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Scheme of Studies Bachelor of Science in Computer Science

Fall 2023

Additional Director Academics
University of Chitral

Department of Computer Science

University of Chitral

Name of Degree: Bachelor of Science in Computer Science

Eligibility Criteria:

- Minimum 50% marks in Intermediate/12 years schooling/A-Level (HSSC) or Equivalent with Mathematics are required for admission in Bachelor of Science in Computer Science.
  **An equivalency certificate by IBCC will be required in case of education from some other country or system.*

- The students who have not studied Mathematics at the intermediate level have to pass deficiencycourses in Mathematics (06 credits) in the first two semesters.

Pathway for the associate degree Holders:

- The candidates with an Associate Degree in Computer Science (ADCS) are eligible for admission in the 5th Semester of the Bachelor of Science in Computer Science Programs. Such students shall complete the deficiency courses of General Education (if any) during 5th to 8th Semesters.

- The candidates who acquired an Associate Degree in Computer Science before the admission criteria (as stated above) are also eligible for admission in the 5th Semester of the Bachelor of Science in Computer Science Programs. Such students shall also complete the deficiency courses of General Education (if any) during the 5th to 8thSemester.

- The minimum eligibility for admission in the fifth semester is 2.0 CGPA out of 4 in the prior qualification.

- The number of students who will be admitted in 5th semester will be equal to the number of seats vacated from the exit of students in the Associate Degree in Computer Science program.

- The age limit of the admission rules of the university will apply to the Bachelor of Science in Computer Science, plus two additional years for the AD degree.

Pathway for Conventional Two-Year BSc Computer Science Degree Holders:

- Students who have completed a conventional two-year BSc Computer Science degree program are allowed to be admitted in the fifth semester of the Bachelor of Science in Computer Science program, but students shall be required to complete deficiency courses through a bridging semester before commencement of the fifth semester, as determined by the department.

- The minimum eligibility for admission in the fifth semester in this case is 50% cumulative score in the prior qualification, i.e., conventional two-year BSc degree programs.

- The number of students who will be admitted in the 5th semester will be equal

to the number of seats vacated from the exit of students in the Associate Degree program.

- The age limit of the admission rules of the university will apply to the Bachelor of Science in Computer Science, plus two additional years for the AD degree.

Duration:

The minimum duration for the completion of the Bachelor of Science in Computer Science

Degree Completion Requirements:

To become eligible for the award of a Bachelor of Science in Computer Science degree, a student must satisfy the following requirements:

a) Must have studied and passed the prescribed courses, totalling at least 133 credit hours (Annexure A).

b) Must have earned a CGPA (Cumulative Grade Point Average) of at least 2.0 on a scale of 4.0.

Exit with associate degree:

The students, after successful completion of 04 semesters in Bachelor of Science in Computer Science, may exit with an Associate Degree in Computer Science, subject to completion of all requirements for the award of associate degree, i.e., Credit Hours, CGPA, and compulsory courses (Annexure B).

Bachelor of Science in Computer Science Curriculum Design

The structure of the Bachelor of Science in Computer Science program is proposed to meet the needs of students through theory and practical computing experience. The students are expected to learn a theoretical and practical understanding of the respective fields of Computing.

The following are some relevant details:

- Minimum credit hours shall be 133 for the Bachelor of Science in Computer Science program.
- The Bachelor of Science in Computer Science program comprises eight semesters spread over four years.
- The following tables give the distribution of credit hours in different domains of knowledge.

Table 1: Generic Structure for Computing Disciplines

Areas	Number of Courses	**Credit Hours**
Computing Core	12	40
Domain Core	6	18
Domain Elective	7	21
Mathematics & Supporting Courses	4	12
Elective Supporting Courses	1	3
General Education Requirement	12	30
Capstone Project	1	6
Fieldwork/Internship	1	3
Totals		**133**

Semester Wise Breakup

Course Code	Prereq	Course Title	Domain	Cr Hours
1st Semester (18 Credit Hours)				
CS 111	-	Programming Fundamentals	Maj1 CC	4 (3+1)
CS 112	-	Applications of Information and Communication Technologies	GE 1	3 (2-1)
CS 113	-	Applied Physics	GE 2	3 (2-1)
CS 114		Discrete Structure	GE 3	3 (3-0)
CS 115	-	Functional English	GE 4	3 (3-0)
Anyone from the following				
CS 116	-	Islamic Studies	GE 5	2 (2-0)
CS 117	-	Ethics	GE 5	2 (2-0)
Total Credit Hours				18

2nd Semester (17 Credit Hours)				
CS 121	PF	Object Oriented Programming	Maj 2 CC	4 (3-1)
CS 122	-	Ideology and Constitution of Pakistan	GE 6	2 (2-0)
CS 123	FE	Introduction to Expository Writing	GE 7	3 (3-0)
CS 124	-	Calculus & Analytical Geometry	GE 8	3 (3-0)
CS 125	A Ph	Digital Logic Design	Maj 3 CC	3 (2-1)
Any One from the following				
CS 126	-	Introduction to Management	GE 9	2 (2-0)
CS 127	-	Introduction to Sociology	GE 9	2 (2-0)
Total Credit Hours				17

3rd Semester (18 Credit Hours)				
CS 231	OOP	Data Structure & Algorithms	Maj 4 CC	4 (3-1)
CS 232	DLD	Computer Organization & Assembly Language	Maj 5 CC	3 (2-1)
CS 233		Database Systems	Maj 6 CC	4 (3-1)
CS 234		Civics and Community Engagement	GE 10	2 (2-0)
CS 235	CAG	Linear Algebra	MSC 1	3 (3-0)
CS 236		Entrepreneurship	GE 11	2 (2-0)
Total Credit Hours				18

4th Semester (20 Credit Hours)				
CS 241		Artificial Intelligence	Maj 7 CC	3 (2-1)
CS 242		Computer Networks	Maj 8 CC	3 (2-3)
CS 243		Software Engineering	Maj 9 CC	3 (3-0)
CS 244		Information Security	Maj 10 CC	3 (2-1)
CS 245		Arts & Humanities (Professional Practices)	GE 12	2 (2-0)
CS 246		Probability & Statistics	MSC 2	3 (3-0)
CS 247		Internship		3 (0-3)
Total Credit Hours				20

5th Semester (18 Credit Hours)				
CS 351		Operating Systems	Maj11 CC	3 (2-1)
CS 352		HCI & Computer Graphics	Maj12 DC	3 (2-1)
CS 353		Theory of Automata	Maj13 DC	3 (3-0)
CS 354	CAG	Multivariable Calculus	MSC 3	3 (3-0)
Any two courses from the following				
CS 355	CN	Network System and Communication	Maj 14 DE	3 (3-0)
CS 356	OOP	Advanced Programming	Maj 15 DE	3 (2-1)
CS 357		Computer Graphics	Maj	3 (2-1)
CS 358		Software Testing & Quality Assurance	Maj	3 (2-1)
Total Credit Hours				18

6th Semester (18 Credit Hours)				
CS 361	ToA	Compiler Construction	Maj 16 DC	3 (2-1)
CS 362	OS	Parallel & Distributed Computing	Maj 17 DC	3 (2-1)
CS 363	COAL	Computer Architecture	Maj 18 DC	3 (2-1)
CS 364	DS	Analysis of Algorithms	Maj 19 CC	3 (3-0)
Any one courses from the following				
CS 365		Research Methods	Maj	3 (3-0)
CS 366		Web Technologies	Maj 20 DE	3 (2-1)
CS 367		Cyber Security	Maj	3 (2-1)
Any one courses from the following				
CS 368		Introduction to Principles of Marketing	SS	3 (3-0)
CS 369		Introduction to Philosophy	SS	3 (3-0)
Total Credit Hours				18

7th Semester (11 Credit Hours)				
CS 471	FE	Technical & Business Writing	MSC 4	3 (3-0)
Any two courses from the following				
CS 472		Mobile Application Development	Maj 22 DE	3 (2-1)
CS 473		Introduction to Data Mining	Maj 23 DE	3(2-1)
CS 474		Wireless & Mobile N/W	Maj	3 (2-1)
CS 475		E-Commerce: A Case Study of Amazon	Maj	3 (2-1)
CS 476	SE	Software Project Management	Maj	3 (2-1)
CS 477		Distributed Database Systems	Maj 25 DE	3
CS 478		Final Year Project – I*	Capstone Project	2 (0-2)
Total Credit Hours				11

8th Semester (13 Credit Hours)				
CS 481	DS	Advance Database Management Systems	Maj 21 DC	3 (2-1)
Any Two courses from the following				
CS 482		Digital Marketing	Maj	3 (2-1)
CS 483		Web Engineering	Maj 24 DE	3 (2-1)
CS 484		Freelance Services: A Case Study of Fiverr	Maj	3 (2-1)
CS 485		Introduction to Data Science	Maj	3 (2-1)
CS 486		IOT & Sensor Networks	Maj	3
CS 487		Data Analysis using Python		
CS 488		Final Year Project – II*	Capstone Project	4 (0-4)
Total Credit Hours				13

Course Contents

S. No. 1	Course Name: Programming Fundamentals		
Course Code: CS-111	**Credit Hours:** 4 (3+3)	**Contact Hours:**3-3	**Prerequisites:** None
Course Introduction: This course provides fundamental concepts of programming to freshmen. The course is pre- requisite to many other courses, therefore, students are strongly advised to cover all content and try to achieve CLOs to the maximum possible level. The course may be taught as language-independent. Further, it is up to the university to choose any language for the practical/Lab purpose, but that must be the latest and market-oriented.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Understand basic problem-solving steps and logicconstructs		Understand	C2
Apply basic programming concepts		Apply	C3
Design and implement algorithms to solve real worldproblems		Apply	C3

Course Content:

Week-1: Introduction to Programming Languages, History of C++, Basic elements of C++, C++ character set, C++ words, Reserve words, User define words/identifier, Rules for identifier

Week-2: Basic Data Types (Int, Float, Char), Modifiers (Long, Signed, Unsigned, Double, Long Double, Short), Numbers (Integer Numbers, Real Numbers), Types of identifiers (Constant identifier, Variable identifier), Statements

Week-3: General Structure of C++ Program, Input Statement, Output Statement, String/message, Char/Char identifier, Assignment Statement, Operators, Arithmetic Operators, Relational Operators, Logical Operators, Expression, Initialization Statement, Increment Operator (Prefix & Postfix forms), getche () function, getch () function, Escape sequences

Week-4: Comments in C++ Program, Pre-processor Directives, Difference between Declaration & Definition, Arithmetic Assignment Expression, Priority of Operators, Conversion of Mathematical formula into C++ expression

Week-5: Control structures/Decision Control structure, Transfer of control Statements (TOCS), Repetitive Control structure/statements (Loops), Conditional TOCS, Single alternative if statement and Nested if statement, Double alternative if statement (if- else statement) and Nested if-else statement

Week-6: Conditional operator/Ternary Operator (? :), Switch statement/Multiple Branching statement and Nested Switch statement, Manipulators (endl manipulator, setw manipulator), Continue statement, Break statement, goto statement

Week-7: Loop, Types of Loop, Fixed loop (count control loop), Non-fixed loop (event control loop), Fixed loop/for loop, Variations in for loop, Defining variable in for loop, Multiple initializations in for loop, Multiple inc/dec expressions in for loop, Initialization outside for loop, Inc/dec expression inside for loop, No testing (infinite loop), Output statement inside for loop, Nested for loop

Week-8: Non-fixed loop (event control loop), While-loop (Pre-tested loop), Do-while loop (Post-tested loop), Nested while & do-while loop Week-9: Arrays, One-dimensional array, Two-dimensional array Week-10: Searching, Linear search, Strings (array of characters) Week-11: Function, Types of Function, Built-in function, User-defined function, Parts of user defined function Week-12: Function with values and no return, Function with values and return, passing values from a function, Passing arguments to a function, Week-13: Pointers Basic Concepts, Structure, specifying structure, Defining structure variable, Accessing structure members Week-14:String and string operations, Week-15-16: File I/O operations
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: 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

S. No. 2	**Course Name: Application of Information & Communication Tech**		
Course Code: CS-112	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:**
Course Introduction: This is an introductory course in Computer Science designed for beginners. Apart from leading the participants through a whirlwind history of computing, the course also develops a feel for web programming through a series of lectures that help the students develop their own web page. Main objective of the course is to build an appreciation for the fundamental concepts in computing and to become familiar with popular PC productivity software.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Understand basics of computing technology		Knowledge	C1
Do number systems conversions and arithmetic. Have knowledge of types of software		Understand	C2
Have knowledge of computing related technologies		Apply	C3
Course Content: Brief history of Computer, Four Stages of History, Computer Elements, Processor, Memory, Hardware, Software, Application Software its uses and Limitations, System Software its			

Importance and its Types, Types of Computer (Super, Mainframe, Mini and Micro Computer), Introduction to CBIS (Computer Based Information System), Methods of Input and Processing, 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.
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: 1. Charles S. Parker, Understanding Computers: Today and Tomorrow, Course Technology, 25 Thomson Place, Boston, Massachusetts 02210, USA 2. Livesley, Robert Kenneth. An introduction to automatic digital computers. Cambridge University Press, 2017. 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.

S. No. 3	**Course Name: Applied Physics**		
Course Code: CS-113	**Credit Hours: 3(2-3)**	**Contact Hours: 2-3**	**Prerequisites:**
Course Introduction: The course introduces students with the basic concept 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.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level

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

S. No. 4	**Course Name: Discrete Structure**		
Course Code: CS-114	**Credit Hours: 3(3-0)**	**Contact Hours: 3-0**	**Prerequisites:**
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Understand the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs, and Trees etc.		Cognitive	2
Apply formal logic proofs and/or informal, but rigorous, logical reasoning to real problems, such as predicting the behaviour of software or solving problems such as puzzles.		Cognitive	3
Apply discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography.		Cognitive	3

Differentiate various discrete structures and their relevance within the context of computer science, in the areas of data structures and algorithms, in particular.	Cognitive	4

Course Content:

Mathematical reasoning

Week-1: Objectives of the course, Mathematical reasoning
Week-2: Propositional and predicate logic,
Week-3: Rules of inference, proof by induction, proof by contraposition
Week-4: Proof by contradiction, proof by implication

Set theory

Week-5: Relations, equivalence relations and partitions
Week-6: Partial orderings, recurrence relations
Week-7: Functions, mappings, function composition
Week-8: Inverse functions, recursive functions

Number Theory

Week-9: Sequences, series
Week-10: Counting, inclusion and exclusion principle, pigeonhole principle
Week-11: Permutations
Week-12: Combinations

Graph theory

Week-13: Elements of graph theory
Week-14: Planar graphs, graph coloring, euler graph
Week-15: Hamiltonian path, rooted trees
Week-16: Traversals

Teaching Methodology:

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

Course Assessment:

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

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

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

S. No. 5	**Course Name: Functional English**		
Course Code: CS-115	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:**

Course Introduction:

The purpose of this course is to develop the English-language proficiency of students and to help them become confident in reading, writing, speaking, and listening to the English language. Instead of teaching grammar in isolation and only at sentence level, this course is

based on developing the language abilities of students through an integrated approach that provides opportunities to develop their listening, speaking, reading, and writing skills. With a focus on social interaction, the course draws specific attention to the accurate use of structures, improvement of pronunciation, and development of active vocabulary in descriptive, narrative, and instructional texts.

Course Learning Outcomes:

At the end of the course the students will be able to:	Domain	Bloom's Taxonomy Level

After completing this course, students will:

- have improved their listening and reading skills in English
- be able to communicate in written and oral English with peers and teachers
- rely less on their first languages and increase their use of English in formal and informal situations
- have a deeper understanding of correct English structures in descriptive, narrative, and instructional texts.

Course Content:

Basics of Grammar

- Parts of Speech and their Usage
- Sentence and Its Structure
- Phrase, usage of phrases
- Clause, usage of clauses

Introductions

This first unit will provide students with an opportunity to interact with one another in oral and written forms. It will serve to introduce them and help them develop conversations through suggesting simple words and phrases to describe people, preferences, and other conversation topics in a logical sequence.

Making Introductions

- Making effective self and peer introductions
- Taking useful introductory notes

Expressing Requests and Enquiries

- Forming appropriate requests and enquiries
- Responding to enquiries
- Requests versus commands

Social Interaction

This unit is aimed at developing students' social interaction in English and expanding their interpersonal skills. Through class activities, they actively converse in formal and informal contexts to congratulate, express gratitude, make invitations, and respond to speakers in oral and written contexts.

Greetings

- Greeting friends and family on different occasions and for different reasons
- Responding to a positive event
- Using formal greeting expressions appropriately

Gratitude

- Using formal and informal expressions of gratitude appropriately
- Reading a story that uses expressions of gratitude
- Writing a formal letter to say thanks to a teacher, parent, or friend

Invitations

- Demonstrating the use of formal and informal expressions of invitation
- Developing verbal and written skills for invitations
- Responding to invitation requests by accepting or declining

Regrets

- Expressing regrets orally and in writing appropriately
- Saying sorry and accepting apologies

Giving and Following Directions

In this unit, students learn how to follow directions from a map as well as how to give directions to search for a location or specific information. They learn how to follow and provide clear instructions.

Following and Giving Directions

- Following directions from a map
- Giving directions to a location in oral and written forms
- Reaching a destination

Giving Clear Instructions

- Carrying out instructions
- Structuring instructions
- Writing clear instructions

Sharing experiences

In this unit, students will engage with different meanings in a variety of written and visual texts through shared, guided, and independent readings of narratives in various genres. Instructors will encourage them to respond to the narrative and imaginative texts by composing stories and sharing them in written and oral form.

Sharing narratives

- Reading short stories
- Reading excerpts, comic strips, interviews, and other common texts

Sharing unique experiences

- Summarizing and narrating true stories
- Solving word puzzles to develop language awareness
- Reading short stories and completing exercises to test comprehension
- Converting an event into a short story
- Using pictures as stimuli for narrative creation
- Using songs as examples of personal experience

Imaginative texts

- Developing imaginative texts by communicating engrossing stories and descriptions of scenes

Discussion

General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

Composition and Comprehension

Writing Mechanics

- Sentences, sentence fragments, and run-on sentences
- Subject-predicate and pronoun-reference agreement
- Punctuation and structure

Paragraph Writing (practice)

Essay Writing (practice)

Précis writing (practice)
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) • T. K. Carver and S. Fortinos-Riggs, Conversation Book II – English in Everyday Life (New York: Pearson Education Limited, 2006). • J. Eastwood, Oxford Practiceaphy Grammar (Karachi: Oxford University Press, 2005). • J. Swan, Practical English Usage, 3rd ed. (New York: Oxford University Press, 2005). • J. Thomson and A. V. Martinet, A Practical English Grammar (Intermediate) (New York: Oxford University Press, 1986) • Allama Iqbal Open University, Compulsory English 1 (Code 1423) (Islamabad: AIOU Press). • BBC. (2013) Learning English. http://www.bbc.co.uk/worldservice/learningenglish/ • British Council. Learn English. http://learnenglish.britishcouncil.org/en/ • British Council and BBC. Learn English. http://www.teachingenglish.org.uk/ • Grammar English. http://freesoftwarepc.biz/educational-software/ download-

S. No. 6	**Course Name: Islamic Studies**		
Course Code: CS-116	**Credit Hours: 2(2-0)**	**Contact Hours:**	**Prerequisites:**

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.

Course Learning Outcomes:

At the end of the course the students will be able to:	Domain	Bloom's Taxonomy Level
To further enhance the knowledge of Islam		
To understand the basic concept of Islam and Quran Pak		
To understand the concept of Haqooq ul ibad in the light of Quran.		
To know the importance of Islamic concept about other religions.		

Course Content:

English	Urdu

1. Introduction to Quranic Studies • Basic Concepts of Quran • History of Quran • Uloom-ul -Quran	**1. قرآنی علوم کا تعارف** قرآن مجید کے بنیادی اصطلاحات تاریخ تدوین وجمع قرآن علوم القرآن
2. Study of Selected Text of Holy Quran • Verses of Surah al-Furqan Related to Social Ethics (Verse No.6377) • Verses of Surah Al-Hashr (18,19, 20) Related to thinking, Day of Judgment • Verses of Surah Al-Saff Related to Tafakur, Tadabbur (Verse No-1,14)	**2. منتخب آیات کریمہ کا مطالعہ** • معاشرتی آداب سے متعلق سورہ الفرقان کی آیات نمبر 63-77 • آخرت اور اسکی فکر سے متعلق سورہ الحشر کی آیات 18-20 • کائنات میں غور و فکر سے متعلق سورہ الصف کی آیات 1-14
3. Seerat of Holy Prophet (PBUH) • Life of Holy Prophet (PBUH) in Makkah (After Prophethood) and its Important Events • Life of Holy Prophet (PBUH) in Madinah and its Important Events	**3. سیرت طیبہ ﷺ کا مطالعہ** • مکہ مکرمہ میں بعد از نبوت حضور ﷺکی زندگی اور اہم واقعات • مدینہ منورہ میں حضور ﷺکی زندگی اور اہم واقعات
4. Introduction to Sunnah • Basic Concepts of Hadith • History of Hadith • Kinds of Hadith • Legal Position of Sunnah	**4. تعارف حدیث و سنت** • سنت و حدیث کا تعارف و اہمیت • تاریخ حدیث • حدیث کی اقسام • سنت کا شرعی مقام
5. Selected Study from Text of Hadith • عن انس بن مالک رضی اللہ عنہ قال قال رسول اللہ ﷺ:"من خرج فی طلب العلم فھو فی سبیل اللہ حتّیٰ یرجع"۔ • عن ابی امامۃ رضی اللہ عنہ قال قیل یارسول اللہ!الرجلان یلتقیان ایھما یبدا بالسلام فقال اولاھما باللہ"۔ • عن ابی سعید الخدری رضی اللہ عنہ قال سمعت رسول اللہ ﷺ یقول:" من رأیٰ منکم منکراً فلیغیرہ بیدہ فان لم یستطع فبلسانہ فان لم یستطع فبقلبہ و ذالک اضعف الایمان" • عن ابی ھریرۃ رضی اللہ عنہ قال قال رسول اللہ ﷺ:" آیۃ المنافق ثلاث اذا حدث کذب واذا وعد اخلف واذا ائتمن خان" • عن ابی ھریرۃ رضی اللہ عنہ قال قال رسول اللہ ﷺ:" ایاکم و الحسد فان الحسد یأکل الحسنات کما تأکل النار الحطب"۔ • عن ابی ھریرۃ رضی اللہ عنہ ان رسول اللہ ﷺ قال:" من کان یؤمن باللہ والیوم الآخر فلیقل خیرا او لیصمت ومن کان یؤمن باللہ والیوم الآخر فلیکرم جارہ ومن کا ن یؤمن باللہ والیوم الآخر فلیکرم ضیفہ"۔ • عن عبداللہ ابن عمربن الخطاب رضی اللہ عنھما قال سمعت رسول اللہ ﷺیقول:بنی الاسلام علیٰ خمس شھادۃ ان لا الٰہ الا اللہ وان محمدا عبدہٗ ورسولہ واقام الصلوٰۃ وایتاء الزکوٰۃ وحج البیت وصوم رمضان • عن ابی ھریرۃ رضی اللہ عنہ ان رسول اللہ ﷺ قال:" من حسن اسلام المرء ترکہ مالایعنیہ"۔	
6. Introduction to Islamic law and jurisprudence • History and Importance of Islamic Law and Jurisprudence • Sources of Islamic law and jurisprudence • Nature of differences in Islamic law • Islam and sectarianism	**6. اسلامی قانون اور فقہ کا تعارف** • اسلامی قانون اور فقہ کی تاریخ اور اہمیت • اسلامی قانون اور فقہ کے ذرائع • اسلامی قانون میں اختلافات کی نوعیت • اسلام اور فرقہ واریت
7. Political System of Islam	**7. اسلام کا سیاسی نظام**

• Basic Concepts of Islamic Political System • Islamic Concept of Sovereignty • Basic Institutions of government in Islam	• اسلامی سیاسی نظام کے بنیادی تصورات • اسلامی تصور حاکمیت • اسلام میں حکومت کے بنیادی ادارے
8. Social System of Islam • Basic concepts of social system of Islam • Elements of Family • Ethical Values of Islam	**8. اسلام کا معاشرتی نظام** • اسلام کے معاشرتی نظام کے بنیادی تصورات • خاندان کے عناصر • اسلام کی اخلاقی اقدار

Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:
Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam

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

- Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
- Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)
- H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
- Hameed ullah Muhammad, 'Introduction to Islam Maulana Muhammad Yousaf Islahi,"
- Hameed ullah Muhammad, "Emergence of Islam" , IRI, Islamabad
- Hameed ullah Muhammad, "Muslim Conduct of State"
- Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" Leaf Publication Islamabad, Pakistan.
- Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)

S. No. 7	**Course Name: Object Oriented Programming**		
Course Code: CS-121	**Credit Hours: 4(3-3)**	**Contact Hours: 3-3**	**Prerequisites: P.F**
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.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Understand principles of object oriented paradigm.		Understand	C2
Identify the objects & their relationships to build object oriented solution		Identify	C3
Model a solution for a given problem using object oriented principles		Apply	C3
Examine an object oriented solution		Examine	C4

Course Content:
Week-1: Introduction to object oriented design, history and advantages of object oriented design
Week-2: Introduction to object oriented programming concepts
Week-3: Classes, objects
Week-4: Data encapsulation, constructors, destructors
Week-5: Access modifiers
Week-6: const vs non-const functions, static data members & functions
Week-7: Function overloading, operator overloading
Week-8: Identification of classes and their relationships
Week-9: Composition, aggregation
Week-10: Inheritance, multiple inheritance
Week-11: Polymorphism
Week-12: Abstract classes and interfaces, generic programming concepts
Week-13: Function & class templates
Week-14: Standard template library, object streams
Week-15: Data and object serialization using object streams
Week-16: Exception handling.

Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:
Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam

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

S. No. 8	**Course Name: Ideology and Constitution of Pakistan**		
Course Code: CS-122	**Credit Hours: 2(2-0)**	**Contact Hours:**	**Prerequisites:**

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 vision of Historical Perspective, Government, Politics, Contemporary Pakistan, ideological background of Pakistan.

To study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan

Course Learning Outcomes:

At the end of the course the students will be able to:	Domain	Bloom's Taxonomy Level
To educate students about the history of Pakistan		
To educate student about the various pillar of the state		
To educate student Government and politics		

Course Content:

Introduction to Ideology

Defining the Term Ideology, Role of Ideas, Contours of Ideology, Ideology, Truth and Power

Types of Ideologies, Left, Right and Center Debate, Old and New Ideologies, Views about Ideologies

Ideology of Pakistan

Aims and Objects of Pakistan's Formation

Ideology of Pakistan – its Importance

Basics of Pakistan's Ideology

Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Iqbal's and M. A. Jinnah's Notions on Ideology of Pakistan

Constitution, Government and Politics

Definitions, Features, and Functions

Constitutional Development in Pakistan 1947-1973: Constitution of 1956, 1962

Salient Features of Constitution of Pakistan 1973

Fundamental Rights in Constitution of Pakistan 1973

Martial Law 1977-88,

Civilian Rule 1988-99

Martial Law 1999 Onward

Pakistan – Land and Peoples

Geography and its Importance

Natural resources and Their use

Agriculture and Industry

Population, Manpower, and Education

Contemporary Pakistan

Economic Institutions and Issues

Society and Social Structure

Foreign Policy of Pakistan and Challenges

Teaching Methodology:

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

Course Assessment:

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

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
4) Perspectives on Contemporary Pakistan Governance, Development and Environment Edited By Ghulam Ali, Ejaz Hussain, 2020
5) Any other standard and latest books covering the subject.

S. No. 9	Course Name: Introduction to Expository Writing		
Course Code: CS-123	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:** Functional English

Course Introduction:

This course prepares undergraduates to become successful writers and readers of English. The course helps students develop their fundamental language skills with a focus on writing so that they can gain the confidence to communicate in oral and written English outside the classroom. The course is divided into five units and takes a PBL (Project-based Learning) approach. Unit themes target the development of 21st century skills and focus on self-reflection and active community engagement. Course activities include lectures, group, pair and individual activities, as well as a series of required assignments, including reading and writing across various genres. Finally, the course prepares students for taking the next course in the sequence, 'Expository Writing II: Cross-cultural Communication and Translation Skills'

Course Learning Outcomes:

At the end of the course the students will be able to:	Domain	Bloom's Taxonomy Level

Course Content:

Unite 1: Expository Writing

- Introduction
- Types
- Usage

Unit 2: Self Reflection

- Introduction to the basics of the writing process
- Introduction to the steps of essay writing
- Students practice prewriting activities like brainstorming, listing, clustering and freewriting
- Students practice outlining of the essay

Unit 3: Personalized Learning

- Students reflect on their learning process
- Group discussion about learning styles based on the reading material provided to students
- Introduction to personalized learning
- Students practice goal setting
- And create a learning plan
- Introduction to the structure and significance of oral presentations
- Class discussion about content selection and slide preparation for oral presentations
- Peer review through a gallery walk

Unit 4: Critical Reading Skills

- Introduce authentic reading (DAWN newspaper and non-specialist academic books/texts
- Conduct classroom reading activities (using strategies skimming, scanning, SQW3R, previewing, annotating, detailed reading and note-taking) using standard tests (TOEFL and IELTS) Assign books/articles/reports for their individual home assignments.

- Share model review reports and annotated bibliographies

Unit 5: Community Engagement

- Showing short documentaries to students on global environmental issues
- Student-led brainstorming on local versus global issues
- Teacher-led introduction to the unit assignment (using assignment sheet)
- Readings (or other input sources - video, social media) from local news on possible community issues, letters to editor and op-eds
- Identify research problems
- Begin drafting research questions based on the problems identified
- Facilitating students on developing research questions in groups
- Draft interview or survey questions for community research (in English or L1)
- In-class role-plays of interviews with community members
- Engaging students in critical reading and reflection on the issues found in different communities
- In-class work on understanding interview information, how to present interview or survey information
- Refining the research questions, designing a detailed research plan in groups, dividing the tasks and deciding the timeline for the completion of the project
- Exposure to interview questions and interviewing techniques to develop an in-depth understanding of the issues
- Continued group work on report outline
- In-class lecture and group work on analyzing information
- Discussion based on translating the data from the source language to the target language (English)
- Sharing the experience of field work in class orally
- Teacher feedback on outline of report (globally to entire class and individually to groups as needed)
- Revisions to oral report in groups Engaging students in individual structured reflective writing based on their experience of working on the project
- Sharing their reflective writing to learn about each other's points of view
- Think-pair-share the findings (group similar issues)
- Individual writing of reflection on the community engagement project and their role in the group
- Brainstorm using creativity for dissemination - cartoons, advertisements for university magazine or beyond, creating posts for FB
- Summarizing/ converting the report to a letter to the editor to highlight the problems explored and their possible solutions (homework - connecting activity for week 11 - Unit 5)

Unit 6: Letter to the Editor

- Teacher-directed instruction on genres (types) of writing focusing on letter-writing
- Model-practice-reflect: Introduce types of letters comparing the use of formal and informal vocabulary and phrases in each type
- Introduce the format and purpose of the letter-to-editor explaining with the help of an actual letter from a local newspaper
- Group reading of sample letters-to-editor selecting ones that deal with issues familiar to the students

▪ Invite a guest lecturer (local newspaper editor or faculty from journalism) to talk about what issues are currently raised in letters-to-editors and what are editors' criteria to accept letters for publication ▪ Work in groups to continue reviewing letter samples, analyzing the structure of letters ▪ Each group identifies an issue they want to write about and give a brief oral presentation to the class ▪ Submit the first draft of letters (to the teacher and peer-review group) ▪ In-class peer review of drafts using a checklist focusing on content and structure DUE: ▪ First draft f letter (to teacher and peer review group) ▪ Groups revise first draft of letter ▪ Differentiate among revision, proofreading and evaluation (as substages of finalizing documents) ▪ Discuss critically the draft-letter and implement the 'revision' phase of writing Reading of (DAWN) newspaper and sharing important letters (to editors) on local issues ▪ Groups revise second draft of letter Explicit instruction (paragraph structure, syntax, diction, grammar, and mechanics) ▪ Classroom discussion/debrief of activity Discuss critically and finalize the draft-letter as the last phase of writing
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
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

S. No. 10	**Course Name: Calculus & Analytical Geometry**		
Course Code: CS-124	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction: To provide foundation and basic ground for calculus and analytical geometry background.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Course Content: Limits and Continuity; Introduction to functions, Introduction to limits, Techniques of funding limits, Indeterminate forms of limits, Continuous and discontinuous functions and			

their applications, Differential calculus; Concept and idea of differentiation, Geometrical and Physical meaning of derivatives, Rules of differentiation, Techniques of differentiation, Rates of change, Tangents and Normals lines, Chain rule, implicit differentiation, linear approximation, Applications of differentiation; Extreme value functions, Mean value theorems, Maxima and Minima of a function for single-variable, Concavity, Integral calculus; Concept and idea of Integration, Indefinite Integrals, Techniques of integration, Riemann sums and Definite Integrals, Applications of definite integrals, Improper integral, Applications of Integration; Area under the curve, Analytical Geometry; Straight lines in R3, Equations for planes
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
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. Cole

S. No. 11	**Course Name: Digital Logic Design**		
Course Code: CS-125	**Credit Hours: 3(2-3)**	**Contact Hours: 2-3**	**Prerequisites:** Applied Physics
Course Introduction: The course introduces the concept of digital logic, gates and the digital circuits. Further, it focuses on the design and analysis combinational and sequential circuits. It also serves to familiarize the student with the logic design of basic computer hardware components.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Acquire knowledge related to the concepts, tools and techniques for the design of digital electronic circuits			
Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques			
Apply the acquired knowledge to simulate and implement small-scale digital circuits			
Understand the relationship between abstract logic characterizations and practical electrical implementations.			
Course Content: Number Systems, Logic Gates, Boolean Algebra, Combination logic circuits and designs, Simplification Methods: K-Map, Flip Flops and Latches, Asynchronous and Synchronous circuits, Counters, Shift Registers, Counters, Triggered devices & its types. Binary Arithmetic and Arithmetic Circuits, Memory Elements, State Machines. Introduction Programmable Logic Devices (CPLD, FPGA) Lab Assignments using tools such as Verilog HDL/VHDL, MultiSim.			

Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
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

S. No. 12	**Course Name: Introduction to Management**		
Course Code: CS-126	**Credit Hours: 2(2-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Hold informed conversations with functional specialists and understand how to draw effectively on their expertise in managing organizations.			
Understand the relevance of the western management principles and theories, for local settings.			
Understand the Islamic perspective of managing businesses and organizations			
Recognise the need to take a holistic approach to performance improvement rather than a narrowly functional approach.			
Course Content: Week-1: Introduction to Management Organization, The management Process Week-2: The History and evaluation of Management Organizational theories and different approaches to management Week-3: The organizational Culture and the Manager The external environment and the Manager The internal environment and the manager Week-4: Foundations and basic elements of Planning Process of planning and MBO Effective strategic planning Week-5: Decision Making The manager's role as decision maker Decision making process Week-6: Basics of Strategic Management Case of Strategic Management Strategic management process Week-7: Organizational Structure Types of organizational structures Week-8: Case Decision-making Week-9: Human Resource Management HRM processes Week-10: Motivation its theories Current issues in Motivation Week-11: Team work and Group Behaviour Case of team and team work Week-12: Leadership and its characteristics Leadership styles and behaviours Week-13: The process of Control the Control Standards Week-14: Case of Controlling Presentation Week-15: Staffing Presentation Week-16: Conclusion Session			

Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Mary Coulter & Robbins, Management, International ed.

S. No. 13	**Course Name: Introduction to Sociology**		
Course Code: CS-127	**Credit Hours: 2(2-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
The course is designed to introduce the students with sociological concepts and the discipline. The focus of the course shall be on significant concepts like social systems and structures, socio-economic changes and social processes			

Course Content:

Week-1: Introduction, Definition, Scope, and Subject Matter, Sociology as a Science,
Historical back ground of Sociology
Week-2: Basic Concepts, Group, Community, Society, Associations, Non-Voluntary,
Voluntary, Organization, Informal, Formal
Week-3: Social Interaction, Levels of Social Interaction
Week-4: Process of Social Interaction, Cooperation, Competition, Conflict, Accommodation
Week-5: Acculturation and diffusion, Assimilation, Amalgamation
Week-6: Social Groups, Definition & Functions, Types of social groups, In and out groups,
Primary and Secondary group
Week-7: Reference groups, Informal and Formal groups, Pressure groups
Week-8: Culture, Definition, aspects and characteristics of Culture, Material and non-material culture, Ideal and real culture
Week-9: Elements of culture, Beliefs, Values, Norms and social sanctions
Week-10: Organizations of culture, Traits, Complexes, Patterns, Ethos, Theme, Other related
concepts
Week-11: Cultural Relativism, Subcultures, Ethnocentrism and Xenocentrism
Week-12: Socialization, Types of Socialization
Week-13: Agencies of Socialization, Role & Status,

Week-14: Deviance and its types **Week-15 - 16:** Personality, Types of Personality, Factors in Personality Formation
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Anderson, Margaret and Howard F. Taylor. 2001. Sociology the Essentials. Australia: Wadsworth. 2. Brown, Ken 2004. Sociology. UK: Polity Press 3. Gidden, Anthony 2002. Introduction to Sociology. UK: Polity Press. 4. Macionis, John J. 2006. 10th Edition Sociology New Jersey: Prentice-Hall 5. Tischler, Henry L. 2002. Introduction to Sociology 7th ed. New York: The Harcourt Press. 6. Frank N Magill. 2003. International Encyclopedia of Sociology. U.S.A: Fitzroy Dearborn Publishers

S. No. 14	**Course Name: Data Structures**		
Course Code: CS-231	**Credit Hours: 4(3-3)**	**Contact Hours:3-3**	**Prerequisites:** OOP
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.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Implement various data structures and their algorithms and apply them in implementing simple applications		Apply	C3
Analyze simple algorithms and determine their complexities.		Analyze	C5
Apply the knowledge of data structure to other application domains.		Apply	C3
Design new data structures and algorithms to solve problems		Design	C6
Course Content: Abstract data types, complexity analysis, Big Oh notation, Stacks (linked lists and array implementations), Recursion and analyzing recursive algorithms, divide and conquer algorithms, Sorting algorithms (selection, insertion, merge, quick, bubble, heap, shell, radix, bucket), queue, dequeuer, priority queues (linked and array implementations of queues), linked list & its various types, sorted linked list, searching an unsorted array, binary search for sorted arrays, hashing and indexing, open addressing and chaining, trees and tree traversals, binary search trees, heaps, M-way tress, balanced trees, graphs, breadth-first and depth-first traversal, topological order, shortest path, adjacency matrix and adjacency list implementations, memory management and garbage collection			
Teaching Methodology:			

Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Data Structures and Algorithm Analysis in Java by Mark A. Weiss 2. Data Structures and Abstractions with Java by Frank M. Carrano & Timothy M. Henry 3. Data Structures and Algorithms in C++ by Adam Drozdek 4. Data Structures and Algorithm Analysis in C++ by Mark Allen Weiss Java Software Structures: Designing and Using Data Structures by John Lewis and Joseph Chase

S. No. 15	**Course Name: Computer Organization & Assembly Lang**		
Course Code: CS-232	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites: DLD**
Course Introduction: The main objective of this course is to introduce the organization of computer systems and usage of assembly language for optimization and control. Emphasis should be given to expose the low-level logic employed for problem solving while using assembly language as a tool. At the end of the course the students should be capable of writing moderately complex assembly language subroutines and interfacing them to any high level language.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Acquire the basic knowledge of computer organization computer architecture and assembly language		Understand	C2
Understand the concepts of basic computer organization, architecture, and assembly language techniques		Understand	C2
Solve the problems related to computer organization and assembly language		Apply	C3
Course Content: Introduction to computer systems: Information is bits + context, programs are translated by other programs into different forms, it pays to understand how compilation systems work, processors read and interpret instructions stored in memory, caches matter, storage devices form a hierarchy, the operating system manages the hardware, systems communicate with other systems using networks; Representing and manipulating information: information storage, integer representations, integer arithmetic, floating point; Machine-level representation of programs: program encodings, data formats, accessing information, arithmetic and logical operations, control, procedures, array allocation and access, heterogeneous data structures, 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), general principles of pipelining.			
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment:			

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

S. No. 16	**Course Name: Database Systems**		
Course Code: CS-233	**Credit Hours: 4(3-3)**	**Contact Hours:3-3**	**Prerequisites:**
Course Introduction: The course aims to introduce basic database concepts, different data models, data storage and retrieval techniques and database design techniques. The course primarily focuses on relational data model and DBMS concepts			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Explain fundamental database concepts.		Explain	C2
Design conceptual, logical and physical database schemas using different data models.		Design	C5
Identify functional dependencies and resolve database anomalies by normalizing database tables.		Identify	C2
Use Structured Query Language (SQL) for database definition and manipulation in any DBMS		Use	C4
Course Content: Basic database concepts, Database approach vs. file based system, database architecture, three level schema architecture, data independence, relational data model, attributes, schemas, tuples, domains, relation instances, keys of relations, integrity constraints, relational algebra, selection, projection, Cartesian product, types of joins, normalization, functional dependencies, normal forms, entity relationship model, entity sets, attributes, relationship, entity-relationship diagrams, Structured Query Language (SQL), Data Manipulation Language, Insert, Delete, Update, Select Statements, DDL Joins and subqueries in SQL, Grouping and aggregation in SQL, concurrency control, database backup and recovery, indexes, NoSQL systems.			
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam			
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

S. No. 17	**Course Name: Civic and Community Engagement**		
Course Code: CS-234	**Credit Hours: 2(2-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction: Teach students the importance and role of active citizenship in promoting a productive, harmonious and development society/ world. Educate students about the importance of concepts, skills and philosophy of community linkages in developing a sustainable society. Inculcate the importance of community involvement for ensuring an improved, tolerant and generative society/ world. Provide an opportunity to the students to develop their relationship with the community			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Teach students the importance and role of active citizenship in promoting a productive, harmonious and developed society/world			
Educate students about the importance of concepts, skills and philosophy of community linkages in developing a sustainable society			
Provide an opportunity to the students to develop their relationship with the community			
Inculcate the impotence of community involvement for ensuring an improved, tolerant and generative society/world			
Course Content: Introduction to citizenship education and Community Engagement Identity, Culture, and Social Harmony Multi-cultural society and inter-cultural dialogue Active Citizen: Locally Active, Globally Connected Human rights, constitutionalism and citizens' responsibilities Social issues in Pakistan Social Action Project Assignment (Formative/Summative)			
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam			
Reference Materials: (or use any other standard and latest books) 1. John J. Macionis, Lindaa Marie Gerber, Sociology (New York: Pearson Education, 2010) 2. Community Development, Social Action and Social Planning by Alan Twelvetrees 12 May 2017 3. The Constitution of the Islamic Republic of Pakistan (Pakistan: The National Assembly of Pakistan,2012),also available online at the official website of National Assembly of			

Pakistan: http://na.gov.pk/uploads/documents/13333523681 951.pdf(Accessed on April 25, 2017)

S. No. 18	**Course Name: Linear Algebra**		
Course Code: CS-235	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:** Calculus
Course Introduction: To provide fundamentals of solution for system of linear equations, operations on system of equations, matrix properties, solutions and study of their properties.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Course Content: Algebra of linear transformations and matrices. determinants, rank, systems of equations, vector spaces, orthogonal transformations, linear dependence, linear Independence and bases, eigenvalues and eigenvectors, characteristic equations, Inner product space and quadratic forms.			
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam			
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			

S. No. 19	**Course Name: Entrepreneurship**		
Course Code: CS-236	**Credit Hours: 2(2-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Prepare an analysis of the financial requirements and build a financial strategy for the new venture, including incremental appreciation of the equity base;			
Plan for the execution and management of all the relevant functional areas of new venture including operations, supply chain, information systems, and human resources etc.			
Identify and prepare legal documents, IP policy, contracts, etc			
Course Content:			

Week-1: Entrepreneurship: An Evolving Concept, Entrepreneurship –A Perspective, Emerging Trends: The Internet and E-Commerce, Entrepreneurial Opportunities, The Evolution of Entrepreneurship, The Myths & Approaches to Entrepreneurship
Week-2: Understanding Strategic Issues in Business Plan Development, Comparative Analysis Entrepreneurship in Other Countries, Strategic Objectives, Competitor Analysis
Week-3: Understanding Strategic Issues in Business Plan Development, STP Strategies, Marketing Mix Strategies
Week-4: Understanding The Entrepreneurial Perspective in Individuals, The Entrepreneurial Perspective, The Dark Side of Entrepreneurship, Entrepreneurial Motivation Entrepreneurial Perspective in Organizations – Corporate Entrepreneurship Social Entrepreneurship and The Ethical Challenges of Entrepreneurship
Week-5-6: Innovation: The Creative Pursuit of Ideas, Opportunity Identification: The search for New Ideas, Entrepreneurial Imagination and Creativity, the role of Creative Thinking, Arenas in Which People Are Creative, Innovation and the Entrepreneur, The Innovation Process
Week-7: Pathways to Entrepreneurial Ventures, The Pathways to New Ventures for Entrepreneurs, Creating New Ventures, Acquiring an Established Entrepreneurial Venture, Franchising: The Hybrid
Week-8-9: Legal Challenges for Entrepreneurial Ventures, Legal Challenges for The Entrepreneurial Venture, Intellectual Property Protection: Patents, Copyrights, And Trademarks, Identifying Legal Structures for Entrepreneurial Ventures, Sole Proprietorships, Partnerships, Corporations, Specific Forms of Partnerships and Corporations, Understanding Bankruptcy
Week-10-11: Sources of Capital for Entrepreneurial Ventures, The Entrepreneur "S Search for Capital, Debt Versus Equity, The Venture Capital Market, Informal Risk Capital: "Angel" Financing
Week-12: Assessment of Entrepreneurial Plan, The Challenge of New- Venture Start-Ups, Pitfalls in Selecting New Ventures, Critical Factors for New-Venture Development, Why New Ventures Fail, The Evaluation Process
Week-13: Marketing Challenges for Entrepreneurial Ventures, The Marketing Concept for Entrepreneurs, Marketing Research, Inhibitors to Marketing Research, Internet Marketing, Developing The Marketing Concept, Developing A Marketing Plan, Pricing Strategies
Week-14: Financial Preparation for Entrepreneurial Ventures, The Importance of Financial Information for Entrepreneurs, Understanding the Key Financial Statements, Preparing Financial Budgets, Pro Forma Statements, Capital Budgeting, Break-Even Analysis, Ratio Analysis
Week-15-16: Developing an Effective Business Plan, What Is a Business Plan? Pitfalls To Avoid in Planning, Benefits of A Business Plan, Developing A Well- Conceived Business Plan, Elements of a Business Plan, Updating The Business Plan, Presentation of The Business Plan: The "Pitch"

Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:
Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam

Reference Materials: (or use any other standard and latest books)
1. Entrepreneurship – Theory Process Practice, Donald F. Koratko 8th Edition (South

Western - Cengage Learning)

S. No. 20	**Course Name: Artificial Intelligence**		
Course Code: CS-241	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:**
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.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Understand the fundamental constructs of Python programming language.		Understand	C2
Understand key concepts in the field of artificial intelligence		Understand	C2
Implement artificial intelligence techniques and case studies		Apply	C3
Course Content: **Artificial Intelligence.** 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.			
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam			
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.			

S. No. 21	Course Name: Computer Networks		
Course Code: CS-242	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:**

Course Introduction:
Data communication is the fundamental course about the concept, design and management of data over a network. This course focuses on the components of communication system, the representation of data and the transmission mechanisms. The main focus of the course is on the physical layer and Data Link Layer of the OSI model.

Course Learning Outcomes:

At the end of the course the students will be able to:	Domain	Bloom's Taxonomy Level
Describe the key terminologies and technologies of computer networks	Describe	C2
Explain the services and functions provided by each layer in the Internet protocol stack.	Explain	C2
Identify various internetworking devices and protocols and their functions in a networking	Identify	C4
Analyze working and performance of key technologies, algorithms and protocols	Analyze	C4
Build Computer Network on various Topologies	Build	P3

Course Content:
Data Transmission Concept, Communication tasks, Line Configuration, Point to Point and Multipoint Link, Introduction to Data Communication, Distributed Processing, Network Criteria, Protocol and protocol architecture, Standards, Topologies, Transmission Mode of Communication, Types of Network, Communication Model, Signals, Periodic and Aperiodic signal, Sine Wave, Phase, Wavelength, Jitter, Time and Frequency Domain, Composite Signal and Bandwidth, Digital Signals, Bit Rate, Bit Length, Noiseless Channel, Nyquist Bit Rate, Noisy Channel, Shannon Capacity, Performance, Throughput, Latency, Data Encoding, Digital and Analog transmission, Polar, Unipolar, Bipolar, PCM, ASK, PSK, QAM etc., Data Transmission Parallel and Serial Transmission, Synchronous and Asynchronous Transmission, Modems, Transmission Impairments, Attenuation, Delay Distortion, Noise, Channel Capacity, Transmission Media, Guided Transmission Media, Twisted Pair, Coaxial Cable and Optical Fiber, Wireless Transmission- Terrestrial & Satellite Microwave and Broadcast Radio, Multiplexing, FDM, TDM. WDM etc., Error, Error types, Error Detection and Correction Techniques (VRC, LRC, CRC, Checksum, and Hamming Code), Data Link Layer: Flow Control Techniques Stop and Wait ARQ, Go-Back-N ARQ, Selective-Reject ARQ , Multiple Access Techniques, Aloha, Slotted Aloha, CSMA, CSMA/CD etc. , Character and bit oriented protocols, Networking and Internetworking devices.

Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:
Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam

Reference Materials: (or use any other standard and latest books)
1. Stallings, W. (2007). Data and Computer Communications (8 th Ed.). Prentice Hall.

2. Forouzan, B. A. (2012). Data Communications and Networking (Global Ed.). McGraw Hill.
3. Tenanbaum, A. S. (2003). Computer Networks (4th Ed.). Prentice Hall.

S. No. 22	**Course Name: Software Engineering**		
Course Code: CS-243	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Describe various software engineering processes and activates		Describe	C1
Apply the system modeling techniques to model a medium size software systems		Apply	C3
Apply software quality assurance and testing principles to medium size software systems		Apply	C4
Discuss key principles and common methods for software project management such as scheduling, size estimation, cost estimation and risk analysis		Discuss	C2
Course Content: Nature of Software, Overview of Software Engineering, Professional software development, Software engineering practice, Software process structure, Software process models, Agile software Development, Agile process models, Agile development techniques, Requirements engineering process, Functional and non-functional requirements, Context models, Interaction models, Structural models, behavioral models, model driven engineering, Architectural design, Design and implementation, UML diagrams, Design patterns, Software testing and quality assurance, Software evolution, Project management and project planning, configuration management, Software Process improvement			
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam			
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			

S. No. 23	**Course Name: Information Security**		
Course Code: CS-244	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:**
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.

Course Learning Outcomes:

At the end of the course the students will be able to:	Domain	Bloom's Taxonomy Level
Explain key concepts of information security such as design principles, cryptography, risk management, and ethics	Explain	C2
Discuss legal, ethical, and professional issues in information security	Discuss	A2
Apply various security and risk management tools for achieving information security and privacy	Apply	C3
Identify appropriate techniques to tackle and solve problems in the discipline of information security	Identify	C4

Course Content:

Week-1

Information Security , Network Security and Cyber Security, CIA Triangle i:e Confidentiality, Integrity and Availability Critical Characteristics of Information

Expended CIA Triangle, Availability, Accuracy, Authenticity, Confidentiality, Integrity, utility & Possession , Components of Information Security (Hardware, Data, People , Procedures and Networks)

Week-2

Security Mechanisms

Encipherment, Digital Signature, Access Control, Data Integrity and Traffic Padding, Routing Control, Notarization & Authentication Exchange

Security Attack

Passive Attacks (Release of message contents and Traffic Analysis)

Active Attack(Masquerade , Modification of messages, repudiation, Replay & DOS)

Week-3

Cyber Security threads Cryptography

Classical Encryption Techniques

Substitution Cipher (Mono alphabetic cipher, Poly Alphabetic cipher and Play fair cipher)

Week-4

Transposition Techniques

- Rail fence techniques, Simple Columnar Transposition and Vernam Cipher
- Feistel Structure , Block and Stream Cipher
- Private Key Cryptography and Public Key Cryptography

Week-5-7

Cryptographic Algorithms

- o Symmetric Algorithms Introduction (DES and 3DES)
- o Asymmetric Algorithm (Diffie- Hellman Key Exchange & RSA)

Week-8

Key Management in Cryptography

- o Distribution of public keys

□ Public Announcement □ Publically available Directory □ Public Key Authority □ Public Certification Week-9 Access Control • DAC, MAC Authentication □ Types of Authentication • Single factor and multi factor authentication Week-10-11 Hash Functions and Digital Signature Security Technology: Firewall □ Firewalls □ Firewall Processing Modes • Packet Filtering Firewall, Application Gateways Circuit Gateways and MAC layers Firewall Week-12 Software Security , Vulnerabilities and Protection, Malware Week-13-14 Security Policies, policy formation and enforcement Week-15-16 Pakistan Cyber Law and Ethics in Information Security
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
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

S. No. 24	**Course Name: Professional Practices**		
Course Code: CS-245	**Credit Hours: 2(2-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction: A Computing graduate as professional has some responsibilities with respect to the society. This course develops student understanding about historical, social, economic, ethical, and professional issues related to the discipline of Computing. It identifies key sources for information and opinion about professionalism and ethics. Students analyze, evaluate, and assess ethical and professional computing case studies.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level

Course Content: 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.
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
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). ISBN10: 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

S. No. 25	**Course Name: Probability and Statistics**		
Course Code: CS-246	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction: To introduce the concepts of data analysis, presentation, counting techniques, probability and decision making.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Course Content: **1. Introduction to Statistics and Statistical Thinking** 1.1. Define statistics, the science of statistics and its importance, application of statistics in economics or management sciences. 1.2. Role of statistics in critical thinking and ethics 1.3. Fundamental elements of statistics 1.4. Basic terminologies in statistics			

1.5. Branches of statistics (descriptive & inferential statistics).
1.6. Define data, types of data/variables, sources of data.
1.7. Measurement scales (nominal, ordinal, interval, ratio)
1.8. Exercises

2. Descriptive and Inferential Statistics
2.1. Define descriptive statistics (data representation, averages, variance, and standard deviation).
2.2. Define inferential statistics (estimation).
2.3. Shape of distributions
2.4. Exercises

3. Introduction to Sampling Theory
3.1. Define sample, sampling, sample design, and sample frame.
3.2. Sampling with and without replacement
3.3. Types of error in sampling
3.4. Random sampling (simple, stratified, cluster, systematic, & multistage sampling)
3.5. Non-random sampling (convenience, purposive, quota, & snow-ball sampling)
3.6. Exercises

4. Introduction to Probability
4.1. Define probability, probability definitions (classical/priori, relative/posteriori, axiomatic)
4.2. Basic terminologies (sample space, sample points, events, mutually & not mutually exclusive events, exhaustive events)
4.3. Define set theory, set operations, counting techniques and their application in probability.
4.4. Rules of probability (additive, multiplicative and law of complement)
4.5. Conditional probability
4.6. Introduction to random variables
4.7. Mathematical expectations, mean and variance of random variable.
4.8. Exercises

5. Discrete Probability Distributions
5.1. Define probability function and distribution.
5.2. Define discrete probability function and distribution.
5.3. Bernoulli random variable, Bernoulli distribution
5.4. Binomial experiment, Binomial distribution
5.5. Poisson experiment, Poisson distribution
5.6. Exercises

6. Continuous Probability Distributions
6.1. Define continuous function and distribution.
6.2. Uniform distribution
6.3. Normal distribution
6.4. Exercises

7. Hands-on Statistical Packages 7.1. Introduction to R, language essentials, expression, and objects. 7.2. Hands-on R (data analysis and visualization)
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Mann, P. S., (2010). Introductory Statistics. Wiley Publisher. 2. Walpole, R. E. (1982). Introduction to Statistics, 3rd Ed., Macmillan Publishing Co., Inc. New York. 3. Spiegel, M. R., Schiller, J. L., Sirinivasan, R. L., (2000). Probability and Statistics. Schaums outlines series. McGraw Hill, New York. 4. Bluman, A. G., (2014). Elementary Statistics: A step by step Approach. McGraw Hill, New York, USA. 5. Walpole R. E., Myers, R. H., Myers, S. L., (2007). Probability and Statistics for Engineers and Scientist. Printice Hall, New York. 6. Dalgaard, P. (2002). Introductory Statistics with R. Springer Publisher. 7. Sher Muhammad Chaudhry (2009). Introduction to Statistical Theory, Part I & II.

S. No. 27	**Course Name: Operating System**		
Course Code: CS-351	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:** 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.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Understand the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems		Understand	C2
Analyze and evaluate the algorithms of the core functions of the Operating Systems and explain the major performance issues with regard to the core functions		Evaluate	C5
Demonstrate the knowledge in applying system software and tools available in modern operating systems.		Demonstrate	C3
Course Content: Operating systems basics, system calls, process concept and scheduling, inter-process communication, multithreaded programming, multithreading models, threading issues, process scheduling algorithms, thread scheduling, multiple-processor scheduling, synchronization, critical section, synchronization hardware, synchronization problems, deadlocks, detecting and recovering from deadlocks, memory management, swapping,			

contiguous memory allocation, segmentation & paging, virtual memory management, demand paging, thrashing, memory-mapped files, file systems, file concept, directory and disk structure, directory implementation, free space management, disk structure and scheduling, swap space management, system protection, virtual machines, operating system Security.
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1.Operating Systems Concepts, 9th edition by Abraham Silberschatz 2.Modern Operating Systems, 4th edition by Andrew S. Tanenbaum 3.Operating Systems, Internals and Design Principles, 9th edition by William StallingsWu

S. No. 28	**Course Name: HCI and Computer Graphics**		
Course Code: CS-352	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:**
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level

Course Content:

Week 1:

Introduction
Background to HCI

Week 2:

The Human
- Visual Channel
- Auditory Channel
- Touch
- Memory
  - Short-term memory
  - Long-term memory

Week 3:

The Computer
- Text entry devices
- Display devices
- Virtual reality & 3D devices
- Paper: Printing & Scanning

Week 4:

The Interaction
- Introduction
- Models of Interaction
  - Norman's Execution-Evaluation Cycle

Week 5:

- Ergonomics (Human Factor)
- Arrangement of control & display
- The physical environment of the interaction
- Health issues
- The use of color

Week 6:

- Interaction Styles
- Command line style
- Menus
- Natural Language
- Question/Answer & Query dialog
- Form-fills & spread sheets
- The WIMP interface
- Point-and-click interface

Week 7:

- Elements of the WIMP INTERFACE
  - Windows
  - Icons
  - Pointers
  - Menus
  - Buttons
  - Tool bars
  - Palettes
  - Dialog boxes

Week 8:

- Design Guide Lines
  - Introduction
  - The Design Process
  - User Focus
  - Navigation Design

Week 9:

- HCI in the Software Process
  - Software life cycle (over view)
  - Usability engineering
  - Iterative design & Prototype

Week 10:

- Design Rules
  - Principles to support Usability
  - Heuristic Evaluation

Week 11:

- Evaluation Techniques
  - Introduction
  - Goals
  - Evaluation through Expert Analysis
  - Evaluation through User Participation

Week 12:

Universal Design Introduction Universal design principle Multi-Modal Interaction **Week 13**: User Support Requirement of user support Approaches to user support Adaptive Help System **Week 14:** Cognitive Models Task Analysis GOMS Cognitive Complexity theory **Week 15:** Task Analysis Task Decomposition Knowledge-Based Analysis Entity-Relation-Based Techniques **Week 16:** Course Revision
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Human Computer Interaction; By Alan Dix, Janet Finlay, Russell Beale 3e. 2. HCI Models, Theories, & Framework: Toward s Multidisciplinary Sciences; By John Carroll. 3. Usability Engineering: Scenario-Based Development of HCI; By Mary Rosson, John Carroll, Mary Beth Rosson.

S. No. 29	**Course Name: Theory of Automata & Formal Languages**		
Course Code: CS-353	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Explain and manipulate the different concepts in automata theory and formal languages such as formal proofs, automata, regular expressions, Turing machines etc.		Understand	C2
Prove properties of languages, grammars and automata with rigorously formal mathematical methods		Understand	C2

Design of automata, RE and CFG	Apply	C3
Transform between equivalent NFAs, DFAs and Res	Apply	C3
Define Turing machines performing simple tasks	Understand	C2
Differentiate and manipulate formal descriptions of languages, automata and grammars with focus on regular and context-free languages, finite automata and regular expressions.	Apply	C3
Course Content: Finite State Models: Language definitions preliminaries, Regular expressions/Regular languages, Finite automata (FAs), Transition graphs (TGs), NFAs, Kleene's theorem, Transducers (automata with output), Pumping lemma and non-regular language Grammars and PDA: CFGs, Derivations, derivation trees and ambiguity, Simplifying CFLs, Normal form grammars and parsing, Decidability, Context sensitive languages, grammars and linear bounded automata (LBA), Chomsky's hierarchy of grammars Turing Machines Theory: Turing machines, Post machine, Variations on TM, TM encoding, Universal Turing Machine, Defining Computers by TMs		
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations		
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam		
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		

S. No. 30	**Course Name: Multivariable Calculus**		
Course Code: CS- 354	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:** Calculus & AG
Course Introduction: .			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Understand the basic concepts and know the basic techniques of differential and integral calculus of functions of several variables;			
Apply the theory to calculate the gradients, directional derivatives, arc length of curves, area of surfaces, and volume of solids			
; Solve problems involving maxima and minima, line integral and surface integral, and vector calculus;			

Course Content: **Week**-1: Functions of Several Variables and Partial Differentiation **Week**-2-3: Multiple Integrals **Week**-4: Line and Surface Integrals **Week**-5: Green's and Stoke's Theorem **Week**-6-7: Fourier Series: periodic functions **Week**-8: Functions of any period P-2L **Week**-9: Even & odd functions **Week**-10: Half Range expansions **Week**-11-12: Fourier Transform **Week**-13-14: Laplace Transform **Week**-15-16: Z-Transform.
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Multivariable Calculus, 6th edition James, Stewart 2007 Cengage Learning publishers 2. Calculus and Analytical Geometry, 6th edition. Swokowski, Olinick and Pence.1994, Thomson Learning EMEA, Ltd 3. Multivariable Calculus, 5th edition Howard, A. Albert, H. 1995, John Wiley

S. No. 31	**Course Name: Network System & Communication**		
Course Code: CS- 355	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction: This course familiarizes the students about the fundamental concepts of computer networks, its components and design. The main focus is on the network and transport layers. The course discusses the design, working and different protocols working on these layers.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Understand the fundamental concepts of networking.			
Know different protocols and working.			
Identify the data transmission mechanisms and the challenges they pose in computer networks			
Course Contents: Network, Internet, Classification of Networks (By Size, By Connectivity, By Medium, By Mobility), Packet, Frame. Switching Circuit and Packet Switching: a) Switching Networks, Circuit-Switching Networks, Switching Concepts b) Routing In Circuit Switched Networks, Control Signaling c) Packet Switching Principles, Routing , Congestion Control Network Performance			

WAN Protocols: Asynchronous Transfer Mode (ATM) Etc.,

Internetworking: Concepts, Architecture and Protocols:

a) Principles Of Internetworking, Internet Protocol (IP), Classful Addressing Scheme, IPv4 Sub-Netting And CIDR, IP Encapsulation, Fragmentation And Reassembly, IPv4 Header Format.

b) IPv6 (IPng)
IPv4 Shortcomings, Packet Headers, IPv6 Addresses, IPv6 Address Formats, Choosing Between IPv4 and IPv6, Transition from IPv4 to IPv6 (Dual Stack, Tunneling, Header Translation), Effect on Other Protocols,

An Error Reporting Mechanism (ICMP), Internet Group Management Protocol (IGMP), Address Resolution Protocol (ARP), Network Address Translator (NAT), Ethernet and its types.

Routing, Static And Dynamic Routing, Interior Gateway Routing Protocols, Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Enhanced Interior Gateway Routing Protocol (EIGRP), Exterior Gateway Routing Protocols (EGRP), Border Gateway Protocol (BGP) Etc.,

Transport Layer Protocols: User Datagram Protocol (UDP), Characteristics and UDP Header Format. Reliable Transport Service: Introduction To Transmission Control Protocol (TCP), Idea of Packet Lost and Retransmission, Three Way Handshaking, Stream Control Transfer Protocol (SCTP),

Fundamentals of DNS, FTP, SMTP, WWW, HTTP, SHTTP, POP3, IMAP, MIME and SNMP Protocol

Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:
Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam

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

1. Stallings, W. (2007). Data and Computer Communications (8 th Ed.). Prentice Hall.
2. Forouzan, B. A. (2007). Data Communications and Networking (4 th Ed.). McGraw Hill.
3. Tenanbaum, A. S. (2003). Computer Networks (4 th Ed.). Prentice Hall.
4. Forouzan, B. A., & Mosharraf, F. (2012). Computer Networks: A Top-down Approach (Latest ed.). McGraw-Hill

S. No. 32	**Course Name: Advanced Programming**		
Course Code: CS-356	**Credit Hours: 3(2-3)**	**Contact Hours:**	**Prerequisites: OOPs**
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level

Course Content:
Introduction to Java, Java programming environment (JDK, JRE, JVM), Characteristics of Java, Compilation and Execution process of Java Program, OOP concepts, Classes, Objects, Encapsulation, Inheritance, Polymorphism, Abstraction, Interfaces in Java, Java keywords(import, this, new, static, final, super), Exception handling, try, catch and finally block, throw and throws, Java Collections and Generics, Inner Classes and usage, Threads, and Importance, Starting Threads, Sleep, Join, Priority, Daemon Threads, Thread Synchronization and Importance, Synchronized Methods and Synchronized Blocks, wait(), notify(), notifyall(), Network Programming, Java Sockets, and the java.net package, (UDP and TCP based Programming), RMI, Graphical User Interfaces (GUIs), Java Database Connectivity (JDBC), Select Statement, Insert Statement, Update Statement, Delete Statement.

Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:
Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam

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

1. Deitel, H., Deitel, P. (2015). Java How to Program (Latest ed.). Prentice Hall.
2. Schildt, H. (2017). Java: A Beginners Guide (Latest ed.). McGraw-Hill Education

S. No. 33	**Course Name: Computer Graphics**		
Course Code: CS-357	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:**

Course Introduction:
Objective of this course is to show the students how they can implement their mathematical background in computer graphics, to give them the idea of how the graphical user interface work in general so they can apply this knowledge in advance Graphical oriented Software's. Use of C/C++ in DOS mode is applied in one of the parts so that the graphical interfaces for machine oriented software's can be easy for students. And this knowledge can be applied in Linux and UNIX easily by the students if they want to do graphical programming for other operating systems. A user friendly 3D software is introduced to show them the graphical edge of the millennium technology so they would easily switch to more advance and complicated 3D development software's in future, this knowledge can in future help them work in libraries like direct X and open GL, which can be incorporated with C/C++(these C/C++ Libraries). This course is designed in a way that this would not aim to a particular software or application but familiarize the students with the terms that hardware, graphics and game vendors actually use so they can be able to understand and learn any software by their own if required in future.

Course Learning Outcomes:

At the end of the course the students will be able to:	Domain	Bloom's Taxonomy Level

Course Content:
Week-1 Computer Graphics

	Computer Graphics System Framework for Interactive Graphics System Typical application areas of Computer Graphics Basic output primitives of drawing
Week-2	Why to study Computer Graphics Active Computer Graphics Systems Passive Computer Graphics Systems Overview of Pixels Bitmap and Pixmap Systems Resolution
Week-3	Display Devices Refresh Cathode Ray Tube Color CRT Monitors CRT Monitors Method Random scan technology Raster scan technology Refresh Buffer or Frame Buffer Horizontal Retracement Vertical Retracement Graphics libraries o OpenGL o DirectX Graphics Softwares
Week-4	Line drawing techniques Slope of line o Case 1 o Case 2 o Case 3 Circle drawing techniques Ellipse drawing techniques
Week-5	Line drawing algorithms Circle drawing algorithms Ellipse drawing algorithms
Week-6	Matrix Representation of data Dimensions and Elements of Matrices Operations on Matrices Transformation 2-D Transformation Basic geometric transformation Translation Rotation Scaling Matrix Representation of Translation, Rotation and Scalling
Week-7	Introduction to 3D concept

	Coordinate System and its type
	3-Dimensional Transformation
	3-D Translation
	3-D Rotation
	3-D Scaling
Week-8	
	Clipping
	Point Clipping
	Line Clipping
	Text Clipping
	Cohen-Sutherland Clipping technique
Week-9	
	Projection
	Types of Projection
	Parallel Projection
	Perspective Projection
Week-10	-1st step in Programming graphics Using C
	-Using C graphics mode
	C Graphic environment
Week-11	-Selecting colors
	-Drawings
	-Line
	-Circle
	-Rectangle
	-Ellipse
	-Using text in graphics mode using C
	-Changing text colors
Week-12-13	
	Introduction to Photoshop
	Overview of Workspace
	About Photoshop document
	Common Tools
	Photoshop Layers
	Layer effects and styles
	Image editing using image adjustment
Week-14-15	Introduction to Macromedia Flash MX
	Flash MX interface
	TimeLine
	Movie properties
	Frames vs Key frames
	Deleting, Copying and Reversing Key frames
	Movie Testing
	Flash Animations
	o Frame by Frame animations
	o Shape Tweening

o Motion Tweening Guide Line Layer Flash Symbols Adobe Flash Combination **Week-16** Project and Revision
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Computer Graphics by Donald Hearn, M.Pauline Baker 2. The 3d concepts can be found using any 3D Programming Book. 3. Flash bible or Flash Premier. 4. For Mathematical Concepts GRE reference can be used. 5. All the above material can be found on web. Turbo C/C++ manuals, -and its Software Help.

S. No. 34	**Course Name: Software Testing & Quality Assurance**		
Course Code: CS-358	**Credit Hours: 3(2-3)**	**Contact Hours: 2-3**	**Prerequisites:**
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Course Content: Software Testing Foundation: Why Software Testing? Fundamental Test Process, Levels of Software Testing, Software Testing Life Cycle, Model Driven Test Design: Test Design, Test Automation, Test Execution, Test evaluation, Test personnel and Abstraction, Test Automation, Components of Testcase, Test Automation Framework, Data Driven Tests, Graph Coverage Criteria, ; Control Flow; Data Dependency and Interaction Testing; Static and Dynamic Testing, Good and Bad Test Cases; Alpha, Beta and Acceptance Testing; Test Instrumentation and Tools; Test case design techniques, Black Box and White Box testing techniques, Black-Box Vs. Structural Testing Developing Test Plans; Managing the Testing Process; Test Case Results Analysis, Reporting Software Testing Process, Role of Software Metrics in Testing.			
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam			
Reference Materials: (or use any other standard and latest books)			

1. Software Testing Foundations, Spillner A., Linz, T., Schaefer H., 4th Edition, Rocky Nook. 2. Introduction to Software Testing, Paul Ammann and Jeff Offutt, Second Edition (2017).

S. No. 35	**Course Name: Compiler Construction**		
Course Code: CS-361	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:** TOA
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Understand the basic techniques used in compiler construction such as lexical analysis, top-down, bottomup parsing, context-sensitive analysis, and intermediate code generation			
Understand the basic data structures used in compiler construction such as abstract syntax trees, symbol tables, three-address code, and stack machines			
Design and implement a compiler using a software engineering approach Use generators (e.g. Lex and Yacc)			
Course Content: Week-1: Introduction to interpreter and compiler Week-2-3: Compiler techniques and methodology Week-4: Organization of compilers Week-5-6: Lexical and syntax analysis Week-7-8: Parsing techniques Week-9: Types of parsers, Top-down parsing, bottom-up parsing Week-10: Type checking Week-11-12: Semantic analyser Week-13-14: Object code generation and optimization Week-15-16: Detection and recovery from errors			
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam			
Reference Materials: (or use any other standard and latest books) 1. Compilers: Principles, Techniques, and Tools, A. V. Aho, R. Sethi and J. D. Ullman, Addison-Wesley, 2nd ed., 2006 2. Modern Compiler Design, D. Grune, H. E. Bal, C. J. H. Jacobs, K. G. Langendoen, John Wiley, 2003. 3. Modern Compiler Implementation in C, A. W. Appel, M. Ginsburg, Cambridge University Press, 2004.			

S. No. 36	Course Name: Parallel & Distributed Computing		
Course Code: CS-362	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:** Operating System
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Write portable programs for parallel or distributed architectures using Message-Passing Interface (MPI) library			
Analytical modelling and performance of parallel programs.			
Analyse complex problems with shared memory programming with openMP.			
Course Content: Asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, synchronization, and tools (Cuda, Swift, Globus, Condor, Amazon AWS, OpenStack, Cilk, gdb, threads, MPICH, OpenMP, Hadoop, FUSE).			
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam			
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 Ed			

S. No. 37	Course Name: Computer Architecture		
Course Code: CS-363	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:** COAL
Course Introduction: .			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Course Content: Introduction Computer Organization and Architecture, Structure and Function, History of Computer Evaluation: Generation of Computer, Von Neumann			

Machine Architecture Execution: Introduction of Execution Unit (EU), Register Section, General Register Design Processor Control Unit: Basic Concepts Design Methods (Hardwired Control Design and Micro Programmed Control Unit Cache Memory: Characteristics of Memory System, Location, Capacity, Unit of Transfer, Access Method, Performance, Physical Type, Physical Characteristics, Organization Memory Hierarchy: Cache Memory Principles ,Elements of Cache Design Internal Memory Organization, DRAM vs SRAM, Types of ROM External Memory Magnetic Disk, RAID, RAID Level 0 to 6 Advanced Topics: Programmed I/O , Interrupt Driven I/O, DMA (Direct Memory Access)
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. M. Moris Mano, Modern Computer architecture, 3rd Edition, Prentice Hall, 1992. 2. William Stallings, Computer Organization and Architecture, 7th Edition

S. No. 38	**Course Name: Analysis of Algorithms**		
Course Code: CS-364	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:** Data Structure
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.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Explain what is meant by "best", "expected", and "worst" case behavior of an algorithm			
Identify the characteristics of data and/or other conditions or assumptions that lead to different behaviors.			
Determine informally the time and space complexity of simple algorithms			
List and contrast standard complexity classes			
Use big O, Omega, Theta notation formally to give asymptotic upper bounds on time and space complexity of algorithms			
Use of the strategies(brute-force, greedy, divide-and conquer, and dynamic programming) to solve an appropriate problem			
Solve problems using graph algorithms, including single source and all-pairs shortest paths, and at least one minimum spanning tree algorithm			
Trace and/or implement a string-matching algorithm			

Course Content: Introduction; role of algorithms in computing, Analysis on nature of input and size of input Asymptotic notations; Big-O, Big Ω, Big Θ, little-ο, little-ω, Sorting Algorithm analysis, loop invariants, Recursion and recurrence relations; Algorithm Design Techniques, Brute Force Approach, Divide-and-conquer approach; Merge, Quick Sort, Greedy approach; Dynamic programming; Elements of Dynamic Programming, Search trees; Heaps; Hashing; Graph algorithms, shortest paths, sparse graphs, String matching; Introduction to complexity classes.
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
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

S. No. 39	**Course Name: Research Methods**		
Course Code: CS-365	**Credit Hours: 3(3-0)**	**Contact Hours:3-0**	**Prerequisites:**
Course Introduction: .			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Course Content: Research: introduction to the nature of research, and types of Research; Research questions, and the nature of evidence: deciding what type of question to ask, and how to handle the various types of answer; Mud pits and how to avoid them: things that go wrong; Isms: necessary assumptions, dubious assumptions, and being caught in crossfire; Searching the literature: why, where, what for and how; Research in society agendas, context and the like: things we take for granted, and things that can cause you trouble; Research design: Types of design: which to use and how to use them; Surveys and sampling; Field experiments: doing research in the world. Controlled experiments: changing things systematically and seeing what happens; Summary and technical terms; Generic advice; arranging a study: subjects, equipment, procedures, things to remember, things to beware; Handling subjects; Recording; Data collection; Data collection methods: the methods, and choosing and using the appropriate method; Reports: getting respondents to talk about how things happen; Observation: watching what happens; Card sorts: getting respondents to categorize things; Laddering: unpacking the respondents' concepts systematically; Repertory grids: a systematic representation for respondents' knowledge interviews: asking people questions; Face-to -face interactions with respondents: the nuts and bolts of asking questions; Questionnaires: when to use, when not to use, which questions to ask, what format to use; Data analysis; Content analysis: what is said in a text, how it is said, and how			

often it's said; Discourse analysis: who says what, about what, to whom, in what format. Knowledge representation: formats, structures and concepts for making sense of knowledge; Statistics: describing things with numbers, and assessing the odds; Descriptive statistics: giving a systematic description of the numbers you've found; Measurement theory: types of measurement and their implications; Inferential statistics: what are the odds against your findings being due to random chance? Conclusion: the end game; Writing up: demonstrating your excellence efficiently, and practical points to remember; References and referencing: using and citing the right texts to demonstrate your excellence; what next; thinking forward about what you really want your life to be?
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. A Gentle Guide to Research, Gordon Rugg & Marian Petre, Open University Press McGraw-Hill Education, 2007 2. Practical Research Methods, CATHERINE DAWSON, How To Books Ltd,3 Newtec Place, 2002.

S. No. 40	**Course Name: Web Technologies**		
Course Code: CS-366	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:**
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Know the fundamentals of web application architecture and web programming.			
Apply a structured approach to identifying needs, interests, and functionality of a website.			
Write well-structured, easily maintained, standards compliant, accessible HTML code.			
Write well-structured, easily maintained, standards compliant CSS code to present HTML pages in different ways.			
Use PHP to implement server-side script for creating dynamic web pages and access databases. Design and implement an interactive web site(s) with regard to issues of usability, accessibility, and internationalization			
Course Content: Introduction to Web Applications, TCP/IP Application Services. Web Servers: Basic Operation, Virtual hosting, Chunked transfers, Caching support, Extensibility. SGML, HTML5, CSS3. XML Languages and Applications: Core XML, XHTML, XHTM MP. Web Service: SOAP, REST, WML, XSL. Web Services: Operations, Processing HTTP Requests,			

Processing HTTP Responses, Cookie Coordination, Privacy and P3P, Complex HTTP Interactions, Dynamic Content Delivery. Server Configuration. Server Security. Web Browsers Architecture and Processes. Active Browser Pages: JavaScript, DHTML, AJAX. JSON, Approaches to Web Application Development. Programing in any Scripting language. Search Technologies. Search Engine Optimization. XML Query Language, Semantic Web, Future Web Application Framework.
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Web Application Architecture: Principles, protocols and practices by Leon Shklar and Richard Rosen, Wiley; 2nd Edition (May 5, 2009). ISBN-10:047051860X. 2. Web Technologies: A Computer Science Perspective by Jeffrey C. Jackson, Prentice Hall; 1st Edition (August 27, 2006). ISBN-10:0131856030

S. No. 41	**Course Name: Introduction to Cyber Security**		
Course Code: CS-369	**Credit Hours: 3(2-3)**	**Contact Hours: 2-3**	**Prerequisites:** 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			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
To be able to identify computer system threats		Understand	C2
To be able to identify Malware attacks, and understand the stages of attack and payloads.		Understand	C2
Implement various cryptographic techniques and simulate attack scenarios		Apply	C3
Course Content: 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.			
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations			

Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
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

S. No. 42	**Course Name: Principle of Marketing**		
Course Code: CS-368	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Understand the marketplace and the consumers.			
Understand the elements in marketing mix and their			
application in marketing decisions.			
Outline the functions of marketing communication.			

Course Content:

Week-1: Introduction to Marketing, Marketing and The Society, Importance and Scope of Marketing, Nature And Concept Of Marketing

Week-2: Marketing Environments, The Marketing Environment, Macro Environment, Microenvironment, Environmental Scanning and Monitoring

Week-3: Marketing & Strategy, Strategic Planning, Strategic Marketing Planning, Forecasting Marketing Demand

Week-4: Marketing Decisions, Information Required for Marketing Decisions, Reasons for Obtaining Information, Marketing Research

Week-5: Consumer Behaviour, Information for Purchase Decisions, Consumer Decision Process, Influence of Social and Psychological Factors

Week-6: Market Segmentation and Targeting, Factors for Segmentation, Selecting The Target Market, Developing The Positioning and Target Market Strategies

Week-7: Products and Services, Definition of Product and Services, Classification of Consumer Goods, Classification of Business Goods

Week-8: Product Development and Life Cycle, Product Development Process and Commercialization, Product Life Cycle Stages and Its Implications

Week-9: Pricing, Overview of Pricing, Importance of Pricing, Break Even Analysis, Factor Effecting Pricing Decisions

Week-10: Setting The Price and Relating Strategies, Pricing Objectives, Sale Based Objectives, Profit Based Objectives, Status Quo Pricing, Price Strategy

Week-11: Pricing Techniques and Their Applications, Cost Based Pricing, Cost Plus Pricing, Target Pricing, Floor Pricing

Week-12: Distribution, Importance of Distribution Channels, Selecting a Channel of Distribution, Recent Trends in Wholesaling and Retailing

Week-13: Promotion, Importance and Types of Promotion, Channels of Communication, Objectives, Budgeting and Promotional Mix,

Week-14: Advertisement and Publicity, Scope of Advertisement and Publicity, Characteristic of Advertisement and Publicity, **Week-15:** Introduction to E-Business, Different Trends, Rules of Doing E-Business, E-Business Application in The Market **Week-16:** Conclusion Session/presentations
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
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

S. No. 43	**Course Name: Introduction to Philosophy**		
Course Code: CS-369	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Understanding basic concepts of philosophy in the fields of metaphysics, axiology, and epistemology.			
Understanding of philosophical terms.			
Course Content: **Week-1:** A review of the history of philosophy **Week-2:** Discussion on the major problems and methods of philosophy Studying the work of at least two philosophers from each of the following groups: **Week-3**: Greco-Roman Philosophers Plato, Aristotle, Democritus, Pythagoras, Heraclitus, Protagoras, Epicurus, Seneca, and Epictetus **Week-4:** Medieval Religious Philosophers Avicenna, Averroes, St. Thomas Aquinas, Renaissance Philosophers Machiavelli, Erasmus, Thomas More **Week-5**: Enlightenment and Sui Generis Philosophers Copernicus, Descartes, Hobbes, Spinoza, Leibniz, Locke, Berkeley, Hume, Kant **Week-6:** Idealists Fichte, Schelling, Schiller, Hegel **Week-7:** Utilitarian Philosophers Jeremy Bentham, J.S. Mill **Week-8:** Romantic Reactionaries Rousseau, Schopenhauer, Kierkegaard **Week-9:** Materialist Philosophers Feuerbach, Marx **Week-10**: The Irrational Philosophers Bergson, Freud **Week-:11-12** Phenomenologists and Existentialists Husserl, Heidegger, Sartre, Camus, Fanon **Week-13:** Marxist Philosophers Lukacs, Gramsci, Croce, Althusser **Week-14-16:** Linguists, Semiotician, Structuralist, and Deconstructionists Saussure, Levi-Strauss, Lacan, Barthe, Foucault, Derrida			

Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Adorno, T.W., Aesthetic Theory. Tr. By C. Lenhardt. London: Routledge & Kegan Paul,1984 2. Ahmad, Absar, Concept of Self and Self-Identity in Contemporary Philosophy. Lahore: Iqbal Academy,1986 3. Aldrich , Virgil., Philosophy of Art, New Jersey: Prentice Hall,1963 4. Anne, Bruce, Metaphysics: The Elements. Oxford: Basil Blackwell,1986 5. Aristotle, The Works of Aristotle, edited by W.D. Ross. Vol x. Politica, translated by Benjamin Jowett. Oxford: Clarendon Press 1921 6. Ayer , A. J. , Central Questions of Philosophy London: Penguin Books,1973 7. Cairns, Huntington, Legal Theory from Plato to Hegel. Baltimore: John Hopkins Press. 1967. 8. Copleston, Frederick, A History of Philosophy. 9 vols New York: Image Books 1962 9. Frankena , William , K. Ethics Prentice Hall, Inc. 10. Hurley, Patrick, J, A Concise Introduction to Logic, Belmont: Wadsworth Publishing Co. 1988 11. James Rachels [1995] the Elements of Moral Philosophy, McGraw Hill inc. 12. John F. Post [1991] Metaphysics: A Contemporary Introduction. Paragon House NY 13. Russell, Bertrand, A History of Western Philosophy. London: George Allen and Unwin, 1961 14. Russell, Bertrand, Problems of Philosophy. Oxford University Press, 1959 15. Passmore, J., A Hundred Years of Philosophy. Penguin Books, 1966

S. No. 45	**Course Name: Technical and Business writing**		
Course Code: CS-471	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:** F.E
Course Introduction: Students in the senior level needs good technical writing skills not only for writing project report but also useful for them to communicate their resume and get place in the market. This is a high level course which provide useful knowledge to the students for writing proposals etc. Further, the course aims at augmenting students' proficiency in technical writing in order to sensitize them to the dynamics, challenges, and needs of the modern world characterized by technologically advanced social, cultural, and corporate settings. It will focus on students' ability to effectively convey and exchange information in cross-cultural, international, and multinational milieu necessitated by the emergence of global society.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Course Content: Overview of technical reporting, use of library and information gathering, administering questionnaires, reviewing the gathered information; Technical exposition; topical			

arrangement, exemplification, definition, classification and division, casual analysis, effective exposition, technical narration, description and argumentation, persuasive strategy, Organizing information and generation solution: brainstorming, organizing material, construction of the formal outline, outlining conventions, electronic communication, generation solutions. Polishing style: paragraphs, listening sentence structure, clarity, length and order, pomposity, empty words, pompous vocabulary, document design: document structure, preamble, summaries, abstracts, table of contents, footnotes, glossaries, crossreferencing, plagiarism, citation and bibliography, glossaries, index, appendices, typesetting systems, creating the professional report; elements, mechanical elements and graphical elements. Reports: Proposals, progress reports, Leaflets, brochures, handbooks, magazines articles, research papers, feasibility reports, project reports, technical research reports, manuals and documentation, thesis. Electronic documents, Linear verses hierarchical structure documents.
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Technical Report Writing, by Pauley and Riordan, Houghton Mifflin Company, 8th Edition. 2. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill.

S. No. 46	**Course Name: Mobile App Development**		
Course Code: CS-472	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:**
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Describe those aspects of mobile programming that make it unique from programming for other platforms.			
Utilize rapid prototyping techniques to design and develop sophisticated mobile interfaces			
Program mobile applications for the Android operating system that use basic and advanced phone features. Design, implement, test, debug and publish smartphone applications			
Course Content: **Week-1**: Android Platform and Architecture **Week-2**: Configuring Development Environment, Activities, Services **Week 3-6**: Broadcast Receiver, Fragments, Intents, Designing Interface Using Views and Widgets, Linear Layout, Relative Layout, Table Layout, Scrollview Layout **Week 7-9**: List View, Action bar, Dialogs and Notification, Multi-threading, Location and Maps Services			

Week 10-12: Shared Preferences, Creating and Using Database, Content Providers, Accessing External Storage **Week 13-16**: Displaying Videos and Listing Audios Using Media Player, Publishing and Deploying Applications on Android Market
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Horton, J. (2015). Android Programming for Beginners (Latest ed.). Packt Publishing Ltd. 2. Phillips, B., & Hardy, B. (2013). Android programming: the beginners guide (Latest ed.). Pearson Education. 3. Lee, W. M. (2012). Beginning android 4 application Development (Latest ed.). John Wiley & Sons

S. No. 47	**Course Name: Intro to Datamining**		
Course Code: CS-473	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:**

Course Introduction:

Data Mining has emerged at the confluence of artificial intelligence, statistics, and databases as a technique for automatically discovering hidden patterns in large datasets. The main purpose of this course is the ability to analyze and construct knowledge from data.

The aims of this course are to:

- Expand on the student's understanding and awareness of the concepts of datamining basics, techniques, and application.
- Introduce the concepts of Data Pre-processing and Summary Statistics.
- Introduce the concepts of Frequent Item Set Generation, Associations and Correlations measures.
- Introduce the concepts of Classification, Prediction, and Clustering algorithms.

Build on the programming and problem-solving skills developed in previous subjects studied by the student, to achieve an understanding of the development of Classification, Prediction, and Clustering applications

Course Learning Outcomes:

At the end of the course the students will be able to:	Domain	Bloom's Taxonomy Level
Apply preprocessing techniques on any given raw data	C3	Apply
Select and apply proper data mining algorithm to discover interesting patterns	C3	Apply
Analyze and extract patterns to solve problems and point out how to deploy solution	C4	Analyze
Evaluate systematically supervised, semi supervised and unsupervised models and algorithms with respect to their accuracy	C4	Analyze

Course Content: Introduction to data mining and basic concepts, Pre-Processing Techniques & Summary Statistics, Association Rule mining using Apriori Algorithm and Frequent Pattern Trees, Introduction to Classification Types, Supervised Classification (Decision trees, Naïve Bae Classification, K-Nearest Neighbors, Support Vector Machines etc.), Unsupervised Classification (K Means, K Median, Hieratical and Divisive Clustering, Kohonan Self Organizing maps), outlier & anomaly detection, Web and Social Network Mining, Data Mining Trends and Research Frontiers. Implementing concepts using Python.
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Jiawei Han & Micheline Kamber, Jian Pei (2011). Data Mining: Concepts and Techniques, 3rd Edition. 2. Pang-Ning Tan, Michael Steinbach, and Vipin Kumar (2005). Introduction to Data Mining. 3. Charu C. Aggarwal (2015). Data Mining: The Textbook 4. D. Hand, H. Mannila, P. Smyth (2001). Principles of Data Mining. MIT Press.

S. No. 48	**Course Name: Wireless and Mobile Networks**		
Course Code: CS-474	**Credit Hours: 3(3-0)**	**Contact Hours:3-0**	**Prerequisites:**
Course Introduction: Wireless and mobile networking is one of the fastest growing segments of the computer industry. Wireless network has been around for many years and it has already started to dominate the wired network. This course is focused on the introduction and fundamental concepts about wireless and mobile networks. Students will be able to understand how wireless standards and protocols are developed. Furthermore, students will be exposed to the history and future trends in wireless and mobile technologies.			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Course Content: Principles of Wireless Communication, Wireless Networks, Main Components of a Wireless System, Modes of Operation Infrastructure Mode, ad-hoc Mode, Compatibility of Different Technologies, Nyquist-Shannon Sampling Theorem, Nyquist Bandwidth, Signal-to-Noise Ratio, Multiplexing, Antenna and Types, Modes of Propagation, Radio Channel Characterization, Multipath Propagation, co-channel Interference, Exponential Power Delay Profile, Propagation Effects - Scattering, Ground Reflection, Fading, Log-normal Shadowing, Rayleigh & Rician Fading, Coherence Bandwidth, PHY Layer Techniques, Wideband Modulation Techniques to CPE with Inter-symbol Interference (Diversity, Spread Spectrum, Frequency Hopping, Direct Sequence, Adaptive Equalization, and Orthogonal Frequency Division Multiplexing), Components of a Satellite-based Network, Multiple Access Techniques (FDMA, TDMA and CDMA, CSMA/CA and Slotted Aloha),			

Orthogonal and Non-orthogonal Multiple Access (NOMA), Cellular Concepts, Sectorization and Cell Splitting, Handover and Types, Frequency Reuse, Reuse Distance, Cluster Size, Channel Assignment Strategies, Handoff Strategies, co-channel Interference and System Capacity, Trunking and Grade of Service, Mobile Network Generations (1G, 2G, 3G, 4G and 5G Concepts), Wireless Local Area Networks (WLANs), 802.11 Networks and Versions (802.11 a, b, g, n), ad-hoc Wireless Personal Area Networks (WPANs), Bluetooth Standard 802.15 and Version, Infrared Communication, Femtocells, Multi-hop Relay Networks, Wireless Mesh Networks, Homogeneous and Heterogeneous Networks, Integration and Challenges, Coordinated Multipoint (CoMP) and Cooperative Communication Concepts and Advantages.
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Stallings, W. (2013). Wireless Communications & Networks (Pearson New International Edition). Pearson Education Limited. 2. Molisch, A. F. (2010). Wireless communications (Latest Edition). Wiley. 3. Rappaport, T. S. (2002). Wireless communications: Principle and Practice (2nd Edition). Prentice Hall. 4. Tanenbaum A. S. (2002). Computer Networks (4th Edition). Prentice Hall. 5. Schiller, J. (2013). Mobile communications (2nd Edition). Addison-Wesley. 6. Goldsmith, A. (2005). Wireless Communications (Latest Edition). Cambridge University.

S. No. 50	**Course Name: Software Project Management**		
Course Code: CS-476	**Credit Hours: 3(2-3)**	**Contact Hours: 2-3**	**Prerequisites:** Software Engineering
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Explain principles of the project lifecycle and how to identify opportunities to work with learners on relevant and appropriate project scenarios to share this understanding			
Critically evaluate and discuss the issues around project management and its application in the real world with course participants and learners			
Choose project management techniques for IT projects to initiate, plan, execute and evaluate a project and work in teams to create a project plan for a project scenario that includes key tasks, critical path, dependencies and a realistic timeline.			

Present strategies for gaining confidence in managing projects through simple project planning examples.		

Course Content:

Week-1: Introduction to Software Project Management, Project Management concepts,

Week-2: Project Management Tools, PMI's Knowledge areas, PMI Framework, PMI Process Groups.

Week-3-4: Understanding Organizations.

Week-5-6: Project Planning, Project Evaluation, Selection of an Appropriate Approach in Project, Software Effort Estimation,

Week-7-8: Activity Planning, Risk Management,

Week-9-10: Evaluating the Risks to the Schedule, Risk Control, Configuration Management and Maintenance, Environment for Configuration Control,

Week-11-13: Resource Allocation, Monitoring & Control, Review and Evaluation,

Week-14-16: Challenges of Outsourcing in Project Management

Teaching Methodology:

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

Course Assessment:

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

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

1. Software Project Management, Bob Hughes and Mike Cotterell, McGraw-Hill Education; 5th Edition (2009).
2. A Guide to the Project Management Body of Knowledge, 5th Edition (PMBOK Guides),
3. Mastering Software Project Management: Best Practices, Tools and Techniques, Murali K. Chemuturi and Thomas M. Cagley Jr., J. Ross Publishing, 2010
4. Effective Project Management: Traditional, Agile, Extreme, Robert K. Wysocki, Wiley; 6th Edition, 2011

S. No.	**Course Name: Distributed Database Systems**		
Course Code: CS-477	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:**

Course Introduction:

This course introduces the fundamental concepts and issues of distributed database systems. And the approaches of emerging technologies, and to provide insight into related research problems. In this course students will analyze relational database applications with special concentrations on the design of relation, queries, procedures and connections. Describe and use techniques to improve performance object-oriented database systems. It also elaborates the shortcomings of centralized relational database systems, and how to overcome these shortcomings using DDBMS.

Course Learning Outcomes:

At the end of the course the students will be able to:	Domain	Bloom's Taxonomy Level

Course Content:

Week-1

- What is Distributed Database System?
- Distributed Data Processing
- Advantages of data DDBS

Week-2

- Relational Database Concepts
- Normalization
- Integrity Rules

Week-3

- Data communication Concepts
- Types of Networks
- Protocols Standards

Week-4

- Client/Server Systems
- Peer-to-peer Distributed Systems
- MDBS Architecture

Week-5

-Characterization of Query Processors

Week-6

- Layers of Query processing

Week-7, 8

- Fragmentation
- Reasons for Fragmentation
- Types of Fragmentation

Week-9, 10

- Parallel DBMSs
- Database Servers
- Centralized Database Systems

Week-11, 12

- Properties of Transactions
- Concurrency control Techniques
    - Locking Methods
    - Dead Lock
    - Timestamp Method

Week-13

- Recovery
- Causes of Failure
- Local Recovery Protocols
    - Undo/Redo
    - Undo/No-Redo
- Distributed Recovery Protocols

-Distributed Two Phase Commit

Week-14

- Integrity Constraints
- Securities Issues in Distributed Databases
    - Identification & Authorization
    - Distribution of Authorization
    - Encryption

- Global view Mechanism

Week-15

- Data ware Housing introduction
- World Wide Web introduction

Week-16

- **Revision**

Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:
Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam

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

1. Principles of Distributed Systems By M. Tamer Ozsu

S. No. 44	**Course Name: Advance Database management System**		
Course Code: CS-481	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:** Database system

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

Course Learning Outcomes:

At the end of the course the students will be able to:	Domain	Bloom's Taxonomy Level
Understanding advance data models, technologies and approaches for building distributed database systems.	Understand	C2
Applying the models and approaches in order to become enabled to select and apply appropriate methods for a particular case	Apply	C3
To develop a database solution for a given scenario/ challenging problem in the domain of distributed database systems.	Apply	C3

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

Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:
Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam

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

S. No. 52	**Course Name: Digital Marketing**		
Course Code: CS-482	**Credit Hours: 3(2-3))**	**Contact Hours:2-3**	**Prerequisites:**
Course Introduction: .			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Course Content: **Week**-1: Digital Marketing Foundation, Competitor and Website Analysis, Market Research & Niche Potential **Week**-2: Website Design using WordPress CMS, Email Marketing **Week**-3: Content Creation and Promotion, Search Engine Optimization **Week**-4: Social Media Marketing, Optimization & Advertising **Week**-5: PPC Google Ads Campaign Management, Optimization, and Reporting, Bing Advertising, Mobile Marketing (SMS Marketing) **Week**-6: GEO Marketing, YouTube Video Marketing & Advertising, Website Data Analytics **Week**-7: Affiliate Marketing, Blogging, Freelancing **Week**-8: Google AdSense, Digital Marketing Plan & Budget Forecast **Week**-9: Digital Marketing for MULTIPLE Business TYPES, Product Marketing (Google Ads, Instagram, Facebook) **Week**-10: Neuro Marketing Fundamentals, Paid Ads Optimization Strategies, Online Reputation Management **Week**-11: Digital Marketing Automation, FREEMIUM AND PREMIUM Digital Marketing Tools **Week**-12: Case Studies, Internationally Recognized Certification Guidance (Google, Microsoft Bing, and HubSpot) **Week**-13: Career Counselling and Interview Preparation Guidance **Week**-14: Digital Marketing Project Management, MindSet Program, Digital Marketing Growth Hacks.			

Week-15-16: Working on Real-Time Projects (Internship Opportunities for eligible Students)
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam
Reference Materials: (or use any other standard and latest books) 1. Recent Research Resources

S. No. 53	**Course Name: Web Engineering**		
Course Code: CS-483	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:** Web technology
Course Introduction:			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level
Course Content: **Week-1**: History and Advantages and Disadvantages of Internet, Web Server, Web Browser, Web Clients, and Search Engines **Week-2-3:** Client-Server Architecture, Types and Categories of Websites, Creation and Basic Structure of HTML Document, HTML Tags (Headings, Paragraphs, Line Break, Horizontal Line, Font, Preformatted Text, Lists, Images, Tables, Hyperlink, Fame, and Form) **Week-4-7**: CSS, Inserting JavaScript Code in HTML Document, JavaScript Constructs (Variables and Rules of Naming Variables, Operators, Type Casting, Decision Control Structures, Loops, Function, Array, and DOM) **Week-8:** Mid-Term Examination **Week-9-11**: Installing and Configuring Apache and PHP, Creating PHP File, Overview of Variables and Constants, Output Statement in PHP **Week-12-14**: Passing Variables Between Pages (URL, Sessions, Cookies, and Forms) **Week-15-16**: Accessing and Using Database in PHP, and Database, AJAX, Introduction to Service Oriented Architecture and Web Services, Designing and Implementing Web Services with SOAP and JSON.			
Teaching Methodology: Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment: Home Assignments, Quizzes, Project, Presentations, Midterm Exam, Final Exam			
Reference Materials: (or use any other standard and latest books) 1. Duckett, J. (2014). Web Design with HTML, CSS, JavaScript and jQuery Set (Latest ed.). Wiley Publishing. 2. Nixon, R. (2015). PHP: 20 Lessons to Successful Web Development (Latest ed.). McGrawHill Education Group. 3. Nixon, R. (2012). Learning PHP, MySQL, JavaScript, and CSS: A step-by-step guide to creating dynamic websites (Latest ed.). O'Reilly Media, Inc.			

S. No. 55	Course Name: Introduction to Data Science		
Course Code: CS-485	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:**

Course Introduction:

Data Science is the study of the generalizable extraction of knowledge from data. Being a data scientist requires an integrated skill set spanning mathematics, statistics, machine learning, databases and other branches of computer science along with a good understanding of the craft of problem formulation to engineer effective solutions. The aim of this course is to: Introduce students to this rapidly growing field and equip them with some of its basic principles and tools as well as its general mindset. Explain the significance of exploratory data analysis in data science. Identify common approaches used for Feature Generation as well as Feature Selection, and finally discuss the Ethical and Privacy issues. Programming language Python has been proposed for the practical work of this course.

Course Learning Outcomes:

At the end of the course the students will be able to:	Domain	Bloom's Taxonomy Level
Describe what Data Science is and the skill sets needed to be a data scientist.	Understand	C2
Apply EDA and the Data Science process in a case study.	Apply	C3
Comprehend the fundamental constructs of Python programming language.	Understand	C2
Apply basic machine learning algorithms to solve real world problems of moderate complexity.	Apply	C3

Course Content:

Introduction: What is Data Science? Big Data and Data Science hype, Datafication, Current landscape of perspectives, Skill sets needed; Statistical Inference: Populations and samples, Statistical modeling, probability distributions, fitting a model, Intro to Python; Exploratory Data Analysis and the Data Science Process; Basic Machine Learning Algorithms: Linear Regression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes; Feature Generation and Feature Selection; Dimensionality Reduction: Singular Value Decomposition, Principal Component Analysis; Mining Social-Network Graphs: Social networks as graphs, Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs, Neighborhood properties in graphs; Data Visualization: Basic principles, ideas and tools for data visualization; Data Science and Ethical Issues: Discussions on privacy, security, ethics, Next-generation data scientists.

Teaching Methodology:

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

Course Assessment:

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

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

1. Foundations of data science, Blum, A., Hopcroft, J., & Kannan, R., Vorabversion eines Lehrbuchs, 2016.

2. An Introduction to Data Science, Jeffrey S. Saltz, Jeffrey M. Stanton, SAGE Publications, 2017.

3. Python for everybody: Exploring data using Python 3, Severance, C.R., CreateSpace Independent Pub Platform. 2016.

4. Doing Data Science, Straight Talk from the Frontline, Cathy O'Neil and Rachel Schutt, O'Reilly. 2014.

5. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, John Wiley & Sons, 2015.

ANNEXURE – B

Proposed Courses of study for ADC 2- years program

Name of Degree: Associate Degree in Computing (ADC)

Eligibility Criteria:

- Minimum 50% marks in Intermediate/12 years schooling/A- Level (HSSC) or Equivalent with Mathematics are required for admission in Associate Degree Computing.
  **Equivalency certificate by IBCC will be required in case of education from some other country or system.*
- The students who have not studied Mathematics at intermediate level have to pass deficiencycourses of Mathematics (06 credits) in first two semesters.

Duration: The minimum duration for the completion of ADC degree is two years and maximum is three years.

Degree Completion Requirements:

To become eligible for the award of ADC degree, a student must satisfy the following requirements:

a) Must have studied and passed the prescribed courses, totaling at least 79 credit hours.
b) A minimum 2.0 CGPA (Cumulative Grade Point Average) on a scale of 4.0 is required for award of AD Computing degree.

Degree Equivalency:

The Associate Degree is equivalent to 14 years of schooling – level 05 qualification as per National Qualifications Framework of Pakistan.

Associate Degree Semester Wise Breakup

Course Code	Prereq	Course Title	Domain	Cr Hours
1st Semester (18 Credit Hours)				
CS 111	-	Programming Fundamentals	Maj1 CC	4 (3+1)
CS 112	-	ICT	GE 1	3 (2-1)
CS 113	-	Applied Physics	GE 2	3 (2-1)
CS 114		Discrete Structure / QR-I	GE 3	3 (3-0)
CS 115	-	Functional English	GE 4	3 (3-0)
Any One from the following				
CS 116	-	Islamic Studies	GE 5	2 (2-0)
CS 117	-	Ethics	GE 5	2 (2-0)
Total Credit Hours				18
2nd Semester (17 Credit Hours)				
CS 121	PF	Object Oriented Programming	Maj 2 CC	4 (3-1)
CS 122	-	Ideology and Constitution of Pakistan	GE 6	2 (2-0)
CS 123	FE	Introduction to Expository Writing	GE 7	3 (3-0)
CS 124	-	Calculus & Analytical Geometry / QR-II	GE 8	3 (3-0)
CS 125	A Ph	Digital Logic Design	Maj 3 CC	3 (2-1)
Any One from the following				
CS 126	-	Introduction to Management	GE 9	2 (2-0)
CS 127	-	Introduction to Sociology	GE 9	2 (2-0)
Total Credit Hours				17
3rd Semester (18 Credit Hours)				
CS 231	OOP	Data Structure & Algorithms	Maj 4 CC	4 (3-1)
CS 232	DLD	Computer Organization & Assembly Language	Maj 5 CC	3 (2-1)
CS 233		Database Systems	Maj 6 CC	4 (3-1)
CS 234		Civics and Community Engagement	GE 10	2 (2-0)
CS 235	CAG	Linear Algebra	MSC 1	3 (3-0)
CS 236		Entrepreneurship	GE 11	2 (2-0)
Total Credit Hours				18
4th Semester (20 Credit Hours)				
CS 241		Artificial Intelligence	Maj 7 CC	3 (2-1)
CS 242		Computer Networks	Maj 8 CC	3 (2-3)
CS 243		Software Engineering	Maj 9 CC	3 (3-0)
CS 244		Information Security	Maj 10 CC	3 (2-1)
CS 245		Arts & Humanities (Professional Practices)	GE 12	2 (2-0)
CS 246		Probability & Statistics	MSC 2	3 (3-0)
CS 247		Internship		3 (0-3)
Total Credit Hours				20