INFORMATION TECHNOLOGY CENTRE
FACULTY OF AGRICUL TURAL SOCIAL SCIENCES
SINDH AGRICULTURE UNIVERSITY
TANDO JAM

REVISED SYLLABI

Courses of BS (COMPUTER SCIENCE)

B.S (CS) Part – I, II, III & IV

UNDER

SEMESTER SYSTEM

To be adopted from 2K24 Batch onwards

INFORMATION TECHNOLOGY CENTRE
FACULTY OF AGRICULTURAL SOCIAL SCIENCES
SINDH AGRICULTURE UNIVERSITY TANDOJAM

Adaptation of HEC Graduation Policy -2023

Revision / Amendments of Scheme of Studies of Computer Science according to UEP -2023 and NCEAC-2023

BSCS Four Years (8 semester) Degree Program

HEC Undergraduate Policy 2023

Program Structure

Semester-1					
Code	**Pre-Reqs**	**Course Title**	**Domain**	**Cr Hr**	**Marks**
CS-301		Programming Fundamentals	Major	4 (3+1)	100-100
CS-303		Application of Information & Communication Technologies	GER	3 (2+1)	100-100
BE – 301		Natural Sciences: Applied Physics	GER	3 (2+1)	100-100
ENG – 301		Functional English	GER	3(3+0)	100-0
IS/EB-301		Islamic Study / Ethics (Optional for Non-Muslim)	GER	2(2+0)	100-0
Math-301		Quantitative Reasoning-1 (Calculus and Analytic Geometry)	GER	3(3+0)	100-0
Total Cr. Hours				**18(15-3)**	**900**
Semester-2					
CS – 302	PF	Object-oriented Programming	Major	4 (3+1)	100-100
CS -304		Database System	Major	4 (3+1)	100-100
CS -306		Digital Logic & Design	Major	3 (2+1)	100-100
Math-302	CAG	Multivariable Calculus	I	3(3+0)	100-0
ENG-302	ECC	Expository Writing	GER	3(3+0)	100-0
PS-302		Ideology & Constitution of Pakistan	GER	2(2+0)	100-0
Total Cr. Hours				**19(16-3)**	**900**
Semester-3					
CS -401	OOP	Data Structure	Major	4 (3+1)	100-100
CS -403		Computer Networks	Major	3 (2+1)	100-100
CS -405		Software Engineering	Major	3(3+0)	100-0
Math-401	CAG	Linear Algebra	I	3(3+0)	100-0
CS-407		Quantitative Reasoning – 2 (Discrete Structure)	GER	3(3+0)	100-0
CS-409		Entrepreneurship	GER	2(2+0)	100-0
Total Cr. Hours				**18(16-2)**	**800**
Semester-4					
CS -402	DLD	Computer Organization & Assembly Language	Major	3 (2+1)	100-100
CS -404		Theory of Automata	Major	3(3+0)	100-0
CS -406	DB	Advance Database Management System	Major	3 (2+1)	100-100
CS-408		Organizational Behaviour	GER	2(2+0)	100-0
CS-410		Art & Humanities (Professional Practices)	GER	2(2+0)	100-0

RS-402		Civics & Community Engagement	GER	2(2+0)	100-0
CS-412		Bioinformatics	I	3(3+0)	100-0
Total Cr. Hours				**18(17-1)**	**900**
Semester-5					
Code	**Pre-Reqs**	**Course Title**	**Domain**	**Cr Hr**	100-100
CS -501		Operating System	Major	3 (2+1)	100-100
CS -503	COAL	Computer Architecture	Major	3 (2+1)	100-100
CS -505		HCI & Computer Graphics	Major	3 (2+1)	100-100
CS -507		Web Technologies	Major	3 (2+1)	100-100
CS -509		Mobile App Development	Major	3 (2+1)	100-100
STAT-501		Probability & Statistics	I	3 (3+0)	100-0
Total Cr. Hours				**18(13-5)**	**1300**
Semester-6					
CS -502		Information Security	Major	3 (2+1)	100-100
CS -504	OS	Parallel & Distributing Computing	Major	3 (2+1)	100-100
CS -506	TA	Compiler Construction	Major	3 (2+1)	100-100
CS -508	OOP	Advanced Programming (Old Name: Visual programming)	Major	3 (2+1)	100-100
CS -510		Software Verification and Validation	Major	3 (2+1)	100-100
CS -512	WT	Web Engineering	Major	3 (2+1)	100-100
Total Cr. Hours				**18(12-6)**	**1200**
Semester-7					
CS -601	DS	Analysis of Algorithms	Major	3 (3+0)	100-0
CS -603		Cloud Computing	Major	3(2+1)	100-100
ENG-601		Technical & Business Writing	I	3(3+0)	100-0
BE-601		Geographical Information System(GIS)	I	3(3+0)	100-0
CS -605		Final Year Project		3 (0+3)	0-100
Total Cr. Hours				**15(11-4)**	**600**
Semester-8					
CS – 602		Artificial Intelligence	Major	3 (2+1)	100-100
CS -604	IS	Cyber Security	Major	3 (2+1)	100-100
CS -606		Internship		3(0+3)	0-100
Total Cr. Hours				**9(4-5)**	
Grand Total Cr. Hours				**133**	

Course Name: ***Programming Fundamentals***
Credit Hours: 4 (3-1)
Pre-requisites: None

Course Introduction:
This course provides fundamental concepts of programming to freshmen. The courses is prerequisite to many other courses, therefore, students are strongly advised to cover all contents and try to achieve CLOs to the maximum possible level. The course may be taught as language independent. Further, it is up to the university to choose any language for the practical/Lab purpose but that must be latest and market oriented.

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 Understand basic problem solving steps and logic constructs C2 (Understand)
CLO-2 Apply basic programming concepts C3 (Apply)
CLO-3 Design and implement algorithms to solve real world problems C3 (Solve)

Course Outline:
Introduction to problem solving, a brief review of Von-Neumann architecture, Introduction to programming, role of compiler and linker, introduction to algorithms, basic data types and variables, input/output constructs, arithmetic, comparison and logical operators, conditional statements and execution flow for conditional statements, repetitive statements and execution flow for repetitive statements, lists and their memory organization, multidimensional lists, introduction to modular programming, function definition and calling, stack rolling and unrolling, string and string operations, pointers/references, static and dynamic memory allocation, File I/O operations.

Reference Materials (or use any other standard and latest books):
1. Starting out with Programming Logic & Degins, 4th Edition, Tony Gaddis,
2. The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie
3. Object Oriented Programming in C++ by Robert Lafore
4. C How to Program, 7th Edition by Paul Deitel & Harvey Deitel
5. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly & Elliot B. Koffman

Course Name: ***Application to Information & Communication Technologies***
Credit Hours: 3 (2-1)
Pre-requisites: None

Course Introduction: This course is designed to provide an introduction to the key concepts and technologies used in the field of Information and Communication Technologies (ICTs) and their applications. It will cover a wide range of topics including computer networking, database systems, web development, programming, and mobile application development. The course will also introduce students to the latest trends in the field of ICTs and their applications in various industries, including education, finance, healthcare, security and communications.

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 Understand the importance of ICT in various fields and industries, such as business, healthcare,education, and entertainment.
C2 (Understand)
CLO-2 Understand emerging technologies and their impact on various fields and industries
C2 (Understand)
CLO-3 Apply data analytics tools to analyze and visualize data
C3 (Apply)
CLO-4 Analyze and evaluate different software applications C4 (Analyze)

Course Outline: Introduction to Information and Communication Technologies Programming Concepts. Describing role of Computer Networking. Describing role of Database Systems. Explaining Web Development Process 80 WP No. 28-66th ACM-1Sep 2023. Facets of Mobile Application Development. Role of Cyber Security and its importance. Data Analytics tools and techniques. Introduction to Social media analysis. Emerging Technologies. Introduction to Artificial Intelligence and Machine Learning. Internet of Things. Cloud Computing. Blockchain and technologies for distributed ledgers. Introduction to Augmented Reality and Virtual Reality. Case studies of ICT in healthcare, business

Reference Materials:
1. "Discovering Computers 2022" by Misty E. Vermaat, Susan L. Sebok, Steven M. Freund, Jennifer T. Campbell, and Mark Frydenberg (2021)
2. "Fundamentals of Information Technology" by Alexis Leon and Mathews Leon (2015)
3. "Information Technology for Management: On-Demand Strategies for Performance, Growth, and Sustainability" by Efraim Turban, Linda Volonino, and Gregory R. Wood (2015)

Course Name: ***Applied Physics***
Credit Hours: 3 (2-1)
Pre-requisites: None

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1: To apply principles and concepts to analyze problems within specific core areas.
CLO-2: Analyze and interpret quantitative results.
CLO-3: To collect and appropriately analyze data working independently and in collaboration with others.
CLO-4: Familiarity with current developments in physics.

Course Outline: Electric force and its applications and related problems, conservation of charge, charge quantization, Electric fields due to point charge and lines of force. Ring of charge, Disk of charge, A point charge in an electric field, Dipole in a n electric field, The flux of vector field, The flux of electric field, Gauss' Law, Application of Gauss' Law, Spherically symmetric charge distribution, A charge isolated conductor, Electric potential energy, Electric potentials, Calculating the potential from the field and related problem Potential due to point and continuous charge distribution, Potential due to dipole, equipotential surfaces, Calculating the field from the potential , Electric current, Current density, Resistance, Resistivity and conductivity, Ohm's law and its applications, The Hall effect, The magnetic force on a current, The Bio- Savart law, Line of B, Two parallel conductors, Amperes' s Law, Solenoid, Toroid's, Faraday's experiments, Faraday's Law of Induction, Lenz's law, Motional emf, Induced electric field, Induced electric fields, The basic equation of electromagnetism, Induced Magnetic field, The displacement current, Reflection and Refraction of light waves, Total internal reflection, Two source interference, Double Slit interference, related problems, Interference from thin films, Diffraction and the wave theory, related problems, Single-Slit Diffraction, related problems, Polarization of electromagnetic waves, Polarizing sheets, related problems.

Reference Materials:
1. Fundamentals of Physics (Extended) Resnick and Walker
2. Narciso Garcia, Arthur Damask, Steven Schwarz., "Physics for Computer Science Students", Springer Verlag.

Course Name: ***Functional English***
Credit Hours: 3 (3-0)
Pre-requisites: None

Course Introduction:
This is first course in English to the Bachelor of Science students and covers all the fundamental concept of English composition and comprehension. The course is designed in such a way that students can use this knowledge to further enhance their language skills in English. The course aims at enhancing students' skill and competence in communicating their ideas in writing and speaking in English language. It will primarily focus on four areas of language to help the students achieve proficiency in language use, develop skills in listening comprehension, improve reading efficiency, use the conventions of standard written English with skill and assertion, build-up vocabulary, and clearly and accurately reproduce specific data. It will illustrate the force and effectiveness of simple and direct English.

Course Outline:
Paragraph and Essay Writing, Descriptive Essays; Sentence Errors, Persuasive Writing; How to give presentations, Sentence Errors; Oral Presentations, Comparison and Contrast Essays, Dialogue Writing, Short Story Writing, Review Writing, Narrative Essays, Letter Writing

Reference Materials: (or use any other standard and latest books)
1. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.
2. A Textbook of English Prose and Structure by Arif Khattak, et al, GIKI Institute,

Course Name: ***Islamic Studies***
Credit Hours: 2 (2-0)
Pre-requisites: None

Course Introduction:

To provide Basic information about Islamic Studies. To enhance understanding of the students regarding Islamic Civilization. History of Islam, understanding of the worship and its usefulness. The basic concept of Quran Pak: wisdom, patience, loyalty. The comparative analysis of Islam with other religions. The Concept and Value of Haqooq ul Ibad (Bandon Kay Haqooq) in Islam. What is The rights of people in Islamic Point of View. Islamic point of view about other religions.

CLO No. Course Learning Outcomes Bloom Taxonomy

1. To further enhance the knowledge of Islam.
2. To understand the basic concept of Islam and Quran Pak.
3. To understand the concept of Haqooq ul ibad in the light of Quran.
4. To know the importance of Islamic concept aboutother religions.

Course Outline:
Basic Themes of Quran, Introduction to Sciences of Hadith, Introduction to Islamic Jurisprudence, Primary & Secondary Sources of Islamic Law, Makken & Madnian life of the Prophet, Islamic Economic System, Political theories, Social System of Islam. Definition of Akhlaq.The Most Important Characters mentioned in the Holy Qur'an and Sunnah, SIDQ (Truthfulness)Generosity Tawakkaul(trust on Allah)Patience Taqua (piety). Haqooq ul ibad in the light of Quran & Hadith - the important characteristic of Islamic Society.

Reference Materials:
1. Introduction to Islam by Dr Hamidullah, Papular Library Publishers Lahore
2. Principles of Islamic Jurisprudence by Ahmad Hassan, Islamic Research Institute, IIUI
3. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services

Course Name: ***Calculus and Analytic Geometry***
Credit Hours: 3 (3-0)
Pre-requisites: None

Course Introduction:
To provide foundation and basic ground for calculus and analytical geometry background.

CLO No. Course Learning Outcomes Bloom Taxonomy

Course Outline:
Limits and Continuity; Introduction to functions, Introduction to limits, Techniques of funding limits, Indeterminate forms of limits, Continuous and discontinuous functions and their applications, Differential calculus; Concept and idea of differentiation, Geometrical and Physical meaning of derivatives, Rules of differentiation, Techniques of differentiation, Rates of change, Tangents and Normals lines, Chain rule, implicit differentiation, linear approximation, Applications of differentiation; Extreme value functions, Mean value theorems, Maxima and Minima of a function for single-variable, Concavity, Integral calculus; Concept and idea of Integration, Indefinite Integrals, Techniques of integration, Riemann sums and Definite Integrals, Applications of definite integrals, Improper integral, Applications of Integration; Area under the curve, Analytical Geometry; Straight lines in R3, Equations for planes.

Reference Materials:
1. Calculus and Analytic Geometry by Kenneth W. Thomas.
2. Calculus by Stewart, James.
3. Calculus by Earl William Swokowski; Michael Olinick; Dennis Pence; Jeffery A. Cole

Course Name: ***Object Oriented Programming***
Credit Hours: 4 (3-1)
Pre-requisites: Programming Fundamentals

Course Introduction:
The course aims to focus on object-oriented concepts, analysis and software development.
The basic concept of OOP is covered in this course.

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 Understand principles of object oriented paradigm. C2 (Understand)
CLO-2 Identify the objects & their relationships to build object oriented solution
C3 (Identify)
CLO-3 Model a solution for a given problem using object oriented principles C3 (Apply)
CLO-4 Examine an object oriented solution C4 (Examine)

Course Outline:
Introduction to object oriented design, history and advantages of object oriented design, introduction to object oriented programming concepts, classes, objects, data encapsulation, constructors, destructors, access modifiers, const vs non-const functions, static data members & functions, function overloading, operator overloading, identification of classes and their relationships, composition, aggregation, inheritance, multiple inheritance, polymorphism, abstract classes and interfaces, generic programming concepts, function & class templates, standard template library, object streams, data and object serialization using object streams, exception handling.

Reference Materials:
1. Java: How to Program, 9th Edition by Paul Deitel
2. Beginning Java 2, 7th Edition by Ivor Horton
3. An Introduction to Object Oriented Programming with Java, 5th Edition by C. Thomas Wu
4. Starting Out with C++ from Control Structures to Objects, 9th Edition, Tony Gaddis
5. C++ How to Program, 10th Edition, Deitel & Deitel.
6. Object Oriented Programming in C++, 3rd Edition by Robert Lafore

Course Name: ***Database System***
Credit Hours: 4 (3-1)
Pre-requisites: None

Course Introduction:
The course aims to introduce basic database concepts, different data models, data storage and retrieval techniques and database design techniques. The course primarily focuses on relational data model and DBMS concepts

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 Explain fundamental database concepts. C2 (Explain)
CLO-2 Design conceptual, logical and physical database schemas using different data models. C5 (Design)
CLO-3 Identify functional dependencies and resolve database anomalies by normalizing database tables. C2 (Identify)
CLO-4 Use Structured Query Language (SQL) for database definition and manipulation in any DBMS C4 (Use)

Course Outline:
Basic database concepts, Database approach vs. file based system, database architecture, three level schema architecture, data independence, relational data model, attributes, schemas, tuples, domains, relation instances, keys of relations, integrity constraints, relational algebra, selection, projection, Cartesian product, types of joins, normalization, functional dependencies, normal forms, entity relationship model, entity sets, attributes, relationship, entity-relationship diagrams, Structured Query Language (SQL), Joins and subqueries in SQL, Grouping and aggregation in SQL, concurrency control, database backup and recovery, indexes, NoSQL systems.

Reference Materials:
1. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg
2. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom
3. Database System Concepts, 6th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan.
4. Database Management Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke

Course Name: ***Digital Logic Design***
Credit Hours: 3 (2-1)
Pre-requisites: None

Course Introduction:
The course introduces the concept of digital logic, gates and the digital circuits. Further, it focuses on the design and analysis combinational and sequential circuits. It also serves to familiarize the student with the logic design of basic computer hardware components.

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 Acquire knowledge related to the concepts, tools and techniques for the design of digital electronic circuits
CLO-2 Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques
CLO-3 Apply the acquired knowledge to simulate and implement small-scale digital circuits
CLO-4 Understand the relationship between abstract logic characterizations and practical electrical implementations.

Course Outline:
Number Systems, Logic Gates, Boolean Algebra, Combination logic circuits and designs, Simplification Methods (K-Map, Quinn Mc-Cluskey method), Flip Flops and Latches, Asynchronous and Synchronous circuits, Counters, Shift Registers, Counters, Triggered devices & its types. Mealy machines and Moore machines. Binary Arithmetic and Arithmetic Circuits, Memory Elements, State Machines. Introduction Programmable Logic Devices (CPLD, FPGA) Lab Assignments using tools such as Verilog HDL/VHDL, MultiSim.

Reference Materials:
1. Digital Fundamentals by Floyd, 11/e.
2. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e

Course Name: ***Multivariable Calculus***
Credit Hours: 3 (3-0)
Pre-requisites: None

CLO No. Course Learning Outcomes Bloom Taxonomy

CLO - 1 Describe the functions of several variables and partial derivatives with applications to find extrema and saddle points. C-1
CLO - 2 Apply the theory to calculate the gradients, area of surfaces and volumes of solids. 1 C-3
CLO - 3 Represent a given function into Fourier series and Fourier transform. 1 C-2

Course Outline: The course introduces functions of several variables, partial differentiation with applications. Important quadric surfaces are included while students also become familiar with 3-dimensional cylindrical and spherical coordinate systems. Double and triple integration are included with applications to find areas and volumes. In the second part advanced topics in vector analysis like calculus of del operator, gradient, curl and divergence along with their physical interpretations are covered. The course also covers Fourier Series: periodic functions, Functions of any period P-2L, Even & odd functions, Half Range expansions and Fourier Transform.

Reference Materials:

1. Advance Engineering Mathematics Erwin Kreyszig Seven Edition
2. Calculus & Analytical Geometry Howard Anton Fifth 3. Calculus Thomas & Finney 1994

Course Name: ***Expository Writing***
Credit Hours: 3 (3-0)
Pre-requisites: Functional English

Course Introduction:
The course introduces students to the communications so they can effectively communicate their message. The course also covers how to make an effective presentation both written and verbal. Various modern techniques of communication and presentation skills are covered in this course. Further the course aims to enhance students' linguistic command, so they could communicate effectively in diversified socio-cultural situations; create larger stretches of interactive text in speech and writing; and identify and repair any instances of potential communication break-up.

Course Outline:

Principles of writing good English, understanding the composition process: writing clearly; words, sentence and paragraphs; Comprehension and expression; Use of grammar and punctuation. Process of writing, observing, audience collecting, composing, drafting and revising, persuasive writing, reading skills, listening skills and comprehension, skills for taking notes in class, skills for exams; Business communications; planning messages, writing concise but with impact. Letter formats, mechanics of business, letter writing, letters, memo and applications, summaries, proposals, writing resumes, styles and formats, oral communications, verbal and non-verbal communication, conducting meetings, small group communication, taking minutes. Presentation skills; presentation strategies, defining the objective, scope and audience of the presentation, material gathering material organization strategies, time management, opening and concluding, use of audio-visual aids, delivery and presentation.

Reference Materials:
1. Practical Business English, Collen Vawdrey, 1993, ISBN = 0256192740
2. Effective Communication Skills: The Foundations for Change, John Nielsen, 2008, ISBN = 1453506748
3. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.
4. A Textbook of English Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000

Course Name: ***Ideology and Constitution of Pakistan***
Credit Hours: 2 (2-0)
Pre-requisites: None
Course Introduction:
Pakistan studies is an important course at this university in which students study about their motherland. The following are the specific objective of the course
• To develop vision of Historical Perspective, Government, Politics, Contemporary Pakistan, ideological background of Pakistan.
•To study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO - 1 To educate students about the history of Pakistan
CLO - 2 To educate student about the various pillar of the state
CLO - 3 To educate student Government and politics

Course Outline:
Historical background of Pakistan: Muslim society in Indo-Pakistan, the movement led by the societies, the downfall of Islamic society, the establishment of British Raj- Causes and consequences. Political evolution of Muslims in the twentieth century: Sir Syed Ahmed Khan; Muslim League; Nehru; Allama Iqbal: Independence Movement; Lahore Resolution; Pakistan culture and society, Constitutional and Administrative issues, Pakistan and its geopolitical dimension, Pakistan and International Affairs, Pakistan and the challenges ahead.

Reference Materials:
1. The Emergence of Pakistan, Chaudary M., 1967
2. The making of Pakistan, Aziz. 1976
3. A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988

Course Name: ***Data Structures***
Credit Hours: 4 (3-1)
Pre-requisites: Programming Fundamentals

Course Introduction:
The course is designed to teach students structures and schemes, which allow them to write programmer to efficiently manipulate, store, and retrieve data. Students are exposed to the concepts of time and space complexity of computer programs.

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 Implement various data structures and their algorithms
and apply them in implementing simple applications C3 (Apply)
CLO-2 Analyze simple algorithms and determine their complexities.C5 (Analyze)
CLO-3 Apply the knowledge of data structure to other application domains. C3 (Apply)
CLO-4 Design new data structures and algorithms to solve problems. C6 (Design)

Course Outline:
Abstract data types, complexity analysis, Big Oh notation, Stacks (linked lists and array implementations), Recursion and analysing recursive algorithms, divide and conquer algorithms, Sorting algorithms (selection, insertion, merge, quick, bubble, heap, shell, radix, bucket), queue, dequeuer, priority queues (linked and array implementations of queues), linked list & its various types, sorted linked list, searching an unsorted array, binary search for sorted arrays, hashing and indexing, open addressing and chaining, trees and tree traversals, binary search trees, heaps, M-way tress, balanced trees, graphs, breadth-first and depth-first traversal, topological order, shortest path, adjacency matrix and adjacency list implementations, memory management and garbage collection.

Reference Materials: (or use any other standard and latest books)
1. Data Structures and Algorithm Analysis in Java by Mark A. Weiss
2. Data Structures and Abstractions with Java by Frank M. Carrano & Timothy M. Henry
3. Data Structures and Algorithms in C++ by Adam Drozdek
4. Data Structures and Algorithm Analysis in C++ by Mark Allen Weiss Java Software Structures: Designing and Using Data Structures by John Lewis and Joseph Chas

Course Name: ***Computer Networks***
Credit Hours: 3 (2-1)
Pre-requisites: None

Course Introduction:
This course introduces the basic concept of computer network to the students. Network layers, Network models (OSI, TCP/IP) and protocol standards are part of the course.

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 Describe the key terminologies and technologies of computer networks C2 (Describe)
CLO-2 Explain the services and functions provided by each layer in the Internet protocol stack. C2 (Explain)
CLO-3 Identify various internetworking devices and protocols and their functions in a networking C4 (Identify)
CLO-4 Analyze working and performance of key technologies, algorithms and protocols C4 (Analyze)
CLO-5 Build Computer Network on various Topologies P3 (Build)

Course Outline:
Introduction and protocols architecture, basic concepts of networking, network topologies, layered architecture, physical layer functionality, data link layer functionality, multiple access techniques, circuit switching and packet switching, LAN technologies, wireless networks, MAC addressing, networking devices, network layer protocols, IPv4 and IPv6, IP addressing, sub netting, CIDR, routing protocols, transport layer protocols, ports and sockets, connection establishment, flow and congestion control, application layer protocols, latest trends in computer networks.

Reference Materials:
1. Computer Networking: A Top-Down Approach Featuring the Internet, 6th edition by James F. Kurose and Keith W. Ross
2. Computer Networks, 5th Edition by Andrew S. Tanenbaum
3. Data and Computer Communications, 10th Edition by William Stallings
4. Data Communication and Computer Networks, 5th Edition by Behrouz A. Forouzan

Course Name: ***Software Engineering***
Credit Hours: 3 (3-0)
Pre-requisites: None

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 Describe various software engineering processes and activates C1 (Describe)
CLO-2 Apply the system modeling techniques to model a medium size software systems C3 (Apply)
CLO-3 Apply software quality assurance and testing principles to medium size software systems C4 (Apply)
CLO-4 Discuss key principles and common methods for software project management such as scheduling, size estimation, cost estimation and risk analysis C2 (Discuss)

Course Outline:
Nature of Software, Overview of Software Engineering, Professional software development, Software engineering practice, Software process structure, Software process models, Agile software Development, Agile process models, Agile development techniques, Requirements engineering process, Functional and non-functional requirements, Context models, Interaction models, Structural models, behavioral models, model driven engineering, Architectural design, Design and implementation, UML diagrams, Design patterns, Software testing and quality assurance, Software evolution, Project management and project planning, configuration management, Software Process improvement

Reference Materials: (or use any other standard and latest books)
1. Software Engineering, Sommerville I., 10th Edition, Pearson Inc., 2014
2. Software Engineering, A Practitioner's Approach, Pressman R. S.& Maxim B. R., 8th Edition, McGraw-Hill, 2015.

Course Name: ***Linear Algebra***
Credit Hours: 3 (3-0)
Pre-requisites: Calculus and Analytical Geometry

Course Introduction:

To provide fundamentals of solution for system of linear equations, operations on system of equations, matrix properties, solutions and study of their properties.

Course Outline:
Algebra of linear transformations and matrices. determinants, rank, systems of equations, vector spaces, orthogonal transformations, linear dependence, linear Independence and bases, eigenvalues and eigenvectors, characteristic equations, Inner product space and quadratic forms.

Reference Materials: (or use any other standard and latest books)
1. Elementary Linear Algebra by Howard Anton
2. Linear Algebra and its Applications by Gibert Strang

Course Name: ***Discrete Structure***
Credit Hours: 3 (3-0)
Pre-requisites: None

Course Introduction:
Introduces the foundations of discrete mathematics as they apply to Computer Science, focusing on providing a solid theoretical foundation for further work. Further, this course aims to develop understanding and appreciation of the finite nature inherent in most Computer Science problems and structures through study of combinatorial reasoning, abstract algebra, iterative procedures, predicate calculus, tree and graph structures. In this course more emphasis shall be given to statistical and probabilistic formulation with respect to computing aspects.

Course Learning Outcomes Bloom Taxonomy

CLO-1 Understand the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs and Trees etc. C2 (Understand)
CLO-2 Apply formal logic proofs and/or informal, but rigorous, logical reasoning to real problems, such as predicting the behavior of software or solving problems such as puzzles. C3 (Apply)
CLO-3 Apply discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography. C3 (Apply)
CLO-4 Differentiate various discrete structures and their relevance within the context of computer science, in the areas of data structures and algorithms, in particular C4 (Differentiate)

Course Outline:
Mathematical reasoning, propositional and predicate logic, rules of inference, proof by induction, proof by contraposition, proof by contradiction, proof by implication, set theory, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings, function composition, inverse functions, recursive functions, Number Theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations. Algorithms, Searching and Sorting Algorithms, elements of graph theory, planar graphs, graph coloring, Graph Algorithms, euler graph, Hamiltonian path, rooted trees, traversals.

Reference Materials: (or use any other standard and latest books)
1. Discrete Mathematics and Its Applications, 7th edition by Kenneth H. Rosen
2. Discrete Mathematics with Applications, 4th Edition by Susanna S. Epp
3. Discrete Mathematics, 7th edition by Richard Johnson Baugh
4. Discrete Mathematical Structures, 4th edition by Kolman, Busby & Ross
5. Discrete and Combinatorial Mathematics: An Applied Introduction by Ralph P. Grimaldi
6. Logic and Discrete Mathematics: A Computer Science Perspective by Winifred Grassman

Course Name: ***Entrepreneurship***
Credit Hours: 2 (2-0)
Pre-requisites: None

Course Introduction:
In this course, students will focus on learning the essential skills and strategies to successfully launch and grow a new business. Topics covered include market validation, product development, business planning and strategy, marketing and sales, funding and financial management, leadership and team building. The course will also delve into practical aspects of entrepreneurship, such as identifying and overcoming common challenges, building a supportive network, and developing a growth mindset. The course aims to equip students with the knowledge and skills needed to turn their entrepreneurial ideas into successful, thriving businesses.

Course Learning Outcomes Bloom Taxonomy
CLO-1 Understand the basics of Entrepreneurship and its applications
CLO-2 Apply entrepreneurial skills and tools specifically needed for entrepreneurial ventures
CLO-3 Recognize contents of entrepreneurial process and MVP
CLO-4 Develop and understand marketing plan, production plan, Financial Plan, Legal form of new venture, Intellectual Property.

Course Outline:
Introduction Course Outline, objectives, teaching plan, assessment method, Fundamentals of Entrepreneurship & Allocation of projects. Developing the Business Plan and twenty Principles of Entrepreneurship. Intrapreneurial culture. Corporate Versus Intrapreneurial Culture Comparison of Entrepreneurial, Intrapreneurial & Traditional Managers. The Individual Entrepreneur Entrepreneurial Feelings. Entrepreneurial Background and Characteristics. Role Models and Support Systems. Entrepreneurs Versus Inventors. Non-Entrepreneurial Profiles. Presentations of the "Startups case" and Global Competitiveness Report. Essentials of New Product Development. Examples of change in Product Design & Manufacturing. Guest Speaker Session. Development processes & Organizations. Identifying Customer Needs. Sustainable Manufacturing. Guest Speaker Session. Project Management Skills for Entrepreneurial projects. Export Procedures & Documentation. Project Presentations

Reference Materials:
1.Entrepreneurship (5th Edition), Robert D. Hisrich& Michael P. Peters. McGraw Hill Irwin.
2.Product Design & Development, Karl T Ulrich & Steven D. Eppinger

Course Name: ***Computer Organization and Assembly Language***
Credit Hours: 3 (2-1)
Pre-requisites: Digital Logic Design

Course Introduction:
The main objective of this course is to introduce the organization of computer systems and usage of assembly language for optimization and control. Emphasis should be given to expose the low-level logic employed for problem solving while using assembly language as a tool. At the end of the course the students should be capable of writing moderately complex assembly language subroutines and interfacing them to any high level language.

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 Acquire the basic knowledge of computer organization computer architecture and assembly language C2 (Understand)
CLO-2 Understand the concepts of basic computer organization, architecture, and assembly language techniques C2 (Understand)
CLO-3 Solve the problems related to computer organization and assembly language C3 (Apply)

Course Outline:
Introduction to computer systems: Information is bits + context, programs are translated by other programs into different forms, it pays to understand how compilation systems work, processors read and interpret instructions stored in memory, caches matter, storage devices form a hierarchy, the operating system manages the hardware, systems communicate with other systems using networks; Representing and manipulating information: information storage, integer representations, integer arithmetic, floating point; Machine-level representation of programs: a historical perspective, program encodings, data formats, accessing information, arithmetic and logical operations, control, procedures, array allocation and access, heterogeneous data structures, putting it together: understanding pointers, life in the real world: using the gdb debugger, out of-bounds memory references and buffer overflow, x86-64: extending ia32 to 64 bits, machine-level representations of floating-point programs; Processor architecture: the Y86 instruction set architecture, logic design and the Hardware Control Language (HCL), sequential Y86 implementations, general principles of pipelining, pipelined Y86 implementations

Reference Materials:
1. Computer System Architecture, M. Morris Mano, Latest Edition,
2. Assembly Language Programming for Intel- Computer, Latest Edition
3. Computer Systems: A Programmer's Perspective, 3/E (CS:APP3e), Randal E. Bryant and David R.O' Hallaron, Carnegie Mellon University
4. Robert Britton, MIPS Assembly Language Programming, Latest Edition,

Course Name: ***Theory of Automata***
Credit Hours: 3 (3-0)
Pre-requisites: None

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 Explain and manipulate the different concepts in automata theory and formal languages such as formal proofs, automata, regular expressions, Turing machines etc. C2 (Understand)
CLO-2 Prove properties of languages, grammars and automata with rigorously formal mathematical methods C2 (Understand)
CLO-3 Design of automata, RE and CFG C3 (Apply)
CLO-4 Transform between equivalent NFAs, DFAs and REs C3 (Apply)
CLO-5 Define Turing machines performing simple tasks C2 (Understand)
CLO-6 Differentiate and manipulate formal descriptions of languages, automata and grammars with focus on regular and context-free languages, finite automata and regular expressions. C3 (Apply)

Course Outline:
Finite State Models: Language definitions preliminaries, Regular expressions/Regular languages, Finite automata (FAs), Transition graphs (TGs), NFAs, Kleene's theorem, Transducers (automata with output), Pumping lemma and non-regular language Grammars and PDA: CFGs, Derivations, derivation trees and ambiguity, Simplifying CFLs, Normal form grammars and parsing, Decidability, Context sensitive languages, grammars and linear bounded automata (LBA), Chomsky's hierarchy of grammars Turing Machines Theory: Turing machines, Post machine, Variations on TM, TM encoding, Universal Turing Machine, Defining Computers by TMs.

Reference Materials:
1. Introduction to computer theory, Daniel I. A. Cohen, 2nd Edition
2. Automata, Computability and Complexity: Theory and Applications, by Elaine Rich, 2011
3. An Introduction to Formal Languages and Automata, by Peter Linz, 4th edition, Jones & Bartlett Publishers, 2006

Course Name: ***Advance Database Management Systems***
Credit Hours: 3 (2-1)
Pre-requisites: Database Systems

Course Introduction:
Advanced Database Management Systems is an extension to "Database Systems" course. The aim of the course is to enhance the previous knowledge of database systems by deepening the understanding of the theoretical and practical aspects of the database technologies, and showing the need for distributed database technology to tackle deficiencies of the centralized database systems. Moreover, it focuses to introduce the basic principles and implementation techniques of distributed database systems, and expose emerging research issues in database systems and application development.

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 Understanding advance data models, technologies and approaches for building distributed database systems. C2 (Understand)
CLO-2 Applying the models and approaches in order to become enabled to select and apply appropriate methods for a particular case C3 (Apply)
CLO-3 To develop a database solution for a given scenario/challenging problem in the domain of distributed database systems. C3 (Apply)

Course Outline:
Introduction to advance data models such as object relational, object oriented. File organizations concepts, Transactional processing and Concurrency control techniques, Recovery techniques, Query processing and optimization, Database Programming (PL/SQL, T-SQL or similar technology), Integrity and security, Database Administration (Role management, managing database access, views), Physical database design and tuning, Distributed database systems, Emerging research trends in database systems, MONGO DB, NO SQL (or similar technologies)

Reference Materials:
1. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg
2. Database Management Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke
3. Database System Concepts, 6th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan.
4. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom

Organizational Behavior
Credit Hours: 2 (2-0)
Pre-requisites: None

Course Introduction:
The major objective of this course is to make sure by the end of this semester students should be able to have a clear perspective of what organization theory and behavior is an to understand various concepts of organization theory and behavior and practically apply the knowledge gained in their day to day life.

Course Contents:
Organizational Behavior (OB) is an interdisciplinary field geared to satisfy managers' quest to know why people behave as they do in relation to their jobs, their work groups and their organizations. Drawing on numerous disciplines including psychology, sociology, anthropology and economics, OB identifies and explores factors that influence individual and group behavior in organizations. This knowledge of individuals' perceptions, motivational attitudes and behavior enables managers to not only understand themselves better, but also to adopt appropriate managerial policies and leadership styles to increase their effectiveness. Students will be able to demonstrate analytical and problem solving skills in the application of this knowledge to work-related situations.

Reference Materials:
1. Organizational Behavior on the Pacific Rim by Steven McShane and Tony Travaglione Enhanced Edition McGraw Hill (S)
2. Organizational Behavior Robert Kreitner and Angelo Kinicki, Eighth Edition McGraw Hill (K
3. Organizational Behavior, Fred Luthans. Latest Edition.

Course Name: Professional Practices
Credit Hours: 2 (2-0)
Pre-requisites: None

Course Introduction:
A Computing graduate as professional has some responsibilities with respect to the society. This course develops student understanding about historical, social, economic, ethical, and professional issues related to the discipline of Computing. It identifies key sources for information and opinion about professionalism and ethics. Students analyze, evaluate, and assess ethical and professional computing case studies.

Course Outline:
Historical, social, and economic context of Computing (software engineering, Computer Science, Information Technology); Definitions of Computing (software engineering, Computer Science, Information Technology) subject areas and professional activities; professional societies; professional ethics; professional competency and life-long learning; uses, misuses, and risks of software; information security and privacy; business practices and the economics of software; intellectual property and software law (cyber law); social responsibilities, software related contracts, Software house organization. Intellectual Property Rights, The Framework of Employee Relations Law and Changing Management Practices, Human Resource Management and IT, Health and Safety at Work, Software Liability, Liability and Practice, Computer Misuse and the Criminal Law, Regulation and Control of Personal Information. Overview of the British Computer Society Code of Conduct, IEEE Code of Ethics, ACM Code of Ethics and Professional Conduct, ACM/IEEE Software Engineering Code of Ethics and Professional Practice. Accountability and Auditing, Social Application of Ethics.

Reference Materials: (or use any other standard and latest books)
1. Professional Issues in Software Engineering by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, CRC Press; 3rd Edition (2000). ISBN-10: 0748409513
2. Computer Ethics by Deborah G. Johnson, Pearson; 4th Edition (January 3, 2009). ISBN-10: 0131112414
3. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet (3rd Edition) by Sara Baase, Prentice Hall; 3rd Edition (2008). ISBN-10: 0136008488
4. Applied Professional Ethics by Gregory R. Beabout, University Press of America (1993). ISBN-10: 0819193747.

Course Name: Bioinformatics
Credit Hours: 3 (3-0)
Prerequisites: None

Course Learning Outcomes (CLOs):
At the end of the course the students will be able to:

Domain	BT Level*

1. Demonstrate the basic concepts of Bioinformatics and its significance in Biological data analysis.
2. Implement efficient alignment, assembly and clustering algorithms.
3. Formulate and justify appropriate choices in technology, strategy, and analysis for a range of projects involving DNA, RNA, or protein sequence data

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain,

A= Affective domain

Course Content:

Origin of the field , Advances in biology and computers , Brief overview of key Biological concepts related to DNA, RNA, nucleotides, amino acids, proteins, protein interaction, Databases and web resources, Algorithms how to write them, and calculate their complexities, etc. , Nucleotide analysis principals and tools , Sequence similarity, Dot Matrix, Dynamic Programming for local , Global pair wise alignment using Smith-Waterman and Needle-Wunsch algorithms, Gap penalties including Affine gap penalty, Scoring and Substitution Matrices (PAM & BLOSUM), Multiple Sequence Alignment, BLAST and FASTA, etc., Dynamic programming algorithms, Statistical models, Artificial intelligence algorithms, Protein analysis including protein structure prediction from a sequence. , Phylogenetics, Mutations, evolution and protein families, clustering, predictions using distance methods (such as UPGMA), etc.

Reference Materials:

1. Introduction to Bioinformatics by T K Attwood, D J Parry-Smith, Samiron Phukan, Pearson Education (Latest edition).
2. Introduction to Bioinformatics by Arthur Lesk .
3. Algorithms in Bioinformatics by Gary Benson, Roderic Page, Springer.
4. Algorithmic Aspects of Bioinformatics by Hans-Joachim Bockenhauer, Dirk Bongartz, Springer.

Course Name: Operating Systems
Credit Hours: 3 (2-1)
Pre-requisites: Data Structures

Course Introduction:
To help students gain a general understanding of the principles and concepts governing the functions of operating systems and acquaint students with the layered approach that makes design, implementation and operation of the complex OS possible.

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 Understand the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems C2 (Understand)
CLO-2 Analyze and evaluate the algorithms of the core functions of the Operating Systems and explain the major performance issues with regard to the core functions C5 (Evaluate)
CLO-3 Demonstrate the knowledge in applying system software and tools available in modern operating systems. C3 (Demonstrate)

Course Outline:
Operating systems basics, system calls, process concept and scheduling, inter-process communication, multithreaded programming, multithreading models, threading issues, process scheduling algorithms, thread scheduling, multiple-processor scheduling, synchronization, critical section, synchronization hardware, synchronization problems, deadlocks, detecting and recovering from deadlocks, memory management, swapping, contiguous memory allocation, segmentation & paging, virtual memory management, demand paging, thrashing, memory-mapped files, file systems, file concept, directory and disk structure, directory implementation, free space management, disk structure and scheduling, swap space management, system protection, virtual machines, operating system security

Reference Materials: (or use any other standard and latest books)
1.Operating Systems Concepts, 9th edition by Abraham Silberschatz
2.Modern Operating Systems, 4th edition by Andrew S. Tanenbaum
3.Operating Systems, Internals and Design Principles, 9th edition by William StallingsWu

Course Name: Computer Architecture
Credit Hours: 3 (2-1)
Pre-requisites: Data Structures

Course Introduction:
This course aims to provide a strong foundation for students to understand the modern eras of computer architecture (i.e., the single-core era, multi-core era, and accelerator era) and to apply these insights and principles to future computer designs. The course is structured around the three primary building blocks of general-purpose computing systems: processors, memories, and networks.

Course Learning Outcomes (CLOs):
At the end of the course the students will be able to:

Domain	BT Level*

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Outline:
The course includes five parts: the first three parts cover the fundamentals of processor, memory, and network design, while the final two parts cover more advanced processors and memory design. In addition, the final lecture at the end of the course will present in detail an example architecture from industry to help illustrate the concepts discussed in class. A tentative list of topics for each part is included below. The exact topics covered in the course are subject to change based on students. progress and interest. Fundamental Processors– instruction set architecture; single-cycle, FSM, and pipelined processor microarchitecture; resolving structural, data, control, and name hazards; and analyzing processor performance Fundamental Memories- memory technology; direct-mapped vs. associative caches; write-through vs write-back caches; memory protection, translation, and virtualization; FSM and pipelined cache microarchitecture; and analyzing memory performance Integrating Processors, Memories, and Networks– processor and L1 cache interface; banked memory systems; message-passing systems; shared-memory systems advanced Processors (12 lectures) – superscalar execution, out-of-order execution, register renaming, memory disambiguation, branch prediction, speculative execution; multithreaded, VLIW, and SIMD processors Advanced Memories – memory synchronization, consistency, and coherence.

Reference Materials: (or use any other standard and latest books)
1. M. Morris Mano and Michael Ciletti, Digital Design, 5th Edition 2. Hennessy and Patterson
2. Computer Organization and Design: The Hardware/Software Interface, RISC-V Edition (2nd)

Course Name: **Human Computer Interaction and Computer Graphics**
Credit Hours: 3 (3-0)
Prerequisites: Software Engineering

Course Learning Outcomes (CLOs):
At the end of the course the students will be able to:
1. Explain context of HCI and different measures for evaluation.
2. Apply the principles of good design for people from the perspective of age and disabilities.
3. Analyze techniques for user centered design for a medium sized software.
4. Evaluate the usability of a medium size software user interface.

Domain **BT Level***
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:
Contexts for HCI, Psychology of usable things, Processes for User-Centered Design, Metrics and Measures for Evaluation, Usability heuristics and principles of Usability testing, Physical capabilities, Cognitive and social models for interaction design, Principles of good interaction design, Accessibility, Principles of GUI, Visual design elements, Data gathering, Task analysis, Prototyping, Help and user documentation, Internationalization, Usability inspection methods, Usability testing methods, New Interaction Technologies, Usability in practice, Visual Design and Typography, Icon Design, Ubiquitous, Augmented and Virtual Reality. Fundamental Concepts: forward and backward rendering (i.e., ray-casting and rasterization), applications of computer graphics: including game engines, cad, visualization, virtual reality, polygonal representation, basic radiometry, similar triangles, and projection model, use of standard graphics APIs (see HCI GUI construction); basic rendering: rendering in nature, i.e., the emission and scattering of light and its relation to numerical integration, affine and coordinate system transformations, ray tracing, visibility and occlusion, including solutions to this problem such as depth buffering, painter's algorithm, and ray tracing, the forward and backward rendering equation, simple triangle rasterization, rendering with a shader-based API, texture mapping, including minification and magnification (e.g., trilinear MIP-mapping), application of spatial data structures to rendering, sampling and anti-aliasing, scene graphs and the graphics pipeline; geometric modeling: basic geometric operations such as intersection calculation, proximity tests, polynomial curves and surfaces, approximation techniques such as polynomial curves, bezier curves, spline curves and surfaces, animation as a sequence of still images.

Reference Materials:

1. Designing the User Interface: Strategies for Effective Human-Computer Interaction, Ben Shneiderman and Catherine Plaisant, 6th Ed, Pearson Inc, 2016.
2. Designing Interactive Systems: A Comprehensive Guide to HCI, UX and Interaction Design, Benyon, D. 3rd Ed., Pearson. 2013
3. About Face: The Essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, 4th Ed, Wiley, 2014

Course Name: Web Technologies
Credit Hours: 3(2-1)
Prerequisites:

Course Learning Outcomes (CLOs):
At the end of the course the students will be able to:

Domain	**BT Level***

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:
Introduction to Web Applications, TCP/IP Application Services. Web Servers: Basic Operation, Virtual hosting, Chunked transfers, Caching support, Extensibility. SGML, HTML5, CSS3. XML Languages and Applications: Core XML, XHTML, XHTM MP. Web Service: SOAP, REST, WML, XSL. Web Services: Operations, Processing HTTP Requests, Processing HTTP Responses, Cookie Coordination, Privacy and P3P, Complex HTTP Interactions, Dynamic Content Delivery. Server Configuration. Server Security. Web Browsers Architecture and Processes. Active Browser Pages: JavaScript, DHTML, AJAX. JSON, Approaches to Web Application Development. Programing in any Scripting language. Search Technologies. Search Engine Optimization. XML Query Language, Semantic Web, Future Web Application Framework.

Reference Materials:

1. Web Application Architecture: Principles, protocols and practices by Leon Shklar and Richard Rosen, Wiley; 2nd Edition (May 5, 2009). ISBN-10:047051860X
2. Web Technologies: A Computer Science Perspective by Jeffrey C. Jackson, Prentice Hall; 1st Edition (August 27, 2006). ISBN-10:0131856030

Course Name: Mobile Application Development
Credit Hours: 3(2-1)
Prerequisites: Object Oriented Programming

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Discuss different architectures & framework for Mobile Application development.		
2. Develop mobile applications using current software development environments.		
3. Compare the different performance tradeoffs in mobile application development.		

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:
Mobiles Application Development Platform; HTML5 for Mobiles; Android OS: Architecture, Framework and Application Development; iOS: Architecture, Framework; Application Development with Windows Mobile; Eclipse; Fragments; Calling Built-in
Applications using Intents; Displaying Notifications; Components of a Screen; Adapting to Display Orientation; Managing Changes to Screen Orientation; Utilizing the Action Bar; Creating the User Interface; Listening for UI Notifications; Views; User Preferences; Persisting Data; Sharing Data; Sending SMS Messages; Getting Feedback; Sending E-mail; Displaying Maps; Consuming Web Services Using HTTP; Web Services: Accessing and Creating; Threading; Publishing, Android Applications; Deployment on App Stores; Mobile Programming Languages; Challenges with Mobility and Wireless Communication; Location-aware Applications; Performance/Power Tradeoffs; Mobile Platform Constraints; Emerging Technologies..

Reference Materials:

1. Professional Android application development, Reto Meier, Wrox Programmer to Programmer, 2015.
2. iOS Programming: The Big Nerd Ranch Guide, Conway, J., Hillegass, A., & Keur, C., 5th Edition, 2014.
3. Android Programming: The Big Nerd Ranch Guides, Phillips, B. & Hardy, B., 2nd Edition, 2014.

Course Name: Probability & Statistics
Credit Hours: 3 (3-0)
Prerequisites:

Course Learning Outcomes (CLOs):
At the end of the course the students will be able to:

Domain	**BT Level***

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:
Introduction to Statistics and Data Analysis, Statistical Inference, Samples, Populations, and the Role of Probability. Sampling Procedures. Discrete and Continuous Data. Statistical Modeling. Types of Statistical Studies. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes' Rule. Random Variables and Probability Distributions. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem. Discrete Probability Distributions. Continuous Probability Distributions. Fundamental Sampling Distributions and Data Descriptions: Random Sampling, Sampling Distributions, Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of S2, t-Distribution, F-Quantile and Probability Plots. Single Sample & One- and Two-Sample Estimation Problems. Single Sample & One- and Two-Sample Tests of Hypotheses. The Use of P-Values for Decision Making in Testing Hypotheses (Single Sample & One- and Two-Sample Tests), Linear Regression and Correlation. Least Squares and the Fitted Model, Multiple Linear Regression and Certain, Nonlinear Regression Models, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators

Reference Materials:

1. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, Pearson; 9th Edition (January 6, 2011). ISBN-10: 0321629116
2. Probability and Statistics for Engineers and Scientists by Anthony J. Hayter, Duxbury Press; 3rd Edition (February 3, 2006), ISBN-10:0495107573
3. Schaum's Outline of Probability and Statistics, by John Schiller, R. Alu Srinivasan and Murray Spiegel, McGraw-Hill; 3rd Edition (2008). ISBN-10:0071544259

Course Name: Information Security
Credit Hours: 3 (2-1)
Pre-requisites: None

Course Introduction:
This course provides a broad overview of the threats to the security of information systems, the responsibilities and basic tools for information security, and the levels of training and expertise needed in organizations to reach and maintain a state of acceptable security. It covers concepts and applications of system and data security. Areas of particular focus include secure network design, implementation and transition issues, and techniques for responding to security breaches.

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 Explain key concepts of information security such as design principles, cryptography, risk management, and ethics C2 (Explain)
CLO-2 Discuss legal, ethical, and professional issues in information security A2 (Discuss)
CLO-3 Apply various security and risk management tools for achieving information security and privacy C3 (Apply)
CLO-4 Identify appropriate techniques to tackle and solveproblems in the discipline of information security C4 (Identify)

Course Outline:
Information security foundations, security design principles; security mechanisms, symmetric and asymmetric cryptography, encryption, hash functions, digital signatures, key management, authentication and access control; software security, vulnerabilities and protections, malware, database security; network security, firewalls, intrusion detection; security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics in information security, privacy and anonymity of data.

Reference Materials: (or use any other standard and latest books)
1. Computer Security: Principles and Practice, 3rd edition by William Stallings
2. Principles of Information Security, 6th edition by M. Whitman and H. Mattord
3. Computer Security, 3rd edition by Dieter Gollmann
4. Computer Security Fundamentals, 3rd edition by William Easttom
5. Official (ISC)2 Guide to the CISSP CBK, 3rd edition

Course Name: Parallel and Distributed Computing
Credit Hours: 3 (2-1)
Pre-requisites: Object Oriented Programming, Operating Systems

Course Introduction:

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Learn about parallel and distributed computers. -	
CLO-2	Write portable programs for parallel or distributed architectures using Message-Passing Interface (MPI)library	
CLO-3	Analyze complex problems with shared memory programming with openMP.	

Course Outline:
Asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, synchronization, and tools (Cuda, Swift, Globus, Condor, Amazon AWS, OpenStack, Cilk, gdb, threads, MPICH, OpenMP, Hadoop, FUSE).

Reference Materials:
1. Distributed Systems: Principles and Paradigms, A. S. Tanenbaum and M. V. Steen, Prentice Hall, 2nd Edition, 2007
2. Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet, K Hwang, J Dongarra and GC. C. Fox, Elsevier, 1st Ed.

Course Name: Compiler Construction
Credit Hours: 3 (2-1)
Pre-requisites: None

CLO No.	Course Learning Outcomes	Bloom Taxonomy
1.	Have knowledge related to the basic theory of compilers.	
2.	Apply the acquired knowledge Translate and interpret computer languages	
3.	Evaluate the issues involved in implementing a compiler	

Course Outline:
Passes of a Compiler. Lexical Analysis, Specification of Tokens, Recognition of Tokens, Top-down Parsing, Predictive Parsing, Recursive Descent Parsing, LL Parsing, LL Pasing Table Construction, Left Factoring, Bottom-up Parsing, Shift-Reduce Parsing, LR(1) Parsing, LR(1) Canonical Collection of Items, LR(1) Parsing, Shift-Reduce Conflicts, LALR Parsing, Parser Generators – YACC, Sematic Analysis, Attribute Grammars, Ad-hoc scheme for attribute grammars, Intermediate Representation (IR), Intermediate Representation taxonomy, Syntax-directed translation: assignment statement, Code Generation, Code Optimization.

Reference Materials:
1. Compilers and Compiler Generators by PD Terry.
2. Compiler Construction using Flex and Bison by Anthony Aaby
3. Operator-Precedence Parsing by Thomas Niemann

Course Name: Advanced Programming
Credit Hours: 3 (2-1)
Pre-requisites: None

CLO No.	Course Learning Outcomes	Bloom Taxonomy

Course Introduction:

The Advanced Programming course is a successor to the Introduction to Programming course. This course teaches some advanced programming concepts. It builds upon prior knowledge of students about programming using languages like C. This is going to be an intensive hands-on course and is going to heavily based on programming assignments, labs and practical exams. The course begins with a discussion on Introduction to Object Oriented Paradigm and Programming Concepts. Students will learn the key elements of a typical object oriented application such as objects, classes, messages, interfaces, abstraction, inheritance, encapsulation and polymorphism. We will make use of Java language to demonstrate the concepts. However, the concepts can be applied using other programming languages. After covering the basics of object oriented programming, we will cover advanced Java programming features such as the Basic Error amp; Exception handling, IO amp; Streams, Concurrent programming with Threads , GUI programming, Collections Framework, and unit testing with JUnit. Throughout the course, students will use an integrated development environment like Eclipse and learn to make use of Java documentation and also learn to create documentation, using JavaDoc, with code.

Course Outline:
Introduction to Java, Java Applets, the Java Development Kit (JDK) (in Lab), Exception Handling, Graphical User Interface (GUI), Multithreading; Java Network Programming: Protocols, IP, TCP, URL; Java.net Package, URL, URL Connection class, InetAddress class, Socket class Tutorial 9 Assignment 3 Due Date: (11) Client Server Programming; Project Due Date: Client Server Programming; Remote method invocation (Java.rmi package), Database manipulation in Java.

Reference Materials:
1. Core Java 2 Volume 1Fundamental by Cay Horstmann and Gary Cornel Publisher: Sun Microsystems Press a Prentice Hall Title, 2001

Course Name: Software Verification and Validation

Credit Hours: 3 (2-1)
Prerequisites: Software Engineering

Course Learning Outcomes (CLOs):
At the end of the course the students will be able to:
1. Outline software testing and software quality assurance principles.
2. Prepare test case and test suites for completely testing all aspects of a system under test (SUT)
3. Analyze which of the software testing techniques are relevant for a particular case and know software reliability analysis tools and techniques.
4. Compile findings of a quality assurance cycle.

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:
Software Quality, Software Quality Attributes, Quality Engineering., Testing: Concepts, Issues, and Techniques, Software testing lifecycle., Testing Scopes., Testing Approaches., Testing Concepts., Test Planning Process, Introduction to testing process, Requirement of software test planning, Testing documentation, Reporting and historical data recording., Software testing techniques, Testing philosophies , Testing strategies, Model based testing, Software testing techniques, Testing using models, Domain and combinatorial testing, Unit and integration testing, Acceptance testing, Test automation, Slicing, Software reliability models and engineering, Introduction, Exponential model., Reliability growth models, Modeling process, Software inspections, Software reviews, Inspection checks and metrics, Quality Models, Models for quality assessment, Product quality metrics, Quality Measurements, In-Process metrics for software testing, In-Process quality management, Effort/outcome models, System testing, Introduction to sub-system testing, From functional to system aspects of testing, System testing, Introduction to system testing, Scenarios development, System testing, Use-cases for testing, Specification-based testing, Open issues on software testing

Reference Materials:

3. Paul Jorgensen, Software Testing, A Craftsman's Approach, 4th Ed. CRC Press, Taylor and Francis Group, 2015
4. Bernard Homes, Fundamentals of Software Testing, ISTE, Wiley, 2012
5. Software Engineering, "Ian Sommerville, 9th Edition, Addison Wesley, 2011

Course Name: Web Engineering

Credit Hours: 3 (2-1)
Prerequisites: Web Technologies

Course Introduction:
This course aims to equip students with essential concepts and contemporary tools for web application development. It covers the foundational principles related to the architecture and operation of the World Wide Web as a platform, including various hosted web applications. They will gain a comprehensive understanding of the societal and cultural issues associated with these web applications, with a focus on maintaining professional and ethical practices in web development. Students will have the opportunity to build both static and dynamic websites and applications using modern tools and frameworks, including the MERN stack and LARAVEL, among others. They will also learn to apply web-focused programming languages and techniques to address real-world challenges. The course fosters the development of both individual proficiency and teamwork skills, preparing students for success in the field of web development

Course Content:
Introduction to Web & Web applications Course Introduction, Web: Definition, Internet Protocols (Layers), Client Server Model, Request Response Loop, Peer to Peer model, Role of DNS, HTTP, URLs, Web Servers, Client Side - Static content HTML: Syntax, Structure, Elements, Markup, HTML Tags, nested tags, required structured tags, Doctype, Meta Tags, Divs, Images, Links, Lists, Tables, Nav Bar, Client Side - Static content HTML5: Semantic Tags, Canvas, SVG, Media, APIs, Client Side - Content styling basics CSS3: Syntax, Blocks, Selectors, Properties, Inline styles, Id vs class sectors, Margins, Borders, Text, Style sheets, CSS3: Media Queries, Responsive Grid, Grid layout, Client Side – Content styling advanced I Box sizing, Flexbox layout, Responsive web design, Client Side – Dynamic content Javascript: design, syntax, XHTML: DOM, Events, Functions, event handling, Client Side – Content styling advanced II Designing with Bootstrap Layout, Components, and Utilities, Server Side Programming with PHP PHP: Server side scripting concept, introduction, syntax, PHP Datatypes, loops, conditional statements, arrays. Server Side – Content generation Super Globals (Sessions, Server, and others), Object Oriented PHP, Databases in PHP, using MySQLi and PDO, Intro to ORMs (Eloquent), Server Side – Laravel Framework I Laravel framework: Installation, configuration, directory structure, Models, Routing, Server side – Laravel Framework II Controllers, Blade Layout, Advanced topics in Web – I (NoSQL DBs) Intro to NoSQL, Working with MERN Stack – (MongoDB, CouchDB), Advanced topics in Web – II (Frontend) Working with MERN Stack – React JS, React JS: Front end designing, components and their lifecycle, rendering content, Advanced topics in Web – III (Backend) Working with Server side – Express JS, Node JS, Backend designing, concepts, Routing, Middleware, and APIs, Advanced topics in Web – IV Pagination Techniques, Content Management Techniques (search, download, and others).

Reference Materials:
1.Programming PHP Creating Dynamic Web Pages, Kevin Tatroe, Peter Macintyre, 4th Edition, O′Reilly, 2020
2. Web Engineering, Rajiv Chopra, Prentice-Hall of India, 2016

Course Name: Analysis of Algorithms
Credit Hours: 3 (3-0)
Pre-requisites: Data Structures

Course Introduction:
Detailed study of the basic notions of the design of algorithms and the underlying data structures. Several measures of complexity are introduced. Emphasis on the structure, complexity, and efficiency of algorithms.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain what is meant by "best", "expected", and "worst" case behavior of an algorithm	
CLO-2	Identify the characteristics of data and/or other conditions or assumptions that lead to different behaviors.	
CLO-3	Determine informally the time and space complexity of simple algorithms	
CLO-4	List and contrast standard complexity classes	

Course Outline:
Introduction; role of algorithms in computing, Analysis on nature of input and size of input Asymptotic notations; Big-O, Big Ω, Big Θ, little-o, little-ω, Sorting Algorithm analysis, loop invariants, Recursion and recurrence relations; Algorithm Design Techniques, Brute Force Approach, Divide-and-conquer approach; Merge, Quick Sort, Greedy approach; Dynamic programming; Elements of Dynamic Programming, Search trees; Heaps; Hashing; Graph algorithms, shortest paths, sparse graphs, String matching; Introduction to complexity classes.

Reference Materials: (or use any other standard and latest books)
1. Introduction to Algorithms (3rd edition) by Thomas H. Corman, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein
2. Algorithm Design, (1st edition, 2013/2014), Jon Kleinberg, Eva Tardos,
3. Algorithms, (4th edition, 2011), Robert Sedgewick, Kevin Wayne

Course Name: Cloud Computing
Credit Hours: 3 (2-1)
Pre-requisites:

Course Introduction:
Cloud computing services are being widely adopted by a variety of organizations from different domains. Cloud computing is the delivery of computing as a service over a network (usually internet) where the distributed resources are rented, instead of owned, as a utility by the end user. This greatly reduces the capital required for initial infrastructure setup and provides several benefits. This course gives students an overview of the field of Cloud Computing. This includes thorough understanding of cloud enabling technologies, primary building blocks of cloud computing, and hands-on experience by utilizing public cloud infrastructures (e.g. Google Cloud Platform, Amazon AWS, Microsoft Azure etc.). The major topics covered in this course include fundamentals of cloud computing, cloud delivery models (IaaS, PaaS, SaaS), virtualization, containerization, Kubernetes, cloud computing mechanisms and architectures, storage, and cloud security.

Course Outline:
Introduction to Cloud Computing Basic concepts Understand the core concepts of the cloud computing paradigm, Fundamental Concepts and Models Cloud characteristics, cloud delivery models (IaaS) 3 Fundamental Concepts and Models Cloud delivery models (IaaS, PaaS, SaaS), Cloud deployment models (public, private, hybrid, community), Cloud Enabling Technologies, Broadband networks & internet architecture, Data center technology, Cloud Enabling Technologies, Virtualization technology, Containerization, Dockers, Kubernetes, Micro-services, Micro-services in clouds Monolithic vs micro-services Apply fundamental concepts in cloud infrastructures to understand the tradeoffs, Working with micro-services, Development lifecycle of micro-services, Developing a micro-service, Cloud Infrastructure Mechanisms, Cloud storage, Cloud usage monitoring, Resource replication, Cloud Infrastructure Mechanisms, Automated scaling listener, Load balancing Failover system Apply fundamental concepts in cloud infrastructures to understand the tradeoffs, Cloud Architectures, Elastic resource capacity, Service load balancing, Cloud bursting, Redundant storage Distinguish the various characteristics of public, private and hybrid cloud delivery models Display skills to effectively use cloud centric solutions such as serverless application development,Cloud Advanced Architectures, Hypervisor clustering, Load balanced virtual server Non-disruptive service relocation, Cloud Advanced Architectures, Zero downtime, Cloud balancing, Resource reservation, Dynamic failure detection and recovery, Cloud Security, Encryption, hashing, digital signatures, public key infrastructure, single sign-on, identity access and management, federated identity, security as a service Distinguish the various characteristics of public, private and hybrid cloud delivery models, Clouds and Machine Learning, Advanced topics in Cloud Computing

Reference Materials: (or use any other standard and latest books)
1.Erl, Thomas, Ricardo Puttini, and Zaigham Mahmood. Cloud computing: concepts, technology & architecture. Pearson Education, 2013.

Course Name: Cloud Computing
Credit Hours: 3 (2-1)
Pre-requisites:

Course Introduction:
Cloud computing services are being widely adopted by a variety of organizations from different domains. Cloud computing is the delivery of computing as a service over a network (usually internet) where the distributed resources are rented, instead of owned, as a utility by the end user. This greatly reduces the capital required for initial infrastructure setup and provides several benefits. This course gives students an overview of the field of Cloud Computing. This includes thorough understanding of cloud enabling technologies, primary building blocks of cloud computing, and hands-on experience by utilizing public cloud infrastructures (e.g. Google Cloud Platform, Amazon AWS, Microsoft Azure etc.). The major topics covered in this course include fundamentals of cloud computing, cloud delivery models (IaaS, PaaS, SaaS), virtualization, containerization, Kubernetes, cloud computing mechanisms and architectures, storage, and cloud security.

Course Outline:
Introduction to Cloud Computing Basic concepts Understand the core concepts of the cloud computing paradigm, Fundamental Concepts and Models Cloud characteristics, cloud delivery models (IaaS) 3 Fundamental Concepts and Models Cloud delivery models (IaaS, PaaS, SaaS), Cloud deployment models (public, private, hybrid, community), Cloud Enabling Technologies, Broadband networks & internet architecture, Data center technology, Cloud Enabling Technologies, Virtualization technology, Containerization, Dockers, Kubernetes, Micro-services, Micro-services in clouds Monolithic vs micro-services Apply fundamental concepts in cloud infrastructures to understand the tradeoffs, Working with micro-services, Development lifecycle of micro-services, Developing a micro-service, Cloud Infrastructure Mechanisms, Cloud storage, Cloud usage monitoring, Resource replication, Cloud Infrastructure Mechanisms, Automated scaling listener, Load balancing Failover system Apply fundamental concepts in cloud infrastructures to understand the tradeoffs, Cloud Architectures, Elastic resource capacity, Service load balancing, Cloud bursting, Redundant storage Distinguish the various characteristics of public, private and hybrid cloud delivery models Display skills to effectively use cloud centric solutions such as serverless application development,Cloud Advanced Architectures, Hypervisor clustering, Load balanced virtual server Non-disruptive service relocation, Cloud Advanced Architectures, Zero downtime, Cloud balancing, Resource reservation, Dynamic failure detection and recovery, Cloud Security, Encryption, hashing, digital signatures, public key infrastructure, single sign-on, identity access and management, federated identity, security as a service Distinguish the various characteristics of public, private and hybrid cloud delivery models, Clouds and Machine Learning, Advanced topics in Cloud Computing

Reference Materials: (or use any other standard and latest books)
1.Erl, Thomas, Ricardo Puttini, and Zaigham Mahmood. Cloud computing: concepts, technology & architecture. Pearson Education, 2013.

Course Name: Technical and Business Writing
Credit Hours: 3 (3-0)
Pre-requisites: Communication and Presentation Skills

Course Introduction:
Students in the senior level needs good technical writing skills not only for writing project report but also useful for them to communicate their resume and get place in the market. This is a high level course which provide useful knowledge to the students for writing proposals etc. Further, the course aims at augmenting students' proficiency in technical writing in order to sensitize them to the dynamics, challenges, and needs of the modern world characterized by technologically advanced social, cultural, and corporate settings. It will focus on students' ability to effectively convey and exchange information in cross-cultural, international, and multinational milieu necessitated by the emergence of global society.

Course Outline:
Overview of technical reporting, use of library and information gathering, administering questionnaires, reviewing the gathered information; Technical exposition; topical arrangement, exemplification, definition, classification and division, casual analysis, effective exposition, technical narration, description and argumentation, persuasive strategy, Organizing information and generation solution: brainstorming, organizing material, construction of the formal outline, outlining conventions, electronic communication, generation solutions. Polishing style: paragraphs, listening sentence structure, clarity, length and order, pomposity, empty words, pompous vocabulary, document design: document structure, preamble, summaries, abstracts, table of contents, footnotes, glossaries, crossreferencing, plagiarism, citation and bibliography, glossaries, index, appendices, typesetting systems, creating the professional report; elements, mechanical elements and graphical elements. Reports: Proposals, progress reports, Leaflets, brochures, handbooks, magazines articles, research papers, feasibility reports, project reports, technical research reports, manuals and documentation, thesis. Electronic documents, Linear verses hierarchical structure documents.

Reference Materials: (or use any other standard and latest books)
1. Technical Report Writing, by Pauley and Riordan, Houghton Mifflin Company, 8th Edition.
2. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill.

Course Name: Geographic Information System
Credit Hours: 3(3-0)
Prerequisites: None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:

Domain	**BT Level***

1. Comprehend fundamental concepts and practices of Geographic Information Systems (GIS) and advances in Geospatial Information Science and Technology (GIS&T)

2. Demonstrate proficiency in the use of GIS tools to create maps that are fit-for-purpose and effectively convey the information they are intended to.

3. Apply mathematical concepts, including statistical methods, to data to be used in geospatial analysis.

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain,

A= Affective domain

Course Content:

Principles of Geographic Information Systems covered topics include: fundamentals of GIS; introduction to modern spatial data and structures; input of Geospatial data; functions of geographic information systems; spatial Analysis; coordinate transformation and map projection; interpolation techniques; relations between GIS and remote sensing; and applications of geographic information systems to a variety of environmental and geologic issues.

Reference Materials:

1. Heywood, I., Cornelius, S., and Carver S. An Introduction to Geographical Information Systems, Prentice Hall. U.S.A
2. Kasianchuk P., Taggart M. Introduction to ArcGIS. Version 10.1. ESRI Publications.
3. George B., Korte, pe, The GIS Book. Thomson Delmar Learning.

Course Name: Artificial Intelligence
Credit Hours: 3 (2-1)
Pre-requisites: Object Oriented Programming

Course Introduction:
Artificial Intelligence has emerged as one of the most significant and promising areas of computing. This course focuses on the foundations of AI and its basic techniques like Symbolic manipulations, Pattern Matching, Knowledge Representation, Decision Making and Appreciating the differences between Knowledge, Data and Code. AI programming language Python has been proposed for the practical work of this course.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the fundamental constructs of Python programming language.	C2 (Understand)
CLO-2	Understand key concepts in the field of artificial intelligence	C2 (Understand)
CLO-3	Implement artificial intelligence techniques and case studies	C3 (Apply)

Course Outline:
An Introduction to Artificial Intelligence and its applications towards Knowledge Based Systems; Introduction to Reasoning and Knowledge Representation, Problem Solving by Searching (Informed searching, Uninformed searching, Heuristics, Local searching, Minmax algorithm, Alpha beta pruning, Game-playing); Case Studies: General Problem Solver, Eliza, Student, Macsyma; Learning from examples; ANN and Natural Language Processing; Recent trends in AI and applications of AI algorithms. Python programming language will be used to explore and illustrate various issues and techniques in Artificial Intelligence.

Reference Materials: (or use any other standard and latest books)
1. Russell, S. and Norvig, P. “Artificial Intelligence. A Modern Approach”, 3rd ed, Prentice Hall, Inc., 2015.
2. Norvig, P., “Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp”, Morgan Kaufman Publishers, Inc., 1992.
3. Luger, G.F. and Stubblefield, W.A., “AI algorithms, data structures, and idioms in Prolog, Lisp, and Java”, Pearson Addison-Wesley. 2009.
4. Severance, C.R., 2016. “Python for everybody: Exploring data using Python 3.” CreateSpace Independent Publ Platform.
5. Miller, B.N., Ranum, D.L. and Anderson, J., 2019. “Python programming in context.” Jones & Bartlett Pub.
5. Joshi, P., 2017. “Artificial intelligence with python.” Packt Publishing Ltd.

Course Name: ***Cyber Security***
Credit Hours: 3 (2-1)
Pre-requisites: Information Security

Course Introduction:
This course provides students an introduction to common cyber security threats, vulnerabilities, and risks related to web applications, networks, software and mobile applications. The course provides basic concepts and terminology used in the information and cyber security fields. Moreover, it will also enable students to differentiate between the various forms of malware and how they affect computers and networks.

CLO No. Course Learning Outcomes Bloom Taxonomy
CLO-1 To be able to identify computer system threats C2 (Understand)
CLO-2 To be able to identify Malware attacks, and understand the
stages of attack and payloads. C2 (Understand)
CLO-3 Implement various cryptographic techniques and simulate attack scenarios C3 (Apply)

Course Outline:
Introduction to Cyber security; Networks and the Internet; cyber threat landscape; understanding security; information security Principles (Confidentiality, Integrity, Availability); Information Security Terminology; Who are the attackers; Advanced Persistent Threat (APT); Malware, types of malware; Attacks using malware; Malware Attack Lifecycle: Stages of Attack; Social engineering attacks; types of payload; Industrial Espionage in Cyberspace; Basic cryptography; Web application attacks; Database security; Cyber kill chain; Privacy and anonymity; Network security; Software security; Mobile device security; Mobile app security; Cyber Terrorism and Information Warfare; Introduction to Digital Forensics; Digital Forensics Categories.

Reference Materials:
1. Computer Security Fundamentals by Chuck Easttom, 4th edition or latest
2. Security+ Guide to Network Security Fundamentals, by Mark Ciampa, 5th Edition
3. Security in Computing by C.P. Pfleeger, Prentice-Hall, 4th Edition or Latest

Course Name: ***Internship***
Credit Hours: 3 (0-3)

Course Introduction:

This Internship Program is a 6–8 week course designed to provide students with practical experience in professional environments, focusing on applying academic knowledge to real-world challenges. The program begins with preparatory workshops on resume building, interview skills, and career pathways, followed by the internship phase where students work on industry-relevant projects in areas such as software development, networking, data science, or system administration under the guidance of company mentors and faculty advisors. Students are required to maintain weekly progress logs, participate in a midterm evaluation, and submit a comprehensive final report and presentation detailing their contributions, tools used, and lessons learned. The course concludes with feedback from mentors and reflections on how the experience integrates with academic and career goals, emphasizing professionalism, teamwork, and technical expertise.