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(Accredited by NAAC with Grade A+)

GU/Acad –PG/BoS -NEP/2025-26/852 Date: 31.03.2026

CIRCULAR

The Academic Council & Executive Council of the University has approved Ordinance OA-35A relating to PG Programmes offered at the University campus and its affiliated Colleges based on UGC 'Curriculum and Credit Framework for Postgraduate Programmes'. Accordingly, the University has proposed introduction of Ordinance OA-35A from the Academic year 2025-2026 onwards.

The Programme structure and syllabus of Semester I and II of the **Post Graduate Diploma in Business Intelligence Technologies** Programme approved by the Academic Council in its meeting held on 13th September 2025 is attached.

The Dean & Vice-Dean (Academic) of the Goa Business School and the Principals of the affiliated College offering the **Post Graduate Diploma in Business Intelligence Technologies** are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN V LAWANDE
Digitally signed by ASHWIN V LAWANDE
Date: 2026.03.31 15:38:08 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,
1. The Dean, Goa Business School, Goa University.
2. The Vice-Dean (Academic), Goa Business School, Goa University.
3. Principal of affiliated College offering the Post Graduate Diploma in Business Intelligence Technologies Programme.

Copy to:
1. Chairperson, BoS in Computer Science & Technology, Goa University.
2. Controller of Examinations, Goa University.
3. Assistant Registrar Examinations (PG), Goa University.
4. Director, Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

GOA UNIVERSITY

POST GRADUATE DIPLOMA IN BUSINESS INTELLIGENCE TECHNOLOGIES

(Effective from the Academic Year 2025-2026)

ABOUT THE PROGRAMME

The primary goal of the Post Graduate Diploma in Business Intelligence Technologies programme is to provide students with skills and practical knowledge to empower organizations to make better, more informed decisions by providing access to relevant data and insights. This is achieved through the collection, analysis, and visualization of data to identify trends, patterns, and insights that can inform business strategies and processes. By learning to use the various tools for advanced data analysis, students can help businesses identify areas for improvement in their processes, leading to increased efficiency and cost savings.

OBJECTIVES OF THE PROGRAMME

The primary objective of a Business Intelligence technology programme is to empower organizations to make better, more informed decisions by leveraging data insights. This is achieved by providing tools and techniques for collecting, storing, analysing, and presenting data in a clear and understandable way. The student's analytical ability will develop over the course of the study, and they will be ready to make a meaningful input into strategic as well as day-to-day operations. Students will learn to apply analytical techniques to deal with challenging business problems at the very outset by learning:

- Techniques to collect, manage, and analyse business data,
- Use of business intelligence tools and software for data visualisation and reporting,
- Application of data analytics to solve business problems,
- Insights into data warehousing and data mining,
- Understanding of predictive models and forecasting.

Approved by Academic Council held on 13th September 2025

PROGRAMME SPECIFIC OUTCOMES (PSO)	
PSO 1.	Students will be able to apply analytical knowledge effectively to solve business problems.
PSO 2.	Students will be able to identify and analyse business issues based on fundamental principles.
PSO 3.	Students will be equipped to design tailored solutions considering market dynamics and consumer behaviour.
PSO 4.	Students will be able to utilize research methodologies for effective problem formulation and their resolution.
PSO 5.	Students will learn to employ data analytics and visualization tools for business analysis.
PSO 6.	Students will be able to communicate insights clearly to both technical and non-technical audiences.
PSO 7.	Students will be aware and sensitive to uphold ethical standards in analytical practices adhering to societal norms and upholding individual privacy and dignity.
PSO 8.	Students will be engaged in continuous professional development to keep pace with industry trends at the same time making efficient use of available resources

PROGRAMME STRUCTURE

Post Graduate Diploma in Business Intelligence Technologies

Effective from Academic Year 2025-26

Bridge Course			
Sr. No.	**Course Code**	**Title of the Course**	**Credits**
1	BIT-1000	Data Mining Fundamentals For Beginners- (Udemy)	-
2	BIT-1001	Data Mining Foundations and Practice Specialization (Coursera)	
3	BIT-1002	Introduction to Statistics (Coursera)	-
4	BIT-1003	Python Basics: Learn, Apply & Build Programs (Cousera)	-
5	BIT-1004	Introductory Linear Algebra (Edx)	-
6	BIT-1005	Complete Microsoft Advanced Excel Certification (Udemy)	-
7	BIT-1006	Computer Science for Databases using SQL(Edx)	-

Semester I				
Discipline Specific Core (DSC) Courses (16 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	BIT-5000	Business Intelligence and Computing	**3T**	400
2	BIT-5001	Digital Business Transformation	**4T**	400
3	BIT-5002	Statistics for Business	**4T**	400
4	BIT-5003	Business Computing Tools(P)	**1P**	400
5	BIT-5004	Database Systems (P)	**2P**	400
6	BIT-5005	Linear Programming Problems (P)	**2P**	400
Total Credits for DSC Courses in Semester I			**16**	
Discipline Specific Elective (DSE) Course (4 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	BIT-5201	Python for Data Analytics	**4T**	400
2	BIT-5202	Linear Algebra	**4T**	400
3	BIT-5203	E-Business Fundamentals	**4T**	400
Total Credits for DSE Courses in Semester I			**4**	
Total Credits in Semester I			**20**	

Semester II				
Discipline Specific Core (DSC) Courses				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	BIT-5006	Data Visualisation and Dashboards	**3T**	500
2	BIT-5007	Data Management	**3T**	500
3	BIT-5008	Ethical Principles in Business Analytics	**4T**	500
4	BIT-5009	Applied Statistics	**3T**	500
5	BIT-5010	Dashboard Design and Development(P)	**1P**	500
6	BIT-5011	Data Science Workflow Tools (P)	**1P**	500
7	BIT-5012	Applied Statistical Analysis(p)	**1P**	500
Total Credits for DSC Courses in Semester II			**16**	
Discipline Specific Elective (DSE) Courses (4 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	BIT-5204	Generative AI (P)	**2P**	400
2	BIT-5205	Cloud Computing (P)	**2P**	400
3	BIT-5206	Operations Research (P)	**2P**	400
Total Credits for DSE Courses in Semester II			**4**	

Internship			
Sr. No.	**Course Code**	**Title of the Course**	**Credits**
1	BIT-5208	Internship	**4P**
Total Credits in Semester II			**20**

Note: - # 4 Credit Internship can be opted in lieu of 4(2+2) credit DSE practicals.

Blooms Taxonomy Cognitive Levels	
Cognitive Level	**Notations**
K1	Remembering
K2	Understanding
K3	Applying
K4	Analyzing
K5	Evaluating
K6	Create

SEMESTER I

Discipline Specific Core (DSC) Courses

Title of the Course	Business Intelligence and Computing
Course Code	BIT-5000
Number of Credits	3T
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil-	
Course Objectives:	1. To introduce the fundamentals of Business Intelligence (BI) and its role in modern decision-making. 2. To explore key data management and analytical tools used in BI. 3. To equip students with skills to develop, interpret, and use BI dashboards and reporting systems. 4. To expose learners to real-world BI applications in various sectors like finance, healthcare, and retail. 5. To provide hands-on experience in BI software platforms and data visualization tools.	
Course Outcomes:		**Mapped to PSO**

	CO 1. Understand and explain the concepts, architecture, and components of business intelligence systems.		PSO1, PSO2	
	CO 2. Apply Data warehousing and Data Mining techniques for business analysis.		PSO1, PSO3	
	CO 3. Use BI tools for data analysis and visualization.		PSO4, PSO5	
	CO 4. Design and interpret BI reports and dashboards for strategic decision-making.		PSO3, PSO4, PSO5	
	CO 5. Evaluate and apply BI solutions in different business sectors.		PSO1, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Introduction to Business Intelligence and Data Ecosystem** Definition and Importance of BI, BI vs Business Analytics vs Data Science, Components and Architecture of BI Systems, Data Sources and Types: Structured, Semi- structured, Unstructured. Introduction to Data Warehousing, ETL Processes, BI Life Cycle and Project Management, Applications: Retail BI, Customer Analytics, Logistics.	**15**	CO1	K1, K2, K3, K4
Module 2:	**Data Warehousing and OLAP** Data Warehousing Concepts, Dimensional Modeling: Star and Snowflake Schema, OLAP: Concepts, Types (ROLAP, MOLAP, HOLAP), Data Integration and Cleansing, Metadata Management. Introduction to SQL for BI. Applications: Financial Analysis, Inventory Control with Case Studies	**15**	CO2	K2, K3, K4
Module 3:	**Business Analytics, Data Mining, Visualization and Applications.** Descriptive, Predictive, and Prescriptive Analytics, Data Mining Concepts and Techniques, Association, Classification, Clustering (Overview) Introduction to Machine Learning in BI, Data Visualization Principles, Dashboards and KPI Metrics Applications: Healthcare BI, Fraud Detection, Customer Segmentation	**15**	CO2	K2, K3, K4, K5

Pedagogy:	Lectures, Tutorials, Seminars, Assignments, Presentations, Mini- Projects.
Texts:	1. **Sharda, R., Delen, D., & Turban, E. (2024).** *Business Intelligence, Analytics, Data Science, and AI (5th ed., Global ed.). Pearson.* 2. **Loshin, D. (2013).** *Business intelligence: The savvy manager's guide*. Morgan Kaufmann.
References/ Readings:	1. **Kimball, R., & Ross, M. (2013).** *The data warehouse toolkit: The definitive guide to dimensional modeling*. Wiley. 2. **Howson, C. (2013).** *Successful business intelligence: Unlock the value of BI & big data*. McGraw-Hill.
Web Resources:	Coursera, Futurelearn

Title of the Course	Digital Business Transformation
Course Code	BIT-5001
Number of Credits	4T
Theory/Practical	Theory
Level	400
Effective from AY	2025- 26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To introduce digital transformation in an organizational context. 2. To relate digital strategies to sustainable development goals and understand how digital transformation can accelerate the realization of sustainable development goals. 3. To analyze and critically review digital solutions for sustainability. 4. To apply their knowledge in practical scenarios to promote sustainable development through digital projects. 5. To describe the relationship between the strategies of an organisation and their effect on selection, prioritising, and supervision of a project.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Analyze the evolution of technology and its impact on business value chains and competitive landscapes.	PSO1, PSO2, PSO3, PSO4

	CO 2. Evaluate the strategic implications of disruptive technologies and their role in reshaping industries and business models.		PSO1, PSO2, PSO3, PSO4	
	CO 3. Formulate strategies for businesses to leverage emerging digital trends such as Big Data, IoT, Additive Manufacturing, Cybersecurity, and Artificial Intelligence.		PSO1, PSO2, PSO3, PSO4	
	CO 4. Develop a roadmap for digital transformation within an organization, considering the interconnectedness of new digital growth, people and organization, data and analytics, and ecosystems.		PSO1, PSO3, PSO4, PSO5	
	CO 5. Examine the principles of digital platform strategy and its application in shifting from traditional value chains to value ecosystems.		PSO2, PSO3, PSO4	
	CO 6. Critically assess case studies related to technology- driven business changes and synthesize insights to propose innovative solutions for similar challenges.		PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**The Digital Shift: Impact of Technology on Business** ● **Technology Evolution:** Historical trajectory, characteristics, and drivers of technological change (invention, innovation, diffusion). ● **Value Chain Transformation:** How digital technologies redefine value chains, impacting efficiency, costs, and competitive advantage. ● **Emerging Tech Paradigms:** Introduction to cloud computing, big data, automation, and the shift to data-driven decisions.	**12**	CO1, CO2	K1, K2
Module 2:	**Digital Disruption and the Competitive Landscape** ● **The Competitive life cycle** ● **Competitive Life Cycle:** How digital technologies accelerate product/industry life cycles and analyze disruptive innovation. ● **Economics of Innovation:** Economic principles, network effects, and increasing returns to scale in digital markets. ● **Strategic Responses:** Frameworks for identifying and responding to disruptive	**10**	CO2	K1,K2,K3 ,K4,K5

	threats proactively.			
Module 3:	**Key Digital Trends and Technologies** • **Big Data & Analytics:** Significance, sources, introduction to tools and techniques (with Excel lab). • **Internet of Things (IoT):** Architecture, applications, and potential for data collection and optimization. • **Additive Manufacturing (3D Printing):** Principles, business implications, and impact on supply chains. • **Cybersecurity & Digital Trust:** Importance, threats, mitigation strategies, and ethical implications. • **Artificial Intelligence (AI) & Machine Learning (ML):** Concepts, business applications, and potential for automation	**12**	CO3	K1,K2,K3 ,K4,K5
Module 4:	**The Path to Digital Transformation** • **Digital Growth Strategy:** Formulating strategies for new digital growth opportunities and identifying transformation elements. • **People & Organization:** Importance of talent development, reskilling, cultural change, and organizational structures. • **Data & Analytics for Advantage:** Leveraging data for decision-making, data governance, and management. • **Digital Ecosystems & Partnerships:** Importance of external partnerships, ecosystem strategies for value creation and scaling.	**14**	CO4	K1,K2,K3 ,K4,K5
Module 5:	**Digital Platform Strategies and Network Effects** • **Value Chain to Ecosystem:** Shift from linear value chains to interconnected ecosystems; types of digital platforms. • **Network Effects & Platform Strategy:** Power of network effects, strategies for platform launch, growth, and monetization. • **Platform Governance & Competition:** Challenges, opportunities, and regulatory landscape for digital platforms.	**12**	CO5, CO6	K2, K3, K4, K5

Pedagogy:	Lectures, Tutorials, Seminars, Assignments, Presentations, Case Studies.
Texts:	1. Westerman, G., Bonnet, D., & McAfee, A. (2014). Leading digital: Turning technology into business transformation. Harvard Business Press. 2. Maheshwari, A. (2019). Digital Transformation: Building Intelligent Enterprises. John Wiley & Sons, Incorporated. 3. Pethuru, R., Poongodi, T., Balamurugan B., Manju K. (2020). The Internet of Things and Big Data Analytics: Integrated Platforms and Industry Use Cases. Fernandez, M. (2020). Industry 4.0: Technologies and Management in the Digital Transformation of the Industry.
References/ Readings:	1. Moore, G. (1991). Crossing the Chasm. Harper Business. 2. Rifkin, J. (2014). The Zero Marginal Cost Society. Palgrave Macmillan. 3. Tapscott, D., & Tapscott, A. (2016). Blockchain Revolution. Portfolio.
Web Resources:	1. Online Courses Swayam 2, "Digital Transformation: Theory and Applications - Course." Swayam. https://onlinecourses.swayam2.ac.in/cec21_mg06/preview 2. Wiley Online Library, "Digital Transformation: A multidisciplinary perspective and future..." Wiley Online Library

Title of the Course	Statistics for Business
Course Code	BIT-5002
Number of Credits	4T
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil-	
Course Objectives:	1. Understand and apply foundational concepts of descriptive statistics, including graphical and numerical techniques for summarizing data. 2. Utilize probability theory to model uncertainty and reason about random events using principles like conditional probability and Bayes' theorem. 3. Analyze discrete and continuous random variables, and compute their expectations, variances, and probability distributions. 4. Apply statistical software tools to visualize data and simulate key statistical concepts.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Construct and interpret various types of frequency tables, histograms, and graphical summaries of data, including boxplots and ogives	PSO 1, PSO 2
	CO 2. Compute and interpret measures of central tendency (mean, median, mode) and	PSO 1, PSO 3

	dispersion (variance, standard deviation, percentiles)			
	CO 3. Apply basic probability rules, including the use of Venn diagrams, conditional probability, and Bayes' theorem, to solve real-world problems		PSO 3, PSO 4	
	CO 4. Identify and describe properties of discrete and continuous random variables, including Bernoulli, Binomial, Poisson, Uniform, and Normal distributions		PSO 4, PSO 5	
	CO 5. Use R and ggplot2 to visualize data and explore statistical relationships through plots and simulations		PSO 5, PSO 6	
	CO 6. Explain and apply the Central Limit Theorem, and analyze sampling distributions of statistics such as the sample mean, especially from normal and finite populations		PSO 5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Descriptive Statistics** ● Describing data sets ● Frequency tables and graphs ● Relative frequency tables and graphs ● Grouped data, histograms, ogives ● Summarising data sets o sample mean, sample median and sample mode o sample variance and standard deviation o sample percentiles and box plots ● **Visualisation using R:** Use of ggplot2	**14**	CO1, CO2, CO5	K2, K3, K4
Module 2:	**Elements of Probability** ● Sample space and events ● Venn diagrams and algebra of events ● Axioms of probability	**16**	CO3	K1, K2, K3, K4

	• Sample spaces having equally likely outcomes • Conditional probability • Bayes' formula • Independent events			
Module 3:	**Random Variables and Expectation** • Random variable • Independent random variables • Expectation • Properties of expected value • Variance • Markov's inequality • Chebyshev's inequality • Bernoulli and Binomial random variables • Poisson random variable • Uniform random variable • Normal random variable	**22**	CO4	K1, K2, K3, K4, K5
Module 4:	**Distributions of Sampling Statistics** • Sample mean • The central limit theorem • Sampling distributions from a normal population • Sampling from a finite population	**8**	CO6	K1, K2, K3, K4
Pedagogy:	Lectures, Tutorials, Seminars, Assignments, PowerPoint presentations, experiential learning, problem-based learning			
Texts:	Sheldon M. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, Fifth Edition, Elsevier Academic Press			
References/	1. S. C. Gupta: *Fundamentals of Statistics*, 7th Edition, Himalaya Publishing House, 2018.			

Readings:	2. Sheldon Ross, *A First Course in Probability*, Tenth Edition 3. Hadley Wickham & Garrett Grolemund, *R for Data Science, O'Reilly Media*
Web Resources:	Directorate of Higher Education, Government of Goa, "Course Details." Dishtavo. https://dishtavo.dhe.goa.gov.in/course_details_tab.php

Title of the Course	Business Computing Tools
Course Code	BIT-5003
Number of Credits	1P
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To explore key data management and analytical tools used in BI. 2. To equip students with skills to develop, interpret, and use BI dashboards and reporting systems. 3. To expose learners to real-world BI applications in various sectors like finance, healthcare, and retail. 4. To provide hands-on experience in BI software platforms and data visualization tools.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Understand and explain the concepts, architecture, and components of business intelligence systems.	PSO1, PSO2
	CO 2. Apply Data warehousing and Data Mining techniques for business analysis.	PSO1, PSO3
	CO 3. Use BI tools for data analysis and visualization.	PSO4, PSO5
	CO 4. Design and interpret BI reports and dashboards for strategic decision-making.	PSO3, PSO4, PSO5

	CO 5. Evaluate and apply BI solutions in different business sectors.		PSO1, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**List of Suggested Lab Assignments:** **Assignment 1:** Intro to Power BI or Tableau, Dataset: Sample sales or E-commerce dataset and Create first simple bar chart dashboard. **Assignment 2:** Using Power Query or Python (Pandas) for data preprocessing remove duplicates, handle nulls, date formats, Hands-on: Clean a messy Excel dataset and Cleaned dataset ready for analysis. **Assignment 3:** Tables, Relationships, Keys, Create relationships in PowerBI or Tableau and Model relational data for reporting. **Assignment 4:** Basic SQL for BI: SELECT, WHERE, ORDER BY, GROUP BY, Run queries on a sales database and Basic queries for summaries and filtering. **Assignment 5:** Advanced SQL - Joins (INNER, LEFT, RIGHT), Subqueries, Combine multiple tables and Generate detailed reports using joins. **Assignment 6:** SQL to BI Integration, Connect SQL database to Power BI/Tableau, Real-time query execution in BI tools and Live BI dashboard from SQL data. **Assignment 7:** KPI Metrics and Visual Design, Creating KPIs: Revenue, Profit, Growth Rate, Build KPI tiles in Power BI and Dashboard with visual KPIs. **Assignment 8:** Advanced Charts and Interactions, Slicers, drill-downs, filters, Interactive sales performance dashboard and User-friendly analytical interface. **Assignment 9:** Present a dashboard to solve a business problem and Report with narrative insights. **Assignment 10:** Python Data Analysis - Importing, exploring, and cleaning datasets, Use Pandas for analysis and Summarize dataset with code. **Assignment 11:** Data Visualization with Python - Use Matplotlib and Seaborn for plots, Plot trends, correlations and insights from visualization. **Assignment 12:** Exporting Analysis to BI Tools, Export Python output to CSV,	**30**	CO3, CO4, CO5	K1, K2, K3, K4, K5

	Excel and Load into Power BI or Tableau. **Assignment 13:** Case Study – Retail Business, Analyze sales, customer data and Create BI report with recommendations. **Assignment 14 and 15:** Case Study – Marketing Analytics, Analyze campaign data (E-mail, Social, Conversions), Build dashboard for marketing team and Final Presentation of BI Project.			
Pedagogy:	Assignments, Practicals, Mini- Projects.			
Texts:	1. **Sharda, R., Delen, D., & Turban, E. (2024).** *Business Intelligence, Analytics, Data Science, and AI (5th ed., Global ed.). Pearson.* 2. **Loshin, D. (2013).** *Business intelligence: The savvy manager's guide*. Morgan Kaufmann.			
References/ Readings:	1. **Kimball, R., & Ross, M. (2013).** The data warehouse toolkit: The definitive guide to dimensional modeling. Wiley. 2. **Howson, C. (2013).** *Successful business intelligence: Unlock the value of BI & big data*. McGraw-Hill.			
Web Resources:	Coursera, Futurelearn			

Title of the Course	Database Systems
Course Code	BIT-5004
Number of Credits	2P
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	1. Equip students with practical knowledge of modern data management systems. 2. Provide hands-on experience in working with relational and non- relational databases. 3. Develop skills in data extraction, transformation and loading (ETL). 4. Introduce concepts of data warehousing, data modeling, and integration. 5. Ensure students understand data governance, metadata management, and data security best practices.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Design, manage, and query relational databases using SQL.	PSO1, PSO2, PSO3
	CO 2. Work with NoSQL databases like MongoDB for unstructured and semi- structured data.	PSO1, PSO2, PSO3
	CO 3. Develop and manage ETL workflows using industry-standard tools.	PSO2, PSO3, PSO4,

			PSO5, PSO8	
	CO 4. Build and query a data warehouse using appropriate schema models.		PSO2, PSO3, PSO4	
	CO 5. Clean, transform, and prepare data for analytics using SQL and Python.		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 6. Understand and apply data governance, quality control, and metadata principles.		PSO1, PSO2, PSO3, PSO4, PSO7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**List of Suggested Lab Assignments:** **Assignment 1:** Overview of structured/unstructured data, DBMS types, setup of lab tools (MySQL, PostgreSQL, MongoDB). **Assignment 2:** Creating databases, ER modeling, normalization, constraints (Tool: MySQL/PostgreSQL + DBeaver). **Assignment 3:** SQL Basics - Data definition and manipulation (CREATE, INSERT, SELECT, UPDATE, DELETE). **Assignment 4:** Joins, aggregate functions, nested queries, indexing, transactions. **Assignment 5:** Introduction to MongoDB, collections, documents, CRUD operations. **Assignment 6:** Schema design, indexing, aggregation framework in MongoDB. **Assignment 7:** Introduction ETL Tools Talend, Apache NiFi, Pentaho; use cases and tool installation. **Assignment 8:** Import data from files (CSV, Excel), APIs, and databases using ETL tools. **Assignment 9:** Data filtering, joining, data cleansing, type conversion in ETL tools. **Assignment 10:** Load data into relational databases or data warehouses; ETL job scheduling. **Assignment 11:** Handling missing values, duplicates, outliers using Python	**60**	CO1, CO2, CO3, CO4, CO5, CO6	K1, K2, K3, K4, K5, K6

	(Pandas) and SQL. **Assignment 12:** Introduction to Data Warehousing - fact/dimension tables, star/snowflake schemas, schema design exercise. **Assignment 13:** Overview of data lineage, metadata management, quality control, demo using Apache Atlas/Informatica. **Assignment 14 and 15:** Mini Project - End-to-End data pipeline project: data source, ETL, storage, basic analysis, Complete project; student presentations, code reviews, and evaluation.			
Pedagogy:	Practicals, Tutorials, Assignments Problem Solving,Mii-projects.			
Texts:	1. **Silberschatz, A., Korth, H. F., & Sudarshan, S. (2019).** *Database system concepts* (7th ed.). McGraw-Hill. 2. **Kimball, R., & Ross, M. (2013).** *The data warehouse toolkit: The definitive guide to dimensional modeling* (3rd ed.). Wiley. 3. **Bradshaw, S., Brazil, E., & Chodorow, K. (2025).** *MongoDB: The definitive guide* (3rd ed.). O'Reilly Media. 4. **McKinney, W. (2022).** *Python for data analysis: Data wrangling with pandas, NumPy, and Jupyter* (3rd ed.). O'Reilly Media. 5. **Sadalage, P. J., & Fowler, M. (2012).** *NoSQL distilled: A brief guide to the emerging world of polyglot persistence*. Addison-Wesley.			
References/ Readings:	1. **Côté, C., Lah, M., & Saitakhmetova, M. (2020). ETL with Azure Cookbook. Packt Publishing.** 2. **Karau, H., Konwinski, A., Wendell, P., & Zaharia, M. (2015).** *Learning Spark: Lightning-Fast Big Data Analysis*. O'Reilly Media.			
Web Resources:	Coursera, Futurelearn			

Title of the Course	Linear Programing Problems
Course Code	BIT-5005
Number of Credits	2P
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To introduce the concepts of convex sets and linear programming problems, and to enable students to formulate LPPs and identify various types of solutions such as basic, feasible, and optimum solutions. 2. To develop students' ability to apply the simplex method to solve linear programming problems and analyze conditions for optimality and feasibility. 3. To equip students with the understanding of duality in linear programming and the skills to perform post-optimality analysis for changes in problem parameters. 4. To enable students to formulate and solve transportation and assignment problems using linear programming techniques, and interpret their solutions.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Formulate linear programming problems and identify basic feasible and optimum	PSO1, PSO2

	solutions for given systems..			
	CO 2. Apply the simplex method to obtain and analyze optimal solutions to linear programming problems.		PSO1, PSO4	
	CO 3. Formulate dual problems and perform post-optimality analysis for linear programming models.		PSO4, PSO5	
	CO 4. Formulate and solve transportation and assignment problems using linear programming.		PSO3, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	● Study of convex sets and identification of extreme points using graphical examples. ● Formulating standard LPPs from word problems and identifying solution types. ● Solving LPPs graphically (2- variable problems).	12	CO1	K2
Module 2:	● Solving LPPs using the simplex method (Standard Form). ● Applying simplex method to problems with degenerate solutions. ● Solving LPPs with unbounded/infeasible cases using simplex method.	24	CO2	K2
Module 3:	● Formulation of the dual problem from a primal and verifying duality theorems. ● Post-optimality analysis: Changes in c_j (objective coefficients) and (RHS values).	12	CO3	K2
Module 4:	● Solving transportation problems using North-West Corner Rule, Least Cost, and Vogel's Approximation method. Solving assignment problems using the Hungarian method.	12	CO4	K2
Pedagogy:	• Practical lectures, seminars/term papers/assignments/presentations/self-study or combination of some of these can also be used. • Practicals to be carried using softwares such as Microsoft Excel Solver , TORA and similar softwares.			
Texts:	1. Kanti Swarup, P. K. Gupta and Man Mohan,			

	2. Operations Research, 5th Edition, Sultan Chand and sons, 2016
References/ Readings:	1. **G. Hadley,** Linear Programming, Narosa, 2002 2. **J. K. Sharma,** Operations Research: Theory and Applications, Macmillan India Limited 3. **P. K. Gupta and D. S. Hira,** Operations Research, S. Chand, 2019.

Discipline Specific Elective (DSE) Courses

Title of the Course	Python for Data Analytics
Course Code	BIT-5201
Number of Credits	4T
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	1. Introduce students to the Python programming language in the context of business intelligence and data analytics. 2. Enable data ingestion, transformation, and manipulation using Python libraries such as Pandas and NumPy. 3. Train students in visualizing and interpreting business data for actionable insights. 4. Develop students' ability to apply statistical techniques to real-world business problems using Python. 5. Prepare students to build data-driven dashboards, reports, and predictive models for strategic business decision-making.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Demonstrate proficiency in Python programming for business applications.	PSO1, PSO2, PSO3

	CO 2. Analyze, clean, and preprocess structured data using Python libraries.		PSO1, PSO2	
	CO 3. Create meaningful visualizations to explore and explain business data.		PSO5	
	CO 4. Apply statistical and analytical models to identify business trends and patterns.		PSO7, PSO8	
	CO 5. Design and implement basic business intelligence workflows using Python.		PSO1, PSO3, PSO4, PSO5, PSO6, PSO7, PSO8	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Python Programming for Business Analytics** Introduction to Python in the context of Business Intelligence, Python setup (Anaconda, Jupyter Notebook, Google Colab), Variables, data types, and input/output, Control structures: loops, conditional statements, Functions, modules, and importing business logic libraries, File handling: reading/writing CSV, Excel, and JSON, Working with Date and Time in business datasets, Use Case: Automating payroll processing or sales invoicing.	**12**	CO1	K2
Module 2:	**Data Manipulation and Business Data Structures** Introduction to NumPy: arrays, indexing, operations for business calculations,Pandas for data ingestion, transformation, and export, Handling missing and duplicate data, Grouping, filtering, sorting, and merging datasets, Applying business rules through lambda and apply functions, Exploratory Data Analysis (EDA) using Pandas, Time-series data handling in business contexts, Case Study: Sales performance and customer segmentation	**12**	CO2	K2
Module 3:	**Data Visualization and Business Intelligence Tools in Python** Data visualization using Matplotlib and Seaborn, Creating business-focused charts: bar, pie, line, scatter, histograms Visualizing KPI metrics and trends, Dashboards using Plotly or Streamlit (basic), Descriptive statistics: mean, median, mode, variance, standard deviation, Correlation, regression, and forecasting techniques, Case Study:	**12**	CO3, CO4	K2

	Customer churn analysis or inventory trend forecasting.			
Module 4:	**Assignment 1:** Write Python programs using decision structures for business logic (e.g., discounting). **Assignment 2:** Create and manipulate business datasets using NumPy arrays. **Assignment 3:** Load and clean a real-world business CSV file using Pandas. **Assignment 4:** Merge multiple data sources (sales + customer) into one structured dataset. **Assignment 5:** Perform exploratory data analysis on sales/marketing datasets. **Assignment 6:** Group and aggregate sales data by region, product, and time. **Assignment 7:** Detect and treat missing or outlier values in business data. **Assignment 8:** Detect and treat missing or outlier values in business data. **Assignment 9:** Plot market trends using line charts and scatter plots in Seaborn. **Assignment 10:** Create a basic dashboard for sales or financial data using Plotly/Streamlit. **Assignment 11:** Calculate and interpret basic statistical measures on business data. **Assignment 12**: Build a simple linear regression model for forecasting sales. **Assignment 13:** Apply correlation analysis to identify influencing business factors. **Assignment 14:** Analyze time-series data (e.g., monthly sales trends). **Assignment 15:** Mini project: Perform end-to-end data analysis and report generation for a business dataset (retail, banking, or e-commerce).	**24**	CO1, CO2, CO3, CO4, CO5	K3, K4, K5, K6
Pedagogy:	Lectures, Tutorials, Seminars, Assignments, Presentations, Mini- Projects.			
Texts:	1. **McKinney, W. (2022).** *Python for data analysis: Data wrangling with pandas, NumPy, and Jupyter* (3rd ed.).			

	O'Reilly Media. 2. **Provost, F., & Fawcett, T. (2013).** *Data Science for Business: What you need to know about data mining and data-analytic thinking* (1st ed.). O'Reilly Media. 3. **Taddy, M. (2019).** *Business Data Science: Combining machine learning and economics to optimize, automate, and accelerate business decisions* (1st ed.). McGraw-Hill.
References/ Readings:	1. **Molin, S. (2021).** *Hands-On Data Analysis with Pandas: A Python data science handbook for data collection, wrangling, analysis, and visualization* (2nd ed.). Packt Publishing. 2. **Sharda, R., Delen, D., & Turban, E. (2024).** *Business Intelligence, Analytics, Data Science, and AI* (5th ed., Global ed.). Pearson.
Web Resources:	Coursera, Futurelearn

Title of the Course	Linear Algebra
Course Code	BIT-5202
Number of Credits	4T
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To perform elementary operations on matrices 2. To apply elementary matrices and equivalence. 3. To determine the rank of a matrix. 4. To analyze linear independence and to study vector spaces. 5. To apply concepts in business analytics, optimization, machine learning, and simulations.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Apply elementary operations on matrices, identify special matrices, and demonstrate understanding of their properties.	PSO1, PSO2, PSO3, PSO4
	CO 2. Determine the rank of a matrix using minors and elementary operations, and apply it to solve systems of linear equations.	PSO1, PSO2, PSO3, PSO4

	CO 3. Analyze the linear independence of row and column matrices, and understand the equivalence of different definitions of rank.		PSO1, PSO3, PSO4, PSO5	
	CO 4. Apply matrix theory to find characteristic values, diagonalize matrices, and verify the Cayley-Hamilton theorem.		PSO2, PSO3, PSO4	
	CO 5. Solve systems of linear equations using matrix methods such as Gauss Elimination, Gauss-Jacobi, and Gauss-Seidel.		PSO2, PSO3, PSO4	
	CO 6. Perform operations with vectors in R^n, determine linear combinations, and identify basis and dimension.		PSO2, PSO3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Elementary operations on a matrix: Types of matrices, Special matrices – Symmetric, Skew – Symmetric matrices, Conjugate of a matrix, Hermitian matrix, Nilpotent and Idempotent matrices; Properties/Results on each of these; Elementary matrices; Effects of multiplying by these on a matrix; Equivalence of matrices: Row/column equivalence; Echelon forms; Normal form.	**15**	CO1, CO2	K1, K2
Module 2:	Rank of a matrix: Definition using minors; Finding rank of a matrix using definition (upto 3x3 only); Theorem: Elementary operations do not change the rank of a matrix; Finding the rank using echelon forms; Linear Independence of Row and Column Matrices; Definition of rank of a matrix using independence of Row or column vectors; Equivalence of two definitions of Rank.	**15**	CO2, CO3	K2, K3, K4
Module 3:	Application of matrices: Existence of solutions of a system of linear equations using Rank method and their solution using Gauss Elimination, Gauss – Jacobi and Gauss – Seidel method; Characteristic Values of a Matrix; Caley – Hamilton Theorem; Diagonalisation of a matrix.	**15**	CO3, CO4	K2, K3, K4
Module 4:	Vectors in R^n: Operations with vectors in R^3 and generalization to R^n; Linear combinations; Linear dependence and independence; Basis and Dimension.	**15**	CO4, CO5, CO6	K3, K4, K5

Pedagogy:	Lectures, tutorials, group exercises, case discussions and project-based learning.
Texts:	1. H. Kishan, *A Textbook of Matrices*. New Delhi, India: Atlantic Publishers & Distributors, 2008. 2. G. Strang, *Linear Algebra and Its Applications*, 4th ed. Belmont, CA, USA: Cengage Learning, 2006.
References/ Readings:	1. S. Friedberg, A. Insel, and L. Spence, *Linear Algebra*, 5th ed. 2. S. Lipschutz and M. Lipson, *Schaum's Outline of Linear Algebra*, 6th ed. New York, NY, USA: McGraw Hill Professional, 2017. 3. W. K. Nicholson, *Linear Algebra with Applications*, 3rd ed. Boston, MA, USA: PWS Publishing Company, 1995. 4. S. Narayan and P. K. Mittal, *A Textbook of Matrices*. New Delhi, India: S. Chand Publishing, 2016.
Web Resources:	1. NPTEL, “Linear Algebra - Course.” Swayam - NPTEL. https://onlinecourses.nptel.ac.in/noc21_ma50/prev iew 2. UC Davis, "LINEAR ALGEBRA WEBSITES." UC Davis Mathematics. UC Davis

Title of the Course	E-Business Fundamentals
Course Code	BIT-5203
Number of Credits	4T
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	1. Understanding the foundations of e-business and e- commerce. 2. Exploring the e-business ecosystem and its components. 3. Developing an understanding of online business strategies. 4. Assessing e-commerce security and payment systems. 5. Understanding ethical, social, and legal aspects of e- business.	
Course Outcomes:		**Mapped to PSO**
	CO 1. To introduce the concept of E-Business and their different types	PSO1, PSO2, PSO3
	CO 2. To discuss the security aspects of E- Business	PSO1, PSO2, PSO3
	CO 3. To state all the online payment systems	PSO2, PSO3

	CO 4. To analyze the different marketing technologies available		PSO3	
	CO 5. To illustrate the cyber laws related to E- Business		PSO2, PSO3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Introduction to E- Business** ● E-Commerce – definition, History of E- commerce, types of E-Commerce B to B etc. ● Comparison of traditional commerce and e-commerce. E-Commerce business models –major B to B, B to C model, Consumer-to- Consumer (C2C), Consumer-to- Business (C2B) model, Peer to-Peer (P2P) model ● Emerging trends. Advantages/ Disadvantages of e- commerce, web auctions, virtual communities, portals, e-business revenue models	**06**	CO1	K1, K2
Module 2:	**Security For E- Business** • Introduction to E-business security • Foundational security technologies • Securing the e-business environment • Data protection & privacy • Building a security strategy • E- Commerce Communication channels • Security tools : SSL protocol, Firewalls, Cryptography methods, VPNs, protecting, networks, policies and procedures • Case Studies	**08**	CO2	K1,K2,K 3
Module 3:	**E- Payments Systems** ● Introduction to E-payments	**06**	CO3	K1,K2,K 3

	• Types of E-payment Systems • E-payment security and fraud prevention • Payment gateways and processing • Emerging trends and innovations • E-payment implementation & future outlook • Case Studies			
Module 4:	**E- Business Marketing Technologies** • E-Commerce and marketing, B to B and B to C marketing and branding strategies in E-Marketing . • Website & content management systems • Search engine optimization (SEO) • Social media marketing technologies • Email marketing & marketing automation • Emerging marketing technologies	**08**	CO3, CO4	K1,K2,K 3
Module 5:	**Cyber Laws** • Foundations of Cyber Law and the Digital Landscape • Legal Aspects of E- Business, • Internet frauds • Cyber Laws. • IT Act 2000 salient features. • Cybercrime and its Legal Implications	**08**	CO5	K1, K2
Module 6:	**Case Studies** **Session 1:** E-commerce Platform Exploration and Setup **Session 2:** Developing a B2C E-Commerce Business Plan **Session 3:** B2B E-commerce Scenario Analysis and Solution Development	**24**	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4

	Session 4: Web Auction Participation and Analysis **Session 5:** E-commerce Security Implementation and Assessment **Session 6:** E-Payment System Simulation and Troubleshooting **Session 7:** E-Commerce Marketing Campaign Development **Session 8**: Data Mining and Customer Insight Extraction from Web Logs **Session 9:** Cyber Law and Internet Fraud Scenario Analysis **Session 10:** Case Study Analysis and Presentation of E-commerce Successes and Failures			
Pedagogy:	Lectures, Tutorials, Seminars, Assignments, Presentations, Case-Studies, Mini- Projects.			
Texts:	1. G. Schneider, *E-Business*, 10th ed. New Delhi: Cengage Learning India, 2015. 2. M. Suman – E – Commerce & Accounting, 2017, 10 Edition: 3. R. Kalakota and A. B. Whinston, *Frontiers of Electronic Commerce*. Boston, MA, USA: Addison-Wesley, 1996.			
References/ Readings:	1. Watson R T :"Electronic Commerce – the strategic perspective." The Dryden press,2016 2. Agarwala K.N and Deeksha Ararwala: "Business on the Net – Whats and Hows of E-Commerce",2017 3. Agarwala and Agarwala : "Business on the Net – Bridge to the online store front," 2017 4. Murthy CSV: "E. Commerce" Himalaya Publishing House Pvt.Ltd,2016			
Web Resources:	"E-Business - Course - Swayam - NPTEL" by NPTEL "Best E-Commerce Courses & Certificates Online [2025]" by Coursera			

SEMESTER II

Discipline Specific Core (DSC) Courses

Title of the Course	Data Visualisation and Dashboards
Course Code	BIT-5006
Number of Credits	3T
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	1. Provide foundational knowledge in principles of data visualization. 2. Train students to use modern tools (e.g., Tableau, Power BI, Python, Excel) to create dashboards. 3. Enable students to design visual interfaces that convey key business insights clearly and effectively. 4. Enhance interpretation and storytelling skills using visual data. 5. Prepare students to build real-time, interactive dashboards for decision-making.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Apply principles of effective data visualization and dashboard design.	PSO1, PSO5

	CO 2. Use tools like Tableau, Power BI, and Python to create interactive visualizations.		PSO4, PSO8	
	CO 3. Identify appropriate chart types based on business data and context.		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 4. Create dynamic dashboards for various business domains.		PSO1, PSO2, PSO3, PSO4, PSO5, PSO6	
	CO 5. Communicate data-driven insights through visual storytelling.		PSO3, PSO4, PSO5, PSO7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Fundamentals of Data Visualization** Introduction to data visualization: Importance and applications in business, Types of data: categorical, numerical, time-series, geospatial, Principles of perception and cognition in visual design, Choosing the right chart: bar, line, pie, scatter, heatmaps, Common pitfalls and misleading visualizations, Data storytelling: framing business insights visually, Case Study: Analyzing sales trends with visual metaphors.	**15**	CO1, CO5	K2
Module 2:	**Tools and Techniques for Visualization** Introduction to visualization tools: Excel, Tableau, Power BI, Python (Matplotlib/Seaborn/Plotly), Data preparation for visualization: filters, joins, groupings, Visualization best practices for KPIs, dashboards, reports, Charts and maps in Tableau/Power BI, Cross-filtering, hierarchies, and calculated fields, Connecting to multiple data sources (databases, Excel, cloud services), Case Study: Comparing Tableau and Power BI for executive dashboards	**15**	CO2, CO3	K2
Module 3:	**Designing and Building Dashboards** Components of a good dashboard: layout, interactivity, responsiveness, Strategic, analytical, and operational dashboards, Drill- downs and filters for user-driven exploration, Real-time dashboards with live data connections, Embedding dashboard in web apps or presentations, Introduction to web- based dashboard tools (e.g., Streamlit, Google Data Studio), Case Study: Design a sales and marketing campaign dashboard.	**15**	CO4	K3

Pedagogy:	Lectures, Tutorials, Seminars, Assignments, Presentations, Mini- Projects.
Texts:	1. **Knaflic, C. N. (2015).** *Storytelling with Data: A data visualization guide for business professionals*. Wiley. 2. **Murray, S. (2017).** *Interactive data visualization for the web* (2nd ed.). O'Reilly Media. 3. **Milligan, J. N. (2024).** *Learning Tableau* (6th ed.). Packt Publishing.
References/ Readings:	1. **Wexler, S., Shaffer, J., & Cotgreave, A. (2017).** *The big book of dashboards: Visualizing your data using real-world business scenarios*. Wiley. 2. **Healy, K. (2018).** *Data visualization: A practical introduction*. Princeton University Press.
Web Resources:	Coursera, Futurelearn

Title of the Course	Data Management
Course Code	BIT-5007
Number of Credits	3T
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To introduce foundational concepts in data management and their integration with Artificial Intelligence (AI) technologies. 2. To explore the application of AI techniques in data quality, processing, integration, and governance. 3. To equip with the ability to design intelligent data pipelines using open-source tools. 4. To implement real-world AI-driven data workflows for business intelligence and decision support.	
Course Outcomes:		**Mapped to PSO**
	Analyze and evaluate data management frameworks and recommend AI-based optimizations.	PSO1
	Apply machine learning and NLP techniques for data cleaning, integration and enrichment.	PSO1, PSO2, PSO3

	Develop intelligent data workflows using open- source tools like Python, Apache NiFi, and KNIME.		PSO3, PSO4	
	Create AI-driven dashboards and reporting systems to support business intelligence and strategic decisions.		PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Foundations of Data Management and AI in Business** Introduction to Data Management Concepts, Data Lifecycle and Data Architecture, Introduction to AI in Data Management, Data Warehouses, Data Lakes, and Lakehouses, Data Governance and Compliance, Metadata Management and Semantic Data, Cloud- native Data Storage Solutions, Applications of Industry use-case: AI-powered data cataloging in E-commerce	**15**	CO1	K2
Module 2:	**AI Techniques for Data Processing, Enrichment, and Integration** Introduction to Machine Learning for Data Processing, Natural Language Processing (NLP) for Text Data, Data Pre-processing and Feature Engineering, Automated Data Cleaning with AI, AI for Data Transformation and Normalization, Semantic Web and Knowledge Graphs, Data Augmentation Techniques, Building AI-Driven ETL Pipelines, Scalable Data Integration Techniques.	**15**	CO2	K3
Module 3:	**AI for Business Intelligence and Decision Support** Overview of Business Intelligence and Decision Support, BI Tools and Architectures, Natural Language Generation (NLG) in BI Reporting, Explainable AI (XAI) in Business Contexts, Real-Time Analytics and Stream Processing, AI-Enhanced Decision Support Systems.	**15**	CO4	K2, K3, K4
Pedagogy:	Lectures, Tutorials, Seminars, Assignments, Presentations, Mini- Projects.			
Texts:	1. **Provost, F., & Fawcett, T. (2013).** *Data science for business: What you need to know about data mining and data-analytic thinking* (1st ed.). O'Reilly Media. 2. **Kleppmann, M., & Riccomini, C. (2024).** *Designing data-intensive applications: The big ideas behind reliable, scalable, and maintainable systems* (2nd ed.). O'Reilly Media.			

	3. **Géron, A. (2022).** *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems* (3rd ed.). O'Reilly Media.
References/ Readings:	1. **Reis, J., & Housley, M. (2022). Fundamentals of data engineering: Plan and build robust data systems. O'Reilly Media.** 2. **Minelli, M., Chambers, M., & Dhiraj, A. (2022).** *Big data, big analytics: Emerging business intelligence and analytics trends for today's businesses*. Wiley.
Web Resources:	1. OpenRefine Docs: https://openrefine.org 2. KNIME Documentation: https://www.knime.com/ 3. Great Expectations: https://greatexpectations.io/ 4. Apache NiFi User Guide: https://nifi.apache.org/docs.html

Title of the Course	Ethical Principles in Business Analytics
Course Code	BIT-5008
Number of Credits	4T
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	1. Understand the foundational concepts of data and its role in business intelligence. 2. Explore the principles and challenges of data privacy and data security. 3. Analyse the ethical considerations in data handling, sharing, and usage. 4. Evaluate the importance of intellectual property rights and ethical compliance in the digital economy. 5. Apply ethical reasoning to real-world business intelligence scenarios.	
Course Outcomes:		**Mapped to PSO**
	Explain the ethical dimensions of data-driven decision-making.	PSO1, PSO2, PSO3, PSO4
	Identify privacy and security risks in data systems used in business intelligence.	PSO1, PSO2, PSO3, PSO4
	Assess ethical issues in data collection, processing, and storage.	PSO1, PSO3, PSO4, PSO5

	Apply data ethics principles to ensure compliance and integrity in BI systems.		PSO2, PSO3, PSO4	
	Understand legal frameworks, including IPR, influencing business analytics.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Understanding Data in Business Intelligence** Introduction to Data: Definitions and Types Structured, Semi-Structured, and Unstructured Data Data Lifecycle in Business Intelligence Data as an Organisational Asset Data Collection Techniques in Business Settings Metadata and Data Contextualisation Data Aggregation and Warehousing Data Quality and Reliability in BI Ethical Considerations in Data Representation	**15**	CO1, CO3	K1, K2, K3, K4
Module 2:	**Data Privacy Principles and Challenges** Fundamentals of Data Privacy Personally Identifiable Information (PII) and Privacy Risks Principles of Data Minimisation and Consent Privacy by Design and by Default GDPR and Other Global Privacy Frameworks Organisational Compliance with Privacy Standards Ethical Issues in Data Sharing Privacy vs Innovation in Business Intelligence Tools and Techniques for Ensuring Privacy	**15**	CO2, CO4	K2, K3, K4
Module 3:	**Data Security and Confidentiality in BI** Introduction to Data Security Concepts Threats to Data Integrity and Availability Confidentiality in Business Intelligence Systems Cryptographic Techniques and Access Control Cybersecurity Policies in BI Environments Role of AI in Data Protection Security vs Usability in Business Systems Regulatory Compliance and Auditing Risk Assessment and Ethical Response Planning	**15**	CO2, CO4	K2, K3, K4, K5

Module 4:	**Data Ethics and Intellectual Property** Introduction to Data Ethics Moral Philosophy and Ethics in Data Usage Bias, Discrimination and Fairness in Data Handling Stakeholders and Ethical Accountability Ethical Decision-Making Frameworks Introduction to Intellectual Property Rights (IPR) Copyright, Patents, and Trademarks in Data Context Data Ownership and Licensing Models Ethics of Open Data and Free Access	**15**	CO1, CO3, CO5	K2, K3, K4, K5
Pedagogy:	Mostly lectures, tutorials and practicals, seminars/term papers/assignments/presentations/self-study or combination of some of these can also be used. ICT mode to be preferred.			
Texts:	**Shukla, S., George, J. P., Tiwari, K., & Kureethara, J. V.** (2022). *Data ethics and challenges*. Springer Nature (SpringerBriefs in Applied Sciences and Technology			
References/ Readings:	1. **Martin, K.** (2022). *Ethics of data and analytics: Concepts and cases*. Auerbach Publications/CRC Press. 2. **Lane, J., Stodden, V., Bender, S., & Nissenbaum, H.** (Eds.). (2014). *Privacy, big data, and the public good: Frameworks for engagement*. Cambridge University Press.			

Title of the Course	Applied Statistics
Course Code	BIT-5009
Number of Credits	3T
Theory/Practical	Theory
Level	500
Effective from AY	2025- 26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	To make students aware of various statistical methods that can be employed in data analysis, hypothesis testing and research	
Course Outcomes:		**Mapped to PSO**
	CO 1. Interpret and compute correlation and regression coefficients including Karl Pearson's and Spearman's rank correlation to analyze relationships between variables.	PSO1, PSO3, PSO2
	CO 2. Apply bivariate regression models to predict outcomes and interpret regression coefficients meaningfully in real-world contexts.	PSO1, PSO4, PSO5, PSO7
	CO 3. Formulate and test statistical hypotheses using interval estimation and large-	PSO2, PSO3, PSO5

	sample tests for attributes and variables.			
	CO 4. Perform parametric tests such as the t-test and ANOVA to compare group means and assess statistical significance.		PSO3, PSO4, PSO6	
	CO 5. Employ non-parametric tests to analyze data that do not meet parametric assumptions.		PSO1, PSO7, PSO8	
	CO 6. Use statistical software tools such as R, SPSS, or PSPP to carry out statistical analyses including hypothesis testing, correlation, regression, and interpretation of output.		PSO2, PSO5, PSO7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Correlation and Regression Analysis** ● Karl Pearson's coefficient of correlation ● Spearman's rank correlation ● Bivariate regression analysis	**15**	CO1, CO2, CO6	K1, K3, K4
Module 2:	**Testing of Hypothesis** ● Interval estimation, testing of hypothesis ● Large sample tests: sampling of attributes and variables	**10**	CO3, CO6	K2, K4
Module 3:	**Parametric tests** ● Student's t test: Independent test paired t- test ● ANOVA: one way, two way	**10**	CO4, CO6	K3, K4, K5
Module 4:	**Non-parametric tests** ● Chi-square test ● Kruskal Wallis test ● Mann-Whitney test	**10**	CO5, CO6	K1, K2, K4
Pedagogy:	Lectures/Case study/practicals			

Texts:	S. C. Gupta: *Fundamentals of Statistics*, 7th Edition, Himalaya Publishing House, 2018.
References/ Readings:	1. M. Goon, M. K. Gupta, and B. Dasgupta: *Fundamentals of Statistics, Vol. I*, 8th Edition, The World Press, Kolkata, 2016. 2. S. C. Gupta, and V. K. Kapoor: *Fundamentals of Mathematical Statistics*, 12th Edition, S. Chand and Sons, Delhi, 2020. 3. S. P. Gupta: *Statistical Methods*, S. Chand & Sons, 2017. 4. S. Bernstein, and R. Bernstein: *Schaum's Outlines: Elements of Statistics I – Descriptive Statistics and Probability*, McGraw Hill, 2020
Web Resources:	https://dishtavo.dhe.goa.gov.in/course_details_tab.php

Title of the Course	Dashboard Design and Development
Course Code	BIT-5010
Number of Credits	1P
Theory/Practical	Practical
Level	500
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:		
Course Outcomes:		**Mapped to PSO**
	CO 1. Use tools like Tableau, Power BI, and Python to create interactive visualizations.	PSO4, PSO8
	CO 2. Identify appropriate chart types based on business data and context.	PSO1, PSO2, PSO3, PSO4, PSO5
	CO 3. Create dynamic dashboards for various business domains.	PSO1, PSO2, PSO3, PSO4, PSO5, PSO6
	CO 4. Communicate data-driven insights through visual storytelling.	PSO3, PSO4, PSO5,

			PSO7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**List of Suggested Lab Assignments:** **Assignment 1:** Create basic charts (bar, line, pie) using Excel or Google Sheets. **Assignment 2:** Clean and transform a dataset for visualization (Power BI) **Assignment 3:** Build a KPI summary dashboard using Excel. **Assignment 4:** Create a multi-chart dashboard in Tableau using sales data. **Assignment 5:** Connect Power BI to a SQL database and visualize real-time data. **Assignment 6:** Use calculated fields and filters in Tableau to compare product performance. **Assignment 7:** Build a time-series trend visualization in Power BI. **Assignment 8:** Create a customer segmentation dashboard using demographic data. **Assignment 9:** Visualize geospatial data (store locations, sales by region) using maps. **Assignment 10:** Design an HR dashboard to track hiring, attrition, and diversity metrics. **Assignment 11:** Create interactive dashboards using Python and Streamlit. **Assignment 12:** Use Python Plotly to build drill- down charts for financial data. **Assignment 13:** Combine Excel data with online API data in Power BI. **Assignment 14:** Create a dashboard for real- time social media analytics. **Assignment 15:** Design and present a fully functional, interactive business dashboard on any domain.	**30**	CO1, CO2, CO3, CO4, CO5	K3, K4, K5, K6
Pedagogy:	Tutorials, Practicals, Assignments, Presentations, Mini- Projects.			
Texts:	1. **Knaflic, C. N. (2015).** *Storytelling with Data: A data visualization guide for business professionals*. Wiley.			

	2. **Murray, S. (2017).** *Interactive data visualization for the web* (2nd ed.). O'Reilly Media. 3. **Milligan, J. N. (2024).** *Learning Tableau* (6th ed.). Packt Publishing.
References/ Readings:	1. **Wexler, S., Shaffer, J., & Cotgreave, A. (2017).** *The big book of dashboards: Visualizing your data using real-world business scenarios*. Wiley. 2. **Healy, K. (2018).** *Data visualization: A practical introduction*. Princeton University Press.
Web Resources:	Coursera, Futurelearn

Title of the Course	Data Science Workflow Tools
Course Code	BIT-5011
Number of Credits	1P
Theory/Practical	Practical
Level	500
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To introduce foundational concepts in data management and their integration with Artificial Intelligence (AI) technologies. 2. To explore the application of AI techniques in data quality, processing, integration, and governance. 3. To equip with the ability to design intelligent data pipelines using open-source tools. 4. To implement real-world AI-driven data workflows for business intelligence and decision support.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Analyze and evaluate data management frameworks and recommend AI-based optimizations.	PSO1
	CO 2. Apply machine learning and NLP techniques for data cleaning, integration and enrichment.	PSO1, PSO2, PSO3

	CO 3. Develop intelligent data workflows using open- source tools like Python, Apache NiFi, and KNIME.		PSO3, PSO4	
	CO 4. Create AI-driven dashboards and reporting systems to support business intelligence and strategic decisions.		PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**List of Suggested Lab Assignments:** **Assignment 1:** Install and configure Python, Jupyter, and KNIME for Data Pipelines. **Assignment 2:** Data ingestion from CSV, APIs, and JSON using Python and Apache NiFi. **Assignment 3:** Data profiling and quality analysis using OpenRefine. **Assignment 4:** Data cleaning using Pandas and Scikit-learn. **Assignment 5:** Feature engineering and missing value imputation. **Assignment 6:** Text preprocessing using NLP libraries (spaCy/NLTK) **Assignment 7:** Classification of text data using Scikit-learn. **Assignment 8:** Clustering with K-means for market segmentation. **Assignment 9:** Building an ML-based anomaly detector. **Assignment 10:** Forecasting using ARIMA or Prophet. **Assignment 11:** Creating interactive dashboards in PowerBI. **Assignment 12:** Implementing Explainable AI (XAI) with LIME/SHAP. **Assignment 13:** Automating data workflows using KNIME or RapidMiner. **Assignment 14:** Building and querying a knowledge graph using Neo4j. **Assignment 15: Project** - End-to-End AI- Powered Data Pipeline	**30**	CO1, CO2, CO3, CO4	K3, K4, K5, K6
Pedagogy:	Tutorials, Practicals, Assignments, Presentations, Mini- Projects.			
Texts:	1. **Provost, F., & Fawcett, T. (2013).** *Data science for business: What you need to know about data mining and data-analytic thinking* (1st ed.). O'Reilly Media.			

	2. **Kleppmann, M., & Riccomini, C. (2024).** *Designing data-intensive applications: The big ideas behind reliable, scalable, and maintainable systems* (2nd ed.). O'Reilly Media. 3. **Géron, A. (2022).** *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems* (3rd ed.). O'Reilly Media.
References/ Readings:	1. **Reis, J., & Housley, M. (2022).** *Fundamentals of data engineering: Plan and build robust data systems*. O'Reilly Media. 2. **Minelli, M., Chambers, M., & Dhiraj, A. (2022).** *Big data, big analytics: Emerging business intelligence and analytics trends for today's businesses*. Wiley.
Web Resources:	1. OpenRefine Docs: https://openrefine.org 2. KNIME Documentation: https://www.knime.com/ 3. Great Expectations: https://greatexpectations.io/ 4. Apache NiFi User Guide: https://nifi.apache.org/docs.html

Title of the Course	Statistical Methods for Data Analysis
Course Code	BIT-5012
Number of Credits	1P
Theory/Practical	Practical
Level	500
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	To make students aware of various statistical methods that can be employed in data analysis, hypothesis testing and research	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO 1. Interpret and compute correlation and regression coefficients including Karl Pearson's and Spearman's rank correlation to analyze relationships between variables.	PSO1, PSO3, PSO2
	CO 2. Apply bivariate regression models to predict outcomes and interpret regression coefficients meaningfully in real-world contexts.	PSO1, PSO4, PSO5, PSO7
	CO 3. Formulate and test statistical hypotheses using interval estimation and large- sample tests for attributes and variables.	PSO2, PSO3, PSO5
	CO 4. Perform parametric tests such as the t-test and ANOVA to compare group means and	PSO3, PSO4, PSO6

	assess statistical significance.			
	CO 5. Employ non-parametric tests to analyze data that do not meet parametric assumptions.		PSO1, PSO7, PSO8	
	CO 6. Use statistical software tools such as R, SPSS, or PSPP to carry out statistical analyses including hypothesis testing, correlation, regression, and interpretation of output.		PSO2, PSO5, PSO7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**List of Assignments:** Here is a concise overview of the provided statistical analysis topics: 1. **Correlation Analysis** o **Purpose:** Measures the strength and direction (positive or negative) of a linear relationship between two variables. 2. **Regression Analysis** o **Purpose:** Predicts the value of a dependent variable based on one or more independent variables and describes the nature and strength of that relationship. 3. **Testing Hypothesis for Single Mean** o **Purpose:** Determines if a sample mean significantly differs from a known or hypothesized population mean. 4. **Testing Hypothesis for Difference of Means** o **Purpose:** Determines if there is a statistically significant difference between the means of two independent groups or two related groups. 5. **ANOVA (Analysis of Variance)** o **Purpose:** Compares the means of three or more groups to determine if at least one group mean is significantly different. 6. **Chi-square test (X^2 Test)** o **Purpose:** Used for categorical data to test for association between two	**30**	CO1, CO2, CO3, CO4, CO5, CO6	K1, K2, K3, K4, K5

	variables (independence) or to determine if observed frequencies match expected frequencies (goodness of fit). 7. **Kruskal-Wallis test** o **Purpose:** A non-parametric test comparing the central tendencies of three or more independent groups when the assumptions for ANOVA (e.g., normality) are not met. 8. **Mann-Whitney U test** o **Purpose:** A non-parametric test comparing the central tendencies of two independent groups; an alternative to the independent t-test when normality or equal variance assumptions are violated.			
Pedagogy:	Case studies and Practicals			
Texts:	S. C. Gupta: *Fundamentals of Statistics*, 7th Edition, Himalaya Publishing House, 2018.			
References/ Readings:	1. M. Goon, M. K. Gupta, and B. Dasgupta: *Fundamentals of Statistics, Vol. I*, 8th Edition, The World Press, Kolkata, 2016. 2. S. C. Gupta, and V. K. Kapoor: *Fundamentals of Mathematical Statistics*, 12th Edition, S. Chand and Sons, Delhi, 2020. 3. S. P. Gupta: *Statistical Methods*, S. Chand & Sons, 2017 4. S. Bernstein, and R. Bernstein: *Schaum's Outlines: Elements of Statistics I – Descriptive Statistics and Probability*, McGraw Hill, 2020			
Web Resources:	https://dishtavo.dhe.goa.gov.in/course_details_tab.php			

Discipline Specific Elective (DSE) Courses

Title of the Course	Generative AI
Course Code	BIT-5204
Number of Credits	2P
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil
Course Objectives:	1. Understand and articulate the fundamental concepts, capabilities, and limitations of various generative AI models. 2. Apply practical skills to generate diverse forms of content, including text, images, and code, using leading generative AI tools and platforms. 3. Implement advanced techniques such as Retrieval Augmented Generation (RAG) and model fine-tuning to enhance the performance and applicability of generative AI solutions. 4. Evaluate and address the ethical implications and responsible deployment considerations associated with generative AI technologies. 5. Design and conceptualize practical, real-world generative AI solutions to address specific problems and creative challenges.

Course Outcomes:			**Mapped to PSO**	
	CO 1. Generate diverse textual content and basic images by effectively applying prompt engineering principles to large language models and text-to-image tools.		PSO1, PSO2, PSO3, PSO4	
	CO 2. Apply advanced generative AI techniques for image manipulation and enhance the knowledge and capabilities of large language models through Retrieval Augmented Generation (RAG) and basic fine-tuning.		PSO1, PSO2, PSO3	
	CO 3. Design practical generative AI solutions for varied applications, including code and multimedia content, while critically evaluating and addressing associated ethical implications.		PSO1, PSO2, PSO3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Prompt Engineering & AI Content Creation** • Mastering Text Generation: Prompt Engineering for LLMs • Creative Writing with AI: From Story Ideas to Drafts • AI for Content Creation: Emails, Summaries & Social Media Posts • Image Generation Basics: Text-to-Image with Open- Source Tools	**20**	CO1	K3, K4, K5, K6
Module 2:	**Generative AI and Retrieval Augmented Generation** • Image Editing & Style Transfer with Generative AI • Introduction to Generative AI for Code: Code Completion & Generation • Retrieval Augmented Generation (RAG): Enhancing LLM Knowledge • Fine-Tuning a Small Language Model for Specific Tasks	**20**	CO2	K3, K4, K5, K6
Module 3:	**Building with Generative AI** • Building a Simple Chatbot with Generative AI • Exploring Audio & Video Generation • Ethical Considerations & Responsible AI in Generative Models	**20**	CO3	K3, K4, K5, K6

Pedagogy:	Lab Exercises, Problem-Based Learning.
Texts:	**Bhat, H.** (2023, September 1). *Demystifying prompt engineering: AI prompts at your fingertips (A step-by-step guide)*. Harish Bhat.
References/ Readings:	**Zhu, A. (Shudong), & Fisher, M.** (2024). *Using Stable Diffusion with Python: Leverage Python to control and automate high-quality AI image generation using Stable Diffusion* (1st ed.). Packt Publishing.
Web Resources:	1. OpenAI, "Developer quickstart." OpenAI 2. Google AI for Developers, "Gemini API reference." Google AI for Developers

Title of the Course	Cloud Computing
Course Code	BIT-5205
Number of Credits	2P
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	1. Introduce students to the principles of cloud computing using open-source tools. 2. Develop hands-on skills in deploying and managing cloud infrastructure using open-source platforms. 3. Enable students to build, monitor, and scale applications using open-source IaaS, PaaS, and storage systems. 4. Equip students with the ability to integrate open-source cloud tools with business intelligence workflows. 5. Promote best practices in containerization, orchestration, and cloud-native development in a BI context.	
Course Outcomes:		**Mapped to PSO**
	Install, configure, and manage private cloud environments using open-source platforms such as OpenStack or Apache CloudStack.	PSO6
	Use open-source tools like Docker, Kubernetes, and MinIO to deploy cloud-native services.	PSO1, PSO2, PSO3

	Implement storage, computing, and network services using open-source IaaS and PaaS tools.		PSO1, PSO3, PSO6	
	Integrate open-source cloud tools with BI platforms.		PSO1, PSO3, PSO5, PSO6	
	Build end-to-end open-source cloud-based data pipelines and applications for business analytics.		PSO1, PSO2, PSO3, PSO4, PSO5, PSO7, PSO8	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Practical Work (Hands-On)** **Experiment 1:** Install and configure OpenStack (DevStack/MicroStack) on Linux for private cloud setup. **Experiment 2:** Create virtual machines and manage instances in OpenStack. **Experiment 3:** Set up Apache CloudStack and deploy a cloud VM. **Experiment 4:** Install and run containers using Docker (business apps or microservices). **Experiment 5:** Build and deploy a multi- container app using Docker Compose (e.g., BI dashboard and DB) **Experiment 6:** Set up a local Kubernetes cluster using Minikube and deploy containerized apps. **Experiment 7:** Configure MinIO for S3- compatible cloud object storage and integrate it with BI tools. **Experiment 8:** Deploy Nextcloud for secure file sharing and collaboration in a business context. **Experiment 9:** Monitor container and server performance using Prometheus and Grafana. **Experiment 10:** Set up a PostgreSQL database in Docker and connect it to a BI tool (Superset/Metabase) **Experiment 11:** Install and configure Apache Superset or Metabase for	**60**	CO1, CO2, CO3, CO4, CO5	K3, K4, K5, K6

	interactive dashboards. **Experiment 12:** Create a business intelligence pipeline using ETL tools and open-source cloud storage. **Experiment 13:** Implement basic IAM roles and access controls in OpenStack or CloudStack. **Experiment 14:** Automate deployment with Terraform or Ansible in an open cloud environment. **Experiment 15:** Build a complete BI cloud stack (MinIO, PostgreSQL and Superset) hosted in Docker or Kubernetes.			
Pedagogy:	Assignments and Mini-Projects.			
Texts:	T. Erl, R. Puttini, and Z. Mahmood, *Cloud Computing: Concepts, Technology & Architecture*. Upper Saddle River, NJ, USA: Pearson Prentice Hall, 2013.			
References/ Readings:	1. T. Fifield et al., OpenStack Operations Guide. Sebastopol, CA, USA: O'Reilly Media, 2014. 2. K. Hightower, B. Burns, and J. Beda, Kubernetes Up & Running. Sebastopol, CA, USA: O'Reilly Media, 2017. 3. N. Poulton, Docker Deep Dive. [Publisher and location not explicitly stated in the prompt, assumed Leanpub as the platform]. Leanpub, 2017. 4. P. Kathiravelu, Learning Apache CloudStack. Birmingham, UK: Packt Publishing, 2014. 5. Turnbull, Monitoring with Prometheus. [Place of Publication]: Turnbull Press, 2018.			
Web Resources:	1. MinIO, "MinIO Documentation." MinIO. 2. Nextcloud, "Admin documentation." Nextcloud. 3. Apache Software Foundation, "Apache Superset." Apache Superset. 4. Metabase, "Metabase Docs." Metabase (accessed Aug. 14, 2025). 5. Prometheus, "Documentation." Prometheus. 6. Kubernetes, "Tutorials." Kubernetes.			

Title of the Course	Operations Research
Course Code	BIT-5206
Number of Credits	2P
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To understand the fundamental principles and methodologies of Operations Research. 2. To develop proficiency in formulating real-world problems as mathematical models, using techniques such as linear programming, integer programming, network models, and game theory. 3. Apply graphical methods to determine optimal strategies in games and interpret the results in the context of competitive scenarios.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO 1. Identify and model optimization problems in networks using techniques such as the Minimal Spanning Tree and Shortest Route algorithms, and express them using linear programming formulations.	PSO1, PSO3, PSO 2
	CO 2. Apply Maximal Flow algorithms and their LPP formulations to solve capacity-based network flow problems in transportation, communication, and supply chain networks	PSO1, PSO4, PSO5, PSO7

	CO 3. Analyze project scheduling problems using Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT), including forward pass, backward pass, float calculations, and probability- based analysis.		PSO 2, PSO 4, PSO 5	
	CO 4. Differentiate between deterministic and probabilistic project planning approaches, and use appropriate techniques to evaluate project duration and risk.		PSO 3, PSO 5, PSO 6	
	CO 5. Demonstrate the use of decision-support tools like TORA, Gambit, GTE, and Gantt Project for modeling, solving, and interpreting network and game theory problems in operational research.		PSO 1, PSO7, PSO 8	
	CO 6. Apply game theoretic and network models to real-world decision-making scenarios involving competition, cooperation, and uncertainty.		PSO3, PSO 5, PSO 7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Network Model:** 1) Minimal Spanning Tree Algorithm 2) Shortest Route Problem 3) LPP formation of Shortest Route Problem 4) Maximal Flow Model 5) LPP formation of Maximal Flow Model 6) Network Representation 7) Critical path analysis: forward pass, backward pass, floats, 8) Probability considerations in PERT 9) Deterministic Critical Path Method 10) Probabilistic Critical Path Method	**40**	CO1, CO2, CO3	K1, K3, K4
Module 2:	**Game Theory:** 1) Two persons zero sum games 2) 2 × 2 games without saddle point	**20**	CO5, CO6	K2, K4

	3) Graphical solution of $2 \times n$ games 4) Graphical solution of $m \times 2$ games 5) Dominance property			
Pedagogy:	Problem Solving, Case Studies, Assignments and Mini-Projects. Practical using **TORA/GanttProject/Gambit/GTE**.			
Texts:	H. A. Taha, *Operations Research: An Introduction*. Upper Saddle River, NJ, USA: Pearson Prentice Hall, 2011.			
References/ Readings:	1. K. Swarup, P. K. Gupta, and M. Mohan, *Operations Research*. New Delhi, India: Sultan Chand & Sons, 2018. 2. S. D. Sharma, *Operations Research*. Meerut, India: Kedar Nath Ram Nath & Company, 2012.			
Web Resources:	Directorate of Higher Education, Government of Goa, "Course Details." Dishtavo. https://dishtavo.dhe.goa.gov.in/course_details_tab.php			