Course Content for BS-Computer Science

Department of Computer Science
Millennium Institute of Technology & Entrepreneurship MiTE

Application of Information & Communication Technologies

Credit Hours:	3 (2+1)	**Prerequisites:**	NILL

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Describe** the history of computers and their classification based on types of computers	PLO1	C1 (Remembering)
2	**Understanding** the working principles of computer's hardware components such as processor, memory, and input/output devices	PLO1	C2 (Understanding)
3	**Explain** the importance, types, and limitation of system software and applications of information systems	PLO2	C2 (Understanding)
4	**Demonstrate** the understanding different types of computer networks, data communication methods, and network services and protocols	PLO2	C2 (Understanding)

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

Course Content:

Brief history of Computer, Four Stages of History, Computer Elements, Processor, Memory, Hardware, Software, Application Software its uses and Limitations, System Software its Importance and its Types, Types of Computer (Super, Mainframe, Mini and Micro Computer), Introduction to CBIS (Computer Based Information System), Methods of Input and Processing, Organizing Computer Facility, Centralized Computing Facility, Distributed Computing Facility, Decentralized Computing Facility, Input Devices. Keyboard and its Types, Terminal (Dump, Smart, Intelligent), Dedicated Data Entry, SDA (Source Data Automation), Pointing Devices, Voice Input, Output Devices. Soft- Hard Copies, Monitors and its Types, Printers and its Types, Plotters, Computer Virus and its Forms, Storage Units, Primary and Secondary Memories, RAM and its Types, Cache, Hard Disks, Working of Hard Disk, Diskettes, RAID, Optical Disk Storages (DVD, CD ROM), Magnetic Types, Backup System, Data Communications, Data Communication Model, Data Transmission, Digital and Analog Transmission, Modems, Asynchronous and Synchronous Transmission, Simplex. Half Duplex, Full Duplex Transmission, Communications, Medias (Cables, Wireless), Protocols, Network Topologies (Star, Bus, Ring), LAN, LAN, Internet, A Brief History, Birthplace of ARPA Net, Web Link, Browser, Internet Services provider and Online Services Providers, Function and Features of Browser, Search Engines, Some Common Services available on Internet

Teaching Methodology:

Lecturing, Written Assignments, Final Exam

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Charles S. Parker, Understanding Computers: Today and Tomorrow, Course Technology, 25 Thomson Place, Boston, Massachusetts 02210, USA
2. Livesley, Robert Kenneth. An introduction to automatic digital computers. Cambridge University Press, 2017.

Programming Fundamentals			
Credit Hours:	4 (3+1)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understand** basic problem-solving steps and logic constructs	PLO1	C2 (Understanding)
2	**Apply** basic programing concepts	PLO2	C3 (Applying)
3	**Design** and implement algorithms to resolve real world problems.	PLO2	C3 (Applying)

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

Course Content:

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, multi-dimensional 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

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project,

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Final Exam

Reference Materials:

1. Starting out with Python, 4th Edition, Tony Gaddis.
2. Starting out with Programming Logic & Degins, 4th Edition, Tony Gaddis,
3. The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie
4. Object Oriented Programming in C++ by Robert Lafore
5. Introduction to Computation and Programming Using Python: With Application to Understanding Data, 2nd Edition by Guttag, John
6. Practice of Computing Using Python, 3rd Edition by William Punch & Richard Enbody
7. C How to Program, 7th Edition by Paul Deitel & Harvey Deitel
8. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly & Elliot B. Koffman

Islamic Studies			
Credit Hours:	2 (2+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Understanding** of basic themes of holy Quran and sciences of Hadith	PLO9	C2 (Understanding)
2	**Explaining** Islamic laws and jurisprudence	PLO9	C2 (Understanding)
3	**Learning** the life of the Prophet and its impact on economics, politics and society	PLO9	C2 (Understanding)

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

Course Content:

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

Teaching Methodology:

Lecturing, Written Assignments.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

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

Applied Physics			
Credit Hours:	3 (2+1)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Understanding** the concept of electric field, electric force, gauss' law and its applications, current and current density, resistance, resistivity and conductivity, ohm's law and its applications	PLO1	C2 (Understanding)
2	**Illustrate** the concepts of electromagnetism, electromagnetic induction, the Biot-Savart law, line of B, two parallel conductors, Amperes' s law, solenoid, toroids, Faraday's experiments, Faraday's law of induction, Lenz's law etc.	PLO1	C2 (Understanding)
3	**Explain** the behavior of light waves, total internal reflection, two source interference, interference from thin films, diffraction and the wave theory, Polarization of electromagnetic waves, Polarizing sheets	PLO2	C2 (Understanding)

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

Course Content:

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 Biot- Savart law, Line of B, Two parallel conductors, Amperes' s Law, Solenoid, Toroids, 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.

Teaching Methodology:

Lecturing, Assignments,

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Fundamentals of Physics (Extended), 10th edition, Resnick and Walker
2. Narciso Garcia, Arthur Damask, Steven Schwarz., "Physics for Computer Science Students", Springer Verlag, 1998

Functional English			
Credit Hours:	3 (3+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Understanding** essay writing skills	PLO7	C2 (Understanding)
2	**Understanding** grammatical errors	PLO7	C2 (Understanding)
3	**Build** reading/writing skills for different types of compositions	PLO7	C3 (Applying)

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

Course Content:

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

Teaching Methodology:

Lecturing, Written Assignments, Presentation, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentation, Final Exam

Reference Materials:

1. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.

A Textbook of English Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000

Digital Logic Design			
Credit Hours:	3(2+1)	**Prerequisites:**	Applied Physics

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Acquire** knowledge related to the concepts, tools, and techniques for the design of digital electronic circuits	PLO1	C2 (Understanding)
2	**Demonstrate** the skills to design and analyze both combinational and sequential circuits using a variety of techniques	PLO2	C2 (Understanding)
3	**Apply** the acquired knowledge to simulate and implement small-scale digital circuits	PLO2	C3 (Applying)
4	**Apply** programmable logic devices using simulation tools	PLO5	C3 (Applying)

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

Course Content:

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. 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

Teaching Methodology:

Lectures, Written Assignments, Practical labs

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Digital Fundamentals by Floyd, 11/e.

Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e.

Object Oriented Programming			
Credit Hours:	4 (3+1)	**Prerequisites:**	Programming Fundamentals

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understand** the fundamental principles of object-oriented paradigm.	PLO1	C2 (Understanding)
2	**Applying** encapsulation, inheritance, polymorphism, and operator overloading and overriding through programming.	PLO2	C2 (Applying)
3	**Applying** abstract classes, interfaces, serialization, and exception handling through programming.	PLO2	C2 (Applying)
4	**Build** and **Debug** programs for real-world scenarios	PLO4	C3 (Applying)

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

Course Content:

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.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project,

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Final Exam

Reference Materials:

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

Database Systems			
Credit Hours:	4(3+1)	**Prerequisites:**	Data Structures and Algorithms

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Describe** fundamental database concepts.	PLO2	C2 (Understanding)
2	**Design** conceptual, logical, and physical database architecture using different data models.	PLO4	C5 (Designing)
3	**Identify** functional dependencies and resolve database anomalies by normalizing database tables	PLO3	C2 (Understanding)
4	**Design** database projects using Structured Query Language (SQL) for database definition and manipulation in any RDBMS	PLO5	C6 (Creating)

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

Course Content:

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 sub-queries in SQL, Grouping and aggregation in SQL, concurrency control, database backup and recovery, indexes, NoSQL systems.

Teaching Methodology:

Lectures, Written Assignments, Practical labs.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

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

EXPOSITORY WRITING			
Credit Hours:	3 (3+0)	**Prerequisites:**	**English Composition & Comprehension**

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Understanding** composition process.	PLO7	C2 (Understanding)
2	Write effective business reports and letter	PLO7	C3 (Applying)
3	**Create** and deliver effective business presentations	PLO7	C3 (Applying)

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

Course Content:

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.

Teaching Methodology:

Lecturing, Written Assignments, Project, Presentation, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentation, Final Exam

Reference Materials:

1. Practical Business English, Collen Vawdrey, 1993, ISBN = 0256192740
2. Effective Communication Skills: The Foundations for Change, John Nielsen, 2008, ISBN = 1453506748

Business Ethics			
Credit Hours:	2 (2+0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** of morals of Business ethics	PLO1	C2 (Understanding)
2	**Managing** Ethical Behavior in the Workplace	PLO9	C3 (Applying)
3	**Understanding** ethical and professional conducts in the businesses	PLO10	C2 (Understanding)

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

Course Content:

Business Ethics in Contemporary Businesses, Ethical Decision Making, Factors that Affect Ethical Behavior in the Workplace, Theories of Ethics: Rights & Natural Laws, Why Ethical Problems Occur in Business, Managing Ethical Behavior in the Workplace, Organizational Ethical Climate: Definition, Issues & Improvement, The Importance of Ethics Policies, Training & Reporting Programs in the Workplace, Organizational Citizenship Behavior in the Workplace: Definition and Examples, The Difference Between Workplace Ethics and the Law, Attorney Professional and Ethical Conduct in Business

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

Business Ethics by Barcharts

Information Security			
Credit Hours:	3(2+1)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Explain** the fundamental approach of information security such as design principles, cryptography, risk management, and ethics.	PLO2	C2 (Understanding)
2	**Identify** appropriate techniques to tackle and solve problems in the discipline of information security	PLO3	C3 (Applying)
3	**Apply** firewall and intrusion detection/prevention tools for achieving information security and privacy	PLO5	C3 (Applying)

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

Course Content:

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.

Teaching Methodology:

Lectures, Written Assignments.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

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

Data Structure			
Credit Hours:	4 (3+1)	**Prerequisites:**	Object Oriented Programming

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	Implement various data structures and their algorithms and **apply** them in implementing simple applications.	PLO2	C3 (Applying)
2	**Apply** the knowledge of data structures to other application domains	PLO2	C3 (Applying)
3	**Analyze** simple algorithms and determine their complexities	PLO3	C4 (Analyzing)
4	**Evaluate** data structures to assess the functionality of algorithms	PLO4	C5 (Evaluating)

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

Course Content:

Abstract data types, complexity analysis, Big Oh notation, Stacks (linked lists and array implementations), Recursion and analyzing 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.

Teaching Methodology:

Lectures, Written Assignments, Practical labs,

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Data Structures and Algorithms in C++ by Adam Drozdek
2. Data Structures and Algorithm Analysis in Java by Mark A. Weiss
3. Data Structures and Abstractions with Java by Frank M. Carrano & Timothy M. Henry
4. Data Structures and Algorithm Analysis in C++ by Mark Allen Weiss
5. Java Software Structures: Designing and Using Data Structures by John Lewis and Joseph Chase

Artificial Intelligence			
Credit Hours:	3 (2+1)	**Prerequisites:**	Discrete Structures

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Describe** the basic components of Artificial Intelligence	PLO1	C1 (Remembering)
2	**Understanding** the core concepts of artificial intelligence systems, its branches, and Reasoning and Knowledge Representation (Propositional Logic)	PLO2	C2 (Understanding)
3	**Solve** problems by searching methods such as informed searching, uninformed searching, local searching	PLO3	C3 (Applying)
4	**Develop** an artificial intelligence system for real-world problem using recent trends in machine learning algorithm and/or fuzzy logic	PLO4	C3 (Applying)

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

Course Content:

Introduction (Introduction, basic component of AI, Identifying AI systems, branches of AI, etc.); Reasoning and Knowledge Representation (Introduction to Reasoning and Knowledge Representation, Propositional Logic, first order Logic); Problem Solving by Searching (Informed searching, Uninformed searching, Local searching.); Constraint Satisfaction Problems; Adversarial Search (Min-max algorithm, Alpha beta pruning, Game-playing); Learning (Unsupervised learning, Supervised learning, Reinforcement learning) ;Uncertainty handling (Uncertainty in AI, Fuzzy logic); Recent trends in AI and applications of AI algorithms (trends, Case study of AI systems, Analysis of AI systems)

Teaching Methodology:

Lectures, Assignments, labs, Projects.

Course Assessment:

Exams, Assignments, Quizzes, Project.

Reference Materials:

1. Stuart Russell and Peter Norvig, Artificial Intelligence. A Modern Approach, 3rd edition, Prentice Hall, Inc., 2010.
2. Hart, P.E., Stork, D.G. and Duda, R.O., 2001. Pattern classification. John Willey & Sons.
3. Luger, G.F. and Stubblefield, W.A., 2009. AI algorithms, data structures, and idioms in Prolog, Lisp, and Java. Pearson Addison-Wesley.

Computer Networks			
Credit Hours:	3 (2+1)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Understanding** architecture, topologies and physical layer implementation of computer networks	PLO2	C2 (Understanding)
2	**Identify** the applications and issues of data link layer protocols for wired and wireless networks	PLO3	C3 (Applying)
3	**Develop** small scale LAN / WAN networks using interior and exterior gateway protocols via network simulation tools	PLO5	C3 (Applying)

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

Course Content:

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.

Teaching Methodology:

Lectures, Written Assignments, Practical labs.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

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

Software Engineering			
Credit Hours:	3 (3+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No.	CLOs	Mapped PLOs	Domain
1	**Understanding** various software engineering processes and activities such as Software Development, Software Engineering Practices, Software Process Model, and development techniques	PLO2	C2 (Understanding)
2	**Apply** the system modeling techniques, software quality assurance and testing principles	PLO3	C3 (Applying)
3	**Analyze and design** software project management systems using UML diagrams and design patterns	PLO4	C4 (Analyzing)

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

Course Content:

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.

Teaching Methodology:

Lecturing, Written Assignments.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

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.

Calculus & Analytical Geometry			
Credit Hours:	3 (3+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Understanding** basics of functions, limits, and continuity	PLO1	C2 (Understanding)
2	**Understanding** concept, rules and techniques of differentiation with applications	PLO2	C2 (Understanding)
3	**Understanding** concept, rules and techniques of integration with applications and analytical geometry	PLO2	C2 (Understanding)

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

Course Content:

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.

Teaching Methodology:

Lecturing, Assignments

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

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.

Computer Organization and Assembly Language			
Credit Hours:	3 (2+1)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Explain** basic concepts of computer systems such as compilation systems, memory, cache and storage devices	PLO1	C2 (Understanding)
2	**Understanding** the working principles of programs at machine level with the help of assembly language.	PLO2	C2 (Understanding)
3	**Solve** the problems related to computer organization and architecture with the help of assembly language	PLO3	C3 (Applying)

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

Course Content:

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, outof-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

Teaching Methodology:

Lectures, Written Assignments, Practical labs.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

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

Theory of Automata			
Credit Hours:	3(3+0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Explain** and manipulate the different concepts in automata theory and formal languages such as formal proofs, automata, regular expressions, Turing machines etc.	PLO1	C2 (Understanding)
2	**Design** of automata, RE and CFG	PLO2	C3 (Applying)
3	**Transform** between equivalent NFAs, DFAs and REs	PLO3	C4 (Analyzing)
4	**Understanding** Turing machines performance for simple tasks.	PLO1	C2 (Understanding)

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

Course Content:

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.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

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
4. Theory of Automata, Formal Languages and Computation, by S. P. Eugene, Kavier, 2005, New Age Publishers

Advance Database Management Systems			
Credit Hours:	3(2+1)	**Prerequisites:**	Database Systems

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** advance data models, technologies and approaches for building distributed database systems	PLO1	C2 (Understanding)
2	**Applying** the models and approaches in order to become enabled to select and apply appropriate methods for a particular case	PLO2	C3 (Applying)
3	To develop a database solution for a given scenario/challenging problem in the domain of distributed database systems.	PLO3	C3 (Applying)

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

Course Content:

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)

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

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

Multivariate Calculus			
Credit Hours:	3(3+0)	Prerequisites:	Calculus and Analytical Geometry

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1.	**Understand** the basic concepts and techniques of differential and integral calculus of functions of multiple variables	PLO2	C2 (Understanding)
2.	**Apply** the theory to calculate the gradients, directional derivatives, arc length of curves, area of surfaces, and volume of solids	PLO3	C3 (Applying)
3.	**Understanding** Fourier Series, periodic functions, Functions of any period, Even & odd functions	PLO2	C2 (Understanding)
4	**Understanding** transform techniques like Fourier Transform; Laplace Transform, Z-Transform	PLO2	C2 (Understanding)

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

Course Content:

Functions of Several Variables and Partial Differentiation. Multiple Integrals, Line and Surface Integrals. Green's and Stoke's Theorem. Fourier Series: periodic functions, Functions of any period P-2L, Even & odd functions, Half Range expansions, Fourier Transform; Laplace Transform, Z-Transform.

Teaching Methodology:

Lectures, Written Assignments.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Multivariable Calculus, 7th Edition by James Stewart, Brooks Cole, ISBN-13: 978-0538497879

2. *Calculus and Analytical Geometry*, 6 th edition. Swokowski, Olinick and Pence. 1994. Thomson Learning EMEA, Ltd.

3. ***Multivariable Calculus***, 5th edition Howard, A. Albert, H. 1995, John Wiley.

Discrete Structures			
Credit Hours:	3(3+0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** the key concepts of Discrete Structures such as sets, permutations, relations, graphs, and trees.	PLO1	C2 (Understanding)
2	**Apply** formal logic proofs and/or informal, rigorous, logical reasoning to real problems, such as predicting the behavior of software or solving problems such as puzzles.	PLO2	C3 (Applying)
3	**Apply** discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography	PLO2	C3 (Applying)

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

Course Content:

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, elements of graph theory, planar graphs, graph coloring, euler graph, Hamiltonian path, rooted trees, traversals.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

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

Linear Algebra			
Credit Hours:	3 (3+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Understanding** basics of matrices and determinants and their operations such as inverse of matrix, addition, subtraction, and multiplication, transpose etc.	PLO2	C2 (Understanding)
2	**Develop** a system model using linear algebra and solve linear systems	PLO4	C3 (Applying)
3	**Apply** linear algebra for solving nonlinear equations	PLO2	C3 (Applying)

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

Course Content:

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

Teaching Methodology:

Lecturing, Written Assignments

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Elementary Linear Algebra 11th Edition by Howard Anton
2. Linear Algebra and its Applications by Gibert Strang
3. Introduction to Linear Algebra, Fifth Edition by Gilbert Strang, 2016, ISBN: 978-0980232776.

Human Computer Interaction & Computer Graphics

Credit Hours:	3(2+1)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Explain** context of HCI and different measures for evaluation	PLO2	C3 (Applying)
2	**Apply** the principles of good design for people from the perspective of age and disabilities	PLO2	C3 (Applying)
3	**Analyze** interface problems to recognize what design approach and interaction styles is required in the light of usability standards and guidelines.	PLO3	C4 (Analyzing)
4	**Choose** appropriate HCI techniques for an interface that are preferred by the user. Apply an interactive design process and universal design principles in designing of computer based interactive systems.	PLO3	C5 (Evaluating)

* 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.

Teaching Methodology:

Lecturing, Written Assignments, Project,

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Final Exam

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

Operating Systems			
Credit Hours:	3 (2+1)	**Prerequisites:**	Data Structures and Algorithms

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understand** the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems	PLO1	C2 (Understanding)
2	**Demonstrate** the knowledge in applying system software and tools available in modern operating systems	PLO5	C3 (Applying)
3	**Analyze** and **evaluate** the algorithms of the core functions of the Operating Systems and explain the major performance issues regarding the core functions	PLO4	C4 (Analyzing)

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

Course Content:

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

Teaching Methodology:

Lectures, Written Assignments, Practical labs

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

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 Stallings

Probability & Statistics			
Credit Hours:	3 (3+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Understanding** basic statistical methods, statistical inference, statistical modeling, and regression models	PLO2	C2 (Understanding)
2	**Understanding** probabilistic distribution, conditional probability, and random variables	PLO2	C2 (Understanding)
3	**Solve** sampling distribution, basic and advance probabilistic and statistical problems.	PLO3	C3 (Applying)

* 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, FQuantile and Probability Plots. Single Sample & One- and Two-Sample Estimation Problems. Single Sample & One- and Two-Sample Tests of Hypotheses. The Use of PValues 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.

Teaching Methodology:

Lecturing, Written Assignments, Final Exam

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

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

Compiler Construction			
Credit Hours:	3 (2+1)	**Prerequisites:**	Theory of Automata

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Understand** the basic techniques used in compiler construction such as lexical analysis, top-down, bottom-up parsing, context-sensitive analysis, and intermediate code generation	PLO1	C2 (Understanding)
2	**Understand** the basic data structures used in compiler construction such as abstract syntax trees, symbol tables, three-address code, and stack machines	PLO2	C2 (Understanding)
3	**Design** and **implement** a compiler using a software engineering approach	PLO5	C3 (Applying)

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

Course Content:

Introduction to interpreter and compiler. Compiler techniques and methodology; Organization of compilers; Lexical and syntax analysis; Parsing techniques. Types of parsers, top-down parsing, bottom-up parsing, Type checking, Semantic analyser, Object code generation and optimization, detection and recovery from errors.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Compilers: Principles, Techniques, and Tools, A. V. Aho, R. Sethi and J. D. Ullman, Addison-Wesley, 2nd ed., 2006
2. Modern Compiler Design, D. Grune, H. E. Bal, C. J. H. Jacobs, K. G. Langendoen, John Wiley, 2003.
3. Modern Compiler Implementation in C, A. W. Appel, M. Ginsburg, Cambridge University Press, 2004.

Parallel and Distributed Computing			
Credit Hours:	3(2+1)	**Prerequisites:**	Operating Systems

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Understanding** basic concepts of parallel and distributed computers**.**	PLO1	C2 (Understanding)
2	**Write** portable programs for parallel or distributed architectures using Message-Passing Interface (MPI) library	PLO5	C3 (Applying)
3	**Analytical** modelling and performance of parallel programs	PLO3	C5 (Analyzing)
4	**Analyze** complex problems with shared memory programming with openMP	PLO5	C5 (Analyzing)

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

Course Content:

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).

Teaching Methodology:

Lectures, Written Assignments, Practical labs.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

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.

Analysis of Algorithms			
Credit Hours:	3(3+0)	**Prerequisites:**	**Data Structures and Algorithms**

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** behavior of algorithms, basic characteristics of data and standard complexity classes.	PLO2	C2 (Understanding)
2	**Examine** big O, Omega, Theta notation formally to give asymptotic upper bounds on time and space complexity of algorithms.	PLO3	C4 (Analyzing)
3	**Select** the strategies(brute-force, greedy, divide-and conquer, and dynamic programming) to solve an appropriate problem.	PLO4	C5 (Evaluating)
4	**Explain** problems using graph algorithms, including single source and all-pairs shortest paths, and at least one minimum spanning tree algorithm.	PLO4	C5 (Evaluating)
5	**Trace** and/or implement a string-matching algorithm.	PLO2	C3 (Applying)

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

Course Content:

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;

Teaching Methodology:

Lectures, Written Assignments.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

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

Technical & Business Writing			
Credit Hours:	3 (3+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Demonstrate** writing and speaking processes through invention, organization, drafting, revision, editing, and presentation.	PLO7	C3 (Applying)
2	**Analyze** documents appropriate to audience, purpose, and genre	PLO7	C4 (Analyzing)
3	**Demonstrate** ethically appropriate verbal, visual, and multimedia materials as necessary, in individual and/or collaborative projects.	PLO9	C3 (Applying)

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

Course Content:

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, cross-referencing, 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.

Teaching Methodology:

Lecturing, Written Assignments, Presentation, Report Writing, Final Exam

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Report Writing, Presentation, Final Exam

Reference Materials:

1. Technical Report Writing, by Pauley and Riordan, Houghton Mifflin Company, 8th Edition.
2. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill.

Ideology and Constitution of Pakistan			
Credit Hours:	2 (2+0)	Prerequisites:	None

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Learning** history of Muslim society in sub-continent and its downfall	PLO9	C1 (Remembering)
2	**Learning** about the evolution of Independence Movement and establishment of Pakistan	PLO9	C1 (Remembering)
3	**Understanding** the constitution and issues of Pakistan	PLO9	C2 (Understanding)

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

Course Content:

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 geo-political dimension, Pakistan and International Affairs, Pakistan and the challenges ahead.

Teaching Methodology:

Lectures, Written Assignments.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

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

Professional Practices			
Credit Hours:	2 (2+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Understanding** philosophy of professional computing ethics, structure of organizations, computer contracts, intellectual property rights	PLO8	C2 (Understanding)
2	**Interpret** laws for IT in human resource management, health and safety, and regulation and control of personal information	PLO8	C2 (Understanding)
3	**Identify** different international ethical codes of conduct for computing profession such as British Computer Society Code of Conduct, IEEE Code of Ethics, ACM Code of Ethics	PLO9	C3 (Applying)

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

Course Content:

Computing Profession, Computing Ethics, Philosophy of Ethics. The Structure of Organizations, Finance and Accounting, Anatomy of a Software House, Computer Contracts, 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.

Teaching Methodology:

Lecturing, Written Assignments, Final Exam

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

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.

Computer Graphics

Credit Hours:	3(3+0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

S. No	CLOs	Mapped PLOs	Domain
1	**Explain** the basic principles of implementing computer graphics fundamentals	PLO1	C2 (Understanding)
2	**Compare** key algorithms for modelling and rendering graphical data	PLO3	C4 (Analyzing)
3	**Develop** and design problem solving skills with applications to computer graphics	PLO5	C6 (Creating)
4	**Construct** interactive computer graphics programs using OpenGL	PLO5	C6 (Creating)

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

Course Content:

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.

Teaching Methodology:

Lectures, Written Assignments, Labs

Course Assessment:

Midterm exam, Final Exam, Assignments

Reference Materials:

1. Computer Graphics with Open GL (4th Edition) by Donald D. Hearn, Prentice Hall, 2010, ISBN-10: 0136053580.
2. Foundations of 3D Computer Graphics by S. J. Gortler, The MIT press, 2012.
3. Fundamentals of Computer Graphics, 3rd Edition, A K Peters, 2009.
4. Computer Graphics: Principles and Practice, 3rd Edition, Addison Wesley, 2013.

Real-Time Rendering, 3rd Edition, A K Peters, 2008.

Computer Vision			
Credit Hours:	3(3+0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understand** and explain the field of computer vision in general for different applications	PLO2	C2 (Understanding)
2	**Build** programs using OpenCV or Matlab computer vision toolbox	PLO5	C3 (Applying)
3	**Implement** different algorithms for spatial and frequency domain filtering, feature detection, structure from motion, motion estimation	PLO3	C3 (Applying)
4	**Develop** an algorithm for context awareness or scene understanding	PLO4	C3 (Applying)

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

Course Content:

Introduction, Image formation, Spatial and frequency domain processing, Feature detection and extraction, Image registration, Segmentation, Camera calibration, Structure from motion, Motion estimation, Stereo vision, Object detection and recognition, Object tracking, 3D scene reconstruction, Context and scene understanding, Image stitching, Image-based and video-based rendering, High-performance computing paradigms for vision and image processing.,

Teaching Methodology:

Lectures, Written Assignments

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Computer Vision - A Modern Approach, by D. Forsyth and J. Ponce, Prentice Hall, 2003.
2. Szeliski R., Computer Vision - Algorithms and Applications, Springer, 2011.
3. J. R. Parker, Algorithms for Image Processing and Computer Vision, Willey Publishing Inc. 2011.
4. Gonzalez R. C., Woods R. E., Digital Image Processing, Pearson Education, 3rd edition, 2008.

Cyber Security			
Credit Hours:	3(3+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Classify** security types and their threats	PLO3	C4 (Analyzing)
2	**Understanding** server-side attacks by cross site scripting , SQL Injection and Cross-site request forgery	PLO2	C2 (Understanding)
3	Security **planning** and policy making at different layers of the computer networks.	PLO2	C3 (Applying)

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

Course Content:

Basic security concepts, Information security terminology, Malware classifications, Types of malware. Server side web applications attacks. Cross-site scripting, SQL Injection, Cross-site request forgery, Planning and policy, Network protocols and service models, Transport layer security, Network layer security, Wireless security, Cloud & IoT security.

Teaching Methodology:

Lecturing, Written Assignments,

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Lab, Final Exam

Reference Materials:

1. Security+ Guide to Network Security Fundamentals by Mark Ciampa, 6th Edition
2. Corporate Computer Society by Randall J.Boyle, 3rd Edition

Data Encryption and Security			
Credit Hours:	3(3+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** the principles of number theory, modular arithmetic and discrete logarithms.	PLO2	C2 (Understanding)
2	**Explaining** the Fundamentals of secret/public key encryption algorithms and the principles of operation of different types of digital signature	PLO2	C2 (Understanding)
3	**Explaining** the authentication protocols, email security and secure electronic commerce	PLO2	C2 (Understanding)

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

Course Content:

Principle of number theory and probability theory, Primes, random numbers, modular arithmetic and discrete logarithms. Cryptographic algorithms and design principles, including conventional and symmetric encryption (DES, IDEA, Blowfish, Rijndael, RC4, RC-5), public key or asymmetric encryption (RSA, Diffie-Hellman), key management, hash functions (MD5, SHA-1, RIPEMD-160, HMAC), digital signatures and certificates. Authentication protocols (X.509, Kerberos), electronic mail security (S/MIME, PGP), web security and protocols for secure electronic commerce (IPSec, SSL, TLS, SET).

Teaching Methodology:

Lecturing, Written Assignments,

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Cryptography and Network Security: Principles and Practice, William Stallings, 6th edition.

Enterprise Systems			
Credit Hours:	3(3+0)	**Prerequisites:**	Database System

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** the basic of ERP, its life cycle, business process and architecture.	PLO1	C2 (Understanding)
2	**Analyzing** ERP security, data integration and data migration	PLO3	C4 (Analyzing)
3	**Developing** ERP systems using SCM, CRM and BI	PLO5	C6 (Creating)

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

Course Content:

Fundamentals of an Enterprise and Industries artifacts. Introduction to Enterprise Resource Planning (ERP). ERP Implementation life cycle methodologies and strategy. Business processes, architecture, User Interface Designs and their modeling. ERP Security, workflows, data integration, applications migration and data migration.

Study of business modules Human Resource, Procurement, Sales and Distribution, Material Management, and Manufacturing. Concepts and tools of designing and implementing an ERP system. Emerging trends in ERP and special topics such as Supply Chain Management (SCM), Customer Relationship Management (CRM), Business Intelligence (BI).

Teaching Methodology:

Lecturing, Written Assignments, Project & Lab Work

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentation, Final Exam

Reference Materials:

1. Enterprise Resource Planning by Rajesh Ray, Tata McGraw Hill Education Private Limited, New Delhi, 2011
2. Design of Industrial Information Systems by Thomas O. Boucher, Ali Yalcin, Elsevier AP Printer, 2006
3. Enterprise Application Integration by David S. Linthicum, Addison Wesley Information Technology Series, 2000

Formal Methods			
Credit Hours:	3(3+0)	**Prerequisites:**	Discrete Structures

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** the costs and benefits of formal methods	PLO1	C2 (Understanding)
2	**Construct** formal models of sequential software systems	PLO2	C3 (Applying)
3	**Implement** sequential software systems based on formal models	PLO2	C3 (Applying)
4	**Classify** between correct and incorrect system behavior.	PLO3	C4 (Analyzing)

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

Course Content:

Introduction to the use of mathematical models for specification and validation, Finite state machine models, models of concurrent systems, verification of models, and limitations. Analyzing well-formedness (e.g. completeness, consistency, robustness, etc.), Analyzing correctness (e.g. static analysis, simulation, model checking, etc.), Formal analysis, An introduction to VDM-SL, Sets, Sequences, Composite objects, Maps, VDM-SL, Comparative Formal Methods, Proofs, Introduction to Z

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Modern Formal Methods and Applications, Hossam A. Gabbar, Springer-Verlag 2006.
2. Formal Software Development: From VDM to Java, Charatan, Quentin, and Aaron Kans. Palgrave Macmillan, 2003.
3. Understanding Z: a Specification Language and its Formal Semantics. J. M. Spivey.

1988. Cambridge University Press, New York, NY, USA.

Information Technology Project Management			
Credit Hours:	3(3+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Explain** principles of the project lifecycle and identify the opportunities to work with students on appropriate project scenarios	PLO2	C2 (Understanding)
2	Critically **evaluate** and discuss the issues around project management and its application in the real world with students	PLO7	C5 (Evaluating)
3	**Choose** project management techniques to initiate, plan, execute and evaluate a project.	PLO3	C4 (Analyzing)

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

Course Content:

Introduction to Project Management. The Project Management and Information Technology Context. The Project Management Process Groups. Project Integration Management. Project Scope Management. Project Time Management. Project Cost Management. Project Quality Management. Project Human Resource Management. Project Communications Management. Project Risk Management. Project Procurement Management. Project Management Tools.

Teaching Methodology:

Lecturing, Written Assignments, Presentation, Final Exam

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Report Writing, Presentation, Final Exam

Reference Materials:

1. Information Technology Project Management by Kathy Schwalbe, Course Technology; 6th Edition (July 22, 2010). ISBN-10: 1111221758
2. A Guide to the Project Management Body of Knowledge, 3rd Edition (PMBOK Guides), ISBN-13: 978-1930699458
3. IT Project Management: On Track from Start to Finish by Joseph Phillips, McGrawHill Osborne Media; 3rd Edition (February 25, 2010). ISBN-10: 0071700439
4. Information Technology Project Management by Jack T. Marche, Wiley; 3rd Edition (January 6, 2009). ISBN-10: 0470371935

IT Infrastructure			
Credit Hours:	3(3+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** the IT infrastructure and availability concepts, availability patterns and performance issues	PLO2	C2 (Understanding)
2	**Understanding** Virtualization, operating system implementation, availability, performance, and security	PLO2	C2 (Understanding)
3	**Analyzing** availability, performance and security issues of end-user devices	PLO3	C3 (Analyzing)
4	**Explaining** IT infrastructure management processes, such as service delivery process, service support process, and technical and ethical issues	PLO2	C2 (Understanding)

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

Course Content:

Definition of IT Infrastructure, Non-functional Attributes, Availability Concepts, Sources of Unavailability, Availability Patterns. Performance. Security Concepts. Data centers. Servers: Availability, Performance, Security. Networking: Building Blocks, Availability, Performance, Security. Storage: Availability, Performance, Security. Virtualization: Availability, Performance, Security. Operating Systems: Building Blocks, Implementing Various OSs, OS availability, OS Performance, OS Security. End User Devises: Building Blocks, Device Availability, Performance, Security. IT Infrastructure Management. Service Delivery Processes. Service Support Processes. Ethics, Trends, organizational and technical issues related to IT infrastructure.

Teaching Methodology:

Lecturing, Written Assignments, Project, Final Exam

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentation, Final Exam

Reference Materials:

1. IT Infrastructure Architecture: Infrastructure building blocks and concepts by Sjaak Laan, Lulu.com (November 5, 2011). ISBN-10: 1447881281
2. IT Infrastructure and its Management by Prof Phalguni Gupta, Tata McGraw Hill Education Private Limited (October 6, 2009). ISBN-10: 0070699798
3. IT Architecture for Dummies by Kalani Kirk Hausman and Susan Cook, For Dummies; 1st Edition (November 9, 2010). ISBN-10: 0470554231

Operations Research			
Credit Hours:	3(3+0)	Prerequisites:	None

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Learn** the characteristics of different types of decision-making environments, appropriate decision making, approaches and tools to be used in each type	PLO2	C2 (Understanding)
2	**Solve** the Transportation Models and Assignment Models	PLO2	C3 (Applying)
3	**Understand** the basic methodology for the solution of linear programs and integer programs	PLO2	C2 (Understanding)

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

Course Content:

Introduction to operations research, History of operations research, Applications, Modeling the linear programming, Linear programming, Geometry, Solving the linear programming, the Simplex method, Shadow price, Theory of the simplex method, Duality, Dual theory, Sensitivity analysis, Other algorithms for linear programming, The dual simple method, Big – M method, The tow phase method, The transportation and assignment problems, The transportation problem, A streamlined simplex method for transportation problem, The assignment problem, A special algorithm for the assignment problem, Dynamic programming, Characteristic of dynamic programming, Deterministic dynamic programming, Integer programming, Prototype examples, BIP applications and formulation examples, Some perspectives on solving integer programming problems, The branch-and-cut approach to solve BIP problems, The incorporation of constraint programming.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Frederick S. Hiller, Gerald J. Lieberman, Introduction to Operations Research, 9th Edition, English, McGraw-Hill, 2010.
2. W. Winston, Operations Research, Duxbury Press
3. Operations Research: Applications and Algorithms, Wayne L Winston, Indian University, 4th edition, 2004

Web Technologies			
Credit Hours:	3 (3+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** web applications, TCP/IP Application Services, and Web servers' operations	PLO2	C2 (Understanding)
2	**Developing** web service applications such as XML, SOAP, REST, WML and XSL	PLO5	C3 (Applying)
3	**Understanding** web service operations such as Processing HTTP Requests, Processing HTTP Responses, Cookie Coordination.	PLO2	C2 (Understanding)
4	**Developing** Active web server pages using JavaScript, AJAX, JSON, etc.	PLO5	C3 (Applying)

* 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.

Teaching Methodology:

Lecturing, Written Assignments, Presentation, Final Exam

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Report Writing, Presentation, Final Exam

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

E-Commerce			
Credit Hours:	3(3+0)	**Prerequisites:**	Web Engineering

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** the concepts and standards related to the discipline of E-Commerce such as B2B, B2C, C2C	PLO2	C2 (Understanding)
2	**Analyzing** complex real-world problems found in Ecommerce such as Shopping Basket, Tax, Discounts, Vouchers, and Referrals, Taking Payment for Orders, User Account Management	PLO3	C4 (Analyzing)
3	**Analyzing** the professional Social, Legal, and Ethical Issues of E-Commerce	PLO9	C4 (Analyzing)

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

Course Content:

An overview of E-Commerce & its business models and concepts, Planning an ECommerce Framework, Managing Products and Categories, Product Variations and User Uploads, Enhancing the User Experience, The Shopping Basket, The Checkout and Order Process, Shipping and Tax, Discounts, Vouchers, and Referrals, Checkout, Taking Payment for Orders, User Account Management, Administration: Dashboard, Managing Products and Categories, Managing Orders, Customers, Refunds, Voucher Codes, Shipping, Deploying, Security, and Maintenance, Web Payment Systems, Social, Legal, and Ethical Issues of E-Commerce, Auctions, Portals, and Communities, SEO.

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. E-Commerce, Kenneth Laudon and Carol Guercio Traver, 13th Edition, Pearson, 2017.
2. PHP 5 E-commerce Development, Michael Peacock, Packt Publishing, 2010.
3. Introduction to E-Commerce, Jeffrey F. Rayport, McGraw-Hill, 2nd Edition, 2007.
4. Electronic Commerce, Gary Schneider, Course Technology; 12th Edition 2016

Management Information System			
Credit Hours:	3(3+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understand** and articulate concepts of information technology management.	PLO2	C2 (Understanding)
2	**Assess** and apply IT to solve common business problems	PLO3	C4 (Analyzing)
3	**Recommend** solutions to business problems and design a database application to solve a business problem.	PLO4	C5 (Evaluating)
4	**Explain** in detail the ethical aspects of information technology use in the organization and its governance issues	PLO9	C2 (Understanding)

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

Course Content:

Introduction to Information Systems in Organizations; Business Process and Decision Making; Productivity, Innovation and Strategy; Database and Content Management; Decision Making and Business Intelligence; Competitive Advantage and Business Processes; Networks and Collaboration; ERP and E-commerce, Social Networking, and Web 3.0; Acquiring Information Systems Through Projects; Structure, Governance, and Ethics; Managing Information Security and Privacy

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Experiencing MIS, D. M. Kroenke, A. Gemino and P. Tingling. P. 4th Edition. Toronto: Pearson.2016.
2. Business driven information systems, P. Baltzan, B. Detlor, and C. Welsh, 4th Ed., McGraw Hill Ryerson Press, 2015..

Mobile Application Development

Credit Hours:	3(3+0)	Prerequisites:	Object Oriented Programming

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understand** different architectures & framework for Mobile Application development	PLO1	C2 (Understanding)
2	**Develop** mobile applications using current software development environments	PLO5	C3 (Applying)
3	**Compare** the different performance tradeoffs in mobile application development	PLO8	C4 (Analyzing)

* 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 Email; 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..

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

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.

Web Engineering			
Credit Hours:	3 (3+0)	**Prerequisites:**	Programming Fundamentals

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Examine** how web standards impact software development	PLO2	C4 (Analyzing)
2	**Describe** the constraints that the web puts on developers	PLO3	C2 (Understanding)
3	**Design** and implement a simple web application.	PLO4	C6 (Creating)
4	**Review** an existing web application against a current web standard	PLO3	C4 (Analyzing)

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

Course Content:

Web programming languages (e.g., HTML5, CSS 3, Java Script, PHP/JSP/ASP.Net), Design principles of Web based applications, Web platform constraints, Software as a Service (SaaS), Web standards, Responsive Web Design, Web Applications, Browser/Server Communication, Storage Tier, Cookies and Sessions, Input Validation, Full stack state management, Web App Security - Browser Isolation, Network Attacks, Session Attacks, Large scale applications, Performance of Web Applications, Data Centers, Web Testing and Web Maintenance.

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Web Engineering, Rajiv Chopra, Prentice-Hall of India, 2016
2. Web Engineering, Emilia Mendes and Nile Mosley, Springer Verlag, 2010.
3. Web Engineering: A Practitioners' Approach, Roger S. Pressman, McGraw Hill, 2008.
4. Dynamic HTML: The Definitive Reference: A Comprehensive Resource for XHTML, CSS, DOM, JavaScript 3rd Edition, O'Reilly Media 2007.
5. JavaScript: The Definitive Guide, 8th Edition, David Flanagan. O'Reilly Media. 2014.

University Elective Courses

Business Process Management			
Credit Hours:	3 (3+0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** various business processes	PLO1	C2 (Understanding)
2	**Analyze** the performance of existing processes and identify process improvement.	PLO2	C4 (Analyzing)
3	**Understanding** workflow management	PLO2	C2 (Understanding)

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

Course Content:

Introduction to Business Process Management, Motivation and Definitions, Business Process Lifecycle, Classification of Business Processes, Goals, Structure, and Organization. Evolution of Enterprise Systems Architectures. Business Process Modeling. Process Orchestrations. Process Choreographies. Modeling in BPMN. Properties of Business Processes. Workflow Management Architectures, Flexible Workflow Management, Web Services and their Composition, Advanced Service Composition, Data-Driven Processes. Business Process Management Methodology.

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Business Process Management: Concepts, Languages, Architectures by Mathias Weske, Springer; 2nd Ed. 2012
2. Business Process Management Common Body of Knowledge by Yvonne LedererAntonucci, et. al., Create Space Independent Publishing Platform, 2009
3. Process Management: A Guide for the Design of Business Processes by Jörg Becker, Martin Kugeler and Michael Rosemann, Springer; 2nd Ed. 2011
4. BPMN Method and Style with BPMN Implementer's Guide: A structured approach for business process modeling and implementation using BPMN 2.0 by Bruce Silver, Cody Cassidy Press, 2011.

Research Methodology			
Credit Hours:	3 (3+0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** concepts of research methodology	PLO3	C2 (Understanding)
2	**Applying** modern research tools	PLO5	C3 (Applying)
3	**Write** a research proposal	PLO4	C3 (Applying)

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

Course Content:

Introduction to Research. Objectives of Research. Importance of Research Methodology in Research Study. Types of Research. Steps in Conducting Research. What is Literature Review? Why need for Literature Review. Types of Literature Review. Systematic Literature Review Protocol. Problem Statement and Problem formulation. Criteria for selecting a problem. Identifying Types of variables in Research. Types of hypothesis. Identifying Target Population. Types of Sampling. Sampling Techniques. Quantitative Research Methods. Scientific Methods. Design of Quantitative Surveys. Techniques to Conduct Quantitative Methods. Introduction to Qualitative Research. Qualitative Research Methods. Data Analysis and Theory in Qualitative Research Articles. Introduction to Mixed Methods Research. Design of Mixed Methods Research. Evaluation of Mixed Methods Research. Case Study. How to Conduct a Case Study. Case Study Protocol. Importance and Benefits of Case Study. Types of Statistical Tests to Conduct Data Analysis. Data Analysis Tools. Introduction to SPSS. Hands on Practice of SPSS. How to Define variables in SPSS. How to Record Collected Data in SPSS. Types of Tests via SPSS including Regression. Correlation. Cross tabulation and others. How to write Good Research Proposal. Contents of Thesis. Important Elements of Research Thesis

Teaching Methodology:

Lectures, Problem based learning, Research Papers

Course Assessment:

Sessional Exam, Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Research design: Qualitative, quantitative and mixed methods approaches, Creswell, J. W. Thousand Oaks, CA: Sage,4th Ed. 2014.

Introduction to Accounting			
Credit Hours:	3 (3+0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** basic concepts of accounting	PLO1	C2 (Understanding)
2	**Understanding** accounts management	PLO1	C2 (Understanding)
3	**Analyzing** cash flow and making small business budgets	PLO4	C4 (Analyzing)

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

Course Content:

Basic Concepts & Conventions of Accounting, Business & Accounting Cycles, Inventory Management, Debt Management, Receivable Management, Managerial Accounting, Concept of Cost & Cost Accounting, Budgeting, Profit Planning, Risk & Return Cost of Capital, Cash flow Analysis, Capital Budgeting, Dividend Policy.

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Assignments, Quizzes, Project, Final Exam,

Reference Materials:

1. Financial Management – Theory and Practice Brigham and Gapenski (11th edition) Author by Eugene F. Brigham and Lou s C. Gapensk
2. Fundamentals of Financial Management Van Horne and Wachowicz .JR (13th edition) James C. Van Horne and John M.Wachowicz .JR

Psychology			
Credit Hours:	3 (3+0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Describing** human psychology	PLO1	C1 (Remembering)
2	**Developing** social interaction skill to communicate	PLO7	C3 (Applying)
3	**Understanding** professional ethical responsibilities	PLO9	C3 (Understanding)

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

Course Content:

Introduction to Human Behavior, Definition of Human Psychology, Understanding Goals of Psychology, Major Trends in the Development of Psychology, Biological Basis of Behavior, Perception, Attention Processes, Organizational Processes in Perception, Identification and Recognition Processes, Memory, Types of Memory, Forgetting, Learning and Behavior, Classical Conditioning, Operant Conditioning, Cognitive Learning, Observational Learning, Motivation, Definition and Type of Motivates (Primary, Secondary and General), Theories of Motivation, Reinforcement, Rewards, Punishment, Emotion, Basic Emotions and Culture, Theories of Emotions, Functions of Emotions, Personality, Definition and Assessment of Personality, Psychodynamic, Behavioristic, Humanistic, and Trait Theory of Personality Social Psychology, Social Cognition, Attitude and Their Group Behavior, Prejudice, Social Influences and Group Behavior, Interpersonal Attraction and Loving, Stress & Coping (Psychology of Health)

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Assignments, Quizzes, Project, Final Exam,

Reference Materials:

Feldman, Robert S. "Understanding Psychology", McGraw Hill, 2002.

Principles of Marketing			
Credit Hours:	3 (3+0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

S. No.	CLO	Mapped PLOs	Domain
1	**Understanding** concepts of marketing	PLO1	C2 (Understanding)
2	**Analyzing** the market need	PLO3	C4 (Analyzing)
3	**Designing** strategies for effective marketing	PLO4	C3 (Applying)

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

Course Content:

Marketing in a changing worlds, Product: Brands, products, packaging and services, Price: Pricing consideration and strategies, Promotion: Integrated Marketing, communication strategy, Mass communication, Direct and online marketing, Marketing segmentation and targeting, Positioning, Consumer Buyer behavior, Creating competitive advantages, Strategic marketing planning

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Assignments, Quizzes, Project, Final Exam,

Reference Materials:

Principles of Marketing: A South Asian Perspective, 13th edition, Kotler, P., Armstrong, G., Agnihotri, P.Y. and Haque E. (2010).