Department of Computer Science Engineering

M.Tech. Artificial Intelligence and Machine Learning
Curriculum and Syllabus

(Applicable to the students admitted during AY: 2022-23)

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. Promote design, research, product implementation and services in Artificial Intelligence Engineering through strong technical, communication and entrepreneurial skills.
2. Engage to work productively as design and development Engineers, catering to supportive and leadership roles in multidisciplinary domains.
3. Possess the skills in AI & ML expertise ready to provide solutions to society's problems locally and globally.
4. Engage in active research for professional development in the field of Artificial Intelligence

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

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

Program Specific Outcomes (PSO)

1. Apply, analyze, design and develop efficient and effective mathematical and statistical models and applications in Artificial Intelligence and Machine Learning
2. Demonstrate problem solving skills and programming skills to provide innovative solutions to real time industry problems
3. Develop research skills, entrepreneurial skills and leadership skills to solve social problems and maintain ethical values.

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
PEO 4	3	3	3	3	3	2	3	2	3	3	3	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)		0	0
University VAC	0		
School VAC	0		
Skill Enhancement Courses (SEC)		0	0
School SEC	0		
Department SEC	0		
SEC Elective	0		
Foundation / Interdisciplinary courses (FIC)		0	0
School FIC	0		
Department FIC	0		
Core + Core Elective including Specialization (CC)		38	1140
Core	32		
Core Elective (Inc Specialization)	6		
Minor (MC) + Open Elective (OE)	0	0	0
Research / Design / Internship/ Project (RDIP)		26	780
Internship / Design Project / Startup / NGO	2		
Internship / Research / Thesis	24		
Total		**65**	**1950**

Semester wise Course Credit Distribution Under Various Categories						
Category	**Semester**					
	I	**II**	**III**	**IV**	**Total**	**%**
Ability Enhancement Courses - AEC	1	0	0	0	1	**2**
Value Added Courses - VAC	0	0	0	0	0	**0**
Skill Enhancement Courses - SEC	0	0	0	0	0	**0**
Foundation / Interdisciplinary Courses - FIC	0	0	0	0	0	**0**
CC / SE / CE / TE / DE / HSS	19	19	0	0	38	**58**
Minor / Open Elective - OE	0	0	0	0	0	**0**
(Research / Design / Industrial Practice / Project / Thesis / Internship) - RDIP	0	2	10	14	26	**40**
Grand Total	**20**	**21**	**10**	**14**	**65**	**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	Core	CC	MAT560	Mathematical Foundations for Machine Learning	3	0	0	3
2	Core	CC	AML500	Advanced Algorithms and Analysis	3	0	0	3
3	Core	CC	AML501	Machine Learning Techniques	3	0	0	3
4	Core	CC	AML501L	Machine Learning Techniques Lab	0	0	2	2
5	Core	CC	AML502	Artificial Intelligence and Knowledge Representation	3	0	0	3
6	Core	CC	AML502L	Artificial Intelligence and Knowledge Representation Lab	0	0	2	2
7	AEC	HSS	EGL501	English for Research Paper Writing	1	0	0	1
8	Elective	CE	AML558	Computer Vision	3	0	0	3
				Semester Total	**16**	**0**	**4**	**20**

SEMESTER - II								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Core	CC	AML508	Soft Computing	3	0	0	3
2	Core	CC	AML504	Data Warehousing and Pattern Mining	3	0	0	3
3	Core	CC	AML504L	Data Warehousing and Pattern Mining Lab	0	0	2	2
4	Core	CC	AML505	Deep Learning Techniques	3	0	0	3
5	Core	CC	AML505L	Deep Learning Techniques Lab	0	0	2	2
6	Core	CC	AML506	Natural Language Computing	3	0	0	3
7	Elective	CE	AML553	Information Retrieval	3	0	0	3
8	RDIP	RDIP	RM101	Research Methodology and IPR	2	0	0	2
				Semester Total	**17**	**0**	**4**	**21**

SEMESTER - III								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	RDIP	RDIP	AML580	Project Work-Phase - I	0	0	10	10
				Semester Total	**0**	**0**	**10**	**10**

SEMESTER - IV								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	RDIP	RDIP	AML581	Project Work-Phase - II	0	0	14	14
				Semester Total	**0**	**0**	**14**	**14**

List of Core Electives								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE	AML551	Modelling and Simulation of Digital Systems	3	0	0	3
2	Elective	CE	AML552	Knowledge Engineering and Expert Systems	3	0	0	3
3	Elective	CE	AML553	Information Retrieval	3	0	0	3
4	Elective	CE	AML554	Pattern Recognition	3	0	0	3
5	Elective	CE	AML555	Problem Solving Methods in Artificial Intelligence	3	0	0	3
6	Elective	CE	AML556	Cognitive Systems	3	0	0	3
7	Elective	CE	AML557	Introduction to High Performance Computing	3	0	0	3
8	Elective	CE	AML558	Computer Vision	3	0	0	3
9	Elective	CE	AML559	Number theory and Cryptography	3	0	0	3
10	Elective	CE	AML560	Agent Systems	3	0	0	3
11	Elective	CE	AML561	Artificial Intelligence and Neural Networks	3	0	0	3
12	Elective	CE	AML562	Statistical Modelling for Computer Sciences	3	0	0	3
13	Elective	CE	AML563	Fuzzy Logic and its Applications	3	0	0	3
14	Elective	CE	AML564	Electronic Design Automation	3	0	0	3

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Mathematical Foundations for Machine Learning

Course Code	MAT 560	**Course Category**	Core	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Mathematical foundations for Machine learning	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce the key mathematical concepts at the heart of machine learning.
2. Focuses on matrix methods and statistical models and features real-world applications ranging from classification and clustering
3. Apply mathematical topics covered, including linear equations, matrix rank, subspaces and others to Machine learning, particularly regression, classification and clustering.
4. Gain a deep understanding of the concepts, techniques and mathematical frameworks used by experts in machine learning.

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	Apply the tools of probability to solve problems such as the average case analysis of algorithms or analyzing hashing.	2	70%	60%
Outcome 2	Understand functions of one random variable and functions of multiple random variables with all relevant parameters.	1	70%	65%
Outcome 3	Understand the concepts of Vector space and inner-product spaces.	2	80%	70%
Outcome 4	Understand the concept of dimension reduction and analyse PCA.	4	85%	75%
Outcome 5	Apply predictive analytics on version regression techniques	3	70%	60%

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

	Program Learning Outcomes (PLO)												
CLOs	**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	1	1								3	1	2	2
Outcome 2	1	1								3	3	2	2
Outcome 3	2	2								3	3	3	2
Outcome 4	1	2	2	3						3	3	3	3
Outcome 5	1	2	2	3						3	3	3	3
Average	**1**	**2**	**2**	**3**						**3**	**3**	**3**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	**Probability**	**8**		
1	Classical, relative frequency	1	1	1
2	Axiomaticdefinitionsofprobability	1	1	1
3	Additionruleandconditionalprobability	2	1	1
4	Multiplication rule	1	1	1
5	Total Probability	1	1	1
6	Bayes'Theorem, and independence	2	1	1
Unit II	**Random variables**	**12**		
7	Discrete, continuous random variables	2	2	1
8	Mixedrandomvariables	1	2	1
9	Probability mass function	1.5	2	1
10	Probability density function	1.5	2	1
11	Cumulative distribution functions	1	2	1
12	Mathematical expectation	2	2	1
13	Moments, Moment generating function	2	2	1
14	Chebyshev'sinequality	1	2	1
Unit III	**Stochastics process**	**6**		
15	Introduction to Stochastic Processes (SPs)	1	2	2, 3
16	Stationary Processes	1	2	2,3
17	Discrete-time Markov Chains (DTMCs)	2	2	2, 3
18	Continuous-time Markov Chains (CTMCs)	2	2	2, 3
Unit IV	**Linear algebra**	**10**		
19	Finite-dimensional vector spaces over a field	2	3,5	4
20	Linear combination, Linear dependence and independence	2	3,4	4,5
21	Basis and dimension	1	3	4
22	Inner-product spaces	1	3,4	4
23	Linear transformations	2	3	4,5
24	Matrix representation of linear transformations	2	3,4	4
Unit V	**Linear algebra**	**9**		
25	Eigenvalues and eigenvectors	3	3,4	4,5
26	Rank and nullity	2	3,4	4,5
27	Inverse and linear transformation	3	3,4	4,5
28	Cayley-Hamilton Theorem	1	3,4	4,5
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)					End Semester Exam (40%)
		Theory (30%)				Practical (0%)	
		CLA-1 (156%)	Mid-1 (20%)	CLA-2 (15%)	CLA -3 (10%)		Th
Level 1	Remember	50%	70%	50%	40%	-	30%
	Understand						
Level 2	Apply	50%	30%	50%	60%	-	70%
	Analyse						
Level 3	Evaluate					-	-
	Create						
Total		100%	100%	100%	100%	-	100%

Recommended Resources

1. Sheldon Ross (2006) AFirstCourseinProbability,7thEdition,Pearson.
2. J.Medhi (2009) StochasticProcesses, 3rdEdition, NewAgeInternational..
3. S.M.Ross (1996) Stochastic Processes, 2ndEdition,Wiley.
4. Stephen H Friedberg, Arnold J Insel, Lawrence E. Spence (2006) Linear Algebra. 4th Edition,Pearson.
5. Kenneth MHoffman, RayKunz, LinearAlgebra, 2ndEdition, Pearson.

Other Resources

Course Designers

1. Dr. Damodar Reddy, Department of Mathematics, SRM University-AP

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Advanced Algorithms and Analysis

Course Code	AML500	**Course Category**	Core	**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 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.	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	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

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**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 (15%)	Mid1 (15%)	CLA-2 (10%)	CLA-3(15%)	
Level 1	Remember	70%	60%	50%	40%	40%
	Understand					
Level 2	Apply	30%	40%	50%	50%	60%
	Analyse					
Level 3	Evaluate	-	-	-	-	-
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. 1.Text Book: Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest and Clifford Stein, (2009) Introduction to Algorithms, Third Edition, The MIT , Press.
2. 2. Michael T Goodrich and Roberto Tamassia (2005) Competitive Analysis, Cambridge University Press.
3. 3. John Wiley and Sons (2002) Algorithm Design: Foundations, Analysis and Internet Examples
4. 3.SanjoyDasgupta, Christos Papadimitriou and UmeshVazirani (2009) Algorithms, Tata McGraw-Hill.
5. 4.RK Ahuja, TL Magnanti and JB Orlin (1993) Network flows: Theory, Algorithms, and Applications, Prentice Hall Englewood Cliffs.
6. 5.Rajeev Motwani, Prabhakar Raghavan (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	AML501	**Course Category**	Core	**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. Introduce Machine Learning and various tasks involved in the principle 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	Analuse the techniques to deal with data and its dimensions.	3	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)

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	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

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**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**				**End Semester Exam (50%)**
		CLA-1 (10%)	**Mid-1 (20%)**	**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. Tom Mitchell (1997) Machine Learning. First Edition, McGraw- Hill.
2. Alpaydin, Ethem (2020) Introduction to machine learning. MIT press.
3. Kevin P. Murphy (2012) Machine Learning: A Probabilistic Perspective, MIT Press.
4. Christopher Bishop (2007) Pattern Recognition and Machine Learning, Springer.

Other Resources

Course Designers

1. Dr.Jatindra Kumar Dash, Associate Professor, Computer Science and Engineering, SRM University – AP.

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Machine Learning Techniques Lab

Course Code	AML501L	**Course Category**	Core	**L**	**T**	**P**	**C**
				0	0	2	2
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 tasks involved in the pipeline of machine learning application development.
2. Understand a wide variety of regression, classification and clustering algorithms.
3. Apply these 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 be 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	Expertise to use the packages NumPy, Pandas and matplotlib	2	75%	75%
Outcome 2	Able to analyse the data and predictions using statistical techniques	2	75%	70%
Outcome 3	Develop classification models for the prediction of class label	2	70%	65%
Outcome 4	Develop perceptron-based classification models for classification	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	2	3							2		
Outcome 2	3	3	3	3						1	2		
Outcome 3	3	3	3	3						1	2		
Outcome 4	3	2	2	2						1	3		
Average	**3**	**2**	**3**	**3**				**2**		**1**	**2**		

Course 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		Lab Performance (60%)	Viva (40%)
Level 1	Remember	30%	30%
	Understand		
Level 2	Apply	40%	40%
	Analyse		
Level 3	Evaluate	30%	30%
	Create		
Total		100%	100%

Recommended Resources

1. Tom Mitchell (1997) Machine Learning. First Edition, McGraw- Hill.
2. Alpaydin, Ethem (2020) Introduction to machine learning. MIT press.
3. Kevin P. Murphy (2012) Machine Learning: A Probabilistic Perspective, MIT Press.
4. Christopher Bishop (2007) Pattern Recognition and Machine Learning, Springer.

Other Resources

Course Designers

1. Dr.Jatindra Kumar Dash, Associate Professor, Computer Science and Engineering, SRM University – AP.

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Artificial Intelligence and Knowledge Representation

Course Code	AML502	**Course Category**	Core	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Computer Science Engineering 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 knowledge representation techniques in AI systems.
4. To apply AI and knowledge representation 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 Intelligent systems and Approaches.	1	70%	65%
Outcome 2	Discuss the building blocks of AI as presented in terms of intelligent agents.	2	70%	65%
Outcome 3	Formalize the problem as a state space, graph, design heuristics and select amongst search or game-based techniques to solve them.	3	70%	65%
Outcome 4	Develop intelligent algorithms for constraint satisfaction problems and intelligent systems for Game Playing.	4	70%	65%
Outcome 5	Represent logic-based and reinforcement learning techniques to infer and plan given problems.	3	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	3	2	3						3	3	3	2
Average	**3**	**2**	**2**	**2**						**3**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**8**		
	AI problems	1	1	1, 2
	foundation of AI and history of AI intelligent agents	1	1	1, 2
	Agents and Environments.	1	2	1,2
	The concept of rationality	1	2	1, 2
	The nature of environments	1	5	1, 2
	Problem-solving agents	2	1,2	1
	Problem formulation	1	1, 2	1, 2
Unit 2	**Searching**	**10**		
	Searching for solutions	1	1	1, 2
	Uninformed search strategies – Breadth-first search, depth-first Search	2	1	1, 2
	Search with partial information (Heuristic search) Greedy best-first search	2	1	1, 2
	A* search	1	1	1, 2
	Game Playing: Adversial search	1	2, 3	1, 2
	Games, minimax, algorithm	1	1	1, 2
	optimal decisions in multiplayer games	1	3, 4	1, 2
	Alpha-Beta pruning, Evaluation functions, cutting of search	1	3, 4	1, 2
Unit 3	Knowledge Representation	**9**		
	Using Predicate logic	1	2	1, 2, 3, 4
	representing facts in logic, functions and predicates	1	1	1, 2
	Conversion to clause form	1	2, 3	1, 2, 3, 4
	Resolution in propositional logic, Resolution in predicate logic	1	2, 3	1, 2, 3, 4
	Unification	1	1	1, 2
	Representing Knowledge Using Rules**:**	1	2, 3	1, 2, 3, 4
	Procedural Versus Declarative knowledge	1	2, 3	1, 2, 3, 4
	Logic Programming,	1	1	1, 2
	Forward versus Backward Reasoning	1	3, 4	1, 2, 3, 4
Unit 4	**Learning**	**10**		
	What is learning, Rote learning, Learning by Taking Advice	1	1, 2	1, 2, 3, 4
	Learning in Problem-solving	1	1,2	1, 2,3
	Learning from example: induction	1	2	1, 2, 3, 4
	Explanation-based learning	1	3, 4	1, 2, 3, 4
	Connectionist Models: Hopfield Networks	1	2, 3	1, 2, 3, 4
	Learning in Neural Networks	1	3, 4	1, 2, 3, 4
	Applications of Neural Networks	1	1,2	1, 2,3
	Recurrent Networks	2	3, 4	1, 2, 3, 4
	Connectionist AI and Symbolic AI	1	5	1, 2, 3, 4
Unit 5	Expert System	**8**		
	Representing and using Domain Knowledge	1	1,2,3	1, 2
	Reasoning with knowledge	2	2,3	1, 2, 3, 4
	Expert System Shells	2	2,3	1, 2, 3, 4
	Support for explanation examples	1	1,2,3,4	1, 2, 3, 4
	Knowledge acquisition-examples	2	1,2,3,4	1, 2, 3, 4
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%)	
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. Stuart Russel, Peter Norvig, Artificial Intelligence – A Modern Approach. Second Edition, PHI/ Pearson Education.
2. Kevin Knight, Elaine Rich, B. Shivashankar Nair (2008) Artificial Intelligence, 3rd Edition,
3. B. Yagna Narayana, Artificial Neural Networks, PHI.
4. E.Rich and K.Knight, Artificial Intelligence, 2nd Edition, (TMH).

Other Resources

1. https://onlinecourses.nptel.ac.in/noc20_cs42/preview
2. Artificial Intelligence and Expert Systems – Patterson PHI.
3. Giarrantana/ Riley, Expert Systems: Principles and Programming- Fourth Edn, Thomson.
4. Ivan Bratka, PROLOG Programming for Artificial Intelligence. Third Edition – Pearson Education.
5. Simon Haykin, Neural Networks PHI.
6. Patrick Henry Winston., Artificial Intelligence, 3rd Edition, Pearson Edition

Course Designers

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

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Artificial Intelligence and Knowledge Representation Lab

Course Code	AML502L	**Course Category**	Core	**L**	**T**	**P**	**C**
				0	0	2	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Computer Science Engineering 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 knowledge representation techniques in AI systems.
4. To apply AI and knowledge representation 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 requirements of the problem statement	2	70%	65%
Outcome 2	Apply the knowledge to generate an algorithm	3	70%	65%
Outcome 3	Formalise the problem as a state space, graph, design heuristics and select amongst search or game-based techniques to solve them.	3	70%	65%
Outcome 4	Develop intelligent algorithms for constraint satisfaction problems and intelligent systems for Game Playing.	4	70%	65%
Outcome 5	Represent logic-based and reinforcement learning techniques to infer and plan the given problems.	3	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	3	2	3						3	3	3	2
Average	**3**	**2**	**2**	**2**						**3**	**3**	**2**	**2**

Course Unitization Plan

Exp No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
1	FAMILY TREE	**4**	1,2,3	2
2	FACTORIAL, FIBONACCI SERIES AND PRIME NUMBER CHECKING	4	1,2,3	1
3	LISTS	4	1,2,3	3
4	EIGHT QUEENS PROBLEM	6	1,2,3,4,5	4
5	TOWER OF HANOI	4	1,2,3,4,5	5
6	MEDICAL DIAGNOSIS EXPERT SYSTEM DESIGN	8	4	6
Total Theory Contact Hours		**30**		

Learning Assessment

Question Difficulty	Bloom's Level of Cognitive Task	Continuous Learning Assessments (50%)		End Semester Exam (50%)
		Lab Performance and Viva (40%)	Record / Observation Note (10%)	
Level 1	Remember	50%	40%	50%
	Understand			
Level 2	Apply	50%	60%	50%
	Analyse			
Level 3	Evaluate			
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Stuart Russel, Peter Norvig, Artificial Intelligence – A Modern Approach. Second Edition, PHI/ Pearson Education.
2. Kevin Knight, Elaine Rich, B. Shivashankar Nair (2008) Artificial Intelligence, 3rd Edition.
3. B. Yagna Narayana, Artificial Neural Networks, PHI.
4. E.Rich and K.Knight, Artificial Intelligence, 2nd Edition, (TMH).Artificial Intelligence and Expert Systems – Patterson PHI.
5. Giarrantana/ Riley, Expert Systems: Principles and Programming- Fourth Edn, Thomson.

Other Resources

1. https://onlinecourses.nptel.ac.in/noc20_cs42/preview

Course Designers

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English for Research Paper Writing

Course Code	EGL501	**Course Category**	HSS	**L**	**T**	**P**	**C**
				1	0	0	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	English	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the Structure of a Research Paper
2. Familiarize students with the different types of research & methodologies.
3. Develop fundamental proofreading skills to identify and correct common grammatical errors.
4. Guide students in creating clear thesis statements and research questions to shape their papers.

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 and recall the key components of a research paper, including abstracts, introductions, methods, results, discussions, and conclusions.	1,2	75%	75%
Outcome 2	Interpret the structure and organisation of research papers, recognising each section's role in conveying information.	2	75%	75%
Outcome 3	Analyse the effectiveness of thesis statements and research questions in guiding the development of a research paper.	3	75%	75%
Outcome 4	Generate clear and concise sentences, paragraphs, and sections that conform to academic writing standards.	3	75%	75%

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			1	1			3	3	3	3			
Outcome 2			1	1			3	3	3	3			
Outcome 3			1	1			3	3	3	3			
Outcome 4			1	1			3	3	3	3			
Average			1	1			3	3	3	3			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Planning & Preparation**	**3**		
	What is research & the need for research	1	1,2	1,2
	Planning a manuscript	2	1,2	1,2
			1	1,2
Unit 2	**The Key to Good Writing**	**3**		
	Structuring a paragraph	2	1,2	1,2
	Sequencing a paragraph	1	1,2	1,2
Unit 3	**Being Concise**	**3**	1,2	1,2
	The steps to being concise	2	1,2	1,2
	Redundancy Vs Conciseness	1	1,2	1,2
Unit 4	**The Basic Components**	**3**		
	Abstract & Introduction	2	3	1,2
	Basic Formats	1	1,2	1,2
			1,3	1,2
Unit 5	**Practical Implementation**	**3**		
	Presentation of a paper	3	1,2,3,4	1,2
Total Contact Hours		**15**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		CLA -2 (10%)		CLA-3 (15%)		Mid-1 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	30%		20%		30%		50%		50%	
	Understand										
Level 2	Apply	70%		80%		70%		50%		50%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Wallwork Adrian. (2016). English for Writing Research Papers. New York: Springer.
2. Dudley Evans, T. (1998). Developments in English for Specific Purposes: A multidisciplinary approach. U.K: Cambridge University Press
3. Other Resources
4. Hutchinson, T., & Waters, A. (1987). English for Specific Purposes: A learner-centered approach. U.K: Cambridge University Press
5. Raman, Meenakshi, and Sangeetha Sharma. (2008). Technical Communication: English Skills for Engineers. New Delhi: Oxford University Press
6. Trimble, Louis. English for Science and Technology - A Discourse Approach. (1985). Cambridge: Cambridge University Press
7. Williams, Phil. Advanced Writing Skills for Students of English. (2018). Brighton: Rumian Publishing.
8. Wilson, Paige and Teresa Ferster Glazier. (2013). The Least You Should Know About English: Writing Skills, Form C (11th Edition). Boston: Cengage Learning.

Other Resources

Course Designers

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Computer Vision

Course Code	AML558	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	Computer Science Engineering AI ML	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Introduces Computer vision elements, including image, graphics, sound, and video components.
2. To learn the fundamentals of computer vision and a real environment.
3. To gain knowledge over accessing and modification of multimedia content in a real-world scenario

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 what Computer Vision is and the skill sets needed to be a Computer Vision professional.	3	70%	65%
Outcome 2	Apply basic tools (plots, graphs, summary statistics) to perform Computer Vision tasks.	3	70%	65%
Outcome 3	Describe the Computer Vision Process and how it works.	3	70%	65%
Outcome 4	Apply Computer Vision in different case studies.	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	**UNIT I: Introduction**	**9**		
	Digital Image Formation and low-level processing:	1	1	1, 2
	Overview and State-of-the-art Fundamentals of Image Formation,	1	1	1
	Transformation: Orthogonal, Euclidean, Affine, Projective, etc;	1	1	1, 2
	Fourier Transform, Convolution and Filtering,	2	1	1, 2
	Image Enhancement, Restoration, Histogram Processing	3	1	1, 2
	introduction to computer vision.	1	1	1, 2
Unit 2	**Feature**	**9**		
	Feature Extraction: Shape, histogram, color, spectral, texture	2	1,2	1
	Feature analysis, feature vectors, distance /similarity measures, data preprocessing	1	1,2	1
	Edges - Canny, LOG, DOG;	2	1,2	1
	Scale-Space Analysis- Image Pyramids and Gaussian derivative filters	2	1,2	1,2
	Gabor Filters and DWT; Line detectors (Hough Transform), Orientation Histogram	1	1,2	1,2
	SIFT, SURF, GLOH, Corners - Harris and Hessian Affine.	1	1,2	1,2
Unit 3	**3D modelling**	**9**		
	Depth estimation and Multi-camera views: Perspective	1	2	1,2
	Homography, Rectification, DLT, RANSAC,	2	2	1,2
	3-D reconstruction framework; Binocular Stereopsis:	2	2	1,2
	Camera and Epipolar Geometry; Auto-calibration.	1	2	1,2
	Image Segmentation: Region Growing, Edge Based approaches to segmentation,	1	2	1,2
	Graph-Cut, Mean-Shift, MRFs, Texture Segmentation, Object detection.	2	2	1,2
Unit 4	**3D transformation**	**9**		
	Motion Analysis: Optical Flow	2	3	1,2
	KLT, Spatio-Temporal Analysis	3	3	1,2
	Background Subtraction and Modeling,	2	3	1,2
	Dynamic Stereo; Motion parameter estimation	2	3	1,2
Unit 5	**Different Applications**	**9**		
	Shape from X: Light at Surfaces	3	4	2
	Use of Use of Surface Smoothness Constraint	1	4	2
	Shape from Texture, color, motion and edges Albedo estimation	3	4	2
	Photometric Stereo; Phong Model; Reflectance Map.	2	4	2
	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. Richard Szeliski (2011)Computer Vision: Algorithms and Applications, Springer-Verlag London Limited..
2. Richard Hartley and Andrew Zisserman (2004) Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press.

Other Resources

1. D. A. Forsyth, J. Ponce (2003)Computer Vision: A Modern Approach, Pearson Education,.
2. R.C. Gonzalez and R.E. Woods (1992) Digital Image Processing, Addison- Wesley..
3. K. Fukunaga (1990) Introduction to Statistical Pattern Recognition, Second Edition, Academic Press.

Course Designers

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Soft Computing

Course Code	AML508	Course Category	Core	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)

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	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		
Course Average	3	2	3	3							2		

Course Unitization Plan

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 - Intersciece.

Other Resources

Course Designers

1. Dr.Jatindra Kumar Dash, Associate Professor, Computer Science and Engineering, SRM University – AP.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Data Warehousing and Pattern Mining

Course Code	AML504	**Course Category**	Core	**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 introduce the basic concepts of Data Warehouse and Data Mining techniques.
2. Examine the types of data to be mined and apply pre-processing methods to raw data.
3. Discover interesting patterns, analyse 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 visualisation 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 visualisation 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)

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	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
Outcome 5	2	2	3	3									3
Average	**1**	**2**		**1**									**1**

Course Unitization Plan

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		

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%)	CLA-3 (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 Han and M Kamber (2011) Data Mining Concepts and Techniques, Second Edition, Elsevier Publication.
2. Vipin Kumar,Pang-Ning Tan, Michael Steinbach (2006) Introduction to Data Mining , Addison Wesley.
3. G Dong and J Pei (2007) Sequence Data Mining, Springer.
4. Ralph Kimball, Margy Ross (2013) The Data Warehouse Toolkit, 3rd edition, Publisher: Wiley.
5. Jake VanderPlas (2016) Python Data Science Handbook: Essential Tools for Working with Data Paperback
6. Kevin P. Murphy (2013) Machine Learning: A Probabilistic Perspective..
7. Avrim Blum, John Hopcroft and Ravindran Kannan. Foundations of Data Science.

Other Resources

Course Designers

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

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Data Warehousing and Pattern Mining Lab

Course Code	AML504L	**Course Category**	Core	**L**	**T**	**P**	**C**
				0	0	2	2
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 introduce the basic concepts of Data Warehouse and Data Mining techniques.
2. Examine the types of data to be mined and apply pre-processing methods to 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 visualisation tools.

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 and represent knowledge using Visualization tools.	4	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	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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		**9**		
	Lab Experiment 1: Basic exercises on Python Packages such as Numpy, Pandas and matplotlib.	5	1	1,2
	Lab Experiment 2: Given a dataset. Write a program to compute the Mean, Median, Mode, Standard deviation, Covariance, Correlation between a pair of attributes.	4	3	5
Unit 2		9		
	Lab Experiment 3: Write a query to implementation OLAP operations in a data cube.	3	2	3,4
	Lab Experiment 4: Write a program to implement data pre-processing techniques.	3	2	6
	Lab Experiment 5: 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.	3	2	6
Unit 3		9		
	Lab Experiment 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.	3	3	6
	Lab Experiment 7: Write a program to demonstrate the working of APRIORI algorithm. Use an appropriate data set to generate frequent patterns.	2	3	6
	Lab Experiment 8: Write a program to demonstrate the working of stream mining algorithm. Use an appropriate data set to generate frequent patterns.	2	3	6
	Lab Experiment 9: 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	6
Unit 4		9		
	Lab Experiment 10: Write a program to demonstrate web page layout structure, web link structure.	5	4	7
	Lab Experiment 11: Write a program to demonstrate time series and sequence pattern mining considering a suitable dataset.	4	4	7
Unit 5		9		
	Lab Experiment 12: Write a program based on applications of data mining?	9	4	5
	Total	45		

Learning Assessment Lab

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. Jiawei Han and M Kamber (2011) Data Mining Concepts and Techniques, Second Edition, Elsevier Publication.
2. Vipin Kumar,Pang-Ning Tan, Michael Steinbach (2006) Introduction to Data Mining , Addison Wesley.
3. G Dong and J Pei (2007) Sequence Data Mining, Springer.
4. Ralph Kimball, Margy Ross (2013) The Data Warehouse Toolkit, 3rd edition, Publisher: Wiley.
5. Jake VanderPlas (2016) Python Data Science Handbook: Essential Tools for Working with Data Paperback
6. Kevin P. Murphy (2013) Machine Learning: A Probabilistic Perspective.
7. Avrim Blum, John Hopcroft and Ravindran Kannan. Foundations of Data Science.

Other Resources

Course Designers

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

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Deep Learning Techniques

Course Code	AML505	**Course Category**	Core	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	AML501 Machine Learning Techniques	**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.

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	Illustrate the concepts of ML/DL	1	70	68
Outcome 2	Design and implement CNN model	5	70	65
Outcome 3	Design and implement RNN model	5	70	65
Outcome 4	Apply deep learning models to given problems.	3	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	1	1	1	2							2	2	
Outcome 2	2	3	2	3							3	2	
Outcome 3	2	3	2	3							2	3	
Outcome 4	2	3	3	3							2	3	
Average	**2**	**3**	**2**	**3**							**2**	**3**	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction:**	**15**		
1	Overview of machine learning	2	1	1
2	Linear classifiers, loss functions	1	1	1
3	**Introduction to TensorFlow:**	1	1	1
4	Computational Graph, Key highlights, Creating a Graph	2	1	1
5	Regression example	1	1	1
6	Gradient Descent	1	1	1
7	TensorBoard	3	1	1
8	Modularity, Sharing Variables	1	1	1
9	Keras	3	4	3
Unit 2	**ACTIVATION FUNCTIONS, PERCEPTRON, ANN**	**7**		
10	**Activation Functions:** Sigmoid, ReLU, Hyperbolic Fns, Softmax	2	1	1,2
11	**Perceptrons:** What is a Perceptron, XOR Gate	1	1	1
12	**Artificial Neural Networks:** Introduction	1	1	2
13	Perceptron Training Rule	1	1	2
14	Gradient Descent Rule	1	1	2
15	Vanishing gradient problem and solution	1	1	2
Unit 3	**Convolutional Neural Networks**	**7**		
	Introduction to CNNs	1	1,2	3
	Kernel filter	1	1,2	3
	Principles behind CNNs	1	1,2	3
	Multiple Filters	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	1	1,3	2
	Unfolded RNNs	1	1,3	2
	Seq2Seq RNNs	1	1,3	2
	LSTM	1	1,3	2
	GRU	2	1,3	2
	Encoder Decoder architectures	2	1,3	2
Unit 5	**Deep Learning applications**	**8**		
	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	1	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%)		Mid-1 (15%)		CLA-2 (10%)		CLA-3 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%		65%		60%		50%		40%	
	Understand										
Level 2	Apply	30%		35%		40%		50%		60%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Buduma, Nikhil, and Nicholasn (2017) Locascio. Fundamentals of deep learning: Designing next-generation machine intelligence algorithms. O'Reilly Media, Inc.
2. Goodfellow, I., Bengio,Y., and Courville (2016) A., Deep Learning, MIT Press..
3. Josh Patterson, Adam Gibson (2017) Deep Learning: A Practitioner's Approach, OReilly.
4. Gulli, Antonio, and Sujit Pal (2017) Deep learning with Keras. Packt Publishing Ltd,

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. Neeraj Kumar Shamra, Department of CSE, SRM AP
2. Expert Reviewers from Institutes of National Importance / Institutes of International Repute
3. Expert Reviewers from Industry.

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Deep Learning Techniques Lab

Course Code	AML505L	**Course Category**	Core	**L**	**T**	**P**	**C**
				0	0	2	2
Pre-Requisite Course(s)	AML501L Machine Learning Techniques Lab	**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.

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	Illustrate the concepts of ML/DL	1	70	68
Outcome 2	Design and implement CNN model	5	70	65
Outcome 3	Design and implement RNN model	5	70	65
Outcome 4	Apply deep learning models to given problems.	3	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	1	1	1	2							2	2	
Outcome 2	2	3	2	3							3	2	
Outcome 3	2	3	2	3							2	3	
Outcome 4	2	3	3	3							2	3	
Average	**2**	**3**	**2**	**3**							**2**	**3**	

Course Unitization Plan

SI No.	Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Installation and working on python and its different libraries for deep learning (Tensor Flow, NumPy, Kera, Pandas, Matplotlib, etc.)	6	1	1,3
2	Implement a multilayer perceptron (MLP) using Keras with TensorFlow and fine-tune neural network hyperparameters for regression problems (house price prediction).	3	2	1,3
3	To implement an MLP using Keras with TensorFlow for classification problems (heart disease prediction).	3	2	1,2,3
4	To implement a Convolution Neural Network (CNN) for dog/cat classification problems using TensorFlow and Keras.	3	3	1,2,3
5	To implement a Convolution Neural Network (CNN) for multiclass classification problems using TensorFlow and Keras.	3	3	1,2,3
5	To Implement a CNN for object detection in the given image.	3	2	1.2.3
6	Implement a Recurrent Neural Network (RNN) to predict time series data.	3	3	1,3,4
7	Implement a Long Short-Term Memory (LSTM) to predict time series data.	3	3	1,3,4
8	To implement a Seq2Seq Model for Neural Machine Translation in Keras.	3	3	1,3,4
9	To implement an Encoder-Decoder Recurrent neural network model for Neural Machine Translation.	3	3	1,3,4
10	To implement a Gated Recurrent Unit (GRU) for time series data prediction.	3	3	1,3,4
11	Mini project	9	4	1,2,3,4
	Total Contact Hours	45		

Learning Assessment

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

Recommended Resources

1. Buduma, Nikhil, and Nicholas Locascio (2017) Fundamentals of deep learning: Designing next-generation machine intelligence algorithms. O'Reilly Media, Inc..
2. Goodfellow, I., Bengio,Y., and Courville (2016) A., Deep Learning, MIT Press.
3. Josh Patterson, Adam Gibson (2017) Deep Learning: A Practitioner's Approach, OReilly.
4. Gulli, Antonio, and Sujit Pal (2017) Deep learning with Keras. Packt Publishing Ltd.

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. Neeraj Kumar Shamra, Department of CSE, SRM AP
2. Expert Reviewers from Institutes of National Importance / Institutes of International Repute
3. Expert Reviewers from Industry

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Natural Language Computing

Course Code	AML506	**Course Category**	Core	**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. Learn the basics of natural language processing and understand its various steps.
2. To introduce the fundamentals of language processing from the algorithmic viewpoint.
3. To discuss various issues that make natural language processing a hard task.
4. To discuss some well-known applications of natural language processing

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	Recall the fundamental concepts of natural language processing.	1	70%	68%
Outcome 2	Demonstrate algorithms for word level and syntactic analysis of textual data.	2	70%	65%
Outcome 3	Develop systems for language processing and information-related tasks using text processing.	3	70%	60%
Outcome 4	Implement systems using natural language generation algorithms and machine translation techniques based on user queries	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	2	3	3	2							3	2	
Outcome 2	2	3	3	2							2	2	
Outcome 3	2	3	2	2							2	2	
Outcome 4	3	3	3	2							2	3	
Average	**2**	**3**	**3**	**2**							**2**	**2**	

Course Unitization Plan

SL NO	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction:**	**11**		
1	what is Natural Language Processing, the problem of ambiguity and uncertainty in language	2	1	1
2	Ambiguity and uncertainty in language	1	1	1
3	Tuning Set, NLP task in syntax	2	1	1
4	Semantics and pragmatics	2	1	1
5	Application of NLP	1	1,2	1
6	Information extraction and machine translation	1	1,2	1
7	The problem of ambiguity	1	1,2	1
Unit 2	**N-gram language modelling**	**9**		
8	The role of language models	1	1	1,2
9	Simple N-gram models	1	1	1,2
10	Estimating parameters and smoothing	1	1	1,2
11	Evaluating language models	1	1,2	1,2
12	POS tagging and sequence labelling .	1	1,2	1,2
13	Lexical syntax and HMM	2	1	1,2
14	HMM chains	1	1,2	1,2
15	Forward and Viterbi modelling	1	1,2	1,2
Unit 3	**Syntactic parsing**	**8**		
16	Grammar formalism and tree banks.	2	1,2,3	3
17	Efficiency parsing for CFG	1	1,3	3
18	Statistical and probabilistic parsing	1	1,3	3
19	Lexical PCFGs and Neural shift-reduce dependency parsing	1	1,3	3
20	Hidden Markov Models	1	1,3	3
21	Lexical semantics and word-sense disambiguation, Semantic parsing	2	1,3	3
Unit 4	**Maximum entropy classifier**	**10**		
22	Minimum entropy Markov models	2	4	1,3
23	Conditional random fields	1	4	1,3
24	Dirichlet multinomial distribution	1	4	1,3
25	Unsupervised language discovery,	2	4	1,3
26	Information extraction	1	4	1,3
27	Applications of information systems	2	4	1,3
28	Reference resolution	1	4	1,3
Unit 5	**Information Extraction and Machine Translation:**	**7**		
29	Named entity recognition and relation extraction.	2	3,4	1,2,3
30	IE using sequence Labelling	1	3,4	1,2,3
31	Basic issues in MT. Statistical translation,	1	3,4	1,2,3
32	word alignment	1	3,4	1,2,3

33	phrase-based translation	1	3,4	1,2,3
34	synchronous grammars.	1	3,4	1,2,3
	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 (15%)**		**CLA-3 (10%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	70%		65%		60%		50%		40%	
	Understand										
Level 2	Apply	30%		35%		40%		50%		60%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. James Allen, Natural Language Understanding. The Benajmins/Cummings Publishing Company Inc. 1994. ISBN 0-8053-0334-0
2. Manning, Christopher, and Hinrich Schutze (1999) Foundations of statistical natural language processing. MIT press.
3. Daniel Jurafsky, James H. Martin, "Speech & language processing", Pearson publications.

Other Resources

1. https://youtu.be/02QWRAhGc7g
2. https://youtu.be/aeOLjFe256E
3. Bird, Steven, Ewan Klein, and Edward Loper (2009) Natural language processing with Python: Analyzing text with the natural language toolkit, O'Reilly Media, Inc.

Course Designers

1. Dr. Ashu Abdul, Assistant Professor, Dept. of Computer Science and Engineering, SRM University AP.
2. Dr. Jenhui Chen, Professor, Dept. of Computer Science and Information Engineering, Chang Gung University, Taiwan.

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Information Retrieval

Course Code	AML553	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	MAT 560, CSE 500	**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

1. Dr. Niladri Sett, Assistant Professor, Dept. of Computer Science and Engineering, SRM University AP.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Research Methodology and IPR

Course Code	RM101	**Course Category**	RDIP	**L**	**T**	**P**	**C**
				2	0	0	2
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. Developing Research Skills
2. Understanding Intellectual Property Rights (IPR)
3. Enhancing Ethical Research Practices
4. Promoting Effective Communication of Research Results

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	Understand research problem formulation	2	80%	75%
Outcome 2	Analyse research-related information and understand research ethics	2	70%	65%
Outcome 3	Understanding when IPR would take such an important place in the growth of individuals & nations.	3	80%	70%
Outcome 4	Understand that IPR protection provides an incentive to inventors for further research work and investment in R&D.	3	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	2	1	2	2				1		3	2	2	3
Outcome 2	3	2	2	3				2		3	3	2	3
Outcome 3	3	3	3	2				1		3	2	2	3
Outcome 4	3	2	3	2				2		3	3	3	3
Average	**3**	**2**	**3**	**2**				**2**		**3**	**3**	**2**	**3**

Course Unitization Plan

Session	Description of Topic	Contact hours	CLOs Addressed	Reference
1.	**Unit I**	**6**		
2.	Meaning of research problem, Sources of research problem	2	1	1,3
3.	Criteria Characteristics of a good research problem,	2	1	1,2,3
4.	Errors in selecting a research problem, scope, and objectives of research problem.	2	1	1,2,3
5.				
6.	**Unit II**	**6**		
7.	Approaches of investigation of solutions for research problem, data collection,	2	1,2	1,2,3
8.	Analysis, interpretation, Necessary instrumentations.	2	1,2	1,2,3
9.	Effective literature studies approaches, analysis Plagiarism, Research ethics.	2	1,2	1,2,3
10.				
11.	**Unit III**	**6**		
12.	Effective technical writing,	2	1,2	1,2
13.	how to write report, Paper Developing a Research Proposal,	2	1,2	1,2
14.	Format of research proposal, a presentation and assessment by a review committee.	2	1,2	1,2
15.				
16.	**Unit IV**	**6**		
17.	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research,	2	1,2	1,2,3
18.	innovation, patenting, development. International Scenario: International cooperation on Intellectual Property.	2	1,2	1,2,3
19.	Procedure for grants of patents, Patenting under PCT.\	1	1,2	1,2,3
20.	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	1	1,2	1,2,3
	Unit V	**6**		
21.	New Developments in IPR: Administration of Patent System.	2	3,4	4,5
22.	New developments in IPR; IPR of Biological Systems,	2	3,4	4,5
23.	Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	2	3,4	4,5
	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	Th	Th	Th	Th
Level 1	Remember	40%	50%	30%	20%	30%
	Understand					
Level 2	Apply	60%	50%	70%	80%	70%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students' "Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
2. Ranjit Kumar, (2007) Research Methodology: A Step-by-Step Guide for beginners,, Taylor & Francis Ltd.
3. Mayall (1992) Industrial Design,, McGraw Hill.
4. Niebel (1974) Product Design, McGraw Hill.
5. Asimov (1962) Introduction to Design, Prentice Hall.

Other Resources

Course Designers

1. Dr. Manjesh Kumar, Department of Mechanical Engineering, SRM University-AP, Andhra Pradesh.
2. Dr. Manas Das, Department of Mechanical Engineering, IIT Guwahati

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Project Work-Phase I

Course Code	AML580	**Course Category**	RDIP	**L**	**T**	**P**	**C**
				0	0	10	10
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	Conceptualise 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)

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	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

SL No.	Unit Name	Required Contact hours	CLOs Addressed	References Used
Unit 1	Conception of Idea	35		
	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	95		
	Literature survey of the related works	85	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	135		
	Execution of the various modules of the project and intermediate report submission.	110	3	1
	Initiation of the process for a possible publication.	25	5	2,3,4,5
Total		**300 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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Project Work-Phase II

Course Code	AML581	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.

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 conceptualised 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 the Literature survey.	5	70%	65%
Outcome 5	Publish and present findings in reputed journals and conferences.	3	75%	70%

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	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

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	100 hours		
	Optimize the mathematical model for the considered problem	90 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	150 hours		
	Perform the experimental simulations.		3	
Unit 4	Validate the results obtained with Literature survey	70 hours	4	
Unit 5	Publish and present results and finding	50 hours	5	
Total		**420 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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
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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)	MAT 560, CSE 500	**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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Computer Vision

Course Code	AML558	**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	Computer Science Engineering AI ML	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Introduces Computer vision elements, including image, graphics, sound, and video components.
2. To learn the fundamentals of computer vision and a real environment.
3. To gain knowledge over accessing and modification of multimedia content in a real-world scenario

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 what Computer Vision is and the skill sets needed to be a Computer Vision professional.	3	70%	65%
Outcome 2	Apply basic tools (plots, graphs, summary statistics) to perform Computer Vision tasks.	3	70%	65%
Outcome 3	Describe the Computer Vision Process and how it works.	3	70%	65%
Outcome 4	Apply Computer Vision in different case studies.	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
Average	**3**	**2**	**2**	**2**						**3**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**UNIT I: Introduction**	**9**		
	Digital Image Formation and low-level processing:	1	1	1, 2
	Overview and State-of-the-art Fundamentals of Image Formation,	1	1	1
	Transformation: Orthogonal, Euclidean, Affine, Projective, etc;	1	1	1, 2
	Fourier Transform, Convolution and Filtering,	2	1	1, 2
	Image Enhancement, Restoration, Histogram Processing	3	1	1, 2
	introduction to computer vision.	1	1	1, 2
Unit 2	**Feature**	**9**		
	Feature Extraction: Shape, histogram, color, spectral, texture	2	1,2	1
	Feature analysis, feature vectors, distance /similarity measures, data preprocessing	1	1,2	1
	Edges - Canny, LOG, DOG;	2	1,2	1
	Scale-Space Analysis- Image Pyramids and Gaussian derivative filters	2	1,2	1,2
	Gabor Filters and DWT; Line detectors (Hough Transform), Orientation Histogram	1	1,2	1,2
	SIFT, SURF, GLOH, Corners - Harris and Hessian Affine.	1	1,2	1,2
Unit 3	**3D modelling**	**9**		
	Depth estimation and Multi-camera views: Perspective	1	2	1,2
	Homography, Rectification, DLT, RANSAC,	2	2	1,2
	3-D reconstruction framework; Binocular Stereopsis:	2	2	1,2
	Camera and Epipolar Geometry; Auto-calibration.	1	2	1,2
	Image Segmentation: Region Growing, Edge Based approaches to segmentation,	1	2	1,2
	Graph-Cut, Mean-Shift, MRFs, Texture Segmentation, Object detection.	2	2	1,2
Unit 4	**3D transformation**	**9**		
	Motion Analysis: Optical Flow	2	3	1,2
	KLT, Spatio-Temporal Analysis	3	3	1,2
	Background Subtraction and Modeling,	2	3	1,2
	Dynamic Stereo; Motion parameter estimation	2	3	1,2
Unit 5	**Different Applications**	**9**		
	Shape from X: Light at Surfaces	3	4	2
	Use of Use of Surface Smoothness Constraint	1	4	2
	Shape from Texture, color, motion and edges Albedo estimation	3	4	2
	Photometric Stereo; Phong Model; Reflectance Map.	2	4	2
	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. Richard Szeliski (2011) Computer Vision: Algorithms and Applications, Springer-Verlag London Limited .
2. Richard Hartley and Andrew Zisserman (2004) Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press

Other Resources

1. D. A. Forsyth, J. Ponce (2003) Computer Vision: A Modern Approach, Pearson Education, 2003.
2. R.C. Gonzalez and R.E. Woods (1992) Digital Image Processing, Addison- Wesley.
3. K. Fukunaga, Morgan Kaufmann (1990) Introduction to Statistical Pattern Recognition, Second Edition, Academic Press.

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.