Department of Computer Science Engineering

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

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

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

Department Vision

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

Department Mission

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

Program Educational Objectives (PEO)

1. 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)		1	30
University VAC	1		
School VAC	0		
Skill Enhancement Courses (SEC)		4	120
School SEC	4		
Department SEC	0		
SEC Elective	0		
Foundation / Interdisciplinary courses (FIC)		3	90
School FIC	0		
Department FIC	3		
Core + Core Elective including Specialization (CC)		36	1080
Core	30		
Core Elective (Inc Specialization)	6		
Minor (MC) + Open Elective (OE)	0	0	0
Research / Design / Internship/ Project (RDIP)		35	1050
Internship / Design Project / Startup / NGO	3		
Internship / Research / Thesis	32		
Total		**80**	**2400**

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

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

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

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

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

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

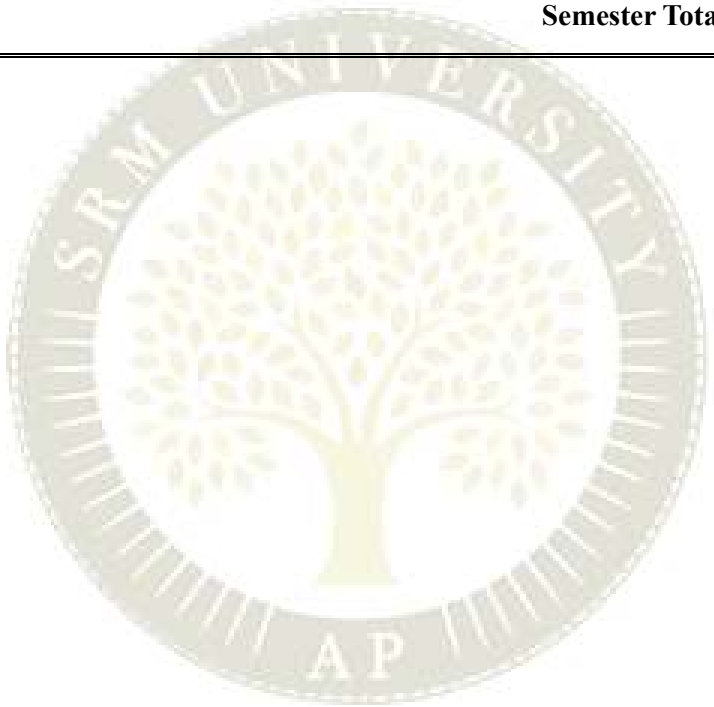
e) Project : 30 project hours (60 minutes each) per semester are equal to 1 credit.

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

SEMESTER - II								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 502	Community Engagement and Social Responsibility	0	0	1	1
2	AEC	S AEC	AEC 503	Research Seminar	0	0	1	1
3	SEC	S SEC	SEC 103	Entrepreneurial mindset	1	0	1	2
4	Core	CC	AML 506	Deep Learning: Methodologies and Techniques	3	0	1	4
5	Core	CC	AML 507	Natural Language Computing	3	0	1	4
6	Core	CC	AML 508	Data Warehousing and Pattern Mining	3	0	1	4
7	Elective	CE		Core Elective - I	3	0	0	3
8	Elective	CE		Core Elective - II	3	0	0	3
9	RDIP	RDIP	AIML 512	Project Management	0	0	3	3
				Semester Total	**16**	**0**	**9**	**25**

SEMESTER - III								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	RDIP	RDIP	AML 509	Thesis - I	0	0	14	14
2	RDIP	RDIP	AML 510	Industrial Practice	0	0	3	3
				Semester Total	**0**	**0**	**17**	**17**

SEMESTER - IV								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	RDIP	RDIP	AML 511	Thesis - II	0	0	15	15
				Semester Total	**0**	**0**	**15**	**15**



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

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Design Thinking

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

Course Objectives / Course Learning Rationales (CLRs)

1. Familiarize with the principles of Design Thinking
2. Learn to apply the principles of Design Thinking
3. Apply Design Thinking to solve problems
4. Analayze design thinking for innovation

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Grasp the Concepts and process of Design Thinking	2	80%	75%
Outcome 2	Learn the process of Design Thinking	2	70%	65%
Outcome 3	Solve a problem using Design Thinking Principles	3	80%	70%
Outcome 4	Design for innovation	3	80%	75%

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

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

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Course Unitization Plan

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

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)		End Sem Exam (50%)
		CLA-1 (25%)	CLA-2 (25%)	
Level 1	Remember	20	40	40
	Understand			
Level 2	Apply	30	30	30
	Analyse			
Level 3	Evaluate	50	30	30
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

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

Other Resources

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

Course Designers

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

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Advanced Probability, Linear Algebra and Optimization Techniques

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

Course Objectives / Course Learning Rationales (CLRs)

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

Course Outcomes / Course Learning Outcomes (CLOs)

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

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

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

Course Unitization Plan

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

Learning Assessment

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

Recommended Resources

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

Other Resources

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

Course Designers

1. Dr. Tapan Kumar Hota

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Machine Learning Techniques

Course Code	AML501	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce Machine Learning and various 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 Theory

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

35.	Discussion on some research papers	1	2,4	3
36.	Discussion on some research papers	1	2,4	3
37.	**Clustering:** Introduction, K-mean clustering	2	2,4	3
38.	agglomerative hierarchical clustering,	1	2,4	3
39.	Python exercise on k-mean clustering.	1	2,4	3
	Total contact hours	**45**		

Course Unitization Plan Lab

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

Learning Assessment

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

1. Dr.Shuvendu Rana, Assistant Professor, Computer Science Engineering, SRM University - AP.

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Artificial Intelligence and Knowledge Representation

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

Course Objectives / Course Learning Rationales (CLRs)

1. To 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 perform inference and planning in given problems.	3	70%	65%

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

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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**10**		
	What is Intelligence, Machines, humans, and mind,	1	1	1, 2
	Foundations and History of Artificial Intelligence.	2	1	1, 2
	The concept of rationality	1	2	1, 2
	Intelligent agents: Agents and Environments, the nature of environments	2	5	1, 2
	Structure of agents, problem-solving agents,	1	1, 2	1, 2
	Problem formulation in AI,	2	1, 2	1, 2
	Typical AI problems, practical applications of AI.	1	1, 2	1, 2
Unit 2	**Searching for solutions**	**9**		
	Philosophy of searching	1	1	1, 2
	Un-informed search strategies – Breadth first search, Depth first Search, DFID	2	1	1, 2
	Informed (Heuristic search)- Greedy best first search, A* search,	2	1	1, 2
	Local search,	2	2, 3	1, 2
	Optimal decisions in multiplayer games,	1	3, 4	1, 2
	Alpha-Beta pruning	1	2	1, 2
Unit 3	**Knowledge Representation and Reasoning**	**8**		
	Propositional Logic and Inference rules.	2	2	1, 2, 3, 4
	Predicate Logic (first order logic).	1	2, 3	1, 2, 3, 4
	Inference in FOL.	2	2, 3	1, 2, 3, 4
	Rule-based system, Logical Reasoning.	1	2, 3	1, 2, 3, 4
	Forward & Backward Chaining.	1	2, 3	1, 2, 3, 4
	Knowledge Resolution.	1	3, 4	1, 2, 3, 4
Unit 4	**Reinforcement Learning**	**9**		
	Introduction to Reinforcement Learning (RL), sequential decision making in RL	2	1, 2	1, 2, 3, 4
	Knowledge Resolution.	1	2	1, 2, 3, 4
	Components of RL agent: policy, value function, and model;	2	3, 4	1, 2, 3, 4
	Exploration and exploitation trade-off,	1	2, 3	1, 2, 3, 4
	Markov decision processes,	1	3, 4	1, 2, 3, 4
	Bellman equation,	1	3, 4	1, 2, 3, 4
	Applications of RL	1	5	1, 2, 3, 4
Unit 5	**Case Studies**	**9**		
	Path planning using searching	2	1,2,3	1, 2
	Game-playing agents	2	2,3	1, 2, 3, 4
	Expert systems	1	2,3	1, 2, 3, 4
	Robotics	1	1,2,3,4	1, 2, 3, 4
	Healthcare agents.	2	1,2,3,4	1, 2, 3, 4
	Autonomous vehicles	1	1,2,3,4	1, 2, 3, 4
Total Theory Contact Hours		**45**		

Course Unitization Plan- LAB

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
	Lab 1: Write a program to convert a binary search tree (BST) into a min-heap. Also show the traversals on the given BST.	2	2	1,2
	Lab 2: Write a program to convert a binary search tree (BST) into a min-heap. Also show the traversals on the given BST.	2	1,2	1
	Lab 3: Chess Knight Problem: Given a chessboard, find the shortest distance (minimum number of steps) taken by a knight to reach a given destination from a given source.	2	2,3	1,2
	Lab 4: Given a Directed Acyclic Graph (DAG), print it in topological order using topological sort algorithm. If the graph has more than one topological ordering, output any of them. Assume valid Directed Acyclic Graph (DAG).	3	2,3	1,2
	Lab 5: Program for Iterative deepening depth-first search. Compare the results with DFS, for any example problem.	2	1	1, 2
	Lab 6: Implement A* algorithm. Illustrate with an example (Tic-Tac-Toe).	2	1	1, 2
	Lab 7: Implement Genetic Algorithm (GA)	2		
	Lab 8: Implement Classroom scheduling problem with CSP formulation	2	1	1, 2
	Lab 9: Write a program for Usage of rules in Prolog. Create a family tree program to include following rules 1. M is the mother of P if she is a parent of P and is female 2. F is the father of P if he is a parent of P and is male 3. X is a sibling of Y if they both have the same parent. 4. Then add rules for grandparents, uncle-aunt, sister and brother. Based on the facts, define goals to answer questions related to. .	2	1	1, 2
	Lab 10: Write a prolog program to solve "Water Jug Problem".	2	1	1, 2
	Lab 11: Case Study 1: Path planning using AI algorithm.	3	1	1, 2
	Lab 12: Case Study 2: Path planning using AI algorithm using reinforcement learning approach.	3	1,2	1, 2,3
	Lab 13: Case Study 2: Path planning using AI algorithm using reinforcement learning approach **(contd.).**	3	1,2	1, 2,3
Total Theory Contact Hours		**30**		

Learning Assessment

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

Recommended Resources

1. Russell, S. J., & Norvig, P. (2016). Artificial intelligence: a modern approach. Pearson.
2. Khemani, D. (2013). A first course in artificial intelligence. McGraw-Hill Education.
3. Sutton, R. S., & Barto, A. G. (1999). Reinforcement learning: An introduction. Robotica.

Other Resources

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

Course Designers

1. Dr Muzakir Hussian, Assistant Professor, Computer Science Engineering, SRM University - AP.

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Advanced Algorithms and Analysis

Course Code	AML504	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

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

Course Outcomes / Course Learning Outcomes (CLOs)

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

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

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

Course Unitization Plan Theory

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

Course Unitization Plan Lab

Sl No.	Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Implement 8 queens problem. Analyse how the number of possibilities decrease with each constraint.	2	4	1, 2
2	Implement generate and test method for 16-puzzle problem. Propose a heuristic function and use it in the program.	2	4	1, 2
3	Write programs for (a) Fractional knapsack and (b) 0/1 Knapsack problems. Explain how the heuristic can work in (a) and not in (b).	2	4	1, 2
4	Implement Towers of Hanoi problem by recursive and non-recursive methods. Discuss the complexity in both cases. Implement a Hash table as a set of linked lists. Discuss advantages.	2	4	1
5	Write a program to find Minimum Spanning tree of a given graph.Mention the possible application.	2	4	1,2
6	Write a program to find All- to- All shortest paths of a given graph.Discuss the complexity and applications	2	4	1,2
7	Implement any algorithm for Ford-Fulkerson method to solve the Maximum flow problem. Discuss the applications.	2	4	1,2
8	Write a program to implement the Graham's algorithm to find Convex Hull of a given set of points.	2	4	1,2
9	Implement Floyd-Warshall's algorithm to get transitive closure of a Graph (Reachability matrix).Implement Brute-force algorithm for pattern matching.	2	4	1,2
10	Implement Boyer-More algorithm for Pattern matching. Implement KMP algorithm for Pattern matching**.**	2	4	1,2
11	Implement Travelling Salesman problem which can give accurate answer. Test it on a graph of at least 6 cities. Discuss complexity.	2	4	1,2
12	Use the MST program to get an approximate solution for Travelling Salesman problem	2	4	1,2
13	Create a pack of playing cards (4 suits (colors) & each suit will have 2,3,..10, Jack , Queen, King, Ace). Display the cards. Simulate shuffling of the pack and display the shuffled cards. Distribute them among 4 players in a Round robin fashion and display the cards with each player. Give some value for each color and card and find the total values of the cards with each player.	2	4	2
14	Simulate the following scenario assuming that the time between calls is random. There are two technical support people: Able and Baker. Able is more experienced and can provide service faster than Baker. Times are usually a continuous measure, but this time-based example is made	2	4	2

	discrete for ease of explanation. The simulation proceeds in a complex manner because of two servers. When both are free Able gets the call. Assume service distribution other than given in your slides.			
15	Implement approximate set cover and Vertex cover algorithms	2	4	2
	Total Lab Hrs	**30**		

Learning Assessment

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

Recommended Resources

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest and Clifford Stein, (2009) Introduction to Algorithms", Third Edition, The MIT , Press.
2. Michael T Goodrich and Roberto Tamassia, (2002) Algorithm Design: Foundations, Analysis and Internet Examples", John Wiley and Sons.
3. SanjoyDasgupta, Christos Papadimitriou and UmeshVazirani (2009) Algorithms, Tata McGraw-Hill.
4. RK Ahuja, TL Magnanti and JB Orlin (1993) Network flows: Theory, Algorithms, and Applications, Prentice Hall Englewood Cliffs, NJ .
5. Rajeev Motwani, Prabhakar Raghavan (1995) Randomized Algorithms, Cambridge University Press.

Other Resources

Course Designers

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COMMUNITY SERVICE AND SOCIAL RESPONSIBILITY

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

Course Objectives / Course Learning Rationales (CLRs)

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

Course Outcomes / Course Learning Outcomes (CLOs)

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

Learning Assessment

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

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Research Seminar

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

Course Objectives / Course Learning Rationales (CLRs)

1. To learn how to prepare power point presentations effectively.
2. To learn the presentation skills and communications.
3. To gain knowledge through discussion.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe the features and characteristics of seminars and presentations.	2	80%	80%
Outcome 2	Gain skills in methods of scientific presentations	2	65%	60%
Outcome 3	Respond to questions and answers effectively and manage conflict during the seminar	3	80%	75%
Outcome 4	Understand the basic structure of research paper	2	80%	75%

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

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	3	3	3	2	2	2	3	3	3	3	3	2	3
Outcome 2	3	2	3	3	3	2	1	3	2	3	3	3	3	2	3
Outcome 3	3	2	3	2	3	2	2	3	2	3	3	3	3	2	3
Outcome 4	3	3	3	2	3	3	2	3	2	3	3	3	3	3	3
Average	3	2	3	3	3	2	2	3	2	3	3	3	3	2	3

Course Unitization Plan

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

Learning Assessment

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

Recommended Resources

1. Garr Reynolds Presentation Zen: Simple Ideas on Presentation Design and Delivery (ISBN: 0321811984)
2. Matt Carter Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters, and More (ISBN: 0123859697)
3. Vernon Booth, Communicating in Science: Writing a Scientific Paper and Speaking at Scientific Meetings (ISBN: 0521429153.

Other Resources

1. https://www.northwestern.edu/climb/resources/oral-communication-skills/creating-an-intro.html

Course Designers

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Entrepreneurial Mindset

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

Course Objectives / Course Learning Rationales (CLRs)

1. To develop the Entrepreneurial Mindset of Students.
2. To provide students an overview of different aspects of starting a business.

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 key entrepreneurship concepts and entrepreneurial traits	1	90%	80%
Outcome 2	Identify entrepreneurial opportunities	2	80%	80%
Outcome 3	Apply entrepreneurial skills to analyze different entrepreneurial ventures.	3	70%	70%
Outcome 4	Apply entrepreneurial concepts to and develop a business model canvas	3	60%	60%

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

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**2**	**1,3**	
1.	What is Entrepreneurship			
2.	Challenges Faced by Entrepreneurs			
3.	Why not entrepreneurship			
4.	Who is an Entrepreneurs (Characteristics and Myths)			
5.	Why become entrepreneurs			
6.	Entrepreneurial Traits			
7.	Significance of entrepreneurship in the economy			
8.	Types of Entrepreneurial Ventures			
Unit 2	**Entrepreneurial Orientation**	4	1,2,4	
9.	Characteristics of successful entrepreneurs			
10.	Mindset shifts: from an employee to an entrepreneur			
11.	Overcoming challenges and dealing with failures			
Unit 3	**Entrepreneurial Skills**	**4**	1,2,3,4	
12.	Innovation & Creativity			
13.	Design Thinking			
14.	Strategic Thinking			
15.	Developing a Growth Mindset			
Unit 4	**Technopreneurship**	**2**	1,2	
16.	Overview of Technopreneurship			
17.	Characteristics of a Technopreneur			
18.	Technology Trends and Disruption			
19.	Real-world Technopreneurship Examples			
Unit 5	**Entrepreneurial Opportunity & Ideation**	4	2	
20.	Difference between idea and opportunity			
21.	Opportunities in Vibrant Indian Entrepreneurial Ecosystem			
22.	Opportunity Recognition (Sources of Opportunity)			
23.	Assessing Opportunity			
24.	Opportunities and Uncertainty			
25.	Idea Generation & Market Research			
26.	Idea Selection			
Unit 6	Business Model Canvas & Pitching	2	1,4	
27.	Why BMC			
28.	Value Proposition			
29.	Customer Discovery			
30.	Customer Relationship			
31.	Channels			
32.	Key Partners			
33.	Key Activities			
34.	Key Resources			
35.	Revenue Structure			
36.	Cost Structure			
37.	From Pitch to Hitch (Pitch Deck)			

Unit 7	Startup Financing	2	1,4	
38.	Stages of Fund Raising			
39.	Startup Valuation			
40.	Mode of Investment			
41.	Shareholder's Agreement			
42.	Financial Analysis			
Total Contact Hours		**20**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (100%)**		
		CLA-1 (30%)	**CLA-2 (30%)**	**CLA-3 (40%)**
Level 1	Remember	100%	40%	
	Understand			
Level 2	Apply		60%	100%
	Analyse			
Level 3	Evaluate			
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

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

Other Resources

1. https://www.coursera.org/specializations/innovation-creativity-entrepreneurship
2. https://www.coursera.org/specializations/wharton-entrepreneurship

Course Designers

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Deep Learning: Methodologies and Techniques

Course Code	AML 506	**Course Category**	CC		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	AML501 Machine Learning Techniques	**Co-Requisite Course(s)**	NIL	**Progressive Course(s)**	NIL			
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	2	70	65
Outcome 3	Design and implement RNN model	2	70	65
Outcome 4	Apply deep learning models to given problems.	3	70	60

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

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

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**		

Course Unitization Plan Lab

Experiment	Required Contact Hours	CLOs Addressed	References Used
Lab 1: To implement a Multilayer Perceptron (MLP) using Keras with TensorFlow, and fine-tune neural network hyperparameters for regression problem (house price prediction).	3	1,2	1
Lab 2: To implement a MLP using Keras with TensorFlow for classification problem (heart disease prediction).	3	1,2,3	1

Lab 3: To implement a Convolution Neural Network (CNN) for dog/cat classification problem using TensorFlow/Keras.	3	2,3	1
Lab 4: To implement a CNN for handwritten digit recognition.	2	1,2,3	1
Lab 5: To Implement a CNN for object detection in the given image.	3	2,3	1
Lab 6: To implement a Long Short-Term Memory (LSTM) for predicting time series data.	3	3,4	
Lab 7: To implement a Seq2Seq Model for Neural Machine Translation.	3	3,4	1
Lab 8: To implement a Recurrent Neural Network (RNN) for predicting time series data.	3	3,4	1
Lab 9: To implement an Encoder-Decoder Recurrent neural network model for Neural Machine Translation.	3	2,3,4	1
Lab 10: Case Study 1: Object detection for Self-Driving Cars	3	1,2,3,4	1,2
Lab 11: Case Study 2: Object detection for Healthcare images	3	1,2,3,4	1,2
Total	**30**		

Learning Assessment Practical

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (5%)		**Mid-1 (15%)**		**CLA-2 (5%)**		**CLA-3 (25%)**			
		Th (5%)	**Prac**	**Th**	**Prac**	**Th (5%)**	**Prac**	**Th (10%)**	**Prac (15%)**	**Th (35%)**	**Prac (15%)**
Level 1	Remember	40%		40%		20%		10%	10%	10%	10%
	Understand										
Level 2	Apply	30%		30%		40%		50%	40%	40%	40%
	Analyse										
Level 3	Evaluate	30%		30%		40%		40%	50%	50%	50%
	Create										
Total		**100%**		**100 %**		**100%**		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Buduma, 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
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3. Expert Reviewers from Institutes of National Importance / Institutes of International Repute
4. Expert Reviewers from Industry

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Natural Language Computing

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

Course Objectives / Course Learning Rationales (CLRs)

1. Learn the basics of natural language processing and understand various steps in it.
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)

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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		**9**		
	Introduction and Overview: What is Natural Language Computing (NLC); Why NLC is difficult: Ambiguity and uncertainty in the language; Application of NLC	2	1	1
	How to build a NLC pipeline: Different phases of NLC	2	1	1
	Text Preprocessing: stop word removal, stemming, TF-IDF along with computational linguistics	2	1	1
	Word forms: Bag of words, skip-gram, Continuous Bag-Of-Words	2	1	1
	Embedding representations for words: Word2Vec	1	1,2	1
Unit 2		**8**		
	Language Models (LM): The role of language models, Applications of LMs, Types of LM: Unigram LM, Bigram LM, N-gram LM	2	1,2	2
	Hidden Markov LM (Forward and Viterbi algorithms and EM training);	2	1,2	2
	Estimating parameters and smoothing LM: comparisons between smoothing techniques,	1	1,2	2
	Part of Speech Tagging: Lexical syntax, Morphology	1	1,2	1
	Information Extraction (IE): Named entity recognition and relation extraction. IE using sequence labeling	2	1,2	3
Unit 3		**7**		
	Syntax parsing: Grammar formalisms and tree banks.	2	2,3	3
	Efficient parsing for context-free grammars (CFGs); Statistical parsing and probabilistic CFGs (PCFGs),	2	2,3	3
	Semantic Analysis: Lexical semantics, Word-sense disambiguation:	1	2,3	3
	Knowledge Based and Supervised Word Sense Disambiguation;	1	2,3	3
	Compositional semantics; Semantic Role Labeling	1	2,3	3
Unit 4		**9**		
	Text Analysis: Sentiment Mining, Classification using Machine Learning (ML) Techniques: Naïve Bayes, Logistic Regression and Support Vector Machines,	3	2,3	5
	Text Summarization using ML Algorithms: LexRank, Luhn: Heuristic Method, LSA, TextRank, SumBasic,	2	2,3	5
	Question Answering system (example: Chatbot) using Encoder-decoder (sequence to sequence) architecture using the recurrent neural networks.	2	2,3	6
	Machine Translation(MT) : MT Approaches, Direct MT, Rule-Based MT,	2	4	2
UNIT 5		**12**		
	Transformers: The Transformer Architecture	1	4	6

	The Encoder, Self-Attention, The Feed-Forward Layer	2	4	6
	Adding Layer Normalization, Positional Embeddings, Adding a Classification Head	2	4	6
	The Decoder, Meet the Transformers, The Transformer Tree of Life	1	4	6
	The Encoder Branch, The Decoder Branch, The Encoder-Decoder Branch	1	4	6
	Generative AI: Introduction	1	4	4, 6
	Large-scale Language models, pretrained transformers	2	4	4, 6
	BERT, GPT-3 fine tuning and chatbot	2	4	4, 6
Total Contact Hours		**45**		

Course Unitization Plan Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Text Preprocessing-I	2	1	1, 2
2	Text Preprocessing-II	2	1	1, 2
3	Word representation	2	2,3	6
4	Pos Tagging, Morphology, Name Entity Recognition	2	1,2	2,3
5	Language Models-I (Unigrams, Bigrams, N-Grams)	2	2,3	2
6	Language Models-II (Hidden Markov Model)	2	2,3	2
7	Syntax parsing and Semantic Analysis	2	1,2	1
8	Text classification-I	2	4	5
9	Text classification-II	2	4	5
10	Text Summarization-I (Extractive)	2	4	5, 6
11	Text Summarization-II (Abstractive)	2	4	5, 6
12	Question-Answering systems (Chatbots)	2	4	6
13	Machine Translation	2	4	2, 6
14	Implementation of Transformers	2	4	4, 6
15	Large Language Model (LLMs)	2	4	4, 6
Total Contact Hours		**30**		

Learning Assessment Practical

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)					End Semester Exam (40%)	
		Theory (40%)				Practical (20%)		
		Mid-Sem (15%)	CLA-1 (5%)	CLA-2 (5%)	CLA-3 (15%)	(20%)	Th (25%)	Prac (15%)
Level 1	Remember	40%	70%	70%	20%		40%	30%
	Understand							
Level 2	Apply	60%	30%	30%	80%	100%	60%	70%
	Analyze							
Level 3	Evaluate							
	Create							
Total		100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. Allen, J. (1995). Natural language understanding. Benjamin-Cummings Publishing Co., Inc..
2. Manning, C., & Schutze, H. (1999). Foundations of statistical natural language processing. MIT press.
3. Jurafsky, D. (2000). Speech & language processing. Pearson Education India.
4. https://scholar.harvard.edu/binxuw/classes/machine-learning-scratch/materials/transformers
5. Mitchell, T.M. and Tom, M. (1997) Machine Learning. McGraw-Hill, New York.
6. https://web.stanford.edu/class/cs224n/index.html

Other Resources

1. https://youtu.be/02QWRAhGc7g
2. 2.https://youtu.be/aeOLjFe256E
3. 3.Bird, S., Klein, E., & Loper, E. (2009). Natural language processing with Python: analyzing text with the natural language toolkit. " O'Reilly Media, Inc.".

Course Designers

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Data Warehousing and Pattern Mining

Course Code	AML 508	Course Category	CC	L	T	P	C
				3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	CSE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

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

Course Outcomes / Course Learning Outcomes (CLOs)

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

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

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

Course Unitization Plan Theory

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

Course Unitization Plan Lab

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

Learning Assessment Practical

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

Recommended Resources

1. Jiawei, H., & Micheline, K. (2011). Data mining: concepts and techniques. Morgan kaufmann.
2. Mining, W. I. D. (2006). Introduction to data mining (pp. 2-12). New Jersey: Pearson Education, Inc.
3. Dong, G., & Pei, J. (2007). Sequence data mining (Vol. 33). Springer Science & Business Media..
4. Kimball, R., & Ross, M. (2019). The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, Ed. Wiley.
5. VanderPlas, J. (2016). Python data science handbook: Essential tools for working with data. " O'Reilly Media, Inc.".
6. Murphy, K. P. (2012). Machine learning: a probabilistic perspective. MIT press.
7. Blum, A., Hopcroft, J., & Kannan, R. (2020). Foundations of data science. Cambridge University Press.

Other Resources

1. No Data

Course Designers

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

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

Project Management

Course Code	PGM 501	**Course Category**	RDIP		**L**	**T**	**P**	**C**
					0	2	1	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Understand Project Management Principles
2. Develop Planning and Organizational Skills
3. Enhance Communication and Leadership Abilities
4. Apply Project Management Tools and 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	Demonstrate proficiency in applying project management principles and practices to real-world projects	1	80%	75%
Outcome 2	Create detailed project plans, schedules, and budgets, and successfully manage project execution and control processes	2	80%	70%
Outcome 3	Exhibit Team Leadership and Communication Skills	3	80%	70%
Outcome 4	Use project management software and tools to plan, monitor, and close projects	2	80%	75%

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

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

Course Unitization Plan

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

Learning Assessment

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

Recommended Resources

1. Bhattacharyya, Production and Operations Management, Universal Press
2. Panneer selvam R, Production and Operations Management, Publisher: Prentice Hall of India

Course Designers

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

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

Thesis I

Course Code	AML 509	**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	Conceptualize an idea	5	75%	70%
Outcome 2	Devise a plan to do the literature survey on the idea	5	75%	70%
Outcome 3	Formulate the mathematical model for the problem.	4	75%	70%
Outcome 4	Assess the relevance and societal impact of the work	5	70%	65%
Outcome 5	Write a technical paper and report the findings.	3	75%	70%

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

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

Course Unitization Plan Theory

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

Learning Assessment

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

Recommended Resources

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

Other Resources

Course Designers

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

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

Industrial Practice

Course Code	AML 510	Course Category	RDIP		L	T	P	C
					0	0	3	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	CSE	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

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

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 ability to apply theoretical knowledge and concepts from their academic coursework to real-world industry challenges and projects.	1	80%	75%
Outcome 2	Exhibit enhanced professional skills, including effective communication, teamwork, and project management, gained through their internship experience.	2	70%	75%
Outcome 3	Demonstrate a comprehensive understanding of industry standards, practices	3	80%	70%
Outcome 4	Develop a professional network and gain insights into career opportunities and pathways within their industry.	2	80%	75%

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

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

Course Unitization Plan Theory

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

Learning Assessment

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

Recommended Resources

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

Other Resources

Course Designers

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

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

Thesis II

Course Code	AML 511	**Course Category**	RDIP		**L**	**T**	**P**	**C**
					0	0	15	15
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

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

Course Outcomes / Course Learning Outcomes (CLOs)

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

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

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

Course Unitization Plan

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

Learning Assessment

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

Recommended Resources

1. As recommended by the 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. 2. Dr. Murali Krishna Enduri, Assistant Professor, CSE, SRM University AP

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

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.

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

Information Retrieval

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

Course Objectives / Course Learning Rationales (CLRs)

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

Course Outcomes / Course Learning Outcomes (CLOs)

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

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

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

Course Unitization Plan

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

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

Learning Assessment

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

Recommended Resources

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

Other Resources

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

Course Designers

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

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Artificial Intelligence and Neural Networks

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

Course Objectives / Course Learning Rationales (CLRs)

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

Course Outcomes / Course Learning Outcomes (CLOs)

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

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

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

Course Unitization Plan

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

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

Learning Assessment

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

Recommended Resources

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

Other Resources

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

Course Designers

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

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Soft Computing

Course Code	AML 531	Course Category	CE	L	T	P	C
				3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	CSE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

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

Course Outcomes / Course Learning Outcomes (CLOs)

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

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

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

Course Unitization Plan Theory

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

Learning Assessment

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

Recommended Resources

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

Other Resources

Course Designers

1. Prof Niraj Upadhayaya, Professor, Computer Science and Engineering, SRM University – AP.