Course File Index
2022-23

Course Name: **Course ID:** **Semester**

Sr. No.	Particulars	Reference
1.	Academic Calendar	
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3.	Course syllabus	
4.	Lecture/Lab/Assignments Plan with recommended books and the books followed for teaching.	
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10.	Question Bank UT1 & UT2	
11.	Question Paper UT1 & UT2 with model answer/Marking Scheme	
12.	Attendance, Grading sheet of Assignment , Tutorial, Experiment, Test, Term work, Course Exit Survey with analysis	
13.	Results and Results Analysis of previous semester Examination of the subject/s taught by you.(ODD)	
14.	Lab manual	
15.	Progress Report 1 & 2 (Ref. Class Teacher)	
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17.	Previous semesters University Question Papers with solutions.	
18.	Mini project list with some sample reports	
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20.	Steps taken to identify weak students and proof of action taken	
21.	Documents of content beyond syllabus	
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23.	Lecture notes	
24.	Student Feedback	
25.	Audit Report	
26.	Proof of any claim made in SAR related to your subject like innovation in teaching learning and assignments and other pedagogical methods.	

Subject: Machine Learning (ML-CSC604) **Credits-3**

Course Objectives:

1. To introduce Machine learning concepts
2. To develop mathematical concepts required for Machine learning algorithms
3. To understand various Regression techniques
4. To understand Clustering techniques
5. To develop Neural Network based learning models

Teaching Scheme

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tut	Credits
CSC604	Machine Learning	03	--	--	03	--	---	03
CSL604	Machine Learning Lab	--	02	--	--	1	--	01

Examination Scheme

Course Code	Course Name	Theory Marks				Term Work	Practical & Oral	Total
		Internal Assessment			End Sem Exam			
		Test1	Test2	Avg				
CSC604	Machine Learning	20	20	20	80 (3hr)	--	---	100
CSL604	Machine Learning Lab					25	25	50

Syllabus: **Prerequisite**: Data Structures, Basic Probability and Statistics, Algorithms

1. **Introduction to Machine Learning (06)**
   - 1.1. Introduction to Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps of developing a Machine, Learning Application.
   - 1.2. Supervised and Unsupervised Learning: Concepts of Classification, Clustering and prediction, Training, Testing and validation dataset, cross validation, overfitting and underfitting of model
   - 1.3. Performance Measures: Measuring Quality of model- Confusion Matrix, Accuracy, Recall, Precision, Specificity, F1 Score, RMSE

2. **Mathematical Foundation for ML (05)**
   - 2.1. System of Linear equations, Norms, Inner products, Length of Vector, Distance between vectors, Orthogonal vectors
   - 2.2. Symmetric Positive Definite Matrices, Determinant, Trace, Eigenvalues and vectors, Orthogonal Projections, Diagonalization, SVD and its applications

3. **Linear Models (07)**
   - 3.1. The least-squares method, Multivariate Linear Regression, Regularized Regression, Using Least-Squares Regression for classification
   - 3.2. Support Vector Machines

4. **Clustering (04)**
   - 4.1. Hebbian Learning rule
   - 4.2. Expectation -Maximization algorithm for clustering

5. **Classification models (10)**
   - 5.1. Introduction, Fundamental concept, Evolution of Neural Networks, Biological Neuron, Artificial Neural Networks, NN architecture, McCulloch-Pitts Model. Designing a simple network, Non-separable patterns, Perceptron model with Bias. Activation functions, Binary, Bipolar, continuous, Ramp. Limitations of Perceptron.
   - 5.2. Perceptron Learning Rule. Delta Learning Rule (LMS-Widrow Hoff), Multi-layer perceptron network. Adjusting weights of hidden layers. Error back propagation algorithm
   - 5.3. Logistic regression

6. **Dimensionality Reduction (07)**
   - 6.1. Curse of Dimensionality.
   - 6.2. Feature Selection and Feature Extraction
   - 6.3. Dimensionality Reduction Techniques, Principal Component Analysis.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

Lecture Plan : SEM VII-ML-CSC604

Modes of Content Delivery:

I	Class Room Teaching	v	Self-Learning Online Resources	ix	Industry Visit
Ii	Tutorial	vi	Slides	x	Group Discussion
Iii	Remedial Coaching	vii	Simulations/Demonstrations	xi	Seminar
Iv	Lab Experiment	viii	Expert Lecture	xii	Case Study

Term : 09th Jan – 22 Apr 2023 (UT1 : 27 Feb - 2 Mar) (UT2 : 17Apr -20 Apr)

No.	Portion to be covered	Planned date	Actual date	Content Delivery - Reference /Assessment Method
1	Introduction Syllabus. **Introduction to Machine Learning**	9-01-23	9/1/23	PPT [1_BigData] – Video1, [TB1] /UT1
2	Issues in Machine Learning, Application of Machine Learning, Steps of developing a Machine, Learning Application.	10-01-23	10/1/23	
3	Supervised and Unsupervised Learning Concepts of Classification, Clustering and prediction.	13-01-23	13/1/23	
4	Training, Testing and validation dataset, cross validation, overfitting and underfitting of model.	16-01-23	16/1/23 17/1/23	
5	Performance Measures: Measuring Quality of model- Confusion Matrix, Accuracy,	17-01-23	20/1/23	
6	Recall, Precision, Specificity, F1 Score, RMSE	20-01-23		
7	**Mathematical Foundation for ML:** System of Linear equations, Norms, Inner products	24-01-23		
8	Length of Vector, Distance between vectors, Orthogonal vectors	27-01-23		
9	Symmetric Positive Definite Matrices, Determinant, Trace, Eigenvalues and vectors,	31-01-23		
10	Orthogonal Projections, Diagonalization	31-01-23		
11	SVD and its applications	02-02-23		
12	**Linear Models-** The least-squares method, Using Least-Squares	03-02-23		
13	Multivariate Linear Regression	07-02-23		
14	Regularized Regression	09-02-23		
15	Regression for classification	10-02-23		
16	Support Vector Machines	14-02-23		
17	Support Vector Machines	16-02-23		
18	Support Vector Machines	17-02-23		
19	**Clustering**	21-02-23		
20	Hebbian Learning rule	23-02-23		
21	Expectation-Maximization algorithm for clustering	24-02-23		
22	Maximization algorithm for clustering – case study	03-03-23		

23	**Classification models** Introduction, Fundamental concept, Evolution of Neural Networks, Biological Neuron	07-03-23		
24	Artificial Neural Networks, NN architecture,	09-03-23		
25	McCulloch-Pitts Model, Designing a simple network,	10-03-23		
26	Non-separable patterns, Perceptron model with Bias.	14-03-23		
27	Activation functions, Binary, Bipolar, continuous, Ramp. Limitations of Perceptron.	16-03-23		
28	Perceptron Learning Rule.	17-03-23		
29	Delta Learning Rule (LMS-Widrow Hoff),	21-03-23		
30	Multi-layer perceptron network.	23-03-23		
31	Adjusting weights of hidden layers. Error back propagation algorithm	24-03-23		
32	Logistic regression	28-03-23		
33	Logistic regression	30-03-23		
34	**Dimensionality Reduction** Curse of Dimensionality.	04-04-23		
35	Feature Selection and Feature Extraction-1	06-04-23		
36	Feature Selection and Feature Extraction-2	07-04-23		
37	Dimensionality Reduction Techniques-1	11-04-23		
38	Dimensionality Reduction Techniques-2	13-04-23		
39	Principal Component Analysis -1	14-04-23		
40	Principal Component Analysis -2	21-04-23		

Total Lectures : 40

Text Books:

1. Nathalie Japkowicz & Mohak Shah, " Evaluating Learning Algorithms: A Classification Perspective", Cambridge.
2. Marc Peter Deisenroth, Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning"
3. Samir Roy and Chakraborty, "Introduction to soft computing", Pearson Edition.
4. Ethem Alpaydm, "Introduction to Machine Learning", MIT Press, McGraw-Hill Higher Education
5. Peter Flach, "Machine Learning", Cambridge University Press

References books:

1. Tom M. Mitchell, "Machine Learning", McGraw Hill
2. Kevin P. Murphy, "Machine Learning - A Probabilistic Perspective ", MIT Press
3. Stephen Marsland, " Machine Learning an Algorithmic Perspective", CRC Press.
4. Shai Shalev-Shwartz, Shai Ben- David, "Understanding Machine Learning", Cambridge University Press
5. Peter Harrington, "Machine learning in Action", Dream Tech Press

Reference Web Resources:

1. NPTEL
2. AI and ML Certification - Enroll in PGP AI ML Courses with Purdue (simplilearn.com)
3. https://www.learndatasci.com/out/coursera-machine-learning/
4. https://www.learndatasci.com/out/google-machine-learning-crash-course/

Course Outcomes: [Target 2.5]

After successful completion of the course students will be able to:

CSC604.1 : Comprehend basics of Machine Learning
CSC604.2 : Build Mathematical foundation for machine learning
CSC604.3 : Understand various Machine learning models
CSC604.4 : Select suitable Machine learning models for a given problem
CSC604.5 : Build Neural Network based models
CSC604.6 : Apply Dimensionality Reduction techniques

Mapping of CO and PO/PSO

Relationship of course outcomes with program outcomes: Indicate 1 (low importance), 2 (Moderate Importance) or 3 (High Importance) in respective mapping cell.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1
CSC604.1	3				3									3
CSC604.2	3													3
CSC604.3	3	3	3	2	3				2					3
CSC604.4	3	3	3	2	3				2	2	2	2		3
CSC604.5	3	3	3	2	3				2	2	2	2		3
CSC604.6	3	3	3	2	3				2	3	2			3
TOTAL	18	12	12	8	15				8	7	6	4		18
CO-PO MATRIX	**3**	**3**	**3**	**2**	**3**				**2**	**2**	**2**			**3**

CO ASSESSMENT TOOLS

	Direct Methods (80%)					**Indirect Methods (20%)**
CSC604.1	Test 1 (20%)	Assign 1 (40%)	UE –TH (20%)	UE-O (10%)	Lab 1-2 (10%)	(100%)
CSC604.2	Test1 (30%)	Lab 3 to 12 (30%)	UE –TH (20%)	UE-O (10%)	A2 (10%)	(100%)
CSC604.3	Test1 (20%)	Lab 3-4-5 (30%)	UE –TH (20%)	UE-O (10%)		(100%)
CSC604.4	Test1 (20%)	Lab 11 (10%)	UE –TH (10%)	UE-O (10%)	MP (50%)	(100%)
CSC604.5	Test2 (20%)	Lab 6-7-8-9-10 (20%)	UE –TH (20%)	UE-O (10%)	MP (30%)	(100%)
CSC604.6	Test2 (20%)	Lab 11 (40%)	UE –TH (20%)	UE-O (20%)		(100%)

Gurriculum Gap/Content Beyond Syllabus:

Sr. No.	Curriculum Gap	Activity
1	Decision Tree, Random Forest, Apriori	
2	Learnability of Models, Loss functions and Optimization for ML	
3	Mathematical working of back propagation	
4	Concepts of standardisation, Regularization, Normalization along with Dimensionality Reduction	
5	Gist of Time series, Reinforcement learning	

Sr. No.	Content Beyond Syllabus	Activity
1	Time Series Data	
2	Ensemble Modelling	
3	Bias Removal in ML	
4	**MLOps**	
5	Build Models from scratch with small dataset	
6	Gradient Descent (Lab 10) – Back Propagation	
7	Paper Review after each lab	
8	Transfer learning in last lab	

1. MLOPs
2. Gradient decent, Bagging, Boosting, hyper parameter tuning
3. Understand Maths behind, dataset splitting, cross validation, F1 score calculation
4. Tensor RT
5. TF Hub&API, Hugging Face, Pytorch,Tensorflow, Scikit, Catboost, LGBM, MLib, XGBoost
6. Stanford video lectures
7. Andrej Karpathys blogs, https://mml-book.github.io/
8. https://www.manning.com/books/deep-learning-with-python-second-edition?a_aid=keras&a_bid=76564dff

Rubrics-Experiment

Class : T.*E. AI & DS* **Semester : V**

Practical No:	
Title:	
Date of Performance:	
Roll No:	
Name of the Student:	

Evaluation:

Indicator	**Very Poor**	**Poor**	**Average**	**Good**	**Excellent**
Timeline (02)	More than three sessions late (0)	More than two sessions late (0)	Two sessions late (0.5)	One session late (1)	Early or on time (2)
Efforts (02)	N/A	N/A	N/A	Partially Completed (1)	Completed (2)
Data Set, Model Training and Interpretation of performance(04)	N/A	Model is trained with some performance (01)	Model is trained using standard parameters and interpretated performance partially (02)	Model is trained using standard parameters and interpreted performance (03)	Model is trained using adjusted parameters and Interpreted performance done on Accuracy/Confusion matrix etc. (04)
Writeup/Oral Assessment (02)	N/A	N/A	N/A	Partially Understood (2)	Understood Concept (2)

Signature

Rubrics for Assignments

Class : T.*E. AI & DS* **Semester : V**

Assignment No:	
Title:	
Date of Performance:	
Roll No:	
Name of the Student:	

Evaluation:

Indicator	**Very Poor**	**Poor**	**Average**	**Good**	**Excellent**
Timeline (2)	More than three sessions late (0)	More than two sessions late (0.5)	Two sessions late (1)	One session late (1.5)	Early or on time (2)
Organization (3)	N/A	Very poor readability and not structured (0.5)	Poor readability and somewhat structured (1)	Readable with one or two mistakes and structured (2)	Very well written and structured without any mistakes (3)
Level of content (3)	N/A	Major points are omitted or addressed minimally (0.5)	All major topics are covered, the information is accurate.(1)	Most major and some minor criteria are included. Information is Accurate (2)	All major and minor criteria are covered and are accurate. (3)
Depth of Knowledge(2)	N/A	One answer correct(0.5)	Two answers correct(1)	Three answers correct(1.5)	Four answers correct(2)

Signature

Rubrics for Mini Project

Class : T.*E. AI & DS* **Semester : V**

Practical No:	
Title:	
Date of Performance:	
Roll No:	
Name of the Student:	

Indicator	**Very Poor**	**Poor**	**Average**	**Good**	**Excellent**
Timeline: Maintains project deadline (2)	Project not done (0)	More than two session late (0.5)	Two sessions late (1)	One session late (1.5)	Early or on time (2)
Completeness: Complete all parts of project (2)	N/A	< 40% complete (0.5)	~ 60% complete (1)	~ 80% complete(1.5)	100% complete(2)
Model Training and Interpretation of performance (4)	N/A	Model is trained with some performance (01)	Model is trained using standard parameters and interpretated performance partially (02)	Model is trained using standard parameters and interpreted performance (03)	Model is trained using adjusted parameters and Interpreted performance done on Accuracy/Confusion matrix etc. (04)
Presentation (2)	Not submitted report (0)	Poorly written and poorly kept report(0.5)	Report with major mistakes(1)	Report with less than 3-4 mistakes (1.5)	Well written accurate report(2)

Signature