

Curricula Scheme of Study and Syllabi

Program

Associate Degree Program in Information Technology (ADP IT)
Offered at Affiliated Colleges of University of the Punjab

Department

Department of Information Technology

Faculty

Faculty of Computing & Information Technology

Version: 1.2.4

Date: 08-08-2024

University of the Punjab, Lahore

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1. Introduction

IT has been a key player in digitizing our lives. From daily routine jobs to the most sophisticated financial applications, IT provides the necessary enabling environment. IT infrastructure in an organization is as important as its other physical and human resources. The Department of Information Technology (DIT) aims to provide state-of-the-art training to its students in the field of IT so that they are considered competitive both in national and international markets.

2. Vision

To be a globally recognized institution known for innovation in education and research.

3. Mission

To rigorously train students in the field of Information Technology (IT) and affiliated disciplines, so that they can serve humanity with skill, knowledge and high character, and be a source of pride to humanity.

4. Program Introduction

The Associate Degree Program in Information Technology (ADP IT) at the DIT has been designed in accordance with the guidelines provided by the National Computing Education Accreditation Council (NCEAC) constituted by the Higher Education Commission (HEC) of Pakistan. With the cutting-edge training imparted to the DIT students, the curriculum prepares DIT students not only for higher education and market jobs, but also for self-initiated ventures that may translate into successful startups.

5. Program Education Objectives (PEOs)

The program education objectives of the ADP IT are to:

PEO1: Technical Proficiency and Innovation

Prepare students to innovate, develop, deploy, analyze, and administer information technology artifacts to solve social and business problems. Graduates will demonstrate technical proficiency by applying theoretical concepts and practical skills to create innovative solutions, enhance problem-solving abilities through critical and computational thinking, and maintain a strong foundation for careers in academia, industry, and further studies.

PEO2: Collaborative, Ethical, and Professional Responsibility

Foster a sense of professional and ethical responsibilities in graduates, enabling them to understand the impact of technology on society at large. Graduates will work effectively in teams, demonstrating leadership and collaboration skills in multi-disciplinary settings,

addressing ethical, legal, societal, and cultural issues, and committing to professional ethics in their practice.

PEO3: Lifelong Learning and Communication Skills

Hone the skills that facilitate lifelong learning, integrating new tools and technologies, and improving students' problem-solving abilities. Graduates will engage in continuous professional development, adapt to emerging technologies, and effectively communicate complex ideas through oral and technical communication, preparing them for diverse roles in both private and public sectors.

5.1 Program Learning Outcomes (PLOs)

Computing programs prepare students to attain educational objectives by ensuring that students demonstrate achievement of the following outcomes (derived from Graduate Attributes define by Seoul Accord www.seoulaccord.org).

PLO1: Academic Education: To prepare graduates as computing professionals.

PLO2: Knowledge for Solving Computing Problems: Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.

PLO3: Problem Analysis: Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.

PLO4: Design/Development of Solutions: Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PLO5: Modern Tool Usage: Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

PLO6: Individual and Team Work: Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.

PLO7: Communication: Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.

PLO8: Computing Professionalism and Society: Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice.

PLO9: Ethics: Understand and commit to professional ethics, responsibilities, and norms of professional computing practice.

PLO10: Life-long Learning: Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

5.2 PLO to PEO Mapping

Following is the PEOs to PLOs mapping for BS Information Technology Program

No.	Program Learning Outcomes (PLOs)	PEO-1	PEO-2	PEO-3
1	Academic Education	√		
2	Knowledge for solving Computing Problems	√		
3	Problem Analysis	√		
4	Design/ Development of Solutions	√		
5	Modern Tool Usage	√		
6	Individual and Teamwork		√	√
7	Communication		√	
8	Computing Professionalism and Society		√	
9	Ethics		√	
10	Life-long Learning			√

5.3 Bloom's Taxonomy for Program Learning Outcomes (PLOs)

Bloom's Taxonomy classifies various outcomes and skills (PLOs) into six levels, as shown in the table below. These levels can be used to structure the learning outcomes, lessons, and assessments of a course. Each level of Bloom's Taxonomy corresponds to one or more PLOs.

Level	Description	Key Words
Remembering	Can the students <u>recall</u> or <u>remember</u> the information?	know, describe, identify, label, list, match, memorize, recall
Understand	Can the students <u>explain</u> ideas or concepts?	classify, describe, cite, discuss, generalize, illustrate, restate (in own words), summarize
Applying	Can the students <u>use</u> the information in a new way?	assess, choose, solve, demonstrate, dramatize, demonstrate, establish, extend, illustrate,
Analyzing	Can the students <u>distinguish</u> between different parts?	analyze, appraise, categorize, compare, identify, contrast, criticize, differentiate, recognize
Creating	Can the students <u>create</u> new product or point of view?	adapt, incorporate, individualize, integrate, intervene, invent, model,

		modify, communicate, construct, create, design, develop, formulate, generate, reconstruct, reinforce,
Evaluating	Can the students <u>justify</u> a stand or decision?	appraise, argue, choose, compare, conclude, contrast, criticize, interpret, judge, justify, predict, rate

6. Admission Eligibility Criteria

- Years of Study completed: 12 Years
- Study Program/Subject: Intermediate of Computer Science (ICS), FSc Pre-engineering, FSc Pre-medical, FSc Pre-medical with Additional Mathematics, Intermediate with Mathematics and Physics, Intermediate with Mathematics and Computer Science, Intermediate with Mathematics and Statistics, A-Levels (with relevant subjects), Diploma of Associate Engineer (DAE) in relevant discipline.
- Percentage/CGPA: 50% marks required with the exception of DAE where 60% marks are required for admission.
- Entry Test (if applicable) with minimum requirement: There is no compulsory entry test requirement. However, owing to the large number of applicants DIT conducts an entry test to select students as per number of available seats.
- Any other (if applicable)

7. Duration of the Program and Degree Awarding Criteria

The ADP in Information Technology spans 4 semesters over 2 years and requires the completion of 74 credit hours. To qualify for the degree, students must achieve a minimum CGPA of 2.0. Additionally, a final year project is mandatory. Other requirements, such as a comprehensive examination, may apply if specified.

8. Categorization of Courses

8.1 Nomenclature of Course Categories and Course Codes

N	Code	Description	Courses Count (Theory, Lab)	Cr. Hrs.	Cont. Hrs.
1	CC	Computing Core	19 (10, 9)	34 (25, 9)	(25, 27)
2,3,4	DI/EI	Domain (IT) Elective	10 (5, 5)	15 (10, 5)	(10, 15)
5	MS	Mathematics & Supporting Courses	1 (1, 0)	3 (3, 0)	(3, 0)
6,9	GE	General Education Courses	9 (8, 1)	21 (20, 1)	(20, 3)
8	HQ	Quran Translation	4 (0, 0)	2 (2, 0)	(2, 0)
Total			43 (28, 15)	75 (60, 15)	(60, 45)

Course Coding Scheme:

Code-NCS

Code = CC / EI / MS / GE / HQ

N = Numeric Code = {1,2,3,4}

C = Course Category Code = 0, 1, ..., 9

S = Serial Number (Resets with Year) = 0, 1, ..., 9

Lab Codes: Code-NCS-L

8.2 Comparison with HEC/NCEAC Recommendation

Note: Basics courses represent Math and Supporting and General Education courses as per HEC/NCEAC approved curriculum based on HEC Undergraduate Policy 2023.

CC = Computing Core, EI = Domain Elective (EI), GE = General Education, MS = Mathematics & Supporting, MD = Math Deficiency, HQ= Quran Translation

Semester	Courses Count (Theory, Lab)	Category (Credit Hours)						Semester Load
		CC	GE	EI	MS	MD	HQ	
1	10 (7, 3)	7	11	0	0	3*	0.5	18.5 (15.5,9)
2	9 (7, 2)	11	5	0	3	3*	0.5	19.5 (17.5,6)
3	12 (7, 5)	13	3	3	0	0	0.5	19.5 (14.5,15)
4	12 (7, 5)	3	2	11	0	0	0.5	17.5 (12.5,15)
PU	43 (28, 15)	34	21	14	3	6*	2	75 (60,45)
HEC Guidelines	43 (28,15)	34	21	14	3	6*	2	75 (60,45)
Difference (HEC &) PU	0	0	0	0	0	0	0	0

** These Math courses will be Non-Credit courses with only Pass/Fail grade assigned to the students.*

The courses with lab are counted as 2 separate courses.

8.3 Category-wise List of Courses

COMPUTING CORE: 34 (25,27)					
Sr.	Sem.	Code	Course Title	Prerequisite	Cr. Hrs.
1	1	CC-110	Digital Logic Design		2 (2,0)
2	1	CC-110-L	Digital Logic Design Lab		1 (0,3)
3	1	CC-112	Programming Fundamentals		3 (3,0)
4	1	CC-112-L	Programming Fundamentals Lab		1 (0,1)
5	3	CC-214	Computer Networks		2 (2,0)
6	3	CC-214-L	Computer Networks Lab		1 (0,3)
7	2	CC-211	Object Oriented Programming	Programming Fundamentals	3 (3,0)
8	2	CC-211-L	Object Oriented Programming Lab	Programming Fundamentals	1 (0,1)
9	2	CC-215	Database Systems		3 (3,0)
10	2	CC-215-L	Database Systems Lab		1 (0,3)
11	3	CC-212	Software Engineering		3 (3,0)
12	4	CC-213	Data Structures	Object Oriented Programming	3 (3,0)
13	4	CC-213-L	Data Structures Lab	Object Oriented Programming	1 (0,3)
14	4	CC-311	Operating Systems		2 (2,0)
15	4	CC-311-L	Operating Systems Lab		1 (0,3)
16	4	CC-312	Information Security		3 (2,3)
17	5	CC-310	Artificial Intelligence		2 (2,0)
18	5	CC-310-L	Artificial Intelligence Lab		1 (0,3)
MATHEMATICS & SUPPORTING: 3 (3, 0)					
Sr.	Sem.	Code	Course Title	Prerequisite	Cr. Hrs.
1	4	MS-251	Probability and Statistics		3 (3,0)
MATH DEFICIENCY: 6 (6,0)*					
Sr.	Sem.	Code	Course Title	Prerequisite	Cr. Hrs.
1	1	MD-001	Math Deficiency – I		3 (3,0)*
2	2	MD-002	Math Deficiency – II		3 (3,0)*

* Non-Credit courses with only Pass/Fail grade assigned to the students.

GENERAL EDUCATION: 21 (20,3)					
Sr.	Sem.	Code	Course Title	Prerequisite	Cr. Hrs.
1	1	GE-160	Applications of Information & Communication Technologies		2 (2,0)
2	1	GE-160-L	Applications of Information & Communication Technologies Lab		1 (0,3)
3	1	GE-163	Islamic Studies		2 (2,0)
4	1	GE-168	Ideology and Constitution of Pakistan		2 (2,0)
5	1	GE-190	Functional English		3 (3,0)
6	2	GE-191	Expository Writing		3 (3,0)
7	2	GE-167	Discrete Structures (Quantitative Reasoning-1)		3 (3,0)
8	3	GE-162	Calculus and Analytical Geometry (Quantitative Reasoning-2)		3 (3,0)
9	6	GE-362	Entrepreneurship		2 (2,0)

**IT TECHNICAL ELECTIVE: 15 (10, 15)
NON-EXHAUSTIVE LIST OF COURSES**

Sr.	Sem.	Code	Course Title	Prerequisite	Cr. Hrs.
1	3	DI-322	Web Technologies		2 (2,0)
2	3	DI-322-L	Web Technologies Lab		1 (0,3)
3	4	EI-333	Mobile Application Development	Object Oriented Programming	2 (2,0)
4	4	EI-333-L	Mobile Application Development Lab	Object Oriented Programming	1 (0,3)
5	4	EI-334	Data Science		2 (2,0)
6	4	EI-334-L	Data Science Lab		1 (0,3)
7	4	EI-339	Cloud Computing		2 (2,0)
8	4	EI-339-L	Cloud Computing Lab		1 (0,3)
9	4	EI-236	Global IT Services and Workspace		2 (2,0)
10	4	EI-236-L	Global IT Services and Workspace Lab		1 (0,3)

9. Scheme of Studies and Semester-wise Workload

Semester - I						
Sr.	Code	Course Title	Pre-Requisite	Domain	Cr. Hrs.	Cont. Hrs.
1	GE-160	Applications of Information & Communication Technologies		GE	2	(2,0)
2	GE-160-L	Applications of Information & Communication Technologies Lab		GE	1	(0,3)
3	CC-112	Programming Fundamentals		CC	3	(3,0)
4	CC-112-L	Programming Fundamentals Lab		CC	1	(0,3)
5	CC-110	Digital Logic Design		CC	2	(2,0)
6	CC-110-L	Digital Logic Design Lab		CC	1	(0,3)
7	GE-167	Discrete Structures		GE	3	(3,0)
8	GE-168	Ideology and Constitution of Pakistan		GE	2	(2,0)
9	GE-190	Functional English		GE	3	(3,0)
10	HQ-001	Quran Translation - I		HQ	0.5	(0.5,0)
11	MD-001	Math Deficiency - I		MD	3*	(3,0)*
Credit Hours (Semester - I)					18.5	(15.5,9)
Semester - II						
Sr.	Code	Course Title	Pre-Requisite	Domain	Cr. Hrs.	Cont. Hrs.
1	CC-211	Object Oriented Programming	Programming Fundamentals	CC	3	(3,0)
2	CC-211-L	Object Oriented Programming Lab	Programming Fundamentals	CC	1	(0,3)
3	CC-215	Database Systems		CC	3	(3,0)
4	CC-215-L	Database Systems Lab		CC	1	(0,3)
5	CC-212	Software Engineering		CC	3	(3,0)
6	MS-251	Probability and Statistics		MS	3	(3,0)
7	GE-191	Expository Writing		GE	3	(3,0)
8	GE-163	Islamic Studies		GE	2	(2,0)
9	HQ-002	Quran Translation - II		HQ	0.5	(0.5,0)
10	MD-002	Math Deficiency - II		MD	3*	(3,0)*
Credit Hours (Semester - II)					19.5	(17.5,6)
Semester - III						
Sr.	Code	Course Title	Pre-Requisite	Domain	Cr. Hrs.	Cont. Hrs.
1	CC-213	Data Structures	Object Oriented Programming	CC	3	(3,0)
2	CC-213-L	Data Structures Lab	Object Oriented Programming	CC	1	(0,3)
3	CC-310	Artificial Intelligence		CC	2	(2,0)
4	CC-310-L	Artificial Intelligence Lab		CC	1	(0,3)
5	CC-214	Computer Networks		CC	2	(2,0)
6	CC-214-L	Computer Networks Lab		CC	1	(0,3)
7	CC-311	Operating Systems		CC	2	(2,0)
8	CC-311-L	Operating Systems Lab		CC	1	(0,3)
9	DI-322	Web Technologies		EI	2	(2,0)
10	DI-322-L	Web Technologies Lab		EI	1	(0,3)
11	GE-162	Calculus & Analytical Geometry		GE	3	(3,0)
12	HQ-003	Quran Translation - III		HQ	0.5	(0.5,0)
Credit Hours (Semester - III)					19.5	(14.5,15)

Semester – IV						
Sr.	Code	Course Title	Pre-Requisite	Domain	Cr. Hrs.	Cont. Hrs.
1	EI-333	Mobile Application Development	Object Oriented Programming	EI	2	(2,0)
2	EI-333-L	Mobile Application Development Lab	Object Oriented Programming	EI	1	(0,3)
3	EI-334	Data Science		EI	2	(2,0)
4	EI-334-L	Data Science Lab		EI	1	(0,3)
5	EI-339	Cloud Computing	Computer Networks	EI	2	(2,0)
6	EI-339-L	Cloud Computing Lab	Computer Networks	EI	1	(0,3)
7	CC-312	Information Security		CC	3	(2,3)
8	EI-236	Global IT Services and Workspace		EI	2	(2,0)
9	EI-236-L	Global IT Services and Workspace Lab		EI	1	(0,3)
10	GE-362	Entrepreneurship		GE	2	(2,0)
11	HQ-004	Quran Translation – IV		HQ	0.5	(0.5,0)
Credit Hours (Semester - IV)					17.5	(12.5,15)

10. Course Outlines

Course outlines of all major categories are shared below (next page).

1) Computing Core

Course Title	Digital Logic Design		
Course Code	CC-110		
Credit Hours	2 (2,0)		
Category	Computing core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	CC-210 Computer Organization & Assembly Language		
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 (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Acquire the basic knowledge of logic gates and digital logic circuits	C1 (Acquire)	1
	CLO2: Understand the working of the fundamental digital circuits used in digital systems and computers.	C2 (Understand)	1,2
	CLO3: Designing a digital circuit for implementing a given scenario.	C3 (Apply)	3,4
Syllabus	<p>Topics: Introduction to Digital Systems, Number Systems, Introduction to Boolean Algebra, Basic theorems and properties of Boolean Algebra, Boolean Functions, Logic Gates, NAND and NOR Implementation, Representation of Function in Sum of Minterms or Product of Maxterms, Simplification of Boolean function using Karnaugh Map, Don't care Conditions, The Tabulation Method, Introduction to Combinational Logic, Design of Adders, Design of Subtractors, Code Convertors, Analysis Procedure of Combinational Circuits, Binary Parallel Adders, Decimal Adders, Magnitude Comparator, Decoders and its applications, Multiplexers, Demultiplexers, Encoders, ROM, Programmable Logic Array (PLA), Introduction to Sequential Circuits, Basic Flip Flop, Clocked RS Flip Flop, Clocked D Flip Flop, Clocked JK Flip Flop, Clocked T Flip Flop, Analysis of Clocked Sequential Circuits, State Reduction and Assignment, Flip Flop Excitation tables, Design Procedure, Design of Counters, Design with State Equations, Introduction to Registers, Shift Registers, Ripple Counters, Synchronous Counters, Timing Sequences, Memory Unit, Random Access Memory. Introduction Programmable Logic Devices (CPLD, FPGA), Lab Assignments using tools such as Verilog HDL/VHDL, MultiSim.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. M. Morris Mano, Digital Logic and Computer Design, 1st Edition, Pearson, 1979, ISBN: 0132145103. 2. Thomas L. Floyd, Digital Fundamentals, 10th Edition, Prentice Hall, 2008, ISBN: 0132359235. 3. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e 		

Course Title	Digital Logic Design Lab		
Course Code	CC-110-L		
Credit Hours	1 (0,3)		
Category	Computing core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	CC-210 Computer Organization & Assembly Language		
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 (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Acquire the basic knowledge of Digital Electronic Trainer	C1 (Acquire)	1
	CLO2: Understand the pin configuration and working of commonly used ICs for digital circuit design	C2 (Understand)	1,2
	CLO3: Designing a digital circuit for implementing a given scenario.	C3 (Apply)	3,4
Syllabus	Topics: Familiarization with Digital Electronic Trainer, Implementation of logic gates using ICs, Illustration of basic properties and theorems Boolean algebra using circuit design, Implementation of given Boolean functions, Half Adder, Full Adder, Half Subtractor, Full Subtractor, Design of 7-Segment Display, BCD To 7-Segment Display, Decoder, Multiplexer, Demultiplexer, Implementation of Boolean function(s) using Decoder and Multiplexer, Magnitude Comparator, D Latch and Flip-Flop Operation, Latching BCD Data for Displaying On 7- Segment Display, JK Flip-Flop Operation, Random Access Memories		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. M. Morris Mano, Digital Logic and Computer Design, 1st Edition, Pearson, 1979, ISBN: 0132145103. 2. Thomas L. Floyd, Digital Fundamentals, 10th Edition, Prentice Hall, 2008, ISBN: 0132359235. 3. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e 		

Course Title	Programming Fundamentals		
Course Code	CC-112		
Credit Hours	3 (3,0)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	CC-211: Object Oriented Programming, DI-322: Web Technologies, EI-338: Enterprise Systems, DI-327: Information Technology Infrastructure		
Course Introduction	This course provides fundamental concepts of programming to freshmen. The course is prerequisite to many other courses, therefore, students are strongly advised to cover all contents and try to achieve CLOs to the maximum possible level.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Understand basic problem-solving steps and logic constructs.	C2 (Understand)	1,2
	CLO2: Apply basic programming concepts.	C3 (Apply)	3,4
	CLO3: Design and implement algorithms to solve real world problems.	C3 (Solve)	3,4
Syllabus	<p>Introduction to Problem Solving, Algorithms, Programming, and C Language: Problem Solving, a brief review of Von-Neumann Architecture., The C Programming Language, Pseudo-code, Concept of Variable, Data types in Pseudo-code, The C Standard Library and Open Source, Input/Output, Arithmetic expressions, Assignment statement, Operator precedence, Concept of Integer division, Flowchart and its notations, Typical C Program Development Environment, Role of Compiler and Linker, Test Driving C Application. Introduction to C Programming: A Simple C Program: Printing Text, Adding Two Integer, Memory Concepts, Arithmetic in C, Operators. Decision Making: Equality and Relational Operators. Structured Program Development: The if, if...else, while Nested Control Statements. Program Control: for, switch, do...while, break, continue, Logical Operators. Functions: Modularizing Program in C, Math Library Functions, Function Definitions and Prototypes, Function-Call Stack and Stack Frames, Stack rolling and unrolling, Headers, Passing Arguments by Value and by Reference, Random Number Generation, Scope Rules, Recursion, Recursion vs Iteration. Arrays: Defining Arrays, Character Arrays, Static and Automatic Local Arrays, Passing Arrays to Function, Sorting and Searching Arrays, Multidimensional and Variable Length Arrays. Pointers: Pointer Definitions and Initialization, Pointer Operators, Passing Arguments to Function by Reference, Using the const and sizeof Operator, Pointer Expressions and Arithmetic, Pointers and Arrays, Array of Pointers, Function Pointers. Characters and Strings: Strings and Characters, Character Handling Library, String Functions, Library Functions. Formatted Input/Output: Streams, Formatted Output with printf, Formatted Input with scanf. Structures: Defining Structures, Accessing Structure Member, Structures and Functions, typedef, Unions. Bit Manipulation and Enumeration: Bitwise Operators, Bit Fields, Enumeration Constants. File Processing: Files and Streams, Creating, Reading and Writing data to a Sequential and a Random-Access File. Preprocessor: #include, #define, Conditional Compilation, #error and #pragma, # and ## Operators, Predefined Symbolic Constants, Assertions. Other Topics: Variable Length Argument List, Using Command Line Arguments, Compiling Multiple-Source-File Programs, Program Termination with exit and atexit, Suffixes for Integer and Floating-Point Literals, Signal Handling, Dynamic Memory Allocation calloc and realloc, goto. Advance Topics: Self-Referential Structures, Linked Lists. Efficiency of Algorithms, Selection and Insertion Sort.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Paul Deitel, Harvey Deitel, C How To Program, 9th Edition, Pearson, 2022. 2. Tony Gaddis, Starting out with Programming Logic and Design, 5th Edition, Pearson, 2018. 3. The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie 4. Object Oriented Programming in C++ by Robert Lafore 5. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly & Elliot B. Koffman 		

Title	Programming Fundamentals Lab		
Code	CC-112-L		
Credit Hours	1 (0,3)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	CC-211: Object Oriented Programming, DI-322: Web Technologies, EI-338: Enterprise Systems, DI-327: Information Technology Infrastructure		
Course Introduction	This course provides fundamental concepts of programming to freshmen. The course is prerequisite to many other courses; therefore, students are strongly advised to cover all contents and try to achieve CLOs to the maximum possible level.		
Course Learning Outcomes (CLOs)	At the end of the lab, the students will be able to:	BT	PLO
	CLO1: Understand basic problem-solving steps and logic constructs.	C2 (Understand)	1,2
	CLO2: Apply basic programming concepts.	C3 (Apply)	3,4
	CLO3: Design and implement algorithms to solve real world problems.	C3 (Solve)	3,4,5
Syllabus	<p>Implementation and Practice of the concepts studied in “CC-112 Programming Fundamentals”</p> <p>Introduction to Problem Solving, Algorithms, Programming, and C Language: Problem Solving, a brief review of Von-Neumann Architecture., The C Programming Language, Pseudo-code, Concept of Variable, Data types in Pseudo-code, The C Standard Library and Open Source, Input/Output, Arithmetic expressions, Assignment statement, Operator precedence, Concept of Integer division, Flowchart and its notations, Typical C Program Development Environment, Role of Compiler and Linker, Test Driving C Application. Introduction to C Programming: A Simple C Program: Printing Text, Adding Two Integer, Memory Concepts, Arithmetic in C, Operators. Decision Making: Equality and Relational Operators. Structured Program Development: The if, if...else, while Nested Control Statements. Program Control: for, switch, do...while, break, continue, Logical Operators. Functions: Modularizing Program in C, Math Library Functions, Function Definitions and Prototypes, Function-Call Stack and Stack Frames, Stack rolling and unrolling, Headers, Passing Arguments by Value and by Reference, Random Number Generation, Scope Rules, Recursion, Recursion vs Iteration. Arrays: Defining Arrays, Character Arrays, Static and Automatic Local Arrays, Passing Arrays to Function, Sorting and Searching Arrays, Multidimensional and Variable Length Arrays. Pointers: Pointer Definitions and Initialization, Pointer Operators, Passing Arguments to Function by Reference, Using the const and sizeof Operator, Pointer Expressions and Arithmetic, Pointers and Arrays, Array of Pointers, Function Pointers. Characters and Strings: Strings and Characters, Character Handling Library, String Functions, Library Functions. Formatted Input/Output: Streams, Formatted Output with printf, Formatted Input with scanf. Structures: Defining Structures, Accessing Structure Member, Structures and Functions, typedef, Unions. Bit Manipulation and Enumeration: Bitwise Operators, Bit Fields, Enumeration Constants. File Processing: Files and Streams, Creating, Reading and Writing data to a Sequential and a Random-Access File. Preprocessor: #include, #define, Conditional Compilation, #error and #pragma, # and ## Operators, Predefined Symbolic Constants, Assertions. Other Topics: Variable Length Argument List, Using Command Line Arguments, Compiling Multiple-Source-File Programs, Program Termination with exit and atexit, Suffixes for Integer and Floating-Point Literals, Signal Handling, Dynamic Memory Allocation calloc and realloc, goto. Advance Topics: Self-Referential Structures, Linked Lists. Efficiency of Algorithms, Selection and Insertion Sort.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Paul Deitel, Harvey Deitel, C How To Program, 9th Edition, Pearson, 2022. 2. Tony Gaddis, Starting out with Programming Logic and Design, 5th Edition, Pearson, 2018. 3. The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie 4. Object Oriented Programming in C++ by Robert Lafore 5. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly & Elliot B. Koffman 		

Course Title	Computer Networks		
Course Code	CC-214		
Credit Hours	2 (2,0)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course provides fundamental concepts related to computer networks. After completion of the course, the students will be able to understand Computer Networks basics, network types, layered communication models and protocols.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Describe the key terminologies and technologies of computer networks	C2 (Describe)	1
	CLO2: Explain the services and functions provided by each layer in the Internet protocol stack	C2 (Explain)	1
	CLO3: Identify various internetworking devices and protocols and their functions in a networking	C4 (Identify)	1,2
	CLO4: Analyze working and performance of key technologies, algorithms and protocols	C4 (Analyze)	3
	CLO5: Build Computer Network on various Topologies.	C5 (Build)	4,5
Syllabus	<p>Introduction: Protocols architecture, basic concepts of networking, network topologies.</p> <p>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, subnetting, CIDR, routing protocols, transport layer protocols, ports and sockets, connection establishment, flow and congestion control, application layer protocols, latest trends in computer networks.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, 6th Edition, Pearson, 2012, ISBN: 0132856204. 2. T. Lammle, CCNA Cisco Certified Network Associate Deluxe Study Guide, 6th Edition, Sybex, 2011, ISBN: 978-0-470-90108-3. 3. Andrew S. Tanenbaum, David J. Wetherall, Computer Networks, 5th Edition, Prentice Hall, 2010, ISBN: 9332518742. 4. William Stallings, Data and Computer Communications, 10th Edition, Pearson, 2013, ISBN: 0133506487. 5. Behrouz A. Forouzan, Data Communication and Computer Networks, 5th Edition, McGraw-Hill, 2012, ISBN: 0073376221. 6. R. Perlman, Interconnections: Bridges, Routers, Switches, and Internetworking Protocols, 2nd Edition, Addison-Wesley, 1999, ISBN: 0201634481. 		

Course Title	Computer Networks Lab		
Course Code	CC-214-L		
Credit Hours	1 (0,3)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course provides fundamental hands-on skills related to computer networks. After completion of the course, the students will be familiar with networking, routing, switching, and Setting up of networks from scratch, major protocols involved in communication and their configurations. Students will also be made aware of the state-of-the-art areas in case they would like to pursue this course in future.		
Course Learning Outcomes (CLOs)	At the end of the lab, the students will be able to:	BT	PLO
	CLO1: Describe the fundamental components, technologies, and devices of computer networks	C2 (Describe)	1
	CLO2: Explain the services and functions provided by each layer in the Internet protocol stack	C2 (Explain)	1
	CLO3: Identify various internetworking devices and protocols and their functions in a networking	C4 (Identify)	1,2
	CLO4: Analyze working and performance of key technologies, algorithms and protocols	C4 (Analyze)	3
	CLO5: Build Computer Network on various Topologies.	C5 (Build)	4,5
Syllabus	Introduction to Wireshark, HTTP GET/response interaction, DNS role in the Internet infrastructure, TCP segments sent and received in transferring, UDP transport protocol IP investigate the IP protocol, NAT behavior of the NAT protocol, DHCP examine the DHCP packets captured, ICMP capturing the packets generated by the Ping program, Ethernet and ARP investigate the Ethernet protocol and the ARP protocol, 802.11 Wireless investigate the 802.11 wireless network protocol, SSL investigate the Secure Sockets Layer (SSL) protocol		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, 6th Edition, Pearson, 2012, ISBN: 0132856204. 2. T. Lammle, CCNA Cisco Certified Network Associate Deluxe Study Guide, 6th Edition, Sybex, 2011, ISBN: 978-0-470-90108-3. 3. Andrew S. Tanenbaum, David J. Wetherall, Computer Networks, 5th Edition, Prentice Hall, 2010, ISBN: 9332518742. 4. William Stallings, Data and Computer Communications, 10th Edition, Pearson, 2013, ISBN: 0133506487. 5. Behrouz A. Forouzan, Data Communication and Computer Networks, 5th Edition, McGraw-Hill, 2012, ISBN: 0073376221. 6. R. Perlman, Interconnections: Bridges, Routers, Switches, and Internetworking Protocols, 2nd Edition, Addison-Wesley, 1999, ISBN: 0201634481. 		

Title	Object Oriented Programming		
Code	CC-211		
Credit Hours	3 (3,0)		
Category	Computing Core		
Prerequisite	CC-112 Programming Fundamentals		
Co-Requisite	None		
Follow-up	CC-213 Data Structures, CC-310 Artificial Intelligence, DI-328 Parallel and Distributed Computing, EI-333 Mobile Application Development		
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 (CLOs)	At the end of the lab, the students will be able to:	BT	PLO
	CLO1: Understand principles of object-oriented paradigm.	C2 (Understand)	1
	CLO2: Identify the objects & their relationships to build object-oriented solution	C4 (Identify)	2,3,4
	CLO3: Model a solution for a given problem using object-oriented principles	C3 (Apply)	4
	CLO4: Examine an object-oriented solution	C4 (Examine)	4
Syllabus	<p>Introduction to Object-oriented Design, History and Advantages of Object-oriented Design. Introduction to OOP and C++: Brief description of C++ concepts, Introduction to OOP. Introduction to Classes Objects and Member Functions: Encapsulation and Abstraction, Class and Object, Getter/Setter Functions, Access Specifiers, Constructors, Overloaded Constructor, Default Constructor, Destructor. Functions: Inline Functions, Function Overloading. Class Templates array: Function Templates, Class Templates array, Vectors and Multidimensional Array, Reference to private Data Members, Default Member wise Assignment, const Objects, const Member Functions. Composition and Aggregation: Object Composition and Aggregation, Class Separation using header. Friend Classes and Functions: Friend Functions, Friend Classes. static Members: "this" pointer, static Data Members, static Member Functions. Copy Constructor: Default Copy Constructor. Operator Overloading: Overloaded Operators of Standard Library, Operator Overloading, Overloading Binary Operators, Overloading Unary Operators, Overloading ++ Operator, Overloading – Operator, Dynamic Memory Management, Operators as Members vs Non-Members, Conversion between Types, Explicit Constructor and Conversion Operators, Overloading the Function call Operator. Stream I/O: Introduction, Streams, Streams Input, Streams Output, Object Streams, data and object serialization using object streams. Inheritance: Introduction, Base and Derived Classes, Relationships between Base and Derived Classes, Constructors in Derived Classes, Destructor in Derived Classes, public protected and private Inheritance. Polymorphism: Relationship among Objects in Inheritance, Virtual Functions, Virtual Destructors, Pure Virtual Functions, Abstract and Concrete Classes. File Processing: Files and Streams, create a Sequential File, read a Sequential File, update a Sequential File, Random Access File, create a Random-Access File, read a Random-Access File, update a Random-Access File, Exception Handling: Flow of Control, Rethrowing an Exception, Constructor Destructor and Exception handling. Generic Programming Concepts: Custom Templates, Class Templates, Function Templates, Arguments to Templates, Overloading Function Templates. Standard Library: Containers, Iterators, Adapters, Sequence Containers, Associative Containers, Container Adapters, Minimum Iterator Requirements, Lambda Expressions, Function Objects.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. P. Deitel, H. Deitel, C++ How To Program, 10th Edition, Pearson. 2. Robert Lafore, Object Oriented Programming in C++, 3rd Edition. 3. Tony Gaddis, Starting Out with C++ from Control Structures to Objects, 9th Edition, Pearson, 2018. 4. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly & Elliot B. Koffman 		

Title	Object Oriented Programming Lab		
Code	CC-211-L		
Credit Hours	1 (0,3)		
Category	Computing Core		
Prerequisite	CC-112 Programming Fundamentals		
Co-Requisite	None		
Follow-up	CC-213 Data Structures, CC-310 Artificial Intelligence, DI-328 Parallel and Distributed Computing, EI-333 Mobile Application Development		
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 (CLOs)	At the end of the lab, the students will be able to:	BT	PLO
	CLO1: Understand principles of object-oriented paradigm.	C2 (Understand)	1
	CLO2: Identify the objects & their relationships to build object-oriented solution	C4 (Identify)	2,3,4
	CLO3: Model a solution for a given problem using object-oriented principles	C3 (Apply)	4
	CLO4: Examine an object-oriented solution	C4 (Examine)	4
Syllabus	<p>Implementation and Practice of the concepts studied in "CC-211 Object Oriented Programming"</p> <p>Introduction to Object-oriented Design, History and Advantages of Object-oriented Design. Introduction to OOP and C++: Brief description of C++ concepts, Introduction to OOP. Introduction to Classes Objects and Member Functions: Encapsulation and Abstraction, Class and Object, Getter/Setter Functions, Access Specifiers, Constructors, Overloaded Constructor, Default Constructor, Destructor. Functions: Inline Functions, Function Overloading. Class Templates array: Function Templates, Class Templates array, Vectors and Multidimensional Array, Reference to private Data Members, Default Member wise Assignment, const Objects, const Member Functions. Composition and Aggregation: Object Composition and Aggregation, Class Separation using header. Friend Classes and Functions: Friend Functions, Friend Classes. static Members: "this" pointer, static Data Members, static Member Functions. Copy Constructor: Default Copy Constructor. Operator Overloading: Overloaded Operators of Standard Library, Operator Overloading, Overloading Binary Operators, Overloading Unary Operators, Overloading ++ Operator, Overloading – Operator, Dynamic Memory Management, Operators as Members vs Non-Members, Conversion between Types, Explicit Constructor and Conversion Operators, Overloading the Function call Operator. Stream I/O: Introduction, Streams, Streams Input, Streams Output, Object Streams, data and object serialization using object streams. Inheritance: Introduction, Base and Derived Classes, Relationships between Base and Derived Classes, Constructors in Derived Classes, Destructor in Derived Classes, public protected and private Inheritance. Polymorphism: Relationship among Objects in Inheritance, Virtual Functions, Virtual Destructors, Pure Virtual Functions, Abstract and Concrete Classes. File Processing: Files and Streams, create a Sequential File, read a Sequential File, update a Sequential File, Random Access File, create a Random-Access File, read a Random-Access File, update a Random-Access File, Exception Handling: Flow of Control, Rethrowing an Exception, Constructor Destructor and Exception handling. Generic Programming Concepts: Custom Templates, Class Templates, Function Templates, Arguments to Templates, Overloading Function Templates. Standard Library: Containers, Iterators, Adapters, Sequence Containers, Associative Containers, Container Adapters, Minimum Iterator Requirements, Lambda Expressions, Function Objects.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. P. Deitel, H. Deitel, C++ How To Program, 10th Edition, Pearson. 2. Robert Lafore, Object Oriented Programming in C++, 3rd Edition. 3. Tony Gaddis, Starting Out with C++ from Control Structures to Objects, 9th Edition, Pearson, 2018. 4. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly & Elliot B. Koffman 		

Course Title	Database Systems		
Course Code	CC-215		
Credit Hours	3 (3,0)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	DI-324: Database Administration and Management		
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 (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: To understand the basic concepts of database systems and Database System environment.	C2 (Understand)	1
	CLO2: To develop strong concepts of data modeling techniques	C2 (Understand)	1,2
	CLO3: Understanding of database design phases and techniques for performance improvement	C2 (Understand)	1,2
	CLO4: To understand the concept of transaction management, concurrency control, database recovery, and distributed databases	C2 (Understand)	1,2
	CLO5: To learn SQL and develop expertise in writing SQL queries	C3 (Apply)	3,4,5
	CLO6: To develop the fundamental knowledge of PL/SQL, stored procedures, and database triggers	C3 (Apply)	3,4,5
	CLO7: To be able to design a database system for small business organizations	C5 (Design)	3,4,5,7
Syllabus	<p>File Systems and Databases: Introduction, A File system Critique, Database Systems, Database approach vs file-based system, database architecture, three level schema architecture, data independence, Database Models. Introduction to RDBMS: Logical view of Data; Entities and Attributes, Tables and their Characteristics, Keys; relational data model, attributes, schemas, tuples, domains, relation instances, keys of relations, integrity constraints. Relational Algebra: Relational Database Operators, selection, projection, Cartesian product, types of joins. Entity Relationship (E-R) Modeling: Basic Modeling Concepts, entity sets, attributes, relationship, entity-relationship diagrams, Normalization of Database Tables: Objectives, Forms, Normalization and Database Design, functional dependencies, normal forms, Denormalization, Structured Query Language (SQL): Introduction, DDL Commands, Joins and subqueries in SQL, Grouping and aggregation in SQL, DML Commands, DCL Commands, Complex Queries and SQL Functions, Procedural SQL; Triggers, Stored procedures. Database Design: The System Development Life Cycle (SDLC), The Database Life Cycle (DBLC), Database Design Strategies, Transaction Management and Concurrency Control: Introduction, Transaction Properties and Types, Concurrency Control Issues, Database Recovery Management. DDBMS: Evolution, Components, Distributed processing and distributed databases, Distributed database transparency features. Distributed database design, Data fragmentation, Data replication, NoSQL systems.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Carlos Coronel, Steven Morris, Database Systems: Design, Implementation & Management, 13th Edition, Cengage Learning, 2017. ISBN-10: 1337627909. 2. Jeffrey A. Hoffer, Ramesh Venkataraman, Heikki Topi, Modern Database Management, 12th Edition, Pearson, 2015. ISBN-10: 0133544613. 3. Thomas Connolly, Carolyn Begg, Database Systems: A Practical Approach to Design, Implementation and Management, 6th Edition, Pearson, 2015. ISBN-10: 1292061189. 4. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, 7th Edition, Pearson, 2016. ISBN-10: 1292097612. 		

Course Title	Database Systems Lab		
Course Code	CC-215-L		
Credit Hours	1 (0,3)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	DI-324: Database Administration and Management		
Course Introduction	The course aims to introduce the Structured Query Language (SQL). It covers the set of commands related to Data Retrieval, Data Definition Language (DDL), Data Manipulation Language (DML), Data Control Language (DCL). It will followed up by procedural flavor of SQL (PL/SQL).		
Course Learning Outcomes (CLOs)	At the end of the lab, the students will be able to:	BT	PLO
	CLO1: To learn SQL and develop expertise in writing SQL queries	C3 (Apply)	3,4,5
	CLO2: To develop the fundamental knowledge of PL/SQL, stored procedures, and database triggers	C3 (Apply)	3,4,5
	CLO3: To be able to design a database system for small business organizations	C5 (Design)	3,4,5,7
Syllabus	<p>Introduction to SQL environment: Writing Basic SQL Statements; SELECT Statement: Arithmetic Expressions, Operator Precedence, Null Value, Column Alias, Concatenation Operator, FROM Clause: Table list, Table Alias. Restricting and Sorting Data; WHERE Clause: Comparison operators, Logical operators, ORDER BY clause, Display table Structure.</p> <p>Single row functions: character functions, number functions, date functions, type conversion functions. Multi row Functions: Sum, Average, Standard deviation, Variance, Subgrouping of data, Group by Clause, use of Having clause. Join: Cross product, natural join, Equi-join, Non equi-join, left outer-join, right outer-join, self-join. Subquery: use of subquery, subquery syntax, Multiple Column Subqueries, pairwise comparison, Non-pair wise comparison, Null Value in a subquery, Subquery in From Clause. Creating and Altering SQL tables: Create table statement, Defining Constraints, Column Level and Table Level, NOT NULL Constraint, UNIQUE Key Constraint, PRIMARY Key Constraint, FOREIGN Key Constraint, CHECK Constraint, Alter table statement, drop statement, Data Manipulation: Insert, Update, Delete statements. SQL Objects: Views, Sequences, Indexes. User Management: Create user, user privileges, user groups, Grant, Revoke statements.</p> <p>Introduction to Procedural SQL (PL/SQL), Sections of a PL/SQL block, Variable declaration and initialization, SELECT statement in PL/SQL, Arithmetic expressions, Selection, Repetition, Exception Handling, Cursors, Stored Procedures and Functions, Introduction to Database Triggers</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Introduction to Oracle 9i: SQL 2. Michael McLaughlin, Oracle Database 11g PL/SQL Programming, 1st Edition, McGraw-Hill Education, 2008, ISBN: 0071494456. 3. Jason Price, Oracle Database 11g SQL, McGraw Hill. ISBN: 0071498508. 		

Course Title	Software Engineering		
Course Code	CC-212		
Credit Hours	3 (3,0)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow Up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Describe various software engineering processes and activates	C1 (Describe)	1
	CLO2: Apply the system modeling techniques to model a medium size software system	C3 (Apply)	1,2
	CLO3: Apply software quality assurance and testing principles to medium size software systems	C3 (Apply)	2,3
Syllabus	Introduction: Nature of Software, Overview of Software Engineering, Professional software development, Software engineering practice, Software process structure, Software Process Models: Waterfall Model, Incremental Model, Prototyping Model, Spiral Model, RAD Model. Agile Software Development: Agile process models, Agile development techniques. Introduction to Project Management, Introduction to Requirements Engineering, Functional and non-functional requirements. Analysis Model: Context models, Interaction models, Structural models, behavioral models, model driven engineering, Data modeling, Functional Modeling, Behavioral Modeling. Software Design: Data Design, Architectural Design, Component Level Design, User Interface Design. Object Oriented Analysis & Design Basics: Introduction to UML, UML Diagrams. Use Case Modeling, Rational Rose overview, Use case modeling in Rational Rose. Domain Model: Identifying business classes, Domain Model Associations, Domain Model Attributes, Implementation of Sequence Diagram and Domain model in Rational Rose. Interaction Diagram: Sequence diagrams, Collaboration Diagrams, Implementation of Sequence and Collaboration diagrams in Rational Rose. Design Class Diagram, Mapping Design to Code. Software Testing Fundamentals. Design patterns, Software testing and quality assurance. Software evolution. Project Management: Project planning, configuration management. Software Process improvement.		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Ian Sommerville, Software Engineering, 10th Edition, Pearson, 2015, ISBN-13: 978-0133943030. 2. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals of Software Engineering, 2nd Edition, Pearson, 2002, ISBN-13: 978-0133056990. 		

Title	Data Structures		
Code	CC-213		
Credit Hours	3 (3,0)		
Category	Computing Core		
Prerequisite	CC-211 Object Oriented Programming		
Co-Requisite	None		
Follow-up	CC-313 Analysis of Algorithms, DI-325 Cyber Security, CC-311 Operating Systems		
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 (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Implement various data structures and their algorithms and apply them in implementing simple applications	C3 (Apply)	1,2
	CLO2: Analyze simple algorithms and determine their complexities.	C4 (Analyze)	3
	CLO3: Apply the knowledge of data structure to other application domains	C3 (Apply)	3,4
	CLO4: Design new data structures and algorithms to solve problems	C6 (Design)	4,5
Syllabus	<p>Algorithm Specification: Properties of Algorithm, examples, performance, analysis, measurement, and Big Oh notation. Introduction to ADTs: Array and Polynomial as an ADT, Sparse Matrices, and Representation of Arrays. The Stack ADT: Linked list and array implementations, Expressions, Postfix Notation, and Infix to postfix conversion. The Queue ADT: Linked and array implementations of circular and double ended queue. Recursion: Recursive Definition and Processes, Writing Recursive Programs. Divide and Conquer Algorithms, Self-Referencing Classes and Dynamic Memory Allocation, Garbage Collection. Linked List: Singly Linked Lists, Circular Lists, Linked Stacks and Queues (Double Ended List), Doubly Linked Lists. Trees: Introduction to Trees, Logical construction and Traversing of Binary Trees, Implementation of Binary Trees (Insertion and Traversing), Searching and deletion in Binary Trees, Binary Search Tree, Introduction to Balanced and AVL Trees. Heaps: Heaps and Heaps as Priority Queues, Double Ended Priority Queue. Searching: Linear Search, Binary Search, and Types of Indexing. Hashing: Hash Functions: Division, Open Addressing; Overflow Handling: Chaining; Introduction to advanced topics: B-Trees, M-Way Trees, Generalized List etc. Sorting: Selection, Insertion, Merge, Quick, Bubble, Heap, Shell, Radix, and Bucket sorts. Graphs: Graph terminology, Adjacency List and Adjacency Matrix and Adjacency list representation of Graph; Elementary Graph Operations: Breadth First Search and Depth First Search, Spanning Trees (BFSST, DFSST), topological order, shortest path.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Ellis Horowitz, Sartaj Sahni, and D. Mehta, "Fundamentals of Data Structures in C++", 2nd Ed., Computer Science Press 2. Adam B. Drozdek, Data Structure and Algorithm in C++, 4th Ed., Cengage Learning 3. Mark Allen Weiss, "Data Structure and Algorithms in C++", 2nd Ed., Pearson Education 4. D. Malhotra and N. Malhotra. Data Structures and Program Design Using C++. 5. Tenenbaum, M. Augenstein, and Y. Lang Sam, "Data Structures using C and C++" 2nd Ed., Prentice Hall 		

Title	Data Structures Lab		
Code	CC-213-L		
Credit Hours	1 (0,3)		
Category	Computing Core		
Prerequisite	CC-211 Object Oriented Programming		
Co-Requisite	None		
Follow-up	CC-313 Analysis of Algorithms, DI-325 Cyber Security, CC-311 Operating Systems		
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 (CLOs)	At the end of the lab, the students will be able to:	BT	PLO
	CLO1: Implement various data structures and their algorithms and apply them in implementing simple applications	C3 (Apply)	1,2
	CLO2: Analyze simple algorithms and determine their complexities.	C4 (Analyze)	3
	CLO3: Apply the knowledge of data structure to other application domains	C3 (Apply)	3,4
	CLO4: Design new data structures and algorithms to solve problems	C6 (Design)	4,5
Syllabus	<p>Implementation and Practice of the concepts studied in “CC-213 Data Structures”</p> <p>Algorithm Specification: Properties of Algorithm, examples, performance, analysis, measurement, and Big Oh notation. Introduction to ADTs: Array and Polynomial as an ADT, Sparse Matrices, and Representation of Arrays. The Stack ADT: Linked list and array implementations, Expressions, Postfix Notation, and Infix to postfix conversion. The Queue ADT: Linked and array implementations of circular and double ended queue. Recursion: Recursive Definition and Processes, Writing Recursive Programs. Divide and Conquer Algorithms, Self-Referencing Classes and Dynamic Memory Allocation, Garbage Collection. Linked List: Singly Linked Lists, Circular Lists, Linked Stacks and Queues (Double Ended List), Doubly Linked Lists. Trees: Introduction to Trees, Logical construction and Traversing of Binary Trees, Implementation of Binary Trees (Insertion and Traversing), Searching and deletion in Binary Trees, Binary Search Tree, Introduction to Balanced and AVL Trees. Heaps: Heaps and Heaps as Priority Queues, Double Ended Priority Queue. Searching: Linear Search, Binary Search, and Types of Indexing. Hashing: Hash Functions: Division, Open Addressing; Overflow Handling: Chaining; Introduction to advanced topics: B-Trees, M-Way Trees, Generalized List etc. Sorting: Selection, Insertion, Merge, Quick, Bubble, Heap, Shell, Radix, and Bucket sorts. Graphs: Graph terminology, Adjacency List and Adjacency Matrix and Adjacency list representation of Graph; Elementary Graph Operations: Breadth First Search and Depth First Search, Spanning Trees (BFSST, DFSST), topological order, shortest path.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Ellis Horowitz, Sartaj Sahni, and D. Mehta, “Fundamentals of Data Structures in C++”, 2nd Ed., Computer Science Press 2. Adam B. Drozdek, Data Structure and Algorithm in C++, 4th Ed., Cengage Learning 3. Mark Allen Weiss, “Data Structure and Algorithms in C++”, 2nd Ed., Pearson Education 4. D. Malhotra and N. Malhotra. Data Structures and Program Design Using C++. 5. Tenenbaum, M. Augenstein, and Y. Lang Sam, “Data Structures using C and C++” 2nd Ed., Prentice Hall 		

Course Title	Operating Systems		
Course Code	CC-311		
Credit Hours	2 (2,0)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	DI-323: System and Network Administration		
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 (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Understand the characteristics of different structures of the Operating Systems and the core functions of the Operating Systems	C2 (Understand)	1,2
	CLO2: Analyze and evaluate the algorithms of the core functions of the Operating Systems and explain the major performance issues with regard to the core functions	C4 (Analyze)	3
	CLO3: Demonstrate the knowledge in applying system software and tools available in modern operating systems.	C3 (Demonstrate)	3,4
Syllabus	<p>Introduction: Operating systems basics, system calls, process concept and scheduling, inter-process communication, multithreaded programming, multithreading models, threading issues. Process Scheduling: Algorithms, thread scheduling, multiple-processor scheduling, synchronization, critical section, synchronization hardware, synchronization problems, deadlocks, detecting and recovering from deadlocks. Memory Management: swapping, contiguous memory allocation, segmentation & paging, virtual memory management, demand paging, thrashing, memory-mapped files. File Systems: file concept, directory and disk structure, directory implementation, free space management, disk structure and scheduling, swap space management. System Protection: Virtual machines, operating system security.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. A. Silberschatz, P. B. Galvin, G. Gagne, Operating Systems Concepts, 9th Edition, Wiley, 2012, ISBN: 1118063333. 2. Andrew S. Tanenbaum, Herbert Bos, Modern Operating Systems, 4th Edition, Pearson, 2014, ISBN: 013359162X. 3. William Stallings, Operating Systems: Internals and Design Principles, 9th Edition, Pearson, 2017, ISBN: 0134670957. 		

Course Title	Operating Systems Lab		
Course Code	CC-311-L		
Credit Hours	1 (0,3)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	DI-323: System and Network Administration		
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 (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Understand the characteristics of different structures of the Operating Systems and the core functions of the Operating Systems	C2 (Understand)	1,2
	CLO2: Analyze and evaluate the algorithms of the core functions of the Operating Systems and explain the major performance issues with regard to the core functions	C4 (Analyze)	3
	CLO3: Demonstrate the knowledge in applying system software and tools available in modern operating systems.	C3 (Demonstrate)	3,4
Syllabus	<p>Interacting with Linux Operating System: Virtualization and Hypervisors. Installation of VMWare and Ubuntu, Installation G++ the C++ Compiler on Ubuntu VMWare, Basic commands of Linux, Working with VIM editor, Compiling and executing a C/C++ program in VIM, File System Architecture: Schematic view of a standard UNIX file system. File System Mounting: Introduction to the concept of file system mounting. Linux configuration files related to file system mounting. File Permissions: standard file permissions. Use of chmod and chown commands. Device files: Seven File Types in Linux and the concept of device files. Terminal Attributes: Overview of Terminal Devices and current attributes of the terminal driver. Hard and Soft Links. Managing services using systemd: Introduction to Linux system daemon. Shell commands to manage services using systemctl. Booting process of a Linux system.</p> <p>Linux Shell Programming: Linux System Call Interface, Use of GNU gcc compiler, Implementation of process scheduling algorithms, Process Creation and Termination: getpid(), getppid(), fork(), exit(), wait() and execl() system calls. File management in Linux. Concept of PPFDT. Concept of input, output and error redirection. Inter Process Communication: Linux IPC tools, Pipes, FIFOS and Sockets. Use of pipes and fifos on a Linux terminal. Signals: Signal delivery and execution of a signal handler. Synchronous and Asynchronous signals. Threads and Scheduling: Writing multi-threaded C programs using library calls from the POSIX pthread library like pthread_create(), pthread_join(), and pthread_exit(), Socket programming using threads in Linux, Implementation of process synchronization techniques</p>		
Suggested Instructional/ Reading Material	1. B. Unix: The Text Book, 3rd edition by Sarwar and Koretsky, ISBN-13: 978-1-4822-3358-2		

Course Title	Information Security		
Course Code	CC-312		
Credit Hours	2 (2,0)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course provides a broad overview of the threats to the security of information systems, the responsibilities and basic tools for information security, and the levels of training and expertise needed in organizations to reach and maintain a state of acceptable security. It covers concepts and applications of system and data security. Areas of particular focus include secure network design, implementation and transition issues, and techniques for responding to security breaches.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain key concepts of information security such as design principles, cryptography, risk management, and ethics.	C2 (Explain)	1,2
	CLO2: Discuss legal, ethical, and professional issues in information security.	C2 (Discuss)	1,2
	CLO3: Apply various security and risk management tools for achieving information security and privacy.	C3 (Apply)	3,4,5
Syllabus	CLO4: Identify appropriate techniques to tackle and solve problems in the discipline of information security.		
	Information security foundations, security design principles; security mechanisms, symmetric and asymmetric cryptography, encryption, hash functions, digital signatures, key management, authentication and access control; software security, vulnerabilities and protections, malware, database security; network security, firewalls, intrusion detection; security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics in information security, privacy and anonymity of data.		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. M. Whitman and H. Mattord, Principles of Information Security, 6th edition. 2. William Stallings, Computer Security: Principles and Practice, 3rd edition. 3. Dieter Gollmann, Computer Security, 3rd edition. 4. William Easttom, Computer Security Fundamentals, 3rd edition. 		

Course Title	Artificial Intelligence		
Course Code	CC-310		
Credit Hours	2 (2,0)		
Category	Computing core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
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 (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO2: Understand the fundamental concepts in the field of artificial intelligence	C2 (Understand)	1,2
	CLO3: Implement artificial intelligence techniques and case studies	C3 (Apply)	3,4,5
	CLO3: Understand and apply the Object-oriented concepts in the programming languages.	C4 (Identify)	1,2,3
Syllabus	An Introduction to Artificial Intelligence and its applications towards Knowledge Based Systems; Symbolic AI: the physical symbol system hypothesis. Search: exhaustive & heuristic search techniques. 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, Game playing, Genetic algorithms, Introduction to Machine Learning for AI, Decision Trees, Bayesian classification, Artificial Neural Networks, Computer Vision.		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Stuart Russell and Peter Norvig, Artificial Intelligence. A Modern Approach, 3rd edition, Prentice Hall, Inc., 2015. 2. Luger, G.F. and Stubblefield, W.A., 2009. AI algorithms, data structures, and idioms in Prolog, Lisp, and Java. Pearson Addison-Wesley. 3. George F. Luger, Artificial Intelligence - Structures and Strategies for Complex Problem Solving, 6th Edition, Pearson, 2008, ISBN-13: 978-0321545893. 4. Hart, P.E., Stork, D.G. and Duda, R.O., Pattern classification. John Wiley & Sons, 2001. 5. P. Winston, Artificial Intelligence, 3rd Edition, Pearson, 1992, ISBN-13: 978-0201533774. 		

Course Title	Artificial Intelligence Lab		
Course Code	CC-310-L		
Credit Hours	1 (0,3)		
Category	Computing core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	The objective of the course is to introduce and then build the proficiency of students in different AI programming languages. Python is proposed for the course.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Understand the fundamental constructs of Python programming language.	C2 (Understand)	1,2
	CLO2: Comprehend the fundamental constructs of programming languages for data analysis and representation.	C3 (Apply)	1,2,3
	CLO3: Understand and apply the Object-oriented concepts in the programming languages.	C4 (Identify)	1,2,3
	CLO4: Apply various libraries for plotting, interpreting and analyzing data in Python.	C3 (Apply)	3,4,5
Syllabus	Introduction to Python programming, variables, expressions, operands and operators, loops, control structures, debugging, error messages, functions, strings, lists, object-oriented constructs and basic graphics in the languages. Logic programming: knowledge representation & search in the context of logic programming. Reasoning in logic programming: unification, horn clause logic, and resolution, Knowledge Representation Schemas: Logic, frames, semantic nets, scripts; problems in knowledge representation. Expert systems.		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Tony Gaddis, "Starting out with Python", 4th Edition, Pearson Education, 2017. 2. Ivan Bratko, Prolog: Programming for Artificial Intelligence, 4th Edition, Pearson, 2011, ISBN-13: 978-0321417466. 3. Severance, C.R., "Python for everybody: Exploring data using Python 3." CreateSpace Independent Publ Platform, 2016. 4. Miller, B.N., Ranum, D.L. and Anderson, J., "Python programming in context." Jones & Bartlett Pub., 2019. 5. McKinney, W., "Python for data analysis: Data wrangling with Pandas, NumPy, and IPython.", 2nd Edition O'Reilly Media, Inc., 2023. 6. Luger, G.F. and Stubblefield, W.A., "AI algorithms, data structures, and idioms in Prolog, Lisp, and Java", Pearson Addison-Wesley. 2009. 7. Russell, S. and Norvig, P. "Artificial Intelligence. A Modern Approach", 3rd ed, Prentice Hall, Inc., 2015. 8. Severance, C.R., 2016. "Python for everybody: Exploring data using Python 3." CreateSpace Independent Publ Platform. 9. Miller, B.N., Ranum, D.L. and Anderson, J., 2019. "Python programming in context." Jones & Bartlett Pub. 10. Joshi, P., 2017. "Artificial intelligence with python." Packt Publishing Ltd. 11. Handouts and Internet references 		

2) Mathematics & Supporting

Course Title	Probability and Statistics		
Course Code	MS-251		
Credit Hours	3 (3,0)		
Category	Mathematics & Supporting		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Know the concept and applications of probability and statistics.	C1 (Know)	1
	CLO2: Describe expectation and distributions	C2 (Describe)	1
	CLO3: Solve single sample and one- and two- sample estimation.	C3 (Apply)	1,3
	CLO4: Use regression techniques.	C3 (Apply)	1,3
Syllabus	<p>Introduction: Statistics and Data Analysis, Statistical Inference, Samples, Populations, and the Role of Probability. Sampling Procedures, Discrete and Continuous Data, Statistical Modeling, Types of Statistical Studies. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes' Rule. Random Variables and Probability Distributions. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem. Probability Distributions: Discrete Probability Distributions, Continuous Probability Distributions. Fundamental Sampling Distributions: Sampling Distributions and Data Descriptions, Random Sampling, Sampling Distributions, Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of S^2, t-Distribution, F-Quantile and Probability Plots. Single Sample & One- and Two-Sample Estimation Problems: Single Sample & One- and Two-Sample Tests of Hypotheses. The Use of P-Values for Decision Making in Testing Hypotheses (Single Sample & One- and Two-Sample Tests). Regression: Linear Regression and Correlation, Least Squares and the Fitted Model, Multiple Linear Regression and Certain, Nonlinear Regression Models, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Dimitri P. Bertsekas, John Tsitsiklis, Introduction to probability, Athena Scientific, 2nd Edition, 2008, ISBN: 978-1886529236. 2. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, Cengage Learning, 9th Edition, 2015, ISBN: 978-1305251809. 3. R.E. Walpole, R.H. Myers and S.L Myers, "Probability and Statistics for Engineers and Scientists", 9th Edition. 4. MIT open courseware: https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/ 		

3) Math Deficiency

Course Title	Math Deficiency - I		
Course Code	MD-001		
Credit Hours	3* (3,0)		
Category	Math Deficiency		
Prerequisite	None		
Co-Requisite	None		
Follow Up	Math Deficiency-II		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Know the concepts and applications of sets, relations, functions, systems of equations, trigonometric functions and matrix algebra	C1 (Know)	1
	CLO2: Describe system of linear equations, matrix algebra, trigonometry and related techniques.	C2 (Describe)	1
	CLO3: Solve problems related to system of linear equations, matrix algebra, and trigonometry.	C3 (Apply)	1,3
	CLO4: Know the general form of Conic, polar coordinate and parametric equations.	C1 (Know)	1
Syllabus	<p>Sets: Definition, various types of set representation and operations. Relation and Function: Graphical transformation of one and two dimensional functions, Properties of functions, composition and inverses of functions, domain and range of the functions, Maximum and minimum values of functions, increasing and decreasing functions, zeros and intercept of functions, piecewise functions, continuity and Discontinuity of functions, Polynomials and rational functions, Polynomial long division and Synthetic division, Solution of rational functions, Absolute valued function, properties of absolute valued functions, Asymptotes (Horizontal, vertical and oblique), Exponential functions and their properties, Logs functions and their properties. Systems of Equations: Systems of Two Equations and Two Unknowns, Systems of Three Equations and Three Unknowns. Matrix Algebra: Addition, subtraction and multiplication. Row Operations and Row Echelon Forms, Augmented Matrices, Determinant of Matrices (2 x 2 and higher order matrices), Cramer's Rule, Inverse Matrices. Series and Sequences. Trigonometry: Angles in Radians and Degrees, Right Triangle Trigonometry, Law of Cosines & Sines, Area of Triangle, Graphs of Other Trigonometric Functions , Graphs of Inverse Trigonometric Functions, Basic Trigonometric Identities (Pythagorean, Sum and Difference, Double, Half, and Power Reducing), Trigonometric Equations. General Form of a Conic: Parabolas, Circles, Ellipses, Hyperbolas, Degenerate Conics. Polar and Parametric Equations: Polar and Rectangular Coordinates.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Textbook of Algebra and Trigonometry Class XI is published by Punjab Textbook Board (PTB) Lahore, Pakistan. 2. Calculus and Analytic Geometry, MATHEMATICS 12 (Mathematics FSc Part 2 or HSSC-II), Punjab Text Book Board Lahore, Pakistan 3. Gilbert, S. S., B. C. Andy and B. Andrew, B. 2005. Linear Algebra and Its Applications. 4th Ed. Thomson Brooks/Cole, Belmont, CA, USA. 		

Course Title	Math Deficiency - II		
Course Code	MD-002		
Credit Hours	3* (3,0)		
Category	Math Deficiency		
Prerequisite	None		
Co-Requisite	None		
Follow Up	Calculus and analytic Geometry		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Know the concepts and applications of complex number, sequences, series, permutations and combinations, integration and differentiation	C1 (Know)	1
	CLO2: Describe functions, limit, continuity chain rule and related techniques.	C2 (Describe)	1
	CLO3: Identify and solve problems related to differentiation and integration.	C3 (Apply)	1,3
Syllabus	<p>Complex Numbers: Complex Numbers, Arithmetic with Complex Numbers (Add, subtract, multiply and divide complex numbers), Trigonometric Polar Form of Complex Numbers, De Moivre's Theorem and nth Roots, Recursion. Sequences and Series: Sigma Notation, Arithmetic Series, Geometric Series (Sum infinite and finite geometric series and categorize geometric series). Counting with Permutations and Combinations. Basic Probability. Binomial Theorem. Limit: Notation, Graphs to Find Limits, Tables to Find Limits, Substitution to Find Limits, Rationalization to Find Limits, One Sided Limits and Continuity. Rate of Change: Instantaneous Rate of Change, Tangent Lines and Rates of Change. Derivatives: The Derivative Function, Introduction to Techniques of Differentiation, The Product and Quotient Rules, Derivatives of Trigonometric Functions, The Chain Rule, Derivatives of Logarithmic Functions, Derivatives of Exponential and Inverse Trigonometric Functions. Increase, Decrease, and Concavity, Relative Extrema, Absolute Maxima and Minima. Integrals: An Overview of the Area Problem, Area Under a Curve, The Indefinite Integral, Integration by Substitution, The Definition of Area as a Limit; Sigma Notation, The Definite Integral.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Textbook of Algebra and Trigonometry Class XI is published by Punjab Textbook Board (PTB) Lahore, Pakistan. 2. Calculus and Analytic Geometry, MATHEMATICS 12 (Mathematics FSc Part 2 or HSSC-II), Punjab Text Book Board Lahore, Pakistan 3. Mark J. Christensen, Computing for Calculus, 1st Edition, Academic Press, (1st January 1981), 240 pages, ISBN: 9781483271088. 4. Lay, L. D. 2015. Probability and Statistics for Engineering and the Sciences, 9th Ed. Cengage Learning, Boston, MA, USA. 5. Howard, Anton, Irl Bivens, Stephen Davis, Calculus, 11th Ed, 2011, John Wiley & Sons, Inc. (1318 Pages) 		

4) General Education

Course Title	Applications of Information & Communication Technologies		
Course Code	GE-160		
Credit Hours	2 (2,0)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow Up	None		
Course Introduction	This course is designed to provide students with an exploration of the practical applications of Information and Communication Technologies (ICT) and software tools in various domains. Students will gain hands-on experience with a range of software applications, learning how to leverage ICT to solve daily life problems, enhance productivity and innovate in different fields. Through individual and interactive exercises and discussions, students will develop proficiency in utilizing software for communication, creativity, and more.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain the fundamental concepts, components, and scope of ICT.	C2 (Explain)	1,2
	CLO2: Identify uses of various ICT platforms and tools for different purposes.	C4 (Identify)	1,2,3
	CLO3: Apply ICT platform and tools for different purposes to address basic needs in different domains of daily, academic, and professional life.	C3 (Apply)	3,4,5
	CLO4: Understand the ethical and legal considerations in use of ICT platforms and tools.	C2 (Understand)	1,2,3
Syllabus	<p>Introduction to ICT Components of ICT (basics of hardware, software, ICT platforms, networks, local and cloud data storage, etc.), Scope of ICT (use of ICT in education, business, governance, healthcare, digital media and entertainment, etc.), Emerging technologies and future trends.</p> <p>Basic ICT Productivity Tools: Effective use of popular search engines to explore WWW, Formal communication tools and etiquettes (Gmail, Microsoft Outlook, etc.) Microsoft Office Suites (Word, Excel, PowerPoint), Google Workspace (Google Docs, Sheets, Slides), Google Drive, Dropbox (cloud storage and file sharing), Google Drive (Cloud storage with Google Docs integration) and Microsoft OneDrive (Cloud storage with Microsoft integration), Evernote (Note-taking and organization applications) and OneNote (Microsoft's digital notebook for capturing and organizing ideas), Video conferencing (Google Meet, Microsoft Teams, Zoom, etc.), social media applications (LinkedIn, Facebook, Instagram, etc.)</p> <p>ICT in Education: Working with learning management systems (Moodle, Canvas, Google Classrooms, etc.), Sources of online education courses (Coursera, edX, Udemy, Khan Academy, etc.), Interactive multimedia and virtual classrooms</p> <p>ICT in Health and Well-being: Health and fitness tracking devices and applications (Google Fit, Samsung Health, Apple Health, Xiaomi Mi Band, Runkeeper, etc.), Telemedicine and online health consultations (OLADOC, Sehat Kahani, Mahram, etc.)</p> <p>ICT in Personal Finance and Shopping: Online banking and financial management tools (JazzCash, Easypaisa, Zong PayMax, 1Link and MNET, Keenu Wallet, etc.), E-commerce platforms.</p> <p>Digital Citizenship and Online Etiquette: Intellectual property and copyright issues, Ensuring originality in content creation by avoiding plagiarism and unauthorized use of information sources, Content accuracy and integrity (ensuring that the content share through ICT platforms is free from misinformation, fake news, and manipulation).</p>		
Practical Requirements	1. Guided tutorials and exercises to ensure that students are proficient in commonly used software applications such as word processing software (e.g., Microsoft Word), presentation software, (e.g., Microsoft PowerPoint), spreadsheet software (e.g., Microsoft Excel) among such other tools. Students may be assigned practical tasks that require them to create documents, presentations, and spreadsheets etc.		

	<p>2. Assigning of tasks that involve creating, managing, and organizing files and folders on both local and cloud storage systems. Students will practice file naming conventions, creating directories, and using cloud storage solutions (e.g., Google Drive, OneDrive).</p> <p>3. The use of online learning management systems (LMS) where students can access course materials, submit assignments, participate in discussion forums, and take quizzes or tests. This will provide students with the practical experience with online platforms commonly used in education and the workplace.</p>
<p>Suggested Instructional/ Reading Material</p>	<ol style="list-style-type: none"> 1. "Discovering Computers" by Vermaat, Shaffer, and Freund. 2. Deborah Morley and Charles S. Parker, Understanding Computers: Today and Tomorrow, 16th edition, Cengage Learning, 2016, ISBN-13: 978-1337251853 3. "Computing Essentials" by Morley and Parker. 4. "GO! With Microsoft Office" Series by Gaskin, Vargas, and McLellan. 5. "Exploring Microsoft Office" Series by Grauer and Poatsy. 6. "Technology in Action" by Evans, Martin and Poatsy. 7. Livesley, Robert Kenneth. An introduction to automatic digital computers. Cambridge University Press, 2017. 8. Joan Lambert, Curtis Frye, Microsoft Office 2019 Step by Step, First Edition. ISBN: 978-1-50-930597-1.

Course Title	Applications of Information & Communication Technologies Lab		
Course Code	GE-160-L		
Credit Hours	1 (0,3)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow Up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain the fundamental concepts, components, and scope of ICT.	C2 (Explain)	1,2
	CLO2: Identify uses of various ICT platforms and tools for different purposes.	C4 (Identify)	1,2,3
	CLO3: Apply ICT platform and tools for different purposes to address basic needs in different domains of daily, academic, and professional life.	C3 (Apply)	3,4,5
	CLO4: Understand the ethical and legal considerations in use of ICT platforms and tools.	C2 (Understand)	1,2,3
Syllabus	<p>Implementation of courses contents applications of Information and Communication Technologies: Interaction with components of ICT (basics of hardware, software, ICT platforms, networks, local and cloud data storage, etc.), Basic ICT Productivity Tools: Effective use of popular search engines to explore WWW, Formal communication tools and etiquettes (Gmail, Microsoft Outlook, etc.) 1. Guided tutorials and exercises to ensure that students are proficient in commonly used software applications such as word processing software (e.g., Microsoft Word), presentation software, (e.g., Microsoft PowerPoint), spreadsheet software (e.g., Microsoft Excel) among such other tools, Google Workspace (Google Docs, Sheets, Slides), Dropbox (cloud storage and file sharing), Google Drive (Cloud storage with Google Docs integration) and Microsoft OneDrive (Cloud storage with Microsoft integration), Evernote (Note-taking and organization applications) and OneNote (Microsoft's digital notebook for capturing and organizing ideas), Video conferencing (Google Meet, Microsoft Teams, Zoom, etc.), social media applications (LinkedIn, Facebook, Instagram, etc.). ICT in Education: Working with learning management systems (Moodle, Canvas, Google Classrooms, etc.), Sources of online education courses (Coursera, edX, Udemy, Khan Academy, etc.), Interactive multimedia and virtual classrooms. ICT in Health and Well-being: Health and fitness tracking devices and applications (Google Fit, Samsung Health, Apple Health, Xiaomi Mi Band, Runkeeper, etc.), Telemedicine and online health consultations (OLADOC, Sehat Kahani, Mahram, etc.). ICT in Personal Finance and Shopping: Online banking and financial management tools (JazzCash, Easypaisa, Zong PayMax, 1Link and MNET, Keenu Wallet, etc.), E-commerce platforms. Digital Citizenship and Online Etiquette: Intellectual property and copyright issues, Ensuring originality in content creation by avoiding plagiarism and unauthorized use of information sources, Content accuracy and integrity (ensuring that the content share through ICT platforms is free from misinformation, fake news, and manipulation). Students may be assigned practical tasks that require them to create documents, presentations, and spreadsheets etc.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. "Discovering Computers" by Vermaat, Shaffer, and Freund. 2. Deborah Morley and Charles S. Parker, Understanding Computers: Today and Tomorrow, 16th edition, Cengage Learning, 2016, ISBN-13: 978-1337251853 3. "Computing Essentials" by Morley and Parker. 4. "GO! With Microsoft Office" Series by Gaskin, Vargas, and McLellan. 5. "Exploring Microsoft Office" Series by Grauer and Poatsy. 6. "Technology in Action" by Evans, Martin and Poatsy. 7. Livesley, Robert Kenneth. An introduction to automatic digital computers. Cambridge University Press, 2017. 8. Joan Lambert, Curtis Frye, Microsoft Office 2019 Step by Step, First Edition. ISBN: 978-1-50-930597-1. 		

Title	Functional English		
Code	GE-190		
Credit Hours	3 (3,0)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	GE-191 Expository Writing		
Course Introduction	This course is designed to equip students with essential language skills for effective communication in diverse real-world scenarios. It focuses on developing proficiency in English language usage: word choices, grammar and sentence structure. In addition, the course will enable students to grasp nuanced messages and tailor their communication effectively through application of comprehension and analytical skills in listening and reading. Moreover, the course encompasses a range of practical communication aspects including professional writing, public speaking, and everyday conversation, ensuring that students are equipped for both academic and professional spheres. An integral part of the course is fostering a deeper understanding of the impact of language on diverse audiences. Students will learn to communicate inclusively and display a strong commitment to cultural awareness in their language use. Additionally, the course will enable them to navigate the globalized world with ease and efficacy, making a positive impact in their functional interactions.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Apply enhanced English communication skills through effective use of word choices, grammar and sentence structure.	C4 (Apply)	1,6,7,10
	CL2: Comprehend a variety of literary / non-literary written and spoken texts in English.	C2 (Understand)	1,6,7,10
	CLO3: Effectively express information, ideas and opinions in written and spoken English.	C2 (Explain)	1,6,7,10
Course Learning Outcomes (CLOs)	CLO4: Recognize inter-cultural variations in the use of English language and to effectively adapt their communication style and content based on diverse cultural and social contexts.	C4 (Identify)	1,6,7,10
	Course Description		
	Foundations of Functional English: Vocabulary building (contextual usage, synonyms, antonyms and idiomatic expressions), Communicative grammar (subject-verb-agreement, verb tenses, fragments, run-ons, modifiers, articles, word classes, etc.), Word formation (affixation, compounding, clipping, back formation, etc.), Sentence structure (simple, compound, complex and compound-complex), Sound production and pronunciation. Comprehension and Analysis: Understanding purpose, audience and context, Contextual interpretation (tones, biases, stereotypes, assumptions, inferences, etc.), Reading strategies (skimming, scanning, SQ4R, critical reading, etc.), Active listening (overcoming listening barriers, focused listening, etc.). Effective Communication: Principles of communication (clarity, coherence, conciseness, courteousness, correctness, etc.), Structuring documents (introduction, body, conclusion and formatting), Inclusivity in communication (gender-neutral language, stereotypes, cross-cultural communication, etc.), Public speaking (overcoming stage fright, voice modulation and body language), Presentation skills (organization content, visual aids and engaging the audience), Informal communication (small talk, networking and conversational skills), Professional writing (business e-mails, memos, reports, formal letters, etc.)		
	Practical Requirements		
As part of the overall learning requirements, students will also be exposed to relevant simulations, role-plays and real-life scenarios and will be required to apply skills acquired throughout the course in the form of a final project.			
Suggested Instructional / Reading Material	<ol style="list-style-type: none"> 1. "Understanding and Using English Grammar" by Betty Schramper Azar. 2. "English Grammar in Use" by Raymond Murphy. 3. "The Blue Book of Grammar and Punctuation" by Jane Straus. 4. "English for Specific Purposes: A Learning-Centered Approach" by Tom Hutchinson and Alan Waters. 5. "Cambridge English for Job-hunting" by Colm Downes. 6. "Practical English Usage" by Michael Swan. 7. "Reading Literature and Writing Argument" by Missy James and Alan P. Merickel. 8. "Improving Reading: Strategies, Resources, and Common Core Connections" by Jerry Johns and Susan Lenski. 9. "Comprehension: A Paradigm for Cognition" by Walter Kintsch. 10. "Communication Skills for Business Professionals" by J.P. Verma and Meenakshi Raman. 		

Title	Expository Writing		
Code	GE-191		
Credit Hours	3 (3,0)		
Category	General Education		
Prerequisite	GE-190: Functional English		
Co-Requisite	None		
Follow-up	MS-254: Technical and Business Writing		
Course Introduction	Expository Writing is a sequential undergraduate course aimed at refining writing skills in various contexts. Building upon the foundation of the pre-requisite course, Functional English, this course will enhance students' abilities of producing clear, concise and coherent written texts in English. The course will also enable students to dissect intricate ideas, to amalgamate information and to express their views and opinions through well-organized essays. The students will further be able to refine their analytical skills to substantiate their viewpoints using credible sources while adhering to established ethical writing norms. Additionally, the course will highlight the significance of critical thinking enabling students to produce original and engaging written texts.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Understand the essentials of the writing process integrating pre-writing, drafting, editing and proof reading to produce well-structured essays.	C2 (Understand)	1,6,7,10
	CLO2: Demonstrate mastery of diverse expository types to address different purposes and audiences.	C3 (Apply)	1,6,7,10
	CLO3: Uphold ethical practices to maintain originality in expository writing.	C3 (Demonstrate)	1,6,7,9
Syllabus	<p>Introduction to Expository Writing: Understanding expository writing (definition, types, purpose and applications), Characteristics of effective expository writing (clarity, coherence and organization), Introduction to paragraph writing. The Writing Process: Pre-writing techniques (brainstorming, free-writing, mind-mapping, listing, questioning and outlining etc.), Drafting (three stage process of drafting techniques), Revising and editing (ensuring correct grammar, clarity, coherence, conciseness etc.), Proof reading (fine-tuning of the draft), Peer review and feedback (providing and receiving critique). Essay Organization and Structure: Introduction and hook (engaging readers and introducing the topic), Thesis statement (crafting a clear and focused central idea), Body Paragraphs (topic sentences, supporting evidence and transitional devices), Conclusion (types of concluding paragraphs and leaving an impact), Ensuring cohesion and coherence (creating seamless connections between paragraphs). Different Types of Expository Writing: Description, Illustration, Classification, Cause and effect (exploring causal relationships and outcomes), Process analysis (explaining step-by-step procedures), Comparative analysis (analyzing similarities and differences). Writing for Specific Purposes and Audiences: Different types of purposes (to inform, to analyze, to persuade, to entertain etc.), Writing for academic audiences (formality, objectivity, and academic conventions), Writing for public audiences (engaging, informative and persuasive language), Different tones and styles for specific purposes and audiences. Ethical Considerations: Ensuring original writing (finding credible sources, evaluating information etc.), Proper citation and referencing (APA, MLA, or other citation styles), Integrating quotes and evidences (quoting, paraphrasing, and summarizing), Avoiding plagiarism (ethical considerations and best practices)</p>		
Practical Requirements	As part of the overall learning requirements, students will be required to build a writing portfolio having a variety of expository texts and present the same at the end of the course showcasing proficiency in expository writing.		
Suggested Instructional / Reading Material	<ol style="list-style-type: none"> "The St. Martin's Guide to Writing" by Rise B. Axelrod and Charles R. Cooper. "They Say / I Say: The Moves That Matter in Academic Writing" by Gerald Graff and Cathy Birkenstein. "Writing Analytically" by David Rosenwasser and Jill Stephen. "Style: Lessons in Clarity and Grace" by Joseph M. Williams and Joseph Bizup. "The Elements of Style" by William Strunk Jr. and E.B. White. "Good Reasons with Contemporary Arguments" by Lester Faigley and Jack Selzer. "Writing to Learn; How to Write – and Think – Clearly About Any Subject at All" by William Zinsser. "The Norton Field Guide to Writing" by Richard Bullock, Maureen Daly Goggin, and Francine Weinberg. "The Art of Styling Sentences" by Ann Longknife and K.D. Sullivan. "Writing Today" by Richard Johnson-Sheehan and Charles Paine. 		

Course Title	Calculus and Analytical Geometry		
Course Code	GE-162		
Credit Hours	3 (3,0)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow Up	MS-253: Multivariable Calculus		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Know the concepts and applications of calculus and analytical geometry.	C1 (Know)	1
	CLO2: Describe functions, limit, continuity chain rule and related techniques.	C2 (Describe)	1
	CLO3: Identify and solve problems related to differentiation and integration.	C3 (Apply)	1,3
	CLO4: Know the concepts analytical geometry.	C1 (Know)	1
Syllabus	Motivation and applications of the course. Introduction to limits: Limits and Continuity, Techniques of finding limits, Indeterminate forms of limits, Introduction to functions: 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 Normal lines, Chain rule, implicit differentiation, linear approximation, Applications of differentiation: Extreme value functions, Mean value theorems, Maxima and Minima of a function for single-variable, Concavity. Integral calculus: Concept and idea of Integration, Indefinite Integrals, Techniques of integration, Riemann sums and Definite Integrals, Applications of definite integrals, Improper integral, Applications of Integration; Area under the curve. Analytical Geometry: Straight lines in R ³ , Equations for planes.		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> Howard Anton, Irl C. Bivens and Stephen Davis, Calculus, 11th Edition, Wiley, 2016, ISBN-10: 1119228581, ISBN-13: 978-1119228585. Thomas and Finney, Calculus and Analytic Geometry, 9th Edition, ISBN-13: 978-0201531749, ISBN-10: 0201531747. 		

Title	Ideology and Constitution of Pakistan		
Code	GE-168		
Credit Hours	2 (2,0)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course is designed to provide students with a fundamental exploration of the ideology and the constitution of Pakistan. The course focuses on the underlying principles, beliefs, and aspirations that have been instrumental in shaping the creation and development of Pakistan as a sovereign state. Moreover, the course will enable students to understand the core provisions of the Constitution of the Islamic Republic of Pakistan concerning the fundamental rights and responsibilities of Pakistan citizens to enable them function in a socially responsible manner.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Demonstrate enhanced knowledge of the basis of the ideology of Pakistan with special reference to the contributions of the founding father of Pakistan.	C3 (Demonstrate)	1,10
	CLO2: Demonstrate fundamental knowledge about the Constitution of Pakistan 1973 and its evolution with special reference to state structure.	C3 (Demonstrate)	1,10
	CLO3: Explain about the guiding principles on rights and responsibilities of Pakistan citizens as enshrined in the Constitution of Pakistan 1973.	C2 (Understand)	1,3,10
Syllabus	<p>1. Introduction to the Ideology of Pakistan: Definition and significance of ideology, Historical contest of the creation of Pakistan (with emphasis on socio-political religious and cultural dynamics of British India between 1857 till 1947), Contributions of founding fathers of Pakistan of Pakistan in the freedom movement including but not limited to Allama Muhammad Iqbal, Muhammad Ali Jinnah., etc. Contributions of women and students in the freedom movement for separate homeland for Muslims of British India. Two-Nation Theory: Evolution of the Two-Nation Theory (Urdu-Hindi controversy, Partition of Bengal, Simla Deputation 1906, Allama Iqbal's Presidential Address 1930, Congress Ministries 1937 Lahore Resolution 1940). Introduction to the Constitution of Pakistan: Definition and importance of a constitution, Ideological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949). Constitution and State Structure: Structure of Government (executive, legislature, and judiciary), Distribution of powers between federal and provincial governments, 18th Amendment and its impact on federalism. Fundamental Right, Principles of Policy and Responsibilities: Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles 8-28), Overview of Principles of Policy (Articles 29-40), Responsibilities of the Pakistan citizens (Article 5). Constitutional Amendments: Procedures for amending the Constitution, Notable Constitutional amendments and their implications</p>		
Suggested Instructional / Reading Material	<ol style="list-style-type: none"> 1. "The Idea of Pakistan" by Stephen P. Cohen. 2. "Ideology of Pakistan" by Javed Iqbal. 3. "The Struggle for Pakistan" by I.H. Qureshi. 4. "Pakistan the Formative Phase" by Khalid Bin Sayeed. 5. "Pakistan: Political Roots and Development" by Safdar Mahmood. 6. "Ideology of Pakistan" by Sharif-ul-Mujahid. 7. "The Struggle for Pakistan: A Muslim Homeland and Global Politics" by Ayesha Jala. 8. "Jinnah, Pakistan and Islamic Identity: The Search for Saladin" by Akbar S. Ahmed. 9. "The Making of Pakistan: A Study in Nationalism" by K.K. Aziz. 10. "Pakistan: A New History" by Lan Talbot. 11. "Pakistan in the Twentieth Century: A Political History" by Lawrence Ziring. 12. "The Constitution of Pakistan 1973". Original. 13. "Constitutional and Political Development of Pakistan" by Hamid Khan. 14. "The Parliament of Pakistan" by Mahboob Hussain. 15. "Constitutional Development in Pakistan" by G.W. Choudhury. 16. "Constitution-Making in Pakistan: The Dynamics of Political Order" by G.W. Choudhury. 		

Course Title	Discrete Structures		
Course Code	GE-167		
Credit Hours	3 (3,0)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Understand the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs and Trees etc.	C2 (Understand)	1,3
	CLO2: Apply formal logic proofs and/or informal, but rigorous, logical reasoning to real problems, such as predicting the behavior of software or solving problems such as puzzles.	C3 (Apply)	1,3
	CLO3: Apply discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography.	C3 (Apply)	1,2,3,4
	CLO4: Differentiate various discrete structures and their relevance within the context of computer science, in the areas of data structures and algorithms, in particular	C4 (Differentiate)	1,2,3,4
Course Description	<p>Mathematical Reasoning: Propositional and predicate logic. Propositional Logic: Logical operators, translations between symbolic expressions and formal English expression, logical equivalences. Predicate Logic: Quantifiers, Nested quantification, equivalences, translations between symbolic forms and formal English. Rules of Inference: Proof methods and strategies, Direct proof, Proof by contraposition, proof by induction, proof by implication, Existence proof, Uniqueness proofs, trivial proofs, vacuous proofs. Sets: Notations, set operations, Venn diagrams, countable and uncountable sets, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings. Functions: Injective, surjective, bijective, special types of functions, function composition, inverse functions, recursive functions, compositions, number theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations. Integers and Divisibility: Division theorem, modular arithmetic, LCM, GCD, Euclidean and Extended Euclidean method, finding solutions to congruence. Primes: Fundamental theorem of arithmetic, characterizations of primes, Mersenne primes. Induction: Weak induction, strong induction. Recursion and Recurrences: Formulation of recurrences, closed formulas, Counting: product rule, sum rule, principle of inclusion-exclusion, combinations and permutations, binomial coefficients, Pascal's identity and Pascal's triangle, binomial theorem, pigeonhole principle. Relations: Reflexive, symmetric, transitive, antisymmetric, equivalence relations and equivalence classes, partial orders. Graph Theory: Terminologies, elements of graph theory, planar graphs, graph coloring, Euler graph, Hamiltonian path, rooted trees, traversals, handshaking lemma and corollary, special families of graphs, isomorphism, planarity, Eulerian and Hamiltonian graphs, trees.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Kenneth H. Rosen, Discrete Mathematics and Its Applications, 7th Edition, McGraw Higher-Ed, 2011, ISBN: 0073383090. 2. Susanna S. Epp, Discrete Mathematics with Applications, 4th Edition. 3. Richard Johnsonbaugh, Discrete Mathematics, 7th Edition. 4. Kolman, Busby & Ross, Discrete Mathematical Structures, 4th Edition. 5. Ralph P. Grimaldi, Discrete and Combinatorial Mathematics: An Applied Introduction, 5th Edition. 		

Course Title	Entrepreneurship		
Code	GE-362		
Credit Hours	2 (2,0)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course is designed to promote entrepreneurial spirit and outlook among students, encouraging them to think critically, identify opportunities, and transform their ideas into successful ventures. It aims at imparting them with the requisite knowledge; skills and abilities, enabling them seize the identified opportunities for initiating of business (including requirements for registration and incorporation with regulators such as SECP and others), market research, opportunity identification, business planning, financial literacy for managing finances and securing funding, marketing and sales, team building and innovation, overall, the course is geared towards personal growth and professional development for pursuing innovative ideas, availing opportunities and initiating start-ups.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Knowledge of fundamental entrepreneurial concepts, skills and process	C1 (Knowledge)	1
	CLO2: Understanding of different personal, social and financial aspects associated with entrepreneurial activities	C2 (Understand)	1,3,10
	CLO3: Basic understanding of regulatory requirements to set up an enterprise in Pakistan, with special emphasis on exports	C2 (Understand)	1,3,10
	CLO4: Ability to apply knowledge, skills and abilities acquired in the course to develop a feasible business plan for implementation	C5 (Create)	4,5,6,10
Course Description	<p>Introduction: Definition and concept of entrepreneurship, Why to become an entrepreneur? Entrepreneurial process, Role of entrepreneurship in economic development. Entrepreneurial Skills: Characteristics and qualities of successful entrepreneurs (including stories of successes and failures), Areas of essential entrepreneurial skills and abilities such as creative and critical thinking innovation and risk taking. Opportunity Recognition and Idea Generation: Opportunity identification, evaluation and exploitation, Innovative ideas generation techniques for entrepreneurial ventures. Marketing and sales: Four P's of Marketing, Developing a marketing strategy, Branding. Financial Literacy: Basic concepts of income, savings and investments, Basic concepts of assets, liabilities and equity, Basic concepts of revenue and expenses, Overview of cash-flows, Overview of banking products including Islamic modes of financing, Sources of funding for startups (angel financing, debt financing, equity financing etc.) Team Building for Startups: Characteristics and features of effective teams, Team building and effective leadership for startups. Regulatory Requirements to Establish Enterprises in Pakistan: Types of enterprises (e.g., sole proprietorship; partnership; private limited companies etc.), Intellectual property rights and protection, Regulatory requirements to register an enterprise in Pakistan, with special emphasis on exports firms, Taxation and financial reporting obligation.</p>		
Practical Requirements	As part of the overall learning requirements, students shall be tasked with creating and presenting a comprehensive business plan at the end of the course for a hypothetical or real business idea. This practical exercise shall allow them to apply the knowledge, skills and abilities acquired in the course to develop a feasible business plan and where possible explore the possibility of implementing the plan with support and assistance from established business-persons and entrepreneurs.		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. B. R. Barringer, and R. D. Ireland, Entrepreneurship: Successfully Launching New Ventures, 6th Edition, Prentice Hall, 2019, ISBN: 978-0134729534. 2. "Entrepreneurship: Theory, Process, and Practice" by Donald F. Kuratko. 3. "New Venture Creation: Entrepreneurship for the 21st Century" by Jeffrey A. Timmons, Stephen Spinelli Jr., and Rob Adams. 4. "Entrepreneurship: A Real-World Approach" by Rhonda Abrans. 5. "The Lean Startup: How Today's Entrepreneurs use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries. 6. "Effectual Entrepreneurship" by Stuart Read, Saras Sarasvathy, Nick Dew, Robert Wiltbank, and Anne-Valcric Ohlsson. 		

5) IT Technical Electives

Course Title	Web Technologies		
Course Code	DI-322		
Credit Hours	2 (2,0)		
Category	Domain Core		
Prerequisite	CC-112: Programming Fundamentals		
Co-Requisite	None		
Follow Up	EI-338: Enterprise Systems		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Know web application architecture and, languages and application.	C1 (Know)	1
	CLO2: Describe various approaches to web application development.	C2 (Describe)	1
	CLO3: Develop web applications.	C3 (Apply)	1,3
Syllabus	<p>Introduction: Web Applications, TCP/IP Application Services. Web Servers: Basic Operation, Virtual hosting, Chunked transfers, Caching support, Extensibility. SGML, HTML5, CSS3. XML Languages and Applications: Core XML, XHTML, XHTML MP. Web Services: SOAP, REST, WML, XSL. Operations, Processing HTTP Requests, Processing HTTP Responses, Cookie Coordination, Privacy and P3P, Complex HTTP Interactions, Dynamic Content Delivery. Server Configuration. Server Security. Web Browsers Architecture and Processes: Active Browser Pages: JavaScript, DHTML, AJAX. JSON. Approaches to Web Application Development: Programming in any Scripting language. Search Technologies, Search Engine Optimization. XML Query Language, Semantic Web, Future Web Application Framework.</p> <p>Implementation on compiler of all the concepts/topics discussed in the course which includes, Introduction to Java, Variables, data types, Control Structures, Methods, Classes, Interfaces, Method Overloading and Overriding, Revision of Object oriented programming courses in Java, GUI development, Event Handling, Database Connectivity, Exception Handling, File handling, HTML, CSS, Java Script, Server side Programming in Java, Http Request and Response, Servlets, Servlet Life Cycle, Java Beans, MVC.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Paul J. Deitel and Harvey Deitel, Java How to Program, 11th Edition, Pearson, 2017, ISBN-10: 0134743350, ISBN-13: 978-0134743356. 2. Marty Hall and Larry Brown, Core Servlets and Java Server Pages, 2nd Edition, Pearson, 2017, ISBN-10: 8131701638, ISBN-13: 978-8131701638. 		

Course Title	Web Technologies Lab		
Course Code	DI-322-L		
Credit Hours	1 (0,3)		
Category	Domain Core		
Prerequisite	CC-112: Programming Fundamentals		
Co-Requisite	None		
Follow Up	EI-338: Enterprise Systems		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Know web application architecture and, languages and application.	C1 (Know)	1
	CLO2: Describe various approaches to web application development.	C2 (Describe)	1
	CLO3: Develop web applications.	C3 (Apply)	1,3
Syllabus	Implementation on compiler of all the concepts/topics discussed in the course which includes, Introduction to Java, Variables, data types, Control Structures, Methods, Classes, Interfaces, Method Overloading and Overriding, Revision of Object oriented programming courses in Java, GUI development, Event Handling, Database Connectivity, Exception Handling, File handling, HTML, CSS, Java Script, Server side Programming in Java, Http Request and Response, Servlets, Servlet Life Cycle, Java Beans, MVC.		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Paul J. Deitel and Harvey Deitel, Java How to Program, 11th Edition, Pearson, 2017, ISBN-10: 0134743350, ISBN-13: 978-0134743356. 2. Marty Hall and Larry Brown, Core Servlets and Java Server Pages, 2nd Edition, Pearson, 2017, ISBN-10: 8131701638, ISBN-13: 978-8131701638. 		

Course Title	Mobile Application Development		
Course Code	EI-333		
Credit Hours	2 (2,0)		
Category	Domain Elective		
Prerequisite	CC-211: Object Oriented Programming		
Co-Requisite	None		
Follow-up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain characteristics of mobile application.	C2 (Explain)	1,2
	CLO2: Use Android platform for application development.	C3 (Apply)	1,2,3
	CLO3: Identify potential and applications of data storage technologies.	C4 (Identify)	1,2,3
	CLO4: Use Android Native Development Kit in a mobile application development.	C3 (Apply)	3,4,5
Syllabus	<p>Introduction: Mobile Computing Domain, Comparison of different Mobile Platforms, Revision of Java. Android Platform: Dalvik Virtual Machine, Android Constructs (Activity, Intent, Content Provider, Service, Broadcast Receiver), Activity Lifecycle, Project Structure, Manifest File, Emulators (AVD), Debugging (DDMS), R.java, Inter Activity Communication (Intent), Event Handlers, Layout XML, @ Sign, Layouts, Adapters, Dynamic Lists, Holder Pattern, Menus and dialogs, Menu, Menu Group, Menu Item, Icon Menu, Sub Menu, Context Menu, Sub Menu, Dynamic Menu, Using XML Files for Menus, Services, Intents. Data Storage: Key Value Sets, Files, Intro to SQLite, Web Service Integration, JSON, HTTPClient, Graphics, Widgets & Notifications, Multimedia and telephony API, Android Native Development Kit (NDK).</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Mark L. Murphy, Beginning Android 2, Apress, ISBN 978-1-4302-2629-1 2. Zigurd Mednieks, Laird Dornin, G. Blake Meike, and Masumi Nakamura Programming Android, 2nd Edition, O Reilly Press, ISBN: 978-1-449-31664-8 3. Syed Hashmi, Satya Komatineni, Dave Maclean, Pro Android 2, Apress, ISBN 978-1-4302-2659-8 4. http://developer.android.com/develop/index.htm 5. http://developer.android.com/guide/components/services.html 6. http://developer.android.com/guide/components/intents-filters.html 7. http://developer.android.com/guide/topics/data/data-storage.html 8. http://developer.android.com/guide/topics/graphics/index.html 9. http://developer.android.com/guide/topics/sensors/index.html 		

Course Title	Mobile Application Development Lab		
Course Code	EI-333-L		
Credit Hours	1 (0,3)		
Category	Domain Elective		
Prerequisite	CC-211: Object Oriented Programming		
Co-Requisite	None		
Follow-up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain characteristics of mobile application.	C2 (Explain)	1,2
	CLO2: Use Andriod platform for application development.	C3 (Apply)	1,2,3
	CLO3: Identify potential and applications of data storage technologies.	C4 (Identify)	1,2,3
	CLO4: Use Android Native Development Kit in a mobile application development.	C3 (Apply)	3,4,5
Syllabus	<p>Implementation of the concepts/topics discussed in the course.</p> <p>Introduction: Mobile Computing Domain, Comparison of different Mobile Platforms, Revision of Java. Android Platform: Dalvik Virtual Machine, Android Constructs (Activity, Intent, Content Provider, Service, Broadcast Receiver), Activity Lifecycle, Project Structure, Manifest File, Emulators (AVD), Debugging (DDMS), R.java, Inter Activity Communication (Intent), Event Handlers, Layout XML, @ Sign, Layouts, Adapters, Dynamic Lists, Holder Pattern, Menus and dialogs, Menu, Menu Group, Menu Item, Icon Menu, Sub Menu, Context Menu, Sub Menu, Dynamic Menu, Using XML Files for Menus, Services, Intents. Data Storage: Key Value Sets, Files, Intro to SQLite, Web Service Integration, JSON, HTTPClient, Graphics, Widgets & Notifications, Multimedia and telephony API, Android Native Development Kit (NDK).</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Mark L. Murphy, Beginning Android 2, Apress, ISBN 978-1-4302-2629-1 2. Zigurd Mednieks, Laird Dornin, G. Blake Meike, and Masumi Nakamura Programming Android, 2nd Edition, O Reilly Press, ISBN: 978-1-449-31664-8 3. Syed Hashmi, Satya Komatineni, Dave Maclean, Pro Android 2, Apress, ISBN 978-1-4302-2659-8 4. http://developer.android.com/develop/index.htm 5. http://developer.android.com/guide/components/services.html 6. http://developer.android.com/guide/components/intents-filters.html 7. http://developer.android.com/guide/topics/data/data-storage.html 8. http://developer.android.com/guide/topics/graphics/index.html 9. http://developer.android.com/guide/topics/sensors/index.html 		

Course Title	Data Science		
Course Code	EI-334		
Credit Hours	3 (2,1)		
Category	Domain Elective		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course is designed to introduce students to the rapidly growing field of data science and equip them with some of its basic principles and tools, as well as its general mindset. It covers the significance of exploratory data analysis in data science, the identification of common approaches used for feature generation as well as feature selection, and the discussion regarding ethical and privacy issues.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Describe what Data Science is and the skill sets needed to be a data scientist.	C2 (Explain)	1, 2
	CLO2: Apply EDA and the Data Science process in a case study.	C3 (Apply)	2, 3
	CLO3: Comprehend the fundamental constructs of Python programming language.	C2 (Understand)	1, 2, 5
	CLO4: Apply basic machine learning algorithms to solve real world problems of moderate complexity.	C3 (Apply)	3, 4, 5
Syllabus	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; Introduction 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, Neighbourhood 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.		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Igual, L. S. Segui. 2017. Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications. 1st edition, Springer. Cham. ISBN 978-3-319-50016-4. 2. Saltz, J.S., J. M. 2017. Stanton, An Introduction to Data Science, SAGE Publications. 3. Subramanian, G. 2015. Python Data Science Cookbook. Packt Publishing, 1st Edition. ISBN 978-1-78439-640-4 4. Grus, J. 2015. Data Science from Scratch, O'Reilly Media, 1st Edition, 2015; ISBN 978-1-491-90142-7 5. Zaki. M. J., W. Meira. 2014. Data Mining and Analysis: Fundamental Concepts and Algorithms. 1st edition. Cambridge University Press. ISBN 978-0-521-76633-3 		

Course Title	Data Science Lab		
Course Code	EI-334-L		
Credit Hours	1 (0,3)		
Category	Domain Elective		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course is designed to introduce students to the rapidly growing field of data science and equip them with some of its basic principles and tools, as well as its general mindset. It covers the significance of exploratory data analysis in data science, the identification of common approaches used for feature generation as well as feature selection, and the discussion regarding ethical and privacy issues.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Describe what Data Science is and the skill sets needed to be a data scientist.	C2 (Explain)	1, 2
	CLO2: Apply EDA and the Data Science process in a case study.	C3 (Apply)	2, 3
	CLO3: Comprehend the fundamental constructs of Python programming language.	C2 (Understand)	1, 2, 5
	CLO4: Apply basic machine learning algorithms to solve real world problems of moderate complexity.	C3 (Apply)	3, 4, 5
Syllabus	<p>Implementation of the concepts/topics discussed in the course.</p> <p>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; Introduction 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, Neighbourhood 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.</p>		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. Igual, L. S. Segui. 2017. Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications. 1st edition, Springer. Cham. ISBN 978-3-319-50016-4. 2. Saltz, J.S., J. M. 2017. Stanton, An Introduction to Data Science, SAGE Publications. 3. Subramanian, G. 2015. Python Data Science Cookbook. Packt Publishing, 1st Edition. ISBN 978-1-78439-640-4 4. Grus, J. 2015. Data Science from Scratch, O'Reilly Media, 1st Edition, 2015; ISBN 978-1-491-90142-7 5. Zaki. M. J., W. Meira. 2014. Data Mining and Analysis: Fundamental Concepts and Algorithms. 1st edition. Cambridge University Press. ISBN 978-0-521-76633-3 		

Course Title	Cloud Computing		
Course Code	EI-339		
Credit Hours	3 (2,1)		
Category	Domain Elective		
Prerequisite	CC-214: Computer Networks		
Co-Requisite	None		
Follow-up	None		
Course Introduction	Nowadays cloud computing becomes popular for individuals' users as well as for the business community. It provides on-demand huge computation and storage resources which is attractive for a large number of users mainly due to pay-per-usage charging model. This course will introduce topics related to Cloud Computing and also expose students to the latest tools and technologies used in Cloud Computing. The aim of this course is to provide an in-depth knowledge of Cloud Computing topics. The course would also expose students to important methods and tools used Cloud Computing.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain Cloud computing, virtualization, Dockers and scalable web applications.	C2 (Explain)	1,2
	CLO2: Familiarize with Load Balancing AWS ELB, Nginx, Ipvadm, Ldirectord.	C1 (Know)	1,2
	CLO3: Demonstrate the use of NoSQL, MongoDB and DynamoDB, Revision, MapReduce	C3 (Apply)	3,4,5
	CLO4: Explain Big Data transformation methods.	C2 (Explain)	2,4,5
Syllabus	Introduction To Cloud Computing, Introduction To Cloud Computing (Cont.), AWS Services, EC2 hands, Accessing AWS S3 , Virtualization , Containerization/Dockers, Scalable Web Application in The Cloud, Scalable Web Application in The Cloud (Cont.), Load Balancing AWS ELB, Nginx, Ipvadm, Ldirectord, Web Application Deployment Models, Introduction to Big Data, Introduction to Big Data (Cont.), Introduction to NoSQL, MongoDB and DynamoDB, Revision, MapReduce, Distributed Systems, Consistency and Fault Tolerance in Distributed Systems, Big Data Transformation Methods , Blockchain, Practical Considerations in Cloud Computing, Future of the Cloud Computing and Big Data		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. JothyRosenberg and Arthur Mateos;The Cloud at Your Service;Manning Publications. ISBN: 1935182528 2. Paul Zikopoulos and Chris Eaton; Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data; McGraw-Hill. ISBN: 0071790535 3. Kyle Banker, Peter Bakkum, Shaun Verch, Douglas Garrett, and Tim Hawkins; MongoDB in Action, Second Edition. 4. Clinton W. Brownley; Foundations for Analytics with Python from Non-Programmer to Hacker. 		

Course Title	Cloud Computing Lab		
Course Code	EI-339-L		
Credit Hours	1 (0,3)		
Category	Domain Elective		
Prerequisite	CC-214: Computer Networks		
Co-Requisite	None		
Follow-up	None		
Course Introduction	Nowadays cloud computing becomes popular for individuals' users as well as for the business community. It provides on-demand huge computation and storage resources which is attractive for a large number of users mainly due to pay-per-usage charging model. This course will introduce topics related to Cloud Computing and also expose students to the latest tools and technologies used in Cloud Computing. The aim of this course is to provide an in-depth knowledge of Cloud Computing topics. The course would also expose students to important methods and tools used Cloud Computing.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain Cloud computing, virtualization, Dockers and scalable web applications.	C2 (Explain)	1,2
	CLO2: Familiarize with Load Balancing AWS ELB, Nginx, Ipvadm, Ldirectord.	C1 (Know)	1,2
	CLO3: Demonstrate the use of NoSQL, MongoDB and DynamoDB, Revision, MapReduce	C3 (Apply)	3,4,5
	CLO4: Explain Big Data transformation methods.	C2 (Explain)	2,4,5
Syllabus	Implementation of the concepts/topics discussed in the course. Introduction To Cloud Computing, Introduction To Cloud Computing (Cont.), AWS Services, EC2 hands, Accessing AWS S3 , Virtualization , Containerization/Dockers, Scalable Web Application in The Cloud, Scalable Web Application in The Cloud (Cont.), Load Balancing AWS ELB, Nginx, Ipvadm, Ldirectord, Web Application Deployment Models, Introduction to Big Data, Introduction to Big Data (Cont.), Introduction to NoSQL, MongoDB and DynamoDB, Revision, MapReduce, Distributed Systems, Consistency and Fault Tolerance in Distributed Systems, Big Data Transformation Methods , Blockchain, Practical Considerations in Cloud Computing, Future of the Cloud Computing and Big Data		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. JothyRosenberg and Arthur Mateos;The Cloud at Your Service;Manning Publications. ISBN: 1935182528 2. Paul Zikopoulos and Chris Eaton; Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data; McGraw-Hill. ISBN: 0071790535 3. Kyle Banker, Peter Bakkum, Shaun Verch, Douglas Garrett, and Tim Hawkins; MongoDB in Action, Second Edition. 4. Clinton W. Brownley; Foundations for Analytics with Python from Non-Programmer to Hacker. 		

Course Title	Global IT Services and Workspace		
Course Code	EI-236		
Credit Hours	2 (2,0)		
Category	IT Elective		
Prerequisite	Programming Fundamentals		
Co-Requisite	None		
Follow Up	None		
Course Introduction	<p>This course is designed to prepare students in the Associate Degree Program in Information Technology for global IT services and employment, equipping them with the necessary knowledge and skills to leverage their programming, web and mobile development, databases, and software engineering expertise in the global market. It covers global IT services, remote working, freelancing, self-employment, and lifelong learning, including relevant processes, procedures, tools, methods, techniques, legislation, rules, ethics, and critical considerations. Additionally, it explores Free and Open Source Software (FOSS) and entrepreneurship, providing insights into FOSS impact, benefits, and challenges, as well as guiding students in starting and managing IT businesses. This course bridges the gap between academic learning and real-world IT practices, preparing students for successful careers in the global IT market.</p>		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Analyze the structure and dynamics of the global IT market, identifying key players, service models, and emerging trends.	C4 (Analyze)	1, 2, 8
	CLO2: Apply and evaluate effective remote working models and freelancing practices, utilizing appropriate tools and platforms to manage virtual workspaces and teams.	C3 (Apply)	5, 6, 7
	CLO3: Demonstrate proficiency in using essential communication, collaboration, and project management tools, as well as version control systems and cloud services, to facilitate global IT employment.	C3 (Apply)	4, 5
	CLO4: Assess and apply ethical, legal, and regulatory considerations in global IT work, including data protection laws, intellectual property rights, and cross-border legal issues.	C6 (Evaluate)	8, 9
	CLO5: Explain the benefits and challenges of Free and Open Source Software (FOSS), and develop entrepreneurial skills by creating business plans, managing clients, and understanding the essentials of starting and running an IT business.	C3 (Apply)	4, 10
Course Description	<p>Comprehensive overview of global IT services, service models, key players, and emerging trends in the market. Remote working and freelancing, platforms, tools, and techniques for setting up remote workspaces and managing virtual teams. Communication and project management tools, version control systems, and cloud services. Agile and Scrum methodologies, DevOps practices, and CI/CD pipelines. Ethical, legal, and regulatory aspects of global IT work, data protection laws, intellectual property rights, and cross-border legal issues. Free and Open Source Software (FOSS), benefits, challenges, major projects, and legal considerations. Entrepreneurship, starting an IT business, business planning, personal branding, marketing, client management, and financial management for freelancers and entrepreneurs. Lifelong learning, online learning platforms and obtaining professional certifications.</p>		
Text Book(s)	<ol style="list-style-type: none"> 1. Kristina Romero, The Art of Freelance: A Practical Guide to Finding and Winning Clients, publisher and year not available, ISBN not available. 2. Jason Fried and David Heinemeier Hansson, Remote: Office Not Required, Crown Business, 2013, ISBN 978-0804137508. 3. Joey Korenman, The Freelance Manifesto: A Field Guide for the Modern Motion Designer, Lioncrest Publishing, 2017, ISBN 978-1544512280. 4. Eric Ries, The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Crown Business, 2011, ISBN 978-0307887894. 5. Jeff Sutherland, Scrum: The Art of Doing Twice the Work in Half the Time, Crown Business, 2014, ISBN 978-0385346450. 6. Eric S. Raymond, The Cathedral & the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary, O'Reilly Media, 2001, ISBN 978-0596001087. 		
Reference Material	NA		

Course Title	Global IT Services and Workspace Lab		
Course Code	EI-236-L		
Credit Hours	1 (0,3)		
Category	IT Elective		
Prerequisite	Programming Fundamentals		
Co-Requisite	None		
Follow Up	None		
Course Introduction	This course is designed to prepare students in the Associate Degree Program in Information Technology for global IT services and employment, equipping them with the necessary knowledge and skills to leverage their programming, web and mobile development, databases, and software engineering expertise in the global market. It covers global IT services, remote working, freelancing, self-employment, and lifelong learning, including relevant processes, procedures, tools, methods, techniques, legislation, rules, ethics, and critical considerations. Additionally, it explores Free and Open Source Software (FOSS) and entrepreneurship, providing insights into FOSS impact, benefits, and challenges, as well as guiding students in starting and managing IT businesses. This course bridges the gap between academic learning and real-world IT practices, preparing students for successful careers in the global IT market.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CL01: Analyze the structure and dynamics of the global IT market, identifying key players, service models, and emerging trends.	C4 (Analyze)	1, 2, 8
	CL02: Apply and evaluate effective remote working models and freelancing practices, utilizing appropriate tools and platforms to manage virtual workspaces and teams.	C3 (Apply)	5, 6, 7
	CL03: Demonstrate proficiency in using essential communication, collaboration, and project management tools, as well as version control systems and cloud services, to facilitate global IT workspace.	C3 (Apply)	4, 5
	CL04: Assess and apply ethical, legal, and regulatory considerations in global IT work, including data protection laws, intellectual property rights, and cross-border legal issues.	C6 (Evaluate)	8, 9
	CL05: Explain the benefits and challenges of Free and Open Source Software (FOSS), and develop entrepreneurial skills by creating business plans, managing clients, and understanding the essentials of starting and running an IT business.	C3 (Apply)	4, 10
Course Description	Practical implementation of course contents studied in the course of Global IT services and Workspace, service models, key players, and emerging trends in the market. Remote working and freelancing, platforms, tools, and techniques for setting up remote workspaces and managing virtual teams. Communication and project management tools, version control systems, and cloud services. Agile and Scrum methodologies, DevOps practices, and CI/CD pipelines. Ethical, legal, and regulatory aspects of global IT work, data protection laws, intellectual property rights, and cross-border legal issues. Free and Open Source Software (FOSS), benefits, challenges, major projects, and legal considerations. Entrepreneurship, starting an IT business, business planning, personal branding, marketing, client management, and financial management for freelancers and entrepreneurs. Lifelong learning, online learning platforms and obtaining professional certifications.		
Text Book(s)	<ol style="list-style-type: none"> 1. Kristina Romero, The Art of Freelance: A Practical Guide to Finding and Winning Clients, publisher and year not available, ISBN not available. 2. Jason Fried and David Heinemeier Hansson, Remote: Office Not Required, Crown Business, 2013, ISBN 978-0804137508. 3. Joey Korenman, The Freelance Manifesto: A Field Guide for the Modern Motion Designer, Lioncrest Publishing, 2017, ISBN 978-1544512280. 4. Eric Ries, The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Crown Business, 2011, ISBN 978-0307887894. 5. Jeff Sutherland, Scrum: The Art of Doing Twice the Work in Half the Time, Crown Business, 2014, ISBN 978-0385346450. 6. Eric S. Raymond, The Cathedral & the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary, O'Reilly Media, 2001, ISBN 978-0596001087. 		
Reference	NA		

