OCS-401 **Python Programming**

Course category:	Open Elective (OE)
Pre-requisite Subject:	NIL
Contact hours/week:	Lecture: 2, Tutorial: 1, Practical: 0
Number of Credits:	3

Course Assessment methods:	Continuous Assessment through Two Tests, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance), and One Major Theory Examination.

Course Objective: It contains a basic introduction to familiarize students with the basics of Python Language. Here are the key objectives covered in this covered.

1. Build basic programs using fundamental programming constructs like variables, conditional logic, looping, and functions.
2. Work with user input to create fun and interactive programs.
3. Create simple games with images, animations, and audio using our custom beginner-friendly programming library

Course Outcomes: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. Able to apply the principles of python programming.
2. Write clear and effective python code.
3. Create applications using python programming.
4. Access database using python programming.
5. Develop web applications using python programming.
6. Develop and use Web Services using python.

UNIT-I **6L**

Introduction to Python Programming Language- Strengths and Weaknesses, IDLE, Dynamic Types, Naming Conventions, String Values, String Operations, String Slices, String Operators, Numeric Data Types, Conversions, Built in Functions.

Data Collections and Language Component-Introduction, Control Flow and Syntax, Indenting, if Statement, Relational Operators, Logical, Operators, True or False, Bit Wise Operators, while Loop, break and continue, for Loop, Lists, Tuples, Sets, Dictionaries, Sorting Dictionaries, Copying Collections.

UNIT-II **6L**

Object and Classes-Classes in Python, Principles of Object Orientation, Creating Classes, Instance Methods, File Organization, Special Methods, Class Variables, Inheritance, Polymorphism, Type Identification, Custom Exception Classes

UNIT-III **6L**

Functions and Modules-Introduction, Defining Own Functions, Parameters, Function Documentation, Keyword and Optional Parameters, Passing Collections to a Function, Variable Number of Arguments, Scope, Functions - "First Class Citizens", Passing Functions to a Function, Mapping Functions in a Dictionary, Lambda Modules, Standard Modules – sys, Standard Modules – math, Standard Modules – time, The dir Function

UNIT-IV

I/O and Error Handling in Python-Introduction, Data Streams, Creating Own Data Streams, Access Modes, Writing Data to a File, Reading Data from a File, Additional File Methods, Using Pipes as Data Streams, Handling IO Exceptions, Working with Directories, Metadata, Errors, Run Time Errors, The Exception Model, Exception Hierarchy, Handling Multiple Exceptions

EXPERIMENTS

1. Write python program to print "Hello World".
2. Write python program to Hello World using string variable
3. Write python program to store data in list and then try to print them.
4. Write python program to do basic trim and slice on string.
5. Write python program to print list of numbers using range and for loop
6. Write python program to store strings in list and then print them.
7. Write python program to let user enter some data in string and then verify data and print welcome to user.
8. Write python program in which a function is defined and calling that function prints Hello World
9. Write python program in which a function (with single string parameter) is defined and calling that function prints the string parameters given to function.
10. Write python program in which a class is define, then create it.

Textbooks:

1. Dive into Python, Mike
2. Learning Python, 4th Edition by Mark Lutz
3. Programming Python, 4th Edition by Mark Lutz

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Course Category: PC

Pre-requisite Subject NIL

Contact Hours/Week: Lecture: 3, Tutorial: 1 & Practical: 0 Number of Credits 4

Course Assessment Methods: Continuous Assessment through Two Tests, T Assessment (Quiz, Tutorial, Assignment, Attendance), and One Major Theory Examina

Course Objective: Students shall be able to know

1. The content with a general overview on the rail system & its specificiti stakeholders, the main rail functions to be protected against cyber-attacks and on signalling system considered as a main critical IT system within railway sys
2. The railway systems, an inventory of existing security technologies and proce well as standards and rail related normative which are available.

Course Outcomes: The students are expected to be able to demonstrate the fo knowledge, skills, and attitudes after completing this course.

1. The identification of the requirements for safety and security in railways, and v functions are acceptable to lose, and
2. The inventory of technologies and solutions available and already in place to p cyber-security of systems and data.

TOPIC COVERED

UNIT-I

Digital Train Control, Mission Critical Systems Resilience, Practical application s software tools, Timetabling, operational simulation, design, routing. Applica Information and Communication Technology (ICT) on Railways, Financial and Proc Gains, advancements are in fields of Security, Operations, Customer Services and a railway services.

UNIT-II

Rail system overview: Railway system stakeholders, Infrastructure manager, Ma Passenger operator, Interaction with other operators, Dependencies with external stake Interaction in public areas, Interactions in operational environment, Rail functi severity, Railway signalling

UNIT-III

Safety & Security Requirements: Definition of rail safety and security, Rai requirements, Rail security requirements, Requirements for staff, Operational staff Support staff, Administrators, Physical protection requirements, Access mana

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requirements, Identification and authentication requirements, Access management requirements, Registration and recording requirements, Integrity control requirements., Requirements for data storage devices, Software requirements, Intrusion detection requirements, Information security incidents response requirements, reliability requirements

Foundational Requirements: Identification and Authentication Control (IAC), Use Control (UC), System Integrity (SI), Data Confidentiality (DC), Restricted Data Flow (RDF), Timely Response to Events (TRE), Resource Availability (RA)

UNIT-IV 9L

Safety & Security Solutions:

Access Control: Authentication, Perimeter Protection, Cryptography, Encryption, Key Exchange, Digital Signatures, System Integrity, Antivirus, Audit and Monitoring, Intrusion Detection and Prevention Systems (IDPS), Physical Access,

Management: Network Management, Policies, State of the art of currently used solutions, Network Security, Technologies, Processes, People,

Signalling Security: Functional analysis, Continuity of the system, Deployment security, Other Railway Related Solutions, Relationship between Foundational Requirements & Cyber-security Technologies

TEXTBOOKS

1. Israel Koren and C. Mani. Krishna, "Fault Tolerant Systems", Elsevier.2007.
2. D. K. Pradhan, "Fault-Tolerant Computing, Theory and Techniques", Prentice-Hall, 1998. 98
3. P. Jalote, "Fault Tolerance in Distributed Systems", Prentice-Hall Inc. 1994.
4. Hoang Pham, "System Software Reliability", Springer 2006.
5. Elena Dubrova; Fault-Tolerant Design; Springer, 2013
6. Michael R. Lyu; Handbook of Software Reliability Engineering; IEEE Computer Society Press (and McGraw-Hill), 1996
7. Martin L. Shooman; Reliability of Computer Systems and Networks: Fault Tolerance, Analysis, and Design; John Wiley & Sons Inc., 2002
8. Kishor S. Trivedi; Probability and Statistics with Reliability, Queuing and Computer Science Applications; John Wiley & Sons Inc., 2016
9. Magdi S. Mahmoud, Yuanqing Xia, "Analysis and Synthesis of Fault-Tolerant Control Systems", John Wiley & Sons, 2014
10. Cyber-security Standards
11. M. Bartock, J. Cichonski, M. Souppaya, M. Smith, G. Witte, and K. Scarfone, "Guide for cybersecurity event recovery," Gaithersburg, MD, Dec. 2016.
12. Microsoft, "Secret Key Exchange," *Basic Components of Modern Cryptography*, 2017. [Online]. Available: https://technet.microsoft.com/en-us/library/cc962035.aspx.
13. K. A. Scarfone and P. M. Mell, "Guide to Intrusion Detection and Prevention Systems (IDPS)," Gaithersburg, MD, 2007.

OCS- 403 **Introduction to Artificial Intelligence**

Course category:	Open Elective (OE)
Pre-requisite Subject:	NIL
Contact hours/week:	Lecture: 2, Tutorial: 1, Practical: 0
Number of Credits:	3
Course Assessment methods:	Continuous assessment through (Quiz, Tutorial, Assignment, and Attendance), one minor theory exam and one major theory examination.

Course Objective: This course introduces the fundamentals of artificial intelligence. It contains a theory component about the concepts and principles that covers basic algorithms, methods and programming aspects.

Course Outcomes: The students will be able to understand and demonstrate the following knowledge, skills and attitudes after completing this course.

1. Theoverview and history of artificial intelligence, domains and applications.
2. An understanding of the foundation of artificial intelligence including problem solving, knowledge representation, reasoning, decision making, game playing and learning.
3. Methods of learning algorithms, evaluation matrices and implementation using python libraries.
4. Knowledge of agent-environment systems, decision support system and expert systems.
5. Application of real-world based on principles and techniques of intelligent systems.

Unit I **6L**

Definition of Artificial Intelligence (AI), History and evolution of AI, Domain and Mundane Tasks, Types of AI: Weak AI and Strong AI, ELIZA, Alice, Turing Test, Human Computer Interaction, Myths and misconceptions about AI,Applications trends of AI.

Unit II **6L**

Concepts: data, algorithms, models, Heuristic Approaches, Informed and Uninformed Search Algorithms, DFS, BFS, A, A* algorithms, Hill Climbing algorithm, Problem solving through AI Classical Water Jug Problem, Constrain Satisfaction Problem (CSP), Knowledge representation, State-space searching problem, basic of game playing and ply concepts.

Unit III **6L**

Machine Learning (ML): Regression, Logistic Regression KNN, SVM, K-means PCA, Naïve Bias, Artificial Neural Network, model performance evaluation (MAE, MSE, RMSE, R^2), Accuracy, Precision, Recall, F-1 Score, AUC/ROC, t-SNE, Data Analysis using python library: Plotly, numpy, pandas, matplotlib, seaboarn, sckit-learn. Role of data in AI systems, Agent-environment systems, Decision Support System, Expert Systems

Unit IV **6L**

AI in communication: chatbots, virtual assistants (e.g., Alexa, Siri), AI in healthcare, education, and agriculture, Smart cities and smart homes, AI in transportation and digital manufacturing, Ethical dilemmas in AI (bias, fairness, privacy), AI in decision-making: risks and accountabilityAI and global policy regulations, Sustainable AI and environmental impacts, Case study presentation on AI application in a chosen field.

Text and Reference Books

1. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, 4th Edition (2020), Publisher: Pearson.
2. Artificial Intelligence, Elaine Rich, Kevin Knight, and Shivashankar B. Nair, 3rd Edition, Publisher: Tata McGraw-Hill
3. Machine Learning, Tom M. Mitchell, 2nd edition, (2017), Publisher: McGraw-Hill
4. Artificial Intelligence: Structures and Strategies for Complex Problem Solving, George F. Luger, Publisher: Pearson
5. Hands-On Artificial Intelligence with Python, Anthony S. Williams, (2020), Artificial Intelligence with Python, 2nd Edition, 2020, Alberto Artasanchez, Prateek Joshi, Publisher: Packt

OCS- 404 **Big Data Analytics**

Course Category:	Open Elective (OE)
Pre-requisite Subject:	NIL
Contact Hours/ Week:	Lecture: 2, Tutorial: 1 Practical: 0
Number of Credits:	3
Course Assessment methods:	Continuous Assessment through Two Tests, Teacher Assessment (Quiz, Tutorial, and Assignment Attendance), and One Major Theory Examination.

Course Objectives: It contains a basic introduction to familiarize students with the basics of Big Data Analytic. Here are the key objectives covered in this covered.

1. Introduce the fundamentals of Big Data, its characteristics, types, and analytics techniques.
2. Explore Big Data technologies including Hadoop and its ecosystem components.
3. Impart knowledge on data processing, cleaning, and analysis using modern tools and frameworks.
4. Develop competency in data visualization, real-time analytics, and understanding ethical challenges in Big Data.

Course Outcomes: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. Understand the concept of Big Data and evaluate its implications in business and decision-making.
2. Describe the architecture and components of the Hadoop ecosystem, including core modules and related tools.
3. Perform Data Preprocessing and Analysis using Modern Tools
4. Develop Insightful Analytics Solutions using Visualization and Real-Time Tools.

Unit I **6L**

Introduction to Big Data and Analytics- Definition, Characteristics (Volume, Velocity, Variety, Veracity, and Value), Types of Data: Structured, Semi-Structured, and Unstructured, Introduction to Data Analytics: Descriptive, Predictive, and Prescriptive Analytics, Big Data Applications in Business, Healthcare, Finance, Retail, etc.

Unit II 6L

Big Data Technologies and Hadoop- Introduction to Hadoop Ecosystem, The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and . Iadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

Unit III 6L

Data Processing and Analysis-Introduction to Apache Spark and Spark SQL, Data Preprocessing and Cleaning Techniques, Exploratory Data Analysis (EDA), Introduction to NoSQL databases, Types of NoSQL databases: Document, Key-Value, Column, Graph, Data Processing with Apache Pig.

Unit IV 6L

Advanced Analytics and Tools-Data Visualization Tools: Tableau, Power BI, and Python Libraries (Matplotlib, Seaborn), Real-Time Analytics with Kafka and Storm (overview), Case Studies: Business Intelligence, Fraud Detection, Social Media Analytics, Ethical Issues and Challenges in Big Data Analytics.

EXPERIMENTS:

1. Work with examples of structured, semi-structured, and unstructured data to understand how they are stored and used.
2. Use a real-world dataset (like business or healthcare data) and try different types of analytics: descriptive, predictive, and prescriptive.
3. Install Hadoop on your system and try basic file commands using the Hadoop Distributed File System (HDFS).
4. Bring data from external sources into Hadoop using tools like Flume (for logs) and Sqoop (for databases), and store it in HDFS.
5. Learn how to compress and serialize data using Avro in Hadoop and see how it helps in saving storage.
6. Use Apache Spark to clean and prepare a large dataset by fixing missing values, removing errors, and organizing the data.
7. Use Spark SQL to explore and find patterns in a dataset, like sales data from a retail company.
8. Try out basic Create, Read, Update, and Delete (CRUD) operations in a NoSQL database like MongoDB and compare how different NoSQL types work.
9. Use tools like Tableau or Power BI to create charts and dashboards using data from social media or other platforms.
10. Simulate live data (like sensor data or logs), and process it in real-time using Apache Kafka and Storm.

Text Books:

1. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley.
2. Eric Sammer, "Hadoop Operations", O'Reilley.
3. Sadalage, Pramod J. "NoSQL distilled", 2013.

References:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press.
3. Bill Franks, Taming the Big Data Tidal wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & Sons.
4. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley
5. David Dietrich, Barry Heller, Beibei Yang, "Data Science and Big Data Analytics", EMC Education Series, John Wiley
6. Frank J Ohlhorst, "Big Data Analytics: Turning Big Data into Big Money", Wiley and SAS Business Series
7. Colleen Mccue, "Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis", Elsevier
8. Michael Berthold, David J. Hand," Intelligent Data Analysis", Springer
9. Paul Zikopoulos, Chris Eaton, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGraw Hill
10. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer

OCS-405 **Introduction to Data Science**

Course Category:	Open Elective (OE)
Pre-requisite Subject:	NIL
Contact Hours/Week	Lecture: 2, Tutorial: 1, Practical: 0
Number of Credits:	3
Course Assessment Methods:	Continuous Assessment (Assignments, Quizzes, Tutorials, Minor Test), and One Major Theory Examination.

Course Objectives:

1. To introduce basic concepts and applications of data science
2. To provide hands-on practice in data handling and Python-based analysis
3. To build foundations in statistics, algebra, and simple machine learning
4. To promote ethical awareness in data usage and communication

Course Outcomes:

1. Understand data collection, preparation, and storage techniques
2. Perform data analysis and visualization using Python tools
3. Apply basic statistical and algebraic techniques in data modeling
4. Evaluate simple ML models and interpret data insights ethically

UNIT-I

Introduction to data science: types of data, applications across domains, and data science workflow. Python basics: variables, data types, loops, conditionals, functions, and introduction to data science libraries (NumPy, Pandas, Matplotlib).

UNIT-II

Working with datasets: reading, cleaning, and summarizing data using Pandas. Descriptive statistics, handling missing values, visual exploration using histograms, boxplots, and scatter plots. Deriving insights from real-world data.

UNIT-III

Understanding features and labels: basics of feature generation and importance. Visualizing data using Matplotlib and Seaborn. Best practices for effective graphs. Introduction to ethical issues: data privacy, consent, and fairness.

UNIT-IV

Linear algebra: vectors, matrices, projections, pseudo-inverse. Statistics: probability, mean, variance, distributions, covariance, hypothesis testing. Simple and multivariate linear regression, logistic regression, k-NN, and k-means clustering.

EXPERIMENTS

1. Write a Python program to accept marks of five subjects from the user and calculate the average.