Lovely Professional University, Punjab

Course Code	Course Title	Course Planner	Lectures	Tutorials	Practicals	Credits
INT254	FUNDAMENTALS OF MACHINE LEARNING	27659::Rajan kakkar	2	0	2	3
Course Weightage	ATT: 5 CA: 25 MTT: 20 ETT: 50	**Exam Category: 55: Mid Term Exam: All Subjective – End Term Exam: All Subjective**				
Course Focus	SKILL DEVELOPMENT					
Course Focus	SKILL DEVELOPMENT					

Course Outcomes :Through this course students should be able to

CO1 :: define the concepts of linear algebra and multivariate calculus.

CO2 :: demonstrate the usage of various python libraries for data handling and visualization.

CO3 :: explain the concepts of dimensionality reduction using PCA.

CO4 :: make use of fuzzy logic to handle uncertainity in data.

CO5 :: solve the optimization problems using genetic algorithms.

CO6 :: examine the various swarm optimization techniques to solve optimization problems.

	TextBooks (T)		
Sr No	**Title**	**Author**	**Publisher Name**
T-1	MATHEMATICS FOR MACHINE LEARNING	MARC DEISENROTH, A. ALDO FAISAL, CHENG SOON ONG	CAMBRIDGE UNIVERSITY PRESS
T-2	SOFT COMPUTING WITH MATLAB PROGRAMMING	N.P. PADHY & S. P. SIMON	OXFORD UNIVERSITY PRESS

	Reference Books (R)		
Sr No	**Title**	**Author**	**Publisher Name**
R-1	PRINCIPLES OF SOFT COMPUTING	PRINCIPLES OF SOFT COMPUTING	WILEY

Relevant Websites (RW)		
Sr No	**(Web address) (only if relevant to the course)**	**Salient Features**
RW-1	http://www.tutorialspoint.com/python/python_gui_programming.htm	Learn python from basics to advanced
RW-2	https://www.geeksforgeeks.org/linear-algebra-gq/	Linear Algebra
RW-3	https://www.geeksforgeeks.org/jacobian-matrix-in-pytorch/	Jacobian matrix

RW-4	https://www.tutorialspoint.com/python_data_science/python_matplotlib.htm	Data visualization using matplotlib
RW-5	https://www.geeksforgeeks.org/principal-component-analysis-with-python/#:~:text=PCA%20is%20basically%20a%20dimension,correlation%20with%20the%20principal%20amount.	To study PCA and LDA
RW-6	http://www.austinlinks.com/Fuzzy/tutorial.html	Fuzzy systems
RW-7	http://www.ai-junkie.com/ann/evolved/nnt1.html	neural networks tutorial
RW-8	http://www.scholarpedia.org/article/Swarm_intelligence	swarm intelligence tutorial
RW-9	http://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol1/hmw/article1.html	Genetic algorithm tutorial
RW-10	http://www.worldscientific.com/worldscibooks/10.1142/4612	Application of soft computing
RW-11	http://www.wildml.com/2015/09/implementing-a-neural-network-from-scratch/	implementing neural networks in python
RW-12	http://code.activestate.com/recipes/578128-genetic-algorithm-in-python-source-code-ai-junkie-/	Implementing genetic algorithm in python

Audio Visual Aids (AV)		
Sr No	**(AV aids) (only if relevant to the course)**	**Salient Features**
AV-1	http://nptel.ac.in/courses/106108056/	NPTEL video for optimization
AV-2	http://nptel.ac.in/video.php?subjectId=117105084	NPTEL video for artificial neural networks

Software/Equipments/Databases		
Sr No	**(S/E/D) (only if relevant to the course)**	**Salient Features**
SW-1	https://www.python.org/	Pyhton
SW-2	https://pypi.python.org/pypi/scikit-fuzzy	Fuzzy logic in python

LTP week distribution: (LTP Weeks)	
Weeks before MTE	7
Weeks After MTE	7
Spill Over (Lecture)	4

Detailed Plan For Lectures

Week Number	Lecture Number	Broad Topic(Sub Topic)	Chapters/Sections of Text/reference books	Other Readings, Relevant Websites, Audio Visual Aids, software and Virtual Labs	Lecture Description	Learning Outcomes	Pedagogical Tool Demonstration/ Case Study / Images / animation / ppt etc. Planned	Live Examples

An instruction plan is only a tentative plan. The teacher may make some changes in his/her teaching plan. The students are advised to use syllabus for preparation of all examinations. The students are expected to keep themselves updated on the contemporary issues related to the course. Upto 20% of the questions in any examination/Academic tasks can be asked from such issues even if not explicitly mentioned in the instruction plan.

Week 1	Lecture 1	Linear algebra(Introduction to linear algebra)	T-1 T-2 R-1	RW-2 SW-1 SW-2	Lecture 1 should be used to discuss lecture Zero. Lecture 2 should be used to discuss fundamentals of linear Algebra and operations.	Students will be able to learn about importance of linear Algebra in Machine learning	Class room discussion using power point presentation	Linear algebra is massively used in the field of Science and Maths
	Lecture 2	Linear algebra(operations with vectors)	T-1 T-2 R-1		Lecture 2 should be used to discuss fundamentals of Linear Algebra and its operations	Students will be able to learn about Operations with vectors and modulus and inner product.	Class room discussion using power point presentation and Live demonstration of programs in Python.	Linear algebra is massively used in the field of Science and Maths
		Linear algebra(modulus and inner product)	T-1 T-2 R-1		Lecture 2 should be used to discuss fundamentals of Linear Algebra and its operations	Students will be able to learn about Operations with vectors and modulus and inner product.	Class room discussion using power point presentation and Live demonstration of programs in Python.	Linear algebra is massively used in the field of Science and Maths
		Linear algebra(cosine and dot product)	T-1 T-2 R-1		Lecture 2 should be used to discuss fundamentals of Linear Algebra and its operations	Students will be able to learn about Operations with vectors and modulus and inner product.	Class room discussion using power point presentation and Live demonstration of programs in Python.	Linear algebra is massively used in the field of Science and Maths
Week 2	Lecture 3	Linear algebra(projection)	T-1 T-2 R-1		Lecture3 should be used to discuss projections and types of matrix transformation	Discuss its matrix relative to given bases which can be understood geometrically in a two-dimensional or a three-dimensional space.	Class room discussion using power point presentation and Live demonstration of programs in Python.	Transformations are stretching, rotation, reflection and projection
		Linear algebra(changing basis)	T-1 T-2 R-1		Lecture3 should be used to discuss projections and types of matrix transformation	Discuss its matrix relative to given bases which can be understood geometrically in a two-dimensional or a three-dimensional space.	Class room discussion using power point presentation and Live demonstration of programs in Python.	Transformations are stretching, rotation, reflection and projection

Week 2	Lecture 3	Linear algebra(matrices, solving simultaneous equation problems)	T-1 T-2 R-1		Lecture3 should be used to discuss projections and types of matrix transformation	Discuss its matrix relative to given bases which can be understood geometrically in a two-dimensional or a three-dimensional space.	Class room discussion using power point presentation and Live demonstration of programs in Python.	Transformations are stretching, rotation, reflection and projection
		Linear algebra(types of matrix transformation)	T-1 T-2 R-1		Lecture3 should be used to discuss projections and types of matrix transformation	Discuss its matrix relative to given bases which can be understood geometrically in a two-dimensional or a three-dimensional space.	Class room discussion using power point presentation and Live demonstration of programs in Python.	Transformations are stretching, rotation, reflection and projection
	Lecture 4	Linear algebra(determinants and inverses)	T-1 T-2 R-1		Lecture4 should be used to discuss projections and types of matrix transformation like orthogonal, eigen values and eigen vectors	Discuss its matrix relative to given bases which can be understood geometrically in a two-dimensional or a three-dimensional space.	Class room discussion using power point presentation and Live demonstration of programs in Python.	Transformations are stretching, rotation, reflection and projection
		Linear algebra(matrices changing basis)	T-1 T-2 R-1		Lecture4 should be used to discuss projections and types of matrix transformation like orthogonal, eigen values and eigen vectors	Discuss its matrix relative to given bases which can be understood geometrically in a two-dimensional or a three-dimensional space.	Class room discussion using power point presentation and Live demonstration of programs in Python.	Transformations are stretching, rotation, reflection and projection
		Linear algebra(orthogonal matrices)	T-1 T-2 R-1		Lecture4 should be used to discuss projections and types of matrix transformation like orthogonal, eigen values and eigen vectors	Discuss its matrix relative to given bases which can be understood geometrically in a two-dimensional or a three-dimensional space.	Class room discussion using power point presentation and Live demonstration of programs in Python.	Transformations are stretching, rotation, reflection and projection
		Linear algebra(eigen values and eigen vectors)	T-1 T-2 R-1		Lecture4 should be used to discuss projections and types of matrix transformation like orthogonal, eigen values and eigen vectors	Discuss its matrix relative to given bases which can be understood geometrically in a two-dimensional or a three-dimensional space.	Class room discussion using power point presentation and Live demonstration of programs in Python.	Transformations are stretching, rotation, reflection and projection

Week 3	Lecture 5	Multivariate calculus (Introduction to multivariate calculus)	T-1 T-2 R-1		Lecture 5 will discuss about the multivariate calculus and differentiation examples	To understand a continuous-time dynamic system for optimal control	Class room discussion using power point presentation and Live demonstration of programs in Python	vectors and matrices, parametric curves, partial derivatives, double and triple integrals, and vector calculus in 2- and 3-space
		Multivariate calculus (definition of a derivative, differentiation examples & special cases,)	T-1 T-2 R-1		Lecture 5 will discuss about the multivariate calculus and differentiation examples	To understand a continuous-time dynamic system for optimal control	Class room discussion using power point presentation and Live demonstration of programs in Python	vectors and matrices, parametric curves, partial derivatives, double and triple integrals, and vector calculus in 2- and 3-space
	Lecture 6	Multivariate calculus (product rule, chain rule)	T-1 T-2 R-1	RW-3	Lecture 6 to discuss about the jacobian and the hessian	It is to understand the slope of the function along multiple dimensions	Class room discussion using power point presentation and Live demonstration of programs in Python.	To represents the best linear approximation to a differentiable function near a given point
		Multivariate calculus (differentiate with respect to anything, The Jacobian, The Hessian)	T-1 T-2 R-1		Lecture 6 to discuss about the jacobian and the hessian	It is to understand the slope of the function along multiple dimensions	Class room discussion using power point presentation and Live demonstration of programs in Python.	To represents the best linear approximation to a differentiable function near a given point
Week 4	Lecture 7	Multivariate calculus (multivariate chain rule)	T-1 T-2 R-1		Lecture 7 will discuss about the multivariate calculus and chain rule.	To find the derivative of a composite function	Class room discussion using power point presentation and Live demonstration of programs in Python.	From the Chain Rule, we can see how variables like time, speed, distance, volume, and weight are interrelated

Week 4	Lecture 7	Multivariate calculus (building approximate functions)	T-1 T-2 R-1		Lecture 7 will discuss about the multivariate calculus and chain rule.	To find the derivative of a composite function	Class room discussion using power point presentation and Live demonstration of programs in Python.	From the Chain Rule, we can see how variables like time, speed, distance, volume, and weight are interrelated
		Multivariate calculus(power series)	T-1 T-2 R-1		Lecture 7 will discuss about the multivariate calculus and chain rule.	To find the derivative of a composite function	Class room discussion using power point presentation and Live demonstration of programs in Python.	From the Chain Rule, we can see how variables like time, speed, distance, volume, and weight are interrelated
	Lecture 8	Multivariate calculus (linearisation)	T-1 T-2 R-1		Lecture 8 covers the topic linearisation and multivariate taylor	to find patterns and correlations between several variables simultaneously	Class room discussion using power point presentation and Live demonstration of programs in Python.	used in world of mathematics and optimization theory
		Multivariate calculus (multivariate taylor)	T-1 T-2 R-1		Lecture 8 covers the topic linearisation and multivariate taylor	to find patterns and correlations between several variables simultaneously	Class room discussion using power point presentation and Live demonstration of programs in Python.	used in world of mathematics and optimization theory
Week 5	Lecture 9	Data handling and visualization using python (types of data)	T-1 T-2 R-1	RW-1 AV-1 AV-2	Lecture 9 covers the topic types of data,math operations and handling missiong values	To learn library like numpy and pandas to handle missing	Class room discussion using power point presentation and Live demonstration of programs in Python.	
		Data handling and visualization using python (reading the data)	T-1 T-2 R-1		Lecture 9 covers the topic types of data,math operations and handling missiong values	To learn library like numpy and pandas to handle missing	Class room discussion using power point presentation and Live demonstration of programs in Python.	

Week 5	Lecture 9	Data handling and visualization using python (math operations for data analysis)	T-1 T-2 R-1		Lecture 9 covers the topic types of data,math operations and handling missiong values	To learn library like numpy and pandas to handle missing	Class room discussion using power point presentation and Live demonstration of programs in Python.	
		Data handling and visualization using python (handling missing values)	T-1 T-2 R-1		Lecture 9 covers the topic types of data,math operations and handling missiong values	To learn library like numpy and pandas to handle missing	Class room discussion using power point presentation and Live demonstration of programs in Python.	
	Lecture 10	Data handling and visualization using python (Converting data into numerical format)	T-1 T-2 R-1	RW-4	Lecture 10 to discuss about matplot and seaborn libraries.	To visualize the data and representation of data in correlation matrix	Class room discussion using power point presentation and Live demonstration of programs in Python.	
		Data handling and visualization using python (correlation matrix)	T-1 T-2 R-1		Lecture 10 to discuss about matplot and seaborn libraries.	To visualize the data and representation of data in correlation matrix	Class room discussion using power point presentation and Live demonstration of programs in Python.	
		Data handling and visualization using python (data visualization using different graphs)	T-1 T-2 R-1		Lecture 10 to discuss about matplot and seaborn libraries.	To visualize the data and representation of data in correlation matrix	Class room discussion using power point presentation and Live demonstration of programs in Python.	
Week 6	Lecture 11	Dimensionality Reduction (statistics of dataset)	T-1 T-2 R-1		Lecture 11 to discuss about statistics about dataset	To show hidden detail and all connecting parts by using orthogonal projection	Class room discussion using power point presentation and Live demonstration of programs in Python.	
		Dimensionality Reduction (orthogonal projections)	T-1 T-2 R-1		Lecture 11 to discuss about statistics about dataset	To show hidden detail and all connecting parts by using orthogonal projection	Class room discussion using power point presentation and Live demonstration of programs in Python.	

Week 6	Lecture 12	Dimensionality Reduction (problem setting and PCA objective)	T-1 T-2 R-1	RW-5	Lecture 12 covers topic PCA and finding the coordinates of the projected data.	To understand the unsupervised learning algorithms across the variety of applications such as EDA.	Class room discussion using power point presentation and Live demonstration of programs in Python.	
		Dimensionality Reduction (finding the coordinates of the projected data)	T-1 T-2 R-1		Lecture 12 covers topic PCA and finding the coordinates of the projected data Lecture 12 covers kernel PCA and LDA	To understand the unsupervised learning algorithms across the variety of applications such as EDA and kernel PCA	Class room discussion using power point presentation and Live demonstration of programs in Python.	
		Dimensionality Reduction (steps of PCA)	T-1 T-2 R-1		Lecture 12 covers topic PCA and finding the coordinates of the projected data Lecture 12 covers kernel PCA and LDA	To understand the unsupervised learning algorithms across the variety of applications such as EDA and kernel PCA	Class room discussion using power point presentation and Live demonstration of programs in Python.	
		Dimensionality Reduction (linear discriminant analysis)	T-1 T-2 R-1		Lecture 12 covers topic PCA and finding the coordinates of the projected data Lecture 12 covers kernel PCA and LDA	To understand the unsupervised learning algorithms across the variety of applications such as EDA and kernel PCA	Class room discussion using power point presentation and Live demonstration of programs in Python.	
		Dimensionality Reduction (kernel PCA)	T-1 T-2 R-1		Lecture 12 covers topic PCA and finding the coordinates of the projected data Lecture 12 covers kernel PCA and LDA	To understand the unsupervised learning algorithms across the variety of applications such as EDA and kernel PCA	Class room discussion using power point presentation and Live demonstration of programs in Python.	
Week 7	Lecture 13				Test - Code based 1			
		SPILL OVER						
Week 7	Lecture 14				Spill Over			
		MID-TERM						

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Week 8	Lecture 15	Fuzzy logic(basic definition and terminology)	T-2 R-1		This lecture should be used to discuss basics of fuzzy set, difference between fuzzy and crisp set, fuzzy logic application and fuzzy logic toolbox in python plugins for fuzzy logic	Students will be able to learn fuzzy logic basic concepts in python.	Class room discussion, demonstration using Python.	
		Fuzzy logic(set-theoretic fuzzy operations)	T-2 R-1	RW-6 RW-7	This lecture should be used to discuss basics of fuzzy set, difference between fuzzy and crisp set, fuzzy logic application and fuzzy logic toolbox in python plugins for fuzzy logic	Students will be able to learn fuzzy logic basic concepts in python.	Class room discussion, demonstration using Python.	
		Fuzzy logic(fuzzy sets and operations on fuzzy sets)	T-2 R-1		This lecture should be used to discuss basics of fuzzy set, difference between fuzzy and crisp set, fuzzy logic application and fuzzy logic toolbox in python plugins for fuzzy logic	Students will be able to learn fuzzy logic basic concepts in python.	Class room discussion, demonstration using Python.	
	Lecture 16	Fuzzy logic(fuzzy relations)	T-2 R-1		Lecture 15 should be used to discuss fuzzyfication, defuzzyfication and fuzzy rules .Lecture 16 should be used to discuss implementation of fuzzification, defuzzyfication and fuzzy rules in Python.	Students will be able to learn fuzzy inference system and implement it in python	Class room discussion, demonstration using Python.	

Week 8	Lecture 16	Fuzzy logic(fuzzy rules and fuzzy reasoning)	T-2 R-1		Lecture 15 should be used to discuss fuzzyfication, defuzzyfication and fuzzy rules .Lecture 16 should be used to discuss implementation of fuzzification, defuzzyfication and fuzzy rules in Python.	Students will be able to learn fuzzy inference system and implement it in python	Class room discussion, demonstration using Python.	
Week 9	Lecture 17	Fuzzy logic(fuzzy inference system)	T-2 R-1		Lecture 17 should be used to discuss implementation of fuzzification, defuzzyfication and fuzzy rules in Python.	Students will be able to learn fuzzy inference system and implement it in python	Class room discussion, demonstration using Python.	
		Fuzzy logic(fuzzification and defuzzification methods)	T-2 R-1		Lecture 17 should be used to discuss implementation of fuzzification, defuzzyfication and fuzzy rules in Python.	Students will be able to learn fuzzy inference system and implement it in python	Class room discussion, demonstration using Python.	
	Lecture 18	Fuzzy logic(fuzzy based expert system)	T-2 R-1		Lecture 18 should be used to discuss expert system components. Lecture 18 should be used to discuss implementation of expert system using fuzzy logic in Python.	Students will be able to learn expert system and its application	Class room discussion, demonstration using Python.	
Week 10	Lecture 19	Genetic algorithms (introduction to genetic algorithms)	T-1 T-2 R-1	RW-8 RW-9 RW-10	Lecture 19 should be used to discuss genetic algorithm concepts .Lecture 19 should be used to discuss genetic algorithm tool box in Python.	Students will be able to learn genetic operators and its Application.	Class room discussion, demonstration using Python.	

Week 10	Lecture 19	Genetic algorithms(genetic operators)	T-1 T-2 R-1		Lecture 19 should be used to discuss genetic algorithm concepts .Lecture 19 should be used to discuss genetic algorithm tool box in Python.	Students will be able to learn genetic operators and its Application.	Class room discussion, demonstration using Python.	
	Lecture 20	Genetic algorithms(working of genetic algorithm)	T-1 T-2 R-1		Lecture 19 should be used to discuss genetic algorithm use in optimization . Lecture 20 should be used to discuss application of genetic algorithm in Python.	Students will be able to apply genetic algorithm in Python.	Class room discussion, demonstration using Python.	
		Genetic algorithms (applications of genetic algorithm)	T-1 T-2 R-1		Lecture 19 should be used to discuss genetic algorithm use in optimization . Lecture 20 should be used to discuss application of genetic algorithm in Python.	Students will be able to apply genetic algorithm in Python.	Class room discussion, demonstration using Python.	
Week 11	Lecture 21	Genetic algorithms(genetic programming)	T-1 T-2 R-1		Lecture 20 should be used to discuss genetic algorithm use in Optimization. Lecture 21 should be used to discuss application of genetic algorithm in Python.	Students will be able to apply genetic algorithm in Python.	Class room discussion, demonstration using Python.	
	Lecture 22	Swarm optimization techniques(swarm intelligence)	T-1 T-2 R-1		Lecture 22 should be used to discuss swarm intelligence fundamentals and applications.	Student will be able to understand swarm intelligence usages, applications.	Class room discussion, demonstration using Python.	
Week 12	Lecture 23				Project			

Week 12	Lecture 24	Swarm optimization techniques(ant colony optimization)	T-1 T-2 R-1		Lecture 24 should be Used to discuss firefly algorithm. and should be Used to discuss firefly algorithm program in python and usage.	Students will learn How nature motivates to solve problems.	Video Demonstration, class room discussion	
		Swarm optimization techniques(swarm intelligence in bees)	T-1 T-2 R-1	RW-11 RW-12	Lecture 24 should be Used to discuss firefly algorithm. and should be Used to discuss firefly algorithm program in python and usage.	Students will learn How nature motivates to solve problems.	Video Demonstration, class room discussion	
Week 13	Lecture 25	Swarm optimization techniques(Firefly Algorithm)	T-1 T-2 R-1		Lecture 25 should be Used to discuss program on crow search and Used to discuss crow search algorithm.	Students will learn how Problems are solved using Crow search	Demonstration using animations and videos	
		Swarm optimization techniques(Crow Search Algorithm)	T-1 T-2 R-1		Lecture 25 should be Used to discuss program on crow search and Used to discuss crow search algorithm.	Students will learn how Problems are solved using Crow search	Demonstration using animations and videos	
	Lecture 26	Swarm optimization techniques(cuckoo search)	T-1 T-2 R-1		Lecture 26 should be used to discuss implementation of wolf bat and cuckoo in Python.	Students will learn how problems are solved using wolf bat technique to solve real world problem.	Animation, problem based learning	
		Swarm optimization techniques(Hybrid Wolf-Bat Algorithm)	T-1 T-2 R-1		Lecture 26 should be used to discuss implementation of wolf bat and cuckoo in Python.	Students will learn how problems are solved using wolf bat technique to solve real world problem.	Animation, problem based learning	

Week 13	Lecture 26	Swarm optimization techniques(Whale Search Algorithm)	T-1 T-2 R-1		Lecture 26 should be used to discuss implementation of wolf bat and cuckoo in Python.	Students will learn how problems are solved using wolf bat technique to solve real world problem.	Animation, problem based learning	
		Swarm optimization techniques(grasshopper optimization)	T-1 T-2 R-1		Lecture 26 should be used to discuss implementation of wolf bat and cuckoo in Python.	Students will learn how problems are solved using wolf bat technique to solve real world problem.	Animation, problem based learning	
Week 14	Lecture 27				Test - Code based 2			
		SPILL OVER						
Week 14	Lecture 28				Spill Over			
Week 15	Lecture 29				Spill Over			
	Lecture 30				Spill Over			

Scheme for CA:

CA Category of this Course Code is:C010102 (Total 3 tasks, 1 compulsory and out of remaining 1 best out of 2 to be considered)

Component	Iscompulsory	Weightage (%)	Mapped CO(s)
Project	Yes	50	CO1, CO2, CO3, CO4, CO5, CO6
Test - Code based 1	NO	50	CO1, CO2, CO3
Test - Code based 2	NO	50	CO4, CO5, CO6

Details of Academic Task(s)

Academic Task	Objective	Detail of Academic Task	Nature of Academic Task (group/individuals)	Academic Task Mode	Marks	Allottment / submission Week
Project	To check and enhance the project development ability and team work among students.	A project topic assigned by instructor to each group	Group	Offline	30	3 / 12
Test - Code based 1	To evaluate subject understanding and learning ability of the students	Syllabus of test will cover from Unit 1,Unit 2 and Unit 3 and Student should answer the question based on python code. Maximum marks of code based test is 30.	Individual	Offline	30	7 / 8
Test - Code based 2	To evaluate subject understanding and learning ability of the students.	Syllabus of Test will cover from fuzzy logic, genetic algorithms and optimization problems.	Individual	Offline	30	12 / 13