HSNC UNIVERSITY,MUMBAI

HSNCU Syllabus

School of Applied Sciences

Syllabus of MSc Data Science and Business Analytics

Board of Faculty of Science & Technology

Board of Studies in the Subject of Data Science & Business Analytics:

1. Name of the Chairperson: Dr.Nandini Sengupta, Associate professor, Department of Economics
2. Name of the Co – Chairperson: Mrs. Shailaja. J. Rane, Co- Ordinator of Data Science and Business Analytics.

Teachers from the college:

3. Miss. Beenarani Karutharan, Assistant Professor, Department of Computer science
4. Mrs.Mrunal M Hardikar , Assistant Professor, Department of Mathematics
5. Mr. Sikandar Yadav , Assistant Professor , Department of Data Science and Business Analytics.

External Professors:

6. Rosemary Gosling, Director of External Studies(Retd) for the London School of Economics and Political Science (LSE)
7. Dr. Santosh Bothe, Founder and Director AiSense(Start up funded by BIRAC, Govt. of India), Principal, Saraswati College, Shegaon, Affiliated to SGBU Amravati University.

External experts:

8. Prof. Parag Mahulikar is Ex- Dean and Senior Professor of Marketing at IES Management College and Research Centre, Bandra, India and Management Consultant.
9. Dr. Alok Deepak Dabade, Assistant Professor, Department of Statistics, University of Mumbai.

10. Dr. Sujata Suvarnapathki, Assistant Professor, Department of Statistics, Ramnarayan Ruia Autonomous College, Matunga, Mumbai.

11. Mr. Subhash Kumar, Assistant Professor, MCA, MPHIL IT department, St.Xavier's college, Mumbai.

12. Industry Expert: Mr. Vinayak Deshpande, Managing Director, Sankhya Analytical Research Pvt. Ltd.

13. Industry Expert: Mr. Nishad Kapadia, MCA, Technical trainer,Data and Solution Architect Project Manager, TeraData, Mumbai.

14. Industry Expert: Miss. Praveena Premanand Menon, MSc in Big Data Analytics.

15.Industry Expert: Mr. Awesh Bhornya ,Infinity Learning (Founder)

Alumni: Proposed names Sara kale, Pranit Kadam

Part –I

Outline of choice based credit system as outlined by university grants commission:

R. ** : The definitions of the key terms used in the choice based credit system and grading system introduced from the academic year 2023-2024 are as under:**

1. **Major discipline:** Major discipline is the discipline or subject of main focus and the degree will be awarded in that discipline. Students should secure the prescribed number of credits (about 50% of total credits) through core courses in the major discipline.

2. Minor discipline: Minor discipline helps a student to gain a broader understanding beyond the major discipline. For example, if a student pursuing an Economics major obtains a minimum of 12 credits from a bunch of courses in Statistics, then the student will be awarded B.A. degree in Economics with a Minor in Statistics.

2. **Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

2.1 **Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main

discipline/subject of study referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by the main discipline/subject of study).

2.2 **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

2.3 **Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

3. **Choice Based Credit System:** CBCS allows students to choose inter- disciplinary, intra-disciplinary courses, skill oriented papers (even from other disciplines according to their learning needs, interests and aptitude) and more flexibility for students.

4. **Program:** A Program is a set of courses that are linked together in an academically meaningful way and generally ends with the award of a Degree Certificate depending on the level of knowledge attained and the total duration of study

6. **Course:** A 'course' is essentially a constituent of a 'program' and may be conceived of as a composite of several learning topics taken from a certain knowledge domain, at a certain level. All the learning topics included in a course must necessarily have academic coherence, i.e. there must be a common thread linking the various components of a course. A number of linked courses considered together are in practice, a 'program'.

7. **Bridge Course:** Bridge course is visualized as Pre semester preparation by the learner before commencement of regular lectures. For each semester the topics, whose knowledge is considered as essential for effective and seamless learning of topics of the Semester, will be specified. The Bridge Course can be conducted in online mode. The Online content can be created for the Bridge Course Topics.

8. **Module and Unit:** A course which is generally an independent entity having its own separate identity, is also often referred to as a 'Module' in today's parlance, especially when we refer to a 'modular curricular structure'. A module may be studied in conjunction with other learning modules or studied independently. A topic within a course is treated as a Unit. Each course should have exactly 3 Units.

9. **Self-Learning: 20% of the topics will be marked for Self-Learning.** Topics for Self Learning are to be learned independently by the student, in a time- bound manner, using online and offline resources including online lectures, videos, library, discussion forums, fieldwork, internships etc.

Evaluative sessions (physical/online), equivalent to the credit allocation of the Self Learning topics, shall be conducted, preferably, every week for each course. Learners are to be evaluated real time during evaluative sessions. The purpose of evaluative sessions is to assess the level of the students' learning achieved in the topics earmarked for Self-Learning.

The teacher's role in these evaluative sessions will be that of a Moderator and Mentor, who will guide and navigate the discussions in the sessions, and offer concluding remarks, with proper reasoning on the aspects which may have been missed by the students, in the course of the Self-Learning process.

The modes to evaluate self-learning can be a combination of the various methods such as written reports, handouts with gaps and MCQs, objective tests, case studies and Peer learning. Groups can be formed to present self- learning topics to peer groups, followed by Question and Answer sessions and open discussion. The marking scheme for Self-Learning will be defined under Examination and Teaching.

The topics stipulated for self-learning can be increased or reduced as per the recommendations of the Board of Studies and Academic Council from time to time. All decisions regarding evaluation need to be taken and communicated to the stakeholders preferably before the commencement of a semester. Some exceptions may be made in exigencies, like the current situation arising from the lockdown, but such ad hoc decisions are to be kept to the minimum possible.

10. **Credit Point:** Credit Point refers to the 'Workload' of a learner and is an index of the number of learning hours deemed for a certain segment of learning. These learning hours may include a variety of learning activities like reading, reflecting, discussing, attending lectures / counseling sessions, watching especially prepared videos, writing assignments, preparing for examinations, etc. Credits assigned for a

single course always pay attention to how many hours it would take for a learner to complete a single course successfully. A single course should have, by and large a course may be assigned anywhere between 2 to 8 credit points wherein 1 credit is construed as corresponding to approximately 30 to 40 learning hours.

11. **Credit Completion and Credit Accumulation:** Credit completion or Credit acquisition shall be considered to take place after the learner has successfully cleared all the evaluation criteria with respect to a single course. Thus, a learner who successfully completes a 4 CP (Credit Point) course may be considered to have collected or acquired 4 credits. Learner level of performance above the minimum prescribed level (viz. grades / marks obtained) has no bearing on the number of credits collected or acquired. A learner keeps on adding more and more credits as he completes more and more courses. Thus, the learner 'accumulates' course wise credits.

12. **Credit Bank:** A Credit Bank in simple terms refers to stored and dynamically updated information regarding the number of Credits obtained by any given learner along with details regarding the course/s for which Credit has been given, the course-level, nature, etc. In addition, all the information regarding the number of Credits transferred to different programs or credit exemptions given may also be stored with the individual's history.

13. **Credit Transfer:** (performance transfer) When a learner successfully completes a program, he/she is allowed to transfer his/her past performance to another academic program having some common courses and Performance transfer is said to have taken place.

14. **Course Exemption:** Occasionally, when two academic programs offered by a single university or by more than one university, may have some common or equivalent course-content, the learner who has already completed one of these academic programs is allowed to skip these 'equivalent' courses while registering for the new program. The Learner is 'exempted' from 'relearning' the common or equivalent content area and from re-appearing for the concerned examinations. It is thus taken for granted that the learner has already collected in the past the credits corresponding to the exempted courses.

Part-II

The Scheme of Teaching and Examination:

The performance of the learners shall be evaluated in two components: Internal Assessment with 40% marks by way of continuous evaluation and by Semester End Examination with 60% marks by conducting the theory examination.

INTERNAL ASSESSMENT: - It is defined as the assessment of the learners on the basis of continuous evaluation as envisaged in the credit-based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

A). Internal Assessment

Major Discipline and General Elective Course

Sr. No.	Particulars	Marks
1	Self-Learning Evaluation	15 Marks
2	Practical Assessment	25 Marks

Minor Discipline

Sr. No.	Particulars	Marks
1	Practical Assessment	50 Marks

B). Summative Assessment

The semester end examination (external component) of 60% for each course will be as follows:

i) **Duration** – **2 Hours.**

ii) **Theory Questions**

Paper Pattern: -

1. There shall be four questions each of 15 marks each. Based on each unit there will be one question and the fourth one will be based on the entire syllabus.
2. All questions shall be compulsory with internal choice within the questions. (Each question will be of 15 marks with options.)

3. Questions may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the topic.

The marks will be given for all examinations and they will be converted into grade (quality) points. The semester-end, final grade sheets and transcripts will have only credits, grades, grade points, SGPA and CGPA.

C). Project:

• Project which can in the following forms
− Case Studies
− Videos
− Blogs
− Research paper (Presented in Seminar/Conference)
− Field Visit Report
− Presentations related to the subject (Moot Court, Youth Parliament, etc.)
− Internships (Exposition of theory into practice)
− Open Book Test
− any other innovative methods adopted with the prior approval of Director Board of Examination and Evaluation.

D). Self-Learning Evaluation:

− 20% of the topics of the curriculum are learned by the student through self learning using online / offline academic resources specified in the curriculum. Hence 20% of the lectures shall be allocated for evaluation of students on self learning topics

− The identified topics in the syllabus shall be learned independently by the students in a time bound manner preferably from online resources.

- Club the self-learning topics into 3-4 groups of topics only for evaluation.

- Prescribe time duration (in days) for completion of each group of topics and earmark self learning evaluation lectures in the timetable. Hence each group of topic can be assigned 3 regular lectures for this evaluation for the entire class.

<u>Methods for Evaluation of Self-learning topics:</u>

− Seminars/presentation (PPT or poster), followed by Q&A − Objective questions /Quiz / Framing of MCQ questions.

− Debates

− Group discussion
− You-Tube videos (Marks shall be based on the quality and viewership)
− Improvisation of videos
− Role Play followed by question-answers
− Viva Voce
− Any other innovative method

Teachers can frame other methods of evaluation, provided that the method is duly approved by the college examination committee and is notified to the students at least 7 days before the commencement of the evaluation session.

HSNC University, Mumbai

(2024-2025)

Ordinances and Regulations

With Respect to

Choice Based Credit System (CBCS)

For the Programmes Under

The Faculty of Science and Technology

For the Course

Data Science & Business Analytics

Curriculum – Second Year Postgraduate Programmes

Semester-III and Semester -IV

2024-2025

Data Science & Business Analytics

Part 1- Preamble

M.Sc. Data Science and Business Analytics program is of minimum 84 credits covering four semesters. Data is the new oil. The analytics may be input for human decisions or may drive fully automated decisions. It helps decision makers in building strategies to perform deep-dive understanding and provide descriptive, predictive, and prescriptive analytics. It is used to run the business effectively and is instrumental in growing the business. It is an area with huge potential for corporate investments. Business Analytics include identifying KPIs, measurement strategy, data analysis, complex statistical model, data mining and deep understanding of cause-and-effect models. Business analytics can drive key decision making in the organization and help executive decision makers in building data driven strategies. Some of the impactful use of this is in the areas of Management Information Systems, Financial Service, Marketing Research, Process Improvements, Process Excellence, End-to-End Product Management, etc.

The program emphasizes both theory and modern applications of Data Science and Business analytics. It is structured to provide knowledge and in-depth skills necessary for the employability of the students in industries, academics and other government and non-government organizations. The program has some unique features like independent projects, number of elective courses and extensive computer training of statistical computations including standard software packages like SQL, SPSS AMOS, MINITAB, R and PYTHON etc. Being a part of Cluster University, the department got the academic autonomy and it has been utilized to add the new and need based elective courses. The independent project work is one among the important components of this program. The syllabus has been framed to possess a decent balance of theory, methods, and applications of data science in various fields. The thrust of the course is to prepare students to enter a promising career after graduation, and also provide them a platform for pursuing higher studies.

Program Outcomes:

1. Develop in-depth understanding of the key technologies in data science and business analytics such as data mining, machine learning, visualization techniques, predictive modeling, and statistics.
2. Practice problem analysis and decision-making.
3. Gain practical, hands-on experience using programming languages and big data tools through coursework and research projects.
4. Explore text mining analysis/techniques to understand the influence of social media applications.
5. Apply Principles and skills of Data Science in Marketing and Supply chain environments.
6. Encourage an aptitude for business improvement, innovation and entrepreneurial action.
7. Analyze legal and Ethical Principles in Data Science and Decision making contexts.

8. Enable all participants to recognise, understand and apply the language, theory and models of the field of business analytics.
9. Employ cutting edge tools and technologies to analyze Big Data.
10. Create and configure virtual machines, storage, networking, and other resources in a cloud environment.
11. Apply advanced data analysis techniques to financial data and explore emerging technologies and trends in FinTech.
12. Demonstrate use of teamwork, leadership skills, decision making and organization theory.

Course Structure

Semester III			
Course Code	**Course Type**	**Course Name**	**Credits**
	Major	**Advance Machine Learning**	**3**
	Major	**Deep Learning**	**3**
	Major	**Big Data Analytics**	**3**
	Minor	**Data Visualization**	**2**
	General Elective Course	**Statistical Quality Control (SQC)**	**3**
		Marketing Analytics	**3**
	Discipline Specific practical	**Advance Machine Learning Practicals**	**1**
		Deep Learning Practicals	**1**
		Big Data Analytics Practicals	**1**
		General Elective Course Practicals	**1**
	Research Project		**4**
Total Credits			**22**

Semester IV			
Course Code	**Course Type**	**Course Name**	**Credits**
	Major	**Business Analytics**	**3**
	Major	**Artificial Intelligence**	**3**
	Major	**MLOps with Cloud Technologies**	**3**
	General Elective Course	**Natural Language Processing**	**3**
		Supply Chain Analytics	**3**
	Discipline Specific practical	**Business Analytics Practicals**	**1**
		Artificial Intelligence Practicals	**1**
		MLOps with Cloud Technologies Practicals	**1**
		General Elective Course Practicals	**1**
	Research Project		**6**
Total Credits			**22**

Detailed Syllabus

Semester III

Major Courses

Course Name: Advance Machine Learning		**Course Code:**	
Course Type		**Major**	
Session Per Week (1 session is 60 minutes)		**3**	
Credits		**3**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2**	**60**
	Internal	**-**	**15**

Course outcome:

- CO1: Correctly apply and interpret results from clustering methods in scikit-learn, including k-means, agglomerative clustering, hierarchical clustering, and DBSCAN.
- CO2: Understand and apply Gaussian mixture models for clustering
- CO3: Implement recommender systems based on collaborative and content-based filtering methods.
- CO4: Understand reinforcement learning concepts, including dynamic programming and deep reinforcement learning

Unit	Content	No. of Lectures
1	**Unsupervised Learning:** Overview of Unsupervised Learning, Introduction to Clustering, Applications of Clustering, Difference between Factor Analysis and Cluster Analysis, Procedure for conducting cluster Analysis using i) Hierarchical Clustering Method, Agglomeration Schedule, vertical icicle Plot with complete linkage, Dendrogram with complete linkage	**15**

	ii) Density-Based Clustering Method iii) Grid-Based Clustering Method iv) Model-Based Clustering Method Evaluation of Clustering- Silhouette Score, Davies–Bouldin Index, Adjusted Rand Index, Fowlkes-Mallows Index	
2	**Gaussian Mixture Models:** Cluster data with Gaussian mixture models Optimize Gaussian mixture models with expectation maximization. **Frequent Itemset Mining and Recommender Systems:** Introduction to Frequent Itemset Mining, The Apriori Property and Apriori Algorithm, Evaluation Metrics for Association Rule Mining Recommender Systems: Collaborative Filtering and Content-Based Filtering Low-Rank Approaches in Recommender Systems, Applications of Recommender Systems in E-commerce, Media, and Social Networks	**15**
3	**Reinforcement Learning:** Introduction to reinforcement learning, multi-armed bandits, Dynamic Programming Methods for RL, Monte Carlo Methods for RL, Temporal Difference Learning, Deep Reinforcement Learning	**15**

Self – Learning Topics (Unit wise)

Unit	Topics
1	Applications of Clustering, Difference between Factor Analysis and Cluster Analysis, Dendrogram with complete linkage
2	Applications of Recommender Systems in E-commerce, Media, and Social Networks
3	Temporal Difference Learning, Deep Reinforcement Learning

Online Resources:

Introduction to Machine Learning by Dr. Balaraman Ravindran from IIT Madras available on swayam

portal https://nptel.ac.in/courses/106106139
Introduction to Machine Learning by Prof. S. Sarkar from IIT Kharagpur available on swayam portal https://nptel.ac.in/courses/106105152

Reference:

Reinforcement Learning: An Introduction by Richard S. Sutton and Andrew G. Barto
Pattern Recognition and Machine Learning by Christopher M. Bishop
Machine Learning Algorithms, 2nd Edition, Giuseppe Bonaccorso, Packt Publication
Mining of Massive Datasets by Jure Leskovec, Anand Rajaraman, and Jeffrey D. Ullman

Course Name: Advance Machine Learning Practicals	**Course Code:**
Session Per Week(1 period is 60 minutes)	**2**
Credits	**1**

List of Practicals
Minimum 10 practicals based on syllabus topics in python or R

Course Name: Deep Learning		**Course Code:**	
Course Type		**Major**	
Session Per Week (1 session is 60 minutes)		**3**	
Credits		**3**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2**	**60**
	Internal	**-**	**15**

Course outcome:

- CO1: Understand the fundamentals of neural networks, including biological neurons, activation functions, and training techniques such as gradient descent and backpropagation.
- CO2: To gain an in-depth understanding of artificial neural networks (ANNs)
- CO3: Analyze time series data to identify trends, seasonality, and stationarity, and make predictions using ANN-based time series forecasting models.
- CO4: To acquire knowledge of advanced concepts of Convolution Neural Networks, Recurrent Neural Networks, Autoencoders and generative adversarial networks.

Unit	Content	No. of Lectures
1	**Introduction:** Basics of Neural Networks: Biological Neurons, McCulloch Pitts Neuron, Perceptron, Multilayer Perceptron: Linearly separable, linearly non-separable classes Deep Networks: Fundamentals, Brief History, Three Classes of Deep Learning Basic Terminologies of Deep Learning **Artificial Neural Networks (ANN):** Multi-Layered Feedforward Neural Networks, Activation Functions: Tanh,	**15**

	Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss Functions: Squared Error loss, Cross Entropy, Optimization: Gradient Descent, Stochastic Gradient Descent, Backpropagation Regularization Techniques: L1/L2 regularization, Dropout, Weight Decay, Batch Normalization **Introduction to TensorFlow:** Computational Graphs, Gradient Descent, TensorBoard, Keras	
2	**Time Series Analysis:** Trends, Seasonality, Stationarity, Time Series Preprocessing: Smoothing, Differencing, Traditional Time Series Models - exponential smoothing, weighted average, AR, MA, ARMA, ARIMA, SARIMA, Applications of ANN in Time Series forecasting. **Recurrent Neural Networks (RNN):** Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Backpropagation Through Time (BTT), Vanishing and Exploding Gradients, Truncated BTT, Long Short-Term Memory (LSTM): Architecture, Selective Read/Write/Forget, Gated Recurrent Unit (GRU). Applications in Time series analysis	**15**
3	**Convolutional Neural Networks (CNN):** Convolution operation, Padding, Stride, Relation between input, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function, Different types of CNN architectures - LeNet, AlexNet, VGG (Visual Geometry Group) Net, GoogLeNet. **Unsupervised deep learning methods:** Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders, Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders, Application of Autoencoders: Image Compression. Introduction to GANs: Architecture, Training Process, Applications: Image Generation, DeepFake.	**15**

Self – Learning Topics (Unit wise)

Unit	Topics
1	Brief History, Three Classes of Deep Learning Basic Terminologies of Deep Learning, Regularization Techniques: L1/L2 regularization, Dropout
2	Traditional Time Series Models - exponential smoothing, weighted average, AR, MA, ARMA, ARIMA, SARIMA, Applications in Time series analysis
3	Different types of CNN architectures - LeNet, AlexNet, VGG (Visual Geometry Group) Net, GoogLeNet, Applications: Image Generation, DeepFake

Online Resources:

Deep Learning by Prof. P.K. Biswas from IIT Kharagpur available on swayam portal https://nptel.ac.in/courses/106105215
Deep Learning by Prof. Sudarshan Iyengar,Dr. Padmavati from IIT Ropar available on swayam portal https://nptel.ac.in/courses/106106184

Reference:

Ian Goodfellow, Yoshua Bengio, Aaron Courville. ―Deep Learning, MIT Press Ltd, 2016
Buduma, N. and Locascio, N., ―Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc."
Li Deng and Dong Yu, ―Deep Learning Methods and Applications, Publishers Inc.
Deep Learning, A practice approach by Josh Patterson, Adam Gibson, O'Reilly Media, Inc.

Course Name: Deep Learning Practicals	**Course Code:**
Session Per Week(1 period is 60 minutes)	**2**
Credits	**1**

List of Practicals
Minimum 10 practicals based on syllabus topics

Course Name: Big Data Analytics		**Course Code:**	
Course Type		**Major**	
Session Per Week (1 session is 60 minutes)		**3**	
Credits		**3**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2**	**60**
	Internal	**-**	**15**

Course outcome:

- CO1: Identify Big Data and its Business Implications.
- CO2: List the components of Hadoop and Hadoop Ecosystem
- CO3: Access and Process Data on Distributed File System
- CO4: Manage Job Execution in Hadoop Environment
- CO5: Develop Big Data Solutions using Hadoop EcoSystem
- CO6: Analyze Infosphere BigInsights, Big Data Recommendations.

Unit	Content	No. of Lectures
1	**Big Data Analytics:** Difference between big data analytics and big data engineering; Importance of	15

	data engineering in the big data world; Role of RDBMS (SQL Server), Hadoop, Spark, NoSQL and Cloud computing in data engineering; Key terminologies (Data Mart, Data Warehouse, ETL, Data Model, Schema, Data Pipeline, and more); Overview of available big data products & analytics services in cloud. **Hadoop Ecosystem:** Comparison of traditional data management systems with big data, Hadoop Architecture - HDFS overview/distributed file system, Hadoop components, Hadoop MapReduce, A typical enterprise cluster - Hadoop cluster mode, Get the data into Hadoop from local machine (Data Loading) - vice versa, Get the data into Hadoop from local machine (Data Loading) - vice versa	
2	**Introduction to Hive and Kafka:** Hive architecture and its components, Overview of Pig Latin and Impala, Hive data types bucketing, Hive partitions and joins, Kafka architecture and its components. **Introduction to NoSQL:** Limitations of RDBMS and motivation for NoSQL, NoSQL design goals and its advantages, Types of NoSQL databases (Categories), CAP theorem, Indexing and searching in NoSQL database, Clustering and scaling in NoSQL database.	**15**
3	**Introduction to Spark** Introduction to Spark and its architecture, Introduction to Scala and PySpark programming, working with DataFrames and Schemas, Data Analysis with DataFrame queries **Spark Resilient Distributed Datasets (RDD)** Introduction to RDD: Structure and basic operations, Aggregation and Pair operations on RDDs, Working with persist RDDs, Working with persist RDDs, Iterative algorithms using Spark **Introduction to Spark Data Processing, Data Streams and Machine Learning** Overview of Spark Streaming and Stream processing, Aggregating and joining streaming DataFrames, Processing Graph Data: GraphX, Introduction to Spark Machine Learning library (MLib), Case Studies	**15**

Self – Learning Topics (Unit wise)

Unit	Topics
1	Importance of data engineering in the big data world, Comparison of traditional data management systems with big data
2	Limitations of RDBMS and motivation for NoSQL, NoSQL design goals and its advantages
3	Aggregation and Pair operations on RDDs, Aggregating and joining streaming DataFrames, Processing Graph Data: GraphX, Case Studies

Online Resources:

Big Data Computing by Dr. Rajiv Misra from IIT Patna https://nptel.ac.in/courses/106104189
Introduction to Big Data with Spark and Hadoop offered by IBM available on coursera https://www.coursera.org/learn/introduction-to-big-data-with-spark-hadoop

Reference:

Tom White " Hadoop: The Definitive Guide" Third Edit on, O'reily Media, 2012
Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015
Michael Mineli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publications, 2013
Damji, J., Wenig, B., Das, T., Lee, D. (2020). Learning spark (2nd ed.) O'Reilly Media Inc

Course Name: Big Data Analytics Practicals	**Course Code:**
Session Per Week(1 period is 60 minutes)	**2**
Credits	**1**

List of Practicals
Minimum 10 practicals based on syllabus topics

Minor Course

Course Name: Data Visualization		**Course Code:**	
Course Type		**Minor**	
Session Per Week (1 session is 60 minutes)		**2**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2**	**50**

Course outcome:

- CO1: Design effective data visualizations in order to provide new insights into a research question or communicate information to the viewer.
- CO2: Find and select appropriate data that can be used in order to create a visualization that answers a particular research question.
- CO3: Handle data and data visualizations in a manner that demonstrates an understanding of ethical considerations surrounding data (including data storage, citation, and protection).
- CO4: Properly document and organize data and visualizations in order to prepare them for reuse.

Unit	**Content**	**No. of Lectures**
1	**Data Visualization using Tableau:** 1.1 Connect to and Customize Data 1.2 Organize Data and Create Filters 1.3 Build Common Views 1.4 Map Geographic Data 1.5 Create Calculated Fields	**30**

	1.6 Apply Table Calculations 1.7 Apply Analytics 1.8 Work with Multiple Data Sources 1.9 Create Dashboards and Stories 1.10 Restructure Data and Create Filters 1.11 Do more with Data Sources 1.12 Create Calculated Fields 1.13 Create Level of Detail (LOD) Expressions 1.14 Making Projections with Trend Lines and Forecasts 1.15 Map Data: Use Best Practices	
2	**Data Visualization using Power BI:** 2.1 Introduction to Power Query 2.2 Introduction to Data Literacy Module 2.3 Get started with Microsoft data analytics 2.4 Prepare data for Analysis 2.5 Model data in Power BI 2.6 Visualize data in Power BI 2.7 Advance Modelling Tasks in Power BI 2.8 Build Power BI visuals and reports 2.9 Advance Modelling Tasks in Power BI – 2 2.10 Dashboards in Power BI 2.11 Project and case study using Power BI	**30**

Online Resources:

Online resource for visualizations offered by Tableau https://public.tableau.com/
Online learning resource offered by Tableau https://www.tableau.com/learn
Data-Driven Decisions with Power BI available on coursera https://www.coursera.org/learn/data-driven-decisions-with-power-bi

Reference:

Mastering Power BI by Chandraish Sinha September 2021
Learning Tabelau 2022 packt publication
Mastering Tabelau packt publication
Data visualization with Excel Dashboards and Reports by Dick Kusleika

General Elective Courses

Course Name: Statistical Quality Control (SQC)		**Course Code:**	
Course Type		**General Elective Course - I (GEC)**	
Session Per Week (1 session is 60 minutes)		**3**	
Credits		**3**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2**	**60**
	Internal	**-**	**15**

Course outcome:

- CO1: Understand the philosophy and basic concepts of quality improvement.
- CO2: Describe the DMAIC processes (define, measure, analyze, improve, and control).
- CO3: Demonstrate the ability to use the methods of statistical process control.
- CO4: Demonstrate the ability to design, use, and interpret control charts for variables.
- CO5: Demonstrate the ability to design, use, and interpret control charts for attributes.
- CO6: Perform analysis of process capability and measurement system capability.
- CO7: Understand and interpret the basic concepts and usage of Lean Six Sigma.

Unit	Content	No. of Lectures
1	Course Introduction - Definitions of Quality and Quality Improvement. Statistical Methods and Management Aspects for Quality Control and Improvement. The DMAIC Process. The DMAIC Process, Statistical Process Control, Applications of SPC. Brainstorming and Negative Brainstorming,Case studies on DMAIC methodology	**15**
2	Control Charts for Variables, Control Charts for Attributes, Applications of	**15**

	Control Charts, Process Capability Analysis, Process Capability Ratios. Pareto chart, run chart,Real life examples on Pareto Chart	
3	Introduction to Lean and six – sigma : Definition of Lean , 5 S in Lean ,7 wastes in lean 5 principles of lean. Definition of six – sigma and definition of Lean six – sigma. DMAIC overview , Define phase : VOC,VOB,VOP,CTQ,COPQ, Stakeholder Analysis Problem Statement , Goal statement , Process definition, Process Mapping , Value Stream Mapping ,Project charter.	**15**

Self – Learning Topics (Unit wise)

Unit	Topics
1	Definitions of Quality Brainstorming and Negative Brainstorming, Case studies on DMAIC methodology
2	Control Charts for Variables Pareto chart, Real life examples on Pareto Chart Run chart
3	VOC,VOB,VOP,CTQ,COPQ, Value Stream Mapping , Project charter.

Online Resources:

NOC:Six Sigma, IIT Kharagpur by Prof. Jitesh J Thakkar https://nptel.ac.in/courses/110105123
Six Sigma, IIT Kharagpur by Prof. Tapan P. Bagchi https://nptel.ac.in/courses/110105039

Reference:

Montgomery, Douglas C. (2009). Introduction to Statistical Quality Control, Sixth Edition. John Wiley and Sons, Inc. (ISBN: 978-0-470-16992-6). Course Description: A comprehensive coverage of modern quality control techniques to include the design of statistical process control systems, lean 6 sigma, and process improvement
Montgomery, Douglas C. (2009). Introduction to Statistical Quality Control, Sixth Edition. John Wiley and Sons, Inc. (ISBN: 978-0-470-16992-6).

Course Description: A comprehensive coverage of modern quality control techniques to include the design of statistical process control systems, lean 6 sigma, and process improvement

Course Name: Statistical Quality Control Practicals	**Course Code:**
Session Per Week(1 period is 60 minutes)	**2**
Credits	**1**

List of Practicals
Minimum 10 practicals based on Statistical Quality Control(SQC) using Minitab.

Course Name: Marketing Analytics		**Course Code:**	
Course Type		**General Elective Course - II(GEC)**	
Session Per Week (1 session is 60 minutes)		**3**	
Credits		**3**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2**	**60**
	Internal	**-**	**15**

Course outcome:

- CO1: To understand the role and importance of marketing analytics in contemporary marketing practice.
- CO2: To apply analytical frameworks to address real-world marketing challenges and make informed strategic decisions.
- CO3: To gain hands-on experience with data analysis, visualization, and reporting for marketing campaigns and initiatives.
- CO4: To have know-how to use marketing analytics to develop a predictive marketing dashboard for the organization
- CO5: To analyze data and develop insights from it to address strategic marketing challenges.

Unit	Content	No. of Lectures
1	**Introduction to Marketing Analytics:** Introduction, basic marketing models, Analytical framework for marketing models, Overview of marketing analytics, Evolution and importance of marketing analytics in modern marketing, Modeling segmentation and Pricing, Market Basket Analysis, Marketing-Mix Analytics Measuring ROI, MROI, advertisement elasticity, Data Collection and Management ● Data sources and types in marketing ● Data collection methods (primary and secondary data) ● Data management best practices and tools	15
2	**Data Analysis Techniques:** Descriptive analytics: summarizing and visualizing marketing data, Inferential analytics: hypothesis testing, correlation, regression analysis, Predictive analytics: forecasting, predictive modeling, customer lifetime value (CLV) **Customer Analytics:** Survival Analysis, Analyzing customer lifetime value. Predicting customer retention and profit. Customer segmentation based on demographics, psychographics, and behavior, Targeting strategies: mass marketing, differentiated marketing, niche marketing **Customer Relationship Management (CRM) Analytics:** Understanding customer behavior and preferences, Customer acquisition,	15

	retention, and churn analysis, Personalization and recommendation systems	
3	**Digital Analytics** Planning search engine marketing and mobile marketing, Web analytics: tracking website traffic, conversion rates, and user engagement, Social media analytics: measuring reach, engagement, and sentiment, Email marketing analytics: open rates, click-through rates, conversion rates **Resource Allocation** Planning and modeling resource allocation in the organization. Case studies on the recent trends in management: ● Netflix: Leveraging Data for Content Recommendation ● Amazon: Optimizing Product Recommendations ● Starbucks: Data-Driven Customer Segmentation ● How Airbnb Uses Marketing Analytics to Drive Growth	**15**

Self – Learning Topics (Unit wise)

Unit	Topics
1	Evolution and importance of marketing analytics in modern marketing, Data collection methods (primary and secondary data), Data management best practices and tools
2	Descriptive analytics: summarizing and visualizing marketing data, Targeting strategies: mass marketing, differentiated marketing, niche marketing
3	Case studies on the recent trends in management: ● Netflix: Leveraging Data for Content Recommendation ● Amazon: Optimizing Product Recommendations ● Starbucks: Data-Driven Customer Segmentation ● How Airbnb Uses Marketing Analytics to Drive Growth

Online Resources:

Marketing Analytics by Prof. Swagato Chatterjee from IIT Kharagpur available on swayam portal https://nptel.ac.in/courses/110105142

Innovation in Marketing and Marketing of Innovation by Prof. Vinay Sharma from IIT Roorkee available on swayam portal https://nptel.ac.in/courses/110107432

Reference:

Kotler, P., & Keller, K. L. (2016). Marketing management (15th ed.). Pearson.
Brea Cesar (2014), "Marketing and Sales Analytics: Proven Techniques and Powerful Applications from Industry Leaders", FT Press, ISBN-0133761711
Chapman Christopher N, Feit Elea McDonnell (2015), "R for Marketing Research and Analytics", Springer, ISBN-3319144367
Emmett Cox (2012), "Retail Analytics: The Secret Weapon", Wiley, ISBN- 978-1-118-09984-1

Course Name: Marketing Analytics Practicals	**Course Code:**
Session Per Week(1 period is 60 minutes)	**2**
Credits	**1**

List of Practicals
Minimum 10 practicals based on syllabus topics

Course Name: Research Project		Course Code:	
Session Per Week (1 session is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation System	Internal (Presentations)	-	100

Semester IV

Major Courses

Course Name: Business Analytics		Course Code:	
Course Type		Major	
Session Per Week (1 session is 60 minutes)		3	
Credits		3	
		Hours	Marks
Evaluation System	Theory Examination	2	60
	Internal	-	15

Course outcome:

- CO1: Understand the fundamental principles of business analytics and its role in organizational decision-making.
- CO2: Explore the startup landscape and its relevance to business analytics initiatives.
- CO3: Examine the stages of the product life cycle and how business analytics can inform product management strategies.
- CO4: Gain practical insights into getting started with business analytics, including key considerations and challenges.

Unit	Content	No. of Lectures
1	**Business Analytics Landscape** Overview of Startup Landscape Product Lifecycle Management Details of Business Analytics Competing on Analytics Getting started with Business Analytics	**15**
2	**Introduction to Data Mining** Introduction: Basic concept of Data mining, need, challenges and application of Data mining. Discussion of Some case studies of data mining. On-line Analytical Processing. Major Issues in data mining. Getting to know your data: data objects and attribute types, basic statistical descriptions of Data, Data Visualization, Measuring Data Similarity and dissimilarity.	**15**
3	**Data Preparation & Basic Mining tools** Data Pre-processing: An Overview, Data Cleaning, Data Integration, Data Reduction, Data transformation and data discretization, Normalization and Smoothing of data. Associations and Correlations: Basic Concepts and methods. Classification: Basic concepts decision Tree Induction, Rule-Based Classification, Model Evaluation and Selection.	**15**

Self – Learning Topics (Unit wise)

Unit	Topics
2	Discussion of Some case studies of data mining, Major Issues in data mining, Data Visualization
3	Classification: Basic concepts decision Tree Induction, Rule-Based Classification, Model

	Evaluation and Selection.

Online Resources:

'Data Mining' by Prof. Pabitra Mitra from IIT Kharagpur available on the Swayam portal https://nptel.ac.in/courses/106/105/106105174
'Data Mining' by Mr. L. Abraham David from St.John's College, Palayamkottai Tirunelveli available on the Swayam portal
'Business Analytics and Data Mining Modelling using R' by Dr. Gaurav Dixit from IIT Roorkee available on the Swayam portal https://nptel.ac.in/courses/110/107/110107092
'Business Analytics and Data Mining Modelling using R Part II' by Dr. Gaurav Dixit from IIT Roorkee available on the Swayam portal https://nptel.ac.in/courses/110/107/110107095

Course Name: Business Analytics Practicals	**Course Code:**
Session Per Week(1 period is 60 minutes)	**2**
Credits	**1**

List of Practicals
Minimum 10 practicals based on syllabus topics

Course Name: Artificial Intelligence		**Course Code:**	
Course Type		**Major**	
Session Per Week (1 session is 60 minutes)		**3**	
Credits		**3**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2**	**60**
	Internal	**-**	**15**

Course outcome:

- CO1: Design and evaluate intelligent expert models for perception and prediction from an intelligent environment.
- CO2: Formulate valid solutions for problems involving uncertain inputs or outcomes by using decision making techniques.
- CO3: Demonstrate and enrich knowledge to select and apply AI tools to synthesize information and develop models within constraints of application area.
- CO4: Utilize advanced packages for implementing artificial intelligence.
- CO5: Develop a minor project in multidisciplinary areas to demonstrate team work through reports and presentation.

Unit	Content	No. of Lectures
1	**Introduction to Artificial Intelligence and Search Algorithm** What is artificial intelligence, A brief review of AI history , Related research fields, Problem formulation Review of tree structure, Review of graph structure, Graph implementation, State space representation, Search graph and search tree **Simple Search Algorithm - I** - Random search, Search with closed list, Search	**15**

	with open list, Depth-first and breadth-first search again, Uniform-cost search **Simple Search Algorithm-II**- What are heuristics? What is heuristic search? Best first search A* algorithm, Generalization of search problems **Adversarial Search** Minimax Algorithm for two player games , An Example of Minimax Search, An Example of Minimax Search , Analysis of Alpha Beta Pruning , Horizon Effect, Game Databases & Other Ideas	
2	**Reasoning:** Proposition and first-order logic, Rule-based systems, semantic net, conceptual graph, inference and deduction, Resolution refutation, answer extraction, Reasoning under uncertainty - probabilistic reasoning, belief networks **Production system:** Inference engine, Working memory, Knowledge base , Pattern matching , Conflict resolution , Forward inference, Back inference	**15**
3	**Genetic Algorithms:** Difference between traditional algorithms and Genetic Algorithm (GA); Basic concepts of GA; Working principle; Encoding methods; Fitness function; GA Operators: Reproduction, Crossover, Mutation; Convergence of GA; Detailed algorithmic steps; Adjustment of parameters; Multicriteria optimization; Solution of typical problems using genetic algorithm; Recent applications **Hybrid Systems:** Introduction to hybrid systems: Fuzzy-neural systems, Genetic Fuzzy systems, Neuro-genetic systems.	**15**

Self – Learning Topics (Unit wise)

Unit	Topics
1	A brief review of AI history , Related research fields, Review of tree structure, Review of graph structure, Graph implementation, Horizon Effect, Game Databases & Other Ideas

2	Proposition and first-order logic, Rule-based systems, semantic net, conceptual graph
3	Difference between traditional algorithms and Genetic Algorithm (GA), Recent applications

Online Resources:

"AN INTRODUCTION TO ARTIFICIAL INTELLIGENCE" by PROF. MAUSAM, Department of Computer Science and Engineering,IIT Delhi https://nptel.ac.in/courses/106/102/106102220/
"Artificial Intelligence : Search Methods For Problem Solving" by PROF. DEEPAK KHEMANI, Department of Computer Science and Engineering, IIT Madras https://nptel.ac.in/courses/106/106/106106126/

References:

Artificial Intelligence: A Modern Approach Book by Peter Norvig and Stuart J. Russell
S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, PHI.
"Artificial Intelligence: Foundations of Computational Agents" by David L. Poole and Alan K. Mackworth
S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, 2nd ed., Wiley India.

Course Name: Artificial Intelligence Practicals	**Course Code:**
Session Per Week(1 period is 60 minutes)	**2**
Credits	**1**

List of Practicals
Minimum 10 practicals based on syllabus topics

Course Name: MLOps with Cloud Technologies		**Course Code:**	
Course Type		**Major**	
Session Per Week (1 session is 60 minutes)		**3**	
Credits		**3**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2**	**60**
	Internal	**-**	**15**

Course outcome:

- CO1: To gain a comprehensive understanding of MLOps, including its importance in machine learning development and its components.
- CO2: To articulate the differences between MLOps and DevOps and understand their respective roles in the machine learning lifecycle.
- CO3: To learn about the various stages of the machine learning lifecycle and how MLOps principles and practices can be applied at each stage.
- CO4: To understand the different tools and technologies used in MLOps, including those for version control, CI/CD pipelines, model monitoring, and deployment.

- CO5: To gain an overview of cloud computing platforms, with a focus on AWS and Azure, and understand how these platforms support MLOps workflows.

Unit	Content	No. of Lectures
1	**MLOps Introduction:** Introduction to MLOps and its importance in machine learning development, MLOps Components, Machine Learning Life Cycle, MLOps Vs DevOps, Different tools for MLOps, MLOps Maturity Model Levels, MLOps - Stages of CI / CD Overview of cloud computing platforms and services relevant to MLOps. Basics of containerization and orchestration for deploying ML models. Integration of version control systems with cloud repositories. Security and compliance considerations in MLOps workflows.	15
2	**AWS MLOps:** Introduction to AWS cloud computing services relevant to MLOps. Setting up an AWS account and configuring AWS CLI, Amazon SageMaker and its capabilities for end-to-end ML workflows, SageMaker for model training, deployment, and management, Setting up CI/CD pipelines for deploying ML models with SageMaker, Integrating version control systems with AWS CodeCommit Implementing model monitoring and management workflows using AWS CloudWatch, Detecting and handling model drift with AWS tools, Automating model retraining and deployment based on monitoring metrics, Deploying serverless ML inference pipelines with AWS Lambda and Amazon API Gateway	15
3	**Azure MLOps:** Overview of Azure cloud computing services, Understanding the Azure portal and Azure CLI, Introduction to Azure Machine Learning service, Azure ML for model development, training, and deployment, Overview of Azure DevOps for CI/CD pipelines, Implementing model monitoring with Azure Monitor,	15

	Automation of model retraining and deployment **Case Studies:** Deploy a Classification Model using MLOps on AWS Deploy a Multiple Linear Regression Model using MLOps Deploy a Personalized Product Recommendation using MLOps Deploy a Gaussian Model in Time Series using MLOps on Azure	

Self – Learning Topics (Unit wise)

Unit	Topics
1	Machine Learning Life Cycle, MLOps Vs DevOps, Security and compliance considerations in MLOps workflows.
2	Automating model retraining and deployment based on monitoring metrics, Deploying serverless ML inference pipelines with AWS Lambda and Amazon API Gateway
3	Implementing model monitoring with Azure Monitor, Automation of model retraining and deployment **Case Studies:** Deploy a Classification Model using MLOps on AWS Deploy a Multiple Linear Regression Model using MLOps Deploy a Personalized Product Recommendation using MLOps Deploy a Gaussian Model in Time Series using MLOps on Azure

Online Resources:

Machine Learning Engineering for Production (MLOps) Specialization available on coursera https://www.coursera.org/specializations/machine-learning-engineering-for-production-mlops
Foundation of Cloud IoT Edge ML by Prof. Rajiv Misra from IIT Patna available on swayam portal https://nptel.ac.in/courses/106104242
MLOps Platforms: Amazon SageMaker and Azure ML available on coursera https://www.coursera.org/learn/mlops-aws-azure-duke

References:

"MLOps: Continuous Delivery and Automation Pipelines in Machine Learning" by Mark Treveil
"Production-Ready Machine Learning: Navigating from Idea to Deployment" by Andrew Bruce and Kim Nilsson
"Data Science on AWS: Implementing End-to-End, Continuous AI and Machine Learning Pipelines" by Chris Fregly and Antje Barth
"Data Science on Azure: Implementing End-to-End, Continuous AI and Machine Learning Pipelines" by Wee Hyong Tok, Danielle Dean, and Max Kaznady

Course Name: MLOps with Cloud Technologies Practicals	**Course Code:**
Session Per Week(1 period is 60 minutes)	**2**
Credits	**1**

List of Practicals
Minimum 10 practicals based on syllabus topics

General Elective Courses

Course Name: Natural Language Processing		**Course Code:**	
Course Type		**General Elective Course-I (GEC)**	
Session Per Week (1 session is 60 minutes)		**3**	
Credits		**3**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2**	**60**
	Internal	**-**	**15**

Course outcome:

- CO1: To understand the fundamentals of Natural Language Processing (NLP)
- CO2: To identify and apply various techniques for text preprocessing, including tokenization, stemming, and lemmatization.
- CO3: Understand the basics of semantic analysis, including meaning representation and lexical semantics.
- CO4: Apply Part-Of-Speech (POS) tagging techniques, including rule-based, stochastic, and transformation-based tagging methods.
- CO5: Design and implement an NLP pipeline, including data acquisition, text extraction, preprocessing, feature engineering, modeling, evaluation, and post-modeling phases.
- CO6: Apply NLP techniques to various applications, including text classification, chatbots, text summarization, sentiment analysis, information retrieval, and question-answering systems.

Unit	Content	No. of Lectures
1	**Introduction:** What is Natural Language Processing (NLP), Origins of NLP, Language and Knowledge, The Challenges of NLP, Language and Grammar, Processing Indian Languages, NLP Applications	**15**

	Basic Terms: Tokenization, Stemming, Lemmatization; Survey of English Morphology, Inflectional Morphology, Derivational Morphology; Regular expression with types; Grams and its variation: Bigram, Trigram; Simple (Unsmoothed) N-grams; N-gram Sensitivity to the Training Corpus; Unknown Words: Open versus closed vocabulary tasks; Evaluating N-grams: Perplexity.	
2	**Syntax analysis:** Part-Of-Speech tagging(POS) – POS categories, methods for POS tagging: Rule-based, Stochastic, Transformation based tagging, Difficulties /Challenges in POS tagging; Generative Model: Hidden Markov Model (HMM Viterbi) for POS tagging **Semantic Analysis:** Introduction, meaning representation; Lexical Semantics; Corpus study; Study of Various language dictionaries like WorldNet, Babelnet; Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy; Semantic Ambiguity; Word Sense Disambiguation (WSD)	**15**
3	**NLP Pipeline:** Data Acquisition, Text Extraction and Cleanup, Pre-Processing, Feature Engineering, Modeling, Evaluation, Post-Modeling Phases. **Applications:** Case studies on Text Classification, Chatbots, Text Summarization, Sentiment analysis, Information retrieval, Question Answering system	**15**

Self – Learning Topics (Unit wise)

Unit	Topics
1	The Challenges of NLP, Language and Grammar, Processing Indian Languages, NLP Applications, Regular expression with types

2	Difficulties /Challenges in POS tagging, Study of Various language dictionaries like WorldNet, Babelnet
3	Case studies on Text Classification, Chatbots, Text Summarization, Sentiment analysis, Information retrieval, Question Answering system

Online Resources:

Natural Language Processing By Prof. Pawan Goyal from IIT Kharagpur available on swayam portal https://archive.nptel.ac.in/courses/106/105/106105158
APPLIED NATURAL LANGUAGE PROCESSING by PROF. RAMASESHAN R from Chennai Mathematical Institute available on swayam portal https://archive.nptel.ac.in/courses/106/106/106106211
Natural Language Processing by Prof. Pushpak Bhattacharyya from IIT Bombay available on swayam portal https://archive.nptel.ac.in/courses/106/101/106101007

References:

Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana, Practical Natural Language Processing, 2020.
Steven Bird, Ewan Klein, Edward Loper., Natural Language Processing with Python, 2009.
Nitin Indurkhya and Fred J. Damerau, ―Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.

Course Name: Natural Language Practicals	**Course Code:**

Session Per Week(1 period is 60 minutes)	**2**
Credits	**1**

List of Practicals
Minimum 10 practicals based on syllabus topics

Course Name: Supply Chain Analytics		**Course Code:**	
Course Type		**General Elective Course-II (GEC)**	
Session Per Week (1 session is 60 minutes)		**3**	
Credits		**3**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2**	**60**
	Internal	**-**	**15**

Course outcome:

- CO1: To understand how analytics techniques are applied to optimize various aspects of supply chain operations, including demand forecasting, inventory management, and network design.
- CO2: To gain proficiency in supply chain planning concepts, including different views of the supply chain, supply chain strategy, drivers, and strategic fit.
- CO3: To understand the principles of inventory management in supply chains, including the bullwhip effect, inventory optimization, and multi-echelon inventory management.

- CO4: To design and optimize supply chain networks, considering factors such as distribution channels, location decisions, and uncertainty.
- CO5: To use decision trees to handle uncertainty and make informed decisions in supply chain management.

Unit	Content	No. of Lectures
1	Introduction to Supply Chain Management, Evolution of Supply Chain Management, Analytics in Supply Chain Management, Supply Chain Planning, Different views of Supply Chain, Supply Chain Strategy, Supply Chain Drivers, Developing Supply Chain Strategy, Strategic Fit in Supply Chain, Demand Forecasting in Supply Chain Bullwhip Effect and Time Series Analysis, Exponential Smoothing Method of Forecasting, Measures of Forecasting Errors, Tracking Signal and Seasonality Models, Forecasting using multiple characteristics in Demand Data and Inventory Management in Supply Chain	**15**
2	Inventory Management in Supply Chain, Multi echelon Inventory Management, Multi echelon Inventory Management for four stations (Numerical Example) Network Design in Supply Chain, Network Design of Global Supply Chain, Alternative channels of Distribution, Location Decisions in Supply Chain, Network Optimization Models, Using Excel Solver for Network Optimization, Uncertainty in Network Design, Network Design in Uncertain Environment and Flexibility, Flexibility in Supply Chain	**15**
3	Optimal Level of Product Availability in Supply chain, Time Value of money in Supply Chain, Different types of Analytics in Supply Chain, Predictive Modelling in Forecasting in Supply Chain, Representation on Uncertainty in Supply Chain. Using Decision Tree for handling Uncertainty, Example of using Decision Tree incorporating Uncertainty in Single Factor, Example of using Decision Tree incorporating Uncertainty in two Key Factors, Modelling Flexibility in Supply Chain,Trends, Challenges and Future of Supply Chain	**15**

Self – Learning Topics (Unit wise)

Unit	Topics
1	Evolution of Supply Chain Management, Time Series Analysis, Exponential Smoothing Method of Forecasting,
2	Using Excel Solver for Network Optimization
3	Trends, Challenges and Future of Supply Chain

Online Resources:

Supply Chain Analytics by Prof. Rajat Agrawal from IIT Roorkee available on swayam portal https://nptel.ac.in/courses/110107074
Modelling and Analytics for Supply Chain Management by Prof. Anupam Ghosh, Prof. Kunal Kanti Ghosh from IIT Kharagpur available on swayam portal https://nptel.ac.in/courses/110105141

References:

"Supply Chain Management: Strategy, Planning, and Operation" by Sunil Chopra and Peter Meindl
"Supply Chain Analytics: Concepts, Techniques and Applications" by Kurt Y. Liu
"Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain" by Michael Watson, Sara Lewis, Peter Cacioppi, and Jay Jayaraman

Course Name: Supply Chain Analytics Practicals	**Course Code:**
Session Per Week(1 period is 60 minutes)	**2**
Credits	**1**

List of Practicals
Minimum 10 practicals based on syllabus topics

Course Name: Research Project		**Course Code:**	
Session Per Week (1 session is 60 minutes)		**6**	
Credits		**6**	
		Hours	**Marks**
Evaluation System	**Internal (Presentations)**	**-**	**150**