AC: 10/03/2025

S P Mandali's
R. A. PODAR COLLEGE OF COMMERCE AND ECONOMICS
(EMPOWERED AUTONOMOUS),
Matunga, Mumbai-400019

Course Structure

Bachelor of Science (Data Science and Analytics)

Semester V and VI

College Website: www.rapodar.ac.in

AC: 10/03/2025

S P Mandali's
R. A. PODAR COLLEGE OF COMMERCE AND ECONOMICS
(EMPOWERED AUTONOMOUS),
Matunga, Mumbai-400019

Bachelor of Science (Data Science and Analytics)
TYBSc Semester V

Syllabus
And
Question paper pattern of Course

As per National Education Policy 2020
To be implemented from Academic Year 2025- 2026

College Website: www.rapodar.ac.in

Bachelor of Science (Data Science and Analytics) Programme
Syllabus as per National Education Policy 2020
Course Structure
T.Y.B.S.C (Data Science and Analytics) (Level 5.5)
(To be implemented from Academic Year 2025-26)

No of Courses	Course Code	Semester V	Credits
1	**Major (12 credits)**		
1.A	**Discipline Specific Core**		
1.A.a		Natural Language Processing	**04**
1.A.b		Deep Learning	**04**
1.B	**Discipline Specific Elective**		
1.B.a		Computer Networks	**04**
2	**Minor (03 credits)**		
2.A.a		Regression Analysis	**03**
3	**General Elective (GE)/ Open Elective (OE) (03 Credits)**		
3.A.a		Social Entrepreneurship	**03**
3.A.b		Competitive Dynamics and Strategy	**03**
3.A.c		Emotional Intelligence	**03**
4	**Vocational & Skill Enhancement Courses (VSEC) (02 credits)**		
4.A	**Vocational Skill Course**		
4.A.a		Design Thinking	**02**
5	**Field Project / Apprenticeship / Community Engagement & Services (02 credits)**		
5.A.a		Campus Preparatory - Competence and Employability	**02**
TOTAL CUMULATIVE CREDITS			**22**

Exit option at the end of the Third year (on completion of semester V and semester VI):
Under Graduate Certificate in Data Science and Analytics will be awarded to a learner on fulfillment of the following conditions:
1. The learner should have acquired 44 credits in Semester V and VI considered together.

2. The learner should acquire an additional 4 credits as per norms by completing recognized courses under the National Skill Qualification Framework (NSQF) such as a certificate course on Introduction to Cloud Computing, a Course on Generative AI concepts, and an Internship.

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
1.Major
1.A. Discipline Specific Core Courses
1.A.a Natural Language Processing (4 Credits)
Semester V

1. Major	
1.A Discipline Specific Core	
1.A.a Natural Language Processing	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	Provide a strong foundation in NLP concepts, covering text processing, linguistic structures, and computational techniques.
CObj 2	Introduce students to key NLP tasks, such as tokenization, part-of-speech tagging, named entity recognition (NER), and parsing.
CObj 3	Develop an understanding of machine learning and deep learning approaches in NLP, including word embeddings and transformers.
CObj 4	Equip students with the skills to implement NLP applications like text summarization, sentiment analysis, and machine translation.
CObj 5	Enable students to apply ethical and fairness considerations in NLP models to mitigate bias and misinformation.
Course Outcomes	
COut 1	Understand and explain core NLP concepts, applications, and computational techniques.
COut 2	Implement text processing techniques such as tokenization, stemming, and morphological analysis.
COut 3	Perform part-of-speech tagging (POS) using rule-based and statistical models.
COut 4	Apply NLP techniques for named entity recognition (NER) and word sense disambiguation (WSD).
COut 5	Develop syntactic and semantic parsers using probabilistic models and deep learning.

COut 6	Train and fine-tune deep learning models (RNNs, LSTMs, Transformers) for NLP applications.
COut 7	Evaluate the performance of NLP models using precision, recall, F1-score, and BLEU score.
COut 8	Build real-world NLP solutions, such as sentiment analysis, text summarization, and machine translation.

Modules at a Glance

Natural Language Processing		
Sr. No.	**Modules**	**No. of Lectures**
1	Introduction to NLP & Text Processing	15
2	POS Tagging, NER & WSD	15
3	Parsing, Clustering & Association Rule Mining	15
4	Deep Learning for NLP & Ethical Considerations	15
Total		**60**

Sr. No.	Modules
1	**Introduction to NLP & Text Processing**
	Basics of NLP: Definition, History & Importance of NLP, NLP Applications: Speech to Text (STT), Text to Speech (TTS), Machine Translation, Text Summarization, Sentiment Analysis, NLP Abstraction Levels **Challenges in NLP:** Handling Ambiguity, Polysemy, Language Variations, Morphological, Syntactic & Semantic Challenges **Text Preprocessing & Tokenization:** Text Cleaning & Normalization, Tokenization: Word & Sentence Segmentation, Stopword Removal, Lemmatization & Stemming **Morphological Processing:** Types of Morphology & Word Formation, Finite-State Automata (FSA) & Finite-State Transducers (FST), Rule-based vs. Machine Learning-based Morphology
2	**POS Tagging, NER & WSD**
	Part-of-Speech (POS) Tagging: Definition & Importance of POS Tagging, POS Tagging Methods: Rule-Based, HMM, CRF, TBL **Named Entity Recognition (NER):** Rule-Based vs. Machine Learning-based NER, NER using SpaCy, Stanford NLP, Deep Learning **Word Sense Disambiguation (WSD):** Lexical Ambiguity & Polysemy, WSD Methods: Lesk Algorithm, WordNet-based, Machine Learning-based **Evaluation Metrics for NLP Tasks:** Precision, Recall, F1 Score, BLEU Score for Machine Translation
3	**Parsing, Clustering & Association Rule Mining**
	Parsing & Grammar Formalisms: Constituency Parsing vs. Dependency Parsing, CFG, PCFG, Feature-Unification Grammar, Probabilistic Parsing (Earley's & CYK Algorithms)

	Unsupervised Learning in NLP: Clustering for Text Data: K-Means, Hierarchical Clustering, Topic Modeling: Latent Dirichlet Allocation (LDA) **Dimensionality Reduction in NLP:** Curse of Dimensionality, Feature Selection & Principal Component Analysis (PCA) **Association Rule Mining:** Market Basket Analysis for NLP, Apriori Algorithm for text association mining
4	**Deep Learning for NLP & Ethical Considerations**
	Introduction to Deep Learning in NLP: Basics of Artificial Neural Networks (ANNs), Supervised vs. Unsupervised Learning in NLP, Recurrent Neural Networks (RNNs) & Long Short-Term Memory (LSTMs) **Word Embeddings & Representation Learning:** Word2Vec, GloVe, FastText, Transformer Models: BERT, GPT, T5, Fine-tuning Pretrained Models **NLP Applications Using Deep Learning:** Sentiment Analysis using BERT, Machine Translation (Seq2Seq Models), Text Summarization with Transformer Networks **Ethics & Challenges in NLP:** Bias in NLP Models, Fake News Detection & Misinformation, Fairness & Explainability in NLP Models

Practical Work (20 Marks)

List of Practicals to be Conducted	
1	Implement text cleaning, tokenization, and stemming using NLTK/SpaCy
2	Apply Hidden Markov Models (HMM) & Conditional Random Fields (CRF) for tagging
3	Train an NER model using SpaCy or Stanford NER
4	Implement Lesk Algorithm & WordNet-based WSD
5	Perform syntactic parsing using Stanford CoreNLP & SpaCy
6	Train a Naïve Bayes or Transformer-based sentiment classifier
7	Implement extractive and abstractive summarization using NLP models
8	Train a simple Neural Machine Translation (NMT) model using TensorFlow
9	Implement a Q&A system using Hugging Face Transformers
10	Process unstructured text from a real-world dataset (Tweets, Reviews, News articles)

AC: 10/03/2025

Question Paper Pattern (Academic Year: 2025-2026)
Natural Language Processing
Semester End Examination and Practical Examination – 100 Marks
SEMESTER V
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q2.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q3.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q4.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
	Total	**80**	**60**

B] Practical Examination - 40 Marks
A Certified copy journal is essential to appear for the practical examination.

1.	**Practical Work**	**20**
2.	**Journal**	**10**
3.	**Viva Voce**	**10**

Books and References:

- Jurafsky, Daniel, and James H. Martin. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition. 3rd ed., Pearson, 2023.
- Manning, Christopher D., and Hinrich Schütze. Foundations of Statistical Natural Language Processing. MIT Press, 1999.
- Goldberg, Yoav. Neural Network Methods in Natural Language Processing. Morgan & Claypool Publishers, 2017.
- Eisenstein, Jacob. Natural Language Processing. MIT Press, 2019.
- Bird, Steven, Ewan Klein, and Edward Loper. Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit. O'Reilly Media, 2009.
- Vaswani, Ashish, et al. Attention Is All You Need. NeurIPS, 2017.

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
1.Major
1.A Discipline Specific Core Courses
1.A.b Deep Learning (4 Credits)
Semester V

1. Major	
1.A Discipline Specific Core	
1.A.b Deep Learning	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	Introduce the fundamental concepts of deep learning, including neural networks and optimization techniques.
CObj 2	Develop an understanding of key architectures such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs).
CObj 3	Equip students with hands-on skills in implementing deep learning models using frameworks like TensorFlow and PyTorch.
CObj 4	Explore deep generative models, representation learning, and autoencoders for feature extraction and generation.
CObj 5	Enable students to apply deep learning techniques to real-world problems such as image processing, NLP, and reinforcement learning.
Course Outcomes	
COut 1	Understand the core principles of deep learning and artificial neural networks.
COut 2	Build and optimize deep learning models for various applications.
COut 3	Implement convolutional and recurrent architectures for structured and unstructured data.
COut 4	Train and fine-tune deep generative models for feature extraction and synthesis.
COut 5	Apply deep learning techniques to solve real-world problems in vision, NLP, and generative AI.
COut 6	Evaluate model performance using metrics such as accuracy, precision, recall,

	and loss functions.
COut 7	Deploy deep learning models efficiently on cloud or edge devices.
COut 8	Understand the ethical implications of AI and deep learning applications.

Modules at a Glance

Deep Learning		
Sr. No.	**Modules**	**No. of Lectures**
1	Foundations of Deep Learning	15
2	Advanced Neural Network Architectures	15
3	Specialized Deep Learning Models and Applications	15
4	Ethics and Practical Considerations in Deep Learning	15
Total		**60**

Sr. No.	Modules
1	**Foundations of Deep Learning**
	Introduction: Evolution and significance of deep learning, Key applications across industries **Mathematical Foundations:** Linear Algebra: Scalars, Vectors, Matrices, and Tensors, Matrix operations: Multiplication, Identity, and Inverses, Eigenvalues and Eigenvectors, Norms and special matrices **Numerical Computation:** Issues of overflow and underflow, Conditioning and stability in algorithms **Neural Networks Basics:** Structure and function of neurons, Activation functions: Sigmoid, Tanh, ReLU, and variants, Loss functions: MSE, Cross-Entropy **Training Neural Networks:** Forward and backward propagation, Gradient Descent and its variants, Overfitting and underfitting, Regularization techniques: L1, L2, Dropout
2	**Advanced Neural Network Architectures**
	Deep Feedforward Networks: Architecture and training challenges, Weight initialization strategies **Regularization Techniques:** Batch Normalization, Dropout and its impact on training **Optimization for Deep Networks:** Advanced optimizers: RMSprop, Adam, Learning rate scheduling, Handling vanishing and exploding gradients **Convolutional Neural Networks (CNNs):** Convolution operations and feature maps Pooling mechanisms, Popular CNN architectures: LeNet, AlexNet, VGG, ResNet **Recurrent Neural Networks (RNNs):** Sequence modeling and applications, Long Short-Term Memory (LSTM) and Gated Recurrent Units (GRUs), Bidirectional RNNs and attention mechanisms

3	**Specialized Deep Learning Models and Applications**
	Autoencoders and Representation Learning: Undercomplete and sparse autoencoders, Denoising and variational autoencoders **Generative Models:** Generative Adversarial Networks (GANs), Conditional GANs and applications **Sequence Modeling:** Advanced RNN architectures, Transformer models and attention mechanisms **Deep Reinforcement Learning:** Fundamentals of reinforcement learning, Deep Q-Networks and policy gradients **Applications of Deep Learning:** Natural Language Processing: Text generation, translation, Computer Vision: Image classification, object detection, Speech Recognition and synthesis
4	**Ethics and Practical Considerations in Deep Learning**
	Ethical Considerations: Bias and fairness in AI models, Interpretability and explainability **Scalability and Deployment:** Model optimization for deployment, Hardware considerations: GPUs, TPUs **Case Studies:** Analysis of real-world deep learning applications, Lessons learned from industry implementations, **Future Directions:** Emerging Architectures, Quantum computing and deep learning, Neuromorphic computing

Practical Work (20 Marks)

List of Practicals to be Conducted	
1	Build and train a simple neural network for classification tasks.
2	Apply dropout and batch normalization to improve model performance.
3	Develop a CNN for image classification using a dataset like CIFAR-10.
4	Implement an RNN for sequence prediction tasks.
5	Construct an autoencoder for image denoising applications.
6	Develop a GAN to generate synthetic images.
7	Implement a transformer-based model for language translation.
8	Experiment with different hyperparameters to optimize model performance.
9	Deploy a trained model using a web framework for real-time inference.

AC: 10/03/2025

Question Paper Pattern (Academic Year: 2025-2026)
Deep Learning
Semester End Examination and Practical Examination – 100 Marks
SEMESTER V
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q2.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q3.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q4.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
	Total	**80**	**60**

B] Practical Examination - 40 Marks
A Certified copy journal is essential to appear for the practical examination.

1.	**Practical Work**	**20**
2.	**Journal**	**10**
3.	**Viva Voce**	**10**

Books and References:

- Goodfellow, Ian, et al. Deep Learning. MIT Press, 2016.
- Chollet, François. Deep Learning with Python. Manning Publications, 2018.
- Géron, Aurélien. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow. O'Reilly Media, 2019.
- Nielsen, Michael A. Neural Networks and Deep Learning. Determination Press, 2015.
- Aggarwal, Charu C. Neural Networks and Deep Learning: A Textbook. Springer, 2018

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
1.Major
1.B Discipline Specific Elective Courses
1.B.a Computer Networks (4 Credits)
Semester V

1. Major	
1.B Discipline Specific Elective	
1.B.a Computer Networks	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	Knowledge of uses and services of Computer Network.
CObj 2	Ability to identify types and topologies of network
CObj 3	Understanding of analog and digital transmission of data.
CObj 4	Familiarization with the techniques of routing.
Course Outcomes	
COut 1	Identify various data communication standards, topologies and terminologies
COut 2	Describe how signals are used to transfer data and communication aspects between nodes
COut 3	Configure IP addresses using TCP/IP protocol suite
COut 4	Use different application layer protocols

Modules at a Glance

Computer Networks		
Sr. No.	**Modules**	**No. of Lectures**
1	Introduction to Networks	15
2	Physical layer and Data Link layer	15
3	Network and Transport layer	15
4	Application layer	15
Total		**60**

Sr. No.	Modules
1	**Introduction to Networks**
	Computer Network: Evolution of Computer Networks Different types of Computer Network, Difference between LAN, MAN and WAN, **Hardware Devices**: Network Interface Card (NIC), Modem, Hub, Switch L1 and L2 switches, Comparison between switch and hub, Bridge, Router, Gateway **Standards and administration:** ISO, IEEE, RFC Standards **Network Models:** Protocol layering, TCP/IP protocol suite, The OSI model
2	**Physical layer and Data Link layer**
	Introduction to Physical layer: Data and signals, periodic analog signals, digital signals, transmission impairment, data rate limits, performance **Introduction to the Data Link Layer:** Link layer addressing, Data Link Layer Design Issues, Error detection and correction, block coding **Wireless LANs:** IEEE 802.11 project, Bluetooth, WiMAX, Cellular telephony, Satellite networks
3	**Network and Transport layer**
	Network Layer: IPv4 Addresses, IPv4 Protocol, ARP, ICMP, IPv6 **Routing:** RIP, OSPF, BGP **Transport Layer:** UDP, TCP
4	**Application layer**
	Applications & WWW, HTTP, DNS, SMTP, POP3, MIME, IMAP, DHCP, TELNET, SSH, FTP

AC: 10/03/2025

Practical Work (20 Marks)

List of Practicals to be Conducted	
1	Colour code for crimping LAN (Cat 5/6/7) cable
2	Configuring LAN setup
3	IPv4 Addressing and Subnetting
4	Designing and configuring a network topology
5	Configure IP routing using RIP
6	Configuring Simple and multi-area OSPF
7	Configuring server and client (DHCP, DNS, HTTP, Telnet, FTP)
8	Configure basic security features for networks
9	Packet capture and header analysis by wire-shark (TCP, UDP, IP etc.)
10	Planning and Design a corporate network for a given scenario

AC: 10/03/2025

Question Paper Pattern (Academic Year: 2025-2026)
Computer Networks
Semester End Examination and Practical Examination – 100 Marks
SEMESTER V
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q2.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q3.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q4.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
	Total	**80**	**60**

B] Practical Examination - 40 Marks
A Certified copy journal is essential to appear for the practical examination.

1.	**Practical Work**	**20**
2.	**Journal**	**10**
3.	**Viva Voce**	**10**

Books and References:

- TCP/IP Protocol Suite, Behrouz A. Forouzan, Tata McGraw Hill, 2010
- Data Communication and Networking, Behrouz A. Forouzan, Tata McGraw Hill
- Computer Networks, Andrew Tanenbaum, Pearson, Fifth Edition, 2013

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
2. Minor
2.A.a Regression Analysis (3 Credits)
Semester V

2. Minor	
2.A.a Regression Analysis	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	To understand the basics of simple linear regression, including model formulation and estimation of coefficients.
CObj 2	To understand how multiple predictors influence the dependent variable in a multiple linear regression model.
CObj 3	To learn the application of logistic regression for binary classification and understand its extensions.
Course Outcomes	
COut 1	Learners will be able to create and interpret simple linear regression models and assess their goodness of fit.
COut 2	Learners will be able to build and interpret multiple linear regression models and perform hypothesis testing for predictors.
COut 3	Learners will be able to apply logistic regression for binary outcomes and interpret model results effectively.

Modules at a Glance

Regression Analysis		
Sr. No.	**Modules**	**No. of Lectures**
1	Simple Linear Regression	15
2	Multiple Linear Regression	15
3	Logistic Regression	15
Total		**45**

Sr. No.	Modules
1	**Simple Linear Regression**
	Correlation Analysis: Scatter Diagram. Karl Pearson's Product Moment Correlation Coefficient and its properties, Spearman's Rank Correlation (With and without ties). **Introduction to Regression:** Concept of Simple Linear Regression (SLR), Model: $Y=\beta0+\beta1X+\epsilon$, where ϵ is a continuous random variable. Assumptions of SLR. Interpretation of regression coefficients. **Model Estimation & Evaluation:** Estimation of regression parameters ($\beta0,\beta1$) using the least squares method (no derivation). Coefficient of Determination (R^2). Residual plots, detection of outliers. Interpretation of model outputs in Python/R. Significance of regression coefficients (t-test). Confidence intervals for regression coefficients.
2	**Multiple Linear Regression**
	Introduction to Multiple Regression: Model: $Y=\beta0+\beta1X1+\ldots+\beta pXp+\epsilon$. Assumptions of multiple linear regression. Estimation of parameters using least squares *(no derivation)*. **Model Evaluation & Diagnostics:** Residual analysis: Standardized residuals, detection of outliers. Multicollinearity: Detection using Variance Inflation Factor (VIF). Heteroscedasticity: Detection using the Breusch-Pagan test, and corrective measures. Autocorrelation: Concept, detection using the Durbin-Watson test. **Interpreting Model:** Interpreting summary() output in Python (statsmodels) and R (lm function). Checking model assumptions using diagnostic plots. Feature selection using AIC/BIC. **Binary Classification:** Concept of binary response variable. Logit transformation and interpretation of coefficients. Model estimation using Maximum Likelihood Estimation (MLE) (no derivation). Evaluating model fit using pseudo R^2 (McFadden's R^2, Cox & Snell R^2).
3	**Time Series Analysis**

	Definition of Time Series and its Applications. **Components of Time Series:** Trend, Seasonal, Cyclical, and Irregular Components. Models of Time Series: Additive and Multiplicative. **Estimation of Trend:** Freehand Curve Method, Method of Semi-Average Method of Moving Average, Method of Least Squares (Linear Trend only). **Estimation of Seasonal Component:** Method of Simple Average, Ratio to Moving Average, Ratio to Trend Method, Forecasting based on exponential smoothing, Fitting of autoregressive model AR(p) where p=1,2

Practical Work (20 Marks)

List of Practicals to be Conducted	
1	**Simple Linear Regression** **Aim:** To fit a simple linear regression model and interpret its coefficients, R^2, and regression line.
2	**Multiple Linear Regression** **Aim:** To fit a multiple linear regression model and analyze the impact of multiple predictors.
3	**Residual Analysis & Model Diagnostics** **Aim:** To analyze residuals and diagnose model issues like multicollinearity, heteroscedasticity, and outliers.
4	**Hypothesis Testing in Regression** **Aim:** To perform hypothesis tests on regression coefficients and model significance.
5	**Logistic Regression for Binary Classification** **Aim:** To fit a logistic regression model and interpret its coefficients and odds ratios.
6	**Feature Selection in Regression** **Aim:** To perform feature selection using AIC, BIC, and stepwise regression.
7	**Time Series (Trend Estimation)** **Aim:** To analyze time series data, estimate trends using moving averages and trend lines, and interpret seasonal variations.
8	**Forecasting (Exponential Smoothing, AR Models)** **Aim:** To forecast future values in time series data using methods such as exponential smoothing and autoregressive models.

Question Paper Pattern (Academic Year: 2025-2026)
Regression Analysis
Semester End Examination and Practical Examination – 100 Marks
SEMESTER V
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 2)** A. Numerical/ Theory Based question B. Numerical/ Theory Based question C. Numerical/ Theory Based question	 **10** **10** **10**	**20**
Q2.	**Answer the following questions (Any 2)** A. Numerical/ Theory Based question B. Numerical/ Theory Based question C. Numerical/ Theory Based question	 **10** **10** **10**	**20**
Q3.	**Answer the following questions (Any 2)** A. Numerical/ Theory Based question B. Numerical/ Theory Based question C. Numerical/ Theory Based question	 **10** **10** **10**	**20**
	Total	**90**	**60**

Note: Each 10-mark question may be split into 5+5 if required.

B] Practical Examination - 40 Marks
A Certified copy journal is essential to appear for the practical examination.

1.	**Practical Work**	**20**
2.	**Journal**	**10**
3.	**Viva Voce**	**10**

Books and References:

- Montgomery, D. C., Peck, E. A., & Vining, G. G. (2003). Introduction to Linear Regression Analysis (3rd ed.). Wiley.
- Hosmer, D. W., & Lemeshow, S. (1989). Applied Logistic Regression. Wiley.
- Draper, N. R., & Smith, H. (1998). Applied Regression Analysis (3rd ed.). Wiley.
- Neter, J., Kutner, M. H., Nachtsheim, C. J., & Wasserman, W. (1996). Applied Linear Statistical Models (4th ed.). Irwin.
- Chatterjee, S., & Hadi, A. S. (2012). Regression Analysis by Example (5th ed.). Wiley.
- Kleinbaum, D. G., & Klein, M. (2011). Logistic Regression: A Self-Learning Text (3rd ed.). Springer.

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
3.General Elective/ Open Elective
3.A.a Social Entrepreneurship (3 Credits)
Semester V

3. General Elective/ Open Elective	
3.A.a Social Entrepreneurship	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	To enable learners to examine the impact of social entrepreneurship.
CObj 2	To create awareness about regulatory challenges and emerging trends in the entrepreneurship industry.
CObj 3	To enable learners to get familiar with the growing trend of social entrepreneurship.
CObj 4	To understand the scope and Emerging trends of Social Entrepreneurship.
Course Outcomes	
COut 1	The learner learns about Frameworks for measuring and evaluating social impact.
COut 2	The learner is able to understand the importance of identifying and addressing social needs, approaches to creating social value.
COut 3	The learner understands the basic difference between social entrepreneurship and philanthropy.
COut 4	The learner understands the strategies for building relationships with investors, donors, and other stakeholders.
COut 5	There is awareness of the Regulatory framework and its challenges.
COut 6	The learner is familiar with the Role of social entrepreneurship in addressing global challenges such as poverty, inequality, climate change, and healthcare.
COut 7	There is a better understanding of the framework of technology-enabled social enterprises.
COut 8	The learner is aware of the tools and methodology involved in Emerging trends

	in social entrepreneurship.
COut 9	There is a greater level of financial planning and resource management.
COut 10	The learner is able to make informed investment decisions.

Modules at a Glance

Social Entrepreneurship		
Sr. No.	**Modules**	**No. of Lectures**
1	Foundations of Social Entrepreneurship	15
2	Building a Sustainable Social Enterprise	15
3	Social Entrepreneurship and Global Challenges	15
Total		**45**

Sr. No.	Modules
1	**Foundations of Social Entrepreneurship**
	Defining Social Entrepreneurship: Definition, characteristics of social entrepreneurship, Difference between social entrepreneurship and philanthropy, non-profit organizations, traditional businesses, key motivations and values of social entrepreneurs **The Social Impact Framework:** Frameworks for measuring and evaluating social impact (e.g., SROI, social return on investment), importance of identifying and addressing social needs, approaches to creating social value (e.g., poverty alleviation, environmental sustainability, education) **The Role of Innovation in Social Entrepreneurship:** Analysis of social entrepreneurs using innovation to address social challenges, types of social innovations (e.g., technological, business model, social), importance of creativity and problem-solving in social entrepreneurship
2	**Building a Sustainable Social Enterprise**
	Developing a Social Business Model: Different social business models (e.g., for-profit, non-profit, hybrid models), importance of financial sustainability and revenue generation, challenges and opportunities of creating a financially viable social enterprise **Building a Strong Team and Organization:** Importance of leadership, teamwork, and organizational culture, strategies for building a high-performing team with diverse skills and perspectives **Accessing Resources and Funding:** Different funding sources for social enterprises (e.g., impact investing, grants, social impact bonds), strategies for building relationships with investors, donors, and other stakeholders, importance of financial planning and resource management.
3	**Social Entrepreneurship and Global Challenges**

	Addressing Global Challenges through Social Entrepreneurship: Role of social entrepreneurship in addressing global challenges such as poverty, inequality, climate change, and healthcare, Case studies of successful social enterprises addressing specific global challenges, importance of collaboration and partnerships in addressing complex social issues. **The Future of Social Entrepreneurship:** Emerging trends in social entrepreneurship, such as technology-enabled social enterprises, social impact investing, and the sharing economy, Potential and challenges of scaling social impact, Role of technology, innovation, and collaboration in shaping the future of social entrepreneurship.

Question Paper Pattern (Academic Year: 2025-2026)
Social Entrepreneurship
Semester End Examination and Internal Evaluation – 100 Marks
SEMESTER V
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
Q2.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
Q3.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
	Total	**75**	**60**

B] Internal Evaluation - 40 Marks

Method of Evaluation	Marks
Assignment/ Quiz/ Case Study/ Report on guest lecture/ activity	**20**
PowerPoint Presentation-Pre-set criteria	**20**
Total	**40**

Books and References:

- How to Change the World: Social Entrepreneurs and the Power of New Ideas – David Bornstein
- Social Entrepreneurship: What Everyone Needs to Know – David Bornstein & Susan Davis
- Getting Beyond Better: How Social Entrepreneurship Works – Roger L. Martin & Sally R. Osberg
- Social Innovation: How Societies Find the Power to Change – Geoff Mulgan
- Scaling Up Excellence: Getting to More Without Settling for Less – Robert I. Sutton & Huggy Rao
- The Lean Startup – Eric Ries
- The Social Entrepreneur's Playbook – Ian C. MacMillan & James D. Thompson
- Mission, Inc.: The Practitioner's Guide to Social Enterprise – Kevin Lynch & Julius Walls
- I Have a Dream – Rashmi Bansal
- Beyond Profit: A Profile of Social Entrepreneurs – Jeroo Billimoria
- Grassroots Innovation: Minds on the Margin Are Not Marginal Minds – Anil K. Gupta

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
3.General Elective/ Open Elective
3.A.b Competitive Dynamics and Strategy (3 Credits)
Semester V

3. General Elective/ Open Elective	
3.A.b Competitive Dynamics and Strategy	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	To equip students with the knowledge and skills to effectively manage and lead family businesses in a global context.
CObj 2	To develop critical thinking and decision-making skills to navigate the unique challenges and opportunities of family-owned enterprises.
CObj 3	To gain understanding of the complex dynamics between family relationships and business operations in a globalizing world.
CObj 4	To strategically expand family businesses into new markets and achieve sustainable growth.
Course Outcomes	
COut 1	Analyze the distinctive characteristics, strengths, and challenges of family businesses compared to non-family-owned enterprises.
COut 2	Evaluate and recommend appropriate governance structures for family businesses to ensure effective decision-making and succession planning.
COut 3	Develop strategies for managing interpersonal dynamics within the family context and minimizing conflict in business operations.
COut 4	Conduct market research and assess national expansion opportunities for family businesses, considering legal and regulatory complexities.
COut 5	Design and implement effective succession planning strategies for leadership transition and talent development within the family.
COut 6	Manage the financial aspects of family businesses, including capital structure, risk management, and financial performance analysis.
COut 7	Critically evaluate the feasibility and potential challenges of internationalizing

	family businesses.
COut 8	Develop cross-cultural competence to navigate diverse business environments and effectively communicate in an international setting.
COut 9	Identify and manage risks associated with global operations, including currency fluctuations, political instability, and cultural differences.
COut 10	Evaluate and leverage strategic alliances and partnerships to facilitate international expansion and mitigate market entry risks.

Modules at a Glance

Competitive Dynamics and Strategy		
Sr. No.	**Modules**	**No. of Lectures**
1	Foundations of Competitive Strategy	15
2	Competitive Dynamics and Game Theory	15
3	Emerging Competitive Landscapes	15
Total		**45**

Sr. No.	Modules
1	**Foundations of Competitive Strategy**
	Industry Analysis: Introduce Porter's Five Forces model (threat of new entrants, bargaining power of buyers/suppliers, competitive rivalry, threat of substitutes), Analysis of impact of industry structure on competitive dynamics, Other frameworks for industry analysis (e.g., PESTLE analysis, SWOT analysis). **Competitive Advantage:** Definition- competitive advantage and its sources (cost leadership, differentiation, focus), resource-based view of the firm (VRIO framework), importance of sustainable competitive advantage. **Strategic Positioning:** Analysis of firms achieving strategic positioning in the market, competitive strategies (e.g., cost leadership, differentiation, focus, blue ocean strategy), importance of strategic fit and alignment with the external environment.
2	**Competitive Dynamics and Game Theory**
	Competitive Rivalry and Game Theory: Concept of competitive rivalry and its impact on firm performance, Game theory concepts (e.g., prisoner's dilemma, competitive games) and their application to competitive situations, Analysis of firms anticipation and response to competitive moves. **Competitive Intelligence and Market Monitoring:** Importance of competitive intelligence gathering and analysis, methods for collecting and analyzing competitor information (e.g., market research, industry publications, social media monitoring), Analysis of ethical considerations of competitive intelligence gathering. **Responding to Competitive Threats:** Strategies for responding to competitive threats (e.g., price wars, product innovation, strategic alliances), importance of flexibility and adaptability in competitive environments, Analysis of role of speed and responsiveness in competitive advantage.

3	**Emerging Competitive Landscapes**
	Disruptive Innovation and Technology: Analysis of the impact of disruptive technologies on competitive dynamics, challenges and opportunities presented by digital disruption, strategies for responding to disruptive innovation (e.g., embracing disruption, creating new markets). **Globalization and International Competition:** Analysis of the impact of globalization on competitive landscapes, strategies for competing in international markets (e.g., global standardization, local adaptation), challenges of managing global operations and supply chains. **Future of Competition**: Emerging trends in competition (e.g., platform competition, ecosystem competition, AI-powered competition), Analysis of the future of competitive advantage in a rapidly changing world, importance of innovation, agility, and adaptability in the future of business.

Question Paper Pattern (Academic Year: 2025-2026)
Competitive Dynamics and Strategy
Semester End Examination and Internal Evaluation – 100 Marks
SEMESTER V
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
Q2.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
Q3.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
	Total	**75**	**60**

B] Internal Evaluation - 40 Marks

Method of Evaluation	Marks
Assignment/ Quiz/ Case Study/ Report on guest lecture/ activity	**20**
PowerPoint Presentation-Pre-set criteria	**20**
Total	**40**

Books and References:

- Competitive Strategy: Techniques for Analyzing Industries and Competitors – Michael E. Porter
- Competitive Advantage: Creating and Sustaining Superior Performance – Michael E. Porter
- The Art of Strategy: A Game Theorist' Guide to Success in Business and Life – Avinash K. Dixit & Barry J. Nalebuff
- The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail – Clayton M. Christensen
- Seeing What's Next: Using the Theories of Innovation to Predict Industry Change – Clayton M.
- Christensen, Scott D. Anthony, Erik A. Roth
- The End of Competitive Advantage: How to Keep Your Strategy Moving as Fast as Your Business – Rita Gunther McGrath
- Platform Revolution: How Networked Markets Are Transforming the Economy – Geoffrey Parker, Marshall Van Alstyne, Sangeet Paul Choudary
- Thinking Strategically: The Competitive Edge in Business, Politics, and Everyday Life – Avinash K. Dixit & Barry J. Nalebuff
- The Strategy Paradox: Why Committing to Success Leads to Failure (and What to Do About It) – Michael E. Raynor
- Good Strategy, Bad Strategy: The Difference and Why It Matters – Richard P. Rumelt
- Measure What Matters – John Doerr
- Playing to Win: How Strategy Really Works – A.G. Lafley & Roger Martin
- The Hard Thing About Hard Things – Ben Horowitz

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
3.General Elective/ Open Elective
3.A.c Emotional Intelligence (3 Credits)
Semester V

3.General Elective/ Open Elective	
3.A.c Emotional Intelligence	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	Learners will learn about self-awareness, self-regulation, social awareness, relationship management.
CObj 2	Learners will understand and compare different EI models, such as the MSCEIT and Goleman's model.
CObj 3	Learners acclimatize the evaluation of the correlation between EI and success in personal and professional domains.
CObj 4	Learners understand the impact of emotions on their thoughts and behaviours, and develop effective strategies for managing & regulating emotions.
CObj 5	Learners develop self-control, resist impulses, delay gratification, manage anger constructively.
Course Outcomes	
COut 1	Learners are able to define and understand the core concepts of Emotional intelligence.
COut 2	Develop self-awareness and emotional regulation skills.
COut 3	Embrace social awareness and empathy.
COut 4	Understand the role of EI in effective leadership.
COut 5	Explore different models and analyze the impact of EI on various aspects of life.
COut 6	To understand and work on techniques for identifying and labelling emotions
COut 7	To know more about social awareness with respect to relationship management.
COut 8	To evaluate EI and success in different domains.

Modules at a Glance

Emotional Intelligence		
Sr. No.	**Modules**	**No. of Lectures**
1	Foundations of Emotional Intelligence	15
2	Managing Emotions, Self Esteem	15
3	Social Awareness and Relationship Management	15
Total		**45**

Sr. No.	Modules
1	**Foundations of Emotional Intelligence**
	Introduction: Definition of EI, models of EI (Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT), Goleman's model), correlation between EI and success in different domains **Components- I:** Self-awareness, self-regulation, social awareness, relationship management, difference between EI, IQ and personality traits **Importance of EI in Personal Life:** Building strong relationships, managing stress, achieving personal goals, mental and emotional well-being **Importance of EI in Professional Life:** Leadership effectiveness, teamwork, communication, conflict resolution, decision-making, customer service, job satisfaction
2	**Managing Emotions, Self Esteem**
	Understanding Your Emotions: Explore techniques for identifying and labelling emotions (e.g., emotional vocabulary, journaling), impact of emotions on thoughts, behaviours, and decision-making. **Develop strategies for regulating emotions:** Emotional regulation techniques, Deep breathing, relaxation exercises, cognitive reframing, Stress management techniques, Time management, exercise, healthy lifestyle habits. **Developing self-control:** Resisting impulses, delaying gratification, managing anger. **Building Self-Confidence and Self-Esteem:** connection between self- awareness, self-regulation, and self-esteem, Develop strategies for building self-confidence
3	**Social Awareness and Relationship Management**
	Understanding Others' Emotions: Develop empathy and perspective-taking skills, learn to read nonverbal cues (body language, facial expressions, tone of voice). **Building and Maintaining Relationships:** Development of strategies for building and maintaining healthy relationships

	Leading with Emotional Intelligence: the role of EI in leadership- inspiring, motivating, creating positive & supportive work environment, building high performance teams, ethical and responsible decisions

Question Paper Pattern (Academic Year: 2025-2026)
Emotional Intelligence
Semester End Examination and Internal Evaluation – 100 Marks
SEMESTER V
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
Q2.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
Q3.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
	Total	**75**	**60**

B] Internal Evaluation - 40 Marks

Method of Evaluation	Marks
Written Test/ MCQ	**20**
PowerPoint Presentation/ Group discussion/ Assignment	**20**
Total	**40**

Books and References:

- Emotional Intelligence: Why It Can Matter More Than IQ – Daniel Goleman
- The Emotional Intelligence Quick Book: Everything You Need to Know to Put Your EQ to Work – Travis Bradberry & Jean Greaves
- Working with Emotional Intelligence – Daniel Goleman
- Primal Leadership: Unleashing the Power of Emotional Intelligence – Daniel Goleman, Richard Boyatzis, Annie McKee
- Emotional Intelligence 2.0 – Travis Bradberry & Jean Greaves
- The EQ Leader: Instilling Passion, Creating Shared Goals, and Building Meaningful Organizations through Emotional Intelligence – Steven J. Stein
- The Power of Now: A Guide to Spiritual Enlightenment – Eckhart Tolle
- The 7 Habits of Highly Effective People – Stephen R. Covey
- The Language of Emotional Intelligence: The Five Essential Tools for Building Powerful and Effective Relationships – Jeanne Segal
- The Four Agreements: A Practical Guide to Personal Freedom – Don Miguel Ruiz

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
4.Vocational & Skill Enhancement Courses
4.A. Vocational Skill Course
4.A.a Design Thinking (2 Credits)
Semester V

4.Vocational & Skill Enhancement Courses	
4.A. Vocational Skill Course	
4.A.a Design Thinking	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	Introduce students to design thinking methodologies and their role in data science.
CObj 2	Develop skills in problem identification, ideation, and prototyping for data-driven applications.
CObj 3	Teach students how to apply human-centered design to data visualization and model development.
CObj 4	Enable learners to incorporate iterative improvements in data workflows through feedback mechanisms.
CObj 5	Foster creativity and innovation in data storytelling and solution implementation.
Course Outcomes	
COut 1	Define and frame problems effectively using a design thinking approach.
COut 2	Understand user needs through data exploration and human-centered insights.
COut 3	Ideate and prototype data-driven solutions for various business challenges.
COut 4	Use visualization tools to communicate insights effectively.
COut 5	Apply iterative methodologies to refine data models and analytics projects.
COut 6	Test and validate data solutions based on user feedback and business requirements.
COut 7	Integrate design thinking into the data science workflow to enhance usability and

	impact.
COut 8	Create innovative and scalable data solutions that address real-world problems.

Modules at a Glance

Design Thinking		
Sr. No.	**Modules**	**No. of Lectures**
1	Introduction to Design Thinking in Data Science	10
2	Ideation and Prototyping for Data Solutions	10
3	Testing, Evaluation & Implementation	10
Total		**30**

Sr. No.	Modules
1	**Introduction to Design Thinking in Data Science**
	Understanding Design Thinking: Definition and importance in problem-solving, Stages of Design Thinking Process (Empathize, Define, Ideate, Prototype, Test), Traditional vs. Data-Driven Problem Solving **Empathizing with Data:** Identifying data-driven challenges, Understanding user behavior through data analysis, Conducting exploratory data analysis (EDA) with a design mindset **Defining the Problem in Data Science:** Framing the right problem statement, Identifying data requirements and constraints, Creating hypothesis-driven models
2	**Ideation and Prototyping for Data Solutions**
	Brainstorming and Ideation in Data Science: Techniques: Affinity Diagrams, SCAMPER, Mind Mapping, Identifying novel approaches to data problems, Collaborative ideation tools (Miro, FigJam, Jupyter Notebooks) **Prototyping Data Solutions:** Creating Minimum Viable Models (MVMs), Data visualization & storytelling with Tableau, Power BI, Matplotlib, Seaborn, Building quick interactive dashboards & real-time analytics **User-Centered Design for Data Products:** Case Studies: Human-centered AI, Ethical AI Frameworks, Understanding bias in data and model interpretability, Feedback loops and iterative improvements
3	**Testing, Evaluation & Implementation**
	Testing Data Models & Solutions: Evaluating ML models using cross-validation & A/B Testing, User acceptance testing (UAT) for dashboards & reports, Implementing explainability tools like LIME & SHAP **Iterative Improvement & Feedback in Data Science:** Refining models based on stakeholder feedback, Monitoring & improving data pipelines, Handling real-world

	constraints & scalability **Design Thinking Applied to Data Science Use Cases:** Case studies in healthcare, finance, and retail, Industry-relevant applications & final capstone project

Question Paper Pattern (Academic Year: 2025-2026)
Design Thinking
Semester End Examination and Internal Evaluation – 50 Marks
SEMESTER V
A] Semester End Examination (SEE)- 30 Marks

Maximum Marks: 30
Duration: 1 Hour
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 2)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question	 **5** **5** **5**	**10**
Q2.	**Answer the following questions (Any 2)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question	 **5** **5** **5**	**10**
Q3.	**Answer the following questions (Any 2)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question	 **5** **5** **5**	**10**
	Total	**45**	**30**

B] Internal Evaluation - 20 Marks

Method of Evaluation	Marks
Small scale Project on Industry-Based Problem	**20**

Books and References:

- Brown, Tim. Change by Design: How Design Thinking Creates New Alternatives for Business and Society. Harper Business, 2009.
- Liedtka, Jeanne, Tim Ogilvie, and Rachel Brozenske. The Designing for Growth Field Book: A Step-by-Step Project Guide. Columbia Business School Publishing, 2014.
- Kolko, Jon. Well-Designed: How to Use Empathy to Create Products People Love. Harvard Business Review Press, 2014.
- Dam, Rikke Friis, and Teo Yu Siang. Design Thinking: A Quick Overview. Interaction Design Foundation, 2020.
- Steele, Guy. Design Thinking for Data Science: How to Think Like a Data Scientist. O'Reilly Media, 2021.
- Buxton, Bill. Sketching User Experiences: Getting the Design Right and the Right Design. Morgan Kaufmann, 2007.

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
5. Field Project / Apprenticeship / Community Engagement & Services
5.A.a Campus Preparatory - Competence and Employability (2 Credits)
Semester V

5.Field Project / Apprenticeship / Community Engagement & Services	
5.A.a Campus Preparatory - Competence and Employability	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	
CObj 2	
CObj 3	
CObj 4	
Course Outcomes	
COut 1	
COut 2	
COut 3	
COut 4	
COut 5	

AC: 10/03/2025

CRITERIA FOR EVALUATING POWERPOINT PRESENTATION/ CASE STUDY/ APPLICATION BASED ACTIVITY:

MARKS: 20 FY/SY/TY BSc: Division A/B Semester:

Name of the Topic Date of Presentation:

Sr. No	Roll No	Name of the student	Content (5)	Team building (5)	Presentation skills		Total (20)
					Verbal (5)	Non Verbal (5)	
1							
2							
3							
4							

Sign: 1_____2._____3._____4._____Faculty Sign:_____

Name of the Topic Date of Presentation:

Sr. No	Roll No	Name of the student	Content (5)	Team building (5)	Presentation skills		Total (20)
					Verbal (5)	Non Verbal (5)	
1							
2							
3							
4							

Sign: 1_____2._____3._____4._____Faculty Sign:_____

Name of the Topic Date of Presentation:

Sr. No	Roll No	Name of the student	Content (5)	Team building (5)	Presentation skills		Total (20)
					Verbal (5)	Non Verbal (5)	
1							
2							
3							
4							

Sign: 1_____2._____3._____4._____Faculty Sign:_____

AC: 10/03/2025

S P Mandali's
R. A. PODAR COLLEGE OF COMMERCE AND ECONOMICS
(EMPOWERED AUTONOMOUS),
Matunga, Mumbai-400019

Course Structure

Bachelor of Science (Data Science and Analytics)

Semester V and VI

College Website: www.rapodar.ac.in

AC: 10/03/2025

S P Mandali's
R. A. PODAR COLLEGE OF COMMERCE AND ECONOMICS
(EMPOWERED AUTONOMOUS),
Matunga, Mumbai-400019

Bachelor of Science (Data Science and Analytics)
TYBSc Semester VI

Syllabus
And
Question paper pattern of Course

As per National Education Policy 2020
To be implemented from Academic Year 2025- 2026

College Website: www.rapodar.ac.in

Bachelor of Science (Data Science and Analytics) Programme
Syllabus as per National Education Policy 2020
Course Structure
T.Y.B.S.C (Data Science and Analytics) (Level 5.5)
(To be implemented from Academic Year 2025-26)

No of Courses	Course Code	Semester VI	Credits
1	**Major (12 credits)**		
1.A	**Discipline Specific Core**		
1.A.a		Data Security and Privacy	**04**
1.A.b		Generative AI	**04**
1.B	**Discipline Specific Elective**		
1.B.a		Internet of Things	**04**
2	**Minor (03 credits)**		
2.A.a		Optimization for Machine Learning	**03**
3	**General Elective (GE)/ Open Elective (OE) (03 Credits)**		
3.A.a		Sustainable Business Models	**03**
3.A.b		Innovation, Creativity and Problem Solving	**03**
3.A.c		Human Capital Investment	**03**
4	**Vocational & Skill Enhancement Courses (VSEC) (02 credits)**		
4.A	**Skill Enhancement Course**		
4.A.a		Data Governance	**02**
5	**Field Project / Apprenticeship / Community Engagement & Services (02 credits)**		
5.A.a		Internship or Project Work	**02**
TOTAL CUMULATIVE CREDITS			**22**

Exit option at the end of the Third year (on completion of semester V and semester VI):
Under Graduate Certificate in Data Science and Analytics will be awarded to a learner on fulfillment of the following conditions:
1. The learner should have acquired 44 credits in Semester V and VI considered together.

2. The learner should acquire an additional 4 credits as per norms by completing recognized courses under the National Skill Qualification Framework (NSQF) such as a certificate course on Introduction to Data Security, a Course on Generative AI concepts, and an Internship.

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
1.Major
1.A Discipline Specific Core Courses
1.A.a Data Security and Privacy (4 Credits)
Semester VI

1. Major	
1.A Discipline Specific Core	
1.A.a Data Security and Privacy	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	Understand the core principles of data security and privacy, including cryptography, access control, and risk management in data science.
CObj 2	Analyze and implement global data privacy regulations and compliance frameworks, including GDPR, CCPA, HIPAA, DPDP, PCI-DSS, and ISO 27001.
CObj 3	Explore advanced security challenges and solutions in AI/ML, IoT, Cloud, and DevSecOps, focusing on adversarial attacks, secure pipelines, and cloud security frameworks.
CObj 4	Develop hands-on skills in ethical hacking, security testing, and penetration testing, including threat detection using AI and ML techniques.
CObj 5	Apply best practices for cybersecurity governance and incident response, including Zero Trust Security Models, security audits, and forensic analysis.
Course Outcomes	
COut 1	Identify and assess key cybersecurity threats, including malware, phishing, ransomware, SQL injections, and social engineering attacks.
COut 2	Implement cryptographic techniques and access control mechanisms to secure sensitive data in storage and transmission.
COut 3	Analyze and comply with data privacy laws and industry security frameworks to ensure regulatory compliance.
COut 4	Apply security best practices in AI/ML, IoT, cloud computing, and DevSecOps, ensuring secure development lifecycles.

COut 5	Conduct security audits, risk assessments, and incident response planning using frameworks like NIST, MITRE ATT&CK, and CERT-In.
COut 6	Utilize security tools and techniques such as SIEM, network firewalls, and penetration testing frameworks to detect and mitigate cyber threats.
COut 7	Implement privacy-preserving data science techniques, including differential privacy, homomorphic encryption, and federated learning security.
COut 8	Develop and apply enterprise cybersecurity strategies, incorporating real-world case studies and lessons from major data breaches.

Modules at a Glance

Data Security and Privacy		
Sr. No.	**Modules**	**No. of Lectures**
1	Foundations of Data Security and Privacy	15
2	Data Privacy and Risk Management	15
3	Security for AIML, IoT, Cloud, and DevSecOp	15
4	Ethical Hacking, Threat Detection & Security Testing	15
Total		**60**

Sr. No.	Modules
1	**Foundations of Data Security**
	Introduction: Definition & Importance in Data Science, Cybersecurity vs. Data Privacy vs. Data Protection, Key Challenges & Threat Models **Data Security Threats:** Malware, Ransomware, Phishing, SQL Injection, Advanced Persistent Threats (APT), Social Engineering Attacks **Fundamentals of Cryptography:** Symmetric & Asymmetric Encryption, Encoding, Hashing, Digital Signatures, and Key Management, Applications in Secure Data Storage and Transfer **Access Control & Authentication:** Components of Access Control, ACL, Authentication VS Authorization, Multi-Factor Authentication (MFA), Biometric Security Mechanisms & Vulnerabilities, Types of Access Controls, Identity and Access Management (IAM)
2	**Data Privacy and Risk Management**
	Data Privacy Regulations & Compliance: Overview of GDPR, CCPA, DPDP, HIPAA, PCI-DSS, ISO 27001, Privacy by Design & Default Principles, Data Governance & Accountability **Privacy-Preserving Data Science:** Differential Privacy & Homomorphic Encryption, Secure Multi-Party Computation (SMPC), Federated Learning Security & Data Leakage Prevention **Incident Response & Cyber Forensics:** Incident Response Frameworks (NIST, MITRE ATT&CK), CERT-In, Security Incident Management Lifecycle, Cyber Threat Intelligence & Threat Hunting **Security Audits & Risk Assessments:** Types of Security Audits, Security Compliance Metrics & Best Practices, Conducting Risk Assessments & Threat Modeling **Zero Trust Security Model:** Zero Trust Principles & Implementation,

	Micro-Segmentation & Continuous Authentication, Zero Trust in Cloud Environments
3	**Security for AIML, IoT, Cloud, and DevSecOp**
	AIML Security: Threats to AI Models: Adversarial Attacks, Model Poisoning, Model Inversion, Bias, Fairness, & Explainability in AI Security, AI Model Governance & Secure AI Pipelines **IoT Security:** Threats to IoT Devices & Edge Computing, Frameworks related to IoT Security, AI-driven Threat Detection in IoT **Cloud Security**: Security Challenges in AWS, Azure and Google Cloud, Cloud-Native Security Tools (AWS Security Hub, Azure Sentinel) **DevSecOps:** Secure Software Development Life Cycle, Best Practices & CI/CD Pipeline Security
4	**Techniques and Best Practices**
	Ethical Hacking: Types of Hacking, Red Team vs. Blue Team, Dark Web, Phases of Penetration Testing (Reconnaissance, Scanning, Gaining Access, Maintaining Access, Covering Tracks) **Security Testing & Threat Detection:** Types of Security Testing, Web Application Security Testing (OWASP Top 10), Wireless Network & Mobile Application Security, Malware Analysis & its types, Threat Intelligence & SIEM (Security Information and Event Management) **Security Techniques:** Data Masking and Anonymization, Network Security & Firewalls, Data Exfiltration, Detection & Prevention, Anomaly Detection using AI & Machine Learning **Best Practices for Cybersecurity:** Case Studies on Major Data Breaches & Lessons Learned, Security Best Practices for Organizations, Future Trends in Cybersecurity & Data Privacy

Practical Work (20 Marks)

List of Practicals to be Conducted	
1	Implementing Data Encryption & Hashing Techniques in Python
2	Implementing RBAC & Multi-Factor Authentication
3	Using Wireshark & Snort for Intrusion Detection
4	Web Application Security Testing with Burp Suite
5	Reconnaissance, Scanning & Exploiting Vulnerabilities
6	Using MITRE ATT&CK Framework for Security Monitoring
7	Detecting Adversarial Attacks in AI Models

8	Implementing Homomorphic Encryption & Secure Data Transfer
9	Conduct a full security audit & compliance assessment

AC: 10/03/2025

Question Paper Pattern (Academic Year: 2025-2026)
Data Security and Privacy
Semester End Examination and Practical Examination – 100 Marks
SEMESTER VI
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q2.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q3.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q4.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
	Total	**80**	**60**

B] Practical Examination - 40 Marks
A Certified copy journal is essential to appear for the practical examination.

1.	**Practical Work**	**20**
2.	**Journal**	**10**
3.	**Viva Voce**	**10**

Books and References:

- Anderson, Ross J. Security Engineering: A Guide to Building Dependable Distributed Systems. 3rd ed., Wiley, 2020.
- Stallings, William. Cryptography and Network Security: Principles and Practice. 7th ed., Pearson, 2019.
- Schneier, Bruce. Applied Cryptography: Protocols, Algorithms, and Source Code in C. 20th Anniversary ed., Wiley, 2015.
- Chapple, Mike, and David Seidl. CompTIA Security+ Guide to Network Security Fundamentals. Cengage Learning, 2021.
- Sutton, Marshall, and Andrew Patel. Practical Cybersecurity Architecture: A Guide to Creating and Implementing Resilient Security Infrastructure. O'Reilly Media, 2021.
- Kroll, James A. Privacy, Big Data, and the Public Good: Frameworks for Engagement. Cambridge University Press, 2014.

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
1.Major
1.A Discipline Specific Core Course
1.A.b Generative AI (4 Credits)
Semester VI

1. Major	
1.A Discipline Specific Core	
1.A.b Generative AI	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	Understand the core principles of Generative AI, including GANs, VAEs, Transformers, and multimodal models.
CObj 2	Explore Large Language Models (LLMs) like GPT, T5, BERT and their training, fine-tuning, and applications in NLP.
CObj 3	Develop expertise in prompt engineering, understanding how prompts influence model behavior and bias mitigation.
CObj 4	Apply Generative AI techniques in real-world data science applications, including data augmentation, predictive modeling, and anomaly detection.
CObj 5	Analyze ethical and security considerations in Generative AI, including DeepFake detection, misinformation prevention, and responsible AI deployment.
Course Outcomes	
COut 1	Explain the key architectures and training methodologies of Generative AI models such as GANs, VAEs, Transformers, and multimodal models (DALL-E, CLIP, Stable Diffusion).
COut 2	Implement LLM-based text generation and completion models, including machine translation, summarization, and chatbot applications.
COut 3	Design effective AI prompts and optimize model responses using prompt engineering strategies.
COut 4	Use Generative AI techniques for data augmentation and anomaly detection, improving model robustness and fraud detection.

COut 5	Create predictive models and scenario simulations using Generative AI for forecasting and data visualization.
COut 6	Develop AI-powered assistants and automation tools for content creation, storytelling, and chatbots.
COut 7	Identify and mitigate ethical risks related to AI biases, privacy concerns, and misinformation detection.
COut 8	Deploy Generative AI models for real-world applications, ensuring scalability, ethical considerations, and security best practices.

Modules at a Glance

Generative AI		
Sr. No.	**Modules**	**No. of Lectures**
1	Foundations of Generative AI	15
2	Large Language Models (LLMs)	15
3	Prompt Engineering	15
4	Applications of Generative AI in Data Science	15
Total		**60**

Sr. No.	Modules
1	**Foundations of Generative AI**
	Introduction to Generative AI: Definition and significance in the AI landscape, Historical evolution and key milestones. **Core Generative Models:** *Generative Adversarial Networks (GANs):* Architecture and working principles, Applications in image and video generation, *Variational Autoencoders (VAEs):* Latent space representation and sampling, Use cases in data reconstruction and generation, *Transformers:* Mechanism of self-attention and scalability, Role in sequence modeling tasks, *Multimodal Generative AI:* DALL-E & CLIP (Text-to-Image & Image-to-Text Models), Stable Diffusion & Mid Journey, Cross-modal learning techniques **Generative Models Across Modalities:** *Image Generation:* Techniques for creating realistic images, Style transfer and image-to-image translation, DeepFake generation & detection techniques, *Audio Generation:* Speech synthesis and music composition, Challenges in maintaining temporal coherence, *Video Generation:* Text-to-Video & Motion Synthesis, Frame prediction and video synthesis, Applications in entertainment and simulation.
2	**Large Language Models (LLMs)**
	Architecture of LLMs: Transformer-based architectures (GPT, T5, BERT), scalability and handling extensive datasets. **Training Processes:** Pre-training on large corpora, Fine-tuning for specific NLP tasks **Generative Models in NLP:** Text generation and completion, Machine translation and summarization **Ethical Considerations:** Bias identification in prompts and responses, Privacy concerns and strategies for responsible deployment, Case studies on AI misuse, deepfake regulations, and ethical AI guidelines

3	**Prompt Engineering**
	Role of Prompts in AI Behavior: Influence of prompt design on model outputs, Case studies demonstrating prompt impact. **Prompt Designing Strategies:** Techniques for crafting effective prompts, Iterative testing and refinement methods. **Bias Mitigation:** Strategies to identify and reduce bias in prompts, Ensuring fairness and inclusivity in AI responses.
4	**Applications of Generative AI**
	Data Augmentation & Anomaly Detection: Enhancing datasets using generative techniques, Improving model robustness and performance, Identifying outliers using generative approaches, Applications in fraud detection and quality control. **Predictive Modeling:** Leveraging generative models for predictive analytics, Scenario simulation and forecasting. **Generative AI for Data Visualization:** Creating insightful visual representations, Automated generation of charts and infographics. **Real-World Applications & AI-Powered Assistants:** AI-powered storytelling & content generation, Text summarization, machine translation & chatbots **DeepFake Detection & Misinformation Prevention:** Case studies on DeepFakes & AI-generated misinformation, AI for cybersecurity & misinformation tracking

Practical Work (20 Marks)

List of Practicals to be Conducted	
1	Train a simple Generative Adversarial Network (GAN) to generate handwritten digits (MNIST dataset).
2	Use Neural Style Transfer to apply the artistic style of one image to another.
3	Use VAEs to encode and reconstruct images from a dataset.
4	Fine-tune a T5/BART model to summarize news articles.
5	Detect AI-generated DeepFake images or videos using pre-trained models.
6	Enhancing Datasets Using Generative AI for Data Augmentation
7	Use CLIP (Contrastive Language-Image Pretraining) to generate text descriptions for images.
8	Generate coherent text paragraphs using GPT-2/GPT-3 models.

AC: 10/03/2025

Question Paper Pattern (Academic Year: 2025-2026)
Generative AI
Semester End Examination and Practical Examination – 100 Marks
SEMESTER VI
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q2.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q3.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q4.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
	Total	**80**	**60**

B] Practical Examination - 40 Marks
A Certified copy journal is essential to appear for the practical examination.

1.	**Practical Work**	**20**
2.	**Journal**	**10**
3.	**Viva Voce**	**10**

Books and References:

- Goodfellow, Ian, et al. Deep Learning. MIT Press, 2016.
- Vaswani, Ashish, et al. Attention Is All You Need. NeurIPS, 2017.
- Brown, Tom, et al. Language Models Are Few-Shot Learners. OpenAI, 2020.
- Radford, Alec, et al. Learning Transferable Visual Models From Natural Language Supervision (CLIP). OpenAI, 2021.
- Karras, Tero, et al. Analyzing and Improving the Image Quality of StyleGAN. NeurIPS, 2020.
- Tramer, Florian, et al. Model Extraction and Inversion Attacks on AI Models. IEEE Security & Privacy, 2021.
- Chollet, François. Deep Learning with Python. 2nd ed., Manning Publications, 2021.
- Devlin, Jacob, et al. BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding. Google AI, 2019.

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
1.Major
1.B Discipline Specific Elective Courses
1.B.a Internet of Things (4 Credits)
Semester VI

1. Major	
1.B Discipline Specific Elective	
1.B.a Internet of Things	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	Understand the fundamental concepts of the Internet of Things (IoT), including its architecture, communication models, and key technologies.
CObj 2	Develop hands-on experience with IoT prototyping and embedded systems, focusing on microcontrollers (Arduino, Raspberry Pi), sensors, and actuators.
CObj 3	Explore cloud integration, APIs, and real-time data handling in IoT applications, ensuring security, efficiency, and scalability.
CObj 4	Analyze IoT business models, manufacturing challenges, and deployment strategies, including open-source vs. closed-source approaches.
CObj 5	Address ethical considerations, security risks, and privacy challenges in IoT, ensuring responsible and secure IoT implementations.
Course Outcomes	
COut 1	Explain the architecture, design principles, and significance of IoT, including communication protocols such as HTTP, MQTT, CoAP, and XMPP.
COut 2	Develop and prototype embedded IoT systems using microcontrollers (Arduino, Raspberry Pi) and integrate them with sensors and actuators.
COut 3	Design and implement IoT physical prototypes, utilizing 3D printing, CNC milling, and laser cutting for hardware development.
COut 4	Integrate IoT systems with cloud platforms, using APIs and real-time data handling techniques to enhance IoT connectivity.
COut 5	Write optimized embedded code for IoT devices, improving memory

	management, debugging, and system performance.
COut 6	Evaluate IoT business models and funding strategies, including crowdfunding, venture capital, and government funding.
COut 7	Assess security vulnerabilities in IoT networks and implement best practices for data privacy, encryption, and access control.
COut 8	Analyze ethical and environmental challenges in IoT, ensuring responsible development and deployment of connected devices.

Modules at a Glance

Internet of Things		
Sr. No.	**Modules**	**No. of Lectures**
1	Introduction to IoT & Design Principles	15
2	IoT Prototyping & Embedded Systems	15
3	Cloud Integration, Embedded Coding & Business Models	15
4	Manufacturing, Security, and Ethical Considerations in IoT	15
Total		**60**

Sr. No.	Modules
1	**Introduction to IoT & Design Principles**
	Overview: Definition & Significance of IoT, IoT Technologies & Enchanted Objects, Major Players in IoT Development **Design Principles for Connected Devices:** Calm & Ambient Technology, Privacy & Security Considerations, Web Thinking for IoT **Internet Principles for IoT Communication:** IP, TCP, and the IP Protocol Suite (TCP/IP), IPv4 vs. IPv6, DNS, Static & Dynamic IP Assignment, Application Layer Protocols (HTTP, HTTPS, MQTT, CoAP)
2	**IoT Prototyping & Embedded Systems**
	Basics of Prototyping: Cost vs. Ease of Prototyping, Physical Prototypes and Mass Personalisation, Open Source vs. Closed Source Approaches **Prototyping Embedded Devices:** Sensors, Actuators, and Embedded Computing, Microcontrollers (Arduino, Raspberry Pi), Development on Arduino & Raspberry Pi **Prototyping the Physical Design:** Sketching & Iteration in Prototyping, 3D Printing, CNC Milling, Laser Cutting, Repurposing & Recycling in IoT Prototyping
3	**Cloud Integration, Embedded Coding & Business Models**
	Prototyping Online Components: APIs & Cloud Connectivity, Security & Legalities of API Usage, Real-Time Data Handling (Polling, Comet, MQTT, XMPP, CoAP) **Techniques for Writing Embedded Code:** Memory Management & Performance Optimization, Debugging IoT Systems **Business Models in IoT:** Evolution of IoT Business Models, The Business Model Canvas for IoT Startups, Crowdfunding & Government Funding in IoT
4	**Manufacturing, Security, and Ethical Considerations in IoT**

	Moving to IoT Manufacturing: Designing IoT Kits & Printed Circuit Boards (PCBs) Mass Production of IoT Devices, Deployment, Security, and Performance Optimization **Ethics & Challenges in IoT:** Privacy & Data Control in IoT Networks, IoT Crowdsourcing & Environmental Impact, Open IoT Ecosystem & Security Risks

Practical Work (20 Marks)

List of Practicals to be Conducted	
1	Starting Raspbian OS, familiarizing with Raspberry PI components and Interface to ethernet, monitor, USB
2	Displaying different LED pattern with Raspberry PI
3	Capturing images and videos with Raspberry PI and PI camera
4	Displaying Time over 4 Digit 7 Segment Display using Raspberry PI
5	Deploying a Telegram Bot
6	Implementing RFID Module interfacing with Raspberry PI

AC: 10/03/2025

Question Paper Pattern (Academic Year: 2025-2026)
Internet of Things
Semester End Examination and Practical Examination – 100 Marks
SEMESTER VI
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q2.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q3.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
Q4.	**Answer the following questions (Any 3)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question	 **5** **5** **5** **5**	**15**
	Total	**80**	**60**

B] Practical Examination - 40 Marks
A Certified copy journal is essential to appear for the practical examination.

1.	**Practical Work**	**20**
2.	**Journal**	**10**
3.	**Viva Voce**	**10**

Books and References:

- McEwen, Adrian, and Hakim Cassimally. Designing the Internet of Things. 1st ed., Wiley, 2014.
- Kamal, Raj. Internet of Things – Architecture and Design. 1st ed., McGraw Hill, 2017.
- Pfister, Cuno. Getting Started with the Internet of Things. 6th ed., O'Reilly Media, 2018.
- Richardson, Matt, and Shawn Wallace. Getting Started with Raspberry Pi. 3rd ed., SPD, 2016.

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
2. Minor
2.A.a Optimization for Machine Learning (3 Credits)
Semester VI

1. Major	
2.A.a Optimization for Machine Learning	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	To understand the fundamentals of optimization and different types of optimization problems.
CObj 2	To apply derivative-based and heuristic optimization methods to real-world problems.
CObj 3	To explore and implement optimization techniques relevant to Machine Learning and Data Science.
Course Outcomes	
COut 1	Learners will be able to formulate and analyze optimization problems in various domains.
COut 2	Learners will apply optimization techniques such as Gradient Descent, Newton's Method, and Golden Section Search to solve optimization tasks.
COut 3	Learners will evaluate and compare the effectiveness of different optimization techniques in Data Science and Analytics applications.

Modules at a Glance

Optimization for Machine Learning		
Sr. No.	**Modules**	**No. of Lectures**
1	Linear Optimization	15
2	Simplex & Non-Linear Optimization	15
3	Derivative-Based Optimization	15
Total		**45**

Sr. No.	Modules
1	**Linear Optimization**
	Fundamental of Optimization: Objective functions, constraints, and classification of optimization problems (unconstrained vs. constrained, linear vs. nonlinear). Types of Optima: Local optima, global optima, and saddle points. Unconstrained and Constrained Optimization. Convex Optimization: Convex sets, convex functions, and their applications. Ridge & Lasso Regression. **Linear Optimization:** Definitions of LPP, scope, and importance of LPP in decision-making. Components: Objective function, decision variables, and constraints. Assumptions and limitations. **Formulation of LPP:** Translating real-world problems into LPP models. Examples: Resource allocation, and production scheduling. **Graphical Solution Method:** Solving LPPs graphically for two variables. Identifying feasible regions, optimal solutions, and special cases (multiple optima, infeasibility, unbounded solutions).
2	**Simplex & Non-Linear Optimization**
	Simplex Method: Standard form and initial steps of the algorithm. Understanding basic feasible solutions. Step-by-step computational procedure. Special cases: Degeneracy, alternate optima, and unbounded solutions, Formulating the dual problem and understanding the primal-dual relationship, Introduction to the Dual Simplex Method. **Big M Method:** Handling artificial variables in constraints. Problem-solving with infeasible initial solutions. **Nonlinear Programming Problems (NLPP):** NLPP with one equality constraint using Lagrange multipliers (2-3 variables). NLPP with one inequality constraint using Kuhn-Tucker conditions.
3	**Derivative-Based Optimization**
	First-Order Optimization Methods: Gradient Descent: Batch, Stochastic, and Mini-Batch approaches. Learning Rate Strategies: Fixed, adaptive, and decay rates.

	Advanced Variants: Momentum, Nesterov Momentum. **Second-Order Optimization Methods:** Newton's Method and Quasi-Newton Methods. **Unconstrained Optimization:**One-dimensional search methods: Golden Section Method and Fibonacci Search Method. **ML Optimizations:** Adam Optimizer, Bayesian Optimization

Practical Work (20 Marks)

List of Practicals to be Conducted	
1	**Introduction to Optimization & Simple Constrained Optimization** **Aim:** Understand basic optimization concepts, objective functions, constraints, and types of optima.
2	**Convex Optimization: Convex Functions and Applications** **Aim:** Understand convex optimization and applications in Ridge & Lasso regression.
3	**Nonlinear Programming (NLPP) with Constraints** **Aim:** Solve simple NLPPs using Lagrange multipliers for equality constraints.
4	**Gradient Descent and Variants** **Aim:** Implement gradient descent and its variants to solve optimization problems.
5	**Advanced Gradient Descent: Momentum and Nesterov** **Aim:** Improve gradient descent with Momentum and Nesterov methods.
6	**Newton's Method for Optimization** **Aim:** Implement Newton's Method for solving unconstrained optimization problems.
7	**One-Dimensional Search Optimization (Golden Section and Fibonacci)** **Aim:** Implement one-dimensional search methods like Golden Section and Fibonacci search.
8	**Adam Optimizer for Machine Learning** **Aim:** Use Adam optimizer for machine learning optimization problems.
9	**Bayesian Optimization for Hyperparameter Tuning** **Aim:** Apply Bayesian optimization for hyperparameter tuning in machine learning.
10	**Stochastic Optimization Methods** **Aim:** Implement stochastic optimization techniques.
11	**Evolutionary Optimization: Genetic Algorithm (GA)** **Aim:** Apply Genetic Algorithms for optimization problems.
12	**Multi-Objective Optimization and Goal Programming** **Aim:** Solve multi-objective optimization problems using Goal Programming.

Question Paper Pattern (Academic Year: 2025-2026)
Optimization for Machine Learning
Semester End Examination and Practical Examination – 100 Marks
SEMESTER VI
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 2)** A. Numerical/ Theory Based question B. Numerical/ Theory Based question C. Numerical/ Theory Based question	 **10** **10** **10**	**20**
Q2.	**Answer the following questions (Any 2)** A. Numerical/ Theory Based question B. Numerical/ Theory Based question C. Numerical/ Theory Based question	 **10** **10** **10**	**20**
Q3.	**Answer the following questions (Any 2)** A. Numerical/ Theory Based question B. Numerical/ Theory Based question C. Numerical/ Theory Based question	 **10** **10** **10**	**20**
	Total	**90**	**60**

B] Practical Examination - 40 Marks
A Certified copy journal is essential to appear for the practical examination.

1.	**Practical Work**	**20**
2.	**Journal**	**10**
3.	**Viva Voce**	**10**

Books and References:

- Charu C. Aggarwal, Linear algebra and optimization for machine learning, Springer, Cham, 2020.
- Andries P. Engelbrecht, Computational intelligence: An introduction, 2nd ed., Wiley, Hoboken, NJ, 2007.
- Ranjan Ganguli, Engineering optimization: A modern approach, Universities Press, Hyderabad, 2011.
- Mykel J. Kochenderfer and Tim A. Wheeler, Algorithms for optimization, MIT Press, Cambridge, MA, 2019.
- Pablo Pedregal, Introduction to optimization, Springer, Cham, 2016.
- S.S. Rao, Optimization theory and applications, Wiley Eastern Ltd, New Delhi, 1978.
- S.S. Rao, Engineering optimization: Theory and practice, John Wiley & Sons Inc., Hoboken, NJ, 2019

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
3. General Elective/ Open Elective
3.A.a Sustainable Business Models (3 Credits)
Semester VI

3. General Elective/ Open Elective	
3.A.a Sustainable Business Models	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	Understand the principles and importance of sustainability in business.
CObj 2	Analyze sustainable business practices and their impact on economic, environmental, and social dimensions.
CObj 3	Design and evaluate business models that integrate sustainability into core operations.
CObj 4	Explore global and regional trends in sustainable practices across industries.
Course Outcomes	
COut 1	Articulate the principles of sustainability and their relevance in modern business.
COut 2	Assess the effectiveness of sustainable practices in various industries.
COut 3	Develop sustainable business models that balance profitability with environmental and social goals.
COut 4	The learner understands the interconnectedness of profit, people, and planet,
COut 5	There is learning of designing products and services for reuse, repair, and recycling
COut 6	The learner is able to implement CSR initiatives that align with business Sustainability performance indicators Reporting standards

Modules at a Glance

Sustainable Business Models		
Sr. No.	**Modules**	**No. of Lectures**
1	Foundations of Sustainable Business	15
2	Developing Sustainable Business Models	15
3	Implementing and Measuring Sustainable Business	15
Total		**45**

Sr. No.	Modules
1	**Foundations of Sustainable Business**
	Defining Sustainability: different dimensions of sustainability (environmental, social, economic), Environmental Sustainability: Climate change, resource depletion, pollution, biodiversity loss, circular economy, Social Sustainability: Social equity, human rights, fair labor practices, community development, ethical consumption, **Economic Sustainability:** Long-term profitability, inclusive growth, innovation, responsible investment. **Triple Bottom Line (TBL):** Understanding the interconnectedness of profit, people, and planet, Sustainable Development Goals (SDGs): Aligning business strategies with global sustainability objectives, Stakeholder Theory: Identifying and understanding the needs and expectations of various stakeholders (customers, employees, suppliers, communities, investors).
2	**Developing Sustainable Business Models**
	Circular Economy Principles: Designing products and services for reuse, repair, and recycling **Blue Ocean Strategy:** Creating new market spaces and unmet customer needs through innovation **Business Model Canvas:** A framework for analyzing and designing sustainable business models. **Shared Value Creation:** Identifying and capturing both economic and social value, **Eco-innovation:** Developing new technologies and business models that minimize environmental impact, Social Entrepreneurship: Creating businesses that address social and environmental problems **Sustainable Supply Chains:** Ensuring ethical and sustainable practices throughout the entire supply chain **Green Marketing and Consumer Behavior:** Understanding consumer attitudes towards sustainable products and services.

3	**Implementing and Measuring Sustainable Business**
	Sustainability Reporting: Communicating environmental and social performance to stakeholders. **Life Cycle Assessment (LCA):** Evaluating the environmental impacts of products and services throughout their lifecycle. **Environmental Management Systems (EMS):** Implementing and improving environmental performance within an organization. **Corporate Social Responsibility (CSR) Strategies**: Developing and implementing **CSR initiatives that align with business Sustainability performance indicators** **Reporting standards:** GRI, SASB, and integrated reporting, Role of technology in sustainability reporting **Case studies**: Best practices in sustainability reporting, Regulatory and policy challenges, Market trends and consumer behavior **Financing sustainable business:** Green bonds, venture capital, and ESG funds,The future of sustainable business: Trends and innovations.

AC: 10/03/2025

Question Paper Pattern (Academic Year: 2025-2026)
Sustainable Business Models
Semester End Examination and Internal Evaluation – 100 Marks
SEMESTER VI
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
Q2.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
Q3.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
	Total	**75**	**60**

B] Internal Evaluation - 40 Marks

Method of Evaluation	Marks
Assignment/ Quiz/ Case Study/ Report on guest lecture/ activity	**20**
PowerPoint Presentation-Pre-set criteria	**20**
Total	**40**

Books and References:

- The Circular Economy Handbook: Realizing the Circular Advantage – Peter Lacy, Jessica Long, Wesley Spindler
- The Responsible Company: What We've Learned from Patagonia’s First 40 Years – Yvon Chouinard, Vincent Stanley
- Sustainable Business Models: Principles, Promise, and Practice – Lars Moratis, Frans Melissen, Samuel O. Idowu
- The Business of Sustainability: Trends, Policies, Practices, and Stories of Success – Scott T. Young, Kanwalroop Kathy Dhanda
- Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers – Alexander Osterwalder, Yves Pigneur
- Green Giants: How Smart Companies Turn Sustainability into Billion-Dollar Businesses – E. Freya Williams
- The New Sustainability Advantage: Seven Business Case Benefits of a Triple Bottom Line – Bob Willard
- Sustainable Business and Industry: Designing and Operating for Social and Environmental Responsibility – Joseph Jacobsen
- Corporate Sustainability: Integrating Performance and Reporting – Ann Brockett, Zabihollah Rezaee
- The Upcycle: Beyond Sustainability—Designing for Abundance – William McDonough, Michael Braungart
- Sustainable Business Models: Innovation, Implementation and Success – Adam Lindgreen, François Maon, Stefan Gold
- Business Models for Sustainability Transitions: How Organizations Can Move Towards a Sustainable Future – Annabeth Aagaard

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
3.General Elective/ Open Elective
3.A.b Innovation, Creativity and Problem Solving (3 Credits)
Semester VI

3. General Elective/ Open Elective	
3.A.b Innovation, Creativity and Problem Solving	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	Develop a deep understanding of the principles and processes of innovation and creativity in various fields.
CObj 2	Equip students with tools and techniques to approach and solve complex real-world problems creatively.
CObj 3	Inspire students to break conventional thinking patterns and develop original ideas.
CObj 4	Promote collaborative thinking by integrating insights from multiple disciplines.
CObj 5	Apply innovative and creative thinking strategies to real-life challenges in professional or entrepreneurial settings.
Course Outcomes	
COut 1	Demonstrate the ability to generate, evaluate, and implement innovative ideas to address challenges.
COut 2	Utilize creative problem-solving frameworks and techniques to develop novel solutions to complex problems.
COut 3	Analyze and assess problems from multiple perspectives to identify effective solutions.
COut 4	Apply design thinking methodologies to design and prototype user-centered solutions.
COut 5	Work effectively in teams to brainstorm, develop, and present innovative ideas and solutions.
COut 6	Translate creative concepts into actionable strategies for businesses, social causes, or technology ventures.

COut 7	Foster a mindset of curiosity and continuous learning to adapt to evolving challenges and opportunities.

Modules at a Glance

Innovation, Creativity and Problem Solving		
Sr. No.	**Modules**	**No. of Lectures**
1	Foundations of Innovation & Creativity	15
2	Problem-Solving Strategies & Techniques	15
3	Fostering Innovation & Creativity in Organizations	15
Total		**45**

Sr. No.	Modules
1	**Foundations of Innovation & Creativity**
	Defining Innovation: Types of innovation (product, process, business model, etc.), disruptive vs. sustaining innovation, the importance of innovation in a competitive world. **Understanding Creativity: The Creative Process:** Divergent thinking, convergent thinking, stages of the creative process (preparation, incubation, illumination, verification). **Creative Blocks:** Identifying and overcoming common creative blocks (fear of judgment, lack of motivation, perfectionism), Building Creative Confidence: Cultivating curiosity, embracing experimentation, developing a growth mindset. **The Role of Design Thinking:** Human-centered approach to problem-solving, empathizing with users, generating ideas, prototyping and testing.
2	**Problem-Solving Strategies & Techniques**
	Problem Identification & Definition: Identifying root causes using tools like fishbone diagrams, 5 Whys., Defining problems clearly and concisely using the "How Might We" framework. **Problem-Solving Methodologies:** **Design Thinking:** Detailed exploration of the design thinking process with practical applications. **Lean Startup:** Iterative development, rapid prototyping, and customer feedback loops **Six Sigma:** Data-driven approach to process improvement and defect reduction. **Decision-Making Techniques: Decision matrices:** Evaluating options based on criteria, **Cost-benefit analysis:** Assessing the potential risks and rewards., **SWOT analysis:** Identifying strengths, weaknesses, opportunities, and threats.
3	**Fostering Innovation & Creativity in Organizations**

	Creating an Innovative Culture: Encouraging experimentation and risk-taking, Fostering collaboration and knowledge sharing, Providing resources and support for innovation, Recognizing and rewarding innovative ideas. **Leadership in Innovation:** The role of leaders in inspiring and motivating teams. Creating a vision for innovation and aligning teams towards that goal, Building a culture of continuous learning and improvement. **Innovation Tools & Technologies:** Utilizing technology for idea generation and collaboration (e.g., online platforms, AI tools), exploring emerging technologies like artificial intelligence, block chain , and the Internet of Things.

AC: 10/03/2025

Question Paper Pattern (Academic Year: 2025-2026)
Innovation, Creativity and Problem Solving
Semester End Examination and Internal Evaluation – 100 Marks
SEMESTER VI
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
Q2.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
Q3.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
	Total	**75**	**60**

B] Internal Evaluation - 40 Marks

Method of Evaluation	Marks
Assignment/ Quiz/ Case Study/ Report on guest lecture/ activity	**20**
PowerPoint Presentation-Pre-set criteria	**20**
Total	**40**

Books and References:

- Creative Confidence: Unleashing the Creative Potential Within Us All – Tom Kelley & David Kelley
- The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail – Clayton Christensen
- The Medici Effect: What Elephants and Epidemics Can Teach Us About Innovation – Frans Johansson
- The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm – Tom Kelley
- Lateral Thinking: Creativity Step by Step – Edward de Bono
- Thinkertoys: A Handbook of Creative-Thinking Techniques – Michael Michalko
- The Design of Everyday Things – Don Norman
- Problem Solving 101: A Simple Book for Smart People – Ken Watanabe
- Sprint: How to Solve Big Problems and Test New Ideas in Just Five Days – Jake Knapp
- The Back of the Napkin: Solving Problems and Selling Ideas with Pictures – Dan Roam
- A Whack on the Side of the Head: How You Can Be More Creative – Roger von Oech
- Steal Like an Artist: 10 Things Nobody Told You About Being Creative – Austin Kleon
- Imagine: How Creativity Works – Jonah Lehrer
- Mindset: The New Psychology of Success – Carol S. Dweck

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
3.General Elective/ Open Elective
3.A.c Human Capital Investment (3 Credits)
Semester VI

3. Major	
3.A.c Human Capital Investment	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	To understand the concept of human capital and its significance in economic growth and development.
CObj 2	To explore the relationship between education, health, and productivity as components of human capital.
CObj 3	To analyze the costs and benefits of investments in human capital.
CObj 4	To examine policies and strategies for fostering human capital development at micro and macro levels.
Course Outcomes	
COut 1	Define and explain the importance of human capital and its relationship to economic development.
COut 2	Differentiate between physical and human capital investments.
COut 3	Evaluate how investments in education, training, and healthcare affect individual and national economic productivity.
COut 4	Understand the return on investment (ROI) from human capital initiatives.
COut 5	Analyze case studies of human capital strategies in developing and developed countries.
COut 6	Apply human capital theories to solve real-world problems in organizations and economies.
COut 7	Develop strategies for workforce training, leadership development, and organizational growth.
COut 8	Assess the social consequences of inadequate human capital investment.

Modules at a Glance

Human Capital Investment		
Sr. No.	**Modules**	**No. of Lectures**
1	Introduction to Human Capital	15
2	Health and Human Capital	15
3	Policies for Human Capital Development	15
Total		**45**

Sr. No.	Modules
1	**Introduction to Human Capital**
	Concept and definition of human capital, Differences between human and physical capital, Role of human capital in economic growth, Education as an investment in human capital, Private and social returns to education, Education systems and policies: A global perspective, Gender disparities in education and its impact on human capital, Skill development and training programs
2	**Health and Human Capital**
	Health as a component of human capital, Economic impact of health on productivity and development, Public health policies and their role in human capital formation, Challenges in achieving universal health coverage, Cost-benefit analysis of health investments, Measuring returns on investment in human capital, Opportunity costs and long-term impacts
3	**Policies for Human Capital Development**
	Government strategies for fostering human capital, Role of international organizations in human capital formation, Challenges in implementing human capital policies in developing countries

AC: 10/03/2025

Question Paper Pattern (Academic Year: 2025-2026)
Human Capital Investment
Semester End Examination and Internal Evaluation – 100 Marks
SEMESTER VI
A] Semester End Examination (SEE)- 60 Marks

Maximum Marks: 60
Duration: 2 Hours
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
Q2.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
Q3.	**Answer the following questions (Any 4)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question D. Theory/Concept Based question E. Theory/Concept Based question	 **5** **5** **5** **5** **5**	**20**
	Total	**75**	**60**

B] Internal Evaluation - 40 Marks

Method of Evaluation	Marks
Written Test/ MCQ	**20**
PowerPoint Presentation/ Group discussion/ Assignment	**20**
Total	**40**

Books and References:

- Investing in People: Financial Impact of Human Resource Initiatives – Wayne F. Cascio & John W. Boudreau
- The ROI of Human Capital: Measuring the Economic Value of Employee Performance – Jac Fitz-enz
- Human Capital: What It Is and Why People Invest It – Thomas O. Davenport
- The Economics of Human Capital – Gary S. Becker
- Human Capital Management: Achieving Added Value Through People – Angela Baron & Michael Armstrong
- Strategic Human Capital Management: Creating Value Through People – Rob Silzer & Ben Dowell
- Beyond HR: The New Science of Human Capital – John W. Boudreau & Peter M. Ramstad
- Talent Wins: The New Playbook for Putting People First – Ram Charan, Dominic Barton & Dennis Carey
- The Talent Delusion: Why Data, Not Intuition, Is the Key to Unlocking Human Potential – Tomas Chamorro - Premuzic
- Work Rules!: Insights from Inside Google That Will Transform How You Live and Lead – Laszlo Bock
- The Case for Investing in Education and Workforce Development – Henry M. Levin
- Education and Economic Growth: Links and Evidence – Eric Hanushek & Ludger Woessmann
- The Knowledge Economy – Roberto Mangabeira Unger

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
4. Vocational & Skill Enhancement Courses
4.A Skill Enhancement Courses
4.A.a Data Governance (2 Credits)
Semester VI

4. Vocational & Skill Enhancement Courses	
4.A Skill Enhancement Courses	
4.A.a Data Governance	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	Introduce students to the fundamental principles of data governance, including policies, frameworks, and organizational structures.
CObj 2	Develop an understanding of data stewardship, metadata management, and data quality control.
CObj 3	Equip learners with the ability to design and implement data governance programs in organizations.
CObj 4	Teach the significance of data lifecycle management and its role in maintaining data integrity and compliance.
CObj 5	Provide hands-on experience in applying governance models to manage structured and unstructured data effectively.
Course Outcomes	
COut 1	Explain the key components of data governance, including policies, roles, and responsibilities.
COut 2	Analyze different data governance frameworks and apply them to real-world scenarios.
COut 3	Develop data stewardship and data governance strategies to ensure compliance and data security.
COut 4	Implement metadata management solutions to enhance data discoverability and lineage tracking.
COut 5	Apply data lifecycle management principles to ensure effective data retention,

	archival, and deletion.
COut 6	Use industry tools and best practices to enforce data quality and consistency across organizational data assets.
COut 7	Understand the impact of cloud computing and big data on data governance and how to implement governance in these environments.

Modules at a Glance

Data Governance		
Sr. No.	**Modules**	**No. of Lectures**
1	Foundations of Data Governance	10
2	Implementing Data Governance	10
3	Data Governance Automation & Case Studies	10
Total		**30**

Sr. No.	Modules
1	**Foundations of Data Governance**
	Introduction to Data Governance: Definition and core principles, Importance and business value, Key drivers and objectives **Data Governance Frameworks:** Components of a data governance framework, Roles and responsibilities (Data Owners, Stewards, Custodians), Policy development and enforcement **Data Quality Management:** Dimensions of data quality, Data quality assessment and improvement techniques, Establishing data quality metrics and KPIs **Data Lifecycle Management:** Phases of the data lifecycle, Applying governance across the data lifecycle, Data retention and archival policies
2	**Implementing Data Governance**
	Developing a Data Governance Strategy: Assessing organizational readiness, Setting priorities and defining outcomes, Designing a roadmap for implementation **Data Governance in Practice:** Best Practices for successful data governance implementations, Common challenges and solutions, Tools and technologies supporting data governance **Data Stewardship:** Defining data stewardship roles, Responsibilities and skill sets required, Building a data stewardship program **Metadata Management:** Importance of metadata in data governance, Types of metadata (business, technical, operational), Implementing a metadata management strategy
3	**Data Governance Automation & Case Studies**
	Automating Data Governance Processes: Role of AI & Machine Learning in Data Governance, Automated Metadata Management & Data Lineage, Using AI for Data Quality Monitoring & Anomaly Detection

	Data Governance in Cloud & Hybrid Environments: Challenges of Cloud-Based Data Governance, Data Governance Best Practices for AWS, Azure, GCP, Hybrid & Multi-Cloud Data Governance Strategies **Industry-Specific Data Governance:** Healthcare (HIPAA Compliance & Data Protection), Finance (Risk Management & Regulatory Compliance - Basel, SOX), Retail & E-commerce (Customer Data & Personalization Challenges) **Case Studies on Data Governance Implementation:** Success Stories from Large Enterprises (Google, Microsoft, Amazon, IBM), Lessons Learned from Data Breaches & Failures (Equifax, Facebook, etc.), Government & Public Sector Data Governance Initiatives **Future Trends in Data Governance:** Impact of Decentralized Data Governance, Zero Trust Architecture & Next-Gen Privacy Models, Evolving Role of Data Governance with AI & Big Data

Question Paper Pattern (Academic Year: 2025-2026)
Data Governance
Semester End Examination and Internal Evaluation – 50 Marks
SEMESTER VI
A] Semester End Examination (SEE)- 30 Marks

Maximum Marks: 30
Duration: 1 Hour
Note: 1. All questions are compulsory.
2. All questions carry equal marks.

Question No.	Particulars (Nature of Questions)	Marks (Given)	Marks (To be Attempted)
Q1.	**Answer the following questions (Any 2)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question	 **5** **5** **5**	**10**
Q2.	**Answer the following questions (Any 2)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question	 **5** **5** **5**	**10**
Q3.	**Answer the following questions (Any 2)** A. Theory/Concept Based question B. Theory/Concept Based question C. Theory/Concept Based question	 **5** **5** **5**	**10**
	Total	**45**	**30**

B] Internal Evaluation - 20 Marks

Method of Evaluation	Marks
Case study on Industry-Based Problem	**20**

Books and References:

- Ladley, John. Data Governance: How to Design, Deploy, and Sustain an Effective Data Governance Program. 2nd ed., Academic Press, 2019.
- Mosley, M. Boyd, and Barbara Von Halle. The DAMA Guide to the Data Management Body of Knowledge (DMBOK). Technics Publications, 2017.
- Khatri, Vijay, and Carol V. Brown. Designing Data Governance in Organizations. Journal of Database Management, 2010.
- Seiner, Robert S. Non-Invasive Data Governance: The Path of Least Resistance and Greatest Success. Technics Publications, 2014.
- Thomas, Gwen. Data Governance: Managing Information as an Enterprise Asset. DAMA International, 2012.
- Redman, Thomas C. Data Driven: Profiting from Your Most Important Business Asset. Harvard Business Press, 2008.

Teaching Pedagogy:

Lectures/ tutorials/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning

Syllabus of courses of TY BSc (Data Science & Analytics) Programme
(With effect from the Academic Year 2025-2026)
5. Field Project / Apprenticeship / Community Engagement & Services
5.A.a Internship or Project Work (2 Credits)
Semester V

5. Field Project/ Apprenticeship/ Community Engagement & Services	
5.A.a Internship or Project Work	
Course Objectives and Course Outcomes	
Course Objectives	
CObj 1	
CObj 2	
CObj 3	
CObj 4	
Course Outcomes	
COut 1	
COut 2	
COut 3	
COut 4	
COut 5	

AC: 10/03/2025

CRITERIA FOR EVALUATING POWERPOINT PRESENTATION/ CASE STUDY/ APPLICATION BASED ACTIVITY:

MARKS: 20 FY/SY/TY BSc: Division A/B Semester:

Name of the Topic Date of Presentation:

Sr. No	Roll No	Name of the student	Content (5)	Team building (5)	Presentation skills		Total (20)
					Verbal (5)	Non Verbal (5)	
1							
2							
3							
4							

Sign: 1_____2._____3._____4._____Faculty Sign:_____

Name of the Topic Date of Presentation:

Sr. No	Roll No	Name of the student	Content (5)	Team building (5)	Presentation skills		Total (20)
					Verbal (5)	Non Verbal (5)	
1							
2							
3							
4							

Sign: 1_____2._____3._____4._____Faculty Sign:_____

Name of the Topic Date of Presentation:

Sr. No	Roll No	Name of the student	Content (5)	Team building (5)	Presentation skills		Total (20)
					Verbal (5)	Non Verbal (5)	
1							
2							
3							
4							

Sign: 1_____2._____3._____4._____Faculty Sign:_____