Deccan Education Society's

Kirti M. Doongursee College of Arts, Science and Commerce (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for
Program: Master of Science
Course: M.Sc.
Subject: Computer Science

Choice Based Credit System (CBCS)
with effect from
Academic Year 2022-2023

SEMESTER- I

Course Code	Course Title	Credits	Lectures/ Week
KPSCS22101	**Algorithm for Optimization**	04	04

About the Course:
- To study the Optimization techniques to be implemented in Machine Learning and Data Sciences Algorithms

Course Objectives:
- You will be able to effectively implement optimization techniques to the existing algorithm to improve its performance.
- You will be able to work in the areas of Machine Learning and Data Sciences Algorithms

Learning Outcomes:

After successful completion of this course, students would be able to
- Optimization with a focus on practical algorithms for the design of engineering systems
- Exposure to multivariable calculus, linear algebra, and probability concepts.
- Learn a wide variety of optimization topics, introducing the underlying mathematical problem formulations and the algorithms for solving them.

Unit	Topics	No of Lectures
I (Ability Enhancement)	**Introduction to Optimization Process** Basic Optimization Problem, Constraints, Critical Points, Conditions for Local Minima, Contour Plots. Unimodality, Fibonacci Search, Golden Section Search, Quadratic Fit Search.	15L
II	**Order Methods** First-Order Methods, Gradient Descent, Conjugate Gradient, Adagrad, RMSProp, Adadelta, Adam, Hypergradient Descent. Second-Order Methods, Newton's Method, Secant Method, Quasi-Newton Methods.	15L
III	**Sampling and Surrogate Models** Sampling Plans, Full Factorial, Random Sampling, Uniform Projection Plans, Stratified Sampling, Space-Filling Metrics. Surrogate Models, Fitting Surrogate Models, Linear Models, Basis Functions, Fitting Noisy Objective Functions, Model Selection, Probabilistic Surrogate Models, Gaussian Distribution, Gaussian Processes, Prediction	15L
IV (Skill Enhancement)	**Optimization and Uncertainty** Optimization under Uncertainty, Uncertainty, Set-Based Uncertainty, Probabilistic Uncertainty. Uncertainty Propagation, Sampling Methods, Taylor Approximation, Polynomial Chaos, Bayesian Monte Carlo. Dynamic Programming, Ant Colony Optimization. Expression Optimization, Grammars, Genetic Programming, Grammatical Evolution, Probabilistic Grammars, Probabilistic Prototype Trees	15L

Textbooks:
   1. Algorithms for Optimization Mykel J. Kochenderfer, Tim A. Wheeler, The MIT Press 2019.
Additional References:
   1. **Think Julia: How to Think Like a Computer Scientist by Allen B. Downey and Ben Lauwens 1st Edition 2019 O'reilly.**
   2. **Decision Making Under Uncertainty: Theory and Application by Mykel J. Kochenderfer MIT Lincoln Laboratory Series 2015.**
   3. **Introduction to Algorithms, By Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein 3Ed. (International Edition) (MIT Press) 2009**

Course Code	Course Title	Credits	Lectures/ Week
KPSCSP22101	**Practical Course on Algorithm Optimization**	**02**	**04**

Course Objectives:

- To implement the concepts of Optimization techniques to be implemented in Machine Learning and Data Sciences Algorithms using programming language Julia or Python
- Note: All the Practical's should be implemented using Julia Link: Julia: https://julialang.org/

1	**Implement Contour Plots.**
2	**Implement Fibonacci and Golden section search.**
3	**Implement Quadratic Fit Search.**
4	**Implement Gradient descent.**
5	**Implement quasi-Newton methods to find the local maxima.**
6	**Implement the Adagrad method with application, RMSprop and Adadelta.**
7	**Implement radial basis functions using surrogate modelling.**
8	**Apply Random Forest in surrogate Model.**
9	**Implement Gaussian Process and its application.**
10	**Path finding using Ant Colony Optimization with an application.**

Course Code	Course Title	Credits	Lectures/ Week
KPSCS22102	**Software Defined Networking**	**04**	**04**

About the Course:
The course is about learning the network virtualization concept applied in industry standards

Course Objectives:
- To make the students capable of understanding computer network basics.
- To obtain the knowledge of Software defined networks with understanding of data plane, control plane and application plane.
- To apply network virtualization for industry standard solutions.
- To improve skills in implementing network virtualization and Software Defined Network (SDN).

Learning Outcomes:
After successful completion of this course, students would be able to
- Learners will be able to understand basic concepts of Software Defined Networking and network virtualization.
- Learners will be able to explore OpenFlow specifications to build Software defined networks.
- Learners will be able to analyses and implement theories and practical related to Network management and Virtualization.
- Learners will be able to apply knowledge of Software Defined Networking as per industry standards.

Unit	Topics	No of Lectures
I	**Introduction to Computer Networking** **Basic Concepts and Definitions: LAN, MAN, WAN, AD-Hoc,** **Wireless Network, Understanding the layered architecture of** **OSI/RM and TCP-IP Model, Concepts and implementation of IPV4 and** **IPV6, Study of various network Routing protocols, Introduction to** **Transport layer and Application layer protocols.**	**15L**
II	**Software Defined Networking** **Elements of Modern Networking, Requirements and Technology,** **SDN: Background and Motivation, SDN Data Plane and OpenFlow,** **SDN Control Plane, SDN Application Plane**	**15L**
III	**Network Functions Virtualization** **Concepts and Architecture, NFV Functionality, Network** **Virtualization Quality of Service, MODERN NETWORK** **ARCHITECTURE: CLOUDS AND FOG, Cloud Computing, The Internet** **of Things: Components**	**15L**
IV	**(Skill Enhancement)** **Design and implementation of Network** **Understand and implement Layer 2/3 switching techniques (VLAN**	**15L**

/TRUNKING/ Managing Spanning Tree), Implementation of OSPF V2 and V3, Implementation BGP, Implementation Multicast Routing, Implementation of MPLS, Implementation of Traffic Filtering by using Standard and Extended Access Control List, Implementation of Routing redistribution, Implementation of Policy Based Routing/Load Balancing /QOS/Natting /VRF

Textbooks:
1. **Behrouz A Forouzan — TCPIP Protocol Suite Fourth Edition 2010**
2. **William Stallings, — Foundations of Modern Networking, Pearson Ltd., 2016.**
3. **Software Defined Networks: A Comprehensive Approach by Paul Goransson and Chuck Black, Morgan Kaufmann Publications, 2014**
4. **SDN - Software Defined Networks by Thomas D. Nadeau & Ken Gray, O'Reilly, 2013**

Additional References:
5. **Network Programmability and Automation-Jason Edelman, Matt Oswalt First Edition 2018.**

Course Code	Course Title	Credits	Lectures/ Week
KPSCSP22102	**Practical Course on Software Defined Networking**	**02**	**04**

Course Objectives:
- Note: All the Practical's should be implemented using GNS3/EVENG/CISCO VIRL
- Link: GNS3 :https://www.gns3.com/software/download
- EVE-NG: https://www.eve-ng.net/index.php/download/CISCO
- VIRL:https://learningnetwork.cisco.com/s/question/0D53i00000Kswpr/virl-15-download

1	Implement IP SLA (IP Service Level Agreement)
2	Implement IPv4 ACLs 1. Standard 2. Extended
3	1. Implement SPAN Technologies (Switch Port Analyzer) 2. Implement SNMP and Syslog 3. Implement Flexible NetFlow
4	1. Implement a GRE Tunnel 2. Implement VTP 3. Implement NAT
5	Implement Inter-VLAN Routing
6	Observe STP Topology Changes and Implement RSTP 1. Implement Advanced STP Modifications and Mechanisms 2. Implement MST
7	1. Implement EtherChannel 2. Tune and Optimize EtherChannel Operations
8	OSPF Implementation 1. Implement Single-Area OSPFv2 2. Implement Multi-Area OSPFv2 3. OSPFv2 Route Summarization and Filtering

	4. Implement Multiarea OSPFv3
9	Implement BGP Communities 1. Implement MP-BGP 2. Implement eBGP for IPv4 3. Implement BGP Path Manipulation
10	Implement IPsec Site-to-Site VPNs 1. Implement GRE over IPsec Site-to-Site VPNs 2. Implement VRF Lite
11	Simulating SDN with 1. OpenDaylight SDN Controller with the Mininet Network Emulator 2. OFNet SDN network emulator
12	Simulating OpenFlow Using MININET Course

Course Code	Course Title	Credits	Lectures/ Week
KPSCS22103	**Applied Signal and Image Processing**	**04**	**04**

About the Course:

- To study the concepts of signal processing and image processing and apply solutions to real-life problems

Course Objectives:

- Introduce the concepts of signal processing terms and relate them to image processing
- Learn about basic image processing techniques (e.g., noise removal and image enhancement).
- Develop skills to design and implement algorithms for advanced image analysis
- Apply image processing to design solutions to real-life problems

Learning Outcomes:

- After successful completion of this course, students would be able to
- Understanding the terminologies of signal and digital image processing
- Ability to apply various images, intensity transformations, and spatial filtering.
- Knowledge of Perform frequency domain operations on images.
- Ability to apply image segmentation and extract image features.
- Apply image processing algorithms in practical applications.

Unit	Topics	No of Lectures
I	**Fundamentals of Digital Signals Processing** Periodic signals, Spectral decomposition, Signals, Reading and writing Waves, Spectrums, Wave objects, Signal objects Noise: Uncorrelated noise, Integrated spectrum, Brownian noise, Pink Noise, Gaussian noise; Autocorrelation: Correlation, Serial correlation, Autocorrelation, Autocorrelation of periodic signals, Correlation as a dot product Frequency domain Operations: Representing Image as Signals, Sampling and Fourier Transforms, Discrete Fourier Transform, Convolution and Frequency Domain Filtering, Smoothing using lowpass filters, Sharpening using high-pass filters. Fast Fourier Transforms.	15L
II	**Image Processing fundamentals and Pixel-Transformation** Definition, Application of Image Processing, Image Processing Pipeline, Tools and Libraries for Image Processing, Image types and files formats. Intensity Transformations- Log Transform, Power-law Transform, Contrast Stretching, Thresholding Histogram Processing- Histogram Equalization and Histogram Matching; Linear and Non-linear smoothing of Images, Sharpening of images Image Derivative: Derivatives and gradients, Laplacian, the effect of noise on gradient computation	15L
III	**Structural and Morphological Operations**	15L

	Edge Detection: Sobel, Canny Prewitt, Robert edge detection techniques, LoG and DoG filters, Image Pyramids: Gaussian Pyramid, Laplacian Pyramid Morphological Image Processing: Erosion, Dilation, Opening and closing, Hit-or-Miss Transformation, Skeletonizing, Computing the convex hull, removing small objects, White and black top-hats, Extracting the boundary, Grayscale operations	
IV (Skill Enhancement)	**Advanced Image Processing Operations** Extracting Image Features and Descriptors: Feature detector versus descriptors, Boundary Processing and feature descriptor, Principal Components, Harris Corner Detector, Blob detector, Histogram of Oriented Gradients, Scale-invariant feature transforms, Haar-like Features Image Segmentation: Hough Transform for detecting lines and circles, Thresholding and Otsu's segmentation, Edge-based/regionbased segmentation Region growing, Region splitting and Merging, Watershed algorithm, Active Contours, morphological snakes, and GrabCut algorithms	15L

Textbooks:
1. **Digital Image Processing by Rafael Gonzalez & Richard Woods, Pearson; 4th edition, 2018**
2. **Think DSP: Digital Signal Processing in Python by Allen Downey, O'Reilly Media; 1st edition (August 16, 2016)**

Additional References:
1. Understanding Digital Image Processing, Vipin Tyagi, CRC Press, 2018
2. Digital Signal and Image Processing by Tamal Bose, John Wiley 2010
3. Hands-On Image Processing with Python by Sandipan Dey, Packt Publishing, 2018
4. Fundamentals of Digital Images Processing by A K Jain, Pearson, 2010

Course Code	Course Title	Credits	Lectures/ Week
KPSCSP22103	**Practical Course on Applied Signal and Image Processing**	02	04

Course Objectives:
- To implement the concepts of Applied Signal and Image Processing using programming language Python
- Note: All the Practical's should be implemented using Python Link: https://www.python.org/downloads/

1	Write program to demonstrate the following aspects of signal processing on suitable data 1. Up sampling and down sampling on Image/speech signal **2. Fast Fourier Transform to compute DFT**
2	Write program to perform the following on signal 1. Create a triangle signal and plot a 3-period segment. 2. For a given signal, plot the segment and compute the correlation between them.
3	Write program to demonstrate the following aspects of signal on sound/image data 1. Convolution operation **2. Template Matching**

4	Write program to implement point/pixel intensity transformations such as 1. Log and Power-law transformations 2. Contrast adjustments 3. Histogram equalization **4. Thresholding, and halftoning operations**
5	**Write a program to apply various enhancements on images using image derivatives by implementing Gradient and Laplacian operations.**
6	**Write a program to implement linear and nonlinear noise smoothing on suitable image or sound signal.**
7	**Write a program to apply various image enhancement using image derivatives by implementing smoothing, sharpening, and unsharp masking filters for generating suitable images for specific application requirements.**
8	**Write a program to Apply edge detection techniques such as Sobel and Canny to extract meaningful information from the given image samples**
9	**Write the program to implement various morphological image processing techniques.**
10	**Write the program to extract image features by implementing methods like corner and blob detectors, HoG and Haar features.**
11	**Write the program to apply segmentation for detecting lines, circles, and other shapes/objects. Also, implement edge-based and region-based segmentation.**

Course Code	Course Title	Credits	Lectures/ Week
KPSCS22104	**Advanced Database Techniques**	**04**	**04**

About the Course:
- To study the various types of database models and various NoSQL databases

Course Objectives:
- To cover advanced topics of databases to become more proficient.
- To provide students with theoretical knowledge and practical skills in advanced topics in database systems, big data and modern data-intensive systems.
- To Expand Students, view and introduce advanced topics and Business Intelligence.

Learning Outcomes:

After successful completion of this course, students would be able to

- To form professional competencies related to design and implementation of non-relational databases, including object-oriented, parallel and Distributed.
- Learners will be able to explore XML, and Mobile databases.
- Learners will be able to deal with methods used for dealing with spatial and Temporal Databases.
- Learner will have a solid grasp on business intelligence tools and XML.

Unit	Topics	No of Lectures
I	**Enhanced Database Models** **Object–Oriented Databases**: Need of Object-oriented databases, Complex Data Types, Structured Types and Inheritance, Object-Identity and Reference, ODL and OQL, Implementing O-R Features, Persistent Programming Languages, Object-Oriented versus Object-Relational, Example of Object oriented and object relational database implementation, comparison of RDBMS, OODBMS, ORDBMS **XML Databases:** Structured Semi structure and unstructured data, XML hierarchical tree data model, Documents DTD and XML schema, XML Documents & Database, XML query and transformation, Storage of XML data, Xpath. XQuery, Join and Nesting Queries, XML database applications. **Spatial Databases:** Types of spatial data, Geographical Information Systems (GIS), Conceptual Data Models for spatial databases, Logical data models for spatial databases: Raster and vector model. Physical data models for spatial databases: Clustering methods (space filling curves), Storage methods (R-tree). Query processing.	**15L**
II	**Cooperative Transaction Model** **Parallel and Distributed Databases:** Architecture of parallel databases, Parallel query evaluation, Parallelizing individual operations, Sorting Joins Distributed Databases: Concepts, Data fragmentation, Replication and allocation techniques for distributed database design, Query	**15L**

	processing, Concurrency control and recovery in distributed databases, Architecture and Design: Centralised versus non centralized Databases, Homogeneous and Heterogeneous DDBMS, Functions and Architecture, Distributed database design, query processing in DDBMS, Distributed concurrency management, deadlock management, Distributed Commit Protocols: 2 PC and 3 PC, Concepts of replication servers. Temporal Databases: Time ontology, structure, and granularity, Temporal data models, Temporal relational algebra.	
III	**Learning the NoSQL Basics** Introduction to NoSQL: Characteristics of NoSQL, NoSQL Storage types, Advantages and Drawbacks, NoSQL Products Interfacing and interacting with NoSQL: Storing Data In and Accessing Data from MongoDB, Redis, HBase and Apache Cassandra, Language Bindings for NoSQL Data Stores Understanding the storage architecture: Working with Column-Oriented Databases, HBase Distributed Storage Architecture, Document Store Internals,	15L
IV (Skill Enhancement)	**Gaining Proficiency With NoSQL** Querying NoSQL Stores: Similarities Between SQL and MongoDB Query Features, Accessing Data from Column-Oriented Databases Like HBase, Querying Redis Data Stores Indexing And Ordering Data Sets: Essential Concepts Behind a Database Index, Indexing and Ordering in MongoDB, CouchDB and Apache Cassandra Managing Transactions And Data Integrity: RDBMS and ACID, Distributed ACID Systems, Upholding CAP, Consistency Implementations	15L

Textbooks:
1. **Database Management Systems by Raghu Ramakrishnan and Johannes Gehrke, McGraw Hill, 3rd Edition, 2014**
2. **Professional NoSQL By Shashank Tiwari, Wrox-John Wiley & Sons, Inc, 2011**
3. **Getting Started with NoSQL, Gaurav Vaish, Packt Publishing Ltd, 2013**

Additional References:
1. **Advanced Database Management System by by Rini Chakrabarti and Shilbhadra Dasgupta, Dreamtech Press, 2017**
2. **SQL & NoSQL Databases, Andreas Meier · Michael Kaufmann, Springer Vieweg, 2019**
3. **Parallel and Distributed Systems by Arun Kulkarni, Nupur Prasad Giri, Wiley, Second edition, 2017**
4. **Practical Hadoop Migration: How to Integrate Your RDBMS with the Hadoop Ecosystem and Re-Architect Relational Applications to NoSQL By Bhushan Lakhe, Apress; 1st edition, 2016.**

Course Code	Course Title	Credits	Lectures/ Week
KPSCSP22104	**Practical Course on Advanced Database Techniques**	**02**	**04**
Course Objectives:			

- To implement the concepts of Advanced Database Techniques using various NoSQL database like OO, Temporal, Document database, MongoDB, HBASE, Apache Cassandra etc.

• Note: All the Practical's should be implemented using NoSQL • Link:https://www.oracle.com/database/technologies/nosql-databaseserver-downloads.html	
1	**Create different types that include attributes and methods. Define tables for these types by adding a sufficient number of tuples. Demonstrate insert, update and delete operations on these tables. Execute queries on them.**
2	**Create an XML database and demonstrate insert, update and delete operations on these tables. Issue queries on it.**
3	**Demonstrate distributed databases environment by dividing given global conceCreate a table that stores spatial data and issue queries on it. Ptual schema, into vertical and Horizontal fragments and place them on different nodes. Execute queries on these fragments.**
4	**Create a table that stores spatial data and issues queries on it.**
5	**Create a temporal database and issue queries on it.**
6	**Demonstrate the Accessing and Storing and performing CRUD operations in** **1. MongoDB** **2. Redis**
7	**Demonstrate the Accessing and Storing and performing CRUD operations in** **1. HBase** **2. Apache Cassandra**
8	**Demonstrating MapReduce in MongoDB to count the number of female (F) and male (M) respondents in the database.**
9	**Demonstrate the indexing and ordering operations in** **1. MongoDB** **2. CouchDB** **3. Apache Cassandra**
10	**Demonstrate the use of data management and operations using NoSQL in the Cloud.**

SEMESTER - II

Course Code	Course Title	Credits	Lectures/ Week
KPSCS22201	**Applied Machine and Deep Learning**	**04**	**04**

About the Course:
- To study about the Machine Learning and Deep Learning Algorithms and its application implementation in various field of Data Science, Image Processing, NLP, etc.

Course Objectives:
- Developing projects in machine learning for industrial applications.
- Understanding and implementing algorithms and techniques of Machine Learning useful in the field of Data Science, Image Processing, NLP, etc.

Learning Outcomes:

After successful completion of this course, students would be able to
- Optimization with a focus on practical algorithms for the design of engineering systems
- Exposure to multivariable calculus, linear algebra, and probability concepts.
- Learn a wide variety of optimization topics, introducing the underlying mathematical problem formulations and the algorithms for solving them.

Unit	Topics	No of Lectures
I (Ability Enhancement)	**The Fundamentals of Machine Learning** What is Machine Learning? Why use Machine Learning? Types of Machine Learning, Supervised Learning, Unsupervised Learning & Reinforcement Learning. Challenges of Machine Learning, Testing and Validation A First Application: Classification, MNIST Dataset, Performance Measures, Confusion Matrix, Precision and Recall, Precision/Recall Tradeoff, The ROC Curve, Multiclass Classification, Error Analysis.	15L
II	**Training Models** Linear Regression, Gradient Descent, Batch Gradient Descent, Stochastic Gradient Descent, Mini-batch Gradient Descent, Polynomial Regression, Learning Curves, The Bias/Variance Tradeoff, Ridge Regression, Lasso Regression, Early Stopping, Logistic Regression, Decision Boundaries, Softmax Regression, Cross Entropy.	15L
III	**Support Vector Machines** Linear SVM Classification, Soft Margin Classification, Nonlinear SVM Classification, Polynomial Kernel, Gaussian RBF Kernel, SVM Regression, Decision Trees, Training and Visualizing a Decision Tree, Making Predictions, The CART Training Algorithm, Gini Impurity vs Entropy, Regularization Hyperparameters.	15L
IV (Skill Enhancement)	**Fundamentals of Deep Learning** What is Deep Learning? Need Deep Learning? Introduction to Artificial Neural Network (ANN), Core components of neural networks, Multi-Layer	15L

	Perceptron (MLP), Activation functions, Sigmoid, Rectified Linear Unit (ReLU), Introduction to Tensors and Operations, Tensorflow framework.	

Textbooks:
1. **Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow Concepts, Tools, and Techniques to Build Intelligent Systems by AurélienGéron, Second Edition, O'reilly 2019**
2. **Deep Learning with Python by François Chollet Published by Manning 2018**
3. **Reinforcement Learning: An Introduction by Richard S. Sutton and Andrew G. Barto, Second Edition 2014**

Additional References:
4. **Introduction to Machine with Python - A Guide for Data Scientists by Andreas C. Müller & Sarah Guido O'reilly 2016**
5. **Artificial Neural Networks with TensorFlow 2 ANN Architecture Machine Learning Projects Poornachandra Sarang by Apress 2021**

Course Code	Course Title	Credits	Lectures/ Week
KPSCSP22201	**Practical Course on Applied Machine and Deep Learning**	**02**	**04**

Course Objectives:
- To implement the concepts of Applied Machine and Deep Learning practically
- Note: All the Practical's should be implemented using Python and TensorFlow.
- Link: Python :https://www.python.org/downloads/
- TensorFlow :https://www.tensorflow.org/install

1	**Implement Linear Regression (Diabetes Dataset)**
2	**Implement Logistic Regression (Iris Dataset)**
3	**Implements Multinomial Logistic Regression (Iris Dataset)**
4	**Implement SVM classifier (Iris Dataset)**
5	**Train and fine-tune a Decision Tree for the Moons Dataset**
6	**Train an SVM regressor on the California Housing Dataset**
7	**Implement Batch Gradient Descent with early stopping for Softmax Regression**
8	**Implement MLP for classification of handwritten digits (MNIST Dataset)**
9	**Classification of images of clothing using Tensorflow (Fashion MNIST dataset)**
10	**Implement Regression to predict fuel efficiency using Tensorflow (Auto MPG dataset)**

Course Code	Course Title	Credits	Lectures/ Week
KPSCS22202	**Natural Language Processing**	**04**	**04**

About the Course:
- To study importance, concepts of Natural Language Processing (NLP) using various algorithms

Course Objectives:

- Understanding the importance and concepts of Natural Language Processing (NLP)
- Applying algorithms available for the processing of linguistic information and computational properties of natural languages.
- Knowledge on various morphological, syntactic, and semantic NLP tasks.
- Introducing various NLP software libraries and data sets publicly available.
- Designing and developing practical NLP based applications

Learning Outcomes:

After successful completion of this course, students would be able to

- The ability to describe the concepts of morphology, syntax, semantics, discourse & pragmatics of natural language
- Discover various linguistic and statistical features relevant to the basic NLP task, namely, spelling correction, morphological analysis, parts-of speech tagging, parsing, and semantic analysis
- Assess and Evaluate NLP based systems
- Ability to choose appropriate solutions for solving typical NLP subproblems (tokenizing, tagging, parsing)
- Analyse NLP problems to decompose them inadequate independent components and develop real-life applications.

Unit	Topics	No of Lectures
I	**Introduction to Natural Language Processing (NLP) and Language Modelling** Introduction to NLP: Introduction and applications, NLP phases, Difficulty of NLP including ambiguity; Spelling error and Noisy Channel Model; Concepts of Parts-of speech and Formal Grammar of English. Language Modelling: N-gram and Neural Language Models Language Modelling with N-gram, Simple N-gram models, smoothing (basic techniques), Evaluating language models; Neural Network basics, Training; Neural Language Model, Case study: application of neural language model in NLP system development Python Libraries for NLP: Using Python libraries/packages such as Natural Language Toolkit (NLTK), spaCy, genism	15L
II	**Morphology & Parsing in NLP** Computational morphology & Parts-of-speech Tagging: basic concepts; Tagset; Lemmatization, Early approaches: Rule-based and TBL; POS tagging using HMM, Introduction to POS Tagging using Neural Model. Parsing Basic concepts: top-down and bottom-up parsing, treebank; Syntactic parsing: CKY parsing; Statistical Parsing basics: Probabilistic Context-Free Grammar (PCFG); Probabilistic CKY Parsing of PCFGs.	15L
III	**Semantics and Word Embedding** Semantics Vector Semantics: Words and Vector; Measuring Similarity; Semantics with dense vectors; SVD and Latent Semantic Analysis Embeddings from prediction: Skip-gram and Continuous Bag of words; Concept of Word Sense; Introduction to WordNet	15L

IV (Skill Enhancement)	**NLP Applications and Case Studies** Intelligent Work Processors: Machine Translation; User Interfaces; man-machine Interfaces: Natural language Querying Tutoring and Authoring Systems. Speech Recognition Commercial use of NLP: NLP in customer Service, Sentiment Analysis, Emotion Mining, Handling Frauds and SMS, Bots, LSTM & BERT models, Conversations	15L

Textbooks:
1. **Speech and Language Processing, Jurafsky Dan and Martin James H., 3rd Edition, Pearson, 2018.**
2. **Natural Language Processing with Python, Steven Bird, Ewan Klein, and Edward Loper, 2nd Edition, O'Reilly, 2016.**

Additional References:
1. **Practical Natural Language Processing with Python, Mathangi Sri, Apress, 2021**
2. **"Handbook of Computational Linguistics and Natural Language Processing, Martin Whitehead, Clanrye International, 2020**
3. **Handbook of Natural Language Processing, Nitin Indurkhya, and Fred J. Damerau, Pearson; 2nd edition, 2008**
4. **Foundations of Statistical Natural Language Processing, Manning, Christopher and Heinrich, Schutze, MIT Press, 1997**

Course Code	Course Title	Credits	Lectures/ Week
KPSCSP22202	**Practical Course on Natural Language Processing**	**02**	**04**

Course Objectives:
- To implement the concepts of NLP using programming language Python
- Note: - The following set of practical's can be performed using any Python Libraries for NLP such as NLTK, spaCy, genism:
- Link:-https://www.python.org/downloads/

1	Write a program to implement sentence segmentation and word **tokenization**
2	**Write a program to Implement stemming and lemmatization**
3	**Write a program to Implement a tri-gram model**
4	Write a program to Implement PoS tagging using HMM & Neural **Model**
5	**Write a program to Implement syntactic parsing of a given text**
6	**Write a program to Implement dependency parsing of a given text**
7	Write a program to Implement Named Entity Recognition (NER)
8	Write a program to Implement Text Summarization for the given sample text
Apply the concepts and techniques of Natural language processing learned for real-life applications. A suitable application can be modelled which demonstrates the NLP skills. Some of the concepts/themes for lab exercises (not limited to the following) are described.	
9	Consider a scenario of applying NLP in Customer Service.

	Design and develop an application that demonstrates NLP operations for working with tasks and data like voice calls, chats, Ticket Data, Email Data. Process the data to understand the voice of the Customer (intent mining, Top words, word cloud, classify topics). Identify issues, replace patterns and gain insight into sales chats.
10	Consider a scenario of Online Review and demonstrate the concept of sentiment analysis and emotion mining by applying various approaches like lexicon-based approach and rule-based approaches.
11	Apply NLP in Banking, Financial Services, and Insurance. Design Application to detect frauds and work with SMS data.
12	Demonstrate the use of NLP in designing Virtual Assistants. Apply LSTM, build conversational Bots.

Course Code	Course Title	Credits	Lectures/Week
KPSCS22203	**Web Mining**	**04**	**04**

About the Course:

- To study the concept of Web Mining and implementations

Course Objectives:

- To Understand the difference between Web Mining and Data mining.
- To Understand the Basics and Needs of Web Mining.
- To Understand Web-based Data.
- To Understand Opinion Mining and Sentiment classification.

Learning Outcomes:

After successful completion of this course, students would be able to

- Develop deep understanding of mining techniques exclusively for the Internet
- Understand and develop analytics for social media data.
- Design and implementation of various web analytical tool to understand complex unstructured data on the Internet for aiding individuals and Businesses to grow their business

Unit	Topics	No of Lectures
I	**Introduction to Web Mining** Web Mining, Data Mining, Basic Concepts, Difference, Mining Sequential Patterns on Prefix Span, Generating Rules from Sequential Patterns. Basic Concepts of Information Retrieval, Information Retrieval Models, Relevance feedback, Evaluation measures Text and Web Page Preprocessing, Inverted Index and Its Compression, latent semantic indexing, Web Search, Web Spamming	15L
II	**Opinion Mining and Web Usage Mining** Web Information Retrieval, Sentiment Classification, Feature based Opinion Mining and Summarization, Comparative Sentence and Relation Mining, Opinion Search and Opinion Spam. Web Usage Mining.	15L
III	**Social Network & Link Analysis** Link Analysis, Scrapy using python (without pipelining), Social Network Analysis, Co-Citation and Bibliographic Coupling, PageRank, HITS, Community Discovery	15L
IV (Skill Enhancement)	**Optimization and Uncertainty** Basic Crawler Algorithm, Implementation Issues, Universal Crawlers, Focused Crawlers, Topical Crawlers, Crawler Ethics and Conflicts, Data modelling and webpage usage mining., Discovery and analysis of web usage patterns, Recommender systems and collaborative filtering, query log mining	15L

Textbooks:
1. Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data by Bing Liu (Springer

Publications) 2017 publication

Additional References:
2. Data Mining: Concepts and Techniques, Second Edition Jiawei Han, Micheline Kamber (Elsevier Publications),2017
3. Web Mining: Applications and Techniques by Anthony Scime,2010
4. Mining the Web: Discovering Knowledge from Hypertext Data by Soumen Chakrabarti 2010

Course Code	Course Title	Credits	Lectures/Week
KPSCSP22203	**Practical Course on Web Mining**	**02**	**04**

Course Objectives:

- To implement the concepts of Web Mining to scrape, IR and crawler using programming language Python
- Note: - The following set of practical's should be implemented in Scrape, python: Link:-Python : https://www.python.org/downloads/

1	**Scrape an online E-Commerce Site for Data.** **1. Extract product data from Amazon - be it any product and put these details in the MySQL database. One can use pipeline. Like 1 pipeline to process the scraped data and other to put data in the database and since Amazon has some restrictions on scraping of data, ask them to work on** **small set of requests otherwise proxies and all would have to be used.** **2. Scrape the details like color, dimensions, material etc. Or customer ratings by features.**
2	**Scrape an online Social Media Site for Data. Use python to scrape information from twitter.**
3	**Page Rank for link analysis using python. Create a small set of pages namely page1, page2, page3 and page4 apply random walk on the same**
4	**Perform Spam Classifier.**
5	**Demonstrate Text Mining and Webpage Pre-processing using meta information from the web pages (Local/Online).**
6	**Apriori Algorithm implementation in case study.**
7	**Develop a basic crawler for the web search for user defined keywords.**
8	**Develop a focused crawler for local search.**
9	Develop a programme for deep search implementation to detect plagiarism in documents online.
10	Sentiment analysis for reviews by customers and visualize the same.

Course Code	Course Title	Credits	Lectures/Week
KPSCS22204	**Embedded and IoT Technology**	**04**	**04**

About the Course:	

Unit	Topics	No of Lectures
	• To study the concepts of IoT Technology and its application in the industry.	

Course Objectives:
- The course is designed to enable students, to understand and implement IoT in industry.
- Design and executive projects in IoT with Automatic Identification and Data Capture

Learning Outcomes:
After successful completion of this course, students would be able to
- Understand basic components and functionalities of Embedded System including its hardware.
- Effectively achieve collaboration of various technologies in IoT and enable the same using software programming like Python, Embedded C etc.
- Understand case studies in IoT and replicate the same for more detailed analysis of the IoT development

Unit	Topics	No of Lectures
I	**Embedded System Basics** Introduction to Embedded Systems, Design of Embedded Systems, Memory Architecture, Input/Output. Basic electronics: Semiconductors, Transistors, BJT, Flip Flops, Resistors, Capacitors, CMOS, MOSFET, FPGA, Relays. Microcontrollers, UART Communications, SPI-peripherals interface, I2C communication, Wireless Sensor Network (WSN)	15L
II	**Basics of IOT** Introduction IoT:Evolution of the IoT concept, vision and definition of IoT, basic characteristics of IoT, distinguish the IoT from other related technologies, IoT enablers, IoT architectures, pros and cons of IoT, IoT architecture concepts for specific IoT applications. IoT Building Blocks-Hardware and Software: The basic IoT building blocks, smart thing components and capabilities, basics of Packet Tracer with reference to IoT, basics of IoT gateway, Cloud, and analytics Sensing Principles and Wireless Sensor Network: Sensor fundamentals and classification of sensors, physical principles of some common sensors, basics of WSNs, WSN architecture and types, layer-level functionality of WSN protocol stack.	15L
III	**Advanced IOT Technologies** IoT Gateway: IoT architecture domains, IoT gateway architecture, IoT gateway functionalities, IoT gateway selection criteria, IoT gateway and edge computing, edge computing-based solution for specific IoT applications IoT Protocol Stack: Mapping of IoT protocols to layered IoT architecture, functionality of infrastructure, service discovery, and application layer protocols of IoT protocol stack IoT Cloud and Fog Computing:Components of IoT Cloud architecture, usage of application domains of IoT Cloud platforms, layered architecture of Fog computing, distinguish Fog computing from other related terms IoT Applications: Main applications of IoT, Implementation details of various IoT application domains	15L
IV (Skill Enhancement)	**Security, Communication and Data analytics in IOT** IoT Security: Security constraints in IoT systems, security requirements of IoT systems, IoT attacks, security threats at each layer of IoT architecture,	15L

design secure IoT system for specific application
Social IoT: Nature of social relationships among IoT Devices,
functionality of different components of social IoT architecture, social
aspects of smart devices in IoT applications
Packet Tracer and IoT: Basics of Packet Tracer and Blockly programming
language, design simple IoT projects in Packet Tracer

Textbooks:
1. **Introduction to Embedded Systems – Cyber physical systems Approach Edward Ashford Lee &SanjitArunkumarSeshia Second Edition — MIT Press — 2017**
2. **Enabling the Internet of Things Fundamentals, Design and Applications by Muhammad Azhar Iqbal, Sajjad Hussain, Huanlai Xing, Muhammad Ali Imran Wiley Pub.1stEdition 202**

Additional References:
3. **Introduction Embedded Systems by K.V. Shibu Second Edition McGraw Hills–2017**
4. **Build your own IoT Platform Develop a Fully Flexible and Scalable Internet of Things Platform in 24 Hours by Anand Tamboli 2019 Apress**

Course Code	Course Title	Credits	Lectures/ Week
KPSCSP22204	**Practical Course on Embedded and IoT Technology**	**02**	**04**

Course Objectives:

- To implement the concepts of Embedded and IoT Technology
- Note: - The following set of practicals should be implemented in CodeVisionAVR, Proteus8, Cisco Packet Tracer, Keli V5, Python
  Link: -Python: https://www.python.org/downloads/
  CodeVisionAVR : https://www.codevision.be/
  Proteus8: https://www.labcenter.com/downloads/
  Cisco Packet Tracer: https://www.netacad.com/courses/packet-tracer
  Keli V5: https://www.keil.com/download/

1	**Design and implement basics embedded circuits** **1. Automatic Alarm system- Alarm should get tigger by senor** **2. Timer based buzzer** **3. Sensor based Counting device**
2	**Demonstrate communication between two embedded devices using UART port**
3	**Built an IoT system to send ticket before entering the bus.**
4	**Demonstrate an IoT based game which can be played between two player who are physically at a considerable distance.**
5	**Develop a IoT application which will record the movement and orientation of your phone and give the data back to the PC**
6	**Develop an IoT application that will raise an alarm whenever with going to rain outside based on the weather prediction data.**
7	**Deploy an IoT application which will alert you by beeping or vibrating your phone whenever you get someone call your name.**
8	**Develop an IoT application for monitoring water levels in tanks and automatically**

		start the motor to fill the tank if the level goes below the critical level.
	9	Develop an IoT module to which measure the intensity of light and send the same to your PC/ Phone
	10	Develop an IoT application for Motion detection.

Evaluation Scheme for First Year (PG) under AUTONOMY

I. Internal Evaluation for Theory Courses – 40 Marks

Continuous Internal Assessment 1 (Seminar Presentations) – 40 Marks

II. External Examination for Theory Courses – 60 Marks

Duration: 2 Hours

Theory question paper pattern:

All questions are compulsory.

Question	Based on	Options	Marks
Q.1	Unit I	*Any 2 out of 4*	12
Q.2	Unit II	*Any 2 out of 4*	12
Q.3	Unit III	*Any 2 out of 4*	12
Q.4	Unit IV	*Any 2 out of 4*	12
Q.5	Unit I, II, III, IV	*Any 2 out of 4*	12

- All questions shall be compulsory with internal choice within the questions.
- Each Question may be sub-divided into sub questions as a, b, c, d, etc. & the allocation of Marks depends on the weightage of the topic.

III. Practical Examination

- Each core subject carries 50 Marks (30 marks External + 20 marks Internal)

Sr. No.	Postgraduate Practical Internal Evaluation:	Marks
1	Short Experiment/Field Trip/Excursion/Industrial Visit Report	15
2	Journal	5

Sr. No.	Postgraduate Practical External Evaluation:	Marks
1	Experiment/s	25
2	Viva	5

- Duration: 2 Hours for each practical course.

- Minimum 80% practical from each core subjects are required to be completed.

- Certified Journal is compulsory for appearing at the time of Practical Exam