Major/Minor Specialization Scheme-AY-2020-2021(R-2020)
Data Science

Course Description			Teaching Scheme (Program Specific)				
Semester	Course Code	Course Title	Modes of Teaching / Learning / Weightage				
			Hours Per Week (Approx)				Credits
			Theory	Tutorial	Practical	Total Contact Hours	
3	SP-CS-DS-301	Introduction to Statistics	3-5	-	-	40	3
4	SP-CS-DS-401	Introduction to Data Analytics	3-5	-	-	40	3
5	SP-CS-DS-501	Introduction to Machine Learning	3-5	-	-	40	3
6	SP-CS-DS-601	Deep Learning	3-5	-	-	40	3
7	SP-CS-DS-701	Tools for Data Analytics	3-5	-	-	40	3
8	SP-CS-DS-801	Reinforcement Learning	3-5	-	-	40	3
		Total (per semester)	**40**	**0**	**0**	**240**	**18**

1) ESE- End Semester Examination
2) Assignments can be either NPTEL Assignments/Assignments assigned to Students by Faculty Mentor
3) Students need to go through the syllabus in sequential fashion.
4) Students can do two parallel courses in a semester if he has backlog.

Dr. Rashmi Thakur
Specialization Incharge

Dr. Harshali Patil
HOD-COMP

Syllabus for Data Science Specialization – R-2020
A.Y. (20-21)
S.E. Semester –III

B.E. (Computer Engineering)							**S.E. SEM: III**		
Course Name: Introduction to Statistics							**Course Code:**SP-CS-DS-301		
Teaching Scheme (Program Specific)					**Examination Scheme (Formative/ Summative)**				
Modes of Teaching / Learning / Weightage					**Modes of Continuous Assessment / Evaluation**				
Hours Per Week					**Theory (100)**		**Practical/Oral (25)**	**Term Work (25)**	**Total**
Theory	**Tutorial**	**Practical**	**Contact Hours**	**Credits**	**Assignment**	**ESE**	**PR/OR**	**TW**	
3	-	-	3	3	25	75	-	-	**100**
ESE: End Semester Examination - Paper Duration - 3Hours									
Prerequisite:									

Course Objective:
This is an introductory course in statistics designed to provide students with the basic concepts of data analysis and statistical computing. The main objective is to provide students with pragmatic tools for assessing statistical claims and conducting their own statistical analyses.

Detailed Syllabus:
Total Hours:- 40 (12 Weeks)

Module No.	Topics	NPTEL/MOOCLink
1	**Introduction to Statistics and Data** Types of Statistics, types of Data and sources of Data, Population vs Sample, Scales of Measurement, Data representation techniques- Part 1 , Data representation techniques- Part 2 and measures of central tendency- Part 1, Measures of Central Tendency- Part 2, Examples of introduction to data and data representation techniques, Measures of Variation, Applications of Measures of Central Tendency and Measures of Variation, Chapter concepts- Measures of central tendency and measures of variation, Outliers, and shape of a distribution	https://nptel.ac.in/courses/110/107/110107114/
2	**Numerical Descriptive Measures** Covariance and Coefficient of Correlation, Introduction to Probability, Probability- Part 1, Probability- Part 2, Probability- Part 3, Probability Distributions- Part 1, Probability Distributions- Part 2, Probability Distributions- Part 3, Examples for Standardized Normal Distribution, Evaluating Normality, Exponential Probability Distribution	https://nptel.ac.in/courses/110/107/110107114/
3	**Concepts â€“ Probability Distributions**	

	Sampling and Sampling Techniques, Sampling Distribution-I Sampling Distribution-II, Sampling Distribution-III, Method of Estimation, Interval Estimation, Confidence Interval-I, Confidence Interval-II, Types of Hypothesis Testing	https://nptel.ac.in/courses/110/107/110107114/
4	**Hypothesis Testing**	https://nptel.ac.in/courses/110/107/110107114/
	Hypothesis Testing Process-I, Hypothesis Testing Process-II, Hypothesis Testing Examples, Hypothesis Testing of Proportions-I, Hypothesis Testing of Proportions-II, Hypothesis Testing-One sample Test, Hypothesis Testing using Minitab, Hypothesis Testing of Proportions using Minitab, Hypothesis Testing Two Sample Test-I, Hypothesis Testing Two Sample Test-II	
5	**Hypothesis Testing&Analysis of variance**	https://nptel.ac.in/courses/110/107/110107114/
	Hypothesis Testing: Two sample test-III, Paired Sample Test, Hypothesis Testing of Proportion, Example of Hypothesis Testing, Analysis of variance-I, Analysis of variance-II, Analysis of variance-III, Tukey Kramer test, Randomized Blocked Design	
6	**A Factorial Design&Simple linear regression**	https://nptel.ac.in/courses/110/107/110107114/
	A Factorial Design-I, A Factorial Design-II, Chi-square test goodness of fit-I, Chi-square test goodness of fit-II, Chi-square test of independence, Simple linear regression â€“I, Simple linear regression â€“II, Assumption of Regression, Multiple Regression Example of multiple Regression	

Detailed Syllabus:

Total Hours:- 40 (12 Weeks)

One Module =Approx. 2 weeks

Dr. Manish Rana	**Dr. Rashmi Thakur**	**Dr. Harshalipatil**
Faculty Mentor	**Specialization In-charge**	**HOD**

Syllabus for Data Science Specialization – R-2020
A.Y. (20-21)
S.E. Semester –IV

B.E. (Computer Engineering)							**S.E. SEM: IV**		
Course Name: Introduction to Data Analytics							**Course Code:**SP-CS-DS-401		
Teaching Scheme (Program Specific)					**Examination Scheme (Formative/ Summative)**				
Modes of Teaching / Learning / Weightage					**Modes of Continuous Assessment / Evaluation**				
Hours Per Week					**Theory (100)**		**Practical/Oral (25)**	**Term Work (25)**	**Total**
Theory	**Tutorial**	**Practical**	**Contact Hours**	**Credits**	**Assignment**	**ESE**	**PR/OR**	**TW**	
3	-	-	3	3	25	75	-	-	**100**
ESE: End Semester Examination - Paper Duration - 3 Hours									
Prerequisite: Python programming									

Course Objective: the course intends to learn how one can use analytics in their career and life and creating analytics models.

Detailed Syllabus:

Module No.	Topics	NPTEL/MOOCLink
1	**Introduction to Data Analytics and Probability** Introduction to data analytics and Python fundamentals, Introduction to probability	https://onlinecourses.nptel.ac.in/noc21_cs45/preview
2	**Sampling Theory** Sampling and sampling distributions and Hypothesis testing	https://onlinecourses.nptel.ac.in/noc21_cs45/preview
3	**Introduction to ANOVA** Two sample testing and introduction to ANOVA, Two way ANOVA and linear regression	https://onlinecourses.nptel.ac.in/noc21_cs45/preview
4	**Regression** Linear regression and multiple regression, Concepts of MLE and Logistic regression	https://onlinecourses.nptel.ac.in/noc21_cs45/preview
5	**Regression Analysis** ROC and Regression Analysis Model Building, C^2 Test and introduction to cluster analysis	https://onlinecourses.nptel.ac.in/noc21_cs45/preview
6	**Clustering** Clustering analysis, Classification and Regression Trees (CART)	https://onlinecourses.nptel.ac.in/noc21_cs45/preview

Total Hours: - 40 (12 Weeks)

One Module =Approx. 2 weeks

Mr. Shailesh Sangle	**Dr. Rashmi Thakur**	**Dr. Harshali Patil**
Faculty Mentor	**Specialization In-charge**	**HOD-COMP**

Syllabus for Data Science Specialization – R-2020
A.Y. (2020-2021)
T.E. Semester –V

B.E. (Computer Engineering)							**T.E. SEM: V**		
Course Name: Introduction to Machine Learning							**Course Code:**SP-CS-DS-501		
Teaching Scheme (Program Specific)					**Examination Scheme (Formative/ Summative)**				
Modes of Teaching / Learning / Weightage					**Modes of Continuous Assessment / Evaluation**				
Hours Per Week					**Theory (100)**		**Practical/Oral (25)**	**Term Work (25)**	**Total**
Theory	**Tutorial**	**Practical**	**Contact Hours**	**Credits**	**Assignment**	**ESE**	**PR/OR**	**TW**	**100**
3	-	-	3	3	25	75	-	-	
ESE: End Semester Examination - Paper Duration - 3 Hours									
Prerequisite: Linear Algebra and Calculus, Probability Basics									

Course Objective: The Objective of this course is to introduce some of the basic concepts of machine learning from a mathematically point of view. Also introduce various machine learning algorithms to solve real world problemsin the domain of Data Science, Data Mining, Information Retrieval, Computer visionand Linguistics.

Detailed Syllabus:
Total Hours:- 40 (12 Weeks)

Module No.	Topics	NPTEL Link
1	**Introduction to Machine Learning**	https://onlinecourses.nptel.ac.in/noc21_cs24/preview
	Basics of Machine Learning,Types of Machine Learning Introduction: Statistical Decision Theory - Regression, Statistical Decision Theory -Classification, Bias Variance	
2	**Regression**	
	Linear Regression, Multivariate Regression, Subset Selection, Shrinkage Methods, Principal Component Regression, Partial Least squares	
3	**Neural Network**	
	Introduction, Early Models, Perceptron Learning, Neural Networks - Backpropagation, Neural Networks - Initialization, Training & Validation, Parameter Estimation	
4	**Classification**	
	Linear Classification, Logistic Regression, SVM, Decision Trees, Regression Tree, Decision Trees - Stopping Criterion & Pruning, Loss functions, Decision Trees - Categorical Attributes, Multiway Splits, Missing Values, Decision Trees - Instability, Example, Evaluation Measures-1	
5	**Trends in Machine Learning**	
	Bootstrapping & Cross Validation, Class Evaluation Measures, ROC curve, MDL, Ensemble Methods - Bagging, Committee Machines and Stacking, Ensemble Methods – Boosting	

	Gradient Boosting, Random Forests, Multi-class Classification, Naive Bayes, Bayesian Networks, Undirected Graphical Models, HMM, Variable Elimination, Belief Propagation	
6	**Clusteringand Reinforcement Learning**	
	Partitional Clustering, Hierarchical Clustering, Birch Algorithm, CURE Algorithm, Density-based Clustering, Gaussian Mixture Models, Expectation Maximization, Learning Theory, Introduction to Reinforcement Learning, RL Framework and application	
	Total Hours	

One Module =Approx. 2 weeks

Ms. VaishaliNirgude	**Dr. Rashmi Thakur**	**Dr. HarshaliPatil**
Faculty Mentor	**Specialization In-charge**	**HOD COMP**

Syllabus for Data Science Specialization – R-2020
A.Y. (20-21)
S.E. Semester –VI

B.E. (Computer Engineering)									**S.E. SEM: VI**
Course Name: Deep Learning									**Course Code:** SP-CS-DS-601
Teaching Scheme (Program Specific)					**Examination Scheme (Formative/ Summative)**				
Modes of Teaching / Learning / Weightage					**Modes of Continuous Assessment / Evaluation**				
Hours Per Week					**Theory (100)**		**Practical/Oral (25)**	**Term Work (25)**	**Total**
Theory	**Tutorial**	**Practical**	**Contact Hours**	**Credits**	**Assignment**	**ESE**	**PR/OR**	**TW**	
3	-	-	3	3	25	75	-	-	**100**
ESE: End Semester Examination - Paper Duration - 3 Hours									
Prerequisite:									

Course Objective:

Module No.	Topics	NPTEL/MOOCLink
1	**Introduction to Deep Learning** History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons,Perceptron Learning Algorithm Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks	https://onlinecourses.nptel.ac.in/noc21_cs35/preview
2	**Feed Forward Neural Networks** Feed Forward Neural Networks, Backpropagation Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam,	https://onlinecourses.nptel.ac.in/noc21_cs35/preview
3	**Autoencoder & PCA** Eigenvalues and eigenvectors, Eigenvalue Decomposition, Basis Principal Component Analysis and its interpretations, Singular Value Decomposition Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders	https://onlinecourses.nptel.ac.in/noc21_cs35/preview
4	**Regularization & Normalization** Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharin and tying, Injecting noise at input, Ensemble methods, Dropout Greedy Layerwise Pre-training, Better activation functions, Better	https://onlinecourses.nptel.ac.in/noc21_cs35/preview

	weight initialization methods, Batch Normalization	
5	**Convolutional Neural Networks**	https://onlinecourses.nptel.ac.in/noc21_cs35/preview
	Learning Vectorial Representations Of Words Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks	
6	**Recurrent Neural Networks**	https://onlinecourses.nptel.ac.in/noc21_cs35/preview
	Recurrent Neural Networks, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU,LSTMs Encoder Decoder Models, Attention Mechanism, Attention over images	

Detailed Syllabus:
Total Hours:- 40 (12 Weeks)

One Module =Approx. 2 weeks

Mr.Nitin Harane	**Dr.Rashmi Thakur**	**Dr.Harshali Patil**
Faculty Mentor	**Specialization In-charge**	**HOD**

Syllabus for Data Science Specialization – R-2020
A.Y. (2020-2021)
B.E. Semester –VII

B.E. (Computer Engineering)							**S.E. SEM: VII**		
Course Name: Tools for Data Analytics							**Course Code:** SP-CS-DS-701		
Teaching Scheme (Program Specific)					**Examination Scheme (Formative/ Summative)**				
Modes of Teaching / Learning / Weightage					**Modes of Continuous Assessment / Evaluation**				
Hours Per Week					**Theory (100)**		**Practical/Oral (25)**	**Term Work (25)**	**Total**
Theory	**Tutorial**	**Practical**	**Contact Hours**	**Credits**	**Assignment**	**ESE**	**PR/OR**	**TW**	
3	-	-	3	3	25	75	-	-	**100**
ESE: End Semester Examination - Paper Duration - 3 Hours									
Prerequisite: Python programming									

Course Objective: The course intends to learn how one can use different analytics tools to collect, measure, analysis and reporting of data about learners and their interactions with a learning environment.

Detailed Syllabus:

Module No.	Topics	NPTEL/MOOC Link
1	**Tools for preprocessing** Introduction to data analytics. Tools for Data Preprocessing	https://nptel.ac.in/courses/127/101/106101224/
2	**Tools for Machine Learning and Descriptive Analytics** Introduction to Machine Learning and Descriptive Analytics. Tools for Machine Learning and Descriptive Analytics.	https://nptel.ac.in/courses/127/101/106101224/
3	**Tools for Diagnostic Analytics and Data Mining** Introduction to Diagnostic Analytics and Data Mining Tools for Diagnostic Analytics and Data Mining.	https://nptel.ac.in/courses/127/101/106101224/
4	**Tools for Predictive Analytics** Introduction to Predictive Analytics and tools for Predictive Analytics.	https://nptel.ac.in/courses/127/101/106101224/
5	**Tools for Text Analytics** Introduction to Text Analytics and tools for Text Analytics.	https://nptel.ac.in/courses/127/101/106101224/
6	**Tools for Multimodal Learning Analytics** Introduction to Multimodal Learning Analytics and tools for multimodal Learning Analytics.	https://nptel.ac.in/courses/127/101/106101224/

Total Hours: - 40 (12 Weeks)

One Module =Approx. 2 weeks

Mrs. Ashwini Patil — **Faculty Mentor**

Dr. Rashmi Thakur — **Specialization In-charge**

Dr. Harshali Patil — **HOD-COMP**

Syllabus for Data Science Specialization – R-2020
A.Y. (2020-21)
S.E. Semester –VIII

B.E. (Computer Engineering)									**B.E. SEM: VIII**
Course Name: Reinforcement Learning									**Course Code:**SP-CS-DS-801
Teaching Scheme (Program Specific)					**Examination Scheme (Formative/ Summative)**				
Modes of Teaching / Learning / Weightage					**Modes of Continuous Assessment / Evaluation**				
Hours Per Week					**Theory (100)**		**Practical/Oral (25)**	**Term Work (25)**	**Total**
Theory	**Tutorial**	**Practical**	**Contact Hours**	**Credits**	**Assignment**	**ESE**	**PR/OR**	**TW**	
3	-	-	3	3	25	75	-	-	**100**
ESE: End Semester Examination - Paper Duration - 3 Hours									
Prerequisite:									

Course Objective: The course intends to develop an intuitive understanding of the foundational ideas of reinforcement learning by exploring various processes and mathematical approaches. The students will also learn different reinforcement techniques to be applied in real world problems.

Detailed Syllabus:
Total Hours:- 40 (12 Weeks)

Module No.	Topics	NPTEL/MOOCLink
1	**Introduction to Reinforcement Learning** Introduction, Bandit algorithms – UCB, PAC	https://onlinecourses.nptel.ac.in/noc21_cs25/preview
2	**Bandit Algorithms and MDP** Bandit algorithms –Median Elimination, Policy Gradient, Full RL & MDPs	https://onlinecourses.nptel.ac.in/noc21_cs25/preview
3	**Dynamic Programming and Temporal Difference Learning** Bellman Optimality, Dynamic Programming & TD Methods	https://onlinecourses.nptel.ac.in/noc21_cs25/preview
4	**Function Approximation Methods** Eligibility Traces, Function Approximation	https://onlinecourses.nptel.ac.in/noc21_cs25/preview
5	**Deep Reinforcement Learning** Least Squares Methods, Fitted Q, DQN & Policy Gradient for Full RL	https://onlinecourses.nptel.ac.in/noc21_cs25/preview
6	**Hierarchical Reinforcement Learning and MDP** Hierarchical RL, POMDPs	https://onlinecourses.nptel.ac.in/noc21_cs25/preview

***One Module =Approx. 2 weeks**

Dr. Prachi Janrao	**Dr. Rashmi Thakur**	**Dr. HarshaliPatil**
Faculty Mentor	**Specialization In-charge**	**HOD**