UNIVERSITY OF THE PUNJAB

NOTIFICATION

The Vice-Chancellor has, in exercise of the powers vested in him under Section 15(3) of the University of the Punjab Act, 1973 and in anticipation of approval of the Academic Council/Syndicate, been pleased to approve the recommendations of the Boards of Studies in Software Engineering, Information Technology and Computer Science and Board of Faculty of Computing & Information Technology at their meetings held on 10-04-2026, 23-04-2026, 30-04-2026 and 04-06-2026 respectively regarding the launch and approval of the Curriculum for the following Programs to be offered at University of the Punjab and its Affiliated Colleges from Fall 2026 :-

1. BS Computer Science
2. BS Computer Science (Specialization in Information Technology)
3. BS Computer Science (Specialization in Software Engineering)
4. BS Computer Science (Specialization in Artificial Intelligence)
5. Associate Degree in Computing
6. Associate Degree in Computing (Specialization in Information Technology)
7. Associate Degree in Computing (Specialization in Artificial Intelligence)

The Curriculum and Course Syllabi for above mentioned Programs are attached herewith, vide Annexure 'A' to 'G'.

Sd/-
Dr. Ahmad Islam
Registrar

Admin. Block,
Quaid-i-Azam Campus,
Lahore.
No. D/ 2690 /Acad. **Dated: 10-06-2026.**

Copy of the above is forwarded to the following for information and further necessary action: -

1. Pro-Chancellor/The Minister of Education, Govt. of the Punjab, Lahore.
2. Members of the Syndicate.
3. Dean, Faculty of Computing & Information Technology.
4. Chairman, Department of Computer Science/Software Engineering/ Information Technology
5. Principals of Affiliated Colleges (Concerned)
6. Controller of Examinations
7. Director. Quality Enhancement Cell
8. Director, IT (for Uploading on website)
9. Additional Registrar (Affiliation)
10. Deputy Registrar (General)
11. Secretary to the Vice-Chancellor
12. Secretary to the Pro-Vice-Chancellor
13. Secretary to the Registrar
14. Assistant Registrar (Statutes)
15. Assistant Registrar Syndicate (with file)
16. Assistant Registrar (Syllabus)

Dr. Ahmad Islam
Registrar

Curricula Scheme of Study and Syllabi

Program

Associate Degree Computing (Specialization in Artificial Intelligence)
[ADC (AI)]
Offered at Affiliated Colleges of University of the Punjab

Department

Department of Information Technology

Faculty

Faculty of Computing & Information Technology

Version: 1.0.0

Date: 08-06-2026

University of the Punjab, Lahore

Contents

1. Introduction

Artificial Intelligence (AI) has become a transformative force in shaping modern society. From everyday applications such as recommendation systems and virtual assistants to advanced solutions in healthcare, finance, and autonomous systems, AI provides intelligent capabilities that enhance decision-making and efficiency. AI technologies are now a critical component of digital infrastructure, enabling organizations to innovate and remain competitive. The Department of Information Technology (DIT) is committed to providing cutting-edge education and training to equip students with the skills needed to excel in this dynamic field. Our graduates are prepared to compete on both national and international levels, contributing to the advancement of AI and its applications.

2. Vision

To be a globally acclaimed institution, recognized for excellence in education, research, and innovation.

3. Mission

To rigorously train students in the field of Artificial Intelligence and related disciplines, empowering them with the knowledge, skills, and ethical values necessary to serve society and contribute to the advancement of humanity.

4. Program Introduction

The Associate Degree Computing (Specialization in Artificial Intelligence) [ADC(AI)] 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 ADC(AI) are to:

5.1 PEO1: Technical Proficiency and Innovation

Enable students to design, develop, and deploy AI-based solutions to solve real-world problems. Graduates will exhibit technical expertise by applying theoretical knowledge and practical skills in AI, fostering innovation and enhancing problem-solving through critical and computational thinking. They will be prepared for successful careers in academia, industry, and entrepreneurial endeavors.

Instill a strong sense of ethical and professional responsibility in graduates, ensuring they understand the societal implications of AI technologies. Graduates will work collaboratively in interdisciplinary teams, demonstrate leadership, and address ethical, legal, and cultural considerations while adhering to professional standards in their practice.

5.2 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.

5.3 PEO3: Lifelong Learning and Communication Skills

Cultivate lifelong learning abilities, enabling graduates to stay abreast of emerging AI technologies and tools. Graduates will adapt to evolving challenges, pursue continuous professional growth, and communicate complex ideas effectively through oral and technical mediums. This prepares them for diverse roles in academia, industry, and public service.

6. 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.

7. 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			√

8. 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 recall or remember the information?	know, describe, identify, label, list, match, memorize, recall
Understand	Can the students explain ideas or concepts?	classify, describe, cite, discuss, generalize, illustrate, restate (in own words), summarize
Applying	Can the students use the information in a new way?	assess, choose, solve, demonstrate, dramatize, demonstrate, establish, extend, illustrate,
Analyzing	Can the students distinguish between different parts?	analyze, appraise, categorize, compare, identify, contrast, criticize, differentiate, recognize
Creating	Can the students create 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 justify a stand or decision?	appraise, argue, choose, compare, conclude, contrast, criticize, interpret, judge, justify, predict, rate

9. Admission Eligibility Criteria

- Higher Secondary School Certificate/A-levels (involving minimum 12 years of schooling) or an IBCC equivalent qualification, with at least 45% marks and having studied Mathematics, is the basic eligibility requirement for admission in all BS Computer Science.
    - The students who have not studied Mathematics at intermediate level have to pass deficiency courses of Mathematics (06 credits) in first year including zero semester.
- Additionally, applicants may be required to pass an entry test conducted by the department, university, or admission authority, along with fulfilling any other criteria set by the institution, such as interviews or aptitude assessments.

Note: For admission to the BS Computing programs (5th Semester) through the Associate Degree in Computing (AD Computing) pathway, a candidate must have obtained at least 50% marks in the Higher Secondary School Certificate/A-levels (involving minimum 12 years of schooling) or an IBCC equivalent qualification and a CGPA of 2.0 in AD Computing degree. (NCEAC Letter No. NCEAC/HEC/Notification/Admission/4-26/02, Dated: April 22, 2026)

10. Duration of the Program and Degree Awarding Criteria

The ADP in Artificial Intelligence spans 4 semesters over 2 years and requires the completion of 72 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.

11. Categorization of Courses

11.1 Nomenclature of Course Categories and Course Codes

C	Code	Description	Courses	Cr. Hrs.	
0	MD	Math Deficiency	2*	6*	(6,0)*
1	CC	Computing Core	13	26	(20,6)
2,3	EI	Specialization Elective	8	12	(8,4)
6	GE	General Education Courses (Math & Science)	5	12	(10,2)
7	GE	General Education Courses (Management & Social Science)	4	8	(8,0)
9	GE	General Education Courses (Arts & Languages)	7	14	(12,2)
		Total	**36**	**72**	**(58,14)**

Course Coding Scheme:

Code-SCN

Code = CC / EI / MS / GE / HQ

S = Year of Offering (Earliest) = 1, 2, 3, 4

C = Course Category Code = 0, 1, …, 9

N = Serial Number (Resets with Year) = 0, 1

Lab Codes: Code-SCN-L

11.2 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 2025.*

CC: Computing Core **MD:** Math Deficiency **GE:** General Education
EI: Specialization Elective **ID:** Interdisciplinary

Semester	Courses Count (Theory, Lab)	Category (Credit Hours)					Semester Load	
		CC	GE	EA		MD	Cr. Hrs.	Cont. Hrs.
1	8 (6, 2)	04	15	00		3*	**19 (15,4)**	**(15,12)**
2	8 (6, 2)	08	09	00		3*	**17 (14,3)**	**(14,9)**
3	10 (6, 4)	10	02	06		0	**18 (14,4)**	**(14,12)**
4	10 (7,3)	04	08	06		0	**18 (15,3)**	**(15,9)**
PU	**36 (25, 11)**	**26**	**34**	**12**		**6***	**72 (58,13)**	**(58,34)**
HEC Guidelines	**36 (25, 11)**	**26**	**34**	**12**		**6***	**72 (58,13)**	**(58,34)**
Difference (HEC &) PU	**0**	**00**	**00**	**00**		**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.

11.3 Category-wise List of Courses

COMPUTING CORE: 26 (20,6)					
Sr.	**Sem.**	**Code**	**Course Title**	**Prerequisite**	**Cr. Hrs.**
1	1	CC-112	Programming Fundamentals		3 (3,0)
2	1	CC-112-L	Programming Fundamentals Lab		1 (0,1)
3	2	CC-211	Object Oriented Programming	Programming Fundamentals	3 (3,0)
4	2	CC-211-L	Object Oriented Programming Lab	Programming Fundamentals	1 (0,1)
5	2	CC-215	Database Systems		3 (3,0)
6	2	CC-215-L	Database Systems Lab		1 (0,1)
7	3	CC-213	Data Structures	Object Oriented Programming	3 (3,0)
8	3	CC-213-L	Data Structures Lab	Object Oriented Programming	1 (0,1)
9	3	CC-113	Computer Networks		2 (2,0)
10	3	CC-113-L	Computer Networks Lab		1 (0,1)
11	3	CC-212	Software Engineering		3 (3,0)
12	4	CC-216	Operating Systems		3 (3,0)
13	4	CC-216-L	Operating Systems Lab		1 (0,1)
GENERAL EDUCATION: 34 (30,4)					
Sr.	**Sem.**	**Code**	**Course Title**	**Sub Category**	**Cr. Hrs.**
1	1	GE-160	Applications of Information & Communication Technologies	Math & Science	2 (2,0)
2	1	GE-160-L	Applications of Information & Communication Technologies Lab	Math & Science	1 (0,1)
3	1	GE-167	Discrete Structures	Math & Science (QR-1)	3 (3,0)
4	1	GE-169	Applied Physics	Math & Science	3 (2,1)
5	1	GE-190	Functional English	Arts & Languages	3 (3,0)
6	1	GE-194	Pakistan Studies	Arts & Languages	2 (2,0)
7	2	GE-191	Expository Writing	Arts & Languages	3 (3,0)
8	2	GE-260	Probability and Statistics	Math & Science (QR-2)	3 (3,0)
9	2	GE-196	Islamic Studies	Arts & Languages	2 (2,0)
10	2	GE-197	Fehm-e-Quran-I	Arts & Languages	1 (0,1)
11	2	GE-198	Fehm-e-Quran-II	Arts & Languages	1 (0,1)
12	3	GE-271	Entrepreneurship	Management & Social Sciences	2 (2,0)
13	4	GE-195	Ideology and Constitution of Pakistan	Arts & Languages	2 (2,0)
14	4	GE-170	Introduction to Management	Management & Social Sciences	2 (2,0)
15	4	GE-270	Professional Practices	Management & Social Sciences	2 (2,0)
16	4	GE-272	Civics and Community Management	Management & Social Sciences	2 (2,0)
AI Specialization Electives: 12 (8,4)					
Sr.	**Sem.**	**Code**	**Course Title**	**Prerequisite**	**Cr. Hrs.**
1	3	EA-331	Web Technologies/Development	Programming Fundamentals	2 (2,0)
2	3	EA-331-L	Web Technologies/Development Lab	Programming Fundamentals	1 (0,1)
3	3	EA-320	Programming for AI		2 (2,0)
4	3	EA-320-L	Programming for AI Lab		1 (0,1)
5	4	EA-321	Machine Learning		2 (2,0)
6	4	EA-321-L	Machine Learning Lab		1 (0,1)
7	4	EA-329	AI-Assisted Software Development		2 (2,0)
8	4	EA-329-L	AI-Assisted Software Development Lab		1 (0,1)

12. Scheme of Studies and Semester-wise Workload

Semester – I						
Sr.	**Code**	**Course Title**	**Pre-Requisite**	**Domain**	**Cr. Hrs.**	**Cont. Hrs.**
1	CC-112	Programming Fundamentals		CC	3	(3,0)
2	CC-112-L	Programming Fundamentals Lab		CC	1	(0,3)
3	GE-160	Applications of Information & Communication Technologies		GE	2	(2,0)
4	GE-160-L	Applications of Information & Communication Technologies Lab		GE	1	(0,3)
5	GE-167	Discrete Structures		GE	3	(3,0)
6	GE-169	Applied Physics		GE	3	(2,3)
7	GE-190	Functional English		GE	3	(3,0)
8	GE-194	Pakistan Studies		GE	2	(2,0)
9	GE-197	Fehm-e-Quran-I		HQ	1	(0,3)
10	MD-101	Math Deficiency – I		MD	3*	(3,0)*
			Credit Hours (Semester - I)		**19**	**(15,12)**
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	GE-260	Probability and Statistics		GE	3	(3,0)
6	GE-191	Expository Writing		GE	3	(3,0)
7	GE-196	Islamic Studies		GE	2	(2,0)
8	GE-198	Fehm-e-Quran-II		HQ	1	(0,3)
9	MD-102	Math Deficiency – II		MD	3*	(3,0)*
			Credit Hours (Semester - II)		**17**	**(14,9)**
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-113	Computer Networks		CC	2	(2,0)
4	CC-113-L	Computer Networks Lab		CC	1	(0,3)
5	CC-212	Software Engineering		CC	3	(3,0)
6	EA-331	Web Technologies/Development		EA	2	(2,0)
7	EA-331-L	Web Technologies/Development Lab		EA	1	(0,3)
8	EA-320	Programming for AI		EA	2	(2,0)
9	EA-320-L	Programming for AI Lab		EA	1	(0,3)
10	GE-362	Entrepreneurship		GE	2	(2,0)
			Credit Hours (Semester - III)		**18**	**(14,12)**
Semester – IV						
Sr.	**Code**	**Course Title**	**Pre-Requisite**	**Domain**	**Cr.**	**Cont.**

					Hrs.	Hrs.
1	CC-216	Operating Systems		CC	3	(3,0)
2	CC-216-L	Operating Systems Lab		CC	1	(0,3)
3	EA-321	Machine Learning		EA	2	(2,0)
4	EA-321-L	Machine Learning Lab		EA	1	(0,3)
5	EA-329	AI-Assisted Software Development		EA	2	(2,0)
6	EA-329-L	AI-Assisted Software Development Lab		EA	1	(0,3)
7	GE-195	Ideology and Constitution of Pakistan		GE	2	(2,0)
8	GE-170	Introduction to Management		GE	2	(2,0)
9	GE-270	Professional Practices		GE	2	(2,0)
10	GE-272	Civics and Community Management		GE	2	(2,0)
Credit Hours (Semester - IV)					**18**	**(15, 9)**

13. Course Outlines

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

1) Computing Core

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, EI-322: Web Technologies, EI-326: Enterprise Application Development, EI-327: Information Technology Infrastructure		
Course Introduction	This course provides fundamental concepts of programming to freshmen. The courses 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: Explain core programming concepts including variables, control structures, functions, and data types.	C2 (Understand)	1,2
	CLO2: Demonstrate proficiency in writing, debugging, and executing basic programs using programming languages such as C or Python.	C3 (Apply)	2,3,5
	CLO3: Apply best practices in coding to solve computing problems using efficient and readable programs. Analyze program outputs and troubleshoot common errors effectively.	C4 (Analyze)	2,3,4 5,7
Syllabus	**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.		
Suggested Instructional/ Reading Material	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, EI-322: Web Technologies, EI-326: Enterprise Application Development, EI-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: Explain core programming concepts including variables, control structures, functions, and data types.	C2 (Understand)	1,2
	CLO2: Demonstrate proficiency in writing, debugging, and executing basic programs using programming languages such as C or Python.	C3 (Apply)	2,3,5
	CLO3: Apply best practices in coding to solve computing problems using efficient and readable programs. Analyze program outputs and troubleshoot common errors effectively.	C4 (Analyze)	2,3,4 5,7
Syllabus	**Implementation and Practice of the concepts studied in "CC-112 Programming Fundamentals"** **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.		
Suggested Instructional/ Reading Material	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-113**		
Credit Hours	3 (2,3)		
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	C1 (Remember)	1
	CLO2: Explain the services and functions provided by each layer in the Internet protocol stack	C2 (Understand)	1, 2
	CLO3: Identify various internetworking devices and protocols and their functions in a networking	C3 (Apply)	1, 2, 3
	CLO4: Analyze working and performance of key technologies, algorithms, and protocols	C4 (Analyze)	3, 4, 5
	CLO5: Build Computer Network on various Topologies.	C5 (Evaluate)	4, 5. 6
Syllabus	**Introduction**: Protocols architecture, basic concepts of Networking, Network topologies. **Layered Architecture**: Physical layer functionality, Data link layer functionality, Multiple access techniques, Circuit switching and Packet switching, LAN technologies, Wireless networks, MAC addressing, Networking devices, Network layer protocols**,** IPv4 and IPv6, IP addressing, Subnetting, CIDR, Routing protocols, Transport layer protocols, Ports and Sockets, Connection establishment, Flow and Congestion control, Application layer protocols, Latest trends in computer networks. **Lab Topics:** 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	1. Andrew S. Tanenbaum, Nick Feamster, David J. Wetherall, Computer Networks, 6th Edition, Published by Pearson (July 14, 2021) © 2021, ISBN-13: 9780137523214 (2021 update). 2. James Kurose and Keith Ross, Computer Networking: A top-down,layered approach to computer networking, 8th Edition, Pearson, June 10, 2021, ISBN-13 : 978-1292405469. 3. Todd Lammle, CCNA Cisco Certified Network Associate Deluxe Study Guide, 7th Edition, Wiley Publishing, 2011, ISBN: 978-0470901083. 4. William Stallings, Data and Computer Communications, 11th Edition, Pearson, 2018, ISBN-13: 978-0134997193 5. Behrouz A. Forouzan, Data Communications and Networking with TCPIP Protocol Suite, 6th Edition, McGraw Hill, 3 August 2022, ISBN-13: 978-9355320940 6. Radia Perlman, Interconnections: Bridges, Routers, Switches, and Internetworking Protocols, 2nd Edition, Addison-Wesley, 1999, ISBN: 0201634481.		

Course Title	**Computer Networks Lab**		
Course Code	**CC-113-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	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-218 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 the principles of object-oriented programming, including encapsulation, inheritance, and polymorphism.	C2 (Understand)	1,2
	CLO2: Design and implement classes and objects to model real-world entities using the principles of OOP. Write reusable and modular code using OOP concepts.	C3 (Apply)	2,4, 5
	CLO3: Analyze the advantages of OOP over procedural programming paradigms.	C4 (Analyze)	2,3
	CLO4: Develop small-scale applications utilizing OOP concepts in languages like Java or C++.	C6 (Create)	2,4,5
Syllabus	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.		
Suggested Instructional/ Reading Material	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 (0,1)		
Category	Computing Core		
Prerequisite	CC-112 Programming Fundamentals		
Co-Requisite	None		
Follow-up	CC-213 Data Structures, CC-218 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 the principles of object-oriented programming, including encapsulation, inheritance, and polymorphism.	C2 (Understand)	1,2
	CLO2: Design and implement classes and objects to model real-world entities using the principles of OOP. Write reusable and modular code using OOP concepts.	C3 (Apply)	2,4,5
	CLO3: Analyze the advantages of OOP over procedural programming paradigms.	C4 (Analyze)	2,3
	CLO4: Develop small-scale applications utilizing OOP concepts in languages like Java or C++.	C6 (Create)	2,4,5
Syllabus	***Implementation and Practice of the concepts studied in "CC-211 Object Oriented Programming"*** 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.		
Suggested Instructional/ Reading Material	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	EI-324: Database Administration & 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, Database System environment, transaction management, concurrency control, and database recovery.	C2 (Understand)	1
	CLO2: To learn SQL and the fundamentals of PL/SQL. Implement basic database management tasks using popular database management systems.	C3 (Apply)	2,3,4, 5
	CLO3: Analysis and Design of conceptual, logical and physical database schemas using different data models. Analyze the role of databases in information systems and their security considerations.	C4 (Analysis)	2,3,4, 5
	CLO4: Design and normalize relational database schemas based on user requirements.	C5 (Design)	3,4,5, 7
Syllabus	**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.		
Suggested Instructional/ Reading Material	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	EI-324: Database Administration & 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 follow 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 and implement database system for small business organizations	C5 (Design)	3,4,5, 7
Syllabus	**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. **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. 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		
Suggested Instructional/ Reading Material	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: Apply software development life cycle models to manage projects effectively.	C3 (Apply)	2,4
	CLO2: Analyze and manage software project risks and quality.	C4 (Analyze)	2,3,4
	CLO3: Develop software requirements specifications and design documents. Collaborate effectively in team-based software projects.	C5 (Create)	2,4,6
	CLO4: Implement and test software applications using best practices.	C5 (Evaluate)	2,3,4,5
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	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, EI-325 Cyber Security, CC-216 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 and analyze various data structures such as arrays, linked lists, stacks, queues, trees, and graphs.	C4 (Analyze)	2,3
	CLO2: Demonstrate proficiency in traversing and manipulating data structures.	C3 (Apply)	2,5
	CLO3: Select and evaluate the efficiency of algorithms based on data structure choices.	C5 (Evaluate)	2,3,4
	CLO4: Solve complex problems using suitable data structures and algorithms.	C6 (Create)	2,4
Syllabus	**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.		
Suggested Instructional/ Reading Material	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, EI-325 Cyber Security, CC-216 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 and analyze various data structures such as arrays, linked lists, stacks, queues, trees, and graphs.	C4 (Analyze)	2,3
	CLO2: Demonstrate proficiency in traversing and manipulating data structures.	C3 (Apply)	2,5
	CLO3: Select and evaluate the efficiency of algorithms based on data structure choices.	C5 (Evaluate)	2,3,4
	CLO4: Solve complex problems using suitable data structures and algorithms.	C6 (Create)	2,4
Syllabus	***Implementation and Practice of the concepts studied in "CC-213 Data Structures"*** **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.		
Suggested Instructional/ Reading Material	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-216**		
Credit Hours	3 (2,0)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	EI-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. Explain the functions and services provided by operating systems.	C2 (Understand)	1,2
	CLO2: Demonstrate the knowledge in applying system software and tools available in modern operating systems. Implement basic scheduling algorithms.	C3 (Demonstrate, Apply)	3,4
	CLO3: 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
	CLO4: Evaluate operating system performance and security features.	C6 (Evaluate)	2,4,5
Syllabus	**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.		
Suggested Instructional/ Reading Material	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-216-L**		
Credit Hours	1 (0,3)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	EI-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 fundamentals of Linux operating system, Linux commands, virtual machines,	C2 (Understand)	1,2
	CLO2: Installation of VMWare and Ubuntu. Compiling and executing a C/C++ program in VIM editor. Demonstrate the knowledge in applying system software and tools available in modern operating systems. Linux shell programming.	C3 (Apply, Demonstrate)	3,4,5
Syllabus	**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.** **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		
Suggested Instructional/ Reading Material	Unix: The Text Book, 3rd edition by Sarwar and Koretsky, ISBN-13: 978-1-4822-3358-2		

2) 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	**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. **Basic ICT Productivity Tools:** Effective use of popular search engines to explore WWW, Formal communication tools and etiquettes (Gamail, 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.) **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).
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.

	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). 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.
Suggested Instructional/ Reading Material	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

	At the end of the course, the students will be able to:	**BT**	**PLO**
Course Learning Outcomes (CLOs)	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	**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 (Gamail, 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.
Suggested Instructional/ Reading Material	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	**Applied Physics**		
Course Code	GE-169		
Credit Hours	3 (2,3)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow Up	None		
Course Introduction	The primary objective of the course is to teach student calculus based general physics, particularly basic concepts of electrostatics, electricity, magnetism and optics. To equip the learner with the basic philosophy of different physical phenomenon. To make them able to solve to given physical problems related to the subject. To lay strong foundations of their basic scientific knowledge.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	**BT**	**PLO**
	CLO1: To understand the fundamental concepts of Physics.	C2 (Understand)	1,2
	CLO2: To understand about charges and their interactions.	C2 (Understand)	1,2
	CLO3: To develop strong concepts of numerical techniques related to vectors and electrostatics and magnetism.	C2 (Understand)	1,2
	CLO4: To develop the relation between electricity and magnetism.	C4 (Analyze)	1,2,3
Syllabus	Electric force: Introduction to electric force, its applications and related problems, conservation of charge, charge quantization, Electric fields due to point charge and lines of force. Ring of charge, Disk of charge, A point charge in an electric field, Dipole in a n electric field, The flux of vector field, The flux of electric field, Gauss' Law, Application of Gauss' Law, Spherically symmetric charge distribution, A charged isolated conductor. Electric potential energy: Electric potentials, Calculating the potential from the field and related problem Potential due to point and continuous charge distribution, Potential due to dipole, equipotential surfaces, Calculating the field from the potential. Electric current: Current density, Resistance, Resistivity and conductivity, Ohm's law and its applications, The Hall effect, The magnetic force on a current, The Biot- Savart law, Line of B, Two parallel conductors, Amperes' s Law, Solenoid, Toroids, Faraday's experiments, Faraday's Law of Induction, Lenz's law, Motional emf. Induced electric field, Induced electric fields. Electromagnetics: The basic equation of electromagnetism, Induced Magnetic field, The displacement current, Reflection and Refraction of light waves, Total internal reflection, Two source interference, Double Slit interference, related problems, Interference from thin films, Diffraction and the wave theory, related problems, Single-Slit Diffraction, related problems, Polarization of electromagnetic waves, Polarizing sheets, related problems.		
Suggested Instructional/ Reading Material	1. D. Halliday, R. Resnick, Kenneth S. Krane, Physics Vol. 2, 5th Ed., John Wiley, 2001, ISBN: 978-0471401940. 2. Hugh D. Young, Roger A. Freedman, A. Lewis, Sears, University Physics, 11th Ed., Benjamin-Cummings Pub. Co., 2004, ISBN: 978-0805391794. 3. D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics, 6th Ed., Wiley, 2010, ISBN: 978-0470469118.		

<table>
<tr><td>Title</td><td colspan="3">Functional English</td></tr>
<tr><td>Code</td><td colspan="3">GE-190</td></tr>
<tr><td>Credit Hours</td><td colspan="3">3 (3,0)</td></tr>
<tr><td>Category</td><td colspan="3">General Education</td></tr>
<tr><td>Prerequisite</td><td colspan="3">None</td></tr>
<tr><td>Co-Requisite</td><td colspan="3">None</td></tr>
<tr><td>Follow-up</td><td colspan="3">GE-191 Expository Writing</td></tr>
<tr><td>Course Introduction</td><td colspan="3">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.</td></tr>
<tr><td rowspan="5">Course Learning Outcomes (CLOs)</td><td>At the end of the course, the students will be able to:</td><td>BT</td><td>PLO</td></tr>
<tr><td>CLO1: Apply enhanced English communication skills through effective use of word choices, grammar and sentence structure.</td><td>C4 (Apply)</td><td>1,6,7,10</td></tr>
<tr><td>CL2: Comprehend a variety of literary / non-literary written and spoken texts in English.</td><td>C2 (Understand)</td><td>1,6,7,10</td></tr>
<tr><td>CLO3: Effectively express information, ideas and opinions in written and spoken English.</td><td>C2 (Explain)</td><td>1,6,7,10</td></tr>
<tr><td>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.</td><td>C4 (Identify)</td><td>1,6,7,10</td></tr>
<tr><td>Course Description</td><td colspan="3">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.)</td></tr>
<tr><td>Practical Requirements</td><td colspan="3">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.</td></tr>
<tr><td>Suggested Instructional / Reading Material</td><td colspan="3">1. “Understanding and Using English Grammar” by Betty Schrampfer 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.</td></tr>
</table>

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	**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)		
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	1. "The St. Martin's Guide to Writing" by Rise B. Axelrod and Charles R. Cooper. 2. "They Say / I Say: The Moves That Matter in Academic Writing" by Gerald Graff and Cathy Birkenstein. 3. "Writing Analytically" by David Rosenwasser and Jill Stephen. 4. "Style: Lessons in Clarity and Grace" by Joseph M. Williams and Joseph Bizup. 5. "The Elements of Style" by William Strunk Jr. and E.B. White. 6. "Good Reasons with Contemporary Arguments" by Lester Faigley and Jack Selzer. 7. "Writing to Learn; How to Write – and Think – Clearly About Any Subject at All" by William Zinsser. 8. "The Norton Field Guide to Writing" by Richard Bullock, Maureen Daly Goggin, and Francine Weinberg. 9. "The Art of Styling Sentences" by Ann Longknife and K.D. Sullivan. 10. "Writing Today" by Richard Johnson-Sheehan and Charles Paine.		

Course Title	**Discrete Structures**		
Course Code	**GE-167**		
Credit Hours	3 (3,0)		
Category	General Education (Quantitative Reasoning-1)		
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 fundamental concepts of discrete mathematics such as sets, relations, functions, propositional logic, sequences, recurrence, sums, permutations, graphs etc.	C2 (Understand)	1,2
	CLO2: **Apply** discrete structures into computing problems such as formal specification, verification, logical reasoning to real problems, complexity of algorithms.	C3 (Apply)	3,4,5
	CLO3: **Analyze** discrete structures such as graphs and trees to determine properties like connectivity, paths, and cycles. Differentiate various discrete structures and their relevance within the context of computer science.	C4 (Analyze)	3,4
Course Description	**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.		
Suggested Instructional/ Reading Material	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 Johnson Baugh, 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	**Probability and Statistics**		
Course Code	**GE-260**		
Credit Hours	3 (3,0)		
Category	General Education (Quantitative Reasoning-2)		
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. Use regression techniques.	C3 (Apply)	1,3
Syllabus	**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 S2, 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.		
Suggested Instructional/ Reading Material	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/		

Title	**Islamic Studies**		
Code	**GE-196**		
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 comprehensive overview of the fundamental aspects of Islam, its benefits, practices, history and influence on society. It will further familiarize the students with a solid foundation in understanding Islam from an academic and cultural perspective. Through this course, students will have an enhanced understanding of Islam's multifaceted dimensions which will enable them to navigate complex discussions about Islam's historical and contemporary role, fostering empathy, respect, and informed dialogue.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	**BT**	**PLO**
	CLO1: Demonstrate enhanced knowledge of Islamic foundational beliefs, practices, historical development, fundamental sources of Shiarah, spiritual values and ethical principles.	C1 (Knowledge)	1,7,9,10
	CLO2: Describe basic sources of Islamic law and their application in daily life.	C2 (Understand)	1,7,9,10
	CLO3: Identify and discuss contemporary issues being faced by the Muslim world including social challenges, gender roles and interfaith interactions.	C4 (Analyze)	1,6,7,9,10
Syllabus	1۔قرآن مجید 1۔ قرآن مجید: معنی و مفہوم، اہمیت و فضیلت، آداب و شرائط تلاوت 2۔ وحی کا معنی و مفہوم، وحی کی اقسام 3۔ قرآن مجید کی جمع و تدوین، حفاظت قرآن 2۔حدیث نبوی صلی اللہ علیہ وآلہ وسلم 1۔ حدیث کا معنی و مفہوم، اقسام حدیث (قولی۔ فعلی۔ تقریری) 2۔ ضرورت و اہمیت حدیث 3۔ مطالعہ حدیث (ترجمہ 6+تشریح 4=10 نمبر) 1۔عَنْ عُمَرَ بْنِ الْخَطَّابِ رضی اللہ عنہ قَالَ سَمِعْتُ رَسُوْلَ اللّٰہِ ﷺ یَقُوْلُ: إِنَّمَا الْأَعْمَالُ بِالنِّیَّاتِ، وَإِنَّمَا لِامْرِئٍ مَا نَوٰی، فَمَنْ کَانَتْ ہِجْرَتُہٗ إِلٰی اللّٰہِ وَرَسُوْلِہٖ فَہِجْرَتُہٗ إِلَی اللّٰہِ وَرَسُوْلِہٖ، وَمَنْ کَانَتْ ہِجْرَتُہٗ إِلٰی دُنْیَا یُصِیْبُہَا أَوِ امْرَأَۃٍ یَنْکِحُہَا فَہِجْرَتُہٗ إِلٰی مَا ہَاجَرَ إِلَیْہِ (صحیح بخاری:1) 2۔عَنْ عُثْمَانَ بْنِ عَفَّانَ رضی اللہ عنہ عَنِ النَّبِیِّ ﷺ قَالَ: خَیْرُکُمْ مَنْ تَعَلَّمَ الْقُرْآنَ وَعَلَّمَہٗ (صحیح بخاری، 502) 3۔عَنْ مَالِکِ بْنِ أَنَسٍ رضی اللہ عنہ قَالَ: قَالَ رَسُوْلُ اللّٰہِ ﷺ: تَرَکْتُ فِیْکُمْ أَمْرَیْنِ لَنْ تَضِلُّوْا مَا تَمَسَّکْتُمْ بِہِمَا کِتَابَ اللّٰہِ وَسُنَّۃَ رَسُوْلِہٖ (رواہ مالک فی الموطا مرسلاً) 4۔عَنْ عَبْدِ اللّٰہِ بْنِ عُمَرَ رضی اللہ عنہما قَالَ: قَالَ رَسُوْلُ اللّٰہِ ﷺ: بُنِیَ الْإِسْلَامُ عَلٰی خَمْسٍ شَہَادَۃِ أَنْ لَّا إِلٰہَ إِلَّا اللّٰہُ وَأَنَّ مُحَمَّدًا عَبْدُہٗ وَرَسُوْلُہٗ وَإِقَامِ الصَّلَاۃِ وَإِیْتَاءِ الزَّکَاۃِ وَالْحَجِّ وَصَوْمِ رَمَضَانَ (صحیح مسلم:113) 5۔وَعَنِ النُّعْمَانِ بْنِ بَشِیْرٍ رضی اللہ عنہ قَالَ قَالَ رَسُوْلُ اللّٰہِ ﷺ تَرَی الْمُؤْمِنِیْنَ فِیْ تَرَاحُمِہِمْ وَتَوَادِّہِمْ وَتَعَاطُفِہِمْ کَمَثَلِ الْجَسَدِ إِذَا اشْتَکٰی عُضْوًا تَدَاعٰی لَہٗ سَائِرُ جَسَدِہٖ بِالسَّہَرِ وَالْحُمّٰی (متفق علیہ بخاری:6011)		

Syllabus

6. عَنْ أَبِي هُرَيْرَةَ رَضِيَ اللهُ عَنْهُ أَنَّ رَسُولَ اللهِ ﷺ قَالَ: أَتَدْرُونَ مَا الْمُفْلِسُ؟ قَالُوا الْمُفْلِسُ فِينَا مَنْ لَا دِرْهَمَ لَهُ وَلَا مَتَاعَ فَقَالَ: إِنَّ الْمُفْلِسَ مِنْ أُمَّتِي مَنْ يَأْتِي يَوْمَ الْقِيَامَةِ بِصَلَاةٍ وَصِيَامٍ وَزَكَاةٍ وَيَأْتِي قَدْ شَتَمَ هَذَا وَقَذَفَ هَذَا وَأَكَلَ مَالَ هَذَا وَسَفَكَ دَمَ هَذَا وَضَرَبَ هَذَا فَيُعْطَى هَذَا مِنْ حَسَنَاتِهِ وَهَذَا مِنْ حَسَنَاتِهِ فَإِنْ فَنِيَتْ حَسَنَاتُهُ قَبْلَ أَنْ يُقْضَى مَا عَلَيْهِ أُخِذَ مِنْ خَطَايَاهُمْ فَطُرِحَتْ عَلَيْهِ ثُمَّ طُرِحَ فِي النَّارِ. (رواہ مسلم، کتاب البر: 6579)

7. عَنْ أَبِي هُرَيْرَةَ رَضِيَ اللهُ عنه قَالَ كَانَ رَسُولُ اللهِ ﷺ يَقُولُ اللَّهُمَّ إِنِّي أَعُوذُ بِكَ مِنَ الْأَرْبَعِ مِنْ عِلْمٍ لَا يَنْفَعُ وَمِنْ دُعَاءٍ لَا يُسْمَعُ وَمِنْ قَلْبٍ لَا يَخْشَعُ وَمِنْ نَفْسٍ لَا تَشْبَعُ. (رواہ مسلم و احمد سنن ابن ماجہ: 250)

5۔ عن أبي هريرة رضي الله عنه قال: قال رسول الله ﷺ كانت بنو إسرائيل تسوسهم الأنبياء كلما هلك نبي خلفه نبي وإنه لا نبي بعدي وسيكون خلفاء فيكثرون (صحیح البخاری، 3455)

8. عَنْ عَبْدِ اللهِ ابْنِ عُمَرَ رَضِيَ اللهُ عَنْهُمَا قَالَ قَالَ رَسُولُ اللهِ ﷺ أَلَا كُلُّكُمْ رَاعٍ وَكُلُّكُمْ مَسْئُولٌ عَنْ رَعِيَّتِهِ فَالْإِمَامُ الْأَعْظَمُ الَّذِي عَلَى النَّاسِ رَاعٍ وَهُوَ مَسْئُولٌ عَنْ رَعِيَّتِهِ وَالْوَالِي رَاعٍ فِي أَهْلِ بَيْتِهِ وَهُوَ مَسْئُولٌ عَنْ رَعِيَّتِهِ وَالْمَرْأَةُ رَاعِيَةٌ عَلَى بَيْتِ زَوْجِهَا وَوَلَدِهِ وَهِيَ مَسْئُولَةٌ عَنْهُمْ وَعَبْدُ الرَّجُلِ رَاعٍ عَلَى مَالِ سَيِّدِهِ وَهُوَ مَسْئُولٌ عَنْهُ أَلَا فَكُلُّكُمْ رَاعٍ وَكُلُّكُمْ مَسْئُولٌ عَنْ رَعِيَّتِهِ (ترمذی: 1705)

9. وَعَنِ النُّعْمَانِ بْنِ بَشِيرٍ رَضِيَ اللهُ عَنْهُ قَالَ قَالَ رَسُولُ اللهِ ﷺ تَرَى الْمُؤْمِنِينَ فِي تَرَاحُمِهِمْ وَتَوَادِّهِمْ وَتَعَاطُفِهِمْ كَمَثَلِ الْجَسَدِ إِذَا اشْتَكَى عُضْوٌ تَدَاعَى لَهُ سَائِرُ الْجَسَدِ بِالسَّهَرِ وَالْحُمَّى (بخاری: 6011)

10. عَنْ عَبْدِ اللهِ رَضِيَ اللهُ عَنْهُ قَالَ: قَالَ رَسُولُ اللهِ ﷺ طَلَبُ كَسْبِ الْحَلَالِ فَرِيضَةٌ بَعْدَ الْفَرِيضَةِ (شعب الایمان بیہقی)

11. عَنْ أَبِي سَعِيدٍ رَضِيَ اللهُ عَنْهُ عَنِ النَّبِيِّ ﷺ قَالَ التَّاجِرُ الصَّدُوقُ الْأَمِينُ مَعَ النَّبِيِّينَ وَالصِّدِّيقِينَ وَالشُّهَدَاءِ (جامع ترمذی: 1209)

12. عَنْ أَبِي هُرَيْرَةَ رَضِيَ اللهُ عنه قال قال رسول ﷺ اجْتَنِبُوا السَّبْعَ الْمُوبِقَاتِ قَالُوا يَا رَسُولَ اللهِ وَمَا هُنَّ قَالَ الشِّرْكُ بِاللهِ وَالسِّحْرُ وَقَتْلُ النَّفْسِ الَّتِي حَرَّمَ اللهُ إِلَّا بِالْحَقِّ وَأَكْلُ الرِّبَا وَأَكْلُ مَالِ الْيَتِيمِ وَالتَّوَلِّي يَوْمَ الزَّحْفِ وَقَذْفُ الْمُحْصَنَاتِ الْمُؤْمِنَاتِ الْغَافِلَاتِ (متفق علیہ)

13. ثبت عن رسول الله عليه الصلاة والسلام أنه قال: لا يزني الزاني حين يزني وهو مؤمن، ولا يسرق السارق حين يسرق وهو مؤمن، ولا يشرب الخمر حين يشربها وهو مؤمن، ولا ينتهب نهبةً ذات شرف يرفع الناس إليه فيها أبصارهم حين ينتهبها وهو مؤمن (صحیح البخاری: 6810)

14. عَنْ أَبِي سَعِيدٍ الْخُدْرِيِّ رَضِيَ اللهُ عَنْهُ قَالَ سَمِعْتُ رَسُولَ اللهِ ﷺ يَقُولُ مَنْ رَأَى مِنْكُمْ مُنْكَرًا فَلْيُغَيِّرْهُ بِيَدِهِ فَإِنْ لَمْ يَسْتَطِعْ فَبِلِسَانِهِ فَإِنْ لَمْ يَسْتَطِعْ فَبِقَلْبِهِ وَذَلِكَ أَضْعَفُ الْإِيمَانِ (مسلم: 177)

15. عَنْ أَنَسٍ رَضِيَ اللهُ عنه قَالَ قَالَ رَسُولُ اللهِ ﷺ وَالَّذِي نَفْسِي بِيَدِهِ لَا يُؤْمِنُ عَبْدٌ حَتَّى يُحِبَّ لِأَخِيهِ مَا يُحِبُّ لِنَفْسِهِ. (مسلم: 170)

16. وَعَنْ عِمْرَانَ بْنِ حُصَيْنٍ رَضِيَ اللهُ عَنْهُ قَالَ قَالَ رَسُولُ اللهِ ﷺ: خَيْرُكُمْ قَرْنِي ثُمَّ الَّذِينَ يَلُونَهُمْ ثُمَّ الَّذِينَ يَلُونَهُمْ. (بخاری: 3659)

17. عَنْ جَابِرِ بْنِ عَبْدِ اللهِ رَضِيَ اللهُ عَنْهُ قَالَ: خَطَبَنَا رَسُولُ اللهِ ﷺ وَسْطَ أَيَّامِ التَّشْرِيقِ يَوْمَ خُطْبَةِ الْوَدَاعِ فَقَالَ: يَا أَيُّهَا النَّاسُ إِنَّ رَبَّكُمْ وَاحِدٌ وَإِنَّ أَبَاكُمْ وَاحِدٌ لَا فَضْلَ لِعَرَبِيٍّ عَلَى عَجَمِيٍّ وَلَا لِعَجَمِيٍّ عَلَى عَرَبِيٍّ وَلَا لِأَحْمَرَ عَلَى أَسْوَدَ وَلَا أَسْوَدَ عَلَى أَحْمَرَ إِلَّا بِالتَّقْوَى إِنَّ أَكْرَمَكُمْ عِنْدَ اللهِ أَتْقَاكُمْ أَلَا هَلْ بَلَّغْتُ قَالُوا بَلَّغَ رَسُولُ اللهِ قَالَ فَلْيُبَلِّغِ الشَّاهِدُ الْغَائِبَ فَلْيُبَلِّغِ الشَّاهِدُ الْغَائِبَ. (البیہقی، شعب الایمان، باب فی حفظ اللسان، فصل فی حفظ اللسان عن الفخر بالآباء)

3۔ ایمانیات وعبادات: تعارف اور متعلقہ۔

4۔ سیرت نبوی صلی اللہ علیہ وآلہ وسلم

1۔ رسول اللہ صلی اللہ علیہ وآلہ وسلم کی حیات طیبہ (حالتِ زندگی قبل از بعثت، اعلانِ نبوت، ہجرتِ مدینہ، غزوات، صلح حدیبیہ، خطبہ حجۃ الوداع)

2۔ رسول اللہ ﷺ کی مختلف حیثیات: (i) بحیثیت معلم (ii) بحیثیت پیغمبرِ امن

Syllabus	**5۔ خلافتِ راشدہ** ۱۔ خلفائے راشدین (حضرت ابو بکر صدیقؓ، حضرت عمر فاروقؓ، حضرت عثمان غنیؓ، حضرت علی المرتضیٰؓ) کے شخصی احوال ۲۔ عہد خلافت راشدہ کے اہم خصائص **6۔ فقہِ اسلامی** 1۔ فقہِ اسلامی کے ماخذ: (قرآن، سنت، اجماع، قیاس، اجتہاد) 2۔ ائمہ اربعہ کا تعارف (امام ابو حنیفہؒ، امام مالکؒ، امام شافعیؒ، امام احمد بن حنبلؒ) **7۔ اسلام کی سماجی تعلیمات** 1۔ خاندان کا تعارف و اہمیت 2۔ اسلام میں عورت کا مقام 3۔ اسلام کا تصور حقوق العباد 4۔ اسلام کی اخلاقی تعلیمات **8۔ اسلام اور جدید دنیا** 1۔ عالمگیریت اور اس کے مسائل و تقاضے 2۔ اسلاموفوبیا 3۔ تکثیری معاشرہ Pluralistic Society اور اسلامی تعلیمات
Suggested Instructional/ Reading Material	1. "Introduction to Islam" by Dr. Muhammad Hamidullah 2. "Principles of Islamic Jurisprudence" by Dr. Ahmad Hasan 3. "Muslim Jurisprudence and the Quranic Law of Crimes" by Mir Waliullah 4. "Sirat-un-Nabi" by Shibli Nomani and Sulaiman Nadvi

Course Title	**Pakistan Studies**				
Course Code	**GE-194**				
Credit Hours	2 (2,0)				
Category	General Education				
Prerequisite	None				
Co-Requisite	None				
Follow-up	GE-168 Ideology and Constitution of Pakistan				
Course Introduction	The course imparts the fundamental knowledge and historical background and political evolution of Muslim society in Indo-Pakistan, including key events and figures leading to the creation of Pakistan.				
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:			**BT**	**PLO**
	CLO1: To understand the historical background and political evolution of Muslim society in Indo-Pakistan, including key events and figures leading to the creation of Pakistan.			C2 (Understand)	1
	CLO2: To analyze Pakistan's constitutional, administrative, and geopolitical frameworks, along with its cultural and social challenges and international relations.			C4 (Analyze)	2
	CLO3: To develop skills in independent research, critical evaluation of historical sources, and effective communication through academic writing and presentations.			C5 (Create)	3,4,6
Syllabus	**Historical background of Pakistan:** Muslim society in Indo-Pakistan, & Pakistan culture and society, & Pakistan and the challenges ahead. Muslim society in Indo-Pakistan, the movement led by the societies, the downfall of Islamic society, the establishment of British Raj- Causes and consequences. Political evolution of Muslims in the twentieth century: Sir Syed Ahmed Khan; Muslim League; Nehru; Allama Iqbal: Independence Movement; Lahore Resolution; Pakistan culture and society, Constitutional and Administrative issues, Pakistan and its geo-political dimension, Pakistan and International Affairs, Pakistan and the challenges ahead.				
Suggested Instructional/ Reading Material	A. Wynbrandt, James. A Brief History of Pakistan. B. Hayat, Sikandar. Aspects of the Pakistan Movement. National Institute of Historical and Cultural Research. C. Talbot, Ian. Pakistan: A Modern History. D. Khan, Yasmin. Colonial Lahore: A History of the City and Beyond. E. Khan, Hamid. Constitutional and Political History of Pakistan. University of Zulfiqar. F. Ali, Khurram. "K.K. Aziz's Historiography: A Review on the Making of Pakistan in Perspective of Nationalist Muslims and Muslim Nationalism." Pakistan Social Sciences Review 4, no. 1 (2020).				
Assessment Plan	**Criteria**	**Marks**	**CLO1**	**CLO2**	**CLO3**
	Quizzes	15	8	7	0
	Assignments	08	2	1	5
	Class Participation	02	1	1	0
	Mid Term	35	20	15	0
	Final Term	40	15	15	10
	Total	**100**	**45**	**30**	**15**

Title	**Ideology and Constitution of Pakistan**		
Code	**GE-195**		
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	**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		
Suggested Instructional / Reading Material	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.		

Title	**Fehm-e-Quran-I**		
Code	**GE-197**		
Credit Hours	1 (0, 1)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course is designed to provide students with a fundamental understanding and to develop the ability to understand of the Quran.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	**BT**	**PLO**
	CLO1: Understanding the meanings of basic words the Quran, phrases and sentences.	C1 (Remember)	2
	CLO2: Recognize and understand different styles of Quranic sentences.	C2 (Understand)	2, 8
	CLO3: Comprehend Quranic vocabulary, particles (operative & non-operative particles), compounds (Adjective & Possessive compound), pronouns (singular & plural), and types of plural through hundreds of Quranic sentences.	C3 (Apply)	2, 10
Syllabus	This course is designed to develop the ability to understand basic words of the Quran, phrases and sentences that do not contain verbs and sentences having present tense. Acquire a strong foundation for understanding long verses of the Quran with clarity. Comprehend Quranic vocabulary, particles (operative & non operative particles), compounds (Adjective & Possessive compound), pronouns (singular & plural) and types of plural through hundreds of Quranic sentences. Recognize and understand different styles of Quranic sentences, including nominal sentence, emphatic sentence, double emphatic sentence, negative sentence, interrogative sentence, oath –based sentences.		
Suggested Instructional / Reading Material	1. Muallimul Quran by Dr. Ubaidurrahman volume 1,2,3 2. The Holy Quran Translations.		

Title	**Fehm-e-Quran-II**		
Code	**GE-198**		
Credit Hours	1 (0, 1)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course is designed to provide students with a fundamental understanding and to develop the ability to understand of the Quran.		
Course Learning Outcomes	At the end of the course, the students will be able to:	**BT**	**PLO**
	CLO1: Understanding the meanings of basic words the Quran, phrases and sentences.	C1 (Remember)	2

(CLOs)	CLO2: Recognize and understand different styles of Quranic sentences.	C2 (Understand)	2, 8
	CLO3: Comprehend Quranic vocabulary, particles (operative & non-operative particles), compounds (Adjective & Possessive compound), pronouns (singular & plural), and types of plural through hundreds of Quranic sentences.	C3 (Apply)	2, 10
Syllabus	This course is designed to develop the ability to understand basic words of the Quran, phrases and sentences that do not contain verbs and sentences having present tense. Acquire a strong foundation for understanding long verses of the Quran with clarity. Comprehend Quranic vocabulary, particles (operative & non operative particles), compounds (Adjective & Possessive compound), pronouns (singular & plural) and types of plural through hundreds of Quranic sentences. Recognize and understand different styles of Quranic sentences, including nominal sentence, emphatic sentence, double emphatic sentence, negative sentence, interrogative sentence, oath –based sentences.		
Suggested Instructional / Reading Material	1. Muallimul Quran by Dr. Ubaidurrahman volume 1,2,3 2. The Holy Quran Translations.		

Course Title	**Entrepreneurship**
Code	**GE-271**
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	**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.
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	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 Jeffry 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.

Title	**Introduction to Management**		
Code	**GE-170**		
Credit Hours	2 (2,0)		
Category	General Education (Social Sciences)		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course is designed to provide a comprehensive overview of organizational management. It covers the diverse roles of managers, the crucial interplay between an organization's mission, its goals, and its detailed objectives, and the impact of both internal and external environmental factors on organizations and how they strategize in response. Students will gain empirical insights into organizational processes, behaviors, and their foundational theories. Emphasis will be placed on honing critical thinking, particularly in addressing ethical dilemmas, global perspectives, and diversity within management functions. Finally, this course sheds light on the intricacies of organizational design and structural challenges, providing a holistic grasp of management dynamics.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	**BT**	**PLO**
	CLO1: Understand the fundamental roles and functions of managers and explain how organizational goals align with internal and external environmental factors.	C2 (Understand)	1, 8
	CLO2: Apply management functions (planning, organizing, leading, and controlling) to solve basic managerial problems in case-based scenarios.	C3 (Apply)	2, 3
	CLO3: Evaluate management strategies and organizational structures in terms of their effectiveness in addressing change, innovation, ethical concerns, and cultural diversity.	C5 (Evaluate)	4, 8, 9
Course Contents / Syllabus	**Managing and the Managers Job:** The management process, kinds of managers, basic managerial roles and skills, and the nature of managerial work. **The Environment and Culture of Management:** The external and internal environment, the organization's cultures, organization-environment relationship. **Planning and Decision Making:** Decision making and planning process, organizational goals and levels of planning, various levels of strategies, rational perspectives on decision making, behavioral aspects of decision making, group and team decision making in organizations. **The Organizing Process:** Designing Jobs, grouping jobs, establishing reporting relationships, distributing authority, coordinating activities. **Managing Change and Innovation:** Forces for change, steps in the change process, understanding and overcoming resistance to change, the innovation process. **Leadership and Influence Process:** Different approaches to leadership, political behavior in organizations. **Managing Effective Communication:** The communication process, barriers to effective communication. **The Controlling Process:** The purpose of control, steps in the control process; operational, structural, and strategic control, managing total quality and productivity. **The Ethical and Social Environment:** Individual ethics in organization, emerging ethical issues, social responsibility and organizations.		
Suggested Instructional/ Reading Material	1. Ricky W. Griffin, Management, 12th Edition, Cengage Learning, 2017, ISBN: 1305501292. 2. Stephen P Robbins, Mary Coulter, Management, 14th Edition, Pearson, 2017, ISBN: 0134527607.		

Course Title	**Professional Practices**		
Course Code	**GE-270**		
Credit Hours	2 (2,0)		
Category	General Education (Arts and Humanities)		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	A computing graduate as a professional has some responsibilities with respect to society. This course develops student understanding of historical, social, economic, ethical, and professional issues related to the discipline of computing. It identifies key sources for information and opinions about professionalism and ethics. Students analyze, evaluate, and assess ethical and professional computing case studies.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	**BT**	**PLO**
	CLO1: Understand fundamental ethical theories, professional responsibilities, and key provisions of software engineering codes of ethics.	C2 (Understand)	1, 9
	CLO2: Apply ethical frameworks and professional codes of conduct to analyze and resolve real-world dilemmas in software engineering and IT practice.	C3 (Apply)	3, 8, 9
	CLO3: Evaluate complex professional scenarios involving privacy, intellectual property, and software liability by comparing competing ethical principles and legal standards.	C5 (Evaluate)	4, 8, 9
Course Contents / Syllabus	Historical, social, and economic context of computing (software engineering, computer science, information technology, and so on); the paradigm of professions, sorting out computing and its status as a profession, ethics and some fundamental ethical viewpoints (utilitarianism, deontological theories, rights, virtue ethics). The ethical judgment of moral dilemmas (the ethical cycle), professional activities; professional societies; professional ethics; professional competency and life-long learning; uses, misuses, and risks of software; information security and privacy; business practices and the economics of software; intellectual property and software law (cyber law); social responsibilities; software-related contracts; software house organization. Hacking and hackers' ethics, identity theft, privacy, intellectual property rights, the framework of employee relations law and changing management practices, human resource management and it, health and safety at work, software liability, liability and practice, computer misuse, and the criminal law, regulation, and control of personal information. Overview of the British Computer Society Code of Conduct, IEEE Code of Ethics, ACM Code of Ethics and Professional Conduct, and the ACM/IEEE Software Engineering Code of Ethics and Professional Practice. Accountability and auditing, computer applications in various sectors along with ethical dilemmas.		
Suggested Instructional/ Reading Material	1. Michael J. Quinn, Ethics for the Information Age, 7th Edition, Pearson Education, 2017, ISBN: 978-0134296548 2. Sara Baase, A Gift of Fire: Social, Legal, and Ethical Issues in Computing, 5th Edition, Pearson, 2018, ISBN: 978-0132492676 3. George W. Reynolds, Ethics in Information Technology, 5th Edition, Cengage Learning, 2015, ISBN: 978-1285197159 4. Poel, van de, I. R., & Royakkers, L. M. M. (2007). The ethical cycle. Journal of Business Ethics, 71(1), 1-13. 5. "Professional Issues in Software Engineering" by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, 3rd Edition, CRC Press, 2000. ISBN-10: 0748409513		

Title	**Civics and Community Management**		
Code	**GE-272**		
Credit Hours	2		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course is designed to provide students with fundamental knowledge about civics, citizenship, and community engagement, Students will learn about the essentials of civil society, government, civic responsibilities, inclusivity, and effective ways to participate in shaping the society which will help them apply theoretical knowledge to the real-world situations to make a positive impact on their communities.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	**BT**	**PLO**
	CLO1: Demonstrate fundamental understanding of civics, government, citizenship and civil society.	C3 (Demonstrate)	1
	CLO2: Understand the concept of community and recognize the significance of community engagement for individuals and groups.	C2 (Understand)	1,3,6,7,9,10
	CLO3: Recognize the importance of diversity and inclusivity for societal harmony and peaceful co- existence.	C4 (Identify)	1,6,7,9,10
Syllabus	**Introduction to Civics and Citizenship:** Definition of civics, citizenship, and civic engagement, Historical evolution of civic participation, Types of citizenship: active, participatory, digital, etc., The relationship between democracy and citizenship. **Civics and Citizenship:** Concepts of civics, citizenship, and civic engagement, Foundations of modern society and citizenship, Types of citizenship: active, participatory, digital, etc., **State, Government and Civil Society:** Structure and functions of government in Pakistan, the relationship between democracy and civil society, right to vote and importance of political participation and representation. **Rights and Responsibilities:** Overview of fundamental rights and liberties of citizens under Constitution of Pakistan 1973, Civic responsibilities and duties, Ethical considerations in civic engagement (accountability, non-violence, peaceful dialogue, civility, etc.) **Community Engagement:** Concept, nature and characteristics of community, Community development and social cohesion, Approaches to effective community engagement, Case studies of successful community driven initiatives. **Advocacy and Activism:** Public discourse and public opinion, Role of advocacy in addressing social issues, Social action movements. **Digital Citizenship and Technology:** The use of digital platforms for civic engagement, Cyber ethics and responsible use of social media, Digital divides and disparities (access, usage, socioeconomic, geographic, etc.) and their impacts on citizenship. **Diversity, Inclusion and Social Justice:** Understanding diversity in society (ethnic, cultural, economic, political etc.), Youth, women and minorities' engagement in social development, Addressing social inequalities and injustices in Pakistan, Promoting inclusive citizenship and equal rights for societal harmony and peaceful co-existence.		
Suggested Instructional / Reading Material	1. "Civics Today: Citizenship, Economics, & You" by McGraw-Hill Education 2. "Citizenship in Diverse Societies" by Will Kymlicka and Wayne Norman. 3. “Engaging Youth in Civic Life” by James Youniss and Peter Levine. 4. "Digital Citizenship in Action: Empowering Students to Engage in Online Communities" by Kristen Mattson. 5. ''Globalization and Citizenship: In the Pursuit of a Cosmopolitan Education" by Graham Pike and David Selby. 6. "Community Engagement: Principles, Strategies, and Practices" by Becky J. Feldpausch and Susan M. Omilian. 7. "Creating Social Change: A Blueprint for a Better World" by Matthew Clarke and Marie-Monique Steckel.		

3) AI Technical Electives

Course Title	**Web Technologies/Development**		
Course Code	**EA-331**		
Credit Hours	2 (2,0)		
Category	Specialization Elective		
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, languages and application.	C1 (Know)	1
	CLO2: Demonstrate understanding of web architecture and protocols. Use modern web development tools and frameworks effectively.	C3 (Apply) (Demonstrate)	2,3,4,5
	CLO3: Design and implement responsive web pages using HTML, CSS, and JavaScript. Work collaboratively to develop and test web applications. Communicate design decisions through documentation and presentations.	C5 (Design) (Collaborate)	4,5,6,7
Syllabus	**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, XHTM 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:** Programing in any Scripting language. Search Technologies, Search Engine Optimization. XML Query Language, Semantic Web, Future Web Application Framework. 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	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/Development Lab**
Course Code	**EA-331-L**
Credit Hours	1 (0,3)
Category	Specialization Elective
Prerequisite	None
Co-Requisite	None
Follow Up	EI-338: Enterprise Systems

	At the end of the course, the students will be able to:	**BT**	**PLO**
Course Learning Outcomes (CLOs)	**CLO2:** Demonstrate understanding of web architecture and protocols. Use modern web development tools and frameworks effectively.	C3 (Apply) (Demonstrate)	2,3,4,5
	CLO3: Design and implement responsive web pages using HTML, CSS, and JavaScript. Work collaboratively to develop and test web applications. Communicate design decisions through documentation and presentations.	C5 (Design) (Collaborate)	4,5,6,7

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	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	**Programming for Artificial Intelligence (AI)**		
Course Code	**EA-320**		
Credit Hours	3 (2,0)		
Category	AI Specialization Elective		
Prerequisite	Object Oriented Programing		
Co-Requisite	None		
Follow-up	Deep Learning		
Course Introduction	This course aims to provide students with a comprehensive foundation in programming for AI and practical experience in applying AI techniques and methods to real-world problems. Emphasis is placed on hands-on programming and project work, as well as critical thinking and problem-solving skills. By the end of the course, students will have the knowledge and skills needed to pursue further studies and careers in the field of Artificial Intelligence.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	**BT**	**PLO**
	CLO1: Write efficient and well-documented code.	C3 (Apply)	2,3,4
	CLO2: Utilize version control (Git) to manage and collaborate on AI-related code repositories.	C3 (Apply)	5,6
	CLO3: Implement basic Machine Learning models using standard ML frameworks	C5 (Create)	4,5,6
	CLO4: Implement and evaluate machine learning and basic neural network models for solving real-world problems.	C3 (Apply),	3,4,5
	CLO5: Use version control tools (e.g., Git) and collaborative practices in AI-based software development.	C3 (Apply)	5,6
	CLO6: Design and develop AI-based solutions through projects, demonstrating problem-solving, critical thinking, and communication skills.	C5 (Create)	3,4,5,6
Syllabus	Introduction to Python language, Variables, Data types, Control Structures, Procedures and Classes. Introduction to the Python libraries and packages: NumPy and Pandas for data processing; Matplotlib, Seaborn and Plotly for exploratory data analysis and visualization; Sklearn for machine learning models; PyTorch, Tensorflow and Tensorboard for neural network models.		
Suggested Instructional/ Reading Material	1. Staring out with Python by Tony Gaddis, 5th Edition, Pearson, ISBN: 978-0-13-592903-2 2. Hands-on machine learning with scikit-learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems, 2nd Edition, Géron, A., 2019, O'Reilly Media. ISBN: 978-1492032649 3. Deep Learning with PyTorch, Stevens, E., Antiga, L., & Viehmann, T., 2020, Manning Publications, ISBN: 978-1617295263 4. Interactive data visualization with Python: Create interactive plots with Plotly, Bokeh, and Dash in Python, Belorkar, A., 2023, 2nd Edition, Packt Publishing, ISBN: 978-1804615656		

Course Title	**Programming for Artificial Intelligence - Lab**		
Course Code	**EA-320-L**		
Credit Hours	1 (0,3)		
Category	AI Specialization Elective		
Prerequisite	Object Oriented Programing		
Co-Requisite	None		
Follow-up	Deep Learning		
Course Introduction	This course aims to provide students with a comprehensive foundation in programming for AI and practical experience in applying AI techniques and methods to real-world problems. Emphasis is placed on hands-on programming and project work, as well as critical thinking and problem-solving skills. By the end of the course, students will have the knowledge and skills needed to pursue further studies and careers in the field of Artificial Intelligence.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	**BT**	**PLO**
	CLO1: Write efficient and well-documented code.	C3 (Apply)	2,3,4
	CLO2: Utilize version control (Git) to manage and collaborate on AI-related code repositories.	C3 (Apply)	5,6
	CLO3: Implement basic Machine Learning models using standard ML frameworks	C5 (Create)	4,5,6
	CLO4: Implement and evaluate machine learning and basic neural network models for solving real-world problems.	C3 (Apply),	3,4,5
	CLO5: Use version control tools (e.g., Git) and collaborative practices in AI-based software development.	C3 (Apply)	5,6
	CLO6: Design and develop AI-based solutions through projects, demonstrating problem-solving, critical thinking, and communication skills.	C5 (Create)	3,4,5,6
Syllabus	Introduction to Python language, Variables, Data types, Control Structures, Procedures and Classes. Introduction to the Python libraries and packages: NumPy and Pandas for data processing; Matplotlib, Seaborn and Plotly for exploratory data analysis and visualization; Sklearn for machine learning models; PyTorch, Tensorflow and Tensorboard for neural network models.		
Suggested Instructional/ Reading Material	1. Staring out with Python by Tony Gaddis, 5th Edition, Pearson, ISBN: 978-0-13-592903-2 2. Hands-on machine learning with scikit-learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems, 2nd Edition, Géron, A., 2019, O'Reilly Media. ISBN: 978-1492032649 3. Deep Learning with PyTorch, Stevens, E., Antiga, L., & Viehmann, T., 2020, Manning Publications, ISBN: 978-1617295263 4. Interactive data visualization with Python: Create interactive plots with Plotly, Bokeh, and Dash in Python, Belorkar, A., 2023, 2nd Edition, Packt Publishing, ISBN: 978-1804615656		

Title	**Machine Learning**		
Code	**EA-321**		
Credit Hours	2 (2,0)		
Category	AI Specialization Elective		
Prerequisite			
Co-Requisite	EA-320: Programming for Artificial Intelligence		
Follow-up			
Course Introduction	Machine learning is one of the fastest growing areas of computer science, with far-reaching applications. The aim of this course is to: a) Present the basic machine learning concepts; b) Present a range of machine learning algorithms along with their strengths and weaknesses; c) Apply machine learning algorithms to solve problems of moderate complexity.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	**BT**	**PLO**
	CLO1: Explain fundamental concepts, paradigms, and algorithms of machine learning, including supervised and unsupervised learning.	C2 (Understand)	1,2
	CLO2: Implement and fine-tune supervised and unsupervised machine learning models to solve real-world problems.	C3 (Apply)	2,3,4
	CLO3: Analyze the performance of ML models using evaluation metrics.	C4 (Analyze)	2,3,4
	CLO4: Implement ML solutions using modern toolkits.	C3 (Apply)	2,3,4
	CLO5: Design and conduct machine learning experiments, including model development, validation, and iterative improvement.	C5 (Create)	3,4,5,6
	CLO6: Evaluate and compare machine learning models to select optimal solutions for specific tasks.	C6 (Evaluate)	3,4,5,6
Syllabus	**Topics**: Machine learning course begins with foundational concepts, such as understanding supervised and unsupervised learning, feature engineering, and model evaluation techniques. As the course progresses, students delve into various supervised machine learning algorithms, including linear and nonlinear regression, logistic regression, decision trees, random forest, support vector machines, and neural networks. For each of the aforementioned algorithms, students learn about their hypothesis functions, cost functions, optimization functions and regularization techniques to avoid overfitting. The topics related to unsupervised machine learning are also part of the course. The students learn clustering techniques such as k-mean's clustering, and dimensionality reduction algorithms like principal component analysis and auto-encoders. Implementation of the theoretical concepts using Python, Different libraries and frameworks such as NumPy, Pandas, Scikit Learn and TensorFlow, Libraries for supervised and unsupervised machine learning algorithms such as linear and nonlinear regression, logistic regression, decision trees, random forest, support vector machines, neural networks (forward and backward propagation), k-mean's clustering, and dimensionality reduction algorithms like principal component analysis and auto-encoders. Publicly available datasets are used for practical demonstration of the aforementioned algorithms.		
Suggested Instructional/ Reading Material	1. Introduction to Machine Learning by Ethem Alpaydin 2. The Hundred-Page Machine Learning Book by Andriy Burkov 3. Hands On Machine Learning with Scikit Learn, Keras and TensorFlow 2e by Aurélien Géron 4. Deep Learning with Python by François Chollet 5. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville		

Title	**Machine Learning-Lab**		
Code	**EA-321-L**		
Credit Hours	1 (0,3)		
Category	AI Specialization Elective		
Prerequisite			
Co-Requisite	EA-320: Programming for Artificial Intelligence		
Follow-up			
Course Introduction	Machine learning is one of the fastest growing areas of computer science, with far-reaching applications. The aim of this course is to: a) Present the basic machine learning concepts; b) Present a range of machine learning algorithms along with their strengths and weaknesses; c) Apply machine learning algorithms to solve problems of moderate complexity.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	**BT**	**PLO**
	CLO1: Implement and fine-tune supervised and unsupervised machine learning models to solve real-world problems.	C3 (Apply)	2,3,4
	CLO2: Analyze the performance of ML models using evaluation metrics.	C4 (Analyze)	2,3,4
	CLO3: Implement ML solutions using modern toolkits.	C3 (Apply)	2,3,4
	CLO4: Design and conduct machine learning experiments, including model development, validation, and iterative improvement.	C5 (Create)	3,4,5,6
Syllabus	**Topics**: Machine Learning-Lab course deals with the implementation of the theoretical concepts studied in Machine Learning (EA-321) course using Python, Different libraries and frameworks such as NumPy, Pandas, Scikit Learn and TensorFlow, Libraries for supervised and unsupervised machine learning algorithms such as linear and nonlinear regression, logistic regression, decision trees, random forest, support vector machines, neural networks (forward and backward propagation), k-mean's clustering, and dimensionality reduction algorithms like principal component analysis and auto-encoders. Publicly available datasets are used for practical demonstration of the aforementioned algorithms.		
Suggested Instructional/ Reading Material	1. Introduction to Machine Learning by Ethem Alpaydin 2. The Hundred-Page Machine Learning Book by Andriy Burkov 3. Hands On Machine Learning with Scikit Learn, Keras and TensorFlow 2e by Aurélien Géron 4. Deep Learning with Python by François Chollet 5. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville		

Title	**AI-Assisted Software Development**		
Code	**EA-329**		
Credit Hours	2 (2,0)		
Category	AI Specialization Elective		
Prerequisite			
Co-Requisite	EA-320: Programming for Artificial Intelligence		
Follow-up			
Course Introduction	This course focuses on AI-assisted software development, often referred to as "vibe coding," where natural language and generative AI tools are used to design, generate, and refine software systems. It emphasizes rapid prototyping, code generation, debugging, and automation using modern large language models. Students will learn how to turn problem descriptions into working code, build applications using AI-assisted workflows, and integrate AI-generated components into real-world systems. The course also introduces prompt engineering for coding, code evaluation, debugging practices, and ethical considerations. Through hands-on projects, students will develop applications such as chatbots, web interfaces, and automation tools, preparing them to effectively use generative AI in modern software development.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	**BT**	**PLO**
	CLO1: Explain the fundamental concepts, principles, and workflows of AI-assisted software development using generative AI.	C2 (Understand)	1,2
	CLO2: Apply prompt engineering techniques and AI tools to support code generation, debugging, and software development tasks.	C3 (Apply)	2,3,4
	CLO3: Analyze AI-assisted development workflows and assess their effectiveness in building real-world applications.	C4 (Analyze)	2,3,4
	CLO4: Implement AI-assisted development workflows using modern generative AI tools and frameworks.	C3 (Apply)	2,3,4
	CLO5: Design and develop AI-assisted software solutions by integrating generative AI tools into real-world applications.	C5 (Create)	3,4,5,6
	CLO6: Evaluate AI-generated software solutions in terms of quality, reliability, and ethical implications.	C6 (Evaluate)	3,4,5,6
Syllabus	**Topics**: The course begins with an introduction to AI-assisted development, commonly referred to as vibe coding, where students learn how natural language and generative AI tools can support software development. It then covers prompt engineering for effective code generation, followed by techniques for generating, debugging, and refactoring code using AI tools (e.g., GitHub Copilot, ChatGPT). Students explore AI-assisted software design and learn how to build applications using modern development environments. The course also includes lightweight chatbot development and AI-driven web and application development, along with integration of external APIs and services. Students are introduced to testing and validation of AI-generated code to ensure reliability and performance. Finally, the course addresses ethical considerations, including the limitations, risks, and responsible use of AI-generated software.		
Suggested Instructional/ Reading Material	1. Foster, D., Generative Deep Learning, O'Reilly Media, 2022. 2. Géron, A., Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, 2022. 3. Tunstall, L. et al., Natural Language Processing with Transformers, O'Reilly Media, 2022. 4. Vaswani et al., Attention Is All You Need, 2017. 5. Yao et al., ReAct: Synergizing Reasoning and Acting in Language Models, 2023. 6. Wu et al., AutoGen: Enabling Next-Gen LLM Applications via Multi-Agent Conversation, 2023. 7. Official documentation and tutorials of modern AI development frameworks and APIs.		

Title	**AI-Assisted Software Development Lab**		
Code	**EA-329-L**		
Credit Hours	1 (0,3)		
Category	AI Specialization Elective		
Prerequisite			
Co-Requisite	EA-320: Programming for Artificial Intelligence		
Follow-up			
Course Introduction	This lab course provides hands-on experience in AI-assisted software development, commonly known as vibe coding. Students will use modern generative AI tools to build, debug, and refine software applications using natural language prompts. The lab emphasizes rapid prototyping, code generation, and integration of AI-generated components into real-world applications. Students will develop practical skills in building chatbots, web interfaces, and AI-powered tools while ensuring code quality, reliability, and ethical use of AI-generated software.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	**BT**	**PLO**
	CLO1: Apply prompt engineering techniques to generate, debug, and refine code using AI tools.	C3 (Apply)	2,3,4
	CLO2: Develop applications such as chatbots, web interfaces, and automation tools using AI-assisted workflows.	C5 (Create)	3,4,5,6
	CLO3: Integrate APIs, external tools, and data sources into AI-assisted applications.	C3 (Apply)	3,4,5
	CLO4: Evaluate the functionality, reliability, and usability of AI-generated software solutions.	C6 (Evaluate)	3,4,5,6
Syllabus	**Topics**: The lab begins with environment setup and API configuration, where students explore development environments and access AI services. It then covers prompt engineering for effective code generation, followed by practical exercises in generating, debugging, and refactoring code using AI tools such as GitHub Copilot, ChatGPT, and similar platforms. Students learn to build simple applications directly from natural language prompts and develop chatbots using AI-assisted workflows. The lab also includes AI-assisted web page and interface generation, along with integration of external APIs and services to enhance application functionality. Students work with both structured and unstructured data to build meaningful applications and are introduced to testing and validation techniques for AI-generated code. Further activities focus on improving and refining AI-generated applications for better performance and usability. Finally, the lab addresses ethical considerations and safe usage practices, ensuring responsible development and deployment of AI-assisted software solutions.		
Suggested Instructional/ Reading Material	1. Foster, D., Generative Deep Learning, O'Reilly Media, 2022. 2. Géron, A., Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, 2022. 3. Tunstall, L. et al., Natural Language Processing with Transformers, O'Reilly Media, 2022. 4. Vaswani et al., Attention Is All You Need, 2017. 5. Yao et al., ReAct: Synergizing Reasoning and Acting in Language Models, 2023. 6. Wu et al., AutoGen: Enabling Next-Gen LLM Applications via Multi-Agent Conversation, 2023. 7. Official documentation and tutorials of modern AI development frameworks and APIs.		

4) Math Deficiency

Course Title	**Math Deficiency - I**		
Course Code	**MD-101**		
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	**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.		
Suggested Instructional/ Reading Material	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-102**		
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	**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.		
Suggested Instructional/ Reading Material	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)		

14. Transition Scheme of Studies and Semester-wise Workload for ADC to BSCS (AI)

Semester – V						
Sr.	**Code**	**Course Title**	**Pre-Requisite**	**Domain**	**Cr. Hrs.**	**(Theory, Lab)**
1	CC-110	Digital Logic Design		CC	3	(3,0)
2	CC-110-L	Digital Logic Design Lab		CC	1	(0,1)
3	CC-218	Artificial Intelligence	Data Structures	CC	2	(2,0)
4	CC-218-L	Artificial Intelligence Lab	Data Structures	CC	1	(0,1)
5	CC-313	Design and Analysis of Algorithms	Data Structures	CC	3	(3,0)
6	ID-152	Calculus & Analytical Geometry	Semester-3	ID	3	(3,0)
7	ID-252	Linear Algebra		ID	3	(3,0)
				Credit Hours (Semester - V)	**16**	**(14,2)**
Semester – VI						
Sr.	**Code**	**Course Title**	**Pre-Requisite**	**Domain**	**Cr. Hrs.**	**(Theory, Lab)**
1	CC-111	Computer Organization & Architecture	Semester-3	CC	2	(2,0)
	CC-111-L	Computer Organization & Architecture Lab	Semester-3	CC	1	(0,1)
2	EA-324	Game Design and Development	Object Oriented Programming	EA	2	(2,1)
3	EA-324-L	Game Design and Development Lab	Object Oriented Programming	EA	1	(0,1)
4	CC-314	Cloud Computing	Computer Networks	CC	3	(3,0)
5	EI-333	Mobile Application Development	Object Oriented Programming	EA	2	(2,0)
6	EI-333	Mobile Application Development Lab	Object Oriented Programming	EA	1	(0,1)
7	EA-322	Deep Learning	Programming for AI	EA	2	(2,0)
8	EA-322-L	Deep Learning Lab		EA	1	(0,1)
				Credit Hours (Semester - VI)	**15**	**(12,3)**
Semester – VII						
Sr.	**Code**	**Course Title**	**Pre-Requisite**	**Domain**	**Cr. Hrs.**	**(Theory, Lab)**
1	CC-411	Final Year Project - I		CC	2	(0,2)
2	PT-380	Professional Certification		PT	3	(3,0)
3	EA-325	Computer Vision	Deep Learning	EA	2	(2,0)
	EA-325-L	Computer Vision Lab	Deep Learning	EA	1	(0,1)
4	EA-326	Natural Language Processing	Deep Learning	EA	2	(2,0)
5	EA-326-L	Natural Language Processing Lab	Deep Learning	EA	1	(0,1)
6	ID-350	Bioinformatics		ID	3	(3,0)
				Credit Hours (Semester - VII)	**14**	**(11, 3)**
Semester – VIII						
Sr.	**Code**	**Course Title**	**Pre-Requisite**	**Domain**	**Cr. Hrs.**	**(Theory, Lab)**
1	CC-412	Final Year Project - II	Final Year Project - I	CC	4	(0,4)
2	CC-312	Information Security	Semester-4	CC	3	(3,0)
3	CC-219	Theory of Automata	Semester-4	CC	3	(3,0)
4	PT-381	Field Experience/Internship		PT	3	(0,3)
				Credit Hours (Semester - VIII)	**13**	**(6,7)**
				Total Credit Hours	**58**	**(43,15)**
				ADC-IT	**72**	**(62,10)**
				Grand Total Credit Hours	**130**	**(105,25)**