Major/Minor Specialization Scheme-AY-2020-2021(R-2020)
Artificial Intelligence

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-AI-301	Essential Mathematics for Machine Learning	3-5	-	-	40	3
4	SP-CS-AI-401	Introduction to Artificial Intelligence	3-5	-	-	40	3
5	SP-CS-AI-501	Introduction to Machine Learning	3-5	-	-	40	3
6	SP-CS-AI-601	Introduction to Soft Computing	3-5	-	-	40	3
7	SP-CS-AI-701	Applied Natural Language Processing	3-5	-	-	40	3
8	SP-CS-AI-801	Deep 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. Megharani Patil
Specialization Incharge

Dr. Harshali Patil
HOD

Syllabus for Artificial Intelligence Specialization – R-2020
A.Y. (2021-2022)
S.E. Semester –III

B.E. (Computer Engineering)							**S.E. SEM: III**		
Course Name: Essential Mathematics for Machine Learning							**Course Code:** SP-CS-AI-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**	**IA**	**ESE**	**PR/OR**	**TW**	
3	-	-	3	3	25	75	-	-	**100**
ESE: End Semester Examination - Paper Duration - 3 Hours									
Prerequisite: Basic Mathematics									

Course Objective: The Objective of this course is to introduce mathematical concepts required to apply in Machine Learning and Data science, an area that is in demand today.

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

Module No.	Topics	NPTEL Link
1	**Calculus for Machine Learning**	https://nptel.ac.in/courses/111/107/111107137/
	Vectors in Machine Learning, Basics of Matrix Algebra, Vector Space, Subspace, Basis and Dimension. Linear Transformations, Norms and Spaces, Orthogonal Complement and Projection Mapping, Eigenvalues and Eigenvectors, Special Matrices and Properties.	
2	**Dimensionality Reduction**	
	Spectral Decomposition, Singular Value Decomposition, Low Rank Approximations, Python Implementation of SVD and Low-rank Approximation. Principal Component Analysis, Python Implementation of PCA, Linear Discriminant Analysis, Python Implementation of LDA.	
3	**Linear Algebra for Machine Learning**	
	Least Square Approximation and Minimum Normed Solution, Linear and Multiple Regression, Logistic Regression. Classification Metrics, Gram Schmidt Process, Polar Decomposition, Minimal Polynomial and Jordan Canonical Form, Some more Matrices Applications in Machine Leaning.	
4	**Calculus**	
	Basics concepts of Calculus, gradient, Jacobian, Chain rule, Change of variables. Calculus in Python, Convex sets and convex functions, properties of convex functions, Introduction to Optimization.	
5	**Optimization**	

	Numerical Optimization in Machine Learning, Gradient Descent and other optimization algorithms in machine learning. Optimization using Python, Review of Probability, Bayes theorem and random variable, Expectation and variance.	
6	**SVM**	
	Discrete and continuous distribution functions, joint probability and covariance, Introduction to SVM, Error minimizing LPP. Lagrangian Multiplier method, concepts of duality, hard and soft margin classifier, SVM in Python.	
	Total Hours	

One Module =Approx. 2 weeks

Mrs. Shiwani Gupta Dr. MegharaniPatil Dr. HarshaliPatil

Assist. Prof COMP **AI Specialization Incharge** **HOD-COMP**

Syllabus for Artificial Intelligence Specialization – R-2020
A.Y. (2020-2021)
S.E. Semester –IV

B.E. (Computer Engineering)							**S.E. SEM: IV**		
Course Name: Introduction to Artificial Intelligence							**Course Code:** SP-CS-AI-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: Data Structures, Probability									

Course Objective: The Objective of this course is to understand the variety of concepts in the field of artificial intelligence. It discusses the philosophy of AI, and how to model a new problem as an AI problem. It describes a variety of models such as search, logic, Bayes nets, and MDPs, which can be used to model a new problem. It also teaches many first algorithms to solve each formulation. The course prepares a student to take a variety of focused, advanced courses in various subfields of AI.

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

Module No.	Topics	NPTEL Link
1	**Philosophy of AI**	
	Introduction: What to Expect from AI, History of AI from 40s - 90s, History of AI in the 90s, History of AI in NASA & DARPA(2000s), Introduction: The Present State of AI, Definition of AI Dictionary Meaning, Definition of AI Thinking VS Acting and Humanly VS Rationally, Definition of AI Rational Agent View of AI, Examples Tasks, Phases of AI	
2	**Modeling a Problem as Search Problem and Game Theory**	
	Uniform Search: Notion of a State, Search Problem and Examples, Basic Search Strategies, Uniformed Search: Iterative Deepening DFS, Uniformed Search: Bidirectional Search	

	Informed Search: Best First Search, Greedy Best First Search and A* Search, Analysis of A* Algorithm, Informed Search Proof of optimality of A*, Informed Search: Iterative Deepening A* and Depth First Branch & Bound, Informed Search: Admissible Heuristics and Domain Relaxation, Informed Search: Pattern Database Heuristics **Local Search:** Satisfaction VsOptimization, The Example of N-Queens, Hill Climbing, Drawbacks of Hill Climbing, Random Walk & Random Restart, Simulated Anealing, Local Beam Search and Genetic Algorithms **Adversarial Search** : Minimax Algorithm for two player games, An Example of Minimax Search, Alpha Beta Pruning, Analysis of Alpha Beta Pruning, Cutting Off Search, Horizon Effect, Game Databases & Other Ideas, Summary and Other Games **Constraint Satisfaction Problems**: Representation of the atomic state, Map coloring and other examples of CSP, Backtracking Search, Variable and Value Ordering in Backtracking Search, Inference for detecting failures early, Exploiting problem structure	https://nptel.ac.in/courses/106/102/106102220/
3	**Propositional Logic &Satisfiability**	
	Logic in AI : Different Knowledge Representation systems, Syntax, Semantics, Forward Chaining, Resolution, Reduction to Satisfiability Problems, SAT Solvers : DPLL Algorithm, WalkSAT Algorithm	
4	**Uncertainty in AI**	
	Basics of Probability, Conditional Independence & Bayes Rule Syntax **Bayesian Networks**: Factorization, Conditional Independences and d-Separation, Inference using Variable Elimination, Bayesian Networks: Reducing 3-SAT to Bayes Net, Rejection Sampling, Likelihood Weighting MCMC with Gibbs Sampling, Maximum Likelihood Learning, Maximum a-Posteriori Learning, Bayesian Networks: Bayesian Learning, Structure Learning and Expectation Maximization, Agents and Environments **Decision Theory:**Steps in Decision Theory, Non Deterministic Uncertainty, Probabilistic Uncertainty & Value of perfect information, Expected Utility vs Expected Value **Markov Decision Processes:** Definition, Markov Decision Processes: An example of a Policy, Policy Evaluation using system of linear equations, Iterative Policy Evaluation, Value Iteration Policy Iteration and Applications & Extensions of MDPs	
5	**Reinforcement Learning**	
	Reinforcement Learning: Background, Model-based Learning for policy evaluation (Passive Learning), Model-free Learning for policy evaluation (Passive Learning), TD Learning, TD Learning and Computational Neuroscience, Q Learning, Exploration vs Exploitation Tradeoff, Generalization in RL	
6	**Introduction to Deep Learning & Deep RL**	
	Deep Learning : Perceptrons and Activation functions, Example of Handwritten digit recognition, Neural Layer as matrix operations, Differentiable loss function, Backpropagation through a computational graph, Thin Deep Vs Fat Shallow Networks Convolutional Neural Networks, Deep Reinforcement Learning **Ethics of AI :** Humans vs Robots, Robustness and Transparency of AI systems, Data Bias and Fairness of AI systems, Accountability, privacy and Human-AI interaction	

One Module =Approx. 2 weeks

Dr. MegharaniPatil	Dr. MegharaniPatil	Dr. HarshaliPatil
Faculty Mentor	**Specialization In-charge**	**HOD**

Syllabus for Artificial Intelligence Specialization – R-2020
A.Y. (2020-2021)
S.E. Semester –V

B.E. (Computer Engineering)							**S.E. SEM: V**		
Course Name: Introduction to Machine Learning							**Course Code:** SP-CS-AI-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://swayam.gov.in/nd1_noc20_cs73/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	
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. Vaishali Nirgude	**Dr. Megharani Patil**	**Dr. Harshali Patil**
Faculty Mentor	**Specialization In-charge**	**HOD COMP**

Syllabus for Artificial Intelligence Specialization – R-2020
A.Y. (2020-2021)
T.E. Semester –VI

B.E. (Computer Engineering)							**T.E. SEM: V1**		
Course Name: Introduction to Soft Computing							**Course Code:** SP-CS-AI-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: Applied Mathematic									

Course Objective: Upon successful completion of the course, students will have an understanding of the basic areas of Soft Computing including Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms. Provide the mathematical background for carrying out the optimization associated with neural network learning.

Detailed Syllabus:

Total Hours:- 40 (12 Weeks)

Module No.	**Topics**	**NPTEL Link**
1.0	Introduction to Soft Computing	https://nptel.ac.in/courses/106/105/106105173/
	Difference between soft Computing and hard Computing, Explanation Biological neural network ,Brain v/s Computer , Characteristics of Soft computing, Some applications of Soft computing techniques	
2.0	Neural Network	
	Learning :- Supervise, Unsupervised, Reinforcement learning , McCulloch – Pits Neural model, Realization of Gates using McCulloch Pit Neural Model,	

	Learning Rules :- Hebbian Learning Rule, Perceptron Learning Rule, Delta Learning Rule, Winner take All learning Rule, Adaline	
3.0	Multi-layer Network and Hybrid Computing	
	Linear Separable and non-separable, delta Learning rule for Multi perceptron layer, , Kohonen Self organization Map , Learning Vector Quantization, ART, ANFIS, CNFIS , Genetic Algorithm	
4.0	Fuzzy Set Theory	
	Fuzzy Sets: Basic definition and terminology, Basic concepts of fuzzy sets, Fuzzy set operations, , Lambda-Cuts , Fuzzy relations: Cardinality of fuzzy relations, operations on fuzzy relations, properties of fuzzy relations, Fuzzy composition Fuzzification and Defuzzification: Features of the membership Functions, Fuzzification, Defuzzification methods, Fuzzy Rules: Fuzzy If-Then Rules, Fuzzy Reasoning Fuzzy Inference System (FIS): Mamdani FIS, Sugeno FIS, Comparison between , Mamdani and Sugeno FIS. Developing a Fuzzy System base on different application like (Washing machine, Train Speed, Shower water, etc)	
5.0	Advances in Neural Network	
	SCPTA, MCPTA, Error Back Propagation Algorithm	
6.0	Principal Component Analysis	
	Dimensional Reducibility ,Regularizing network and Generalized RBF, Hand written Character Recongination, Inverse Kinematics Application	

One Module =Approx. 2 weeks

Mr. Vikas Singh	**Dr. MegharaniPatil**	**Dr. HarshaliPatil**
Faculty Mentor	**Specialization In-charge**	**HOD**

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

B.E. (Computer Engineering)							**S.E. SEM: VII**		
Course Name: Applied Natural Language Processing							**Course Code:**SP-CS-AI-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: Data Structures, Probability									

Course Objective: Course should be able to deliver fundamental knowledge of Natural Language Processing and applying knowledge to implement real time problems in fields of natural languages.

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

Module No.	Topics	NPTEL Link
1	**Introduction to Natural Language Processing**	https://swayam.gov.in/nd1_noc20_cs87/preview
	Introduction, What do we do in NLP, Why NLP is hard, Empirical Laws, Text processing basics.	
2	**Language Modeling and evaluation**	
	Spelling correction, Edit distance, basic and advanced smoothing Computational morphology, Regular, Finite State methods, N-gram language model, N-gram for spelling correction.	

3	**Part of Speech**	
	Introduction to Part-Of-Speech tagging (POS), Hidden Markov Model (HMM), Maximum Entropy models (I, and II) , Conditional Random Field (CRF).	
4	**Parsing and Grammar**	
	Synatax analysis, Context Free grammars- CKY, PCFGs ,Inside Outside Probability. Dependency based grammar and Parsing , Transition based parsing formulation and learning, and MST based dependency parsing	
5	**Semantics and topics models**	
	Distributional semantics introduction, Models, applications, structured models, word embedding I and II, Word Sense Disambiguation , Novel Word Sense Detection, LDA and variants , Applications of LDA	
6	**Applications of NLP**	
	Entity Linking, Information and relation Extraction, Distant Supervision, Text summarization and Classification, Sentiment analysis	

One Module =Approx. 2 weeks

Dr. AnandKhandare **Dr. MegharaniPatil** **Dr. HarshaliPatil**

Mrs. AshwiniPatil

Faculty Mentor **Specialization In-charge** **HOD**

Syllabus for Artificial Intelligence Specialization – R-2020
A.Y. (2020-2021)
B.E. Semester –VIII

B.E. (Computer Engineering)							**B.E. SEM: VIII**		
Course Name: Deep Learning							**Course Code:**SP-CS-AI-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: Basic Mathematics,linear algebra, calculus and statistics, as well as programming and some machine learning.									

Course Objective: The Objective of this course is to introduce mathematical concepts required to apply in Machine Learning and Data science, an area that is in demand today andprovide exposure to these advances and facilitate in depth discussions on chosen topics.

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

Module No.	Topics	NPTEL Link
1	**Introduction to Neural Network**	
	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.	

2	**Deep Learning Fundamentals**	https://swayam.gov.in/nd1_noc20_cs62/preview
	FeedForward Neural Networks, Backpropagation. Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp	
3	**PCA & Autoencoders**	
	Principal Component Analysis and its interpretations, Singular Value Decomposition , Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders	
4	**Regularization & Normalization**	
	Regularization: Bias Variance Tradeo-, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying. Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization	
5	**Convolutional Neural Networks**	
	Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet. Learning Vectorial Representations of Words	
6	**Recurrent Neural Networks**	
	Recurrent Neural Networks, Backpropagation through time. Encoder Decoder Models, Attention Mechanism, Attention over images.	

One Module =Approx. 2 weeks

Dr. Manish Rana	**Dr. Megharani Patil**	**Dr. Harshali Patil**
Faculty Mentor	**Specialization In-charge**	**HOD COMP**