University of Chitral
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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 BSCS
  **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 deficiency courses of Mathematics (06 credits) in the first two semesters.

Pathway for the Associate Degree Holders in Computing:

- The candidates with AD Computing Degrees are eligible for admission in 5th Semester of BS Computing Programs. Such students shall complete the deficiency courses of General Education (if any) during 5th to 8th Semester.
- The candidates who acquired ADP Computing Degrees prior to the admission criteria (as stated above) are also eligible for admission in 5th Semester of BSCS Programs. Such students shall also complete the deficiency courses of General Education (if any) during 5th to 8th Semester.
- The minimum eligibility for admission in the fifth semester in this case is 2.0 CGPA out of 4 in the prior qualification.
- 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 ADC program.
- Age limit of the admission rules of the university will apply to BSCS plus two additional years for ADC degree.

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

- Students having completed conventional two-year BSc Computer Science degree program are allowed to be admitted in the fifth semester of the BSCS program, in which case 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.
- 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 ADC program.
- Age limit of the admission rules of the university will apply to BSCS plus two additional years for ADC degree.

Duration:

The minimum duration for the completion of BSCS degree is four years and maximum is seven years.

Degree Completion Requirements:

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

a) Must have studied and passed the prescribed courses, totaling at least 138 credit hours (Annexure A).

b) Must have earned 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 BS Computing Programs may exit with Associate Degree in Computing subject to completion of all requirements for the award of associate degree, i.e., Credit Hours, CGPA, and compulsory courses (Annexure B).

BSCS Curriculum Design

The structure of BSCS Program is proposed to meet the needs of students through theory and practical computing experience. The students are expected to learn theoretical and practical understanding of the respective field of Computing.

The following are some relevant details:

- Minimum credit hours shall be 138 for BSCS programs.
- BSCS 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	38
Domain Core	6	18
Domain Elective	9	27
Mathematics & Supporting Courses	3	9
Elective Supporting Courses	2	6
General Education Requirement	12	30
Capstone Project	1	6
Fieldwork/Internship	1	3
Totals	**46**	**137**

Table 2: Course Breakup According to Undergraduate Research Policy

Courses Category	**Number of Courses**	**Credit Hours**
General education courses (GE)	12	30
Major (Maj)	27	83
Interdisciplinary/Allied courses (AC)	5	15
Field experience/internship	1	3
Capstone project	1	6
Totals	**46**	**137**

Semester Wise Breakup

1st Semester (21 Credit Hours)				
Course Code	**Prereq**	**Course Title**	**Domain**	**Credit Hours**
CS 111	-	Programming Fundamentals	Maj1	4 (3+1)
CS 112	-	Application of Information & Communication Technologies	GE 1	3 (2-1)
CS 113	-	Applied Physics	GE 2	3 (2-1)
CS 114	-	Functional English	GE 3	3 (3-0)
CS 115	-	Calculus and Analytic Geometry	AC 1	3 (3-0)
Any One from the following				
CS 126	-	Islamic Studies	GE 4	2 (2-0)
CS 127	-	Ethics	GE 4	2 (2-0)
Total Credit Hours				18(15+3)

2nd Semester (20 Credit Hours)				
Course Code	**Prereq**	**Course Title**	**Domain**	**Credit Hours**
CS 121	PF	Object Oriented Programming	Maj 2	4 (3-1)
CS 122	-	Introduction to Management	GE 6	2 (2-0)
CS 123	-	Ideology and Constitution of Pakistan	GE 7	2 (2-0)
CS 124	FE	Introduction to Expository Writing	GE 8	3 (3-0)
CS 125	EQS	Tools for Quantitative Reasoning	GE 9	3 (3-0)
CS 126		Exploring Quantitative Skills	GE 3	3 (3-0)
CS 127	CAG	Linear Algebra	AC 3	3 (3-0)
Total Credit Hours				20 (19+1)

3rd Semester (20 Credit Hours)				
Course Code	**Prereq**	**Course Title**	**Domain**	**Credit Hours**
CS 231	OOP	Data Structures	Maj 3	4 (3-1)
CS 232		Database Systems	Maj 4	4 (3-1)
CS 233	A Ph	Digital Logic Design	Maj 5	3 (2-1)
CS 234		Computer Networks	Maj 6	3 (2-3)
CS 235		Civics and Community Engagement	GE 10	2 (2-0)
CS 236		Entrepreneurship	GE 11	2 (2-0)
Total Credit Hours				18 (15+3)

4th Semester (20 Credit Hours)				
Course Code	**Prereq**	**Course Title**	**Domain**	**Credit Hours**
CS 241	DLD	Computer Organization & Assembly Language	Maj 7	3 (2-1)
CS 242		Artificial Intelligence	Maj 8	3 (2-1)
CS 243		Software Engineering	Maj 9	3 (3-0)
CS 244		Information Security	Maj 10	3 (2-1)
CS 245		Arts & Humanities (Professional Practices)	GE 12	2 (2-0)
CS 246		Probability & Statistics	AC 4	3 (3-0)
CS 249		Internship		3 (0-3)
Total Credit Hours				20 (14+6)

5th Semester (20 Credit Hours)				
Course Code	**Prereq**	**Course Title**	**Domain**	**Credit Hours**
CS 351		Operating Systems	Maj 11	3 (2-1)
CS 352		HCI & Computer Graphics	Maj 12	3 (2-1)
CS 353		Theory of Automata	Maj 13	3 (3-0)
CS 454	CAG	Multivariable Calculus	AC 5	3 (3-0)
Any two courses from the following				
CS 355		Web Technologies	Maj 14	3 (2-1)
CS 356	OOP	Advanced Programming	Maj 15	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 (14+4)

6th Semester (20 Credit Hours)				
Course Code	**Prereq**	**Course Title**	**Domain**	**Credit Hours**
CS 361	ToA	Compiler Construction	Maj 16	3 (2-1)
CS 362	OS	Parallel & Distributed Computing	Maj 17	3 (2-1)
CS 463	COAL	Computer Architecture	Maj 18	3 (2-1)
CS 464	DS	Analysis of Algorithms	Maj 19	3 (3-0)
CS 465	SE	Software Project Management	Maj 20	3 (2-1)
Any one courses from the following				
CS 366		Web Engineering	Maj 21	3 (2-1)
CS 367		Cyber Security	Maj	3 (2-1)
CS 368		Distributed Database Systems	Maj	3 (2-1)
Total Credit Hours				18 (12+6)

7th Semester (20 Credit Hours)				
Course Code	**Prereq**	**Course Title**	**Domain**	**Credit Hours**
CS 471	DS	Advance Database Management Systems	Maj 22	3 (2-1)
CS 472	FE	Technical & Business Writing	AC 6	3 (3-0)
Any two courses from the following				
CS 473		Introduction to Data Science	Maj 23	3 (2-1)
CS 366		Mobile Application Development	Maj 24	3 (2-1)
CS 474		Machine Learning	Maj	3(2-1)
CS 475		Cryptography	Maj	3 (2-1)
CS 479		Final Year Project – I*	Capstone Project	2 (0-2)
Total Credit Hours				17 (13+4)

8th Semester (20 Credit Hours)				
Course Code	**Prereq**	**Course Title**	**Domain**	**Credit Hours**
CS 481		Digital Marketing	Maj 25	3 (2-1)
CS 482		E-Commerce: Case study of Amazon	Maj 26	3 (2-1)
CS 483		Freelance Services: Case study of Fiverr	Maj 27	3 (2-1)
CS 489		Final Year Project – II*	Capstone Project	4 (0-4)
Total Credit Hours				13 (6+7)

*** Description of Final Year Project (FYP) Distribution over two semesters**

According to the revised curriculum of Computer Science 2023, HEC has distributed FYP over the last two semesters i.e. 02 cr. hrs. in 7th semester and 04 cr. hrs. in 8th semester. According to this policy the board of studies decides that students must defend their FYP proposal in 7th semester and the departmental panel will evaluate their marks internally and submit to the examination. The remaining 04 cr. hrs. will be evaluated as per routine by the external examiner. Students who fail to defend their proposal in 7th semester will defend it in upcoming semester and their final FYP viva/semester will be delayed accordingly.

Course Contents

<table>
<tr><td>S. No. 1</td><td colspan="3">Course Name: Programming Fundamentals</td></tr>
<tr><td>Course Code: CS-111</td><td>Credit Hours: 4 (3+3)</td><td>Contact Hours:3-3</td><td>Prerequisites: None</td></tr>
<tr><td colspan="4">Course Introduction: This course provides fundamental concepts of programming to freshmen. The courses is pre- requisite to many other courses, therefore, students are strongly advised to cover all contents and try to achieve CLOs to the maximum possible level. The course may be taught as language independent. Further, it is up to the university to choose any language for the practical/Lab purpose but that must be latest and market oriented.</td></tr>
<tr><td colspan="4">Course Learning Outcomes:</td></tr>
<tr><td colspan="2">At the end of the course the students will be able to:</td><td>Domain</td><td>Bloom’s Taxonomy Level</td></tr>
<tr><td colspan="2">Understand basic problem solving steps and logicconstructs</td><td>Understand</td><td>C2</td></tr>
<tr><td colspan="2">Apply basic programing concepts</td><td>Apply</td><td>C3</td></tr>
<tr><td colspan="2">Design and implement algorithms to solve real worldproblems</td><td>Apply</td><td>C3</td></tr>
<tr><td colspan="4">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</td></tr>
</table>

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: Exploring Quantitative Skills**		
Course Code: CS-114	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction: This course aims to develop the basic mathematical skills which ultimately enhance problem solving skills using inductive and deductive reasoning and sets. The basic concepts will be developed with applications from the real world such as algebraic models with equations, rates, ratios, and percentages will be discussed. Students will also explore linear models, including rectangular-coordinates, functions, empowering them to analyze real-world problems with logical precision. By the end of course, students will have practiced problem-solving, logical reasoning, and mathematical modeling abilities to tackle diverse challenges confidently as follows:			

- Students will be introduced to the above concepts, and they will be prepared to apply these concepts to analyze and interpret information in different walks of life.
- Students will get familiarized with the importance of quantitative reasoning skills in the modern age.
- This course will improve their ability to deal with scenarios involving numbers related issues in a logical manner.
- It will provide students an opportunity to appreciate the intellectual beauty of quantitative reasoning skills.
- It will prepare students to apply the quantitative reasoning skills in solving quantitative problems which they will experience in their practical lives.

Course Learning Outcomes:

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

Course Content:

Exploring Importance of Quantitative Reasoning Skills

What is quantitative reasoning, Overview of contributions of mathematicians especially Muslim scholars.

Problem Solving Techniques

Understanding relationship between parts and whole, Practical life scenarios involving units and rate, Unit analysis as a problem-solving tool, Inductive and deductive reasoning, Problem solving strategies.

Numbers & the Universe

Understanding our World through numbers, Dealing with very big and small numbers & their applications, Understanding uncertainty and its applications, Introduction to number systems and different types of standard numbers and their role in practical life scenarios, square roots, cube roots, highest common factors, lowest common multiples, visualizing fractions, decimals, systems of measurements, an overview of contributions of mathematicians, unit analysis as a problem-solving tool.

Financial Issues

Money management (profit, loss, discount, taxation, and other scenarios involving percentage), money management in practical life scenarios like investments and federal budget, simple and compound interest, Saving plans and economy, percentage, profit, loss, discount, taxation, and other scenarios involving percentage, simple and compound interest with applications.

Exploring Expressions

Practical scenarios involving expressions, equating two expressions in one variable & using it to solve practical problems, linear equations, quadratic equations and their applications in social and economic problems.

Exploring Beauty in Architecture & Landscape

Introduce geometrical objects through architecture and landscape, dealing with social and economic issues involving geometrical objects, fundamentals of geometry, applications of

Pythagorean theorem, introduction to unit circles, trigonometric functions and inverse trigonometric functions, problem solving with geometry.

Venn Diagrams

Venn diagrams and their applications

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)
Quantitative Reasoning Courses\Quantitative Reasoning Teacher Manual - Sept 2021 - HEC.pdf

1. R. N. Aufmann, 1. S. Lockwood, R. D. Natio and D. K. Clegg, Mathematical Thinking and Quantitative Reasoning (2008), Houghton Mifflin Company (New York).
2. Bennett,1. & Briggs, W. (2015). Using and understanding mathematics (6th Edition). Pearson Education, Limited.
3. Blitzer, R. (2014). Precalculus. (5th Edition). Pearson Education, Limited.
4. Using and understanding mathematics, 6th edition by Jeffrey Bennet and William Briggs, published by Pearson USA.
5. Mathematical thinking and reasoning 2008 by Aufmann, Lockwood, Nation & Clegg published by Houghton Mifflin Company USA.
6. Precalculus by Robert Blitzer 5th edition published by Pearson USA.
7. Precalculus Graphical, Numerical, Algebraic 8th edition by Franklin D. Demana, Bert K. Waits, Gregory D. Foley & Daniel Kennedy published by Addison Wesley USA.
8. Precalculus Mathematics for Calculus, 6th edition by James Stewart, Lothar Redlin and Saleem Watson published by Brooks/Cole Cengage Learning USA.
9. GRE Math Review https://www.ets.org/s/gre/pdf/gre_math_review.pdf OpenAlgebra.com
10. A free math study guide with notes and YouTube video tutorials.

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: Calculus & Analytical Geometry**		
Course Code: CS-116	**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. 7	**Course Name: Islamic Studies**		
Course Code: CS-117	**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	**3. سیرت طیبہ ﷺ کا مطالعہ** • مکہ مکرمہ میں بعد از نبوت حضور ﷺکی زندگی اور اہم واقعات

• Life of Holy Prophet (PBUH) in Madinah and its Important Events	• مدینہ منورہ میں حضور ﷺ کی 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!الررجلان 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 ذٰالک 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 • Basic Concepts of Islamic Political System • Islamic Concept of Sovereignty • Basic Institutions of government in Islam	**7. اسلام کا سیاسی نظام** • 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. 8	**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. 9	**Course Name: Introduction to Management**		
Course Code: CS-122	**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. 10	**Course Name: Ideology and Constitution of Pakistan**		
Course Code: CS-123	**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. 11	**Course Name: Introduction to Expository Writing**		
Course Code: CS-124	**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. 12	**Course Name: Tools for Quantitative Reasoning**		
Course Code: CS-125	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:**
Course Introduction: The primary objective of this course is to explore probability and statistics. The curriculum includes in-depth study of exponential and logarithmic functions, as well as problem-solving related to these mathematical concepts. Solving system of linear equations and matrix algebra is the part of this course which ultimately develops the necessary background for data analysis. Overall, the course aims to equip students with a comprehensive understanding of mathematical concepts relevant to probability and statistics enabling them to apply these skills in real-world problems. The following are the main objectives: ▪ Students will be introduced to the above listed concepts, and they will be prepared to apply these concepts to practical life scenarios. ▪ This course will enhance their ability to deal with scenarios involving quantitative reasoning skills in a logical manner which they can face in their practical lives. ▪ It will prepare students to deal with different forms of data occurring in professional, social and natural sciences. ▪ Students will be introduced to scenarios involving functions and probability in different disciplines.			

- This course will prepare the students to apply the quantitative reasoning skills in other disciplines.
- This course will provide solid foundation for students to use the quantitative reasoning skills in solving practical life problems.

Course Learning Outcomes:

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

Course Content:

Exploring Graphical Information

Investigating relationships between variables, Exploring tools to find relationship between variables, Resources, and population growth: dealing with economic, environmental, and social issues.

Building blocks of a plane

Graphical and analytical approaches to solve a problem, Applications of graphical & analytical approaches to solve social & economic problems.

Exploring inequalities

Understanding inequalities around us, dealing with practical problems involving inequalities in different disciplines

Comparing quantities

Golden ratio in sculptures, Comparison of statements and their use in social and economic problems, Applications of ratio and proportion, Sequence, Arithmetic sequence, geometric sequence, counting principles and their applications.

Thinking Logically

Survival in the modern World, Propositions and truth values, Categorical proposition, and its applications

Understanding Data

Introduction to data, tabular and graphical presentation of data, descriptive analysis of data,
standard deviation, measure of the locations, Scatter plots, Pearson's correlation coefficient,
measure of dispersions, sampling distributions, levels of measurements, experimental design and basic rules of probability.

Teaching Methodology:

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

Course Assessment:

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

Reference Materials:

1. Using and understanding mathematics, 6th edition by Jeffrey Bennet and William Briggs, published by Pearson USA.
2. Mathematical thinking and reasoning 2008 by Aufmann, Lockwood, Nation & Clegg published by Houghton Mifflin Company USA.
3. Pre-calculus by Robert Blitzer 5th edition published by Pearson USA.
4. Pre-calculus Graphical, Numerical, Algebraic 8th edition by Franklin D. Demana, Bert K. Waits, Gregory D. Foley & Daniel Kennedy published by Addison Wesley USA.
5. Pre-calculus Mathematics for Calculus, 6th edition by James Stewart, Lothar Redlin and Saleem Watson published by Brooks/Cole Cengage Learning USA.

6. OpenAlgebra.com A free math study guide with notes and YouTube video tutorials.
7. R. N. Aufmann, J. S. Lockwood, R. D. Natio and D. K. Clegg, *Mathematical Thinking and Quantitative Reasoning* (2008), Houghton Mifflin Company (New York).
8. Blitzer, R. (2014). Precalculus. (5th Edition). Pearson Education, Limited.
9. R. Walpole, R. Myers, S. Myers and K. Ye, *Probability and Statistics/or Engineers &*
Scientists (9th Edition), Pearson.
10. Bennett, J. & Briggs, W. (2015). Using and understanding mathematics (6th Edition).
Pearson Education, Limited.
11. J. Yeo, T. K. Send, L. C. Yee I. Chow, N.C. Meng, J. Liew, O. C. Hong, New Syllabus Mathematics (7th edition 2019), Oxford University Press.

S. No. 14	**Course Name: Linear Algebra**		
Course Code: CS-127	**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. 15	**Course Name: Data Structures**		
Course Code: CS-231	**Credit Hours: 4(3-3)**	**Contact Hours:3-3**	**Prerequisites:** Programming Fundamentals

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

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. 16	**Course Name: Database Systems**		
Course Code: CS-232	**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), 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: Digital Logic Design**		
Course Code: CS-233	**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, Quinn Mc-Cluskey method), Flip Flops and Latches, Asynchronous and Synchronous circuits, Counters, Shift Registers, Counters, Triggered devices & its types. Mealy machines and Moore machines. Binary Arithmetic and Arithmetic Circuits, Memory Elements, State Machines. Introduction Programmable Logic Devices (CPLD, FPGA) Lab Assignments using tools such as Verilog HDL/VHDL, MultiSim.		
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. 18	**Course Name: Computer Networks**		
Course Code: CS-234	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:**
Course Introduction: This course introduces the basic concept of computer network to the students. Network layers, Network models (OSI, TCP/IP) and protocol standards are part of the course.			
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: Introduction and protocols architecture, basic concepts of networking, network topologies, layered architecture, physical layer functionality, data link layer functionality, multiple			

access techniques, circuit switching and packet switching, LAN technologies, wireless networks, MAC addressing, networking devices, network layer protocols, IPv4 and IPv6, IP addressing, sub netting, CIDR, routing protocols, transport layer protocols, ports and sockets, connection establishment, flow and congestion control, application layer protocols, latest trends in computer networks.
Teaching Methodology: Lectures, Written Assignments, Practical labs, 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 Networking: A Top-Down Approach Featuring the Internet, 6th edition by James F. Kurose and Keith W. Ross 2. Computer Networks, 5th Edition by Andrew S. Tanenbaum 3. Data and Computer Communications, 10th Edition by William Stallings 4. Data Communication and Computer Networks, 5th Edition by Behrouz A. Forouzan

S. No. 19	**Course Name: Civic and Community Engagement**		
Course Code: CS-235	**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. 20	**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: 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-6: Pathways to Entrepreneurial Ventures, The Pathways to New Ventures for Entrepreneurs, Creating New Ventures, Acquiring an Established Entrepreneurial Venture, Franchising: The Hybrid

Week-7: 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-8: 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-9: 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-10: 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-11: 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-12: 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"

Week-13: Strategic Entrepreneurial Growth, The Nature Of Strategic Planning In Emerging Firms, Strategic Planning, The Lack Of Strategic Planning, The Value Of Strategic Planning, Managing Entrepreneurial Growth, Venture Development Stages, The Entrepreneurial Company In The Twenty-First Century , Building The Adaptive Firm, The Transition From An Entrepreneurial Style To A Managerial Approach, Understanding The Growth Stage, Unique Managerial Concerns of Growing Ventures, The International Environment: Global Opportunities, Achieving Entrepreneurial Leadership In The New Millennium

Week-14: Valuation Of Entrepreneurial Ventures, The Importance Of Business Valuation, Underlying Issues When Acquiring A Venture, Due Diligence, Analyzing The Business, Establishing A Firm"S Value, Term Sheets In Venture Valuation, Additional Factors In The Valuation Process

Week-15: Harvesting The Entrepreneurial Venture, Harvesting The Venture: A Focus on the Future, The Management Succession Strategy, Key Factors In Succession

Week-16: Projects/ 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. Entrepreneurship – Theory Process Practice, Donald F. Koratko 8th Edition (South Western - Cengage Learning)

S. No. 21	**Course Name: Computer Organization & Assembly Lang**		
Course Code: CS-241	**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: a historical perspective, program encodings, data formats, accessing information, arithmetic and logical operations, control, procedures, array allocation and access, heterogeneous data structures, putting it together: understanding pointers, life in the real world: using the gdb debugger, out of-bounds memory references and buffer overflow, x86-64: extending ia32 to 64 bits, machine-level representations of floating-point programs; Processor architecture: the Y86 instruction set architecture, logic design and the Hardware Control Language (HCL), sequential Y86 implementations, general principles of pipelining, pipelined Y86 implementations			
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. 22	**Course Name: Artificial Intelligence**		
Course Code: CS-242	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites: OOPs**
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: An Introduction to Artificial Intelligence and its applications towards Knowledge Based Systems; Introduction to Reasoning and Knowledge Representation, Problem Solving by Searching (Informed searching, Uninformed searching, Heuristics, Local searching, Minmax algorithm, Alpha beta pruning, Game-playing); Case Studies: General Problem Solver, Eliza, Student, Macsyma; Learning from examples; ANN and Natural Language Processing; Recent trends in AI and applications of AI algorithms. Python programming language will be used to explore and illustrate various issues and techniques in Artificial Intelligence.			
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. 23	**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. 24	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. 25	**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. 26	**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. 28	**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		Evaluate	C5

major performance issues with regard to the core functions		
Demonstrate the knowledge in applying system software and tools available in modern operating systems.	Demonstrate	C3

Course Content:

Week-1: Operating systems basics, Computer system organization, Multicore, Multiprocessor and SMP organization
Week-2: Interrupts, Program driven I/O, DMA, Memory hierarchy
Week-3: Process concept and scheduling, inter-process communication
Week-4: Multithreaded programming, multithreading models, threading issues
Week-5: Process scheduling criteria, Process scheduling algorithms
Week-6: Thread scheduling, Multiple-processor scheduling,
Week-7: Synchronization, Critical section problem, Semaphores, Race condition, starvation
Week-8: Deadlocks, Deadlock conditions, deadlock detection & avoidance
Week-9: Resource allocation graph, Bankers Algorithm
Week-10: Memory management, swapping, contiguous memory allocation
Week-11: Segmentation & paging, page replacement algorithms
Week-12: Virtual memory management, demand paging, thrashing
Week-13: Disk structure and scheduling algorithms, RAID
Week-14: System protection: Goals of protection, principles of protection, Access control
Week-15: Virtual machines
Week-16: Operating system security: Program threats, Cryptography, User Authentication

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. 29	**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. 30	**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. 31	**Course Name: Web technologies**		
Course Code: CS-354	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:** Web Engineering
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: **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. 32	**Course Name: Advance Programming- Old Visual Programming**		
Course Code: CS-355	**Credit Hours: 3(2-3)**	**Contact Hours:**	**Prerequisites: OOPs**
Course Introduction: The aim of this course is to teach an object oriented programming overviews and specially getting expertise in vb.net application programming. In this course students learn basics of vb.net GUI programming, which includes several built in classes like buttons, text fields etc. After completion of this course the students becomes able to understand the object-oriented aspect of this language			
Course Learning Outcomes:			
At the end of the course the students will be able to:		Domain	Bloom's Taxonomy Level

Course Content:

Week: 1

Installation of Visual Studio.Net
Introduction to Vb.Net IDE

Week: 2

Data Types
- Byte, Short, Integer, Long, Double
- Char, Date

Declaring Variables & Constants
Structures
Operators
- Arithmetic (+, -, *, /, %, ^)
- Concatenation (&)

Week: 3

Conditions
- If … then…. else statement
- Select… end select statement

Loops

Advantages of procedures
Types of Procedures
Scope of procedures

Public, Private, Friend

Week: 4

Introduction to classes
- Simple class
- Declaring objects
- Instance and static class
- Adding methods to class

Week 5

Common properties
- Design Vs Run time

Vb.net forms
Working with different controls in vb.net
Textbox Control
- Common Properties
  - Read only, Password char, Max length, Multi line, Border style, Scrollbar, Text align

Button Control
- Common Properties
- Text, Flat style, Image, Image align, Text align

Checkbox and Radio Controls
Listbox Control
Combobox Control

Week 6

Creating Multi Document Interfaces
MDI Parents
MDI Childs
Adding Menus in MDI Forms

Week 7

- Installation of SQL Server
- Use of Enterprise Manger
- Use of Query Analyzer

Week 8

- Database Creation
- Tables Creation

Working with DML Statements
- Insert, select, Delete, Update

Week 9

- SQL Server joins statements
  - Cross-Join
  - Inner Join
  - Full Outer Join

Week 10

- Stored Procedures & Their Use
- Creation of Store Procedures in
  - Enterprise Manager
  - Query Analyzer

Week 11

- Ado.net Object
- OLEDB Connection
- OLDDB Data Adapter
- OLEDB Command
- Dataset

Week 12

- Working with Data grid
- Bind it with database (Ms-Sql Server) Tables
- Bind the following Controls
- Buttons, Text boxes, List boxes

Week 13-14

- Develop a Database Application Using Coding Method
- Creating Connections
- Data Binding
- Perform Data Manipulation Using Ado.net Coding Methods
- Add New Records, Delete Records
- Update Records, Search a Particular Record

Week 15

- History of Crystal Reports
- Working with Crystal Reports
- Different Section Of Crystal Reports
- Use of Record Selection Formula
- Crystal Report Viewer

Week 16

- Project

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. Vb.net Bible by Bill Evjen, Jason Bores
2. Mastering Vb.net by Sybex
3. Beginning Visual Basic.net by Wrox

S. No. 33	**Course Name: Numerical Analysis (Numerical Computing)**		
Course Code: CS-356	**Credit Hours: 3(2-3)**	**Contact Hours: 2-3**	**Prerequisites:**
Course Introduction:			

The process of obtaining solution by analytical means is to reduce original problem to a repetition of the same steps or series of steps so that the computation becomes automatic. Such a process is called a numerical method and the derivation and analysis of such method lie within the description of numerical analysis. A major objective of the course is to introduce the students to numerical analysis so that the students are able to solve complex numerical problems. The minimum prerequisite for effectively following this course is elementary calculus, Fortran 77 and differential equation.

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 to Numerical Analysis

- The concepts of efficiency
- Reliability and accuracy of a method
- Minimizing computational errors

Week-2

Theory of Differences

- Difference Table,
- Detection and Correction of Errors in a Difference Table

Week-3

- Forward Difference Operator, Backward Difference Operator, Central
- Difference Operator

Week-4

- Shift Operator, Mean Operator Relationship b/w Operators.

Week-5

- Interpolation, Meaning of Interpolation
- Linear, Quadratic Interpolation.

Week-6

- Type of Interpolation Formulas for Equally Spaced Data Points.
- Type of Interpolation Formulas for Unequally Spaced Data Points.

Week-7

- Newton's Forward Difference Interpolation Formulas
- Newton's Backward Difference Interpolation Formulas

Week-8

- Interpolation with Central Difference Formulas.
- Stirling's Interpolation Formulas.
- Bessel's Interpolation Formulas.

Week-9

- Language's Interpolation Formula.
- Everett's Interpolation Formula.
- Gaussian Interpolation Formula.

Week-10

Numerical Differentiation

- Derivation of Differentiation Formulas R/S b/w Operator E and D

- Derivatives Using Newton's Forward Difference Formula.

Week-11

- Derivatives Using Newton's Backward Difference Formula.
- Derivatives Using Central Difference Formulas.

Week-12

NUMERICAL INTEGRATION

- Derivation of Interpolation Formula.
- The Newton Cotes Formulas
- Trapezoidal Rule.

Week-13

- Simpson's 1/3rd Rule.
- Simpson's 3/8th Rule.

Week-14

- Iteration Method
- False- Position Method
- Bisection Method.

Week-15

- Estimation of Errors in Some Weton Cotes Formulas.
- Error in Trapezoidal Rule.
- Error I Simpson's 1/3rd Rule

Week-16

- Linear System of Equation
- Cramer's Rule.
- Gaussian Elimination Method

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 1st Course in Numerical Analysis with C++ 4th Edition by Dr. Saeed Akhtar Bahtti Mr. Naeem Akhtar Bhatti

S. No. 34	**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. 35	**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. 36	**Course Name: Cryptography**		
Course Code: CS-475	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:** Information Security
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: Classsical Cipher Week-2: Prime numbers, Factoring Week-3: Modular arithmetic Week-4: Block cipher principles, Feistel networks, S boxes and P boxes, Block cipher modes of operation, Week-5: DES, 3DES Week-6: AES Week-7: Properties of cryptographic hash functions, MD family Week-8: SHA family Week-9: Digital signatures Week-10: Public key crypto systems, Discrete logarithm problem, DH key Exchange Protocol Week-11: Integer factorization Problem, RSA algorithm Week-12-13: Elliptic Curve cryptography Week-14: Interactive Proofs, Zero-Knowledge Proofs Week-15: Multiparty Secure Computation, Chosen Cipher Text Security Week-16: Homomorphic Encryption.			
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. William Stallings, Cryptography and network security, Pearson Education 2. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone , Handbook of Applied Cryptography, CRC Press 3. Margaret Cozzens, Steven J Miller, The mathematics of encryption, American Mathematical Society

S. No. 37	**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. 38	**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. 39	**Course Name: Mobile App Development**		
Course Code: CS-363	**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. 40	**Course Name: Web Engineering**		
Course Code: CS-364	**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. 41	**Course Name: Introduction to Cyber Security**		
Course Code: CS-365	**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: Distributed Database Systems**		
Course Code: CS-366	**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. 43	**Course Name: Network Security**		
Course Code: CS-367	**Credit Hours: 3(2-3)**	**Contact Hours: 2-3**	**Prerequisites:** Information Security

Course Introduction:
The module aims to develop core competencies in the fields of Network security and offer the opportunity of learning the current network security landscape, understanding current threats and vulnerabilities and examining ways of developing effective countermeasures. It also provides a brief overview to network forensics for analyzing network traffic for the purposes of information gathering, legal evidence, or intrusion detection.

Course Learning Outcomes:

At the end of the course the students will be able to:	Domain	Bloom's Taxonomy Level
To be able to understand network security threats and methods for security networks	Understand	C2
To be able to secure wired networks by deploying various methods.	Apply	C3
To be able to secure wireless networks by deploying various methods	Apply	C3

Course Content:
Course Outline: Introduction to network security, Networking Concepts and Protocols, Network Threats and Vulnerabilities, Network Security Planning and Policy, Access Control, Defense against Network Attacks, DOS and DDOS detection and prevention, Firewalls, Intrusion Detection and Prevention Systems, Antivirus Filtering, Naming and DNS Security, DNSSEC, IP security, Secure Sockets Layer, VPN, Packet Sniffing and spoofing, Honeypot, Ethernet Security, Wireless Security, Wireless Attacks, Wireless LAN Security with 802.11i, Wireless Security Protocols, Wireless Intrusion Detection, Physical access and Security, Tor Network, Network Forensics. Defense against Network Attacks.

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. Network Security Assessment: Know Your Network by Chris McNab, 3rd Edition or

latest.
2. Corporate Computer Security, by Randall J. Boyle, 3th Edition
3. Bulletproof Wireless Security by Praphul Chandra
4. Network Security Essentials: Applications and Standards by William Stallings, 3rd Edition or Latest
5. Cryptography and Network Security Principles and Practices by William Stallings, Latest Edition

S. No. 44	**Course Name: Introduction to Data Science**		
Course Code: CS-473	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:** Artificial Intelligence

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.

S. No. 45	**Course Name: Machine Learning**		
Course Code: CS-474	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**Prerequisites:** Artificial Intelligence
Course Introduction:			
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:			
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)			

S. No. 46	**Course Name: Analysis of Algorithms**		
Course Code: CS-464	**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-o, little-ω, Sorting Algorithm analysis, loop invariants, Recursion and recurrence relations; Algorithm Design Techniques, Brute Force Approach, Divide-and-conquer approach; Merge, Quick Sort, Greedy approach; Dynamic programming; Elements of Dynamic Programming, Search trees; Heaps; Hashing; Graph algorithms, shortest paths, sparse graphs, String matching; Introduction to complexity classes.			
Teaching Methodology: Lectures, Written Assignments, 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. 47	**Course Name: Software Project Management**

Course Code: CS-465	**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. 48	**Course Name: Advance Database management System**		
Course Code: CS-471	**Credit Hours: 3(2-3)**	**Contact Hours:2-3**	**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. 49	Course Name: Multivariable Calculus		
Course Code: CS- 454	**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. 50	Course Name: Technical and Business writing		
Course Code: CS-475	**Credit Hours: 3(3-0)**	**Contact Hours:**	**Prerequisites:** Comm and Presentation Skills
Course Introduction:			

Students in the senior level needs good technical writing skills not only for writing project report but also useful for them to communicate their resume and get place in the market. This is a high level course which provide useful knowledge to the students for writing proposals etc. Further, the course aims at augmenting students' proficiency in technical writing in order to sensitize them to the dynamics, challenges, and needs of the modern world characterized by technologically advanced social, cultural, and corporate settings. It will focus on students' ability to effectively convey and exchange information in cross-cultural, international, and multinational milieu necessitated by the emergence of global society.		
Course 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. 52	**Course Name: Digital Marketing**		
Course Code: CS-481	**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: Computer Architecture**		
Course Code: CS-463	**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

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.

Curriculum Design for AD in Computer Science

Students will be required to complete the following courses to obtain Associate Degree CS.

Generic Structure for Computing Disciplines

Areas	Credit Hours	Courses
Computing Core	34	11
Mathematics & Supporting Courses	6	2
General Education Requirement	30	12
Fieldwork/Internship	3	1
Totals	**79**	**27**

Semester Wise Breakup

1st Semester (21 Credit Hours)				
Course Code	**Prereq**	**Course Title**	**Domain**	**Credit Hours**
CS 111	-	Programming Fundamentals	Maj1	4 (3+1)
CS 112	-	Application of Information & Communication Technologies	GE 1	3 (2-1)
CS 113	-	Applied Physics	GE 2	3 (2-1)
CS 114	-	Exploring Quantitative Skills	GE 3	3 (3-0)
CS 115	-	Functional English	GE 4	3 (3-0)
CS 116	-	Calculus and Analytic Geometry	AC 1	3 (3-0)
Any One from the following				
CS 127	-	Islamic Studies	GE 5	2 (2-0)
CS 128	-	Ethics	GE 5	2 (2-0)
Total Credit Hours				21(18+3)

2nd Semester (20 Credit Hours)				
Course Code	**Prereq**	**Course Title**	**Domain**	**Credit Hours**
CS 121	PF	Object Oriented Programming	Maj 2	4 (3-1)
CS 122	-	Introduction to Management	GE 6	2 (2-0)
CS 123	-	Ideology and Constitution of Pakistan	GE 7	2 (2-0)
CS 124	FE	Expository Writing	GE 8	3 (3-0)
CS 125	EQS	Tools for Quantitative Reasoning	GE 9	3 (3-0)
CS 126	-	Discrete Structures	AC 2	3 (3-0)
CS 127	CAG	Linear Algebra	AC 3	3 (3-0)
Total Credit Hours				20 (19+1)

3rd Semester (20 Credit Hours)				
Course Code	**Prereq**	**Course Title**	**Domain**	**Credit Hours**
CS 231	OOP	Data Structures	Maj 3	4 (3-1)
CS 232		Database Systems	Maj 4	4 (3-1)
CS 233	A Ph	Digital Logic Design	Maj 5	3 (2-1)
CS 234		Computer Networks	Maj 6	3 (2-3)
CS 235		Civics and Community Engagement	GE 10	2 (2-0)
CS 236		Entrepreneurship	GE 11	2 (2-0)
Total Credit Hours				18 (15+3)

4th Semester (20 Credit Hours)				
Course Code	**Prereq**	**Course Title**	**Domain**	**Credit Hours**
CS 241	DLD	Computer Organization & Assembly Language	Maj 7	3 (2-1)
CS 242		Artificial Intelligence	Maj 8	3 (2-1)
CS 243		Software Engineering	Maj 9	3 (3-0)
CS 244		Information Security	Maj 10	3 (2-1)
CS 245		Arts & Humanities (Professional Practices)	GE 12	2 (2-0)
CS 246		Probability & Statistics	AC 4	3 (3-0)
CS 249		Internship	Maj 11	3 (0-3)
Total Credit Hours				20 (14+6)

Course Contents

Same as course content of BSCS from serial no 1 to 27.