30%	40%	30%	30%	30%
	Understand										
Level 2	Apply	30%	50%	40%	60%	40%	50%	50%	50%	50%	50%
	Analyse										
Level 3	Evaluate	-	-	-	-	10%	20%	10%	20%	20%	20%
	Create										
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Williams, G. J. (2017). The essentials of data science: knowledge discovery using R. Chapman and Hall/CRC.
2. Boschetti, A., & Massaron, L. (2015). Python data science essentials. Packt Publishing Ltd.
3. O'Neil, C., & Schutt, R. (2013). Doing data science: Straight talk from the frontline. " O'Reilly Media, Inc.".

Other Resources

1. VanderPlas, J. (2016). Python data science handbook: Essential tools for working with data. " O'Reilly Media, Inc.".

Course Designers

1. Dr. Tapas Kumar Mishra, Assistant Professor, Department of Computer Science & Engineering, SRM University AP

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Big Data Analytics

Course Code	DSC 502	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)	Big Data Analytics	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the importance of big data and its concept.
2. To learn big data processing concepts.
3. To learn and implement big data analytics techniques.
4. To learn and implement Hadoop eco system.
5. To learn and implement NoSQL database.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	To understand big data and it's importance.	1	70 %	65%
Outcome 2	To apply big data processing techniques	3	70 %	65%
Outcome 3	Manage huge amount of data by applying big data analytics techniques.	4	70 %	65%
Outcome 4	Manage huge amount of data using Hadoop eco system.	5	70 %	65%
Outcome 5	Able to manage and analyse big data using NoSql.	2	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	**PSO 3**
Outcome 1													
Outcome 2													
Outcome 3													
Outcome 4													
Outcome 5													
Average													

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	**Introduction to Big Data**	**8**		
	Navigating Big Data: An Overview of Concepts and Terminology	1	1	1,3
	ıtroduction to Advanced Data Processing Frameworks	2	1	1,3
	Mastering Big Data Analytics: Quantitative	1	1	1,3
	Qualitative	2	1	1,3
	Machine Learning Techniques.	2	1	1,3
Unit II	**Advanced Spark Features**	**10**		
	Advanced Spark Features: Introduction to Spark Streaming	2	2	1,3
	Building and managing streaming applications	1	2	1,3
	Windowing and stateful operations	1	2	1,3
	Spark MLlib for Machine Learning: Overview of MLlib, Building and training machine learning models	1	2	1,3
	Evaluation and tuning	1	2	1,3
	Spark GraphX for Graph Processing: Introduction to GraphX	1	2	1,3
	Graph processing operations and algorithms	1	2	1,3
	Use cases	1	2	1,3
	Applications	1	2	1,3
Unit III	**NoSQL Databases**	**9**		
	Introduction to NoSQL Databases: Comparing SQL vs. NoSQL and Exploring Key Types—Key-Value Stores	3	2	1,2
	Document Stores, Wide-Column Stores, and Graph Stores, Data Lakes and Data Warehouses: Differences Between Data Lakes and Data Warehouses	2	2	1,2
	Architecture and use cases, Data storage and processing models, Implementing and Managing a Data Lake, Using AWS S3 and Azure Data Lake, Data ingestion and management strategies	1	2	
	Data Warehouse Solutions, Overview of data warehousing, Amazon Redshift: Architecture and optimization	2	2	1,2
	Google BigQuery: Serverless data warehousing	1	2	1,2
Unit IV	**ETL Techniques**	**10**		
	ata Integration and ETL Processes.	2	3	1,3
	Advanced ETL Techniques.	2	3	1,3
	ETL architecture and workflow, Challenges and best practices	2	3	1,3
	Data cleansing and enrichment techniques.	2	3	1,3
	Data Pipeline Orchestration, Tools: Apache NiFi, Talend, Informatica.	2	3	1,3
Unit V	**Distributed Machine Learning**	**8**		
	Machine Learning at Scale, Distributed Machine Learning with Spark MLlib and H2O.ai, Overview of distributed ML libraries, Model training and scalability	2	4	1,3
	Day 3-4: Model Selection and Tuning for Big Data, Hyperparameter tuning, Cross-validation and model evaluation, Association Rule Mining, Clustering and Classification	3	4	1,3
	Clustering algorithms: K-means, DBSCAN, Classification algorithms: Decision Trees, Random Forest, SVM, Real-Time Data Visualization, Using Tools like Grafana and Kibana, Overview of Grafana and Kibana.	3	4	1,3

List of practical experiments

Session	Description of Experiment	Required Contact Hours	CLOs Addressed	References Used
1.	Apache Spark installation	4	4	1,2,3
2.	Run Spark applications such as word count and matrix multiplication	2	2	1,4
3.	Programs based on DataFrame API	4	2	1,3
4.	Programs based on Spark MLlib - Machine learning library	4	2	1,3
5.	Design an E-commerce product catalog system using MongoDB.	4	2	1,3
6.	CURD operations in Cassandra.	4	3	1,3
7.	Working with HBase commands.	4	4	4
8.	Create multiple nodes and build relationships using Neo4j CQL.	4	1,2	1,3
Total contact hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%	50%	60%	40%	50%	30%	40%	30%	30%	30%
	Understand										
Level 2	Apply	30%	50%	40%	60%	40%	50%	50%	50%	50%	50%
	Analyse										
Level 3	Evaluate	-	-	-	-	10%	20%	10%	20%	20%	20%
	Create										
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resource

1. Damji, J., Lee, D., Wenig, B., & others. (2020). Learning Spark 2e: Lightning-Fast Data Analytics. O'Reilly Media.
2. Hashem, I. A. T., & others. (2016). Big Data Fundamentals: Concepts, Drivers, and Techniques. Pearson Education.
3. Kleppmann, M. (2017). Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems (Greyscale Indian Edition). O'Reilly Media.
4. White, T. (2015). Hadoop: The Definitive Guide, 4th Edition. O'Reilly Media.

Other Resources

1. Programming, Hive, O'Reilly publications
2. Programming Pig, O'Reilly publications
3. NOSQL for Mere Mortals, O'Reilly publications

Course Designers

1. Dr. Rajiv Senapati, Assistant Professor, Department of Computer Science & Engineering, SRM University AP

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Advanced Algorithms and Analysis

Course Code	DSC 503	Course Category	CC	L	T	P	C
				3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	CSE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the importance of algorithm analysis.
2. To learn algorithmic approach and problem-solving techniques.
3. To learn which problem-solving technique to apply for a given problem.
4. To learn to solve complex and NP class problems.
5. To learn to implement and analyse the complexity of all problem-solving techniques.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	To understand the importance of algorithms analysis.	1	70 %	65%
Outcome 2	To learn algorithmic approaches and problem-solving techniques.	2	70 %	65%
Outcome 3	To learn which problem-solving techniques to apply for a given problem.	3	70 %	65%
Outcome 4	To learn to solve complex and NP class problems.	3	65 %	60%
Outcome 5	To learn to implement and analyse the complexity of many complex problems.	3	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	1	3						1	3	2	1
Outcome 2	2	3	2	3						2	2	2	2
Outcome 3	2	3	3	3						3	3	3	3
Outcome 4	2	3	3	3						3	2	3	2
Outcome 5	2	3	3	3						3	3	3	3
Average	2	3	3	3						3	3	3	2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to AAA & General Problem Solving techniques**	**11**		
1	Defining Algorithm complexity	1	1	1
2	Basic programming skills	2	1	1
3	Greedy method	2	1,2	1
4	Dynamic programming	2	1,2	1
5	Backtracking technique	2	2	1
6	Branch-and-bound technique	2	2	1
Unit 2	**NP class and Randomised algorithms**	**9**		
7	Overview - Class P - Class NP	1	4	1,2
8	NP Hardness	1	4	2,3
9	NP Completeness	1	4	2,3
10	Cook Levine Theorem	1	4	2
11	Important NP Complete Problems	2	4	2,3
12	Heuristic algorithms	1	2,3	3,5
13	Randomized algorithms	2	2,3	5
Unit 3	**Various complexity analysis techniques (alternatives to Big O)**	**6**		
14	Use of probabilistic inequalities in analysis	1	3,5	2,3
15	Amortized Analysis	1	3,5	2,3
16	Aggregate Method	1	3,5	2,3
17	Accounting Method	1	3,5	2,3
18	Potential Method	1	3,5	2,3
19	competitive analysis & applications using examples.	1	3,5	2,3
Unit 4	Geometric, Network flow and string-matching algorithms	**9**		
20	Geometric algorithms: Introduction, Convex hull	1	2,3	1,2
21	Voronoi diagrams	1	2,3	1,2
22	graph connectivity	1	2,3	1,2
23	Network Flow Algorithms- Maximum Flow	1	2,3	4
24	Cuts- Karger Min Cut Algorithm	1	2,3	4
25	Bipartite Matching - Graph partitioning	1	2,3	4
26	multi-commodity flow	1	2,3	4
27	String matching and document processing algorithms	2	2,3	1,2
Unit 5	Approximation algorithms & Parallel algorithms	**10**		
28	Approximation algorithms for known NP hard problems	2	3,5	2,3
29	Analysis of Approximation Algorithms	2	3,5	2,3
30	Use of Linear programming and primal dual	1	3,5	2,3
31	Local search heuristics	2	3,5	2,3
32	Parallel algorithms: Basic techniques for sorting, searching, merging, list ranking in PRAMs and Interconnection.	3	3,5	2,3
	Total contact hours	**45**		

Lab Utilization Plan

Sl No.	Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Implement 8 queens problem. Analyse how the number of possibilities decrease with each constraint.	2	4	1, 2
2	Implement generate and test method for 16-puzzle problem. Propose a heuristic function and use it in the program.	2	4	1, 2
3	Write programs for (a) Fractional knapsack and (b) 0/1 Knapsack problems. Explain how the heuristic can work in (a) and not in (b).	2	4	1, 2
4	Implement Towers of Hanoi problem by recursive and non-recursive methods. Discuss the complexity in both cases. Implement a Hash table as a set of linked lists. Discuss advantages.	2	4	1
5	Write a program to find Minimum Spanning tree of a given graph.Mention the possible application.	2	4	1,2
6	Write a program to find All- to- All shortest paths of a given graph.Discuss the complexity and applications	2	4	1,2
7	Implement any algorithm for Ford-Fulkerson method to solve the Maximum flow problem. Discuss the applications.	2	4	1,2
8	Write a program to implement the Graham's algorithm to find Convex Hull of a given set of points.	2	4	1,2
9	Implement Floyd-Warshall's algorithm to get transitive closure of a Graph (Reachability matrix).Implement Brute-force algorithm for pattern matching.	2	4	1,2
10	Implement Boyer-More algorithm for Pattern matching.Implement KMP algorithm for Pattern matching.	2	4	1,2
11	Implement Travelling Salesman problem which can give accurate answer. Test it on a graph of at least 6 cities. Discuss complexity.	2	4	1,2
12	Use the MST program to get an approximate solution for Travelling Salesman problem	2	4	1,2
13	Create a pack of playing cards (4 suits (colors) & each suit will have 2,3,..10, Jack , Queen, King, Ace). Display the cards. Simulate shuffling of the pack and display the shuffled	2	4	2

	cards. Distribute them among 4 players in a Round robin fashion and display the cards with each player. Give some value for each color and card and find the total values of the cards with each player.			
14	Simulate the following scenario assuming that the time between calls is random. There are two technical support people: Able and Baker. Able is more experienced and can provide service faster than Baker. Times are usually a continuous measure, but this time-based example is made discrete for ease of explanation. The simulation proceeds in a complex manner because of two servers. When both are free Able gets the call. Assume service distribution other than given in your slides.	2	4	2
15	Implement approximate set cover and Vertex cover algorithms	2	4	2
	Total Lab Hrs	**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (60%)**								**End Semester Exam (50%)**	
		CLA-1 (5%)		**Mid-1 (20%)**		**CLA-2 (5%)**		**CLA-3(20%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th (5%)**	**Prac (15%)**	**Th (30%)**	**Prac (20%)**
Level 1	Remember	70%		60%		50%		40%	40%	40%	40%
	Understand										
Level 2	Apply	30%		40%		50%		50%	60%	60%	60%
	Analyse										
Level 3	Evaluate	-	-	-	-	-	-	-	-	-	-
	Create										
Total		**100%**	**-**	**100%**	**-**	**100%**	**-**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Thomas, H. (2009). Introduction to algorithms..
2. Goodrich, M. T., & Tamassia, R. (2001). Algorithm design: foundations, analysis, and internet examples. John Wiley & Sons..
3. SanjoyDasgupta, Christos Papadimitriou and UmeshVazirani (2009), "Algorithms",
4. Ahuja, R. K., Magnanti, T. L., & Orlin, J. B. (1995). Network flows: theory, algorithms and applications. Prentice hall..
5. Motwani, R., & Raghavan, P. (1995). Randomized algorithms. Cambridge university press.

Other Resources

Course Designers

1. Dr. Krishna Prasad, Associate Professor, Department of Computer Science & Engineering, SRM University AP.

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Machine Learning Techniques

Course Code	DSC 504	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce Machine Learning and various task involved in the pipeline of machine learning application development.
2. Understand a wide variety of regression, classification and clustering algorithms.
3. Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.
4. Learn the rapid advances in Machine Learning and able to understand the research articles

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate the phases of machine learning application development.	2	75%	75%
Outcome 2	Describe the learning algorithms.	2	75%	70%
Outcome 3	Explain the techniques to deal with data and its dimension.	2	70%	65%
Outcome 4	Develop speech recognition, object recognition and classification models using machine learning algorithms	5	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2							2		
Outcome 2	3	2	3	3							2		
Outcome 3	3	3	3	3							2		
Outcome 4	3	2	2	2							3		
Average	3	2	3	3							2		

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
	UNIT I:	**10**		
1.	**Introduction:** Introduction to Machine Learning	1	1	1
2.	Different types of learning	1	1	1
3.	Hypothesis space and inductive bias, Evaluation	1	1	1
4.	Training and test sets, cross validation	1	3	2
5.	Concept of over fitting, under fitting, Bias and Variance.	1	3	2
6.	Linear Regression: Introduction	1	2	3
7.	Linear Regression: Simple	1	2,4	3
8.	Linear Regression: Multiple	1	2,4	3
9.	Polynomial regression	1	2,4	3
10.	Evaluating regression fit	1	2,4	3
	UNIT II:	**12**		
11.	**Decision tree learning:** Introduction, Decision tree representation	1	2,4	1
12.	appropriate problems for decision tree learning, the basic decision tree algorithm	1	2,4	1
13.	hypothesis space search in decision tree learning, inductive bias in decision tree learning,	1	2,4	1
14.	issues in decision tree learning, Python exercise on Decision Tree.	1	2,4	1
15.	**Instance based Learning:** K nearest neighbour, numerical problem	1	2,4	1
16.	the Curse of Dimensionality, Feature selection, forward search, backward search,	1	2,4	1
17.	Univariate and Multivariate feature selection approaches	1	2,4	1
18.	Feature selection techniques	1	2,4	1
19.	Feature reduction: Principal Component Analysis	1	2,4	1
20.	Feature reduction: Principal Component Analysis	1	2,4	1
21.	Python exercise on kNN and PCA	1	2,4	1
22.	**Recommender System:** Content based system, Collaborative filtering based	1	2,4	4
	UNIT III:	**7**		
23.	**Probability and Bayes Learning:** Probability and classification, Bayesian Learning,	1	2	1
24.	Python exercise on Naïve Bayes, Logistic Regression.	2	2,4	1
25.	**Support Vector Machine:** Introduction, the Dual formulation,	1	2,4	1
26.	Maximum margin with noise, nonlinear SVM and Kernel function, solution to dual problem	3	2,4	1
	UNIT IV:	**8**		
27.	**Artificial Neural Networks:** Introduction,	1	2,4	2
28.	Biological motivation	1	2,4	2
29.	ANN representation	1	2,4	2
30.	appropriate problem for ANN learning,	1	2,4	2
31.	Peceptron	1	2,4	2
32.	multilayer networks	1	2	1
33.	back propagation algorithm	2	2,5	1
	UNIT V:	**8**		
34.	**Ensembles:** Introduction, Bagging and boosting, Random Forest	2	2,4	3
35.	Discussion on some research papers	1	2,4	3
36.	Discussion on some research papers	1	2,4	3
37.	**Clustering:** Introduction, K-mean clustering	2	2,4	3
38.	agglomerative hierarchical clustering,	1	2,4	3
39.	Python exercise on k-mean clustering.	1	2,4	3
	Total contact hours	**45**		

Lab Unitization Plan

Sl. No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
1.	Basic exercises on Python Machine Learning Packages such as Numpy, Pandas and matplotlib	4	1	1,2
2.	Given a dataset. Write a program to compute the Covariance, Correlation between a pair of attributes. Extend the program to compute the Covariance Matrix and Correlation Matrix.	2	2	2
3.	Given a set of sample points in N dimensional feature space. Write a program to fit the points with a hyper plane using Linear Regression. Calculate sum of residual error.	2	2	4
4.	Write a program that provides option to compute different distance measures between two points in the N dimensional feature space. Consider some sample datasets for computing distances among sample points.	2	2	4
5.	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.	2	3	4
6.	Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem.	2	3	4
7.	Write a program to implement feature reduction using Principle Component Analysis	2	3	4
8.	Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.	2	3	4
9.	Given a dataset for classification task. Write a program to implement Support Vector Machine and estimate it test performance.	2	3	3
10.	Write a program to implement perceptron for different learning task	2	4	4
11.	Write programs to implement ADALINE and MADALINE for given learning task.	2	4	2
12.	Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.	4	4	2
13.	Write a program to implement K means clustering algorithm. Select your own dataset to test the program. Demonstrate the nature of output with varying value of K.	2	3	2
	Total contact hours	**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (15%)	CLA-2 (10%)	Mid -2 (15%)	
Level 1	Remember	30%	30%	30%	30%	30%
	Understand					
Level 2	Apply	40%	40%	40%	40%	40%
	Analyse					
Level 3	Evaluate	30%	30%	30%	30%	30%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Mitchell, T. (1997). Introduction to machine learning. Machine learning, 7, 2-5.
2. Alpaydin, E. (2020). Introduction to machine learning. MIT press.
3. Murphy, K. P. (2012). Machine learning: a probabilistic perspective. MIT press.
4. Christopher, B. (2006). Pattern recognition and machine learning.

Other Resources

Course Designers

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Advanced Python Programming Lab

Course Code	DSC 505	**Course Category**	CC	**L**	**T**	**P**	**C**
				0	0	2	2
Pre-Requisite Course(s)	Statistics	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the basics of Python programming.
2. To learn I/O Operations, Basic image processing using Python.
3. To learn the basic data analysis using Python.
4. To learn Extending and Embedding Python.
5. To learn and implement project.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	To understand the basics of Python programming.	1	70 %	65%
Outcome 2	To apply /O Operations and basic image processing techniques.	3	70 %	65%
Outcome 3	Manage huge amount of data by applying data science techniques.	4	70 %	65%
Outcome 4	Manage Embedding Python.	5	70 %	65%
Outcome 5	Able to manage and analyse data using data analytics.	2	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	3		1		1		3	2	1
Outcome 2	3	3	3	3	3		1		1		2	2	2
Outcome 3	3	3	3	3	3		1		1		3	3	3
Outcome 4	3	3	3	3	3		1		1		2	3	2
Outcome 5	3	3	3	3	3				1		3	3	3
Average	3	3	3	3	3		1		1		3	3	2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		**12**		
1	1. Write a Python program to do the following operations: Library: NumPy i) Create multi-dimensional arrays and find their shape and dimension ii) Create a matrix full of zeros and ones iii) Reshape and flatten data in the array iv) Append data vertically and horizontally v) Apply indexing and slicing on an array vi) Use statistical functions on the array - Min, Max, Mean, Median, and Standard Deviation vii) Compute the determinant of an array 2. Write a program to count the numbers of characters in the string and store them in a dictionary data structure	6+6	1	1
Unit 2	3. Write a program to perform the addition, and subtraction of two 3 X 3 matrices 4. Demonstrate Basic date and time classes, Different time formats, converting between formats, Formatting dates and times, and Parsing date/time information.	**12**	**2**	**1**
Unit 3	5. Build a program that creates a scatter plot of two variables from a dataset using Matplotlib, with each point color-coded based on a third categorical variable. 6. Write a Python program to read the file contents and do the following operations i) Print each word of a file in reverse order. ii) Print each line of a file in reverse order. Sample Input: Python Programming Sample Output: Programming Python iii) Display the content without whitespaces.	**12**	3	1
Unit 4	7. Create a class ATM and define ATM operations to create an account, deposit, check_balance, withdraw and delete an account. Use a constructor to initialize members. 8. Write a Python program to handle the run time errors while doing file handling operations.	**12**	4	1
Unit 5	9. Write a Python program to create and raise user-defined exceptions. 10. Write a Python program to implement Pandas Series with labels.	**12**	**5**	**1**
	Total contact hours	**60**		

Learning Assessment

Question Difficulty	Bloom's Level of Cognitive Task	Continuous Learning Assessments (50%)		End Semester Exam (50%)
		Lab Performance (40%)	Record / Observation Note (10%)	
Level 1	Remember	50%	40%	30%
	Understand			
Level 2	Apply	30%	40%	50%
	Analyse			
Level 3	Evaluate	20%	20%	20%
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Python, W. (2005). Introduction to Python.
2. Kamthane, A. N., & Kamthane, A. A. (2018). *Programming and Problem Solving with Python*. McGraw-Hill Education.
3. Beazley, D., & Jones, B. K. (2013). *Python cookbook: Recipes for mastering Python 3*. " O'Reilly Media, Inc.".

Other Resources

1. Luciano, R. (2015). Fluent Python: Clear, concise, and effective programming. Sebastopol, CA, United States: OŔeilly Media

Course Designers

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COMMUNITY SERVICE AND SOCIAL RESPONSIBILITY

Course Code	VAC 501	**Course Category**	VAC	**L**	**T**	**P**	**C**
				0	0	2	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CEL	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Encourage initiatives that address local needs, foster self-sufficiency, and promote environmental sustainability within the community.
2. Equip participants with a deeper understanding of social issues and a sense of responsibility towards marginalized communities.
3. Inspire active participation in community service programs and foster a culture of giving back among individuals and organizations.
4. Develop and implement programs that contribute to skill development, economic empowerment, and equal opportunities for underprivileged sections of society.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Develop effective strategies for identifying and addressing community needs.	3	80%	80%
Outcome 2	Demonstrate empathy and cultural sensitivity when engaging with diverse community groups.	4	80%	75%
Outcome 3	Implement sustainable solutions and evaluate their impact on social well-being.	5	90%	85%
Outcome 4	Collaborate effectively within teams to design and lead community service projects.	6	90%	80%

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments 50%**				**End Semester Exam 50%**
		CLA-1 20%	**Mid-1 20%**	**CLA-2 20%**	**CLA-3 20%**	
Level 1	Remember	10%	10%			20%
	Understand					
Level 2	Apply		10%	10%		20%
	Analyse					
Level 3	Evaluate				10%	10%
	Create					
Total		**10%**	**20%**	**10%**	**10%**	**50%**

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Research Seminar

Course Code	AEC 502	Course Category	AEC		L	T	P	C
					0	0	1	1
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	CSE	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. To learn how to write the seminars in an effective way
2. To learn what are the skills needed for presentation of science
3. To learn effective science communication

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe the features and characteristics seminars and presentations.	2	80%	80%
Outcome 2	Discuss methods of the presentation.	2	65%	60%
Outcome 3	Analyse the parameters of conducting seminars	3	65%	60%
Outcome 4	Discuss the responses to Q&A sessions in seminars.	2	60%	65%
Outcome 5	Explain and Analyse conflict management during presentations and seminars.	3	80%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	3	2	1		3	3	2	3	1	2	2
Outcome 2	2	2	3	2	1		3	3	2	3	2	2	1
Outcome 3	2	2	3	2	1		3	3	2	3	2	2	1
Outcome 4	2	2	3	2	1		3	3	2	3	2	2	1
Outcome 5	2	2	3	2	3	3	3	3	2	3	2	2	1
Average	2	2	3	2	1	3	3	3	2	3	2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit-I	**Research Seminar -Structure**	**5**		
	Explanation on what is a seminar and what are expected during the seminar, followed by student presentations		1,3	1,2
Unit-II	**Ways and tools of presentation in the research seminar**	**7**		
	Discussion on tools for effective presentation		1, 2	3,4,5
Unit-III	**Presentation skills**	8		
	Discussion and presentation demonstration		3	5
Unit-IV	**Handling questioning sessions of presentation**	**5**		
	How to answer the questions during the presentation. Student presentation and discussion		4,5	6
Unit-V	**Conflict management during presentation**	**5**		
	How to manage the conflicts during the presentation		1, 4, 5	6
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**			**End Review (50%)**	
		Mid-Review (50%)				
		Th	**Prac**		**Th**	**Prac**
Level 1	Remember	60%			30%	
	Understand					
Level 2	Apply	40%			70%	
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**			**100%**	

Recommended Resources

1. Tracy, B. (2008). Speak to Win: how to present with power in any situation. Amacom.
2. Anholt, R. R. (2010). Dazzle'em with style: The art of oral scientific presentation. Elsevier (ISBN: 0123694523).
3. Booth, V. (1993). Communicating in science: writing a scientific paper and speaking at scientific meetings. Cambridge University Press (ISBN: 0521429153).
4. Carter, M. (2012). Designing science presentations: A visual guide to figures, papers, slides, posters, and more. Academic Press. (ISBN: 0123859697)
5. Reynolds, G. (2011). Presentation Zen: Simple ideas on presentation design and delivery. New Riders. (ISBN: 0321811984)

Other Resources

Course Designers

1. Dr. Murali Krishna Enduri, Assistant Professor, Department of Computer Science and Engineering, SRM university AP.

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Entrepreneurial Mindset

Course Code	SEC 103	**Course Category**	SEC	**L**	**T**	**P**	**C**
				1	0	1	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Management	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To develop a foundation in innovation and entrepreneurship among the students.
2. To enhance analytical skills of students for practical application of their ideas.
3. To make students proficient in designing solutions.
4. To introduce students to different phases of entrepreneurship.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe and classify the basic concepts of Innovation and Entrepreneurship	2	90%	80%
Outcome 2	Discuss the concept of Design Thinking and prototyping	2	80%	70%
Outcome 3	Apply design thinking to generate innovative ideas and strategize implementation plan	3	65%	60%
Outcome 4	Prepare a business plan by assessing customer segment, market validation and product development	4	60%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	1								2	3	2
Outcome 2	2	2	2		2	2					3	2	2
Outcome 3	1	3	3	2			3		3	3		3	2
Outcome 4	2	3	3	2			3	2	3	3	3		3
Average	2	2	3	2	1	1	2	1	2	2	3	3	3

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Entrepreneurship & Inventions**	**5**		
	Entrepreneurship and Types of Entrepreneurship	2	1	3,4
	Entrepreneurs and their Characteristics	1	1	3,4
	Innovation & its Types	2	1	1
Unit 2	**Exploration & Summarizing Facts**	**3**		
	Structured exploration and quantifying the data	2	3,4	3,4
	Analysing the data	1	3,4	3,4
Unit 3	**Reflection, Synthesizing and ideating**	**3**		
	Summarizing facts and designing a workable model	3	3,4	3,4
Unit 4	**Prototyping**	**8**		
	Definition and Basics of Prototyping	2	2,3,4	2
	Types and methods of Prototyping	4	2,3,4	2
	Innovations in prototyping	2	2,3,4	2
Unit 5	**Concept Ideation & Design Thinking**	**8**		
	Importance of Idea	1	3,4	1,2
	Idea Generation Techniques	1	3,4	1,2
	Validating the idea	1	3,4	1,2
	Definition and Basics of Design Thinking	2	2	5
	Stages of Design Thinking	3	2	5
Unit 6	**Market Validation**	**5**		
	Concept of Market Validation and its importance	2	3,4	3,4
	Customer survey	1	3,4	3,4,5
	Feedback and modifying the idea	2	3,4	3,4,5
Unit 7	**Segmentation of the potential users/ customers**	**3**		
	Customer segment and its types	2	4	3,4
	Understanding niche customer segment	1	4	3,4
	Reaching the real customers	1	4	3,4
Unit 8	**Industry Validation**	**2**		
	Industry validation and mentoring	2	3,4	3,4,5
Unit 9	**Solution Design**	**8**		
	Generate an Innovative Idea	3	3,4	1,2,5
	Develop a Business Plan	5	4	3,4
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			End Semester Exam (50%)
		CLA-1 (10%)	CLA-2 (20%)	Mid-term (20%)	
Level 1	Remember	90%	50%	60%	40%
	Understand				
Level 2	Apply	10%	50%	40%	60%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Keeley, L., Walters, H., Pikkel, R., & Quinn, B. (2013). Ten types of innovation: The discipline of building breakthroughs. John Wiley & Sons.
2. Eric Ries. The lean startup how constant innovation creates radically successful businesses, Penguin Books
3. Bruce R. Barringer, R. Duane Ireland (2020) Entrepreneurship Successfully Launching New Ventures, Pearson;
4. Robert, D., Hisrich, M., Peters, P., & Dean, A. (2020). Shepherd Entrepreneurship McGraw-Hill.
5. Siva Prasad N. Design Thinking (2023) Techniques And Approaches, Ane Books, New Delhi.

Other Resources

Course Designers

1. Mr Udayan Bakshi, Assistant Professor, Paari School of Business, SRM University, A.P.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Advanced Tools and Techniques for Big Data Analytics

Course Code	DSC 506	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)	Statistics, Programming	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the importance of big data and its concept.
2. To learn big data processing concepts.
3. To learn and implement big data analytics techniques.
4. To learn and implement Hadoop eco system.
5. To learn and implement NoSql database.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	To understand big data and it's importance.	1	70 %	65%
Outcome 2	To apply big data processing techniques	3	70 %	65%
Outcome 3	Manage huge amount of data by applying big data analytics techniques.	4	70 %	65%
Outcome 4	Manage huge amount of data using Hadoop eco system.	5	70 %	65%
Outcome 5	Able to manage and analyse big data using NoSql.	2	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	**Program Learning Outcomes (PLO)**												
	POs										**PSOs**		
	Engineering Knowledge	**Design / Development of Solutions**	**Conduct Investigations of Complex Problems**	**Modern Tool Usage**	**The Engineer and Society**	**Environment and Sustainability**	**Ethics**	**Individual and Teamwork**	**Communication**	**Life-long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	3	3	2	3		1		1		3	2	1
Outcome 2	3	2	2	3	2		1		1		2	2	2
Outcome 3	2	2	2	2	2		1		1		3	3	3
Outcome 4	3	2	2	3	2		1		1		2	3	2
Outcome 5	3	3	2	3	2				1		3	3	3
Average	3	2	2	3	2		1		1		3	3	2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		9		
1	Understanding Big Data – Concepts and Terminology	1	1,2	1,4
2	Big Data Characteristics – Different types of Data	1	1,2	1,4
3	Big Data Storage concepts – Clusters	1	1,2	1,4
4	File systems and distributed file systems	1	1	1,4
5	Sharding – Replication	1	1,2	1,4
6	CAP theorem – BASE	1	1,2	1,4
7	Hadoop Distributed File System (HDFS) Architecture	1	1,2,5	1,2
8	HDFS commands for loading/getting data	1	3,4	1,2
9	Accessing HDFS through Java program	1	5	1,2
Unit 2		**9**		
10	Big Data Processing Concepts	1	1,2	1,4
11	Parallel Data Processing	1	1,2	1,4
12	Distributed Data Processing	1	2,3	1,4
13	Hadoop	1	2,4,5	2,3
14	Processing workloads	1	2,5	2,3
15	Batch processing with MapReduce	1	2,4	1,2
16	Map and Reduce Tasks	1	2,5	2
17	MapReduce Example-1	1	2,5	1,2
18	MapReduce Example-2	1	2,5	1
Unit 3		**9**		
19	Big Data Analysis Techniques-1	1	1,3	1,2
20	Big Data Analysis Techniques-2	1	3,5	1,2
21	Quantitative Analysis	1	1,3	1,2
22	Qualitative Analysis	1	3	1,2
23	Data Mining-1	1	3	1,2
24	Data Mining-2	1	3	1,2
25	Statistical Analysis	1	1,3,5	1,2
26	Machine Learning	1	3	1,2
27	Semantic Analysis	1	2,3	1,2
Unit 4		**9**		
28	Hadoop echo system	1	2,4	1,2,3
29	Hadoop echo system and its components	1	4	1,2,3
20	Flume	1	1,4,5	1,2,3
31	Sqoop	1	1,2,4	1,2
32	Pig	1	4,5	1,2
33	Hive	1	1,2,4	1,2
34	Case study 1	1	4	1,2
35	Case study 2	1	4	1,2
36	Case study 3	1	4	1,2
Unit 5		**9**		
37	NoSQL databases: Introduction	1	1,5	1,2
38	NoSQL vs SQL	1	1,5	1,2
39	Types of NoSQL databases- Key-value data store	1	4,5	1,2
40	Dynamo DB	1	4,5	1,2
41	Document Store	1	5	1,2
42	MongoDB	1	4,5	1,2
43	Wide-column store, HBase	1	2,5	1,2
44	Graph Store, Neo4j	1	2,3,5	1,2
45	Review of syllabus	1	5	1,2
	Total contact hours	**45**		

Course Unitization Plan: Lab

Unit Name	Required Contact Hours	CLOs Addressed	References Used
LAB Experiments: Apache Spark installation, Hadoop Installation, Hadoop Shell Commands, writing a file from local file system to Hadoop Distributed file system (HDFS), Reading a file from HDFS to local file system.	6	1,2,3,4	1
LAB Experiments: Implementation of Word Count program using MapReduce without combiner logic, Implementation of Word Count program using MapReduce with combiner logic, Implementation of MapReduce algorithm for Matrix Multiplication.	6	2,4,5	1
LAB Experiments: Programs based on Data Frame API; Programs based on Spark MLlib - Machine learning library	6	2,3,4,5	1
LAB Experiments: Use HiveQL to analyze the stock exchange dataset and calculate the covariance between the stocks for each month. This will help a stockbroker in recommending the stocks to his customers, Implement JOINS using HIVE. a. Inner Join b. Left outer join. c. Right outer Join d. Full outer join	6	2,4,5	1
LAB Experiments: Working with HBase commands., Create multiple nodes and build relationships using Neo4j CQL, Design an E-commerce product catalog system using MongoDB.	6	4,5	1,2
Total	**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%	50%	60%	40%	50%	30%	40%	30%	30%	30%
	Understand										
Level 2	Apply	30%	50%	40%	60%	40%	50%	50%	50%	50%	50%
	Analyse										
Level 3	Evaluate	-	-	-	-	10%	20%	10%	20%	20%	20%
	Create										
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Thomas Erl, Wajid Khattak, and Paul Buhler (2016), Big Data Fundamentals: concepts, Drivers and Techniques: Pearson Education.
2. Tom White, Hadoop The Definitive Guide, IV edition, O'Reilly publications.
3. Chuck lam (2010), Hadoop in Action, Manning publications.

Other Resources

Course Designers

1. Dr. Firoj Gazi, Assistant Professor, Department of Computer Science & Engineering, SRM University AP.

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Deep learning: Methodologies and Techniques

Course Code	DSC 507	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)	DSC 503	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the fundamental concepts of ML/DL, tensor flow, and keras
2. Study of different activation functions and ANN.
3. Study and application of CNN, and RNN models
4. Application of different deep learning concepts

ourse Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Illustrate the concepts of ML/DL	1	70%	68%
Outcome 2	Design and implement CNN model	2	70%	65%
Outcome 3	Design and implement RNN model	2	70%	65%
Outcome 4	Apply deep learning models to given problems.	3	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	1	1	1	2								2
Outcome 2	2	2	3	2	3								3
Outcome 3	2	2	3	2	3								2
Outcome 4	2	2	3	3	3								2
Average	**2**	**2**	**3**	**2**	**3**								**2**

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction:**	**11**		
	Overview of machine learning	2	1	1
	History of Deep Learning	1	1	1
	Introduction to TensorFlow:	1	1	1
	Computational Graph, Key highlights, Creating a Graph	1	1	1
	Linear classifiers, loss functions, Regression example	1	1	1
	Gradient Descent	1	1	1
	Tensor Board	2	1	1
	Modularity, Sharing Variables	1	1	1
	Kera's	1	4	3
Unit 2	**ACTIVATION FUNCTIONS, PERCEPTRON, ANN**	**9**		
	Activation Functions: Sigmoid, ReLU, Hyperbolic Fns, SoftMax	2	1	1,2
	Perceptron's: What is a Perceptron, XOR Gate	1	1	1
	Artificial Neural Networks: Introduction	1	1	2
	Perceptron Training Rule	2	1	2
	Gradient Descent Rule	2	1	2
	Vanishing gradient problem and solution	1	1	2
Unit 3	**Convolutional Neural Networks**	**8**		
	Introduction to CNNs	2	1,2	3
	Kernel filter	1	1,2	3
	Principles behind CNNs	1	1,2	3
	Long Short-Term Memory (LSTM)	2	1,2	3
	Problem and solution of under fitting and overfitting	2	1,2	3
Unit 4	**Recurrent Neural Networks**	**8**		
	Introduction to RNNs	2	1,3	2
	Unfolded RNNs	1	1,3	2
	Seq2Seq RNNs	1	1,3	2
	LSTM	1	1,3	2
	GRU	1	1,3	2
	Encoder Decoder architectures	2	1,3	2
Unit 5	**Deep Learning applications**	**9**		
	Image segmentation	1	4	3
	Self-Driving Cars	1	4	3
	News Aggregation and Fraud News Detection	1	4	3
	Natural Language Processing	1	4	3
	Virtual Assistants	1	4	3
	Entertainment	1	4	3
	Visual Recognition	1	4	3
	Fraud Detection, Healthcare	2	4	3
Total Contact Hours		**45**		

Course Unitization plan: Lab

Unit Name	Required Contact Hours	CLOs Addressed	References Used
Lab 1: To implement a Multilayer Perceptron (MLP) using Keras with TensorFlow, and fine-tune neural network hyperparameters for regression problem (house price prediction).	3	1,2	1
Lab 2: To implement a MLP using Keras with TensorFlow for classification problem (heart disease prediction).	3	1,2,3	1
Lab 3: To implement a Convolution Neural Network (CNN) for dog/cat classification problem using TensorFlow/Keras.	3	2,3	1
Lab 4: To implement a CNN for handwritten digit recognition.	2	1,2,3	1
Lab 5: To Implement a CNN for object detection in the given image.	3	2,3	1
Lab 6: To implement a Long Short-Term Memory (LSTM) for predicting time series data.	3	3,4	
Lab 7: To implement a Seq2Seq Model for Neural Machine Translation.	3	3,4	1
Lab 8: To implement a Recurrent Neural Network (RNN) for predicting time series data.	3	3,4	1
Lab 9: To implement an Encoder-Decoder Recurrent neural network model for Neural Machine Translation.	3	2,3,4	1
Lab 10: Case Study 1: Object detection for Self-Driving Cars	3	1,2,3,4	1,2
Lab 11: Case Study 2: Object detection for Healthcare images	3	1,2,3,4	1,2
Total	**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1		**Mid-1 (15%)**		**CLA-2**		**CLA-3**			
		Th (5%)	**Prac**	**Th**	**Prac**	**Th (5%)**	**Prac**	**Th (10%)**	**Prac (15%)**	**Th (35%)**	**Prac (15%)**
Level 1	Remember	40%		40%		20%		10%	10%	10%	10%
	Understand										
Level 2	Apply	30%		30%		40%		50%	40%	40%	40%
	Analyse										
Level 3	Evaluate	30%		30%		40%		40%	50%	50%	50%
	Create										
Total		**100%**		**100%**		**100%**		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Buduma, N., Buduma, N., & Papa, J. (2022). Fundamentals of deep learning, 2nd ed. O'Reilly Media, Inc."
2. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning, 2nd ed. MIT press.

Other Resources

1. https://www.youtube.com/watch?v=aPfkYu_qiF4&list=PLyqSpQzTE6M9gCgajvQbc68Hk_JKGBAYT
2. https://www.coursera.org/professional-certificates/tensorflow

Course Designers

1. Dr. Md Muzakkir Hussain, Department of CSE, SRM AP.

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Data Warehousing and Pattern Mining

Course Code	DSC 508	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**	IEEE, Microsoft, Oracle, Max Planck Research, Institution of Civil Engineers etc				

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the basic concepts of Data Warehouse and Data Mining techniques.
2. Examine the types of the data to be mined and apply pre-processing methods on raw data.
3. Discover interesting patterns, analyze supervised and unsupervised models, and estimate the accuracy of the algorithms.
4. Understand the implement recommendation system using fundamental mathematical and algorithmic ingredients.
5. Understand the use of data visualization tool.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify methods to pre-process the real world data to make it suitable for various data mining algorithms.	2	75%	70%
Outcome 2	Implement models to measure interesting patterns from different kinds of databases.	5	75%	70%
Outcome 3	Design, develop and model various techniques such as clustering, classification, association finding, feature selection and visualization to real world data for public health and safety, and the cultural, societal, and environmental considerations.	3	70%	60%
Outcome 4	Acquire real world data from different sources to build Recommendation Systems as well as represent knowledge using Visualization tools.	4	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	2		1									1
Outcome 2	2	2	3	3									3
Outcome 3	2	2	3	3									3
Outcome 4	2	2	2	3									3
Average	2	2	3	3									3

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		**11**		
	Data warehouse concepts	2	1	1
	Data warehouse modelling	1	1	1,2
	Data Cube and OLAP	1	1	1,2
	Schemas for multidimensional data models	1	1	**1,2**
	Concept hierarchy, measures, and indexing techniques	1	1	1,2
	Data warehouse – design and usage	1	1	1,2
	Implementation and the architectural components	1	1	1,2
	Role of Metadata, Dimensional Modelling	1	1	1,2
	Data Extraction, Transformation and Loading	1	1	1,2
	Data quality	1	1	1,2
Unit 2		11		
	Classification and prediction introduction	1	1	1,2,3
	Decision tree induction, Bayes, Rule based etc methods	2	1,2	1,2,3
	Advanced classification methods	2	1,2	1,2,3
	Cluster Analysis – Types of Data in Cluster Analysis	1	1,2	1,2,3
	Partitioning methods	1	1,2	1,2,3
	Hierarchical Methods	1	1,2	1,2,3
	Transactional Patterns	1	1,2	1,2,3
	Temporal based frequent patterns	1	1,2	1,2,3
	OLAP Implementation	1	1,2	1,2,3
Unit 3		9		
	Mining Data Streams	1	2	1,2,3
	Methodologies for stream data processing and stream data systems	2	2	1,2,3
	Frequent pattern mining in stream data	1	2	1,2,3
	Sequential Pattern Mining in Data Streams	1	1,2	1,2,3
	Classification of dynamic data streams	1	2,3	1,2,3
	Mining Time series	1	2,3	1,2,3
	Mining Sequence Patterns in Transactional Databases	1	2,3	1,2,3
	Mining Sequence Patterns in Biological Data	1	2,3	1,2,3
Unit 4		9		
	Web Mining	1	3	1,2,3,4
	Mining the web page layout structure	2	3,4	1,2,3,4
	Mining web link structure	1	3,4	1,2,3
	Multimedia web mining	1	3,4	1,2,3
	Automatic classification of web documents	1	3,4	1,2,3
	Web usage mining	1	3,4	1,2,3
	Distributed Data Mining	2	3,4	1,2,3
Unit 5		5		
	Data mining Applications	1	4	1,2,3,4
	Advanced Techniques	1	4	1,2,3,4
	Mining Text and Web data	1	4	1,2,3,4
	Mining Spatiotemporal patterns	1	4	1,2,3,4
	Mining Trajectory Patterns	1	4	1,2,5,6
	Multivariate Time Series (MVTS) Mining		4	1,2,3,7
	Total	**45**		

Course Unitization Plan – Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Basic exercises on Python Packages such as Numpy, Pandas and matplotlib.	2	3	5
2	Given a dataset. Write a program to compute the Mean, Median, Mode, Standard deviation, Covariance, Correlation between a pair of attributes.	2	3	5
3	Write a query to implementation OLAP operations in a data cube.	3	2	6
4	Write a program to implement data pre-processing techniques.	3	2	6
5	Write a program that provides option to compute different distance measures between two points in	**2**	**2**	**6**
6	Write a program that provides option to compute different distance measures between two points in the N dimensional feature space. Consider some sample datasets for computing distances among sample points.	2	3	6
7	Write a program to demonstrate the working of APRIORI algorithm. Use an appropriate data set to generate frequent patterns.	2	3	6
8	Write a program to demonstrate the working of stream mining algorithm. Use an appropriate data set to generate frequent patterns.	3	3	6
9	Write a program to implement K means clustering algorithm. Select your own dataset to test the	**2**	**2**	**6**
10	Write a program to demonstrate web page layout structure, web link structure.	2	4	7
11	Write a program to demonstrate time series and sequence pattern mining considering a suitable dataset.	3	4	7
12	Write a program based on applications of data mining?	4	4	5
Total		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Assessments (50%)
		CLA-1 (10%)	Mid-1 (15%)	CLA-2 (10%)	Mid-2 (15%)	
Level 1	Remember	70%	40%	30%	30%	30%
	Understand					
Level 2	Apply	20%	40%	50%	40%	50%
	Analyse					
Level 3	Evaluate	10%	20%	20%	30%	20%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Jiawei, H., & Micheline, K. (2006). Data mining: concepts and techniques. Morgan kaufmann.
2. Mining, W. I. D. (2006). Introduction to data mining (pp. 2-12). New Jersey: Pearson Education, Inc.
3. Dong, G., & Pei, J. (2007). Sequence data mining (Vol. 33). Springer Science & Business Media.
4. Kimball, R., & Ross, M. (2019). The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, Ed. Wiley.
5. VanderPlas, J. (2016). Python data science handbook: Essential tools for working with data. " O'Reilly Media, Inc.".
6. Murphy, K. P. (2012). Machine learning: a probabilistic perspective. MIT press.
7. Blum, A., Hopcroft, J., & Kannan, R. (2020). Foundations of data science. Cambridge University Press.

Other Resources

Course Designers

1. Dr. Rajiv Senapati, Assistant Professor, Department of Computer Science & Engineering, SRM University AP.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Project Management

Course Code	PGM 509	Course Category	RDIP	L	T	P	C
				0	2	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the fundamentals of production and operations management.
2. To learn about capacity planning, plant layout, scheduling and sequencing
3. To learn about operation management, work-study, time study
4. To understand about Inventory control, supply chain management

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Define and explain the basic concepts and principles of production and operations management (POM),	1	80%	75%
Outcome 2	Develop proficiency in capacity planning, plant layout etc.	2	70%	75%
Outcome 3	Able to perform work study, time study, Gantt chart	3	80%	70%
Outcome 4	Explain supply chain management functions and applications	2	80%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	3	2				3		3	3	2	3
Outcome 2	3	2	3	2				3		3	3	2	3
Outcome 3	3	2	3	2				3		3	3	2	3
Outcome 4	3	3	3	2				3		3	3	3	3
Average	3	2	3	2				3		3	3	2	3

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
1.	**UNIT-I Fundamental concepts**	**8**	**1**	**1**
2	Production planning and control	2	1	1
3	New product development	1	1	1,2
	UNIT-II Plant layout	**8**		
4	Capacity planning, facility planning	2	1	1
5	Plant location and layout	2	1,2	1,2
6	Scheduling and sequencing	2	1,2	1,2
	UNIT- III Operation management	**9**		
7	CPM	3	3	1
8	Gantt chart	3	3	2
9	Work study, time study	3	3	1,2
	UNIT-IV- Material management	**10**		
10	ABC analysis, EOQ	3	3,4	1
11	Supply chain management	4	3,4	1
12	Preventive maintenence	3	3,4	2
	UNIT – V Tools	**10**		
13	Six sigma, Poka yoke, BPR, ERP, Kanban, ISO 9000,	5	3,4	2
14	JIT, TQM, FMS, Push/Pull, Kaizen, CAD CAM	5	3,4	2
Total Contact hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (20%)		CLA-1 (15%)		Midterm-1 (15%)					
		Th.		Th.		Th.		Th.		Th.	
Level 1	Remember	50%		40%		50%		45%		30%	
	Understand										
Level 2	Apply	50%		60%		50%		55%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**				**100%**	

Recommended Resources

1. BHATTACHARYA, S. (2014). Operations Management. PHI Learning Pvt. Ltd..
2. Panneerselvam, R., & Senthilkumar, P. (2009). Project management. PHI Learning Pvt. Ltd

Other Resources

Course Designers

1. Prof. Prakash Jadhav, Professor, Department of Mechanical Engineering, SRM university AP.

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Thesis I

Course Code	DSC 501	Course Category	RDIP		L	T	P	C
					0	0	14	14
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	CSE	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. To widen the understanding of doing research.
2. To facilitate the ideation of a thought.
3. To devise and plan ways to execute an idea.
4. To learn how to avoid plagiarism and publish one's contribution in the research community.

ourse Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Conceptualize an idea	5	75%	70%
Outcome 2	Devise a plan to do the literature survey on the idea	5	75%	70%
Outcome 3	Formulate the mathematical model for the problem.	4	75%	70%
Outcome 4	Assess the relevance and societal impact of the work	5	70%	65%
Outcome 5	Write a technical paper and report the findings.	3	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3			2		1	2	3	2	3	2	2	3
Outcome 2	3	2	3	3	1	1	3	3	3	3	2	1	3
Outcome 3	3	3	3	3	3	3	3	3	3	3	3	3	3
Outcome 4					3	3	3			3	2	1	3
Outcome 5	3	1	3	3			3	3	3	3	3	3	3
Average	3	2	3	3	2	2	3	3	3	3	3	2	3

Course Unitization Plan Theory

SL No.	Unit Name	Required Contact hours	CLOs Addressed	References Used
Unit 1	Conception of Idea	10		
	Based on interest conceive an idea	20	1,4	1
	Do a feasibility check of the project	15	1,4	1
Unit 2	Submission of Abstract of the idea	20		
	Literature survey of the related works	20	2	1,2,3,4,5
	Write an abstract of the proposed idea	10	2	1
Unit 3	Formulate the Mathematical model	35		
	Formulate the mathematical model for the considered problem	30	3	1
	Creating timeline for execution of various module of the project.	5	3	1,6
Unit 4	Conducting Simulations and Publish results	20		
	Execution of the various modules of the project and intermediate report submission.	10	3	1
	Initiation of the process for a possible publication.	20	5	2,3,4,5
Total Contact Hours		**210 Hours**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								External (50%)	
				Internal							
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember										
	Understand										
Level 2	Apply				70%						30%
	Analyse										
Level 3	Evaluate				30%						70%
	Create										
Total					**100%**						**100%**

Recommended Resources

1. As recommended by Advisor pertaining to student research interest.
2. https://ieeexplore.ieee.org/Xplore/home.jsp
3. https://www.sciencedirect.com/
4. www.springer.com
5. https://onlinelibrary.wiley.com/
6. Research Methodology

Other Resources

1.

Course Designers

1. Dr. Ashu Abdul, Assistant Professor, CSE, SRM University AP.
2. Dr. Murali Krishna Enduri, Assistant Professor, CSE, SRM University AP.

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Industrial Practice

Course Code	DSC 511	Course Category	RDIP	L	T	P	C
				0	2	1	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	CSE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To enable students to apply theoretical concepts learned in the classroom to real-world industrial scenarios.
2. To develop and enhance students' professional and technical skills through direct involvement in industry-specific projects
3. To expose students to industry standards, practices, and workplace culture, giving them an understanding of the professional environment in their chosen field.
4. To provide students with networking opportunities and enhance their career development prospects by building connections with industry professionals.

ourse Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate the ability to apply theoretical knowledge and concepts from their academic coursework to real-world industry challenges and projects.	1	80%	75%
Outcome 2	Exhibit enhanced professional skills, including effective communication, teamwork, and project management, gained through their internship experience.	2	70%	75%
Outcome 3	Demonstrate a comprehensive understanding of industry standards, practices	3	80%	70%
Outcome 4	Develop a professional network and gain insights into career opportunities and pathways within their industry.	2	80%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	3	2				3		3	3	2	3
Outcome 2	3	2	3	2				3		3	3	2	3
Outcome 3	3	2	3	2				3		3	3	2	3
Outcome 4	3	3	3	2				3		3	3	3	3
Average	3	2	3	2				3		3	3	2	3

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
1.	**UNIT-I Introduction to Industrial Practice and Internships**	**8**	**1**	**1**
2	Overview of industrial practice	2	1	1
3	Importance of internships in career development	1	1	1,2
	UNIT-II Industry Overview	**8**		
4	Understanding different industries and sectors	2	1	1
5	Key players and market dynamics	2	1,2	1,2
6	Ethical standards and professional behavior and Communication and teamwork in a professional setting	2	1,2	1,2
	UNIT- III Application of Theoretical Knowledge	**9**		
7	Applying theoretical knowledge to practical tasks	3	3	1
8	Techniques for effective problem-solving	3	3	2
9	Decision-making processes in industrial settings and Case studies of successful knowledge application in industry	3	3	1,2
	UNIT-IV- Professional Skill Development	**10**		
10	Effective verbal and written communication	3	3,4	1
11	Presentation skills and public speaking	4	3,4	1
12	Working effectively in teams and Roles and responsibilities within a team	3	3,4	2
	UNIT – V Industry Standards and Practices	**10**		
13	Understanding industry-specific standards, Introduction to quality management principles	5	3,4	2
14	Risk management and safety protocols and Occupational health and safety standards	5	3,4	2
Total Contact hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								External (50%)	
				Internal							
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember										
	Understand										
Level 2	Apply				70%						30%
	Analyse										
Level 3	Evaluate				30%						70%
	Create										
Total					100%						100%

Recommended Resources

1. Heizer, J., Render, B., & Munson, C. (2020). Operations Management: Sustainability and Supply Chain Management (12th ed.). Pearson.
2. Stevenson, W. J. (2018). Operations Management (13th ed.). McGraw-Hill Education.
3. Chase, R. B., Jacobs, F. R., & Aquilano, N. J. (2019). Operations and Supply Chain Management (15th ed.). McGraw-Hill Education.

Other Resources

1.

Course Designers

1. Dr. Murali Krishna Enduri, Assistant Professor, Department of Computer Science and engineering, SRM university AP

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Thesis II

Course Code	DSC 512	Course Category	RDIP	L	T	P	C
				0	0	15	15
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	CSE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To widen the understanding of doing research.
2. To facilitate the ideation of a thought.
3. To devise and plan ways to execute an idea.
4. To learn how to avoid plagiarism and publish one's contribution in the research community.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Refine the conceptualized idea from Phase 1	5	75%	70%
Outcome 2	Implement the mathematical model formulated in Phase 1.	5	75%	70%
Outcome 3	Conduct the simulation analysis and extract the results	5	75%	70%
Outcome 4	Validate the results obtained with Literature survey.	5	70%	65%
Outcome 5	Publish and present finding in reputed journals and conferences.	3	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3			2		1	2	3	2	3	2	2	3
Outcome 2	3	2	3	3	1	1	3	3	3	3	2	1	3
Outcome 3	3	3	3	3	3	3	3	3	3	3	3	3	3
Outcome 4					3	3	3			3	2	1	3
Outcome 5	3	1	3	3			3	3	3	3	3	3	3
Average	3	2	3	3	2	2	3	3	3	3	3	2	3

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact hours	CLOs Addressed	References Used
Unit 1	Refinement of Idea	60 hours	1	All
Unit 2	Implement the Mathematical model	50 hours		
	Optimize the mathematical model for the considered problem	15 hours	2	
	Creating timeline for execution of various module of the project.	10 hours	2	
Unit 3	Conduct the simulation analysis and extract the results	50 hours		
	Perform the experimental simulations.		3	
Unit 4	Validate the results obtained with Literature survey	20 hours	4	
Unit 5	Publish and present results and finding	20 hours	5	
Total		**225 hours**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								External (50%)	
				Internal							
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember										
	Understand										
Level 2	Apply				70%						30%
	Analyse										
Level 3	Evaluate				30%						70%
	Create										
Total					**100%**						**100%**

Recommended Resources

1. As recommended by Advisor pertaining to student research interest.
2. https://ieeexplore.ieee.org/Xplore/home.jsp
3. https://www.sciencedirect.com/
4. www.springer.com
5. https://onlinelibrary.wiley.com/
6. Research Methodology

Other Resources

Course Designers

1. Dr. Ashu Abdul, Assistant Professor, CSE, SRM University AP.
2. Dr. Murali Krishna Enduri, Assistant Professor, CSE, SRM University AP.

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Knowledge Engineering and Expert Systems

Course Code	AML552	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE AI ML	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To develop a foundational understanding of Expert Systems.
2. To develop problem-solving skills and effective reasoning using Knowledge Engineering.
3. To learn and apply various Expert Systems.
4. To apply Knowledge Engineering and Expert Systems concepts to solve real-world problems in diverse domains.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify the Knowledge Engineering Approaches	2	70%	65%
Outcome 2	Analyse the Knowledge Engineering Approaches	4	70%	65%
Outcome 3	Identify the Expert Systems Approaches.	2	70%	65%
Outcome 4	Develop various real-time applications using Expert Systems Concepts	5	70%	65%
Outcome 5	Analyse the strengths and limitations of developed expert systems	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)												
	Engineering Knowledge	Design /Development of solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	1	2						3	3	2	1
Outcome 2	3	1	2	2						3	3	2	2
Outcome 3	3	3	2	2						3	3	2	2
Outcome 4	3	3	2	3						3	3	3	2
Outcome 5	**3**	**2**	**2**	**2**						**3**	**3**	**2**	**2**
Average	3	2	1	2						3	3	2	1

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**9**		
	The nature of Expert Systems,	2	1	1, 2
	Types of applications of Expert Systems	2	1	1, 2
	relationship of Expert Systems to Artificial Intelligence and to Knowledge-Based Systems	1	2	1, 2
	. The nature of expertise Distinguishing features of Expert Systems	1	1, 2	1, 2
	Benefits of using an Expert System	2	1, 2	1, 2
	. Choosing an application.	1	1, 2	1, 2
Unit 2		**10**		
	Theoretical Foundations What an expert system is	2	1	1, 2
	how it works and how it is built.	2	1	1, 2
	Basic forms of inference:	2	1	1, 2
	abduction; deduction; induction	4	2, 3	1, 2
Unit 3		**8**		
	The representation and manipulation of knowledge in a computer	1	2	1, 2, 3, 4
	Rule-based representations (with backward and forward reasoning);	1	2, 3	1, 2, 3, 4
	logic-based representations (with resolution refutation	1	2, 3	1, 2, 3, 4
	taxonomies; meronomies	1	2, 3	1, 2, 3, 4
	frames (with inheritance and exceptions)	1	2, 3	1, 2, 3, 4
	semantic and partitioned nets (query handling).	1	3, 4	1, 2, 3, 4
Unit 4		**10**		
	Basic components of an expert system;	1	1, 2	1, 2, 3, 4
	Generation of explanations; Handling of uncertainties;	2	2	1, 2, 3, 4
	Truth Maintenance Systems; Expert System Architectures;	2	3, 4	1, 2, 3, 4
	An analysis of some classic expert systems; Limitations of first generation expert systems	2	2, 3	1, 2, 3, 4
	Deep expert systems	1	3, 4	1, 2, 3, 4
	Co-operating expert systems and the blackboard model.	2	3, 4	1, 2, 3, 4
Unit 5		**8**		
	Building Expert Systems Methodologies for building expert systems:	2	1,2,3	1, 2,5
	knowledge acquisition and elicitation;	2	1,2,3	1,2,5
	formalisation; representation and evaluation. Knowledge Engineering tools,	2	1,2,3	1,2,5
	Case Study.	2	1,2,3,4	1,2,5
Total Theory Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		40%		40%		40%		10%	
	Understand										
Level 2	Apply	40%		40%		40%		40%		50%	
	Analyse										
Level 3	Evaluate	20%		20%		20%		20%		40%	
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. P Jackson (1990) Introduction to Expert Systems, 2nd Edition, Addison Wesley.
2. Elaine Rich, Kevin Knight (1991) Artificial Intelligence, 2nd Edition, McGraw-Hill, Inc.
3. Jackson. Jean-Louis Lauriere (1990) Problem Solving and Artificial Intelligence, Prentice Hall.
4. PROLOG Programming for Artificial Intelligence. Ivan Bratka- Third Edition – Pearson Education.
5. Neural Networks Simon Haykin PHI
6. Artificial Intelligence, 3rd Edition, Patrick Henry Winston., Pearson Edition

Other Resources

Course Designers

1. Dr. Radha Guha, Professor, Computer Science Engineering, SRM University - AP.

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Information Retrieval

Course Code	AML553	Course Category	CE	L	T	P	C
				3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	CSE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To provide an overview of Information Retrieval.
2. To introduce students to insights into several Information retrieval topics such as – The boolean retrieval model, Vector space model, Latent semantic indexing, XML and Image retrieval model.
3. To provide comprehensive details about various Evaluation methods.
4. To provide implementation insight about the topics covered in the course.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Students will be able to understand different Information retrieval models.	2	70%	70%
Outcome 2	Students will be able to design and implement different data structures, such as an index, to allow efficient access to the information in large bodies of text.	3	70%	65%
Outcome 3	Students will be able to understand evaluation methods for different kinds of information retrieval models.	4	70%	70%
Outcome 4	Students will be able to apply, evaluate and analyze classification and clustering techniques in information retrieval.	4	70%	65%
Outcome 5	Students will be able to develop a small-scale IR system from scratch.	5	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)												
	Engineering Knowledge	Design /Development of solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	2	2							2	2	1
Outcome 2	2	3	2	2							2	2	2
Outcome 3	2	2	2	2							2	2	2
Outcome 4	2	2	2	2							2	2	2
Outcome 5	3	3	2	2							2	3	2
Average	2	2	2	2							2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction:**	**11**		
1	Overview of Information Retrieval, Architecture of a Search Engine	2	1,2,5	1,3
2	Crawling the Web, Document Conversion, Storing the Documents, Detecting Duplicates, Noise Detection and Removal	4	1,3,5	1,3
3	Text Statistics, Document Parsing, Tokenizing, Stopping, Stemming, Phrases, Document Structure, Link Extraction, More detail on Page Rank, Feature Extraction and Named Entity Recognition, Internationalization	5	1,3,5	1
Unit 2	**Indexing, Queries and Interfaces**	**9**		
4	Ranking with Indexes Abstract Model of Ranking, Inverted indexes, Map Reduce, Query Processing: Document-at-a-time evaluation, Term-at-a-time evaluation, Optimization techniques, Structured queries, Distributed evaluation, Caching	4	1,3,5	1,2
5	Information Needs and Queries, Query Transformation and Refinement: Stopping and Stemming Revisited, Spell Checking and Query Suggestions, Query Expansion, Relevance Feedback, Context and Personalization. Displaying the Results: Result Pages and Snippets, Advertising and Search, Clustering the Results; Translation; User Behavior Analysis	5	1,3,5	1,2
Unit 3	**Retrieval Models**	**8**		
6	Retrieval Models: Overview of Retrieval Models; Boolean Retrieval, The Vector Space Model	3	1,5	1
7	Probabilistic Models: Information Retrieval as Classification, The BM25 Ranking Algorithm	1	1	1
8	Ranking based on Language Models: Query Likelihood Ranking, Relevance Models and Pseudo-Relevance Feedback	1	1	1
9	Complex Queries and Combining Evidence: The Inference Network Model, The Galago Query Language	1	1	1,2
10	Models for Web search	1	1	1,2,3
11	Machine Learning and Information Retrieval: Learning to Rank (Le ToR), Topic Models	1	1	1
Unit 4	**Evaluation, Clustering, Classification**	**10**		
12	Evaluating Search Engines: Test collections, Query logs, Effectiveness Metrics: Recall and Precision, Averaging and interpolation, focusing on the top documents. Training, Testing, and Statistics: Significance tests, setting parameter values	3	4,5	1,3
13	Classification	4	4	1,3
14	Clustering	3	4	1,3
Unit 5	**Advanced topics**	**7**		
15	Social Search: Networks of People and Search Engines: User tagging, searching within Communities, Filtering and recommending, Meta search	3	1	1,2,3
16	Beyond Bag of Words: Feature-Based Retrieval Models, Term Dependence Models, Question Answering, Pictures, Pictures of	4	1	1,2,3

	Words, etc., XML Retrieval, Dimensionality Reduction and LSI			
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (10%)		**Mid-1 (15%)**		**CLA-2 (10%)**		**Mid-2 (15%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	70%		65%		40%		50%		40%	
	Understand										
Level 2	Apply	30%		35%		40%		50%		60%	
	Analyse										
Level 3	Evaluate					20%					
	Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Prabhakar Raghavan, and Hinrich Schuetze (2007) Introduction to Information Retrieval. Christopher D. Manning, Cambridge University Press.
2. Bruce Croft, Donald Metzler, and Trevor Strohman (2009) Search Engines: Information Retrieval in Practice. Pearson Education.
3. Baeza-Yates Ricardo and BerthierRibeiro-Neto (2011) Modern Information Retrieval. 2nd edition, Addison-Wesley.

Other Resources

1. https://web.stanford.edu/class/cs276/
2. S. Chakrabarti. Morgan-Kaufmann (2002) Mining the Web.

Course Designers

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Artificial Intelligence and Neural Networks

Course Code	AML561	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE AI ML	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To develop a foundational understanding of AI principles and techniques.
2. To develop problem-solving skills and effective reasoning using AI techniques.
3. To learn and apply various neural network techniques in AI systems.
4. Applying AI and neural network concepts to solve real-world problems in diverse domains.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify the Agents and Environments in AI.	1	70%	65%
Outcome 2	Discuss the evaluation functions for optimal decision-making in multiplayer games.	2	70%	65%
Outcome 3	Formalise the propositional and first-order logic and use resolution in problem-solving.	4	70%	65%
Outcome 4	Develop various aspects of feedforward neural networks	5	70%	65%
Outcome 5	Represent competitive learning neural networks and their applications	6	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)												
	Engineering Knowledge	Design /Development of solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	1	2						3	3	2	1
Outcome 2	3	1	2	2						3	3	2	2
Outcome 3	3	3	2	2						3	3	2	2
Outcome 4	3	3	2	3						3	3	3	2
Outcome 5	3	2	2	2						3	3	2	2
Average	3	2	1	2						3	3	2	1

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**9**		
	Introduction: AI problems, foundation of AI and history of AI intelligent agents	2	1	1, 2
	Agents and Environments,	2	1	1, 2
	The concept of rationality,	1	2	1, 2
	The nature of environments,	1	2	1, 2
	Structure of agents,	1	1, 2	1, 2
	Problem solving agents,	1	1, 2	1, 2
	Problem formulation.	1	1, 2	1, 2
Unit 2		**10**		
	Searching: Searching for solutions,	1	1	1, 2
	uniformed search strategies – Breadth first search, depth first Search.	2	1	1, 2
	Search with partial information (Heuristic search)	1	1	1, 2
	Greedy best first search, A* search	1	2, 3	1, 2
	Game Playing: Adversial search, Games,	1	3, 4	1, 2
	minimax algorithm,	1	3, 4	1, 2
	optimal decisions in multiplayer games,	1	3, 4	1, 2
	Alpha-Beta pruning, Evaluation functions, cutting of search.	2	2	1, 2
Unit 3		**8**		
	Knowledge Representation & Reasons logical Agents, Knowledge – Based Agents,	1	2	1, 2, 3, 4
	The Wumpus world, logic, propositional logic,	1	2, 3	1, 2, 3, 4
	Resolution patterns in propositional logic, Resolution,	2	2, 3,5	1, 2, 3, 4
	Forward & Backward Chaining.	1	2, 3	1, 2, 3, 4
	First order logic. Inference in first order logic,	1	2, 3	1, 2, 3, 4
	Propositional Vs. first order inference,	1	3, 4	1, 2, 3, 4
	unification & lifts forward chaining, Backward chaining, Resolution.	1	3, 4	1, 2, 3, 4
Unit 4		**10**		
	Characteristics of Neural Networks, Historical Development of Neural Networks Principles,	1	1, 2	1, 2, 3, 4
	Artificial Neural Networks: Terminology, Models of Neuron, Topology,	2	2	1, 2, 3, 4
	Basic Learning Laws, Pattern Recognition Problem, Basic Functional Units, Pattern Recognition Tasks by the Functional Units.	2	3, 4	1, 2, 3, 4
	Feed forward Neural Networks: Introduction, Analysis of pattern Association Networks,	2	2, 3	1, 2, 3, 4
	Analysis of Pattern Classification Networks,	1	3, 4	1, 2, 3, 4
	Analysis of pattern storage Networks; Analysis of Pattern Mapping Networks.	2	3, 4	1, 2, 3, 4
Unit 5		**8**		
	Feedback Neural Networks: Introduction,	1	1,2,3	1, 2,5
	Analysis of Linear Auto associative FF Networks, Analysis of Pattern Storage Networks.	2	1,2,3	1,2,5
	Competitive Learning Neural Networks & Complex pattern Recognition: Introduction,	1	1,2,3	1,2,5
	Analysis of Pattern Clustering Networks,	1	1,2,3,4	1,2,5

	Analysis of Feature Mapping Networks	1	1,2,3,4	1,2,5
	Associative Memory	2	1,2,3,4	1,2,5
Total Theory Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (10%)		**Mid-1 (15%)**		**CLA-2 (10%)**		**CLA-3 (15%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	40%		40%		40%		40%		10%	
	Understand										
Level 2	Apply	40%		40%		40%		40%		50%	
	Analyse										
Level 3	Evaluate	20%		20%		20%		20%		40%	
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Stuart Russel, Peter Norvig, Artificial Intelligence – A Modern Approach. Second Edition, PHI/ Pearson Education.
2. B. Yagna Narayana,Artificial Neural Networks PHI
3. E.Rich and K.Knight Artificial Intelligence, 2nd Edition, (TMH).
4. Patterson, Artificial Intelligence and Expert Systems –PHI.
5. Giarrantana/ Riley, Thomson, Expert Systems: Principles and Programming- Fourth Edn,.

Other Resources

1. Ivan Bratka, PROLOG Programming for Artificial Intelligence. Third Edition – Pearson Education.
2. Simon Haykin, Neural Networks, PHI
3. Patrick Henry Winston., Artificial Intelligence, 3rd Edition, Pearson Edition

Course Designers

1. Dr. Radha Guha, Professor, Computer Science Engineering, SRM University - AP.

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Soft Computing

Course Code	AML 567	Course Category	CE	L	T	P	C
				3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	CSE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the fundamental theory and concepts of neural networks, Identify different neural network architectures, algorithms, applications and their limitations.
2. Understand appropriate learning rules for each of the architectures and learn several neural network paradigms and its applications.
3. Comprehend the fuzzy logic and the concept of fuzziness involved in various systems and fuzzy set theory.
4. Understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic.
5. Understand the Genetic Algorithm and able to identify the application area.
6. Understand soft computing techniques and their role in problem solving. Reveal different applications of these models to solve engineering and other problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate the Soft Computing and Artificial Neural Networks model	3	90%	75%
Outcome 2	Describe the evolutionary computation concepts and paradigms	2	70%	65%
Outcome 3	Apply the Neural Network Concepts and Paradigms	3	80%	75%
Outcome 4	Apply the Fuzzy Systems concepts and paradigms	3	80%	75%
Outcome 5	Design solutions using genetic algorithms and compare them with traditional approaches to a given problem.	5	65%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)												
	POs										PSOs		
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2							2		
Outcome 2	3	2	3	3							2		
Outcome 3	3	3	3	3							2		
Outcome 4	3	2	2	2							3		
Outcome 5	3	2	3	2							3		
Average	3	2	3	3							2		

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	**Introduction to Soft Computing, ANN**	**9**		
	What is computational intelligence?- Biological basis for neural networks- Biological versus Artificial neural networks	1	1	1
	Biological basis for evolutionary computation	1	1,2	1
	Behavioral motivations for fuzzy logic	1	1	1,3
	Myths about computational intelligence- Computational intelligence application areas	1	2	1,3
	Evolutionary computation	1	1	1
	computational intelligence-Adoption, Types, self-organisation and evolution	1	1,2	1
	Historical views of computational intelligence	1	1,2	1
	Computational intelligence and Soft computing versus Artificial intelligence.	1	1,2	1
	Hard computing	1	2,5	1
Unit II	Evolutionary computation concepts and paradigms	**9**		
	History of Evolutionary Computation & overview	1	2	1,3
	Genetic algorithms, Evolutionary programming & strategies	1	2	1,3
	Genetic programming	1	2	1,3
	Particle swarm optimisation	1	2	1,3
	Evolutionary computation implementations-Implementation issues	1	2	1,3
	Genetic algorithm implementation	2	2	1,3
	Particle swarm optimisation implementation.	2	2,5	1,3
Unit III	Neural Network Concepts and Paradigms	**9**		
	What are Neural Networks? Why they are useful	1	3	2
	Neural network components and terminology- Topologies	1	3	2
	Adaptation, Comparing neural networks	1	3	2
	other information Processing methods	1	3	2,3
	Stochastic- Kalman filters	1	3	2,3
	Linear and Nonlinear regression - Correlation	1	3	2,3
	Bayes classification	1	3,5	2,3
	Vector quantisation	1	3	2,3
	Radial basis functions -Preprocessing - Post-processing.	1	3,5	2,3
Unit IV	Fuzzy Systems concepts and paradigms	**9**		
	Fuzzy sets and Fuzzy logic	2	4	3,4
	Approximate reasoning	2	4	3
	Developing a fuzzy controller	2	4	3
	Fuzzy rule system implementation	3	4	3
Unit V	Performance Metrics	**9**		
	General issues	1	4	2,3
	Partitioning the patterns for training, testing, and validation- Cross-validation	2	2	1,3
	Fitness and fitness functions - Parametric and nonparametric statistics	1	3,4	2,3
	Evolutionary algorithm effectiveness metrics	1	1,4	2,3
	Receiver operating characteristic curves	1	4,5	2,3
	Computational intelligence tools for explanation facilities	1	3,4	2,3
	Case Studies for implementation of practical applications in computational intelligence	2	5	3
	Total contact hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (15%)	Mid-1 (15%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember	30%	30%	30%	30%	30%
	Understand					
Level 2	Apply	40%	40%	40%	40%	40%
	Analyse					
Level 3	Evaluate	30%	30%	30%	30%	30%
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Russell C. Eberhart and Yuhui Shi (2007) Computational Intelligence: concepts to implementations. Morgan Kaufmann Publishers is an imprint of Elsevier.
2. Andries P. Engelbrecht (2007) Computational Intelligence: An Introduction, Second Edition. Wiley.
3. John Fulcher and Lakshmi C. Jain (2007) Computational Intelligence: A compendium, Springer.
4. David B. Fogel and Charles J. Robinson (2003) Computational Intelligence: The experts speak. Wiley – Interscience..

Other Resources

Course Designers

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