IPS Academy, Institute of Engineering & Science

(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)

Department of Computer Science & Engineering

Bachelor of Technology (B.Tech.)

Honors Certification in Artificial Intelligence & Machine Learning (AI & ML)

(For students of Computer Science & Engineering)

S.No.	Subject Code	Semester	Subject Name	Contact Hours per week			Total Credits
				L	T	P	
1.	HOCS-IML501	V	Statistics and Exploratory Data Analytics	2	1	2	4
2.	HOCS-IML601	VI	Machine Learning Algorithms	2	1	2	4
3.	HOCS-IML701	VII	Deep Learning	2	1	2	4
4.	HOCS-IML801	VIII	*Practical Machine Learning with Tensorflow	2	1	-	3
			Total	8	4	6	15

1 Hr Lecture	1 Hr Tutorial	2 Hr Practical
1 Credit	1 Credit	1 Credit

Note: *VIII semester subject (Practical Machine Learning with Tensorflow or any other course equivalent to Practical Machine Learning with Tensorflow) can also be done from MOOC courses (NPTEL etc.) with minimum credit 3.

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HOCS-IML501	**Statistics and Exploratory Data Analytics**	**2L: 1T: 2P (5 hrs.)**	**Credits:04**

Course Objective:

Course Objective: The main objective of this course is to provide students with the foundations of probabilistic and statistical analysis using R Programming which is mostly used in varied applications in engineering

Module 1: **(08 hrs.)**

Introduction of R Software and Probability theory

Introduction to basic concepts of R programming language, Introduction to Probability , Sample Space and Events , Set Theory and Events using Venn Diagrams , Relative Frequency and Probability , Probability and Relative Frequency - An Example , Axiomatic Definition of Probability , Some Rules of Probability , Basic Principles of Counting- Ordered Set, Unordered Set, and Permutations , Basic Principles of Counting- Combination , Conditional Probability , Multiplication Theorem of Probability, Bayes' Theorem , Independent Events ..

Module 2: **(08 hrs.)**

Random Variables

Random Variables - Discrete and Continuous , Cumulative Distribution and Probability Density Function , Discrete Random Variables, Probability Mass Function and Cumulative Distribution Function , Expectation of Variables, Moments and Variance , Skewness and Kurtosis , Quantiles and Tschebyschevâ€™s Inequality .

Module 3: **(08 hrs.)**

Probability Distributions

Degenerate and Discrete Uniform Distributions, Bernoulli and Binomial Distribution, Poisson Distribution , Geometric Distribution , Continuous Random Variables and Uniform Distribution, Normal Distribution, Exponential Distribution , Bivariate Probability Distribution for Discrete Random Variables, Bivariate Probability Distribution for Continuous Random Variables, Examples in Bivariate Probability Distribution Functions .

Module 4: **(08 hrs.)**

Testing of hypothesis-I

Covariance and Correlation , Bivariate Normal Distribution, Chi square Distribution, t - Distribution , F – Distribution, Distribution of Sample Mean, Convergence in Probability and Weak Law of Large Numbers , Central Limit Theorem , Needs for Drawing Statistical Inferences , Unbiased Estimators , Efficiency of Estimators , CramÃ©râ€“Rao Lower Bound and Efficiency of Estimators , Consistency and Sufficiency of Estimators, Method of Moments, Method of Maximum Likelihood and Rao Blackwell Theorem.

Module 5: **(08 hrs.)**

Testing of hypothesis-II

Basic Concepts of Confidence Interval Estimation ,Confidence Interval for Mean in One Sample with Known Variance ,Confidence Interval for Mean and Variance, Basics of Tests of Hypothesis and Decision Rules ,Test Procedures for One Sample Test for Mean with Known Variance ,One Sample Test for Mean with Unknown Variance ,Two Sample Test for Mean with Known and Unknown Variances ,Test of Hypothesis for Variance in One and Two Samples.

Course Outcome:

CO1: To explain R software and apply basic concepts of probability in engineering problems.
CO2: To explain the basic concepts of statistics and apply in engineering fields.
CO3: To explain and apply the concepts of probability distribution in evaluation of engineering problems.
CO4: Apply the various test of significance to structure engineering decision-making problems.
CO5: To identify and solve problems regarding probability and hypothesis.

List of Text Books / Reference Books:

1. Introduction to Statistics and Data Analysis With Exercises, Solutions and Applications in R Authors: Heumann, Christian, Schomaker, Michael, Shalabh, Publisher" Springer 2016
2. Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 2018, Wiley (Low price edition available)
3. Introduction to. Mathematical. Statistics. Robert V. Hogg. Allen T. Craig,, Low price Indian edition by Pearson Education
4. Probability and Statistics for Engineers. Richard A. Johnson, Irwin Miller, John Freund
5. Mathematical Statistics with Applications. Irwin Miller, Marylees Miller, Pearson Education
6. The R Software-Fundamentals of Programming and Statistical Analysis -Pierre Lafaye de Micheaux, Rémy Drouilhet, Benoit Liquet, Springer 2013
7. A Beginner's Guide to R (Use R) By Alain F. Zuur, Elena N. Ieno, Erik H.W.G. Meesters, Springer 2009.
8. **NPTEL Course Link: https://nptel.ac.in/courses/111/104/111104146/**

List of Experiments:

1. Installation and Working with R.
2. Installation and Working with R Studio.
3. Calculations with R as a Calculator, Calculations with Data Vectors.
4. Built-in Commands and Bivariate Plots.
5. Logical Operators and Selection of Sample.
6. Computation of Probability using R
7. Data Based Moments and Variance in R Software.
8. Discrete Uniform Distribution in R.
9. Binomial Distribution in R.
10. Poisson distribution in R.
11. Geometric Distribution in R.
12. Normal Distribution in R.
13. Chi square Distribution in R
14. Bivariate Probability Distribution in R Software.
15. Covariance and Correlation in R.

HOCS-IML601	Machine Learning Algorithms	2L: 1T: 2P (5 hrs.)	Credits: 04

Course Objective:

The main goal of this course is to help students to learn machine learning techniques, and scaling up machine learning approaches.

Module 1: **(08 hrs.)**

Introduction of Machine Learning, Different Types of Learning, Hypothesis Space and Inductive Bias, Evaluation and Cross-Validation, Linear Regression, Introduction to Decision Trees, Learning Decision Tree, Over fitting.

Module 2: **(08 hrs.)**

k-Nearest Neighbour, Feature Selection, Feature Extraction, Collaborative Filtering, , Bayesian Learning, Naive Bayes, Bayesian Network.

Module 3: **(08 hrs.)**

Logistic Regression, Introduction Support Vector Machine , SVM : The Dual Formulation, SVM :Maximum Margin with Noise , Nonlinear SVM and Kernel Function, SVM : Solution to the Dual Problem, Multilayer Neural Network , Neural Network and Back propagation Algorithm.

Module 4: **(08 hrs.)**

Introduction to Computational Learning Theory, Sample Complexity: Finite Hypothesis Space, VC Dimension, Introduction to Ensembles, Bagging and Boosting

Module 5: **(08 hrs.)**

Introduction to Clustering, Kmeans Clustering, Agglomerative Hierarchical Clustering.

Course Outcome:

1. Understand different types of learning.
2. Identify the feature selection and Extraction process.
3. Explain Logistic Regression, SVM and various concepts of Neural Network.
4. Understand the fundamentals of Sample Complexity
5. State Clustering Techniques.

List of Text Books / Reference Books:

1. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer-Verlag New York Inc., 2nd Edition, 2011.
2. Tom M. Mitchell, “Machine Learning”, McGraw Hill Education, First edition, 2017.
3. Aurelien Geon, “Hands-On Machine Learning with Scikit-Learn and Tensorflow: Concepts, Tools, and Techniques to Build Intelligent Systems”, Shroff/O'Reilly; First edition (2017).
4. Francois Chollet, "Deep Learning with Python", Manning Publications,1edition (2018)
5. Andreas Muller, "Introduction to Machine Learning with Python: A Guide for Data Scientists", Shroff/O'Reilly; First edition (2016).
6. Russell, S. and Norvig, N. “Artificial Intelligence: A Modern Approach”, Prentice Hall Series in Artificial Intelligence. 2003.
7. **NPTEL Course Link: https://nptel.ac.in/courses/106/105/106105152/**

List of Experiments:

1. Write a program to implement Decision Tree.
2. Write a program to implement linear regression.
3. Write a program to implement KNN.
4. Write a program to implement Principal Component Analysis.
5. Write a program to implement Naive Bayes.
6. Write a program to implement Neural Network.
7. Write a program to implement KMeans Clustering.
8. Write a program to implement support vector machine.

HOCS-IML701	Deep Learning	2L: 1T: 2P (5 hrs.)	Credits:04

Course Objective:

This course aims to provide basic knowledge about the deep learning and computational challenges of building stable representations for high-dimensional data, such as images, text.

Module 1: **(08 hrs.)**

Introduction to Deep Learning, Machine learning Vs Deep learning, Feature Descriptor , Bayesian Learning , Discriminate Function , Linear Classifier.

Module 2: **(08 hrs.)**

Support Vector Machine, Linear Machine, Multiclass Support Vector Machine, Optimization, Optimization Techniques in Machine Learning, Nonlinear Functions.

Module 3: **(08 hrs.)**

Introduction to Deep Neural Network, Multilayer Perceptron, Back propagation Learning, Loss Function, Auto encoder, Auto encoder Vs. PCA , Auto encoder Training, Auto encoder Variants , Convolution, Cross Correlation.

Module 4: **(08 hrs.)**

CNN Architecture, MLP versus CNN, Popular CNN Architecture: LeNet, AlexNet,VGC16,Transfer Learning, Vanishing and Exploding Gradient, GoogleNet, ResNet, Optimisers: Momentum and Nesterov Accelerated Gradient(NAG), Adagrad, RMSprop, AdaDelta and Adam Optimiser

Module 5: **(08 hrs.)**

Normalization, Batch Normalization, Layer, Instance, Group Normalization, Training Trick, Regularization, Early Stopping , Face Recognition, Deconvolution Layer, Semantic Segmentation , Image Denoising, Variational Autoencoder , Generative Adversarial Network.

Course Outcome:

1. Understand the concept of Deep Learning.
2. Identify various learning model and optimization technique.
3. State the concepts of Deep Neural Network and Auto encoder.
4. Explain CNN Architecture.
5. Explain Normalization techniques.

List of Text Books / Reference Books:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, “Deep Learning”, MIT Press, 2016.
2. Richard O. Duda, Peter E. Hart, David G. Stork, “Pattern Classification”, John Wiley & Sons Inc.
3. Andrew Glassner, “Deep Learning: A Visual Approach” Penguin Random House Publisher Services ,2021.
4. John D. Kelleher, “Deep Learning (The MIT Press Essential Knowledge series)
5. Francois Chollet, “ Deep Learning with Python ”.
6. **NPTEL Course Link: https://nptel.ac.in/courses/106/105/106105215/**

List of Experiments:

Apply and Analyze the Concepts of Deep Learning on following Data Set.

1. Image Data set
2. Text Data Set
3. Sound Data.
4. Biological Data Set.

HOCS-IML801	**Practical Machine Learning with TensorFlow**	**2L: 1T: 0P (3 Hrs.)**	**Credits:03**

Course Objective:

This course provides a foundation of machine learning using TensorFlow

Course Contents :(40 hrs)

Module 1 **(08 hrs.)**

Overview of Tensorflow & Machine Learning, Steps in Machine Learning Process, Loss Functions in Machine Learning, Gradient Descent, Gradient Descent Variations, Model Selection and Evaluation, Machine Learning Visualization.

Module 2: **(08 hrs.)**

Introduction to Tensors, Mathematical Foundations of Deep Learning - Building Data Pipelines for Tensorflow-Part, Text Processing with Tensorflow

Module 3: **(08 hrs.)**

Classify Images, Regression, Classify Structured Data, Text Classification, Under fitting and Overfitting, Save and Restore Models, CNNs, Transfer learning with pretrained CNNs, Transfer learning with TF hub, Image classification and visualization, Estimator API

Module 4: **(08 hrs.)**

Logistic Regression, Boosted Trees, Introduction to word embeddings, Recurrent Neural Networks ,Time Series Forecasting with RNNs, Text Generation with RNNs.,

Module 5: **(08 hrs.)**

TensorFlow Customization, Customizing tf.keras, TensorFlow Distributed Training

Course Outcome:

1. Understand the concept of Tensor Flow and Machine learning
2. State the concept of Text Processing with Tensorflow
3. Explain classification and visualization.
4. Explain RNN.
5. State the concept of Keras

List of Text / Reference Books:

1. Pramod Singh and Avish Manure, “Implement Machine Learning and Deep Learning Models with Python”, Apress 2019.
2. Rowel Atienza, “Advanced Deep Learning with TensorFlow 2 and Keras”, Packt Publishing Limited, 2020.
3. Josh Patterson and Adam Gibson, “Deep Learning: A Practitioner's Approach”, O'Reilly Media,2017.
4. Seth Weidman, “Deep Learning from Scratch: Building with Python from First Principles” O'Reilly Media, 2019.
5. **NPTEL Course Link: https://nptel.ac.in/courses/106/106/106106213/**