ADVANCED ALGORITHM IN AI & ML **Course Code : 316320**

Programme Name/s : **Artificial Intelligence/ Artificial Intelligence and Machine Learning**
Programme Code : **AI/ AN**
Semester : **Sixth**
Course Title : **ADVANCED ALGORITHM IN AI & ML**
Course Code : **316320**

I. RATIONALE

Machine Learning is a sub-field of Computer Science that leverages algorithms to replicate the way humans learn. It employs statistical techniques to train models and generate predictions. Many state-of-the-art AI and ML models rely on advanced algorithms to function effectively. Advanced algorithms often provide optimized ways to train models or make predictions more efficiently. The demand for AI and ML experts is growing, with roles in research, data science, and machine learning requiring a strong grasp of advanced algorithms. Mastering these techniques can develop ability to solve problems and stay at the forefront of AI innovation.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences:
Apply advanced AI-ML algorithms to solve real world problems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply suitable Machine learning model for dataset feature extraction.
- CO2 - Implement Machine learning algorithms on given problem.
- CO3 - Implement Artificial Neural Networks analyzing associated parameters of Deep Learning.
- CO4 - Build a Convolutional Neural Network for given context.
- CO5 - Classify Sequential and Image Data using Deep Learning.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316320	ADVANCED ALGORITHM IN AI & ML	AAM	DSE	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Select a suitable model for the given data with justification. TLO 1.2 Explain the process of supervised learning on the given data. TLO 1.3 Explain the process of Feature extraction and Engineering. TLO 1.4 Compare Feature Engineering for the given type of data. TLO 1.5 Differentiate between Feature scaling & Feature selection.	**Unit - I ML Models and Features Engineering** 1.1 Introduction of ML models 1.2 Training a model for Supervised learning 1.3 Features : Understanding data, Feature extraction and Engineering 1.4 Feature engineering on : Numerical data, Categorical data & Text data 1.5 Feature scaling & Feature selection	Lecture Using Chalk-Board Presentations
2	TLO 2.1 Explain the working of Support Vector Machines. TLO 2.2 Explain the method of performance analysis of clustering for the given problem. TLO 2.3 Illustrate the process of Dimensionality Reduction. TLO 2.4 Explain Association Rule Learning. TLO 2.5 Differentiate between various Generative models.	**Unit - II Supervised and Unsupervised Learning Algorithms** 2.1 Supervised Learning : Support Vector Machines- Working, Types and Implementation of SVM 2.2 Unsupervised Learning : K-Mediod Algorithm- working and implementation 2.3 Dimensionality Reduction: Introduction, Subset Selection, Principal Component Analysis 2.4 Association Rule Learning–Apriori Algorithm, Eclat Algorithm 2.5 Generative Models - Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs)	Lecture Using Chalk-Board Presentations Demonstration

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Describe the concepts of ANN. TLO 3.2 Explain the functioning of Perceptron Learning Algorithm with example. TLO 3.3 Explain Gradient Descent rule. TLO 3.4 Calculate the output of the network for the given input pattern & given activation function.	**Unit - III Artificial Neural Networks** 3.1 Introduction of Artificial Neural Networks(ANN) 3.2 Perceptron : Basic Components, working, Types ,Training Rule 3.3 Gradient Descent Rule, Gradient, Types of Gradient Descent 3.4 Activation Functions: Sigmoid, ReLU, Hyperbolic tangent, Softmax etc.	Lecture Using Chalk-Board Presentations Flipped Classroom
4	TLO 4.1 Illustrate use of CNN in real-life applications. TLO 4.2 Explain the functions of different Layers in a CNN. TLO 4.3 Describe the characteristics of different types of Pooling. TLO 4.4 Analyse different open source CNN architectures.	**Unit - IV Convolutional Neural Networks** 4.1 Convolutional Neural Networks : Introduction, Architecture and Applications 4.2 Padding, Strided convolution, Convolution over volume, Pooling 4.3 Case studies: LeNet, AlexNet, VGGNet, ResNet, GoogleNet etc.	Lecture Using Chalk-Board Presentations Case Study
5	TLO 5.1 Describe the process of implementing Deep Learning for Sequential Data. TLO 5.2 Illustrate the process of implementing Deep Learning for Image Data. TLO 5.3 Explain working of GPT.	**Unit - V Deep Learning for Sequential data and Image data** 5.1 Sequential Data: Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM) networks, Gated Recurrent Units (GRUs) 5.2 Image Data : Pre-trained Neural Networks, Transfer Learning, Fine Tuning 5.3 Introduction to Transformers, Generative Pre-training Transformer(GPT)	Lecture Using Chalk-Board Presentations Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Install required platform to use Python, PyTorch, Scikit-learn library.	1	* a. Installation of Tools and Libraries (Jupyter Notebook /Matplotlib/ Numpy / Pandas / PyTorch/ scikit-learn) b. Use of google colab (https://colab.research.google.com/)	2	CO1
LLO 2.1 Implement filter and wrapper method on dataset.	2	Apply filter and wrapper method on any standard datasets	2	CO1
LLO 3.1 Implement program for Data Preprocessing Techniques.	3	* Perform following operations :(Assume suitable data/dataset if needed). I. Write program to read dataset (Text,CSV,JSON,XML) II. Which of the attributes are numeric and which are categorical? III. Performing Data Cleaning, Handling Missing Data, Removing Null data IV. Rescaling Data v. Encoding Data V. Feature Selection	2	CO1
LLO 4.1 Implement SVM for classification using dataset.	4	* Write a program to implement SVM for classification using suitable dataset	2	CO2
LLO 5.1 Implement unsupervised machine learning algorithm.	5	Write a program to implement unsupervised machine learning algorithm (Clustering – K Medoid) in python on dataset to cluster data. (Assume suitable dataset)	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Implement Apriori Algorithm for Association Rule Learning.	6	* Write a program to implement Association Rule Learning (Apriori Algorithm) on any dataset	2	CO2
LLO 7.1 Implement Eclat Algorithm for Association Rule Learning.	7	Write a program to implement Association Rule Learning (Eclat Algorithm) on any dataset	2	CO2
LLO 8.1 Implement Perceptron algorithm for AND logic gate.	8	* Write a program to implement AND Logic Gate with 2-bit Binary Input using Perceptron algorithm	2	CO3
LLO 9.1 Implement Perceptron algorithm using dataset.	9	* Write a program to implement Perceptron Learning in Python using Iris flower dataset	2	CO3
LLO 10.1 Develop Gradient Descent in PyTorch.	10	Write a program to implement Gradient Descent in PyTorch	2	CO3
LLO 11.1 Implement Back propagation/feed forward neural network.	11	Write a program to implement /Simulate Back propagation/feed forward neural network	2	CO4
LLO 12.1 Apply given CNN architecture.	12	Build a small CNN model consisting of 5 convolution layers	2	CO4
LLO 13.1 Implement CIFAR 10- CNN.	13	* Write a program to implement CIFAR 10- CNN using PyTorch	2	CO4
LLO 14.1 Implement a basic LSTM model for forecasting future values based on past data.	14	Basic Time Series Forecasting with LSTM	2	CO5
LLO 15.1 Classify image data using pre trained model.	15	* Classification of images using imagenet dataset	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Train a GAN for Image Generation.
- Implement and Tune a Convolutional Neural Network (CNN) for Transfer Learning.
- Implement and Train a Transformer Model for Text Generation.
- Implement a Neural Network with Backpropagation and Vanishing Gradient Problem.
- Implement and Train a Transformer Model for Text Generation
- Build an AI Model for Time Series Forecasting.

Micro project

- Develop a micro project for credit card fraud detection using publically available datasets like Kaggle credit card fraud detection dataset to classify transactions as either fraudulent or non-fraudulent.
- Develop a micro project for image classification using support vector machine. Use labeled dataset of images like CIFAR-10 Dataset, MNIST Dataset etc. Discuss the limitations of SVM for image classification.
- Develop a micro project to implement machine learning model capable of predicting stock market trends (up/down) based on historical data and provide visualization of stock price movement.
- Develop a micro project for Predicting Diabetes. Use Pima Indians Diabetes Database available on kaggle. Provide visualizations of model evaluation, such as confusion matrix and ROC curve, for better interpretation.
- Develop a micro project for Face Recognition system which uses Dlib's deep learning model.

Other

- Complete the course on Infosys Springboard such as Variety of ML algorithms / Support vector algorithm in ML / Advanced setting in ML model etc .

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computer (i5 preferable), RAM minimum 8 GB onwards	All
2	Operating system: Windows 10 onwards	All
3	Software: Editor: Python setup, PyTorch	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	ML Models and Features Engineering	CO1	6	4	2	4	10
2	II	Supervised and Unsupervised Learning Algorithms	CO2	12	4	4	10	18
3	III	Artificial Neural Networks	CO3	9	2	6	6	14
4	IV	Convolutional Neural Networks	CO4	9	4	4	6	14
5	V	Deep Learning for Sequential data and Image data	CO5	9	2	6	6	14
Grand Total				**45**	**16**	**22**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Continuous assessment based on process and product related performance indicators.
- Each practical will be assessed considering 60% weightage to process 40% weightage to product.
- A continuous assessment based term work.

Summative Assessment (Assessment of Learning)

- End semester examination, Lab performance, Viva voce.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	1	1	1	2	-	2			
CO2	2	2	2	2	2	2	3			
CO3	2	2	2	2	2	1	3			
CO4	2	2	2	2	2	1	3			
CO5	2	1	2	2	2	1	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Andreas C. Müller & Sarah Guido	Introduction to Machine Learning with Python	O'Reilly Media, Inc ISBN-13: 978-9352134571
2	Tom M Mitchell	Machine Learning	McGraw Hill Education; First Edition ISBN-13: 978-1259096952
3	Rudolph Russell	Machine Learning Step-by-Step Guide To Implement Machine Learning Algorithms with Python	CreateSpace Independent ISBN-13: 978-1719528405
4	Dipanjan Sarkar, Raghav Bali, Tushar Sharma	Practical Machine Learning with Python A Problem-Solver's Guide to Building Real-World Intelligent Systems	Apress ISBN-13:978-1484232064
5	François Chollet	Deep Learning with Python	Manning Publications ISBN-13:978-1617294433
6	Rajiv Chopra	Deep Learning - A Practical Approach	Khanna Publishing House ISBN-13:978-9386173416
7	Ian Pointer	Programming PyTorch for Deep Learning	O'Reilly Media ISBN-13:978-1492045359
8	Josh Patterson, Adam Gibson	Deep Learning: A Practitioner's Approach	Shroff/O'Reilly ISBN-13:978-9352136049

XIII . LEARNING WEBSITES & PORTALS

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Sr.No	Link / Portal	Description
1	https://www.python.org/downloads/	Python IDE download
2	https://www.pdfdrive.com/machine-learning-step-by-step-guide-to-implement-machine-learning-algorithms-with-python-d158324853.html	AI and ML E-Books
3	https://www.geeksforgeeks.org/how-to-install-python-pycharm-on-windows/	Guidelines for Installation of python
4	https://www.pythoncentral.io/how-to-install-pytorch-using-pip-a-step-by-step-guide/	Installation of PyTorch on windows
5	https://www.geeksforgeeks.org/what-is-feature-engineering/	Feature Engineering
6	https://scikit-learn.org/stable/modules/svm.html	Support Vector Machine
7	https://towardsdatascience.com/an-introduction-to-deep-learning-for-sequential-data-ac966b9b9b67/	Deep learning for sequential data

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students