Vivekanand Education Society's
College of Arts, Science & Commerce
(Autonomous)

Credit Based System for Holistic Development

Syllabus for **TYBSc Computer Science**

Program: B.Sc. Computer Science(Major)

(Program code: VESUSCS)

As per NEP 2020

with effect from Academic Year 2026-2027

PREFACE

The NEP-2020 is aimed to make India a global knowledge superpower with equitable access to the highest-quality education for all learners. The holistic and multidisciplinary education proposed under NEP-2020 is expected to facilitate the all-round development of learners with enhancement in employability potential and skills for new jobs in emerging fields. NEP envisages the development of guidelines for curriculum and credit framework for four year undergraduate programmes, regulations prescribing a minimum standard and the procedure for the award of the one year Certificate, two year Diploma, three years Bachelor Degree, four years Bachelor Degree (Research/ Honors) and Master's degree with multiple entry and exit options and transformation of HEIS into multidisciplinary institutions.

From this academic year, VESASC as an autonomous college, is going to implement NEP for the first year students as per the guidelines given by Government of Maharashtra through the 20th April 2023 GR. This model can be implemented in various ways out of which the **Department of Computer Science would be following the Department/ Subject Specific(DSC) model for Computer Science under which computer science should be pursued by the students as a mandatory requirement. DSCs shall be the core credit** courses which will be appropriately arranged and graded across all the semesters of the study.

Computer Science (CS) has been evolving as an important branch of science throughout the world in the last couple of decades. Nowadays, practically everyone is a computer user, and many people are even computer programmers. Computer Science can be seen on a higher level, as a science of problem solving and problem solving requires precision, creativity, and careful reasoning.

Computer Science education at undergraduate level (+3) will result in earning a Bachelor of Science (BSc) degree in CS. BSc with CS and BSc(Hons) in CS are aimed at undergraduate level training, laying a strong foundation of CS at an early stage of the career and facilitating multiple career paths. Students so graduated, can take up postgraduate programmes in CS leading to research as well as R&D, can be employable at IT industries(as Web Developer, Software Engineer, Network Engineer, Data Scientist, or AI/ML personnel), or can pursue a teachers' training programme such BEd in Computer Education, or can adopt a business management career.

Program Learning Outcomes
• To develop an understanding and knowledge of the basic theory of Computer Science with a good foundation on theory, systems and applications such as algorithms, data structures, data handling, data communication and computation. • To develop the ability to use this knowledge to analyse new situations • To acquire necessary and state-of-the-art skills to take up industry challenges. The objectives and outcomes are carefully designed to suit the above-mentioned purpose. • The ability to synthesize the acquired knowledge, understanding and experience for a better and improved comprehension of the real-life problems • To learn skills and tools like mathematics, statistics, IoT to find the solution, interpret the results and make predictions for the future developments.

The objectives of the 3 year B.Sc. Computer Science programme are as follows:

- To develop an understanding and knowledge of the basic theory of Computer Science with a strong foundation on theory, systems and applications.

- To refine necessary skills and analytical abilities for developing computer based solutions of real-life problems.
- To provide training in emergent computing technologies which lead to innovative solutions for industry and academia.
- To develop the necessary study skills and knowledge to pursue further postgraduate study in computer science or other related fields.
- To develop the professional skill-set required for a career in technology oriented business or industry.
- To enable students to work independently and collaboratively, communicate effectively, and become responsible, competent, confident, insightful, and creative users of computing technology

Programme Learning Outcomes

At the end of three year Bachelor of Computer Science the students will be able:

- To formulate, to model, to design solutions, procedure and to use software tools to solve real world problems.
- To design and develop computer programs/computer -based systems in the areas such as networking, web design, security, cloud computing, IoT, data science and other emerging technologies.
- To familiarize with the modern-day trends in industry and research based settings and thereby innovate novel solutions to existing problems.
- To apply concepts, principles, and theories relating to computer science to new situations. To use current techniques, skills, and tools necessary for computing practice
- To apply standard Software Engineering practices and strategies in real-time software project development
- To pursue higher studies of specialization and to take up technical employment.
- To work independently or collaboratively as an effective team member on a substantial software project.
- To communicate and present their work effectively and coherently.
- To display ethical code of conduct in usage of Internet and Cyber systems.
- To engage in independent and life-long learning in the background of the rapidly changing IT industry.

MAJOR COURSES

Sem.	Theory / Practical	Course Title	No of Credits	No of Hours	Total Credits
V	Theory	Data Science	3	30	10
	Practical	Data Science Practical	1	30	
	Theory	Information and Network Security	3	30	
	Practical	Information and Network Security Practical	1	60	
	Theory	Theory of Computation	2	30	
VI	Theory	Artificial Intelligence	3	30	10
	Theory	Artificial Intelligence Practical	1	30	
	Theory	Cloud Computing	3	30	
	Practical	Cloud Computing Practical	1	60	
	Practical	Foundations of Cyber Security	2	60	

MINOR COURSES

Sem.	Theory / Practical	Course Title	No of Credits	No of Hours	Total Credits
V	Theory	Linear Algebra	2	30	4
	Tutorial	Linear Algebra Practical	2	30	
VI	Theory	Operational Research	2	30	4
	Tutorial	Operational Research Tutorial	2	30	

ELECTIVE COURSES

Sem.	Theory / Practical	Course Title	No of Credits	No of Hours	Total Credits
V Elective1 (Any 1)	Theory	Information Retrieval	2	30	2
	Theory	Human Computer Interaction	2	30	
V Elective2 (Any 1)	Practical	Web Service Practical	2	60	2
	Practical	Game Programming Practical	2	60	
VI Elective3 (Any 1)	Theory	Business Intelligence	2	30	2
	Theory	Wireless Sensor Networks	2	30	
VI Elective4 (Any 1)	Practical	Business Intelligence Practical	2	60	2

	Practical	Wireless Sensor Networks Practical			

VSC

Sem.	Theory/ Practical	Course Title	No of Credits	No of Hours	Total Credits
V	Practical	Blockchain Technologies	2	60	2

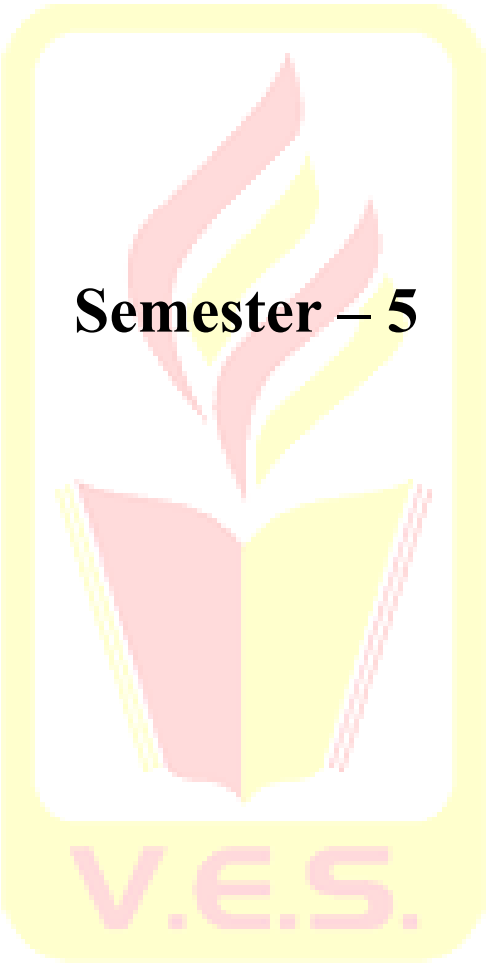
Field Project

Sem.	Theory/ Practical	Course Title	No of Credits	No of Hours	Total Credits
V	Practical	Field Project	2	60	2

On Job Training

Sem.	Theory/ Practical	Course Title	No of Credits	No of Hours	Total Credits
VI	Practical	On Job Training	4	120	4

Semester – 5



Course Code	Course Title	Credits	Lectures / Week
UMMCSS5-301	Data Science	3	3

About the course:
The course will introduce the basic concepts of data science & various machine learning models

Course Objectives:

- To cover basic concepts of data science
- To cover important da huuta preprocessing activities
- To cover aspects of how to analyze data using statistical techniques
- To introduce various machine learning techniques

Learning Outcomes: Learners will be able to -

- Read data from various data sources
- Convert data into suitable formats for processing
- Perform analysis and apply various machine learning models based on type of problem
- Evaluate the model
- Draw insights and present in the right format to the right audience.

Unit	Topic	No. of lectures
I	Introduction to Data Science - What is Data Science, Concepts, Process and tools/technologies used for Data Science, Data Science as compared to other fields like BI, AI, ML, DW-DM, Applications of Data Science, Various roles in data science What is Data, Different kinds of data, Types of Data, Data Sources, Use of popular libraries like - Pandas, Numpy, Sci-kit Learn, etc or technology specific libraries to process data Data Preprocessing - Data Cleaning, Transforming, Selecting columns/fields, Merging data, Handling missing values, outliers, Data aggregation Data Wrangling, Feature Engineering & its types, Dummification, Feature Scaling	15

II	Data Analysis - Exploratory Data Analysis (EDA), Types of Data analysis, Tools used for data analysis, Techniques to analyze data like Hypothesis Testing, ANOVA Machine Learning : What is machine learning, Types of machine learning, Supervised, Unsupervised Methods, Classification, Clustering, Bias variance Tradeoff, Underfitting,Overfitting, Regression and its types(Simple, Multiple, Stepwise, Logistic), Cross-Validation, Issues like multicollinearity, heteroscedasticity, Techniques like Decision Tree , K-Means, PCA	**15**
III	Model Selection and Model Evaluation - Model Evaluation and its techniques like accuracy, confusion matrix, f-score, AUC for various machine learning techniques Data Visualization - What is data visualization, types of data visualization, Benefits in decision making, Principles, Different types of charts like line chart, pie chart, scatter plot, histogram, bar chart, tree map, heat map, Identifying audience types, Key performance indicators (KPIs), Understanding Dashboards, Dashboard planning, Dashboard Layout, Data Storytelling, Visualization Tools, Data Management - Introduction, Activities under data management, Data Pipeline	**15**

TextBooks :

1) Data Science from Scratch First Principles with Python- Joel Grus O'reilly, 2nd Edition
2) Advancing into Analytics From Excel to Python and R, George Mount, Oreilly, First Edition
3)Introduction to Machine Learning with Python, Andreas C. Muller, Sarah Guido, Oreilly, First Edition

Additional References:

1) Doing Data Science, Rachel Schutt and Cathy O'Neil, O'Reilly,2013
2) Mastering Machine Learning with R, Cory Lesmeister, PACKT Publication,2015
3) Hands-On Programming with R, Garrett Grolemund,1st Edition, 2014
4) An Introduction to Statistical Learning, James, G., Witten, D., Hastie, T., Tibshirani, R.,Springer,2015

Course Code	Course Title	Credits	Practical/ Per Week
UMMC SS5-302	**Data Science Practical (Using various softwares like R/Python/Google Colab/Tableau)**	**1**	**2**
1	Introduction to Excel and various functions like conditional formatting, pivot tables, vlookup, what-if analysis, lookup functions, goal-seek, charts etc		
2	Creating data frames from various types of files(csv/json etc) and performing various basic data pre-processing functions		
3	Practical on feature scaling & Feature Dummification		
4	Practical on Hypothesis Testing		

5	Practical on ANOVA
6	Practical on Regression & its types
7	Practical on Logistic Regression & Decision Tree
8	Practical on K-Means & PCA
9	Practical on Data Visualization
10	Practical on Dashboard and Storytelling

Course Code	**Course Title**	**Credits**	**Lectures / Week**
UMMCS S5-303	**Information and Network Security**	**3**	**3**

About the course:
Information and Network Security introduce encryption decryption techniques.introduces about authentication process variety of security threats and vulnerabilities.

Course Objectives:
To provide students with knowledge of basic concepts of computer security including network security and cryptography.

Learning Outcomes:

Understand the principles and practices of cryptographic techniques. Understand a variety of generic security threats and vulnerabilities, and identify & analyze particular security problems for a given application. Understand various protocols for network security to protect against the threats in a network

Unit	**Topic**	**No. of lectures**
I	**Introduction:** Security Trends, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms **Classical Encryption Techniques:** Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Steganography, Block Cipher Principles, The Data Encryption Standard, The Strength of DES, AES (round details not expected), Multiple Encryption and Triple DES, Block Cipher Modes of Operation, Stream Ciphers **Public-Key Cryptography and RSA:** Principles of	**15**

	Public-Key Cryptosystems, The RSA Algorithm	
II	**Key Management:** Public-Key Cryptosystems, Key Management, Diffie-Hellman Key Exchange **Message Authentication and Hash Functions**: Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and Macs, Secure Hash Algorithm, HMAC **Digital Signatures and Authentication:** Digital Signatures, Authentication Protocols, Digital Signature Standard **Authentication Applications:** Kerberos, X.509 Authentication, Public-Key Infrastructure	**15**
III	**Electronic Mail Security:** Pretty Good Privacy, S/MIME **IP Security:** Overview, Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations, Key Management **Web Security:** Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction **Intrusion:** Intruders, Intrusion Techniques, Intrusion Detection **Malicious Software:** Viruses and Related Threats, Virus Countermeasures, DDOS **Firewalls:** Firewall Design Principles, Types of Firewalls	**15**

TextBooks :

1) Cryptography and Network Security: Principles and Practice 5th Edition, William Stallings, Pearson,2010

Additional References:

1) Cryptography and Network Security, Atul Kahate, Tata McGraw-Hill, 2013

2) Cryptography and Network, Behrouz A Fourouzan, Debdeep Mukhopadhyay, 2 nd Edition,TMH,2011

Course Code	Course Title	Credits	Practical/ Per Week

UMMCS S5-304	**Information and Network Security Practical**	**1**	**2**
1	Write programs to implement the following Substitution Cipher Techniques: - Caesar Cipher - Monoalphabetic Cipher		
2	Write programs to implement the following Substitution Cipher Techniques: - Vernam Cipher - Playfair Cipher		
3	Write programs to implement the following Transposition Cipher Techniques: - Rail Fence Cipher - Simple Columnar Technique		
4	Write program to encrypt and decrypt strings using - DES Algorithm - AES Algorithm		
5	Write a program to implement RSA algorithm to perform encryption / decryption of a given string.		
6	Write a program to implement the Diffie-Hellman Key Agreement algorithm to generate symmetric keys.		
7	Write a program to implement the MD5 algorithm compute the message digest.		
8	Write a program to calculate HMAC-SHA1 Signature		
9	Write a program to implement SSL. 10		
10	Configure Windows Firewall to block:		

	- A port - An Program - A website

Course Code	Course Title	Credits	Practicals/ Week
UMMCS S3-305	**Theory Of Computation**	**2**	**2**

About the course:
The course provides a comprehensive insight into theory of computation by understanding grammar, languages and other elements of modern language design. It also helps to develop capabilities to design and develop formulations for computing models and identify its applications in diverse areas.

- **Course Objectives:**
- To give an overview of the theoretical foundations of computer science from the perspective of formal languages
- To illustrate finite state machines to solve problems in computing
- To explain the hierarchy of problems arising in the computer sciences.
- To familiarize Regular grammars, context free grammar.

Learning Outcomes:
After successful completion of this course, students would be able to
- Understand Grammar and Languages
- Learn about Automata theory and its application in Language Design
- Learn about Turing Machines and Pushdown Automata
- Understand Linear Bound Automata and its applications

Unit	Topic	No. of lectures
I	**Automata Theory:** Defining Automaton, Finite Automaton, Transitions and Its properties, Acceptability by Finite Automaton, Nondeterministic Finite State Machines, DFA and NDFA equivalence, Mealy and Moore Machines, Minimizing Automata. **Formal Languages:** Defining Grammar, Derivations, Languages generated by Grammar, Chomsky Classification of Grammar and	10

	Languages,Recursive Enumerable Sets, Operations on Languages, Languages and Automata	
II	**Regular Sets and Regular Grammar:** Regular Grammar, Regular Expressions, Finite automata and Regular Expressions, Pumping Lemma and its Applications, Closure Properties, Regular Sets and Regular Grammar **Context Free Languages:** Context-free Languages, Derivation Tree, Ambiguity of Grammar, CFG simplification, Normal Forms, Pumping Lemma for CFG **Pushdown Automata:** Definitions, Acceptance by PDA, PDA and CFG	10
III	**Linear Bound Automata:** The Linear Bound Automata Model, Linear Bound Automata and Languages. **Turing Machines:** Turing Machine Definition, Representations, Acceptability by Turing Machines, Designing and Description of Turing Machines, Turing Machine Construction, Variants of Turing Machine. **Undecidability:** The Church-Turing thesis, Universal Turing Machine,Halting Problem, Introduction to Unsolvable Problems	10

TextBooks :

1.Theory of Computer Science, K. L. P Mishra, Chandrasekharan, PHI,3rd Edition 2019
2. Introduction to Computer Theory, Daniel Cohen, Wiley, 2nd Edition, 2007
3. Introductory Theory of Computer Science, E.V. Krishnamurthy, Affiliated East-West Press, 2009

Additional References:

1.Theory of Computation, Kavi Mahesh, Wiley India, 2018
2. Elements of The Theory of Computation, Lewis, Papadimitriou, PHI, 2015
3. Introduction to Languages and the Theory of Computation, John E Martin, McGraw-Hill Education, 2010
4. Introduction to Theory of Computation, Michel Sipser, Thomson
5. Introduction to Automata Theory, Languages and Computation, John E Hopcroft, Pearson Education, 2014

Course Code	Course Title	Credits	Lectures /Week
UMNCSS5-316	**Linear Algebra**	**2**	**2**

About the Course:

Linear algebra, a branch of mathematics, provides concepts that are crucial to many areas of computer science, such as graphics, image processing, cryptography, machine learning, computer vision, optimization, graph algorithms, quantum computation, computational biology, information retrieval and web search. The course covers topics such as fields, vectors, matrices, eigenvalues and eigenvectors

Course Objectives:

- To offer the learner the relevant Linear Algebra concepts through Computer Science applications.
- To interpret existence and analyze the solution set of a system of linear equations.
- To formulate, solve, apply, and interpret properties of linear systems.
- To learn about the concept of linear independence of vectors over a field, and the dimension of a vector space.
- To interpret basic concepts of linear transformations, dimension, matrix representation of a linear transformation, and the change of coordinate matrix.

Learning Outcomes:

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

- To Appreciate the relevance and applications of Linear Algebra in the field of Computer Science.
- Understand the concepts through program implementation.
- Instill a computational thinking while learning linear algebra.
- Express clear understanding of the concept of a solution to a system of equations.
- Find eigenvalues and corresponding eigenvectors for a square matrix.

Unit	Topics	No of Lectures
I	**Field:** Introduction to complex numbers, complex numbers in Python, abstracting over fields, Playing with GF (2). **Vectors:** Vectors are functions, Vector addition, Scalar-vector multiplication, combining vector addition and scalar multiplication, Dictionary-based representations of vectors, Dot-product, Solving a triangular system of linear equations, Support Vector Machine – Introduction, Mechanism. **The Vector Space:** Linear combination, Span, The geometry of sets of vectors, Vector spaces, Linear systems, homogeneous and otherwise	**10**
II	**Matrix**: Matrices as vectors, Column space and row space, Matrix-vector and vector-matrix multiplication in terms of linear combinations, Matrix-vector multiplication in terms of dot-products, Null space, Computing sparse matrix-vector product, Linear functions, Matrix-matrix multiplication, Inner product and outer product, From function inverse to matrix inverse **Basis**: Coordinate systems, two greedy algorithms for finding a set of generators, Linear dependence, Basis, Unique representation, Change of basis, first look, Computational problems involving finding a basis **Dimension:** Dimension and rank, Direct sum, Dimension and linear functions, The annihilator **Gaussian elimination**: Echelon form, Gaussian elimination over GF(2), Solving a matrix-vector equation using Gaussian elimination.	**10**

III	**Inner Product**: The inner product for vectors over the reals, Orthogonality. **Orthogonalization**: Projection orthogonal to multiple vectors, projecting orthogonal to mutually orthogonal vectors, Building an orthogonal set of generators, orthogonal complement. **Eigenvalues and Eigenvectors:** Characteristic Polynomials of degree 2 and 3, Eigenvalues and eigenvectors, Properties of eigenvalues and eigenvectors, Cayley–Hamilton Theorem, Minimal Polynomial. Coordinate representation in terms of eigenvectors, The Internet worm, Markov Chains, Google Page Rank algorithm.	**10**

Textbooks:

1. Coding the Matrix Linear Algebra through Applications to Computer Science, First Edition, Philip N. Klein, Newtonian Press 2013
2. Schaum's Outline of Linear Algebra, Sixth Edition by Seymour Lipschutz, Marc Lipson, McGraw Hill 2017

Additional References:

1. Linear Algebra and Probability for Computer Science Applications, First Edition, Ernest Davis, A K Peters/CRC Press, 2012.
2. Linear Algebra and Its Applications, Gilbert Strang, Cengage Learning, 4th Edition, 2007
3. Linear Algebra and Its Applications, David C Lay, Pearson Education India; 3rd Edition, 2002
4. Introduction to Information Retrieval, Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Cambridge University Press, 2008.
5. Computer Networking With Internet Protocols and Technology, William Stallings, Pearson Education India, 2013.

Course Code	**Course Title**	**Credits**	**Tutorial /Week**
UMNCSS5-317	**Linear Algebra – Practical**	**2**	**2**
1	Demonstrates the following: ● Arithmetic operations of two complex numbers ● Displaying the conjugate of a complex number ● Plotting a set of complex numbers ● Creating a new plot by rotating the given number by a 90, 180, 270 degrees and also by scaling by a number a = 1/2, a = 1/3, a = 2 etc.		
2	Demonstrates the following: ● Enter a vector u as a n-list ● Enter another vector v as a n-list ● Find the vector au + bv for different values of a and b ● Find the dot product of u and v		
3	Demonstrates the following: ● Enter two distinct faces as vectors u and v. ● Find a new face as a linear combination of u and v i.e. au+bv for a and b in R. ● Find the average face of the original faces.		

4	Demonstrates the following: ● Enter an r by c matrix M (r and c being positive integers) ● Display M in matrix format ● Display the rows and columns of the matrix M ● Find the scalar multiplication of M for a given scalar. ● Find the transpose of the matrix M.
5	Demonstrates the following: ● Find the vector –matrix multiplication of a r by c matrix M with a c-vector u. ● Find the matrix-matrix product of M with a c by p matrix N.
6	Demonstrates the following: ● Enter a matrix and check if it is invertible ● If the inverse exists, find the inverse.
7	Write a program to convert a matrix into its row echelon form.
8	Demonstrates the following: ● Enter a vector b and find the projection of b orthogonal to a given vector u. ● Find the projection of b orthogonal to a set of given vectors
9	Write a program to enter a given matrix and an eigen value of the same. Find its eigen vector.

Course Code	**Course Title**	**Credits**	**Lectures/ Week**
UME CSS5-311	**Information Retrieval**	**2**	**2**

About the course: Information retrieval (IR) is the process of obtaining information resources relevant to an information need
from a collection of information resources. IR typically employs one or more of the following techniques:
● text indexing and searching
● natural language processing (NLP) and
● Machine Learning etc.
IR systems are used in a variety of applications, including web search engines, enterprise search, and
digital libraries.

Course Objectives
1. Developing an understanding of the fundamental concepts and techniques used in information retrieval, such as indexing, retrieval models, and evaluation.
2. Familiarizing students with various types of information retrieval systems, including text retrieval, image retrieval, and video retrieval.
3. Teaching students how to design, implement, and evaluate information retrieval systems.
4. Introducing students to recent research and developments in the field of information retrieval.
5. Providing students with the ability to apply information retrieval techniques to real-world problems and datasets.

Learning Outcomes

1. The ability to understand and describe the basic concepts, models, and algorithms used in information retrieval.
2. The ability to design and implement information retrieval systems, including text retrieval, image retrieval, and video retrieval.
3. The ability to evaluate information retrieval systems using appropriate metrics and techniques.
4. The ability to apply information retrieval techniques to real-world problems and datasets.
5. The ability to conduct literature reviews and stay current with recent research and developments in the field.
6. The ability to analyze and solve information retrieval problems using a variety of techniques.

Unit	Topic	No. of lectures
I	**Introduction to Information Retrieval:** Introduction, History of IR, Components of IR, and Issues related to IR, Boolean retrieval, Dictionaries, and tolerant retrieval. Vector space model Term frequency and weighting, The vector space model for scoring Techniques. **Sentiment analysis:** determining the overall sentiment (positive, negative, neutral) of a given piece of text. **Text classification:** assigning a label or category to a piece of text based on its content. Natural Language Processing (NLP) techniques, such as tokenization, stemming, lemmatization, and part-of-speech tagging. Text-based Information Retrieval techniques and evaluation metrics. Applications of text analytics in areas such as social media analytics, customer service, and fraud detection.	**10**
II	**Index Construction, Compression & Specialized Search**:, Index Construction & Compression, Personalized search, Collaborative filtering and content-based recommendation of documents and Products. Handling "invisible" Web, Snippet generation, Summarization, Question Answering, Cross- Lingual Retrieval.	**10**
III	**Web Search Engine Crawlers and Link Analysis:** Link Analysis, hubs and authorities, Pagerank and HITS algorithms Web Search Engine: Web search overview, web structure, the user, paid placement, search engine optimization/spam, Web size measurement, search engine optimization/spam, Web Search Architectures Web crawling and indexes. Introduction to web analytics and the importance of data collection and analysis in website design and development. Techniques for collecting web data, including web server logs, cookies, and web analytics tools such as Google Analytics. Methods for analyzing web data, including descriptive statistics, data visualization, and data mining.	**10**

TextBooks :

1) Introduction to Information Retrieval, C. Manning, P. Raghavan, and H. Schütze, Cambridge University Press, 2008
2) Modern Information Retrieval: The Concepts and Technology behind Search, Ricardo Baeza -Yates and Berthier Ribeiro – Neto, 2nd Edition, ACM Press Books 2011.

Additional References:

1) Search Engines: Information Retrieval in Practice, Bruce Croft, Donald Metzler and Trevor Strohman, 1st Edition, Pearson, 2009.
2. Information Retrieval : Madhavi Vaidya, Wiley Publications.

Course Code	Course Title	Credits	Lectures/ Week
UMECSS5-312	**Human Computer Interaction**	**2**	**2**

About the course: This course is designed around the overall development cycle for an interactive software product. It starts with the required basic HCI knowledge,the application of this knowledge by iteratively forming the HCI requirements and modeling the interaction process , designing the interface, implementing the resulting design, and finally evaluating the implemented product.

Course Objectives:

- Gauge the expectations of users with respect to UI/UX design of a software .
- Study the GOMS model used in HCI designs.
- Design product interfaces that align with the users requirement and the HCI guidelines.
- Evaluate the implemented UI/UX designs.

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

- Design UI/UX that satisfies users expectations.
- Apply HCI Guidelines while designing UI/UX of software products.
- Create and implement interactive software products using the GOMS model.
- Evaluate the UI/UX of software products using self heuristics and peer review.

Unit	Topics	No. of Lectures
I	**Introduction:** What HCI Is and Why It Is Important, Principles of HCI. **Specific HCI Guidelines:** Guideline Categories ,Examples of HCI Guidelines. **Human Factors as HCI Theories:**Human Information Processing,Sensation and Perception of Information, Human Body Ergonomics (Motor Capabilities)	**10**
II	**HCI Design:** The Overall Design Process , Interface Selection Options, Wire-Framing, “Naïve” Design Example: No Sheets 1.0. **User Interface Layer:** Understanding the UI Layer and Its Execution Framework, Input and Output at the Low Level, Processing the Input and Generating Output. **UI Development Toolkit:** User Interface Toolkit, Java AWT UI Toolkit, Android UI Execution Framework and Toolkit, Examples: iOS UIKit Framework and Toolkit.	**10**

III	**Interactive System Development Framework:** Model, View, and Controller (MVC), Example of MVC Implementation 1: Simple Bank Application, Example of MVC Implementation 2: No Sheets. **User Interface Evaluation:** Evaluation Criteria, Evaluation Methods **Future of HCI:** Non-WIMP/Natural/Multimodal Interfaces, Mobile and Handheld Interaction, High-End Cloud Service and Multimodal Client Interaction, Natural/Immersive/Experiential Interaction, Mixed and Augmented Reality	**10**

Text Books :

1. Human–Computer Interaction : Fundamentals and Practice, Gerard Jounghyun Kim, CRC Press, 1st Edition, 2015.

Additional References:

1. The Design of Everyday Things, Donald A. Norman, 1988.
2. The Encyclopedia of Human-Computer Interaction, 2nd Ed.

Course Code	Course Title	Credits	Practical/ Week
UMECSS 5-313	**Web Services**	2	4
1	Write a program to implement to create a simple web service that converts the temperature from Fahrenheit to Celsius and vice versa.		
2	Write a program to implement the operation can receive request and will return a response in two ways. a) One - Way operation b) Request –Response		
3	Write a program to implement business UDDI Registry entry.		
4	Develop client which consumes web services developed in different platform.		
5	Write a JAX-WS web service to perform the following operations. Define a Servlet / JSP that consumes the web service.		
6	Define a web service method that returns the contents of a database in a JSON string. The contents should be displayed in a tabular format.		
7	Define a RESTful web service that accepts the details to be stored in a database and performs CRUD operation.		

8	Implement a typical service and a typical client using WCF.
9	Use WCF to create a basic ASP.NET Asynchronous JavaScript and XML (AJAX) service.
10	Demonstrates using the binding attribute of an endpoint element in WCF

Course Code UMECSS5-314	Course Title	Credits	Practical/ Per Week
	Game Programming Practical	2	4
1	Drawing 2D & 3D shapes and performing transformations on them.		
2	Create an environment around representing walls, bricks, ground, sticks etc. The ball should fall using gravity and keep on bouncing randomly as it hits these objects.		
3	Using Unity 2D, Create 2D UFO Game.		
4	Using Unity 2D, Create 2D game for collecting a collectable object and also use TextMeshPro to display count or score on screen.		
5	Using unity 2D, Create 2D game and also add animation on gameObject.		
6	Use Different 3D Primitive game objects and create a game scene along with different light effects.		
7	Using Unity 3D, construct a 3d scene representing any area(such as your college) using basic 3d objects such as cube, sphere, capsule etc. Also use objects like 3d plane, textures(for road, building etc), lights etc.		
8	Using Unity 3D, construct a scene containing a 3d Ball and various objects around it. As the ball rolls, it can hit other objects & both should get affected.		
9	Create a 3D Scene using Textures and Terrain Effect.		
10	Create a 3D/2D game by applying particle system and sound design.		

Course Code	Course Title	Credits	Practicals/ Week
UMECSS6-314	**Blockchain Technologies Practical**	**2**	**4**

About the Course:
This course provides a broad overview of the essential concepts of blockchain technology – by
initially exploring the Bitcoin protocol followed by the Ethereum protocol – to lay the foundation
necessary for developing applications and programming.

Course Objectives:

- To understand the history, types and applications of Blockchain
- To acquire knowledge about cryptography and consensus algorithms.
- Deploy projects using python, solidity and design blockchain based applications.

Learning Outcomes:

- Explore blockchain technology as a security mechanism
- Apply various consensus algorithms to execute transactions in blockchain.
- Construct and deploy Smart contracts using Ethereum
- Implement decentralized applications using blockchain in real-time applications.

1	Demonstrate working of a blockchain. Create a blockchain in Python.
2.	Write a smart contract to demonstrate basic data types in solidity.
3.	Implement pure and view functions in a Solidity smart contract.
4	Implement payable functions using solidity smart contracts and metamask.
5	Write a solidity smart contract to implement custom errors
6	Demonstrate the usage of Solidity modifiers with a smart contract.
7	Write a smart contract to demonstrate the usage of emit-event in solidity.
8	Write a smart contract to mint NFTs. Use IPFS to store tokens.
9.	Create two smart contracts and import the functions of one contract in the other.
10.	Demonstrate the usage of function modifiers in solidity.
11.	Demonstrate the usage of require and revert statements in solidity.
12.	Install Ganache blockchain test network and deploy solidity smart contract
13.	Demonstrate setup of myEtherWallet and connect it to Ganache Network
14.	Demonstrate geth client to create genesis block on your own block chain.
15.	Install and Get Started with the Bitcoin core client. Write a program to get Bitcoin and create transactions.

Field Project

Sem.	Theory/ Practical	Course Title	No of Credits	No of Hours	Total Credits
V	Practical UFPCSS5-371	Field Project	2	60	2

- **As per college guidelines**

Semester 6

Course Code	Course Title	Credits	Lectures / Week
UMMCS S6-301	**Artificial Intelligence**	**3**	**3**

About the course: Artificial Intelligence (AI) and accompanying tools and techniques bring transformational changes in the world. Machines capability to match, and sometimes even surpass human capability, make AI a hot topic in Computer Science. This course aims to introduce the learner to this interesting area.

Course Objectives: The objectives of the course are as follows -

- Introduce the core concepts of AI
- Cover various searching algorithms for problem solving
- Introduce concepts of knowledge representation
- To cover various machine learning algorithms

Learning Outcomes: After completion of this course, learner should -

- get a clear understanding of AI and different search algorithms used for solving problems.
- get acquainted with different learning algorithms and models used in machine learning.

Unit	Topic	No. of lectures
I	What Is AI: Foundations, History and State of the Art of AI. Intelligent Agents: Agents and Environments, Nature of Environments, Structure of Agents. Problem Solving by searching: Problem-Solving Agents, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Knowledge Representation and different forms, Reasoning, Planning, Uncertainty in Knowledge, Fuzzy Logic & Fuzzification	**15**
II	Machine Learning, Forms of Learning, Parametric & Non-Parametric Models, Regression, Decision Trees, Random Forest, SVM, Ensemble Learning, Boosting, K-NN, Gradient Descent,Artificial Neural Networks, Concept of Deep Learning	**15**
III	Unsupervised Learning - Concept of Unsupervised learning, Association Rule Mining Probabilistic models: Statistical Learning, Learning with Complete Data, Naive Bayes Classifier, Learning with Hidden Variables: The EM Algorithm Time Series Analysis Reinforcement learning: Concept of Reinforcement learning, Q-Learning, Hidden Markov Model	**15**

TextBooks :

1) Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig,3rd Edition, Pearson, 2010.

Additional References:

1) Artificial Intelligence: Foundations of Computational Agents, David L Poole,Alan K. Mackworth, 2nd Edition, Cambridge University Press ,2017.
2) Artificial Intelligence, Kevin Knight and Elaine Rich, 3rd Edition, 2017 3) The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani and Jerome Friedman, Springer, 2013

Course Code	Course Title	Credits	Practical Per Week
UMMCS S6-302	**Artificial Intelligence Practical**	**1**	**2**
1	Implement Breadth first search & Iterative depth first search algorithm		
2	Implement A* search and recursive best-first search algorithm		
3	Implement decision tree and random forest learning algorithm		
4	Implement feed forward back propagation neural network learning algorithm		
5	Implement SVM Algorithm		
6	Implement Adaboost ensemble learning algorithm		
7	Implement Naive Bayes' learning algorithm		
8	Implement K-NN Algorithm		
9	Implement Association rule mining algorithm		
10	Demo of OpenAI / TensorFlow tools		

Course Code	Course Title	Credits	Lectures / Week
UMMCS S6-303	**Cloud Computing**	**3**	**3**

About the Course: To provide learners with the comprehensive and in-depth knowledge of Cloud Computing concepts, technologies, architecture, implantations and applications. To expose the learners to frontier areas of Cloud Computing, while providing sufficient foundations to enable further study and research.

Course Objectives:

1. To acquire knowledge about cloud computing and its architecture.
2. To understand services of cloud computing and Types of cloud
3. Introducing students about virtualization and hypervisors
4. Study the concept of openstack.

Learning Outcomes:

After successfully completion of this course -

- The learner should be able to articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing using open source technology.
- Learner should be able to identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.
- They should explain the core issues of cloud computing such as security, privacy, and

interoperability.

Unit	Topic	No. of lectures
I	Introduction to Cloud Computing, Characteristics and benefits of Cloud Computing, Basic concepts of Distributed Systems, Web 2.0, Service-Oriented Computing, Utility-Oriented Computing. Elements of Parallel Computing. Elements of Distributed Computing. Technologies for Distributed Computing. Cloud Computing Architecture. The cloud reference model. Infrastructure as a service. Platform as a service. Software as a service. Types of clouds.	15
II	Characteristics of Virtualized Environments. Taxonomy of Virtualization Techniques. Virtualization and Cloud Computing. Pros and Cons of Virtualization. Virtualization using KVM, Creating virtual machines, oVirt - management tool for virtualization environment. Open challenges of Cloud Computing **Cloud Platforms and Cloud Applications** Microsoft Cloud Services: Azure core concepts, SQL Azure, Windows Azure Platform Appliance,Amazon Web Services (AWS): Amazon Web Services and Components, Amazon Simple DB, Elastic Cloud Computing (EC2), Amazon Storage System, Amazon Database services (Dynamo DB). Case study on Amazon EC2/Microsoft Azure/Google Cloud Platform	15
III	Introduction to OpenStack, OpenStack test-drive, Basic OpenStack operations, OpenStack CLI and APIs, Tenant model operations, Quotas, Private cloud building blocks, Controller deployment, Networking deployment, Block Storage deployment, Compute deployment, deploying and utilizing OpenStack in production environments, Building a production environment, Application orchestration using OpenStack Heat	15

TextBooks :

1) Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi, Tata McGraw Hill Education Private Limited, 2013

2) OpenStack in Action, V. K. CODY BUMGARDNER, Manning Publications Co, 2016

Additional Reference(s):

1) OpenStack Essentials, Dan Radez, PACKT Publishing, 2015

2) OpenStack Operations Guide, Tom Fifield, Diane Fleming, Anne Gentle, Lorin Hochstein, Jonathan Proulx, Everett Toews, and Joe Topjian, O'Reilly Media, Inc., 2014

3) https://www.openstack.org

Course Code	Course Title	Credits	Practical/ Per Week
UMMCSS 6-304	**Cloud Computing Practical**	1	2

1	Study of Cloud Computing & Architecture
2	Study and implementation of Infrastructure as a Service.
3	Study and implementation of Storage as a Service
4	Study and implementation of azure sql Database.
5	User Management in Cloud.(create user,group)
6	Study Cloud Security management
7	Study and Implementation of custom domain
8	Write a program for web feed.
9	Case study on Amazon EC2/Microsoft Azure/Google Cloud Platform

Course Code	**Course Title**	**Credits**	**Practical/ Week**
UMMC SS6-305	**Foundations of Cyber Security**	**2**	**4**

About the Course: This course covers cybersecurity fundamentals, cyber threats, ethical hacking, and cryptography, along with cyber forensic techniques for investigating digital crimes. Students will learn to secure systems, analyze attacks, collect digital evidence, and understand legal and ethical aspects of cybersecurity. It prepares them for careers in cybersecurity and digital forensics.

Course Objectives:

- To understand fundamental concepts of cybersecurity, cyber threats, and forensic investigation.
- To explore various cyber attacks, defense mechanisms, and forensic tools.
- To learn cryptographic techniques and secure communication methods.
- To study network security, intrusion detection, and digital evidence collection.
- To understand legal, ethical, and policy aspects related to cybersecurity and cyber forensics.
- To analyze real-world cybercrime cases and apply forensic investigation techniques.

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

- Identify and analyze various cyber threats, vulnerabilities, and attack vectors.
- Implement security mechanisms such as cryptography, firewalls, and intrusion detection.
- Use forensic tools for data recovery, evidence collection, and analysis.
- Conduct forensic investigations on networks, computers, and mobile devices.
- Apply cybersecurity and forensic techniques to real-world cybercrime scenarios.

Practical:

1. Use Google and Whois for Reconnaissance
2. a) Use CrypTool to encrypt and decrypt passwords using RC4 algorithm
   b) Use Cain and Abel for cracking Windows account password using Dictionary attack and to decode wireless network passwords
3. a) Run and analyze the output of following commands in Linux – ifconfig, ping, netstat, traceroute
   b) Perform ARP Poisoning in Windows
4. Use NMap scanner to perform port scanning of various forms – ACK, SYN, FIN, NULL, XMAS
5. Use Wireshark (Sniffer) to capture network traffic and analyze
6. Simulate persistent cross-site scripting attack and perform SQL injection attack
7. Create a simple keylogger using python
8. Using Metasploit to exploit (Kali Linux)
9. Use Mobsf to perform mobile application scanning for mobile app security.
10. Creating a Forensic Image using FTK Imager/Encase Imager: - Creating Forensic Image - Check Integrity of Data - Analyze Forensic Image
11. Data Acquisition: Perform data acquisition using:
    USB Write Blocker + Encase Imager
12. Forensics Case Study:
    Solve the Case study (image file) provide in lab using Encase Investigator or Autopsy.
13. Recovering and Inspecting deleted files - Check for Deleted Files - Recover the Deleted Files - Analysing and inspecting the recovered files Perform this using recovery option in ENCASE and also Perform manually through command line
14. Email Forensics - Mail Service Providers - Email protocols - Recovering emails - Analyzing email header
15. Web Browser Forensics - Web Browser working - Forensics activities on browser - Cache / Cookies analysis - Last Internet activity

Text Books :

1. Certified Ethical Hacker Study Guide v9, Sean-Philip Oriyano, Sybex; Study Guide Edition, 2016
2. CEH official Certified Ethical Hacking Review Guide, Wiley India Edition, 2007
3. Guide to computer forensics and investigations, Bill Nelson, Amelia Philips and Christopher Steuart, course technology, 5th Edition, 2015.

Additional References:

1. Incident Response and computer forensics, Kevin Mandia, Chris Prosise, Tata McGrawHill, 2nd Edition, 200
2. Certified Ethical Hacker: Michael Gregg, Pearson Education,1st Edition, 2013
3. Certified Ethical Hacker: Matt Walker, TMH,2011
4. http://www.pentest-standard.org/index.php/PTES_Technical_Guidelines

5. https://www.owasp.org/index.php/Category:OWASP_Top_Ten_2017_Project
6. https://www.owasp.org/index.php/Mobile_Top_10_2016-Top_10
7. https://www.owasp.org/index.php/OWASP_Testing_Guide_v4_Table_of_Contents
8. https://www.owasp.org/index.php/OWASP_Secure_Coding_Practices_-_Quick_Reference_Guide
9. https://cve.mitre.org/
10. https://access.redhat.com/blogs/766093/posts/2914051
11. http://resources.infosecinstitute.com/applications-threat-modeling/#gref
12. http://www.vulnerabilityassessment.co.uk/Penetration%20Test.html

Course Code	Course Title	Credits	Lectures /Week
UMNCSS6-316	**Operational Research**	**2**	**2**

About the Course:
This course introduces Operations Research (OR) and its application in decision-making. It covers the fundamental concepts, techniques, and methodologies used in OR, with a focus on linear programming and duality. Students will learn how to formulate and solve optimization problems, analyze sensitivity in linear programming, and explore advanced topics such as goal programming, transportation problems, and assignment problems. The course also introduces computer software commonly used in OR for problem solving.

Course Objectives:
- To understand the fundamental principles and approaches of Operations Research.
- To develop skills in formulating and solving linear programming problems.
- To analyze the duality in linear programming and its managerial significance.
- To apply sensitivity analysis techniques to assess the impact of changes in linear programming models.
- To explore advanced topics in Operations Research, including goal programming, transportation problems, and assignment problems.

Learning Outcomes:
After successful completion of this course, students would be able to
- Define and explain the key concepts and features of Operations Research.
- Formulate and solve linear programming models using appropriate techniques.
- Apply duality concepts to analyze and interpret the results of linear programming problems.
- Conduct sensitivity analysis to assess the robustness and flexibility of linear programming solutions.
- Apply advanced techniques such as goal programming, transportation problems, and assignment problems to real-world decision-making scenarios.

Unit	Topics	No of Lectures

I	**Introduction:** **Nature of Operation Research** History. Nature of OR, Impact of OR, Application Areas **Overview of Modeling approach** Formulating the problem, Constructing a mathematical model, Deriving a solution, Testing a model and the solution, Establishing control over the solution, Implementation issues. **Linear Programming:** Introduction, Graphical solution, Graphical sensitivity analysis, The standard form of linear programming problems, Basic feasible solutions,	**10**
II	**Introduction to Simplex Methods:** Simplex algorithm, Artificial variables, Big M and two phase method, Degeneracy, Alternative optima, Unbounded solutions, Infeasible solutions **Dual Problem**: Relation between primal and dual problems, Dual simplex method	**10**
III	**Transportation, Travelling salesman and Assignment models:** **Transportation problem:** Starting solutions, North-west corner Rule, lowest cost methods, Vogels approximation method, MODI Method **Travelling salesman Problem:** Branch & Bound technique, Hungarian method. **Assignment problem:** Hungarian method	**10**

Textbooks:

1. Operation Research - An Introduction by H.A. Taha.
2. Operations Research by P.K . Gupta, Hira S. Chand
3. Optimization Methods by Mital K.V
4. Operations Research by S.D. Sharma

Additional References:

1. Statistical Distribution in Engineering by Karl Bury.
2. Artificial Intelligence Through Simulated Evolution by Foged, Owence and Walsh.
3. Conference proceedings – Annual conference on Evolution programming

Course Code	**Course Title**	**Credits**	**Tutorial /Week**
UMNCS S6-317	**Operational Research– Tutorial**	**2**	**2**
1	Problems based on Formulation and Graphical Solution of L.P.P.		
2	Problems based on Simplex Method		
3	Problems based on Duality		
4	Transportation Problems		
5	Assignment Problems		
6	Problems based on Sequencing		

7	Problems based on CPM-PERT: Construction of Network
8	Finding a Critical Path. Computing Probability of Project completion.
9	Problems based on Project cost analysis.

Course Code	Course Title Credits	Credits	No. of Lectures/ Week
VESUCS603	**Wireless Sensor Networks and Mobile Communication 2**	**2**	**VESUS603**

About the Course: In this era of wireless and ad hoc network, connecting different wireless devices and understanding their compatibility is very important. Information is gathered in many different ways from these devices. Learner should be able to conceptualize and understand the framework. On completion, will be able to have a firm grip over this very important segment of wireless network.

Course Objectives: The objectives of the course are -

- Introduce WSN and various components
- Cover various types of protocols used in wireless communication
- To inculcate ability to help learners to design networks for real life problems

Learning Outcomes: After completion of this course -

- learners should be able to list various applications of wireless sensor networks, describe the concepts, protocols, design, implementation and use of wireless sensor networks.
- Implement and evaluate new ideas for solving wireless sensor network design issues.

Unit	Topic	No. of lectures
I	**Introduction:** Introduction to Sensor Networks, unique constraints and challenges. Advantage of Sensor Networks, Applications of Sensor Networks, Mobile Adhoc NETworks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks. **Sensor Node Hardware and Network Architecture:** Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC. Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.	**10**
II	**Medium Access Control Protocols:** Fundamentals of MAC Protocols, MAC Protocols for WSNs, Sensor-MAC Case Study.	**10**

	Routing Protocols : Data Dissemination and Gathering, Routing Challenges and Design Issues in Wireless Sensor Networks, Routing Strategies in Wireless Sensor Networks. **Transport Control Protocols :** Traditional Transport Control Protocols, Transport Protocol Design Issues, Examples of Existing Transport Control Protocols, Performance of Transport Control Protocols.	
III	**Introduction, Wireless Transmission and Medium Access Control:** Applications, A short history of wireless communication. **Wireless Transmission:** Frequency for radio transmission, Signals, Antennas, Signal propagation, Multiplexing, Modulation, Spread spectrum, Cellular systems. **Telecommunication, Satellite and Broadcast Systems: GSM:** Mobile services, System architecture, Radio interface, Protocols, Localization And Calling, Handover, security, New data services; DECT: System architecture, Protocol architecture; ETRA, UMTS and IMT- 2000. Satellite Systems: History, Applications, Basics: GEO, LEO, MEO; Routing, Localization, Handover.	**10**

Textbooks:

1) Protocols and Architectures for Wireless Sensor Network, Holger Kerl, Andreas Willig, John Wiley and Sons, 2005

2) Wireless Sensor Networks Technology, Protocols, and Applications ,Kazem Sohraby, Daniel Minoli and TaiebZnati, John Wiley & Sons, 2007

3) Mobile communications, Jochen Schiller,2nd Edition, Addison wisely , Pearson Education,2012 **Additional References:**

1) Fundamentals of Wireless Sensor Networks, Theory and Practice, Waltenegus Dargie, Christian Poellabauer , Wiley Series on wireless Communication and Mobile Computing, 2011 2) Networking Wireless Sensors, Bhaskar Krishnamachari , Cambridge University Press, 2005

Course Code	Course Title	Credits	Lectures/ Week
UMECSS6-311	**Business Intelligence**	**2**	**2**

About the course:
Data warehousing and data mining allow organizations to collect, store, and analyze large amounts

of data from various sources. This can provide valuable insights and information that can be used to improve business processes, make better decisions, and gain a competitive advantage

Course Objectives:

- The concepts and techniques of data warehousing, including data cleaning, data integration, and data consolidation.
- The process of data mining, including the use of algorithms and statistical methods to extract useful information from large sets of data.
- The use of data mining tools and techniques to identify patterns, trends, and relationships in data

Learning Outcomes:

- Improved data accessibility and organization.
- Data warehousing allows for the centralization and consolidation of data from multiple sources, making it easier for users to access and analyze the information they need.
- Increased efficiency and automation of business processes: Data mining can be used to uncover patterns and insights in the data, which can then be used to automate and streamline business processes.
- Better decision-making: With access to more complete and accurate data, organizations can make more informed decisions.

Unit	**Topic**	**No. of lectures**
I	**Data-Information-Knowledge-Decision making-Action cycle**. Business Intelligence; Data warehousing, Business Intelligence architecture, Use and benefits of Business Intelligence. **Knowledge Discovery in Databases:** KDD process model, Data Pre-processing: Cleaning: Missing Values; Noisy Values; Inconsistent values; redundant values. Outliers, Integration, transformation, reduction, Discretization: Equal Width Binning; Equal Depth, Binning, Normalization, Smoothing.	**10**
II	**Introduction to data warehousing and concepts**: definitions, and applications, Definition of Data warehouse, Logical architecture of Data Warehouse, Data Warehouse model- Enterprise warehouse; Data Marts; Virtual warehouse. **Data warehousing architecture and design:** dimensional modeling, star schema, snowflake schema, and data marts, Data warehousing tools and technologies: ETL (Extract, Transform, Load) tools. Data warehousing platforms.	**10**
III	**Data pre-processing**: Principles of dimensional modeling, Data cubes, Data cube operations, data cube schemas.	**10**

	Data cleaning, data integration, data transformation, and data reduction. Designing Business Data Warehouse: Table Characteristics; OLAP Cube, OLAP Operations, OLAP Server Architecture-ROLAP, MOLAP and HOLAP. Data Lake. Data mining techniques: association rule mining, clustering, classification, and prediction, Big data analytics tools, Importance of data governance, security, and privacy in data warehousing and data mining with big data.	

Textbooks: References:

1. Building the Data Warehouse, Inmon: Wiley (1993).
2. Data Mining: Introductory and Advanced Topics, Dunham, Margaret H, Prentice Hall (2006)
3. Data Mining: Practical Machine Learning Tools and Techniques, Second Edition, Witten, Ian and Eibe Frank, Morgan Kaufmann (2011)
4. Data Mining: Concepts and Techniques, The Morgan Kaufmann Series in Data Management Systems, Han J. and Kamber M. Morgan Kaufmann Publishers, (2000).

Additional References:

1. Business Intelligence (2nd Edition), Efraim Turban, Ramesh Sharda, Dursun Delen, David King, Pearson (2013)
2. Business Intelligence for Dummies, Swain Scheps, Wiley Publications (2008).
3. Business Intelligence RoadMap, Larissa T. Moss, Shaku Atr, Addison-Wesley
4. Data Modeling Techniques for Data Warehousing by IBM; International Technical Support Organization, Chuck Ballard, Dirk Herreman, Don Schau, Rhonda Bell, Eunsaeng Kim

Course Code	Course Title	Credits	Lecturs/ week
UMECSS6-314	**Wireless Sensor Networks Practical**	**2**	**4**

About the Course:

This course provides a broad overview of the essential concepts of blockchain technology – by initially exploring the Bitcoin protocol followed by the Ethereum protocol – to lay the foundation
necessary for developing applications and programming.

Course Objectives:

- To understand the history, types and applications of Blockchain
- To acquire knowledge about cryptography and consensus algorithms.
- Deploy projects using python, solidity and design blockchain based applications.

Learning Outcomes:

- Explore blockchain technology as a security mechanism

• Apply various consensus algorithms to execute transactions in blockchain. • Construct and deploy Smart contracts using Ethereum • Implement decentralized applications using blockchain in real-time applications.	
1	Understanding the Sensor Node Hardware. (For Eg. Sensors, Nodes(Sensor mote), Base Station, Graphical User Interface.)
2.	Exploring and understanding TinyOS computational concepts:- Events, Commands and Task. - nesC model - nesC Components
3	Understanding TOSSIM for - Mote-mote radio communication - Mote-PC serial communication
4	Create and simulate a simple adhoc network
5	Understanding, Reading and Analyzing Routing Table of a network.
6	Create a basic MANET implementation simulation for Packet animation and Packet Trace.
7	Implement a Wireless sensor network simulation
8	Create MAC protocol simulation implementation for wireless sensor Network.
9	Simulate Mobile Adhoc Network with Directional Antenna
10	Create a mobile network using Cell Tower, Central Office Server, Web browser and Web Server. Simulate connection between them.

Course Code	**Course Title**	**Credits**	**Practical/ Week**
UME CSS6-313	**Business Intelligence Practical**	**2**	**4**
About the course: Data warehousing and data mining allow organizations to collect, store, and analyze large amounts			

of data from various sources. This can provide valuable insights and information that can be used to improve business processes, make better decisions, and gain a competitive advantage

Course Objectives:

- The concepts and techniques of data warehousing, including data cleaning, data integration, and data consolidation.
- The process of data mining, including the use of algorithms and statistical methods to extract useful information from large sets of data.
- The use of data mining tools & techniques to identify patterns, trends, and relationships in data

Learning Outcomes:

- Improved data accessibility and organization.
- Data warehousing allows for the centralization and consolidation of data from multiple sources, making it easier for users to access and analyze the information they need.
- Increased efficiency and automation of business processes: Data mining can be used to uncover patterns and insights in the data, which can then be used to automate and streamline business processes.
- Better decision-making: With access to more complete and accurate data, organizations can make more informed decisions.

1	Develop an application to design a warehouse by importing various tables from external sources.
2.	Execute a code for implementing ETL in Python.
3.	Implementation of OLAP using Python.
4	Implementation to perform data mining using WEKA and Python separately.
5	Develop an application to pre-process data imported from external sources.
6	Build a BI report using various tables created in the warehouse on Tableau Public/PowerBI
7	Execute a wordcount problem using NLTK.
8	Apply the what – if Analysis for data visualization. Design and generate necessary reports based on the data warehouse.
9.	Perform the data classification using classification algorithms.
10.	Perform the data clustering using clustering algorithms.
11.	Perform the Linear regression on a given data warehouse.
12.	Perform the logistic regression on a given data warehouse.
13.	Create clusters and tables in Databricks.Query these tables using SQL.
14.	Create and execute ML Flow experiments in Databricks.

Course Code	Course Title	Credits	Practical/ Per Week
UJTCSS6-373		**4**	**120**
Please Refer to Project Implementation Guidelines			

MODALITY OF ASSESSMENT (to be finalised)

The performance of the learners for those exams having Semester End Examinations and Internal Assessment shall be evaluated in two parts as per the following ratio:

Semester End Examination: Internal Assessment [60:40]

The learner's performance shall be assessed by conducting the **Semester-end Examination with 60% marks** and **Continuous Internal Assessment (CIA) with 40% mark**s. Practical Examination will consist of Semester-end examination.

Students will have to score 40% of marks INDIVIDUALLY in Internal assessment as well as Semester-end Examination to pass the course.

Internal Assessment: It is defined as the assessment of the learners on the basis of internal evaluation by way of participation of learners in various academic and correlated activities in the given semester of the programme.

Semester End Assessment: It is defined as the assessment of the learners on the basis of Performance in the Semester-end Theory/ Practical examination.

Table-1- Mode of Assessment under NEP 2020

Name of the course	Credits	Nature of Evaluation & Mode of Assessment	Duration	Marks
Major(Theory) OR Minor (Theory) OR Skill Enhancement Course (**SEC**)(Theory) OR Ability Enhancement Course (**AEC**)(Theory) OR Value Education Course (**VEC**)	**2 Credit**	**1. Internal (40%)** (Table 2)		20
		2. Semester-end Theory Examination(60%) (Table 3)	**90 mins**	30
Major(Practical) **(2 subjects)**	**2 Credit**	**Semester-end Practical Examination (Table-4)**	**3 hours**	50
Open Electives(OE) OR Indian Knowledge system (**IKS**)	**2 Credit**	Continuous Internal Evaluation - Assignments/ Presentations/ Group Discussion/ Case Studies etc. **Any two modes of assessment with**	**-**	50

		evaluation at Department level (25 M Each)		
Vocation Skill Course (**VSC**)(Practical)	**2 Credit**	Practicals (Table-4)	**2 horus**	50
On Job training (**OJ**T) /NSS/ NCC/ Co-curricular Course(**CC**)/ Field project (**FP**)/ Internship	**2 Credit**	Continuous Internal Evaluation --Tests, Essays, Articles, Group assignments/ Reports/ Journals/ Diaries/ Reviews/ Dissertations/ Observations of Students (As per the nature of the course)	-	

Note: **CC-Co-curricular Courses** include involvement/ participation in various areas such as Cultural Activities, Departmental activities, Fine/ Applied/ Visual/ Performing Arts, Sports and fitness, NSS/ NCC, DLLE, The Sunday School (TSS), Health & Wellness, Yoga education etc. Record of involvement /participation by students has to be documented with signatures of staff concerned in students' CC Cards.

Table - 2

Theory - Mode of assessment-Continuous Internal Assessment [40%]

Evaluation type
1. Assignments. **2.** Project based learning activities (Group Discussion Research/ Case studies/ Reports / Assignments / Presentations / Skit / Poster / etc.). **3.** Class Test (Objective - Multiple Choice Questions/ Subjective). **4.** Active participation in class activities. **5.** Overall conduct as a responsible student with respect to good behaviour, leadership qualities, interpersonal skills etc. For example - Depending on the subject - 15 Marks MCQ Test + 5 Marks Assignment/Presentation/Case Study OR 10 Marks MCQ Test + 10 Marks Assignment/Presentation/Case Study

Table-3

Paper Pattern for Semester-End Theory Examination
1. Each unit should have equal weightage 2. Minimum one question per unit 3. No MCQ/True-False type of questions should be asked, only descriptive questions are allowed 4. Each question should have extra sub-questions(max 100% option)

Table-4

Semester End Examination for Practical Assessment -50 marks (2-Credit)-Major

[To be conducted at departmental level]

For 1 subject	**For 2 subjects**

Any one/ more experiment/s Viva Journal OR Practical Case-Study	35 10 05 30 20	Min two experiments per subject Viva Journal	40 05 05
Total	**50 M**	Total	**50 M**

Evaluation Pattern for Environmental Science

Evaluation Pattern	Credits -2
Continuous Internal Evaluation	Out of 20 marks
Semester End Evaluation	Out of 30 marks
Total Marks	50 marks

Continuous Internal Evaluation

Class Test: 10 marks

Assignment : 10 marks

Question Paper Pattern

Maximum Marks: 45
Question to be set: 02
Duration: **90 mins**

Note: All questions are compulsory carrying 15 marks each

Q.1 Attempt any two - (15) → based on unit 1

Q.2 Attempt any two - (15) → based on unit 2

Q.3 Attempt any two - (15) → based on unit 3