BS COMPUTER SCIENCE CURRICULUM

This document contains the Curriculum for Bachelor of Science in Computer Science (BSCS), developed according to the new curriculum of NCEAC 2023 and HEC Undergraduate Education Policy 2023.

Department of Computer Science, Shaheed Benazir Bhutto University, Sheringal

Bachelor of Science in Computer Science - BSCS

Computer science is the study of the theory, experimentation, and engineering that form the basis for the design and use of computers. It is the scientific and practical approach to computation and its applications and the systematic study of the feasibility, structure, expression, and mechanization of the methodical procedures (or algorithms) that underlie the acquisition, representation, processing, storage, communication of, and access to information [*WordNet Princeton definition*].

Computer Science is the application of a systematic, disciplined and quantifiable approach to the design, development, operation, and maintenance of software systems. It is the practice of designing and implementing large, reliable, efficient and economical software by applying the principles and practices of engineering. The program aims to train students in all aspects of the software life cycle from specification through analysis and design to testing, maintenance and evaluation of software products.

Computer Science spans a wide range, from its theoretical and algorithmic foundations to cutting – edge developments in robotics, computer vision, intelligent systems, bioinformatics, and other exciting areas. The overall scope of Computer Science may be viewed into the following three categories:

- To develop effective ways to solve computing problems. For example, Computer Science develops the best possible ways to store information in databases, send data over networks, and display complex images. The theoretical background offered by Computer Science allows determining the best performance possible, and their study of algorithms. It enables to develop new problem-solving approaches that provide better performance.
- It devises new ways to use computers intelligently and effectively. Progress in the areas of networking, database, and human-computer-interface came together as a result of the world-wide- web, which changed the entire world. Now, researchers are working to make robots that are practical aides and demonstrate intelligence, databases that create new knowledge and, in general, use computers to do new things.
- It deals with the design and implementation of software systems. Computer Science provides training and skills for the successful implementation of software systems that solve challenging programming jobs. Computer Science spans the range from theory to models, design and programming. Computer Science offers a comprehensive foundation that permits graduates to adapt to new technologies and new ideas.

Program Educational Objectives (PEOs)

We aim to achieve the following PEOs at the end of the BSCS program.

- PEO-1: Graduates apply their in-depth Computer Science knowledge and technical skills in developing software, mobile, or web applications in real-world settings.

- PEO-2: Graduates practice ethics and responsibility in their profession and act as informed citizens in making a socio-economic impact on society.
- PEO-3: Graduates demonstrate lifelong learning skills in Computer Science and allied disciplines.
- PEO-4: Graduates demonstrate leadership and work as good team players in communicating and collaborating in diverse teams and organizations.

Student Outcomes (SOs)

We aim to attain educational objectives by ensuring that students demonstrate achievement of the following outcomes (derived from Graduate Attributes (GA) defined by Seoul Accord (SA) www.seoulaccord.org).

- **Academic Education:** To prepare graduates as computing professionals.
- **Knowledge for Solving Computing Problems:** An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
- **Problem Analysis:** Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.
- **Design/ Development of Solutions:** Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
- **Modern Tool Usage:** Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.
- **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams and multi-disciplinary settings.
- **Communication:** Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.
- **Computing Professionalism and Society:** Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice.
- **Ethics:** Understand and commit to professional ethics, responsibilities, and norms of professional computing practice.
- **Life-long Learning:** Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

Curriculum Model for BS Computer Science

Table 1 shows the generic structure for the BSCS program, formulated by following NCEAC Curriculum 2023 and UGE Policy 2023.

Table 1. Generic Structure for BS Computer Science

NCEAC Requirement	UGE Requirement	Credit Hours	Total Credit Hours	Courses
Computing Core	Major (Minimum 72 Credit Hours)	40	85	14
Domain Core		18		6
Domain Elective		21		7
Final Year Project I & II (Computing Core: 6 Credit Hours)	Capstone Project (Major)	6		
Mathematics & Supporting Courses	Interdisciplinary/Allied Courses	12	12	4
Elective Supporting Courses	Minor (Optional)	3	3	1
General Education Courses	General Education Requirement	30	30	12
-	Field	3	3	-
Tajweed, Quran and Hadith (Compulsory, nor-credit courses, only for Muslim students		-	One contact hour each semester	
Total Credit Hours			133	44
Double Major (Optional)		-		-
Minor (Optional)		-		-

Table 2: Mapping of BS Computer Science Scheme

#	Sem#	C. Code	Pre-Reqs	Course Title	Domain	Cr. Hr. (Cont. Hr.)
Computing Core (46/130) 14 Courses						
1.	1	CS1xx		Programming Fundamentals	Core	4 (3-3)
2.	2	CS1xx	PF	Object Oriented Programming	Core	4 (3-3)
3.	2	CS1xx		Database Systems	Core	4 (3-3)
4.	2	CS1xx		Digital Logic Design	Core	3 (2-3)
5.	3	CS2xx	PF	Data Structures	Core	4 (3-3)
6.	3	CS2xx		Computer Networks	Core	3 (2-3)
7.	3	CS2xx		Software Engineering	Core	3 (3-0)
8.	3	CS2xx	DLD	Computer Organization & Assembly Language	Core	3 (2-3)
9.	4	CS2xx		Information Security	Core	3 (2-3)
10.	4	CS2xx		Artificial Intelligence	Core	3 (2-3)
11.	5	CS3xx	DS	Operating Systems	Core	3 (2-3)
12.	7	CS4xx	DS	Analysis of Algorithms	Core	3 (3-0)
13.	7	CS4xx		Capstone Project-I (Final Year Project – I)	Core	2 (0-6)
14.	8	CS4xx	CP-I/FYP-I	Capstone Project-I (Final Year Project – II)	Core	4 (0-12)
Domain Core (18/130) 6 Courses						
15.	4	CS2xx		Theory of Automata	Domain Core	3 (3-0)
16.	4	CS2xx	DB	Advance Database Management Systems	Domain Core	3 (2-3)
17.	5	CS3xx		HCI & Computer Graphics	Domain Core	3 (2-3)
18.	5	CS3xx	COAL	Computer Architecture	Domain Core	3 (2-3)
19.	6	CS3xx	TA	Compiler Construction	Domain Core	3 (2-3)
20.	6	CS3xx	OS	Parallel & Distributed Computing	Domain Core	3 (2-3)
Domain Elective (21/130) 7 Courses						
21.	5	CS3xx		Web Technologies	Domain Elective	3 (2-3)
22.	6	CS3xx	OOP	Advanced Programming (Old Name: Visual Programming)	Domain Elective	3 (2-3)
23.	6	CS3xx	WT	Web Engineering	Domain Elective	3 (2-3)
24.	6	CS3xx	IS	Introduction to Cyber Security	Domain Elective	3 (2-3)
25.	6	CS3xx		Cloud Computing	Domain Elective	3 (2-3)

26.	7	CS4xx	ICS	Digital Forensics	Domain Elective	3 (2-3)
27.	7	CS4xx		Mobile Application Development	Domain Elective	3 (2-3)
Interdisciplinary/Allied (Mathematics & Supporting) Courses (12/130) 4 Courses						
28.	2	MT1xx	CAG	Linear Algebra	Maths	3 (3-0)
29.	5	MT2xx		Probability & Statistics	Maths	3 (3-0)
30.	5	MT1xx	CAG	Multivariable Calculus	Maths	3 (3-0)
31.	7	EW4xx	ECC	Technical & Business Writing	EW	3 (3-0)
Field Experience/Internship						
32.	7	CS4xx		6-8 weeks, can be completed in winter vacations		
Elective Supporting Courses (3/130) 1 Course						
33.	7	SS1xx		Social Science (Example: Introduction to Marketing)	SS	3 (3-0)
General Education Requirement as per HEC UG Education Policy (30/130) 12 Courses						
34.	1	GE1xx		Application of Information & Communication Technologies	GER	3 (2-3)
35.	1	GE1xx		Functional English (FE)	GER	3 (3-0)
36.	2	GE1xx	FE	Expository Writing	GER	3 (3-0)
37.	1	GE1xx		Quantitative Reasoning – 1 (Discrete Structures)	GER	3 (3-0)
38.	1	GE1xx		Quantitative Reasoning – 2 (Calculus and Analytic Geometry)	GER	3 (3-0)
39.	4	GE2xx		Islamic Studies	GER	2 (2-0)
40.	8	GE4xx		Ideology and Constitution of Pakistan	GER	2 (2-0)
41.	4	GE2xx		Social Sciences (Example: Introduction to Management)	GER	2 (2-0)
42.	4	GE2xx		Natural Sciences (Applied Physics)	GER	3 (2-3)
43.	8	GE4xx		Arts & Humanities (Professional Practices)	GER	2 (2-0)
44.	8	GE4xx		Civics and Community Engagement	GER	2 (2-0)
45.	7	GE4xx		Entrepreneurship	GER	2 (2-0)
Tajweed, Quran and Hadith						
1.	1	ISL111		Tajweed Ul Quran	Tajweed, Quran and Hadith	0(1-0)
2.	2	ISL112		Understanding Quran-I	Tajweed, Quran and Hadith	0(1-0)
3.	3	ISL211		Understanding Quran-II	Tajweed, Quran and Hadith	0(1-0)
4.	4	ISL212		Understanding Quran-III	Tajweed, Quran and Hadith	0(1-0)
5.	5	ISL311		Understanding Quran-IV	Tajweed, Quran and Hadith	0(1-0)
6.	6	ISL312		Understanding Quran-V	Tajweed, Quran and Hadith	0(1-0)
7.	7	ISL411		Seerah-I	Tajweed, Quran and Hadith	0(1-0)
8.	8	ISL412		Seerah-II	Tajweed, Quran and Hadith	0(1-0)

Study Plane for BS Computer Science

Table 3 presents the study plan for BS Computer Science, with the following distribution:

Sem 1 + Sem 3 + Sem 5 + Sem 7 = Theory 57 hours + Lab 36 hours + Project Lab 06 hours

Sem 2 + Sem 4 + Sem 6 + Sem 8 = Theory 55 hours + Lab 42 hours + Project Lab 12 hours

Table 3: Study Plane for BS Computer Science

S. No.	Code	Pre-Reqs	Course Title	Domain	Cr Hr. (Cont. Hr.)
Semester 1					
	CS1xx		Programming Fundamentals (PF)	Comp. Core 1	4 (3-3)
	GE1xx		Application of Information & Communication Technologies	GER 1	3 (2-3)
	GE1xx		Discrete Structures (QR 1)	GER 2	3 (3-0)
			Calculus and Analytic Geometry (CAG -QR 2)	GER 3	3 (3-0)
	GE1xx		Functional English	GER 4	3 (3-0)
	GE1xx		Islamic Studies	GER 5	2 (2-0)
	MT101		Mathematics A for Medical Students	Deficiency Course	0(3-0)
	ISL111		Tajweed Ul Quran	Tajweed, Quran and Hadith	0(1-0)
				Total Credit Hours	**18 (20-6)**
Semester 2					
	CS1xx	PF	Object Oriented Programming (OOP)	Comp. Core 2	4 (3-3)
	CS1xx		Database Systems	Comp. Core 3	4 (3-3)
	CS1xx		Digital Logic Design (DLD)	Comp. Core 4	3 (2-3)
	GE1xx		Ideology and Constitution of Pakistan	GER 6	2 (2-0)
	MT3xx	CAG	Linear Algebra	Maths 3	3 (3-0)
	GE2xx		Natural Sciences (Applied Physics)	GER 7	3 (2-3)
	MT102		Mathematics B for Medical Students	Deficiency Course	0(3-0)
	ISL112		Understanding Quran-I	Tajweed, Quran and Hadith	0(1-0)
				Total Credit Hours	**19 (19-12)**
Semester 3					
	CS2xx	PF	Data Structures (DS)	Comp. Core 5	4 (3-3)
	CS2xx		Software Engineering	Comp. Core 9	3 (3-0)
	CS2xx	DLD	Computer Organization & Assembly Language (COAL)	Comp. Core 10	3 (2-3)
	CS2xx		Computer Networks	Comp. Core 8	3 (2-3)
	GE2xx	ECC	Expository Writing	GER 8	3 (3-0)
	GE2xx		Civics and Community Engagement	GER 9	2 (2-0)
	ISL211		Understanding Quran-II	Tajweed, Quran and Hadith	0(1-0)
					18 (16-9)
Semester 4					
	CS2xx		Information Security	Comp. Core 6	3 (2-3)
	CS2xx		Artificial Intelligence	Comp. Core 7	3 (2-3)
	CS2xx		Theory of Automata	Domain Core 1	3 (3-0)
	CS2xx	DB	Advance Database Management Systems	Domain Core 2	3 (2-3)
	GE2xx		Introduction to Management (Social Science)	GER 10	2 (2-0)
	GE2xx		Professional Practices (Arts & Humanities)	GER 11	2 (2-0)
	GE2xx		Entrepreneurship	GER 12	2 (2-0)
	ISL212		Understanding Quran-III	Tajweed, Quran and Hadith	0(1-0)
				Total Credit Hours	**18 (16-9)**
Semester 5					
	CS3xx	DS	Operating Systems	Comp. Core 11	3 (2-3)
	CS3xx		HCI & Computer Graphics	Domain Core 3	3 (2-3)
	CS3xx	COAL	Computer Architecture	Domain Core 4	3 (2-3)
	CS3xx		Web Technologies	Domain Elective 1	3 (2-3)
	MT3xx		Probability & Statistics	Maths 2	3 (3-0)

	MT1xx	CAG	Multivariable Calculus	Maths 1	3 (3-0)
	ISL311		Understanding Quran-IV	Tajweed, Quran and Hadith	0(1-0)
				Total Credit Hours	**18 (15-12)**
Semester 6					
	CS3xx	TA	Compiler Construction	Domain Core 5	3 (2-3)
	CS3xx	OS	Parallel & Distributed Computing	Domain Core 6	3 (2-3)
	CS3xx	OOP	Advanced Programming	Domain Elective 2	3 (2-3)
	CS3xx	WT	Web Engineering	Domain Elective 3	3 (2-3)
	CS3xx	IS	Introduction to Cyber Security (ICS)	Domain Elective 4	3 (2-3)
	CS3xx		Cloud Computing	Domain Elective 5	3 (2-3)
	ISL312		Understanding Quran-V	Tajweed, Quran and Hadith	0(1-0)
				Total Credit Hours	**18 (13-18)**
Semester 7					
	CS4xx		Capstone Project – I (CS-I): Final Year Project-I	Comp. Core 12	2 (0-6)
	CS4xx	ICS	Digital Forensics	Domain Elective 6	3 (2-3)
	CS4xx	DS	Analysis of Algorithms	Comp. Core 13	3 (3-0)
	CS4xx		Field Experience/Internship (6-8 weeks, can be completed in winter vacations)	UGE Requirement	3 (0-3)
	CS4xx		Mobile Application Development	Domain Elective 7	3 (2-3)
	ISL411		Seerah-I	Tajweed, Quran and Hadith	0(1-0)
				Total Credit Hours	**14 (8-15)**
Semester 8					
	CS4xx	CS-I	Capstone Project – II: Final Year Project-II	Comp. Core 14/UGE Requirement	4 (0-12)
	EN4xx		Technical & Business Writing	EW	3 (3-0)
	SS4xx		Introduction to Marketing	Elective Supporting Course 1	3 (3-0)
	ISL412		Seerah-II	Tajweed, Quran and Hadith	0(1-0)
				Total Credit Hours	**10 (7-12)**
				Total Credit Hours in BS Computer Science: 133	

Course Contents for BS Computer Science

The following are the semester-wise course contents of BS Computer Science.

BS Computer Science 1st Semester

Course Name:	**Programming Fundamentals**
Credit Hours:	4 (3-3)
Contact Hours:	Theory: 3 Hours, Practical: 3 Hours
Pre-requisites:	None
Course Introduction:	This course provides fundamental concepts of programming to freshmen. The course is a pre-requisite 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 teacher to choose any language for practical/Lab purposes but that must be the 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 programing 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, 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.

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:	**Applications of Information and Communication Technologies (ICT)**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	None
Course Introduction:	This course is introduced to provide students with a practical understanding of how information and communication technologies (ICT) are used in various fields and industries. The course covers such areas of knowledge within the application of ICT tools, software, and systems to enhance productivity, communication, decision-making, and problem-solving across different domains. Through this course, students will be engaged in hands-on activities, projects and assignments to reinforce their understanding of ICT applications. The objective of the course is to build an appreciation for the fundamental concepts in computing and to become familiar with popular PC productivity software.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the basics of computing technology	C1 (Knowledge)
CLO-2	Do number systems conversions and arithmetic	C2(Understand)
CLO-3	Know the types of software	C2(Understand)
CLO-3	Know computing-related technologies	C3 (Apply)

Course Outline:

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, Class2. 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.

Reference Materials (or use any other standard and latest books):

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.
3. Zawacki-Richter, Olaf, and Colin Latchem. "Exploring four decades of research in

Computers & Education." Computers & Education 122 (2018): 136-152.
4. Sinha, Pradeep K., and Priti Sinha. Computer fundamentals. BPB publications, 2010.
5. Goel, Anita. Computer fundamentals. Pearson Education India, 2010.

Course Name:	**Discrete Structure**
Credit Hours:	3 (3-0)
Contact Hours:	Theory: 3 Hours, Practical: 0 Hours
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 an understanding and appreciation of the finite nature inherent in most Computer Science problems and structures through the study of combinatorial reasoning, abstract algebra, iterative procedures, predicate calculus, and tree and graph structures. In this course, more emphasis shall be given to statistical and probabilistic formulation with respect to computing aspects.

CLO No.	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 to 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 W. Grassman

Course Name:	**Calculus and Analytical Geometry (CAG)**
Credit Hours:	3 (3-0)
Contact Hours:	Theory: 3 Hours, Practical: 0 Hours
Pre-requisites:	None
Course Introduction:	To provide the foundation and basic ground for calculus and analytical geometry background.

CLO No.	**Course Learning Outcomes**	**Bloom Taxonomy**
CLO-1	Understand the key concepts of calculus and analytical geometry	C2 (Understand)

Course Outline:

Limits and Continuity; Introduction to functions, Introduction to limits, Techniques of finding 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 R^3, Equations for planes.

Reference Materials (or use any other standard and latest books):

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. Co.

Course Name:	**Functional English**
Credit Hours:	3 (3-0)
Contact Hours:	Theory: 3 Hours, Practical: 0 Hours
Pre-requisites:	None
Course Introduction:	This is the first course in English for the Bachelor of Science students and covers all the fundamental concepts 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' skills and competence in communicating their ideas in writing and speaking in the 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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the key concepts of English composition and comprehension	C2 (Understand)
CLO-2	Apply functional English in listening comprehension, improving reading efficiency, building up vocabulary, and accurately reproducing specific data.	C3 (Apply)

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, 2000.

Course Name:	**Islamic Studies**
Credit Hours:	2 (2-0)
Contact Hours:	Theory: 2 Hours, Practical: 0 Hours
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
CLO-1	To further enhance the knowledge of Islam.	-
CLO-2	To understand the basic concept of Islam and Quran Pak.	-
CLO-3	To understand the concept of Haqooq-ul-Ibad in the light of Quran.	-
CLO-4	To know the importance of Islamic concept about other 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 (or use any other standard and latest books):

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:	**Mathematics A**
Credit Hours:	Non-credit, deficiency course for FSc Pre-Medical Students (3-0)
Contact Hours:	Theory: 3 Hours, Practical: 0 Hours
Pre-requisites:	Mathematics at SSC level
Course Introduction:	To introduce the basics of functions with a detailed analysis of elementary functions including exponential, logarithmic and trigonometric functions

CLO No.	**Course Learning Outcomes**	**Bloom Taxonomy**
CLO-1	To enable students with FSc (Pre-Medical) to understand the basic mathematics and its applications.	-

Course Outline:

Sets, Real Numbers and Their Properties, Polynomials, Linear and Quadratic Equations, Inequalities, Relations and Functions, Representing Functions, Linear and Quadratic Functions, Exponential and Logarithmic Functions, Trigonometric Functions, Graphs of Trigonometric Functions, Inverse Functions, Trigonometric Identities, The Law of Sines, The Law of Cosines, Complex Numbers, De Moivre's Theorem.

Reference Materials (or use any other standard and latest books):

1. Margaret L. Lial, John Hornsby, David I. Schneider, Callie J. Daniels, "Precalculus", Pearson, 6th Edition, 2017
2. Sullivan, M., "Precalculus", Pearson, 10th Edition, 2016
3. Stewart, J., Redlin, L., Watson, S., "Precalculus, Mathematics for Calculus", CENGAGE Learning, 7th Edition, 2016
4. Kirkpatrick, C., "Functions 11", Nelson, 1st Edition, 2008

BS Computer Science 2nd Semester

Course Name:	**Object Oriented Programming**
Credit Hours:	4 (3-3)
Contact Hours:	Theory: 3 Hours, Practical: 3 Hours
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 the principles of the object-oriented paradigm.	C2 (Understand)
CLO-2	Identify the objects & their relationships to build object-oriented solutions.	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 (or use any other standard and latest books):

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 Systems**
Credit Hours:	4 (3-3)
Contact Hours:	Theory: 3 Hours, Practical: 3 Hours
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 models 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 sub- queries in SQL, Grouping and aggregation in SQL, concurrency control, database backup and recovery, indexes, NoSQL systems.

Reference Materials (or use any other standard and latest books):

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 (DLD)**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	None
Course Introduction:	The course introduces the concept of digital logic, gates and digital circuits. Further, it focuses on the design and analysis of 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 (or use any other standard and latest books):

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

Course Name:	**Ideology and Constitution of Pakistan**
Credit Hours:	2 (2-0)
Contact Hours:	Theory: 2 Hours, Practical: 0 Hours
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 objectives of the course • To develop the vision of Historical Perspective, Government, Politics, Contemporary Pakistan, and 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 students about the various pillars of the state.	-
CLO-3	To educate students on 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 geo-political dimension, Pakistan and International Affairs, Pakistan and the challenges ahead.

Reference Materials (or use any other standard and latest books):

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:	**Linear Algebra**
Credit Hours:	3 (3-0)
Contact Hours:	Theory: 3 Hours, Practical: 0 Hours
Pre-requisites:	Calculus and Analytical Geometry
Course Introduction:	To provide fundamentals of solution for the system of linear equations, operations on the system of equations, matrix properties, solutions and study of their properties.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the key concepts of Linear Algebra.	C2 (Understand)
CLO-2	Understand the applications of Linear Algebra in Computer Science, including, e.g., Search Engines, Information Retrieval, etc.	C2 (Understand)

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:	**Applied Physics (Natural Sciences)**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	None
Course Introduction:	The course introduces students to the basic concepts of Physics and electronics. Students are also taught Physics laws and other associate topics to prepare them for the advanced level courses in this area. The focus of the course on electric force and its applications and related problems, conservation of charge, charge quantization, Electric fields due to point charge and lines of force and many other useful topics.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	-

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 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.

Reference Materials (or use any other standard and latest books):

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.

Course Name:	**Mathematics B**
Credit Hours:	Non-credit, deficiency course for FSc Pre-Medical Students (3-0)
Contact Hours:	Theory: 3 Hours, Practical: 0 Hours
Pre-requisites:	Mathematics A
Course Introduction:	To introduce the concept of matrices, conic section, basic probability theory, limits, basics of derivatives and basics of definite integrals

CLO No.	**Course Learning Outcomes**	**Bloom Taxonomy**
-	-	-

Course Outline:

System of Linear Equations, Matrices and Determinants, Solving System of Linear Equations in Matrix Form, Circles, Parabolas, Ellipses, Hyperbolas, Sequences and Series, The Binomial Theorem, Mathematical Induction, Basics of Counting Theory, Basics of Probability, Introduction to Limits and Continuity, Tangent Lines and Derivatives, Area and Definite Integral.

Reference Materials (or use any other standard and latest books):

1. John Hornsby, Margaret L. Lial, Gary Rockswold, "A Graphical Approach to Precalculus with Limits", Pearson, 7th Edition, 2019
2. Margaret L. Lial, John Hornsby, David I. Schneider, Callie J. Daniels, "Precalculus", Pearson, 6th Edition, 2017
3. Ron Larson, Robert Hostetler, Bruce H. Edwards, "Precalculs with Limits", Brooks/Cole, 7th Edition, 2016
4. Sullivan, M., "Precalculus", Pearson, 10^{th} Edition, 2016
5. Stewart, J., Redlin, L., Watson, S., "Precalculus, Mathematics for Calculus", CENGAGE Learning, 7^{th} Edition, 2016

BS Computer Science 3rd Semester

Course Name:	**Data Structures**
Credit Hours:	4 (3-3)
Contact Hours:	Theory: 3 Hours, Practical: 3 Hours
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 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.

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
5. Java Software Structures: Designing and Using Data Structures by John Lewis and Joseph Chase

Course Name:	**Computer Organization and Assembly Language**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	None
Course Introduction:	The main objective of this course is to introduce the organization of computer systems and the usage of assembly language for optimization and control. Emphasis should be given to exposing 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 (or use any other standard and latest books):

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:	**Software Engineering**
Credit Hours:	3 (3-0)
Contact Hours:	Theory: 3 Hours, Practical: 0 Hours
Pre-requisites:	None
Course Introduction:	This course enables students to understand the basics of software engineering, including software development processes, engineering practices, and the techniques required during professional software development.

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:	**Computer Networks**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	None
Course Introduction:	This course introduces the basic concept of computer networks 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 the 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 (or use any other standard and latest books):

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:	**Expository Writing**
Credit Hours:	3 (3-0)
Contact Hours:	Theory: 3 Hours, Practical: 0 Hours
Pre-requisites:	Functional English
Course Introduction:	The course introduces students to the communication 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 can 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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	-

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 (or use any other standard and latest books):

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:	**Civics and Community Engagement**
Credit Hours:	2 (2-0)
Contact Hours:	Theory: 2 Hours, Practical: 0 Hours
Pre-requisites:	None
Course Introduction:	This course aims to bring responsible citizenship and active engagement between Universities/HEIs (through their students) and local communities. The course will provide students with a foundational understanding of the principles, institutions, and processes of civic engagement in a democratic society. Moreover, the course will build the capacity of students as leaders and influencers by gaining a fundamental understanding of leadership, citizenship, communication, advocacy, and network building as well as having first-hand experience of community development through volunteer work.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Learn and practice the necessary communication skills to interact in volunteer service.	-
CLO-2	Examine the community environment and focus upon and prioritize major community service needs	-
CLO-3	Identify personal values relevant to community service	-

Course Outline:

Foundations of Civics: Introduction to Civics, Definitions and scope, Historical development, Importance of civic education in a society. Structure of Government: Understanding the political system in Pakistan, Roles and responsibilities of different levels of government, The concept of federalism and its application in Pakistan. Rights and responsibilities: Fundamental rights and duties of citizens, Civil liberties and human rights in the Pakistani context, Balancing individual rights with societal responsibilities. Community Engagement: Community Development, Definition and principles of community development, The role of individuals in fostering community growth, Case studies of successful community development initiatives in Pakistan. Volunteerism and Social Service: Importance of volunteerism in community engagement, Opportunities for social service in Pakistan, Building a culture of volunteerism. Challenges in Community Engagement: Identifying barriers to community engagement, Strategies to overcome challenges, The impact of community engagement on societal well-being. Active Citizenship and Social Change: Advocacy and Civic Participation, Techniques of effective advocacy, Understanding the power of public opinion, Encouraging civic participation among diverse populations. Sustainable Development and Civic Responsibility: The role of citizens in sustainable development, Environmental and social responsibility, Promoting a sense of ownership and stewardship.

Reference Materials (or use any other standard and latest books):

1. Sipe, James W. Seven Pillars of Servant Leadership. 2009.
2. Berger Kaye, Cathryn. The Complete Guide to Service Learning: Proven, Practical Ways to Engage Students in Civic Responsibility, Academic Curriculum & Social Action. 2010.

3. Boyte, H. Everyday Politics: Reconnecting Citizens and Public Life. 2010.
4. Bowen, Glenn. Civic Engagement in Higher Education: Resources and References. 2010.
5. Civics Today: Citizenship, Economics, and You by Glencoe McGraw-Hill.
6. Citizenship Rights and Social Movements: A Comparative and Statistical Analysis" by Jack Rothman.
7. The Civic Imagination: Making a Difference in American Political Life by Gianpaolo Baiocchi, Elizabeth A. Bennett, and Alissa Cordner.

BS Computer Science 4th Semester

Course Name:	**Information Security**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
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 solve problems 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:	**Artificial Intelligence**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
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, Min- max 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.
6. Joshi, P., 2017. "Artificial intelligence with python." Packt Publishing Ltd..

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

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 a 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 (or use any other standard and latest books):

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.

Course Name:	**Advanced Database Management Systems**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	Databased Systems
Course Introduction:	Advanced Database Management Systems is an extension to the "Database Systems" course. The course aims to enhance the previous knowledge of database systems by deepening the understanding of the theoretical and practical aspects of database technologies, and showing the need for distributed database technology to tackle deficiencies of the centralized database systems. Moreover, it focuses on introducing the basic principles and implementation techniques of distributed database systems, and exposes 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 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 (or use any other standard and latest books):

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.

Course Name:	**Introduction to Management**
Credit Hours:	2 (2-0)
Contact Hours:	Theory: 2 Hours, Practical: 0 Hours
Pre-requisites:	None
Course Introduction:	This is an introductory course about the management of organizations applicable to all types of enterprises regarding planning, organizing, leading, and controlling. It equips students to effectively work with and through others in an organization.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the key concepts and theory of the management of an organization	-
CLO-2	Hold informed conversations with functional specialists and understand how to draw effectively on their expertise in managing organizations.	-
CLO-3	Demonstrate empirical investigative skills by producing an in-depth analysis of a management situation usually presented through case studies, resulting in recommendations for a program of action.	-
CLO-4	Recognize the need to take a holistic approach to performance improvement rather than a narrowly functional approach.	-

Course Outline:

Management, organization, and management process. Organizational theories and different approaches to management. The organizational culture and the manager. The external environment and the manager. The internal environment and the manager. Planning: Process of planning and MBO, effective strategic planning. Decision-making: The manager's role as decision maker, decision-making process. Basics of strategic management: case of strategic management, strategic management process. Organizational structure, types of organizational structures. Human resource management (HRM), HRM processes. Team work and group behavior. Leadership and its characteristics, styles and behaviors. The process of control and its standards.

Reference Materials (or use any other standard and latest books):

1. Management by Stephen Robbins and Mary Coulter 14th Edition
2. Introduction to Management by Rutgers Business School, New Brunswick Edition, ISBN: 9781307093346
3. A Guide to the Project Management Body of Knowledge by Project Management Institute; Sixth Edition, (September 22, 2017)
4. The New One Minute Manager by Ken Blanchard and Spencer Johnson, William Morrow; 1st Edition (May 5, 2015)

Course Name:	**Professional Practices**
Credit Hours:	2 (2-0)
Contact Hours:	Theory: 2 Hours, Practical: 0 Hours
Pre-requisites:	None
Course Introduction:	A Computing graduate as a professional has some responsibilities for society. This course develops student understanding of historical, social, economic, ethical, and professional issues related to the discipline of Computing. It identifies key sources for information and opinions about professionalism and ethics. Students analyze, evaluate, and assess ethical and professional computing case studies.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	-

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:	**Entrepreneurship**
Credit Hours:	2 (2-0)
Contact Hours:	Theory: 2 Hours, Practical: 0 Hours
Pre-requisites:	None
Course Introduction:	This course aims to provide students with a basic understanding of the principles and practices of entrepreneurship. It also aims to cultivate an entrepreneurial mindset and equip students with the knowledge and skills necessary to start, manage, and grow their ventures.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the principles and practices of entrepreneurship	-
CLO-2	Equip students with financial literacy and export management to gain a holistic understanding of business in priority areas of the economy	-
CLO-3	To enable students to apply the gained knowledge in developing business plans to start and initiate their ventures.	-

Course Outline:

Entrepreneurship: Fundamentals, Entrepreneurship, Entrepreneur, Entrepreneur vs. Manager, Economic Empowerment/Development/Upliftment. The Entrepreneurial Mindset: Assessment, Feedback, Personal Entrepreneurial Characteristics/Competencies (PECs), Successful Entrepreneur & Reasons for starting own Business. Creating & Starting the Venture: Creativity & the sources of new business idea, Assessing business opportunities, Methods of generating ideas, SWOT frame & analysis, PLC, Product Life Cycle, E-Commerce, Business Startup & Growth. Business plan development: Scope and Value of Business Plan. Marketing, Production/Technical, Organizational, and Financial Planning.

Reference Materials (or use any other standard and latest books):

1. Robert D. Hisrich & Michael P. Peter "Entrepreneurship" (McGraw Hill) 5th Edition International edition
2. Bruce A. Kirchott "Entrepreneurship & Dynamic Capital"
3. Zafar Altaf (Croom Helm) "Entrepreneurship in the third world"
4. Robert J. Calvin "Entrepreneurial Management" (Tata McGraw Hill Edition)

BS Computer Science 5th Semester

Course Name:	**Operating Systems**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
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 concerning the core functions	C5 (Evaluate)
CLO-3	Demonstrate 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. Discrete 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 Wu.

Course Name:	**HCI & Computer Graphics**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	Applications of ICT, Programming Fundamentals
Course Introduction:	This is an introductory course to teach all relevant elements required to understand the basic concepts of HCI and Computer Graphics.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the basics of Human-Computer Interaction and Computer Graphics	-
CLO-2	Develop Interactive CG programs using OpenGL	-
CLO-3	Analyze techniques of user-centred design for desktop software, mobile app, or web application	-
CLO-4	Evaluate the usability of the user interface of desktop software, mobile app, or web application	-

Course Outline*:

Introduction and History: Definition and topics of HCI and computer graphics, history. Human cognition. Human visual system: the human eye, optical illusions, spatial perception, color perception. Colorimetry and color systems. 2D and 3D geometry. Graphical output devices. User Interactions and usability: dialogue techniques, input devices, interaction styles, menus and dialogues, HCI models, design criteria, metaphors. Graphical user interface implementation and evaluation: windows systems, toolkits, event handling, geometry management, platform-independent GUI development. Augmented reality. Pervasive and ubiquitous applications.

Reference Materials (or use any other standard and latest books):

1. Computer Graphics with Open GL 4th Edition by Donald D. Hearn, Prentice Hall,2010.
2. Introduction to Computer Graphics: Using Java 2D and 3D, Springer, 2nd Edition, 2008.
3. Designing the User Interface: Strategies for Effective Human-Computer Interaction by Ben Shneiderman and Catherine Plaisant, 6th Edition, Pearson Inc. 2016.
4. Designing Interactive Systems: A Comprehensive Guide to HCI, UX and Interaction Design by Benyon, D. 3rd Edition, 2023.

*Source: The course of HCI and Computer Graphics was designed in the light of the following sources:

1. M. Rotard, D. Weiskopf, and T. Ertl. A combined introductory course on HCI and Computer Graphics. *Computers and Graphics* **29**(2005):267-272.
2. Reference Materials were taken from *Curriculum of Computer Science, Software Engineering, and Information Technology (Bachelors & Masters Programs) – Revised 2017*, HEC Curriculum Division, HEC Islamabad.

Course Name:	**Computer Architecture**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	Computer Organization and Assembly Language
Course Introduction:	Modern computer technology requires an understanding of both hardware and software, as the interaction between the two offers a framework for mastering the fundamentals of computing. This course covers the basics of modern computer organization and architecture. The emphasis is on understanding the interaction between computer hardware and software at various levels. The students will learn the concepts of computer technology, performance evaluation, instruction set design, computer arithmetic, data path and control unit design of processors and enhancing performance with pipelining.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the architecture of modern computing systems, microprocessors, and multiprocessors.	-
CLO-2	Understand implementations of the arithmetic logic unit and control unit, pipelined processor, hazards, memory hierarchy, and storage devices	-
CLO-3	Understand performance analysis and evaluation.	-

Course Outline:

Computer Architecture and Importance for Computer Science Graduates, Instruction Set Architectures(ISA), Complex Instruction Set Computing (CISC), Reduced Instruction Set Computing (RISC), Operations of the Computer Hardware, Assembly Language, Registers, Data and Instruction Representation, Different Types of Instructions, Loops and IF Statements in Assembly, Supporting Procedures/Functions in Computer Hardware, Supporting Different Data Types in Hardware, Immediate and Addresses in Instructions, Compiling and Linking Processes to Convert a C/Java Program into Assembly and Converting that into Machine Code, Review of Number Systems, Signed and Unsigned Data Types, Arithmetic Operations (Subtraction, Multiplication, Division) in Hardware, Float Data Types and Arithmetic Operations on Float, Evaluating Performance of a System, Latency, Response Time, and Throughput, CPU Execution Time, Calculating CPU Execution Time for a Program, Benchmarks and Amdahl's Law, Processor Design, Building a 32-bit ALU, Processor Data path, Designing a Processor to Execute Instructions and Include Control Unit, Pipelining and Hazards in Pipelining and Solutions, Memory Hierarchy, Caches, Measuring and Improving Cache Performance, Direct Mapped Cache, Fully Associative Caches and Cache Optimizations, Virtual Memory, Virtual Machines. Storage and other I/O topics, Multiprocessors, Multi-cores and Clusters.

Reference Materials (or use any other standard and latest books):

1. Patterson, D. A., & Hennessy, J. L. (2013). Computer Organization and Design the Hardware/Software Interface (Latest Edition). Morgan Kaufmann.
2. Hennessy, J. L., & Patterson, D. A., (2012). Computer Architecture: A Quantitative Approach (Latest Edition). Morgan Kaufmann.

Course Name:	**Web Technologies**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	Programming Fundamentals
Course Introduction:	Introduces the web technologies necessary for the theory and practice of developing web pages and web applications. The main focus is on enabling students to grasp the key concepts of Internet and the Web, learn markup and scripting languages to develop web pages. The course includes hands-on labs to practice markup and styling web pages and writing scripts for client and server sides of the Web.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the fundamentals of Internet, World Wide Web, and Web Technologies.	C2 (Understand)
CLO-2	Understand the syntax of markup and scripting languages necessary for programming the Web	C2 (Understand)
CLO-3	Apply the markup and scripting languages in creating web pages.	C3 (Apply)

Course Outline:

Fundamentals: Internet, The World Wide Web, Web Browsers, Web Servers, Uniform Resource Locators, Multipurpose Internet Mail Extensions, The Hypertext Transfer Protocol, Web development tools and IDEs. HTML5: Basic Syntax, Standard HTML Document Structure, Basic Text Markup, Images, Hypertext Links, Lists, Tables, Forms. Cascading Style Sheets: Levels of Style Sheets, Style Specification Formats, Selector Forms, Property-Value Forms, Font Properties, List Properties, Alignment of Text, Color, The Box Model, Background Images, The and Tags, Conflict Resolution. JavaScript: General Syntactic Characteristics, Primitives, Operations, and Expressions, Screen Output and Keyboard Input, Control Statements, Object Creation and Modification, Arrays, Functions, Constructors, Pattern Matching Using Regular Expressions. Hypertext Preprocessor (PHP): General Syntactic Characteristics, Primitives, Operations, and Expressions, Control Statements, Arrays, Functions, Pattern Matching, Form Handling, Cookies, Session Tracking. The Basics of AJAX. Database Access through the Web: Relational Databases, Structured Query Language, Architectures for Database Access, The MySQL Database System, Database Access with PHP and MySQL.

Reference Materials (or use any other standard and latest books):

1. Programming the World Wide Web by Robert W. Sebesta, 8th edition
2. JavaScript: The Definitive Guide7th Edition by David Flanagan
3. PHP & MySQL: Server-side Web Development by Jon Ducket

Course Name:	**Probability & Statistics**
Credit Hours:	3 (3-0)
Contact Hours:	Theory: 3 Hours, Practical: 0 Hours
Pre-requisites:	None
Course Introduction:	To introduce the concepts of data analysis, presentation, counting techniques, probability and decision-making.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	-

Course Outline:

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 TwoSample 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 (or use any other standard and latest books):

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:	**Multivariate Calculus**
Credit Hours:	3 (3-0)
Contact Hours:	Theory: 3 Hours, Practical: 0 Hours
Pre-requisites:	Calculus and Analytical Geometry
Course Introduction:	This course is an extension of single-variable calculus. It focuses on calculus as it applies to functions of two or more variables. The concept learnt in this course will be useful in analyzing the geometry of curves and surfaces.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the basic concepts of multivariable calculus.	-
CLO-2	Understand concepts as parametric curves, matrix algebra, gradients, directional derivatives, and multiple integrals will be gained.	-
CLO-3	Physical interpretation of these concepts and application in constrained-unconstrained optimization	-

Course Outline:

Calculus of parametric curves, polar coordinates, coordinates and vectors in three-dimensions, dot and cross products, lines and planes in three-dimensions, conic sections and quadratic surfaces, parametric curves in three-dimensions, functions of two and three variables, partial derivatives, tangent planes and differentiability, the chain rule, the gradient and directional derivatives, maxima and minima, Lagrange multipliers, double integrals over rectangles and general regions, double integrals in polar coordinates, applications of double integrals, surface area as double integral, triple integral, cylindrical and spherical coordinates, vector fields and line integrals, Greens theorem, divergence and curl, Stokes theorem, divergence theorem.

Reference Materials (or use any other standard and latest books):

1. Stewart, J., & Cole, B. (2015). Multivariable Calculus (8^{th} Edition). Cengage Learning.
2. 2. Briggs, W. L., Cochran, L., & Gillett, B. (2014). Multivariable Calculus (2^{nd} Edition). Pearson Education India.

BS Computer Science 6th Semester

Course Name:	**Compiler Construction**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	Theory of Automata
Course Introduction:	The course is intended to teach the students the basic techniques that underlie the practice of Compiler Construction. The course introduces the theory and tools required in performing syntax-directed translation of a high-level programming language into an executable code. These techniques can also be employed in wider areas of application, whenever we need a syntax-directed analysis of symbolic expressions and languages and their translation into a lower-level description. They have multiple applications for man-machine interaction, including verification and program analysis. The course also discusses various aspects of the run-time environment into which the high-level code is translated. This will provide deeper insights into the more advanced semantic aspects of programming languages, such as recursion, dynamic memory allocation, types and their inferences, object orientation, concurrency and multi-threading.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand programming language concepts deeply.	C2 (Understand)
CLO-2	Understand processing of programming languages by computers.	C2 (Understand)
CLO-3	Have full command on techniques used by translator software	C3 (Apply)

Course Outline:

Introduction to Translators, Compiler, Interpreter, Assembler, Context of Compiler, Pre-processor, Assembler, Linker, Loader, Compiler introduction: Analysis-Synthesis Model of Compiler, Phases of Compiler, Two-Pass Assembly, Physical Organization of Compiler, Cousins of compiler, Compiler-Compilers, Lexical Analysis: Role of Lexical Analyzer, Lexical Error Handling, Buffering Issues in Lexical Analyzer, Lexical Analyzer Implementation (Hand coding, Lex), Syntax Analysis: Introduction to Top-Down and Bottom-Up Parsers, Recursive-Descent Parsers, Predictive Parsers, Non-Recursive Predictive Parser, Shift-Reduce Parser, Operator Precedence Parsers, LR Parsers, LL(1) Grammars, LR(1) Grammars, YACC, Syntax Error Handling, Type Systems, Symbol Table Management, Runtime Environment, Intermediate Code: Triples, Indirect Triples, Quadruples, Symbol Table: Techniques such as Lists and Hash Tables, Code Optimization, Code Generation.

Reference Materials (or use any other standard and latest books):

1. Watson, D. (2017). A Practical Approach to Compiler Construction (Latest Edition). Springer.
2. Mogensen, T. Æ. (2011). Introduction to compiler design (Latest Edition). Springer

Science & Business Media.
3. Dave, P. H., & Dave, H. B. (2012). Compilers: Principles and Practice (Latest Edition). Pearson Education India.
4. Puntambekar, A. A. (2009). Principles of compiler design (Latest Edition). Technical Publications.
5. Cooper, K., & Torczon, L. (2011). Engineering a compiler (Latest Edition). Elsevier.

Course Name:	**Parallel & Distributed Computing**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
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 a 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 (or use any other standard and latest books):

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 Edition.

Course Name:	**Advanced Programming**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	Object Oriented Programming
Course Introduction:	This course exposes students to the depth and breadth of modern programming practice, to make students better programmers. The objective is to introduce the students to some concepts of advanced programming and practice on reusing components. It focuses on Graphical User Interface (GUI), multithreading, networking, and database manipulation. A selected programming language is used such as Java. By completing this course, the students should be able to write sophisticated Java applications.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand some advanced programming concepts to deal with complex data objects.	-
CLO-2	Develop cognitive skills to define and analyze the problem to develop large programs in handling them.	-
CLO-3	Write the simplest possible program that solves a given problem while explaining to the reader how it solves that problem.	-
CLO-4	Develop programs to promote inheritance and reuse, implement networking and multithreading:	-
CLO-5	Compose more complex programs from simpler parts, and write programs that implement GUIs	-

Course Outline:

Java, Java platform. Java and Object Oriented Programming: Classes, objects, Inheritance, Polymorphism, and Interfaces. Exception Handling. JavaFX Graphical User Interfaces (GUIs). Generic Collections. JavaFX graphics and multimedia. Graphics and Java 2D. Accessing Databases with Java Database Connectivity. Swing GUI components. Networking.

Reference Materials (or use any other standard and latest books):

1. Java In A Nutshell: A Desktop Quick Reference 8th Edition by Benjamin J. Evans, Jason Clark, and David Flangan. Released February 2023. O'Reilly
2. Java How to Program. 11th Edition. 2017 (or Latest Edition). Pearson
3. Online Java Tutorials and API Documentation

Course Name:	**Web Engineering**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	Web Technologies, Software Engineering
Course Introduction:	The World Wide Web has become a major delivery platform for information resources. Many applications continue to be developed in an ad-hoc way, contributing to problems of usability, maintainability, quality and reliability. Web Engineering introduces a structured methodology used in software engineering for web development projects.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the concepts, principles and methods of Web Engineering.	C2(Understand)
CLO-2	Apply the Web Engineering concepts, methods, principles, and methodologies to ensure an operable, usable, maintainable, and secure web application	C3(Apply)

Course Outline:

Categories of Web Applications, Product-, Usage-, and Development-related Characteristics of Web Applications. Technologies for Web Application Development: Client/Server Communication on the Web (SMTP, RTSP, HTTP), Client-side Technologies, Document-specific Technologies (HTML, SVG, SMIL, XML), Server-side Technologies (URI Handlers, Web Services, Middleware Technologies). Requirements Engineering Activities of Web Applications, Adapting Requirements Engineering Methods to Web Application Development. Modelling Specifics in Web Engineering (Requirements, Content, Hypertext, Presentation, and Customization). Design Guidelines. Web Usability Engineering Methods, and Trends. Web Application Development Process: Parallel Development of Different Releases, Analysis of the Rational Unified Process, Analysis of Extreme Programming. Web Project Management: Challenges in Web Project Management, Managing Web Teams, Managing the Development Process of a Web Application.

Reference Materials (or use any other standard and latest books):

1. Chopra, R. (2016). Web Engineering (Latest Edition). PHI Learning Pvt. Ltd.
2. Suh, W. Web Engineering Principles and Techniques (Latest Edition). Idea Group Publishing.
3. Pressman, R., & Lowe, D. Web Engineering: A Practitioners Approach (Latest Edition). McGraw-Hill.

Course Name:	**Introduction to Cyber Security**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
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 (or use any other standard and latest books):

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 Book

Course Name:	**Cloud Computing**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	Computer Networks
Course Introduction:	The course aims to learn tools, techniques and systems related to cloud computing both theoretically and practically. The basic concepts of cloud computing are covered in this course.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand basic concepts of cloud computing.	C2 (Understand)
CLO-2	Identify technical challenges associated with cloud computing.	C3 (Identify)
CLO-3	Address data processing challenges using cloud computing.	C3 (Apply)
CLO-4	Examine cloud computing solutions.	C4 (Examine)

Course Outline:

Overview of Distributed Computing, Emergence of Cloud Computing, Global Nature of the Cloud, Cloud-Based Service Offerings, Grid Computing, Reliability of Cloud Model, Benefits of Cloud Model, Legal Issues, Key Characteristics of Cloud Computing, Challenges for the Cloud. The Evolution of Cloud Computing. Web Services Delivered from the Cloud: Communication-as-a-Service (CaaS), Infrastructure-as-a-Service, Monitoring-as-a-Service (MaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS). Building Cloud Networks. Virtualization. Federation, Presence, Identity, and Privacy in the Cloud. Security in the Cloud. Common Standards in Cloud Computing. End-User Access to Cloud Computing. Mobile Internet Devices and the Cloud.

Reference Materials (or use any other standard and latest books):

1. Cloud Computing Implementation, Management, and Security by John W. Rittinghouse and James F. Ransome, Taylor & Francis Group, LLC (2010). ISBN 978-1-4398-0680-7.
2. Cloud Computing Explained: Implementation Handbook for Enterprises by John Rhoton, Recursive Press (2013).
3. Cloud Computing Bible by Barrie Sosinsky, Wiley; 1st Edition (2011). ISBN-10: 0470903562.
4. Securing the Cloud: Cloud Computer Security Techniques and Tactics by Vic (J.R.) Winkler, Syngress; 1st Edition (2011). ISBN-10: 1597495921.Book

BS Computer Science 7th Semester

Course Name:	**Capstone Project-I (Final Year Project-I)**
Credit Hours:	3 (0-6)
Contact Hours:	Theory: 0 Hours, Practical: 6 Hours
Pre-requisites:	Web Technologies
Course Introduction:	A capstone project is a multifaceted body of work that serves as a culminating academic and intellectual experience for students. The capstone project must be supervised and graded by a faculty member as per the protocols prescribed by the Department of Computer Science.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	-

Course Outline:

Students individually or in groups (of not more than three members) should request a faculty member (who can supervise not more than five projects) of their choice to supervise them in the Capstone Project (Final Year Project), in which they will have to develop a desktop software/mobile application/web application based a unique idea (not previously done by students in the department). Students should register themselves for such a project at the beginning of this semester with the BS Course Coordinator, who will decide in collaboration with the Head of the Department, whether the project is worth doing and suggesting changes if any. After registering for the project, students must ensure their presence when the concerned supervisor calls upon them. A supervisor must maintain an attendance record and progress report of the student and must produce it upon inquiry by the Head of Department and BS Course Coordinator.

At the end of Capstone Project-I, students should have completed the first three chapters and some basic functionalities of their targeted project.

Reference Materials (or use any other standard and latest books):

1. Relevant theses, FYPs, Capstone Projects, and papers
2. Any other material suggested by the concerned supervisor

Course Name:	**Digital Forensics**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	Introduction to Cyber Security
Course Introduction:	This course is an introduction to computer forensics and investigation. It provides an understanding of how to conduct investigations to correctly gather, analyze and present digital evidence to different audiences. It also outlines the tools to locate and analyze digital evidence on a variety of devices, how to keep up to date with changing technologies, and laws and regulations in digital forensics.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	To develop knowledge about forensic law, standards, regulations and ethical values	C2 (Understand)
CLO-2	To be able to conduct digital forensics for multiple platforms and applications by various tools	C3 (Apply)
CLO-3	To be able to generate reports based on digital forensic tools for security systems and platforms	C3 (Apply)

Course Outline:

An introduction to Digital Forensics; use of digital forensics; Key technical concepts; Challenges in Digital Forensics ; The Difference between Computer Experts and Digital Forensics Experts; Investigative Process Methodologies ; Education, Training, and Awareness; Laws, Standards, and Regulations; Ethics and Professional Conduct; Digital Evidence Management; Collecting evidence; Antiforensics; Network forensics; Mobile and Embedded Forensics; Cloud forensics; Internet Forensics; social media forensics; Investigation Methods for Collecting Digital Evidence; Digital Forensic Readiness; Digital forensics tools; Discovery of Computers and Storage Media; Discovery of Audio/ Video Evidence; Data Visualization; Data Sources; Graphing and Charting; Analyzing Data; Data Distributions; Analysis Scenarios; Data Visualization Tools.

Reference Materials (or use any other standard and latest books):

1. The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics by John Sammons, 2nd Edition or latest
2. Digital Forensics and Incident Response: Incident Response Techniques and Procedures to Respond to Modern Cyber Threats, 2nd Edition
3. Guide to Digital Forensics: A Concise and Practical Introduction by Joakim Kävrestad (latest edition).

Course Name:	**Analysis of Algorithms**
Credit Hours:	3 (3-0)
Contact Hours:	Theory: 3 Hours, Practical: 0 Hours
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	-
CLO-5	Use big O, Omega, Theta notation formally to give asymptotic upper bounds on time and space complexity of algorithms	-
CLO-6	Use of the strategies(brute-force, greedy, divide-and-conquer, and dynamic programming) to solve an appropriate problem	-
CLO-7	Solve problems using graph algorithms, including single- source and all-pairs shortest paths, and at least one minimum spanning tree algorithm	-
CLO-8	Trace and/or implement a string-matching algorithm	-

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:	**Field Experience/Internship**
Credit Hours:	3 (3-0)
Contact Hours:	Theory: 3 Hours, Practical: 0 Hours
Pre-requisites:	None
Course Introduction:	Field experience of 6-8 weeks during the winter semester graded by a faculty member in collaboration with the field supervisor.

CLO No.	Course Learning Outcomes	Bloom Taxonomy

Course Outline:

The field experience of six to eight weeks (preferably undertaken during the semester or winter break) must be graded by a faculty member in collaboration with the supervisor in the field. This is a mandatory degree award requirement of 3 credit hours for a BS Computer Science degree.

Reference Materials:

1. Careers in Computer Science and Programming (Careers in Computer Technology), 2011 by Jeri Freedman
2. The Career Counselor's Handbook, Second Edition by Howard Figler Richard N. Bolles
3. Computer Science, Why study it and Best Jobs in computer science (English Edition) by E King

Course Name:	**Mobile Application Development**
Credit Hours:	3 (2-3)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	None
Course Introduction:	This course introduces mobile application programming, especially designing, implementing, testing, debugging and publishing smartphone applications. Students will learn how to take their innovative ideas from conception to the apps market.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the key concepts regarding mobile application development	C2 (Understand)
CLO-2	Understand key design concepts and apply rapid prototyping in developing user-friendly mobile user interfaces on Android platform.	C3 (Apply)
CLO-3	Design, implement, test, debug and publish smartphone applications.	C3 (Apply)

Course Outline:

Android platform and architecture, Comparison of Android and other platforms. Configuring development environment, activities, services, broadcast receiver, fragments, intents. Designing mobile user interfaces: views and widgets, linear layout, relative layout, table layout, scroll view layout, list view, action bar, dialogs and notifications. Location and maps services. Shared preferences. Creating and using database. Content providers. Accessing external storage. Displaying videos and listing audios. Using media player. Accessing and handling. Sensors. Publishing and deploying applications on Android Market.

Reference Materials (or use any other standard and latest books):

1. Horton, J. Android Programming for Beginners (Latest Edition). Packt Publishing Ltd.
2. 2.Phillips, B., & Hardy, B. Android programming: the beginners guide (Latest Edition). Pearson Education.
3. Lee, W. M. Beginning android 4 application Development (Latest Edition). John Wiley & Sons.
4. Meier, R. Professional Android 4 application development (Latest Edition). John Wiley & Sons.

BS Computer Science 8th Semester

Course Name:	**Capstone Project-II (Final Year Project-I)**
Credit Hours:	3 (0-6)
Contact Hours:	Theory: 0 Hours, Practical: 12 Hours
Pre-requisites:	None
Course Introduction:	A capstone project is a multifaceted body of work that serves as a culminating academic and intellectual experience for students. The capstone project must be supervised and graded by a faculty member as per the protocols prescribed by the Department of Computer Science.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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Course Outline:

Students individually or in groups (of not more than three members) should request a faculty member (who can supervise not more than five projects) of their choice to supervise them in the Capstone Project (Final Year Project), in which they will have to develop a desktop software/mobile application/web application based a unique idea (not previously done by students in the department). Students should register themselves for such a project at the beginning of this semester with the BS Course Coordinator, who will decide in collaboration with the Head of the Department, whether the project is worth doing and suggesting changes if any. After registering for the project, students must ensure their presence when the concerned supervisor calls upon them. A supervisor must maintain an attendance record and progress report of the student and must produce it upon inquiry by the Head of Department and BS Course Coordinator.

At the end of Capstone Project-II, students should have completed the whole thesis and all the required functionalities. The thesis must be submitted by the student not more than two months after the commencement of the 8th semester exam.

Reference Materials (or use any other standard and latest books):

1. Relevant theses, FYPs, Capstone Projects, and papers
2. Any other material suggested by the concerned supervisor

Course Name:	**Technical & Business Writing**
Credit Hours:	3 (3-0)
Contact Hours:	Theory: 2 Hours, Practical: 3 Hours
Pre-requisites:	None
Course Introduction:	This course introduces students to different aspects of technical writing in the context of academic writing for Computer Science.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand requirements of technical and academic writings in computer science.	C2 (Understand)
CLO-2	Have familiarity of different aspects of technical writing.	C3 (Apply)
CLO-3	Have improved technical writing skills.	C3 (Apply)
CLO-4	Have understanding of how to avoid informal language in academic writing	C4 (Differentiate)

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, 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, articles, research papers, feasibility reports, project reports, technical research reports, manuals and documentation, thesis. Writing hypotheses, questions and evidence, Describing mathematics. Describing algorithms. Explaining graphs, figures, and tables. Discussing experimentation. Writing a paper. Creating effective presentations.

Reference Materials (or use any other standard and latest books):

1. Zobel, J. (2009). Writing for Computer Science (2nd Edition). Springer.
2. Hardesty, R. E. (2010). Technical and Business Writing for Working Professionals (Latest Edition). Xlibris Corporation.
3. Brown, B. W. (1993). Successful Technical Writing/Instructor's Guide (Latest Edition). Goodheart-Willcox Publisher.

Course Name:	**Introduction to Marketing**
Credit Hours:	3 (3-0)
Contact Hours:	Theory: 3 Hours, Practical: 0 Hours
Pre-requisites:	None
Course Introduction:	This course introduces the foundations and key concepts of marketing as they relate to the whole business enterprise. It provides an understanding of marketing in relation to the product and services including the planning process, organizing the marketing functions, and implementing the marketing decisions keeping in mind the ethical, legal and societal considerations.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand marketing concepts, its elements, the marketplace, marketing communication, and the consumers.	-
CLO-2	Understand the elements in the marketing mix and their application in marketing decisions.	-
CLO-3	Understand the importance of customer relationships in marketing and the creation of customer value.	-
CLO-4	Discuss social responsibility and ethics in marketing.	-

Course Outline:

Marketing: marketing and the society, definition, importance, and scope of marketing. Marketing environments: the marketing environment, macro and micro environments. Marketing and strategy: strategic planning, strategic marketing planning, and forecasting marketing demand. Marketing decisions: information required for marketing decisions and marketing research. Consumer behavior: information for purchase decisions, consumer decision process, influence of social and psychological factors, and market implications. Market segmentation and targeting: factors for segmentation, selecting the target market, developing the positioning and target market strategies. Products and services: Definition of product and services, classification of consumer goods, and classification of business goods. Pricing, its importance, and factors affecting pricing decisions. Advertisement and publicity: Scope and characteristics of advertisement and publicity, Development, planning and implementation of advertising plan, Evaluating the success and failure of promotional plan. Marketing strategies for e-Business and e-Commerce.

Reference Materials (or use any other standard and latest books):

1. Philip Kotler, Principles of Marketing (Latest Edition)
2. David Jobber, Principles of Marketing (Latest Edition)
3. Jerome McCarthy & William, D. Pareanth, Basics Marketing, (Latest Edition).