

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'.

**Admin. Block,
Quaid-i-Azam Campus,
Lahore.
No. D/ 2690 /Acad.**

Sd/-
**Dr. Ahmad Islam
Registrar**

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

BS Computer Science (Specialization in Information Technology) [BSCS(IT)]

Offered at Affiliated Colleges of University of the Punjab

Department of Information Technology

Faculty of Computing & Information Technology

Version: 1.0.6

Date: 08-06-2026

University of the Punjab, Lahore

Curriculum, Course Syllabi, and Model Study Plan for BS Computer Science specialization in Information Technology for Affiliated Colleges, prepared in accordance with the Revised Curriculum for Computer Science 2025 issued by the Higher Education Commission (HEC) of Pakistan (No. HEC/NCRC/CS&IT/2025/8163, dated October 14, 2025), for implementation at the University of the Punjab, Lahore, its sub-campuses, and its affiliated colleges.

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1. Introduction

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

2. Vision

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

3. Mission

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

4. Program Introduction

The BS Computer Science (Specialization in Information Technology) [BSCS(IT)] is a comprehensive four-year degree aligned with the HEC Undergraduate Education Policy V 1.1. It is designed to equip students with a solid foundation in core computing principles, alongside specialized knowledge in Information Technology. 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 BSCS(IT) program are to

PEO1: Technical Proficiency and Innovation

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

PEO2: Collaborative, Ethical, and Professional Responsibility

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

PEO3: Lifelong Learning and Communication Skills

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

5.1 Program Learning Outcomes (PLOs)

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

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

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

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

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

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

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

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

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

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

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

5.2 PLO to PEO Mapping

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

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

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

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

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

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

5.4 Continuous Quality Improvement (CQI) Procedure

Purpose: The purpose of this CQI procedure is to establish a systematic, data-driven, and sustainable mechanism to continuously monitor, evaluate, and enhance the quality of the BS Computer Science (Software Engineering specialization) program. It ensures alignment with Program Educational Objectives (PEOs), Program Learning Outcomes (PLOs), and evolving industry and academic requirements.

CQI Framework: The CQI process follows a closed-loop model: Plan → Deliver → Assess → Evaluate → Improve

Planning Phase: The planning phase involves defining and periodically reviewing the Program Educational Objectives (PEOs), Program Learning Outcomes (PLOs), and Course Learning Outcomes (CLOs) to ensure their continued relevance and alignment with academic and industry needs. It also includes establishing clear CLO–PLO mappings in accordance with Bloom’s Taxonomy to maintain appropriate cognitive levels. Furthermore, this phase encompasses the design and refinement of course content, assessment methods, and instructional strategies to support effective teaching and learning outcomes.

Delivery Phase: The delivery phase involves executing teaching activities in accordance with the approved course outlines while ensuring effective coverage of planned content. Faculty employ modern pedagogical approaches such as problem-based learning, project-based learning, and the use of industry-relevant case studies to enhance student engagement and practical understanding. Additionally, proper documentation is maintained through updated course files and teaching records to ensure transparency and support the overall quality assurance process.

Assessment Phase: The assessment phase comprises both direct and indirect evaluation methods to measure student learning and program effectiveness. Direct assessment includes midterm and final examinations, quizzes, assignments, lab work, projects, and capstone project evaluations to assess the attainment of course learning outcomes. Indirect assessment involves collecting feedback through course evaluation surveys, exit surveys, alumni surveys, and employer feedback to gain insights into student satisfaction and the overall impact of the program.

Evaluation Phase: The evaluation phase involves computing the attainment levels of Course Learning Outcomes (CLOs) at the course level and Program Learning Outcomes (PLOs) at the program level using collected assessment data. These results are then compared against predefined Key Performance Indicators (KPIs). Based on this analysis, weak CLOs and PLOs are identified, along with trends and recurring deficiencies, to inform subsequent improvement actions.

Improvement Phase: The improvement phase involves proposing corrective actions based on the findings of the evaluation process to address identified gaps and enhance program quality. These actions may include revising course content, modifying assessment methods, organizing faculty training and workshops, and introducing new tools or technologies. The approved actions are implemented in the subsequent academic cycle, and all changes, along with their outcomes, are properly documented to ensure effective closing of the CQI loop.

CQI Cycle Frequency: The CQI cycle will be implemented at multiple levels to ensure continuous monitoring and improvement of the program. Course-level CQI will be conducted every semester to assess and enhance individual course outcomes, while program-level CQI will be carried out annually to evaluate overall program performance. Additionally, Program Educational Objectives (PEOs) will be reviewed every two to three years to ensure their continued relevance and alignment with evolving academic and industry requirements.

6. Admission Eligibility Criteria

- Higher Secondary School Certificate/A-levels (involving minimum 12 years of schooling) or an IBCC equivalent qualification, with at least 50% 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.
- Any other (if applicable)

7. Duration of the Program and Degree Awarding Criteria

The BSCS(IT) program spans 8 semesters over 4 years and requires the completion of 130 credit hours. To qualify for the degree, students must achieve a minimum CGPA of 2.0. Additionally, a final year project is mandatory. Other requirements, such as a comprehensive examination, may apply if specified.

8. Categorization of Courses

8.1 Nomenclature of Course Categories and Course Codes

C	Code	Description	Courses	Cr. Hrs.	
0	MD	Math Deficiency	2*	6*	(6, 0)*
1	CC	Computing Core	22	54	(39, 15)
2,3	EI	Specialization Elective	8	24	(18, 6)
5	ID	Interdisciplinary Courses	4	12	(12, 0)
6	GE	General Education Courses (Math & Science)	4	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)
8	PT	Professional Training	2	6	(3, 3)
Total			51	130	(102, 28)

Course Coding Scheme:

Code-YCS

Code = MD / CC / EI / MS / GE / HQ

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

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

S = Serial Number (Resets with Year) = 0, 1, 2, ..., 9

Lab Codes: Code-YCS-L

8.2 Comparison with HEC/NCEAC Recommendation**CC:** Computing Core**EI:** Specialization Elective**GE:** General Education**MD:** Math Deficiency**ID:** Interdisciplinary**FYP:** Final Year Project**PT:** Internship

Semester	Number of Courses	Category (Credit Hours)									Semester Load
		Discipline Related Courses / Major			Cr. Hrs. (Theory, Lab)	Others				Cr. Hrs. (Theory, Lab)	Cr. Hrs. (Theory, Lab)
		CC	EI	PT		GE	ID	MD	FYP		
1	9	4	0	0	4 (3, 1)	14	0	3*	0	14 (11, 3)	18 (14, 4)
2	8	7	0	0	7 (5, 2)	9	0	3*	0	9 (8, 1)	16 (13, 3)
3	8	14	0	0	14 (11, 3)	0	3	0	0	3 (3, 0)	17 (14, 3)
4	7	14	0	0	14 (12, 2)	3	0	0	0	3 (3, 0)	17 (15, 2)
5	8	9	3	0	12 (10, 2)	0	6	0	0	6 (6, 0)	18 (16, 2)
6	9	0	15	0	15 (12, 3)	2	0	0	0	2 (2, 0)	17 (14, 3)
7	8	0	6	3	9 (7, 2)	2	3	0	3	8 (5, 3)	17 (12, 5)
8	4	0	0	3	3 (0, 3)	4	0	0	3	7 (4, 3)	10 (4, 6)
PU	61	48	24	6	78 (60, 18)	34	12	6*	6	52 (48, 10)	130 (102, 28)
HEC Guidelines		48	24	6	78 (60, 18)	34	12	6*	6	55	130
Difference HEC & PU		0	0	0	0	0	0	0	0	0	0

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

The courses with lab are counted as 2 separate courses.

8.3 Category-wise List of Courses

COMPUTING CORE: 48 + 6 (39,15)					
Sr.	Sem.	Code	Course Title	Prerequisite	Cr. Hrs.
1	1	CC-110	Digital Logic Design	None	3 (3, 0)
2	1	CC-110-L	Digital Logic Design Lab		1 (0, 1)
3	2	CC-112	Programming Fundamentals	None	3 (3, 0)
4	2	CC-112-L	Programming Fundamentals Lab	None	1 (0, 1)
5	2	CC-214	Computer Networks	None	2 (2, 0)
6	2	CC-214-L	Computer Networks Lab	None	1 (0, 1)
7	3	CC-111	Computer Organization & Architecture	Digital Logic Design	2 (2, 0)
8	3	CC-111-L	Computer Organization & Architecture Lab	Digital Logic Design	1 (0, 1)
9	3	CC-211	Object Oriented Programming	Programming Fundamentals	3 (3, 0)
10	3	CC-211-L	Object Oriented Programming Lab	Programming Fundamentals	1 (0, 1)
11	3	CC-212	Software Engineering	None	3 (3, 0)
12	3	CC-215	Database Systems	None	3 (3, 0)
13	3	CC-215-L	Database Systems Lab	None	1 (0, 1)
14	3	CC-213	Data Structures	Object Oriented Programming	3 (3, 0)
15	3	CC-213-L	Data Structures Lab	Object Oriented Programming	1 (0, 1)
16	4	CC-216	Operating Systems	None	3 (3, 0)
17	4	CC-216-L	Operating Systems Lab	None	1 (0, 1)
18	4	CC-217	Information Security	None	3 (3, 0)
19	4	CC-219	Theory of Automata	None	3 (3, 0)
20	5	CC-218	Artificial Intelligence	Data Structures	2 (2, 0)
21	5	CC-218-L	Artificial Intelligence Lab	Data Structures	1 (0, 1)
22	5	CC-313	Design and Analysis of Algorithms	Data Structures	3 (3, 0)
23	5	CC-314	Cloud Computing	Computer Networks	3 (3, 0)
24	7	CC-411	Final Year Project - I	None	3 (0, 3)
25	8	CC-412	Final Year Project - II	Final Year Project – I	3 (0, 3)

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-169	Applied Physics	Math & Science	3 (2, 1)
4	2	GE-167	Discrete Structures	Math & Science (QR-1)	3 (3, 0)

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5	4	GE-260	Probability and Statistics	Math & Science (QR-2)	3 (3, 0)
6	1	GE-190	Functional English	Arts & Languages	3 (3, 0)
7	2	GE-191	Expository Writing	Arts & Languages	3 (3, 0)
8	1	GE-194	Pakistan Studies	Arts & Languages	2 (2, 0)
9	2	GE-195	Ideology and Constitution of Pakistan	Arts & Languages	2 (2, 0)
10	1	GE-196	Islamic Studies	Arts & Languages	2 (2, 0)
11	1	GE-197	Fehm-e-Quran-I	Arts & Languages	1 (0, 1)
12	2	GE-198	Fehm-e-Quran-II	Arts & Languages	1 (0, 1)
13	2	GE-170	Introduction to Management	Management & Social Sciences	2 (2, 0)
14	5	GE-270	Professional Practices	Management & Social Sciences	2 (2, 0)
15	6	GE-271	Entrepreneurship	Management & Social Sciences	2 (2, 0)
16	8	GE-272	Civics and Community Management	Management & Social Sciences	2 (2, 0)

IT Specialization Electives: 24 (18, 6)					
Sr.	Sem.	Code	Course Title	Prerequisite	Cr. Hrs.
1	5	EI-322	Web Technologies	Programming Fundamentals	2 (2, 0)
2	5	EI-322-L	Web Technologies Lab	Programming Fundamentals	1 (0, 1)
3	6	EI-335	Machine Learning	Artificial Intelligence	2 (2, 0)
4	6	EI-335-L	Machine Learning Lab	Artificial Intelligence	1 (0, 1)
5	6	EI-330	IT Project Management		3 (3, 0)
6	6	EI-333	Mobile Application Development	Object Oriented Programming	2 (2, 0)
7	6	EI-333-L	Mobile Application Development Lab	Object Oriented Programming	1 (0, 1)
8	6	EI-332	Software Quality Engineering	Software Engineering	3 (3, 0)
9	6	EI-326	Enterprise Application Development	Programming Fundamentals	2 (2, 0)
10	6	EI-326-L	Enterprise Application Development Lab	Programming Fundamentals	1 (0, 1)
11	7	EI-323	System & Network Administration	Operating Systems	2 (2, 0)
12	7	EI-323-L	System & Network Administration Lab	Operating Systems	1 (0, 1)
13	7	EI-324	Database Administration & Management	Database Systems	2 (2, 0)
14	7	EI-324-L	Database Administration & Management Lab	Database Systems	1 (0, 1)

Interdisciplinary: 12 (12,0)				
Sr.	Sem.	Code	Course Title	Cr. Hrs.
1	3	ID-152	Calculus and Analytical Geometry	3 (3, 0)
2	5	ID-252	Linear Algebra	3 (3, 0)
3	5	ID-253	Bioinformatics	3 (3, 0)
4	6	ID-254	Digital Marketing & E-Commerce	3 (3, 0)

Professional Training and Certification: 6 (3,3)				
Sr.	Sem.	Code	Course Title	Cr. Hrs.
1	7	PT-380	Professional Certification	3 (3, 0)
2	8	PT-381	Internship	3 (0, 3)

MATH DEFICIENCY: 6 (6,0)*				
Sr.	Sem.	Code	Course Title	Cr. Hrs.
1	1	MD-101	Math Deficiency – I	3 (3,0)*
2	2	MD-102	Math Deficiency – II	3 (3,0)*

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

9. Scheme of Studies and Semester-wise Workload

Semester – I						
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	GE-160	Applications of Information & Communication Technologies		GE	2	(2, 0)
4	GE-160-L	Applications of Information & Communication Technologies Lab		GE	1	(0, 1)
5	GE-169	Applied Physics		GE	3	(2, 1)
6	GE-190	Functional English		GE	3	(3, 0)
7	GE-194	Pakistan Studies		GE	2	(2, 0)
8	GE-196	Islamic Studies		GE	2	(2, 0)
9	GE-197	Fehm-e-Quran-I		GE	1	(0, 1)
10	MD-101	Math Deficiency - I		MD	3*	(3, 0)*
Credit Hours (Semester - I)					18	(14, 4)

Semester – II						
Sr.	Code	Course Title	Pre-Requisite	Domain	Cr. Hrs.	(Theory , Lab)
1	CC-112	Programming Fundamentals		CC	3	(3, 0)
2	CC-112-L	Programming Fundamentals Lab		CC	1	(0, 1)
3	CC-113	Computer Network		CC	2	(2, 0)
4	CC-113-L	Computer Network Lab		CC	1	(0, 1)
5	GE-167	Discrete Structures		GE	3	(3, 0)
6	GE-191	Expository Writing		GE	3	(3, 0)
7	GE-170	Introduction to Management		GE	2	(2, 0)
8	GE-198	Fehm-e-Quran-II		GE	1	(0, 1)
9	MD-102	Math Deficiency - II		MD	3*	(3, 0)*
Credit Hours (Semester - II)					16	(13, 3)

Semester – III						
Sr.	Code	Course Title	Pre-Requisite	Domain	Cr. Hrs.	(Theory, Lab)
1	CC-111	Computer Organization & Architecture		CC	2	(2, 0)
2	CC-111-L	Computer Organization & Architecture Lab		CC	1	(0, 1)
3	CC-211	Object Oriented Programming	Programming Fundamentals	CC	3	(3, 0)
4	CC-211-L	Object Oriented Programming Lab	Programming Fundamentals	CC	1	(0, 1)
5	CC-212	Software Engineering		CC	3	(3, 0)
6	CC-215	Database Systems		CC	3	(3, 0)
7	CC-215-L	Database Systems Lab		CC	1	(0, 1)
8	ID-152	Calculus & Analytical Geometry		ID	3	(3, 0)
Credit Hours (Semester - III)					17	(14, 3)

Semester – IV						
Sr.	Code	Course Title	Pre-Requisite	Domain	Cr. Hrs.	(Theory, Lab)
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, 1)
3	CC-216	Operating Systems		CC	3	(3, 0)
4	CC-216-L	Operating Systems Lab		CC	1	(0, 1)
5	CC-312	Information Security		CC	3	(3, 0)
6	CC-219	Theory of Automata		CC	3	(3, 0)
7	GE-260	Probability and Statistics		GE	3	(3, 0)
Credit Hours (Semester - IV)					17	(15, 2)

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Semester – V						
Sr.	Code	Course Title	Pre-Requisite	Domain	Cr. Hrs.	(Theory, Lab)
1	CC-218	Artificial Intelligence	Data Structures	CC	2	(2, 0)
2	CC-218-L	Artificial Intelligence Lab	Data Structures	CC	1	(0, 1)
3	CC-313	Design and Analysis of Algorithms	Data Structures	CC	3	(3, 0)
4	CC-314	Cloud Computing	Computer Networks	CC	3	(3, 0)
5	EI-322	Web Technologies (Elective-1)	Programming Fundamentals	EI	2	(2, 0)
6	EI-322-L	Web Technologies Lab (Elective-1)	Programming Fundamentals	EI	1	(0, 1)
7	ID-252	Linear Algebra	Calculus & Analytical Geometry	ID	3	(3, 0)
8	ID-251	Digital Marketing & E-Commerce		ID	3	(3, 0)
Credit Hours (Semester - V)					18	(16, 2)

Semester – VI						
Sr.	Code	Course Title	Pre-Requisite	Domain	Cr. Hrs.	(Theory, Lab)
1	EI-321	IT Project Management (Elective-2)		EI	3	(3, 0)
2	EI-326	Enterprise Application Development (Elective-3)	Programming Fundamentals	EI	2	(2, 0)
3	EI-326-L	Enterprise Application Development Lab (Elective-3)	Programming Fundamentals	EI	1	(0, 1)
4	EI-332	Software Quality Engineering (Elective-3)	Software Engineering	EI	3	(3, 0)
5	EI-333	Mobile Application Development (Elective-4)	Object Oriented Programming	EI	2	(2, 0)
6	EI-333-L	Mobile Application Development Lab	Object Oriented Programming	EI	1	(0, 1)
7	EI-335	Machine Learning (Elective-5)	Artificial Intelligence	EI	2	(2, 0)
8	EI-335-L	Machine Learning Lab (Elective-5)	Artificial Intelligence	EI	1	(0, 1)
9	GE-362	Entrepreneurship		GE	2	(2, 0)
Credit Hours (Semester - VI)					17	(14, 3)

Semester – VII						
Sr.	Code	Course Title	Pre-Requisite	Domain	Cr. Hrs.	(Theory , Lab)
1	CC-411	Final Year Project - I		CC	3	(0, 3)
2	EI-323	System & Network Administration / Elective-7	Operating Systems	EI	2	(2, 0)
3	EI-323-L	System & Network Administration Lab	Operating Systems	EI	1	(0, 1)
4	EI-324	Database Administration & Management / Elective-8	Database Systems	EI	2	(2, 0)
5	EI-324-L	Database Administration & Management Lab	Database Systems	EI	1	(0, 1)
6	PT-380	Professional Certification		PT	3	(3, 0)
7	ID-350	Bioinformatics		ID	3	(3, 0)
8	GE-262	Professional Practices		GE	2	(2, 0)
Credit Hours (Semester - VII)					17	(12, 5)

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	3	(0, 3)
2	PT-381	Internship		PT	3	(0, 3)
3	GE-195	Ideology and Constitution of Pakistan		GE	2	(2, 0)
4	GE-363	Civics and Community Management		GE	2	(2, 0)
Credit Hours (Semester - VIII)					10	(4, 6)
Total Credit Hours					130	(102, 28)

* These Math courses will be as Non-Credit courses with only Pass/Fail grade assigned to the students so that overall credit will not affect.

10. Course Outlines

Course outlines of all major categories are shared below:

1) Computing Core

Course Title	Digital Logic Design		
Course Code	CC-110		
Credit Hours	3 (3,0)		
Category	Computing core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	CC-111 Computer Organization & Architecture		
Course Introduction	The course introduces the concept of digital logic, gates and the digital circuits. Further, it focuses on the design and analysis combinational and sequential circuits. It also serves to familiarize the student with the logic design of basic computer hardware components.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Acquire the basic knowledge of logic gates and digital logic circuits	C1 (Acquire)	1
	CLO2: Understand the working of the fundamental digital circuits used in digital systems and computers.	C2 (Understand)	1,2
	CLO3: Implement simple digital circuits using logic gates. Designing a digital circuit for implementing a given scenario.	C3 (Apply)	3, 4
	CLO4: Analyze the behavior of digital systems using truth tables and Boolean algebra	C4 (Analyze)	3,4
Syllabus	Topics: Introduction to Digital Systems, Number Systems, Introduction to Boolean Algebra, Basic theorems and properties of Boolean Algebra, Boolean Functions, Logic Gates, NAND and NOR Implementation, Representation of Function in Sum of Minterms or Product of Maxterms, Simplification of Boolean function using Karnaugh Map, Don't care Conditions, The Tabulation Method, Introduction to Combinational Logic, Design of Adders, Design of Subtractors, Code Convertors, Analysis Procedure of Combinational Circuits, Binary Parallel Adders, Decimal Adders, Magnitude Comparator, Decoders and its applications, Multiplexers, Demultiplexers, Encoders, ROM, Programmable Logic Array (PLA), Introduction to Sequential Circuits, Basic Flip Flop, Clocked RS Flip Flop, Clocked D Flip Flop, Clocked JK Flip Flop, Clocked T Flip Flop, Analysis of Clocked Sequential Circuits, State Reduction and Assignment, Flip Flop Excitation tables, Design Procedure, Design of Counters, Design with State Equations, Introduction to Registers, Shift Registers, Ripple Counters, Synchronous Counters, Timing Sequences, Memory Unit, Random Access Memory. Introduction Programmable Logic Devices (CPLD, FPGA), Lab Assignments using tools such as Verilog HDL/VHDL, MultiSim.		
Suggested Instructional / Reading Material	1. M. Morris Mano, Digital Logic and Computer Design, 1 st Edition, Pearson, 1979, ISBN: 0132145103. 2. Thomas L. Floyd, Digital Fundamentals, 10th Edition, Prentice Hall, 2008, ISBN: 0132359235. 3. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e		

Course Title	Digital Logic Design Lab		
Course Code	CC-110-L		
Credit Hours	1 (0,3)		
Category	Computing core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	CC-210 Computer Organization & Assembly Language		
Course Introduction	The course introduces the concept of digital logic, gates and the digital circuits. Further, it focuses on the design and analysis combinational and sequential circuits. It also serves to familiarize the student with the logic design of basic computer hardware components.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Acquire the basic knowledge of Digital Electronic Trainer	C1 (Acquire)	1
	CLO2: Understand the pin configuration and working of commonly used ICs for digital circuit design	C2 (Understand)	1,2
	CLO3: Demonstrate the working of the standard digital circuits.	C3 (Demonstrate)	3,4
	CLO4: Designing a digital circuit for implementing a given scenario.	C5 (Design)	3,4
Syllabus	Topics: Familiarization with Digital Electronic Trainer, Implementation of logic gates using ICs, Illustration of basic properties and theorems Boolean algebra using circuit design, Implementation of given Boolean functions, Half Adder, Full Adder, Half Subtractor, Full Subtractor, Design of 7-Segment Display, BCD To 7-Segment Display, Decoder, Multiplexer, Demultiplexer, Implementation of Boolean function(s) using Decoder and Multiplexer, Magnitude Comparator, D Latch and Flip-Flop Operation, Latching BCD Data for Displaying On 7- Segment Display, JK Flip-Flop Operation, Random Access Memories		
Suggested Instructional / Reading Material	1. M. Morris Mano, Digital Logic and Computer Design, 1st Edition, Pearson, 1979, ISBN: 0132145103. 2. Thomas L. Floyd, Digital Fundamentals, 10th Edition, Prentice Hall, 2008, ISBN: 0132359235. 3. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e		

Course Title	Programming Fundamentals		
Course Code	CC-112		
Credit Hours	3 (3,0)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	CC-211: Object Oriented Programming, 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 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 (0,1)		
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-214		
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.
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Course Title	Computer Networks Lab		
Course Code	CC-214-L		
Credit Hours	1 (0,3)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course provides fundamental hands-on skills related to computer networks. After completion of the course, the students will be familiar with networking, routing, switching, and setting up of networks from scratch, major protocols involved in communication and their configurations. Students will also be made aware of the state-of-the-art areas in case they would like to pursue this course in future.		
Course Learning Outcomes (CLOs)	At the end of the lab, the students will be able to:	BT	PLO
	CLO1: Describe the fundamental components, technologies, and devices of computer networks	C2 (Describe)	1
	CLO2: Explain the services and functions provided by each layer in the Internet protocol stack	C2 (Explain)	1
	CLO3: Identify various internetworking devices and protocols and their functions in a networking	C4 (Identify)	1,2
	CLO4: Analyze working and performance of key technologies, algorithms and protocols	C4 (Analyze)	3
	CLO5: Build Computer Network on various Topologies.	C5 (Build)	4,5
Syllabus	Introduction to Wireshark, HTTP GET/response interaction, DNS role in the Internet infrastructure, TCP segments sent and received in transferring, UDP transport protocol IP investigate the IP protocol, NAT behavior of the NAT protocol, DHCP examine the DHCP packets captured, ICMP capturing the packets generated by the Ping program, Ethernet and ARP investigate the Ethernet protocol and the ARP protocol, 802.11 Wireless investigate the 802.11 wireless network protocol, SSL investigate the Secure Sockets Layer (SSL) protocol		
Suggested Instructional/ Reading Material	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	Computer Organization and Architecture		
Course Code	CC-111		
Credit Hours	3 (2,3)		
Category	Computing core		
Prerequisite	CC-110 Digital Logic Design		
Co-Requisite	None		
Follow-up	None		
Course Introduction	The main objective of this course is to introduce the organization of computer systems and usage of assembly language for optimization and control. Emphasis should be given to expose the low-level logic employed for problem solving while using assembly language as a tool. At the end of the course the students should be capable of writing moderately complex assembly language subroutines and interfacing them to any high-level language.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Describe the structure and function of computer components such as CPU, memory, and I/O devices. and assembly language	C1 (Acquire)	1
	CLO2: Understand the concepts of basic computer organization, architecture, and explain the concepts of instruction set architecture and microarchitecture.	C2 (Understand)	2
	CLO3: Write and understand basic assembly language programs. Optimize programs considering hardware limitations.	C3 (Apply)	3,4,5
	CLO4: Analyze how hardware components interact during program execution.	C4 (Analyze)	3
Syllabus	Topics: Introduction to computer systems, Information is bits + context, Evolution of Intel Microprocessor, Introduction to Assembly Language, Computer Organization, Storage devices hierarchy, The Components of a Microcomputer System, Instruction Cycle, Memory Architecture, Memory Representation & Hierarchy, Data, Address, Control Busses, Processor architecture: the Y86 instruction set architecture, logic design and the Hardware Control Language (HCL), sequential Y86 implementations, general principles of pipelining, pipelined Y86 implementations, Intel 8086 family of Microprocessors, Organization of Intel 8088/8086 Processor, Machine-level representation of programs: a historical perspective, program encodings, data formats, accessing information, arithmetic and logical operations, control, procedures, array allocation and access, heterogeneous data structures, putting it together: understanding pointers, Registers and their categories Function of Registers, Memory Addressing, Real Mode Memory Structure, Memory Segmentation (Segment/Offset Scheme), Computer Instructions for Basic computer (Memory Reference, Register Reference and I/O instructions), Addressing modes, Instruction Cycle, Timing and Decoding, RTL of the instructions, Complete flow chart for the Basic Computer Operation, Addressing Modes, Design of the CPU of a basic computer		

Suggested Instructional / Reading Material	1. Charles Marut, Ytha Yu, Assembly Language Programming and Organization of the IBM PC, 1st Edition, McGraw-Hill, 1992, ISBN: 9780070726925. 2. M. Morris Mano, Computer System Architecture, 3rd Edition, Pearson, 1993, ISBN: 9780131755635. 3. Barry B. Brey, The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium Pro-Processor, Pentium II, Pentium III, Pentium 4", 7th Edition, Prentice Hall, 2005, ISBN: 0131195069. 4. Kip R. Irvine, Assembly Language for Intel Based Computers, 4th Edition, Prentice Hall, 2002, ISBN: 9780130910134.
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Course Title	Computer Organization and Architecture Lab		
Course Code	CC-111-L		
Credit Hours	1 (0,3)		
Category	Computing core		
Prerequisite	CC-110 Digital Logic Design		
Co-Requisite	None		
Follow-up	None		
Course Introduction	The main objective of this course is to introduce the organization of computer systems and usage of assembly language for optimization and control. Emphasis should be given to expose the low-level logic employed for problem solving while using assembly language as a tool. At the end of the course the students should be capable of writing moderately complex assembly language subroutines and interfacing them to any high-level language.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Describe the structure and function of computer components such as CPU, memory, and I/O devices. and assembly language	C1 (Acquire)	1
	CLO2: Understand the concepts of basic computer organization, architecture, and explain the concepts of instruction set architecture and microarchitecture.	C2 (Understand)	2
	CLO3: Write and understand basic assembly language programs. Optimize programs considering hardware limitations.	C3 (Apply)	3,4,5
	CLO4: Analyze how hardware components interact during program execution.	C4 (Analyze)	3
Syllabus	Lab Topics: Assembly Language Syntax, using the gdb debugger, Program data, Variables, Variables, Program Structure, Machine-level representation of programs: a historical perspective, program encodings, data formats, accessing information, arithmetic and logical operations, control, Memory Models, Data Segments, Stack Segment, Code Segment, Variants of MOV instruction, Some Basic Instructions, XCHG, ADD, SUB, INC, DEC, NEG, Input and Output Instructions, The Processor Status and Flags Register, Flow Control Instructions, Unconditional Jump, Various Conditional Jumps, Looping Structures, Logic Instructions, AND, OR, XOR, NOT, TEST, Shift Instructions, Rotate Instructions, Procedures to Input Binary, Decimal, Hexadecimal Numbers, Procedures to output Binary, Decimal, Hexadecimal Numbers, The Stack, PUSH and POP Instructions, CALL and RET instructions, MUL instruction, DIV instruction, Related Programming examples, XLAT instruction, String Instructions, MOVSb/W, LOADSB/W, STOSB/W, SCASB/W, CMPSB/W, Procedures, File Operations, Reading a File, Writing a File		
Suggested Instructional / Reading Material	1. Charles Marut, Ytha Yu, Assembly Language Programming and Organization of the IBM PC, 1st Edition, McGraw-Hill, 1992, ISBN: 9780070726925. 2. M. Morris Mano, Computer System Architecture, 3rd Edition, Pearson, 1993, ISBN: 9780131755635. 3. Barry B. Brey, The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium Pro-Processor, Pentium II, Pentium III, Pentium 4", 7th Edition, Prentice Hall, 2005, ISBN: 0131195069. 4. Kip R. Irvine, Assembly Language for Intel Based Computers, 4th Edition, Prentice Hall, 2002, ISBN: 9780130910134.		

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.
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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, 9 th 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		

Course Title	Information Security		
Course Code	CC-217		
Credit Hours	3 (3,0)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This core-computing course provides a broad overview of the threats to the security of information systems, the responsibilities and basic tools for information security, and the levels of training and expertise needed in organizations to reach and maintain a state of acceptable security. It covers concepts and applications of system and data security. Areas of particular focus include secure network design, implementation and transition issues, and techniques for responding to security breaches.		
Course Objectives	– Introduction to Information Security of different types of Information Systems. – To be able to identify Computer System threats. – To be able to identify Malware attacks, and understand the stages of attack and payloads. – To be able to understand basic Cryptographic techniques. – Introduction to the Information Security Laws of Pakistan, US, UK, and EU.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain key concepts of information security such as Design principles, Cryptography, Risk management, and Ethics.	C1 (Remember)	1, 2
	CLO2: Discuss Legal, Ethical, and Professional issues in Information Security.	C2 (Understand)	1, 2
	CLO3: Apply various security and risk management tools for achieving Information Security and Privacy.	C3 (Apply)	3, 4, 5
	CLO4: Identify appropriate techniques to tackle and solve problems in the discipline of information security.	C4 (Analyze)	3, 4, 5, 6
Syllabus	Information Security foundations, Security design principles; Security mechanisms, Symmetric and Asymmetric Cryptography, Encryption, Hash functions, Digital signatures, Key management, Authentication and Access control, OWASP Top 10 Web Application Security Risks, Software security, Vulnerabilities and Protections, Common Vulnerabilities and Exposures (CVE), Vulnerability Metrics, National Vulnerability Database (NVD), Common Vulnerability Scoring System (CVSS), Malware, Database security; Network security, Firewalls, Intrusion detection; Security policies, Policy formation and enforcement, Risk assessment, Cybercrime, Law and Ethics in information security, Privacy and Anonymity of data i.e. Tor Project (https://www.torproject.org/), Tor Browser.		
Suggested Instructional/ Reading Material	1. Michael E. Whitman and Herbert J. Mattord, Principles of Information Security, 6th edition, CENGAGE Learning. 2. William Stallings, Lawrie Brown, Computer Security: Principles and Practice, 5th Edition, Published by Pearson, 2024. 3. William Chuck Easttom, Computer Security Fundamentals, 5th Edition, Pearson Education.		

	4. Dieter Gollmann, Computer Security, Third Edition, Hamburg University of Technology, WILEY 5. Ross Anderson, Security Engineering, Third Edition, A Guide to Building Dependable Distributed Systems, WILEY, 2020 6. Dafydd Stuttard, Marcus Pinto, The Web Application Hacker's Handbook, Finding and Exploiting Security Flaws, Second Edition, WILEY 7. Mark Ciampa, CompTIA Security+ Guide to Network Security Fundamentals, 7th Edition, Information Security, CENGAGE. 8. Randall J. Boyle, Raymond R. Panko, Corporate Computer Security, 4th Edition, PEARSON. 9. Charles Pfleeger, Shari Lawrence Pfleeger, Lizzie Coles-Kemp, Security in Computing, 6th Edition, The Art of Computer and Information Security: From Apps and Networks to Cloud and Crypto Security in Computing, Addison-Wesley.
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Course Title	Artificial Intelligence		
Course Code	CC-218		
Credit Hours	3 (2,3)		
Category	Computing core		
Prerequisite	CC-213: Data Structures		
Co-Requisite	None		
Follow-up	None		
Course Introduction	Artificial Intelligence has emerged as one of the most significant and promising areas of computing. This course focuses on the foundations of AI and its basic techniques like Symbolic manipulations, Pattern Matching, Knowledge Representation, Decision Making and Appreciating the differences between Knowledge, Data and Code. AI programming language Python has been proposed for the practical work of this course.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Describe core AI concepts including search algorithms, knowledge representation, and reasoning.	C2 (Understand)	1,2
	CLO2: Implement basic AI algorithms for problem-solving and decision-making.	C3 (Apply)	3,4,5
	CLO3: Analyze the applications of AI in real-world scenarios.	C4 (Analyze)	1,2,3
	CLO4: Discuss ethical considerations and limitations of AI systems.	C5 (Evaluate)	8,9
	CLO5: Develop simple AI models using appropriate tools and frameworks.	C6 (Create)	2,4,5

Syllabus	An Introduction to Artificial Intelligence and its applications towards Knowledge Based Systems; Symbolic AI: the physical symbol system hypothesis. Search: exhaustive & heuristic search techniques. Introduction to Reasoning and Knowledge Representation, Problem Solving by Searching (Informed searching, Uninformed searching, Heuristics, Local searching, Minmax algorithm, Alpha beta pruning, Game-playing); Case Studies: General Problem Solver, Eliza, Student, Macsyma; Learning from examples; ANN and Natural Language Processing; Recent trends in AI and applications of AI algorithms, Game playing, Genetic algorithms, Introduction to Machine Learning for AI, Decision Trees, Bayesian classification, Artificial Neural Networks, Computer Vision. Lab Topics: Introduction to Python programming, variables, expressions, operands and operators, loops, control structures, debugging, error messages, functions, strings, lists, object-oriented constructs and basic graphics in the languages. Logic programming: knowledge representation & search in the context of logic programming. Reasoning in logic programming: unification, horn clause logic, and resolution, Knowledge Representation Schemas: Logic, frames, semantic nets, scripts; problems in knowledge representation. Expert systems.
Suggested Instructional/ Reading Material	1. Stuart Russell and Peter Norvig, Artificial Intelligence. A Modern Approach, 3rd edition, Prentice Hall, Inc., 2015. 2. Luger, G.F. and Stubblefield, W.A., 2009. AI algorithms, data structures, and idioms in Prolog, Lisp, and Java. Pearson Addison-Wesley. 3. George F. Luger, Artificial Intelligence - Structures and Strategies for Complex Problem Solving, 6th Edition, Pearson, 2008, ISBN-13: 978-0321545893. 4. Hart, P.E., Stork, D.G. and Duda, R.O., Pattern classification. John Willey & Sons, 2001. 5. P. Winston, Artificial Intelligence, 3rd Edition, Pearson, 1992, ISBN-13: 978-0201533774. 6. Tony Gaddis, "Starting out with Python", 4th Edition, Pearson Education, 2017. 7. Ivan Bratko, Prolog: Programming for Artificial Intelligence, 4th Edition, Pearson, 2011, ISBN-13: 978-0321417466. 8. Severance, C.R., "Python for everybody: Exploring data using Python 3." CreateSpace Independent Publ Platform, 2016. 9. Miller, B.N., Ranum, D.L. and Anderson, J., "Python programming in context." Jones & Bartlett Pub., 2019. 10. McKinney, W., "Python for data analysis: Data wrangling with Pandas, NumPy, and IPython.", 2nd Edition O'Reilly Media, Inc., 2023. 11. Joshi, P., 2017. "Artificial intelligence with python." Packt Publishing Ltd. 12. Handouts and Internet references

Course Title	Artificial Intelligence Lab		
Course Code	CC-218-L		
Credit Hours	1 (0,3)		
Category	Computing core		
Prerequisite	CC-213: Data Structures		
Co-Requisite	None		
Follow-up	None		
Course Introduction	The objective of the course is to introduce and then build the proficiency of students in different AI programming languages. Python is proposed for the course.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Understand the fundamental constructs of Python programming language. Comprehend the fundamental constructs of programming languages and Object-oriented concepts for data analysis and representation.	C2 (Understand)	1,2,3
	CLO2: Apply various libraries for plotting, interpreting and analyzing data in Python.	C3 (Apply)	3,4,5
Syllabus	Introduction to Python programming, variables, expressions, operands and operators, loops, control structures, debugging, error messages, functions, strings, lists, object-oriented constructs and basic graphics in the languages. Logic programming: knowledge representation & search in the context of logic programming. Reasoning in logic programming: unification, horn clause logic, and resolution, Knowledge Representation Schemas: Logic, frames, semantic nets, scripts; problems in knowledge representation. Expert systems.		
Suggested Instructional/ Reading Material	1. Tony Gaddis, "Starting out with Python", 4th Edition, Pearson Education, 2017. 2. Ivan Bratko, Prolog: Programming for Artificial Intelligence, 4th Edition, Pearson, 2011, ISBN-13: 978-0321417466. 3. Severance, C.R., "Python for everybody: Exploring data using Python 3." CreateSpace Independent Publ Platform, 2016. 4. Miller, B.N., Ranum, D.L. and Anderson, J., "Python programming in context." Jones & Bartlett Pub., 2019. 5. McKinney, W., "Python for data analysis: Data wrangling with Pandas, NumPy, and IPython.", 2nd Edition O'Reilly Media, Inc., 2023. 6. Luger, G.F. and Stubblefield, W.A., "AI algorithms, data structures, and idioms in Prolog, Lisp, and Java", Pearson Addison-Wesley. 2009. 7. Russell, S. and Norvig, P. "Artificial Intelligence. A Modern Approach", 3rd ed, Prentice Hall, Inc., 2015. 8. Severance, C.R., 2016. "Python for everybody: Exploring data using Python 3." CreateSpace Independent Publ Platform. 9. Miller, B.N., Ranum, D.L. and Anderson, J., 2019. "Python programming in context." Jones & Bartlett Pub. 10. Joshi, P., 2017. "Artificial intelligence with python." Packt Publishing Ltd. 11. Handouts and Internet references		

Course Title	Design & Analysis of Algorithms		
Course Code	CC-313		
Credit Hours	3 (3,0)		
Category	Computing Core		
Prerequisite	CC-213: Data Structures		
Co-Requisite	None		
Follow Up	None		
Course Introduction	Detailed study of the basic notions of the design of algorithms and the underlying data structures. Several measures of complexity are introduced. Emphasis on the structure, complexity, and efficiency of algorithms.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CL01: Explain the fundamental concepts of algorithm analysis, including time and space complexity, asymptotic notation, and recurrence relations.	C2 (Understand)	1,2
	CL02: Apply algorithm design techniques such as divide-and-conquer, greedy methods, and dynamic programming to solve computational problems.	C3 (Apply)	2,3,4
	CL03: Analyze the efficiency and correctness of algorithms using formal methods such as worst-case, average-case analysis, and loop invariants using Big-O notation.	C4 (Analyze)	2,3,4
	CL04: Design efficient algorithms to solve problems related to sorting, searching, graphs, and optimization, with attention to performance trade-offs.	C6 (Create)	3,4,5
	CL05: Evaluate and compare alternative algorithmic approaches to determine the most appropriate solution based on complexity, correctness and constraints.	C5 (Evaluate)	3,4
Syllabus	Topics: Role of Algorithm in Computing, Analysis on nature of input and size of input , Designing Algorithms, Growth of Functions, Asymptotic Notations, Big-O, Big Ω , Big Θ , little-o, little- ω , loop invariants, Brute Force Approach, Divide-and-conquer approach; Sorting Algorithm analysis, Merge, Quick Sort, Greedy approach; Recursion and recurrence relations, Time Complexity of Recursive Algorithms, Algorithm Design Techniques, Dynamic Programming, Greedy Algorithms, String Matching, Search trees; Heaps; Hashing; Graph algorithms, sparse graphs, DFS, BFS, Minimum Spanning Trees, Shortest Path Algorithms, NP Completeness, Polynomial Time Algorithm, Polynomial Time verification.		
Textbook	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, 3 rd Edition, The MIT Press, 2009, ISBN-10: 0262033844, ISBN-13: 978-0262033848		
Other Instructional/ Reading Material	1. Algorithm Design, (1st edition, 2013/2014), Jon Kleinberg, Eva Tardos 2. Algorithms, (4th edition, 2011), Robert Sedgewick, Kevin Wayne		

Course Title	Theory of Automata		
Course Code	CC-219		
Credit Hours	3 (3,0)		
Category	Domain Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course aims to provide students with a comprehensive foundation in the theory of computation, focusing on formal models such as finite automata, regular expressions, context-free grammars, and Turing machines. Emphasis is placed on developing analytical thinking and problem-solving skills through the design and analysis of computational systems. By the end of the course, students will have the theoretical understanding and practical insight needed to analyze the limits of computation and pursue advanced studies in computer science.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain finite automata, regular expressions & formal languages	C2 (Understand)	1,2
	CLO2: Demonstrate equivalence of automata, regular expressions & grammars. Apply automata theory to compiler design & language processing	C3 (Demonstrate, Apply)	2,3,4,5
	CLO3: Analyze limitations of finite automata & context-free grammars	C4 (Analyze)	2,3,4
	CLO4: Design automata to recognize specific languages	C5 (Design)	2,4
Syllabus	Finite State Models: Language definitions preliminaries, Regular expressions/Regular languages, Finite automata (FAs), Transition graphs (TGs), NFAs, Kleene's theorem, Transducers (automata with output), Pumping lemma and non-regular language Grammars and PDA: CFGs, Derivations, derivation trees and ambiguity, Simplifying CFLs, Normal form grammars and parsing, Decidability, Context sensitive languages, grammars and linear bounded automata (LBA), Chomsky's hierarchy of grammars Turing Machines Theory: Turing machines, Post machine, Variations on TM, TM encoding, Universal Turing Machine, Defining Computers by TMs.		
Suggested Instructional/ Reading Material	1. Daniel I. A. Cohen, "Introduction to computer theory", 2nd Ed., Wiley India Pvt. Limited, 2007. ISBN 0471137723, 9780471137726 2. Peter Linz, "An Introduction to Formal Languages and Automata", 5th Ed., Jones & Bartlett Publishers, 2011. ISBN: 144961552X, 9781449615529 3. Automata, Computability and Complexity: Theory and Applications, by Elaine Rich, 2011 4. Theory of Automata, Formal Languages and Computation, by S. P. Eugene, Xavier, 2005, New Age Publishers		

Course Title	Cloud Computing		
Course Code	CC-314		
Credit Hours	3 (2,1)		
Category	Domain Elective		
Prerequisite	CC-214: Computer Networks		
Co-Requisite	None		
Follow-up	None		
Course Introduction	Nowadays cloud computing becomes popular for individuals' users as well as for the business community. It provides on-demand huge computation and storage resources which is attractive for a large number of users mainly due to pay-per-usage charging model. This course will introduce topics related to Cloud Computing and also expose students to the latest tools and technologies used in Cloud Computing. The aim of this course is to provide an in-depth knowledge of Cloud Computing topics. The course would also expose students to important methods and tools used Cloud Computing.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain Cloud computing, virtualization, Dockers and scalable web applications.	C2 (Explain)	1,2
	CLO2: Familiarize with Load Balancing AWS ELB, Nginx, Ipvadm, Ldirectord.	C1 (Know)	1,2
	CLO3: Demonstrate the use of NoSQL, MongoDB and DynamoDB, Revision, MapReduce	C3 (Apply)	3,4,5
	CLO4: Explain Big Data transformation methods.	C2 (Explain)	2,4,5
Syllabus	Introduction To Cloud Computing, Introduction To Cloud Computing (Cont.), AWS Services, EC2 hands, Accessing AWS S3 , Virtualization , Containerization/Dockers, Scalable Web Application in The Cloud, Scalable Web Application in The Cloud (Cont.), Load Balancing AWS ELB, Nginx, Ipvadm, Ldirectord, Web Application Deployment Models, Introduction to Big Data, Introduction to Big Data (Cont.), Introduction to NoSQL, MongoDB and DynamoDB, Revision, MapReduce, Distributed Systems, Consistency and Fault Tolerance in Distributed Systems, Big Data Transformation Methods , Blockchain, Practical Considerations in Cloud Computing, Future of the Cloud Computing and Big Data		
Suggested Instructional/ Reading Material	1. JothyRosenberg and Arthur Mateos;The Cloud at Your Service;Manning Publications. ISBN: 1935182528 2. Paul Zikopoulos and Chris Eaton; Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data; McGraw-Hill. ISBN: 0071790535 3. Kyle Banker, Peter Bakkum, Shaun Verch, Douglas Garrett, and Tim Hawkins; MongoDB in Action, Second Edition. 4. Clinton W. Brownley; Foundations for Analytics with Python from Non-Programmer to Hacker.		

2) General Education

Course Title	Applications of Information & Communication Technologies		
Course Code	GE-160		
Credit Hours	3 (2,1)		
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 (Gmail, Microsoft Outlook, etc.) Microsoft Office Suites (Word, Excel, PowerPoint), Google Workspace (Google Docs, Sheets, Slides), Google Drive, Dropbox (cloud storage and file sharing), Google Drive (Cloud storage with Google Docs integration) and Microsoft OneDrive (Cloud storage with Microsoft integration), Evernote (Note-taking and organization applications) and OneNote (Microsoft's digital notebook for capturing and organizing ideas), Video conferencing (Google Meet, Microsoft Teams, Zoom, etc.), social media applications (LinkedIn, Facebook, Instagram, etc.) 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 (0,1)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow Up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain the fundamental concepts, components, and scope of ICT.	C2 (Explain)	1,2
	CLO2: Identify uses of various ICT platforms and tools for different purposes.	C4 (Identify)	1,2,3
	CLO3: Apply ICT platform and tools for different purposes to address basic needs in different domains of daily, academic, and professional life.	C3 (Apply)	3,4,5
	CLO4: Understand the ethical and legal considerations in use of ICT platforms and tools.	C2 (Understand)	1,2,3
Syllabus	Implementation of courses contents applications of Information and Communication Technologies: Interaction with components of ICT (basics of hardware, software, ICT platforms, networks, local and cloud data storage, etc.), Basic ICT Productivity Tools: Effective use of popular search engines to explore WWW, Formal communication tools and etiquettes (Gmail, Microsoft Outlook, etc.) 1. Guided tutorials and exercises to ensure that students are proficient in commonly used software applications such as word processing software (e.g., Microsoft Word), presentation software, (e.g., Microsoft PowerPoint), spreadsheet software (e.g., Microsoft Excel) among such other tools, Google Workspace (Google Docs, Sheets, Slides), Dropbox (cloud storage and file sharing), Google Drive (Cloud storage with Google Docs integration) and Microsoft OneDrive (Cloud storage with Microsoft integration), Evernote (Note-taking and organization applications) and OneNote (Microsoft's digital notebook for capturing and organizing ideas), Video conferencing (Google Meet, Microsoft Teams, Zoom, etc.), social media applications (LinkedIn, Facebook, Instagram, etc.). ICT in Education: Working with learning management systems (Moodle, Canvas, Google Classrooms, etc.), Sources of online education courses (Coursera, edX, Udemy, Khan Academy, etc.), Interactive multimedia and virtual classrooms. ICT in Health and Well-being: Health and fitness tracking devices and applications (Google Fit, Samsung Health, Apple Health, Xiaomi Mi Band, Runkeeper, etc.), Telemedicine and online health consultations (OLADOC, Sehat Kahani, Mahram, etc.). ICT in Personal Finance and Shopping: Online banking and financial management tools (JazzCash, Easypaisa, Zong PayMax, 1Link and MNET, Keenu Wallet, etc.), E-commerce platforms. Digital Citizenship and Online Etiquette: Intellectual property and copyright issues, Ensuring originality in content creation by avoiding plagiarism and unauthorized use of information sources, Content accuracy and integrity (ensuring that the content share through ICT platforms is free from misinformation, fake news, and manipulation). Students may be assigned practical tasks that require them to create documents, presentations, and spreadsheets etc.		
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.
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Course Title	Applied Physics		
Course Code	GE-169		
Credit Hours	3 (2,1)		
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.		

Title	Functional English		
Code	GE-190		
Credit Hours	3 (3,0)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	GE-191 Expository Writing		
Course Introduction	This course is designed to equip students with essential language skills for effective communication in diverse real-world scenarios. It focuses on developing proficiency in English language usage: word choices, grammar and sentence structure. In addition, the course will enable students to grasp nuanced messages and tailor their communication effectively through application of comprehension and analytical skills in listening and reading. Moreover, the course encompasses a range of practical communication aspects including professional writing, public speaking, and everyday conversation, ensuring that students are equipped for both academic and professional spheres. An integral part of the course is fostering a deeper understanding of the impact of language on diverse audiences. Students will learn to communicate inclusively and display a strong commitment to cultural awareness in their language use. Additionally, the course will enable them to navigate the globalized world with ease and efficacy, making a positive impact in their functional interactions.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Apply enhanced English communication skills by effectively expressing information, ideas, and opinions in written and spoken forms through appropriate word choices, grammar, and sentence structure.	C3 (Apply)	1,6,7,10
	CLO2: Comprehend a variety of literary / non-literary written and spoken texts in English.	C2 (Understand)	1,6,7,10
	CLO3: Analyze inter-cultural variations in the use of the English language to determine how communication style and content should be adapted for diverse cultural and social contexts.	C4 (Analyze)	1,6,7,10
Course Contents / Syllabus	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.)
Suggested Instructional / Reading Material	1. “Understanding and Using English Grammar” by Betty Schramper Azar. 2. “English Grammar in Use” by Raymond Murphy. 3. “The Blue Book of Grammar and Punctuation” by Jane Straus. 4. “English for Specific Purposes: A Learning-Centered Approach” by Tom Hutchinson and Alan Waters. 5. “Cambridge English for Job-hunting” by Colm Downes. 6. “Practical English Usage” by Michael Swan. 7. “Reading Literature and Writing Argument” by Missy James and Alan P. Merickel. 8. “Improving Reading: Strategies, Resources, and Common Core Connections” by Jerry Johns and Susan Lenski. 9. “Comprehension: A Paradigm for Cognition” by Walter Kintsch. 10. “Communication Skills for Business Professionals” by J.P. Verma and Meenakshi Raman.

Title	Expository Writing		
Code	GE-191		
Credit Hours	3 (3,0)		
Category	General Education		
Prerequisite	GE-190: Functional English		
Co-Requisite	None		
Follow-up			
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 stages of the writing process—including pre-writing, drafting, editing, and proofreading—and their role in producing clear, well-structured essays.	C2 (Understand)	1,6,7,10
	CLO2: Apply appropriate expository writing techniques and uphold ethical practices to create original texts tailored to specific purposes and audiences.	C3 (Apply)	1,6,7,10
	CLO3: Analyze written texts to evaluate their structure, coherence, and style.	C4 (Analyze)	1,6,7,9
Course Contents / 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 3. Birkenstein. 4. "Writing Analytically" by David Rosenwasser and Jill Stephen. 5. "Style: Lessons in Clarity and Grace" by Joseph M. Williams and Joseph Bizup. 6. "The Elements of Style" by William Strunk Jr. and E.B. White. 7. "Good Reasons with Contemporary Arguments" by Lester Faigley and Jack Selzer. 8. "Writing to Learn; How to Write – and Think – Clearly About Any Subject at All" by William Zinsser. 9. "The Norton Field Guide to Writing" by Richard Bullock, Maureen Daly Goggin, and Francine Weinberg. 10. "The Art of Styling Sentences" by Ann Longknife and K.D. Sullivan. 11. "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.
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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 S^2, t-Distribution, F-Quantile and Probability Plots. Single Sample & One- and Two-Sample Estimation Problems: Single Sample & One- and Two-Sample Tests of Hypotheses. The Use of P-Values for Decision Making in Testing Hypotheses (Single Sample & One- and Two-Sample Tests). Regression: Linear Regression and Correlation, Least Squares and the Fitted Model, Multiple Linear Regression and Certain, Nonlinear Regression Models, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators.		
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/		

[illegible]

Syllabus	5۔ خلافت 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۔ فقہ اسلامی 1۔ فقہ اسلامی کے حلقہ (فرآن، سنی، 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۔ عالمگیری اور اس کے مسائل و تقاضے 2۔ اسلام و فوج 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

Curricula – BS Computer Science (Specialization in Information Technology) for Affiliated Colleges

	Total	100	45	30	15
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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	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.
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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 (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	Civics and Community Management		
Code	GE-272		
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 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.
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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
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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)	On completion of this course, the students will be able to:	BT	PLO
	CLO1: Understand key entrepreneurial concepts, including the different stages of the entrepreneurial process as well as specific regulatory requirements to set up an enterprise in Pakistan.	C2 (Understand)	1, 8
	CLO2: Apply entrepreneurial frameworks and techniques to identify business opportunities and use this knowledge to produce practical solutions to real-world startup challenges.	C3 (Apply)	2, 3, 4
	CLO3: Develop a comprehensive business plan for a new venture by analyzing the feasibility of a new business idea and by justifying the proposed strategies.	C6 (Create)	3, 4, 7, 10
Course Contents / Syllabus	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. Opportunity Recognition and Idea Generation: Opportunity identification, evaluation and exploitation, Innovative ideas generation techniques for entrepreneurial ventures. Feasibility Analysis: Product/Service, Industry/Target Market, Organizational, and Financial Feasibility Analysis. Business Models: General Categories of Business Models, The Barringer/Ireland Business Model Template. Industry and Competitor Analysis: The Five Forces Model, Industry types and the opportunities they offer, Competitor analysis. The Business Plan: Who reads it and what are they looking for? Guidelines and outline, Presenting it to investors. Marketing and sales: Four P's of Marketing, Developing a marketing strategy, Branding. Financial Literacy: Basic concepts of income, savings, investments, assets, liabilities, equity, revenue and expenses, Overview of financial statements (balance sheet, profit & loss, cash flow), Getting Financing or Funding: Sources of personal financing, Sources of equity funding, Sources of debt financing, Creative sources of financing and funding. 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		

Course Title	Entrepreneurship
	register an enterprise in Pakistan, with special emphasis on exports firms, Taxation and financial reporting obligation.
Textbook	1. B. R. Barringer, and R. D. Ireland, Entrepreneurship: Successfully Launching New Ventures, 6th Edition, Prentice Hall, 2019, ISBN: 978-0134729534.
Suggested Instructional/ Reading Material	1. "Entrepreneurship: Theory, Process, and Practice" by Donald F. Kuratko. 2. "New Venture Creation: Entrepreneurship for the 21st Century" by Jeffry A. Timmons, Stephen Spinelli Jr., and Rob Adams. 3. "Entrepreneurship: A Real-World Approach" by Rhonda Abrans. 4. "The Lean Startup: How Today's Entrepreneurs use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries. 5. "Effectual Entrepreneurship" by Stuart Read, Saras Sarasvathy, Nick Dew, Robert Wiltbank, and Anne-Valcric Ohlsson.

3) IT Specialization Electives

Course Title	Web Technologies		
Course Code	EI-322		
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, XHTML MP. Web Services: SOAP, REST, WML, XSL. Operations, Processing HTTP Requests, Processing HTTP Responses, Cookie Coordination, Privacy and P3P, Complex HTTP Interactions, Dynamic Content Delivery. Server Configuration. Server Security. Web Browsers Architecture and Processes: Active Browser Pages: JavaScript, DHTML, AJAX. JSON. Approaches to Web Application Development: 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 Lab		
Course Code	EI-322-L		
Credit Hours	1 (0,1)		
Category	Specialization Elective		
Prerequisite	None		
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
	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	Cyber Security		
Course Code	EI-325		
Credit Hours	3 (3,0)		
Category	Specialization Elective		
Prerequisite	CC-312 Information Security		
Co-Requisite	None		
Follow-up	None		
Course Introduction	The course provides basic concepts and terminology used in the Information and Cyber Security fields. It provides students an introduction to common Cyber Security threats, Vulnerabilities and Risks related to software, web applications, networks, and mobile applications. Moreover, it will also enable students to differentiate between the various forms of malware and how they affect computers and networks.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLOs
	CLO 1: Identify, explain the principles and challenges of computer system threats, Cyber threats landscape, and software security	C1 (Remember)	1, 2
	CLO 2: Identify, understand Malware attacks, Payloads, Viruses, Trojan horses, IoT and Cloud Security.	C2 (Understand)	1, 2, 3
	CLO 3: Understand and apply Cryptographic techniques. Apply Data Encryption and Decryption methods and techniques to solve real-world scenarios.	C3 (Apply)	3, 4, 5
	CLO 4: Analyze complex Cyber threats.	C4 (Analyze)	3, 4, 5, 6
	CLO 5: Evaluate an infected system. Cyber security planning, policies, and strategies	C5 (Evaluate)	5, 6, 7
Syllabus	Topics: Introduction to Cyber Security, Basic Security concepts, Understanding Security, Information Security terminology, Information Security Principles (Confidentiality, Integrity, Availability), Networks and the Internet, Cyber Threat landscape, Who are the attackers, Privacy and Anonymity, Software security, Network security, Network protocols and service models, Network layer Security, Wireless Security, Transport layer Security, Cloud and IoT (Internet of Things) Security, Cross-Site Scripting, Cross-Site request forgery, SQL Injection, Advanced Persistent Threat (APT), Malware, Malware classifications, Malware Attack Lifecycle, Stages of Malware Attack, Social Engineering attacks, Types of Payloads, Industrial Espionage in Cyberspace, Basic Cryptography, Web Applications attacks, Database security, Cyber kill chain, Mobile device security, Mobile application security, Cyber Terrorism and Information Warfare, Planning and Policy, Cyber Security strategies in the US, UK, EU, and Pakistan, Introduction to Digital Forensics, Digital Forensics Categories.		
Suggested Instructional/ Reading Material	1. Mark Ciampa, CompTIA Security+ Guide to Network Security Fundamentals, 7th Edition, Information Security, CENGAGE. 2. Michael E. Whitman and Herbert J. Mattord, Principles of Information Security, 6th edition, CENGAGE Learning. 3. William Stallings, Lawrie Brown, Computer Security: Principles and Practice, 5th Edition, Published by PEARSON, 2024. 4. Randall J. Boyle, Raymond R. Panko, Corporate Computer Security, 4th Edition, PEARSON.		

	5. William Chuck Easttom, Computer Security Fundamentals, 5th Edition, Pearson Education. 6. Dieter Gollmann, Computer Security, Third Edition, Hamburg University of Technology, WILEY 7. Ross Anderson, Security Engineering, Third Edition, A Guide to Building Dependable Distributed Systems, WILEY, 2020 8. Dafydd Stuttard, Marcus Pinto, The Web Application Hacker's Handbook, Second Edition, Finding and Exploiting Security Flaws, WILEY 9. Charles Pfleeger, Shari Lawrence Pfleeger, Lizzie Coles-Kemp, Security in Computing, 6th Edition, The Art of Computer and Information Security: From Apps and Networks to Cloud and Crypto Security in Computing, Addison-Wesley.
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Course Title	System & Network Administration		
Course Code	EI-323		
Credit Hours	2 (2,0)		
Category	Specialization Elective		
Prerequisite	CC-311: Operating Systems		
Co-Requisite	None		
Follow-up	None		
Course Objectives	• Explain principles of system and network administration. • Configure and troubleshoot network services and operating systems. • Use administrative tools to monitor and secure systems. • Demonstrate professionalism in managing shared computing resources. • Work effectively in teams to maintain IT infrastructure.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO 1: Identify, explain the principles and challenges of computer system threats, Cyber threats landscape, and software security	C1 (Remember)	1, 2
	CLO 2: Identify, understand Malware attacks, Payloads, Viruses, Trojan horses, IoT and Cloud Security.	C2 (Understand)	1, 2, 3
	CLO 3: Understand and apply Cryptographic techniques. Apply Data Encryption and Decryption methods and techniques to solve real-world scenarios.	C3 (Apply)	3, 4, 5
	CLO 4: Analyze complex Cyber threats.	C4 (Analyze)	3, 4, 5, 6
Syllabus	Introduction: System Administration (SA), SA Components, Server Environment (Microsoft and Linux), Reliable Products, Server Hardware Costing, Maintenance Contracts and Spare Parts, Maintaining Data Integrity, Client Server OS Configuration, Providing Remote Console Access. Comparative Analysis of OS: Important Attributes, Key Features, Pros and Cons. Configuring Local Services and Managing Basic System Issues. Administer Users and Groups. System and Network Management: Software Management. Managing Network Services and Network Monitoring Tools. Boot Management and Process Management. IP Tables and Filtering. Securing Network Traffic. Advanced File Systems and Logs. Bash Shell Scripting. Configuring Servers (FTP, NFS, Samba, DHCP, DNS and Apache). Configuration of Hyper-V, Virtual Box & VMware: Linux Installation and Verification: Configuring Local Services and Managing Basic System Issues. Administer Users and Groups. Review of computer networks lab, Server Environment (Microsoft and Linux). Installation and Configuration: Client Server OS Configuration, Installation and configuration of servers, Linux Installation and Verification, Installation of Activity Directory on Domain Controller, Manage and Active Directory Forest and domain. Active Directory & Domain Controller & It's Configuration, Active Directory User & Computer Management (Groups, Organizational Unit & Users), Managing Network Services: Network Monitoring Tools. Boot Management and Process Management. IP Tables and Filtering. Securing Network Traffic. Advanced File Systems and Logs. Bash Shell Scripting. Managing Servers: FTP, NFS, Samba, DHCP, DNS and Apache. Configuring Local Services and Managing Basic System Issues.		

	Administer Users and Groups. Domain controller. Installation and Configuration of Wireless Access Points: Installation and configuration of wireless Router, Manageable and non-manageable Cisco switches, Concept and configuration of VLAN, Switch modes and operations, Setting up WAN on simulator, Identifying necessary devices to build a WAN, Learning static and dynamic routing protocols, Understanding and implementing RIP (Routing Information Protocol). Understanding and implementing IGRP, ACL's configuration on routers. Quota Management System (Quota Templates Soft Quota & Hard Quota), Internet Information Services Configuration (IIS), Configuration & Deploying Websites on IIS, World Wide Web Publishing Service of IIS, Configuration of FTP and Apache Server
Suggested Instructional/ Reading Material	1. The Practice of System and Network Administration, Second Edition by Thomas Limoncelli, Christina Hogan and Strata Chalup, Addison-Wesley Professional; 2nd Edition (2007). ISBN-10: 0321492668. 2. Study guide for Practice of System and Network Administration by Thomas A. Limoncelli, Cram101; 2nd Edition (2011). ISBN-10: 1428851755. 3. Networking Systems Design and Development by Lee Chao, CRC Press; 1st Edition (December 21, 2009). ISBN-10: 142009159X (TB2). 4. Red Hat Enterprise Linux 6 Bible: Administering Enterprise Linux Systems by William von Hagen, 2011.

Course Title	System & Network Administration Lab		
Course Code	EI-323-L		
Credit Hours	1 (0,1)		
Category	Specialization Elective		
Prerequisite	CC-311: Operating Systems		
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 components and environments of System Administration.	C1 (Know)	1
	CLO2: Perform operating system and network, installation and management.	C3 (Demonstrate)	3.4.5
	CLO3: Manage servers, traffic, access points.	C3 (Apply)	3.4.5
Syllabus	Configuration of Hyper-V, Virtual Box & VMware: Linux Installation and Verification: Configuring Local Services and Managing Basic System Issues. Administer Users and Groups. Review of computer networks lab, Server Environment (Microsoft and Linux). Installation and Configuration: Client Server OS Configuration, Installation and configuration of servers, Linux Installation and Verification, Installation of Active Directory on Domain Controller, Manage and Active Directory Forest and domain. Active		

	Directory & Domain Controller & Its's Configuration, Active Directory User & Computer Management (Groups, Organizational Unit & Users), Managing Network Services: Network Monitoring Tools. Boot Management and Process Management. IP Tables and Filtering. Securing Network Traffic. Advanced File Systems and Logs. Bash Shell Scripting. Managing Servers: FTP, NFS, Samba, DHCP, DNS and Apache. Configuring Local Services and Managing Basic System Issues. Administer Users and Groups. Domain controller. Installation and Configuration of Wireless Access Points: Installation and configuration if wireless Router, Manageable and non-manageable Cisco switches, Concept and configuration of VLAN, Switch modes and operations, Setting up WAN on simulator, Identifying necessary devices to build a WAN, Learning static and dynamic routing protocols, Understanding and implementing RIP (Routing Information Protocol). Understanding and implementing IGRP, ACL's configuration on routers. Quota Management System (Quota Templates Soft Quota & Hard Quota), Internet Information Services Configuration (IIS), Configuration & Deploying Websites on IIS, World Wide Web Publishing Service of IIS, Configuration of FTP and Apache Server
Suggested Instructional/ Reading Material	1. The Practice of System and Network Administration, Second Edition by Thomas Limoncelli, Christina Hogan and Strata Chalup, Addison-Wesley Professional; 2nd Edition (2007). ISBN-10: 0321492668. 2. Study guide for Practice of System and Network Administration by Thomas A. Limoncelli, Cram101; 2nd Edition (2011). ISBN-10: 1428851755. 3. Networking Systems Design and Development by Lee Chao, CRC Press; 1st Edition (December 21, 2009). ISBN-10: 142009159X (TB2). 4. Red Hat Enterprise Linux 6 Bible: Administering Enterprise Linux Systems by William von Hagen, 2011.

Course Title	Database Administration & Management		
Course Code	EI-324		
Credit Hours	2(2,0)		
Category	Specialization Elective		
Prerequisite	CC-215: Database Systems		
Co-Requisite	None		
Follow-up	None		
Course Introduction	Introduction to advanced data models such as object relational, object oriented. File organization concepts, Transactional processing and Concurrency control techniques, Recovery techniques, Query processing and optimization, Database Programming, Integrity and security, Database Administration, Physical database design and tuning, Distributed database systems, Emerging research trends in database systems.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Describe and understand database architecture and administrative roles.	C2 (Understand)	1
	CLO2: Configure and manage database systems for performance and reliability. Use database tools for backup, recovery, and monitoring.	C3 (Apply)	3,4,5
	CLO3: Collaborate in teams to manage enterprise-level databases. Document database policies and procedures effectively.	C5 (Collaborate)	6,7,8
Syllabus	Oracle Architectural Components: Introduction to Enterprise Database Systems, Responsibilities of Database Administrator. Oracle Server; Oracle Instance; Physical Structure. Creating Database and Data dictionary: Creation Prerequisites; Creating Database; Starting Instance. Data Dictionary; Data Dictionary Contents. Dynamic Performance Views. Managing Control Files and Redo Log Files: Control File; Control File Contents; Multiplexing Control File; Using Redo Log Files; Structure of Redo Log File; Adding Redo Log Groups and Members; s. Managing Tablespaces: Database Storage Hierarchy; Kinds of Tablespaces; Managing Data files. Storage Structure and Relationships: Adding Data files and other Operations with Data files; Types of Segments. Managing Undo Data: Undo Segment; Read Consistency; Automatic undo Management: Managing Tables. Managing Users: Creating Users; Managing Users; Creating Tables; Managing Tables. Managing Indexes: types of Indexes; Creation and Management of Indexes. Maintaining Data Integrity: Types of Constraints; Managing Constraints. Managing Privileges: System Privileges; Object Privileges. Managing Roles: Assign and Revoke Roles and Roles Management. Network overview, Configuring Listener; Sessions. Client Side Configuration: Host Naming Method; Local Naming Method; Net Assistant; Configurations of Different Methods. Usage and Configuration of Oracle Shared Server: Server Configuration; Dedicated Server Process; Shared Server Process. Backup and Recovery: overview, Instance and Media Recovery, Categories of Failure; Defining Backup and Recovery Strategy. Configuration of Archive log mode: Switching to Archive Log Mode; Archive Process. User Managed Backups: User Managed backups and Issues. User Managed Complete Recovery: How To recover a Database Manually Using Manual Backups. User Managed Incomplete Recovery: How to DO an Incomplete Recovery. Import/Export: Different export and import modes.		
Suggested Instructional/	1. Ramez Elmasri, Shamkant Navathe, Fundamentals of Database Systems, 6 th Edition, Addison Wesley, 2010, ISBN: 0136086209.		

Reading Material	2. Oracle 11i DBA Fundamentals I (Student Guide, Volume I and II). 3. Oracle 11i DBA Fundamentals II (Student Guide, Volume I and II). 4. Henry F. Korth, Abraham Silberschatz, Database System Concepts, 6 th Edition, McGraw Hill, 2010, ISBN: 0073523321. 5. Oracle 11i DBA Fundamentals I (Student Guide, Volume I and II). 6. Oracle 11i DBA Fundamentals II (Student Guide, Volume I and II). 7. Performance Tuning (Student Guide, Volume I and II). 8. Oracle Magazine. 9. Online Material URL http://otn.oracle.com/
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Course Title	Database Administration & Management Lab		
Course Code	EI-324-L		
Credit Hours	1 (0,1)		
Category	Specialization Elective		
Prerequisite	CC-215: Database Systems		
Co-Requisite	None		
Follow-up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Describe and understand database architecture and administrative roles.	C2 (Understand)	1
	CLO2: Configure and manage database systems for performance and reliability. Use database tools for backup, recovery, and monitoring.	C3 (Apply)	3,4,5
	CLO3: Collaborate in teams to manage enterprise-level databases. Document database policies and procedures effectively.	C5 (Collaborate)	6,7,8
Syllabus	Creating Database and Data dictionary: Creation Prerequisites; Creating Database; Starting Instance. Data Dictionary; Data Dictionary Contents. Dynamic Performance Views. Managing Control Files and Redo Log Files: Control File; Control File Contents; Multiplexing Control File; Using Redo Log Files; Structure of Redo Log File; Adding Redo Log Groups and Members; s. Managing Tablespaces: Database Storage Hierarchy; Kinds of Tablespaces; Managing Data files. Storage Structure and Relationships: Adding Data files and other Operations with Data files; Types of Segments. Managing Undo Data: Undo Segment; Read Consistency; Automatic undo Management: Managing Tables. Managing Users: Creating Users; Managing Users; Creating Tables; Managing Tables. Managing Indexes: types of Indexes; Creation and Management of Indexes. Maintaining Data Integrity: Types of Constraints; Managing Constraints. Managing Privileges: System Privileges; Object Privileges. Managing Roles: Assign and Revoke Roles and Roles Management. Network overview, Configuring Listener; Sessions. Client Side Configuration: Host Naming Method; Local Naming Method; Net Assistant; Configurations of Different Methods. Usage and Configuration of Oracle Shared Server: Server Configuration; Dedicated Server Process; Shared Server Process. Backup and Recovery: overview, Instance and Media Recovery, Categories of Failure; Defining Backup and Recovery Strategy. Configuration of Archive log mode: Switching to Archive Log Mode; Archive Process. User		

	Managed Backups: User Managed backups and Issues. User Managed Complete Recovery: How To recover a Database Manually Using Manual Backups. User Managed Incomplete Recovery: How to DO an Incomplete Recovery. Import/Export: Different export and import modes.
Suggested Instructional/ Reading Material	1. Oracle 11i DBA Fundamentals I (Student Guide, Volume I and II). 2. Oracle 11i DBA Fundamentals II (Student Guide, Volume I and II). 3. Performance Tuning (Student Guide, Volume I and II). 4. Oracle Magazine. 5. Online Material URL http://otn.oracle.com/

Course Title	Enterprise Application Development		
Course Code	EI-326		
Credit Hours	2 (2,0)		
Category	Specialization Elective		
Prerequisite	CC-211: Object Oriented Programming		
Co-Requisite	EI-322: Web Technologies		
Follow-up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain characteristics of an enterprise system.	C2 (Explain)	1,2
	CLO2: Use .NET framework for application development.	C3 (Apply)	1,2,3
	CLO3: Identify potential and applications of various object models.	C4 (Identify)	1,2,3
	CLO4: Use service-oriented architecture in a software application.	C3 (Apply)	3,4,5
Course Description	Overview of Enterprise Application Development: Microsoft technology history, Introduction to .NET and its architecture, Concept of MSIL, CLR, CLS, CTS, Introduction to .NET framework: Managed and Unmanaged Code, .Net Assembly, Introduction to C# fundamentals, Boxing and Unboxing, Implementing multi-tier architecture. Introduction to ADO.Net: Sql Injection, parameterized queries, Usage of data set, Data adapter and command builder in disconnected model Introduction to delegate: Multicast delegates, Introduction to windows forms, html, Introduction to javascript: javascript and its data types, variables, functions, Debugging javascript using Firebug. Introduction to various object models: Browser's Object (BOM), Document Object Model. Introduction to JQuery: JQuery effects. Introducing LINQ: LINQ to Objects, LINQ to Sql, Query syntax, Operations (projection, filtering and join) using Linq Queries. Introduction to ADO.NET entity framework: The entity data model, CSDL, Eager vs lazy loading, POCO classes, DbContext API, Querying entity data models, Introduction to ASP.NET MVC, MVC application structure, Controllers overview, Action Methods, Parameterized action methods, Introduction to razor syntax, Code expressions, Code Blocks, Implicit Vs Explicit Code Expression, Data annotations, Client and server Side Validation, Validation and model binding, Validation and model state, MVC Membership, Authorization and security. Introduction to service-oriented architecture: SOAP, WSDL, Service contract, Data contract, XML, WCF bindings, ABC of WCF, Restful services, Consuming rest services (CRUD operations) using JQuery AJAX and JSON, Introduction to web API, Example of web API using CRUD Example, MVC routing.		
Text Book(s)	1. Herbert Schildt, C# 4.0 The Complete Reference, McGraw-Hill, 2010, ISBN: 007174116X. 2. A. Freeman, S. Sanderson, Pro ASP.NET MVC 4, 4th Edition, Apress, 2012, ISBN: 1430242361.		
Reference Material	1. Julia Lerman, Programming Entity Framework, 2nd Edition, O'Reilly, 2010, ISBN: 0596807260. 2. Fabrice Marguerie, Steve Eichert, Jim Wooley, LINQ in Action, Manning Publications, 2008, ISBN: 1933988169. 3. Jeremy McPeak, Beginning JavaScript, 5th Edition, Wiley, 2015, ISBN: 978-1-118-90333-9. 4. Pablo Cibraro, Kurt Claeys, Fabio Cozzolino, Johann Grabner, Professional WCF 4: Windows Communication Foundation with .NET 4, Wiley, 2010, ISBN: 978-0-470-56314-4. 5. Handouts and Internet references		

Course Title	Enterprise Application Development		
Course Code	EI-326-L		
Credit Hours	1 (0,1)		
Category	Specialization Elective		
Prerequisite	CC-211: Object Oriented Programming		
Co-Requisite	EI-322: Web Technologies		
Follow-up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO2: Use .NET framework for application development.	C3 (Apply)	1,2,3
	CLO3: Identify potential and applications of various object models.	C4 (Identify)	1,2,3
	CLO4: Use service-oriented architecture in a software application.	C3 (Apply)	3,4,5
Course Description	.NET framework: Managed and Unmanaged Code, .Net Assembly, Introduction to C# fundamentals, Boxing and Unboxing, Implementing multi-tier architecture. Introduction to ADO.Net: Sql Injection, parameterized queries, Usage of data set, Data adapter and command builder in disconnected model Introduction to delegate: Multicast delegates, Introduction to windows forms, html, Introduction to javascript: javascript and its data types, variables, functions, Debugging javascript using Firebug. Introduction to various object models: Browser's Object (BOM), Document Object Model. Introduction to JQuery: JQuery effects. Introducing LINQ: LINQ to Objects, LINQ to Sql, Query syntax, Operations (projection, filtering and join) using Linq Queries. Introduction to ADO.NET entity framework: The entity data model, CSDL, Eager vs lazy loading, POCO classes, DbContext API, Querying entity data models, Introduction to ASP.NET MVC, MVC application structure, Controllers overview, Action Methods, Parameterized action methods, Introduction to razor syntax, Code expressions, Code Blocks, Implicit Vs Explicit Code Expression, Data annotations, Client and server Side Validation, Validation and model binding, Validation and model state, MVC Membership, Authorization and security. Introduction to service-oriented architecture: SOAP, WSDL, Service contract, Data contract, XML, WCF bindings, ABC of WCF, Restful services, Consuming rest services (CRUD operations) using JQuery AJAX and JSON, Introduction to web API, Example of web API using CRUD Example, MVC routing.		
Text Book(s)	1. Herbert Schildt, C# 4.0 The Complete Reference, McGraw-Hill, 2010, ISBN: 007174116X. 2. A. Freeman, S. Sanderson, Pro ASP.NET MVC 4, 4th Edition, Apress, 2012, ISBN: 1430242361.		
Reference Material	1. Julia Lerman, Programming Entity Framework, 2nd Edition, O'Reilly, 2010, ISBN: 0596807260. 2. Fabrice Marguerie, Steve Eichert, Jim Wooley, LINQ in Action, Manning Publications, 2008, ISBN: 1933988169. 3. Jeremy McPeak, Beginning JavaScript, 5th Edition, Wiley, 2015, ISBN: 978-1-118-90333-9. 4. Pablo Cibraro, Kurt Claeys, Fabio Cozzolino, Johann Grabner, Professional WCF 4: Windows Communication Foundation with .NET 4, Wiley, 2010, ISBN: 978-0-470-56314-4. 5. Handouts and Internet references		

Course Title	IT Project Management		
Course Code	EI-321		
Credit Hours	3 (3,0)		
Category	Specialization Elective		
Prerequisite	None		
Co-Requisite	None		
Follow Up	None		
Course Introduction	This course provides an introduction to the key concepts, methods, and best practices needed to effectively manage software projects. Through a combination of lectures, case studies, and interactive discussions, students will gain insights into the entire software development lifecycle, from ideation to deployment, while emphasizing time management, budgeting, stakeholder communication, and risk management.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Articulate the various phase in project management stages of SDLC and recognize the importance of each phase in the context of project management.	C2 (Explain)	1,2
	CLO2: Allocate and manage project resources, including human capital, time, and budget, to maximize efficiency and effectiveness.	C3 (Apply)	1,2,3,4
	CLO3: Identify potential project risks, assess their impact, and devise strategies to mitigate or respond to these risks.	C4 (Identify)	3,4
	CLO4: Implement modern project management tools and software to aid in task tracking, collaboration, and project monitoring.	C3 (Apply)	3,4,5
	CLO5: Determine the criteria for project success and employ evaluation techniques post-project to assess outcomes and derive lessons for future projects.	C4 (Differentiate)	3,4
Syllabus	Introduction: Project Management. The Project Management Process Groups. Scope triangle, The S curve. Five Phases of Project Management Life Cycle: Defining, planning, executing, controlling, closing, Scope of project, Project Work Breakdown Structure (WBS), Project Time Management. Estimate Activity Duration: Causes of variation in activity duration, five methods of Estimating Activity Duration. Project Networks: Critical Path Method (CPM), Build the project network, Analysis of the project network, Project Evaluation Review Technique (PERT), Activity on Arrow, Activity on Node, GANTT Chart, Using MS-Project to draw GANTT chart and project Networks. Project Proposal: Purpose of the project proposal, Contents of the project proposal, Format of the Project Proposal. Staffing and Personnel Planning: Personnel Plan, Team structures, Democratic decentralized, Controlled Decentralized, Controlled Centralized, Coordination and communication issues, Maslow's need theory of motivation, Software Project Team Roles and Responsibilities, Risk Identification, Analysis and Management. Project Management: Integration Management. Scope Management. Cost Management. Quality Management. Human Resource Management. Communications Management. Risk Management. Procurement Management. Management Tools. Configuration Management: Change Management and Control, baselines, Version Control, Earned Value Analysis for Project Monitoring and Control. Examples of Earned Value Analysis, Project Quality Assurance Plans, SQA Process Project Quality Standards, Project Documents.		

Suggested Instructional/ Reading Material	1. Guide to the Project Management Body of Knowledge (PMBOK® Guide), 6th Edition, Project Management Institute, 2017, ISBN-10: 1628251840. 2. Teresa Luckey, Joseph Phillips, Software Project Management for Dummies, 1st Edition, For Dummies Publisher, 2006, ISBN 0471749346.
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Course Title	Mobile Application Development		
Course Code	EI-333		
Credit Hours	2 (2,0)		
Category	Specialization Elective		
Prerequisite	CC-211: Object Oriented Programming		
Co-Requisite	None		
Follow-up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain characteristics of mobile application.	C2 (Explain)	1,2
	CLO2: Use Andriod platform for application development.	C3 (Apply)	1,2,3
	CLO3: Identify potential and applications of data storage technologies.	C4 (Identify)	1,2,3
	CLO4: Use Android Native Development Kit in a mobile application development.	C3 (Apply)	3,4,5
Syllabus	Introduction: Mobile Computing Domain, Comparison of different Mobile Platforms, Revision of Java. Android Platform: Dalvik Virtual Machine, Android Constructs (Activity, Intent, Content Provider, Service, Broadcast Receiver), Activity Lifecycle, Project Structure, Manifest File, Emulators (AVD), Debugging (DDMS), R.java, Inter Activity Communication (Intent), Event Handlers, Layout XML, @ Sign, Layouts, Adapters, Dynamic Lists, Holder Pattern, Menus and dialogs, Menu, Menu Group, Menu Item, Icon Menu, Sub Menu, Context Menu, Sub Menu, Dynamic Menu, Using XML Files for Menus, Services, Intents. Data Storage: Key Value Sets, Files, Intro to SQLite, Web Service Integration, JSON, HTTPClient, Graphics, Widgets & Notifications, Multimedia and telephony API, Android Native Development Kit (NDK).		
Suggested Instructional/ Reading Material	1. Mark L. Murphy, Beginning Android 2, Apress, ISBN 978-1-4302-2629-1 2. Zigurd Mednieks, Laird Dornin, G. Blake Meike, and Masumi Nakamura Programming Android, 2nd Edition, O Reilly Press, ISBN: 978-1-449-31664-8 3. Syed Hashmi, Satya Komatineni, Dave Maclean, Pro Android 2, Apress, ISBN 978-1-4302-2659-8 4. http://developer.android.com/develop/index.htm 5. http://developer.android.com/guide/components/services.html 6. http://developer.android.com/guide/components/intents-filters.html 7. http://developer.android.com/guide/topics/data/data-storage.html 8. http://developer.android.com/guide/topics/graphics/index.html 9. http://developer.android.com/guide/topics/sensors/index.html		

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

Title	Machine Learning		
Code	EI-335		
Credit Hours	2 (2,0)		
Category	Specialization Elective		
Prerequisite	Artificial Intelligence		
Co-Requisite	None		
Follow-up	EI-436: Applications of Machine Learning		
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
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Title	Machine Learning Lab		
Code	EI-335-L		
Credit Hours	1 (0,1)		
Category	Specialization Elective		
Prerequisite	Artificial Intelligence		
Co-Requisite	None		
Follow-up	EI-436: Applications of Machine Learning		
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: Understand the key concepts and principles of machine learning algorithms and their applications in various domains.	C2 (Understand)	1,2
	CLO2: Demonstrate proficiency in implementing and fine-tuning supervised and unsupervised ML models to solve moderately complex problems.	C3 (Demonstrate)	1,2,3
	CLO3: Selection and evaluation of appropriate evaluation metrics to assess the performance and generalization of ML models.	C3 (Differentiate)	1,2,3
	CLO4: Effectively preprocess and transform data	C3 (Apply)	2,3,4
	CLO5: Apply machine learning techniques to analyze and extract insights from large datasets	C3 (Apply)	2,3,4,5
	CLO6: Gain practical experience in designing and conducting experiments, analyzing model results, and iteratively improving model performance	C3 (Apply)	2,3,4,5

Syllabus	Implementation of the concepts/topics discussed in the course. 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

Course Title	Software Quality Engineering		
Course Code	EI-332		
Credit Hours	3 (3,0)		
Category	Specialization Elective		
Prerequisite	CC-212: Software Engineering		
Co-Requisite	None		
Follow Up	None		
Course Introduction	This course is designed to introduce students to the core principles, methods, and practices of Software Quality Assurance. Through a blend of theory and hands-on exercises, learners will gain a deeper understanding of what it takes to ensure software products meet the required standards of quality before they reach the end-user.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Recognize the importance and business value of high-quality software.	C4 (Recognize)	1,2,3
	CLO2: Differentiate between various software testing methods and strategies.	C4 (Differentiate)	1,2,3
	CLO3: Implement best practices in defect detection, reporting, and management.	C3 (Apply)	3,4,5
	CLO4: Use essential tools for automating tests and managing defects.	C3 (Apply)	3,4,5
	CLO5: Understand the SQA role in modern software development methodologies.	C2 (Understand)	1,2
Syllabus	Introduction to Software Quality Assurance; Software Quality in Business Context; QA, QC and QE; Product Quality and Process Quality; Software Quality Measurement and Metrics; Personal Software Process; Walkthroughs and Inspections; Software Configuration Management; Quality System Documentation; Software Testing Techniques; Software Testing Strategies; Automated Testing; Capability Maturity Model; CMM-Integration, People-CMM; ISO; Six Sigma; Testing Tools, Trends and Perspectives.		
Suggested Instructional/ Reading Material	1. Daniel Galin, Software Quality Assurance From theory to implementation, 1st Edition, Pearson, 2003, ISBN: 0201709457. 2. Roger S. Pressman, B. Maxim, Software Engineering: A Practitioner's Approach, 8th Edition, McGraw-Hill, 2014, ISBN: 0078022126.		

4) Interdisciplinary

Course Title	Calculus and Analytical Geometry		
Course Code	ID-150		
Credit Hours	3 (3,0)		
Category	Interdisciplinary		
Prerequisite	None		
Co-Requisite	None		
Follow Up	MS-253: Multivariable Calculus		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Know the concepts and applications of calculus and analytical geometry.	C1 (Know)	1
	CLO2: Describe functions, limit, continuity chain rule and related techniques.	C2 (Describe)	1
	CLO3: Identify and solve problems related to differentiation and integration.	C3 (Apply)	1,3
	CLO4: Know the concepts analytical geometry.	C1 (Know)	1
Syllabus	Motivation and applications of the course. Introduction to limits: Limits and Continuity, Techniques of finding limits, Indeterminate forms of limits, Introduction to functions: Continuous and discontinuous functions and their applications, Differential calculus: Concept and idea of differentiation, Geometrical and Physical meaning of derivatives, Rules of differentiation, Techniques of differentiation, Rates of change, Tangents and Normal lines, Chain rule, implicit differentiation, linear approximation, Applications of differentiation: Extreme value functions, Mean value theorems, Maxima and Minima of a function for single-variable, Concavity. Integral calculus: Concept and idea of Integration, Indefinite Integrals, Techniques of integration, Riemann sums and Definite Integrals, Applications of definite integrals, Improper integral, Applications of Integration; Area under the curve. Analytical Geometry: Straight lines in R³, Equations for planes.		
Suggested Instructional/ Reading Material	- Howard Anton, Irl C. Bivens and Stephen Davis, Calculus, 11th Edition, Wiley, 2016, ISBN-10: 1119228581, ISBN-13: 978-1119228585. - Thomas and Finney, Calculus and Analytic Geometry, 9th Edition, ISBN-13: 978-0201531749, ISBN-10: 0201531747.		

Course Title	Linear Algebra		
Course Code	ID-250		
Credit Hours	3 (3,0)		
Category	Interdisciplinary		
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 application of linear algebra.	C1 (Know)	1
	CLO2: Describe geometry of vector spaces and optimization.	C2 (Describe)	1
	CLO3: Perform matrix algebra.	C3 (Apply)	1,3
Syllabus	Linear Equations in Linear Algebra: Systems of Linear Equations, Row Reduction and Echelon Forms, Vector Equations, The Matrix Equation $Ax = b$, Solution Sets of Linear Systems, Applications of Linear Systems, Linear Independence, Introduction to Linear Transformations, The Matrix of a Linear Transformation, Linear Models in Business, Science, and Engineering. Matrix Algebra: Matrix Operations, The Inverse of a Matrix, Characterizations of Invertible Matrices, Partitioned Matrices, Matrix Factorizations, Applications to Computer Graphics, Subspaces of R^n, Dimension and Rank. Determinants: Introduction to Determinants, Properties of Determinants, Cramer's Rule, Volume, and Linear Transformations. Vector Spaces: Vector Spaces and Subspaces, Null Spaces, Column Spaces, and Linear Transformations, Linearly Independent Sets; Bases, Coordinate Systems, The Dimension of a Vector Space, Rank, Change of Basis. Eigenvalues and Eigenvectors: Eigenvectors and Eigenvalues, The Characteristic Equation, Diagonalization, Eigenvectors and Linear Transformations, Complex Eigenvalues, Discrete Dynamical Systems. Orthogonality and Least Squares: Inner Product, Length, and Orthogonality, Orthogonal Sets, Orthogonal Projections, The Gram-Schmidt Process, Least-Squares Problems, Applications to Linear Models, Inner Product Spaces, Applications of Inner Product Spaces. Symmetric Matrices and Quadratic Forms: Diagonalization of Symmetric Matrices, Quadratic Forms, Constrained Optimization, The Singular Value Decomposition, Applications to Image Processing and Statistics. The Geometry of Vector Spaces: Affine Combinations, Affine Independence, Convex Combinations, Hyperplanes. Optimization: Matrix Games, Linear Programming—Geometric Method, Linear Programming—Simplex Method, Duality.		
Suggested Instructional/ Reading Material	1. David C. Lay, Steven R. Lay, Judi J. McDonald, Linear Algebra and Its Applications, 5th Edition, Pearson, 2015, ISBN-13: 978-0321982384, ISBN-10: 032198238X. 2. Gilbert Strang, Introduction to Linear Algebra, 5th Edition, Wellesley-Cambridge Press, 2016, ISBN-13: 978-0980232776, ISBN-10: 0980232775. 3. Howard Anton, Elementary Linear Algebra, 11th Edition, Wiley, 2013, ISBN-13: 978-0470458211, ISBN-10: 0470458216. 4. Philip N. Klein, Coding the Matrix: Linear Algebra through Applications to Computer Science, 1st Edition, Newtonian Press, 2013, ISBN-13: 978-0615880990, ISBN-10: 0615880991. 5. David Hill, David Zitarella, Linear Algebra Labs with MATLAB, 3rd Edition, Pearson, 2003, ISBN-13: 978-0131432741, ISBN-10: 0131432745.		

Course Title	Bioinformatics		
Course Code	ID-350		
Credit Hours	3 (3,0)		
Category	Interdisciplinary		
Prerequisite	None		
Co-Requisite	None		
Follow Up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain the fundamental concepts of molecular biology, biological data, and the scope of bioinformatics.	C2 (Understand)	2
	CLO2: Apply biological databases, sequence analysis methods, and programming tools to retrieve, process, and analyze biological data.	C3 (Apply)	2, 5
	CLO3: Perform sequence alignment, phylogenetic analysis, protein structure visualization, and introductory biomolecular modeling and simulation using standard bioinformatics tools.	C4 (Analyze)	3,5
	CLO4: Evaluate bioinformatics, modeling, simulation, and machine learning tools, and select appropriate methods for solving biological problems.	C5 (Evaluate)	4,5,10
Syllabus	Introduction to Bioinformatics: Definition, scope, interdisciplinary nature, and applications in genomics, proteomics, structural bioinformatics, molecular modeling, simulation, and biological data analysis. Molecular Biology Basics: DNA, RNA, proteins, central dogma, gene structure and expression, sequence-structure-function relationships. Biological Databases: GenBank, EMBL, UniProt, PDB, biological data retrieval, and BLAST basics. Sequence Analysis: Pairwise alignment, global vs local alignment, scoring schemes, Needleman–Wunsch, Smith–Waterman, and interpretation of results. Multiple Sequence Alignment and Phylogenetics: Progressive alignment, ClustalW, MUSCLE, evolutionary relationships, and phylogenetic tree construction and interpretation using distance-based and character-based methods. Genomics and Proteomics: Genome sequencing, functional genomics, and proteomics overview. Structural Bioinformatics: Protein structure levels, structure prediction basics, biomolecular visualization, and use of PyMOL. Modeling and Simulation in Bioinformatics: Introductory biomolecular modeling, mutation and refinement concepts, basic workflows using PyRosetta, fundamentals of molecular dynamics, trajectory analysis, and introductory workflows using GROMACS. Programming in Bioinformatics: Introduction to Python, sequence manipulation, and biological file formats including FASTA, FASTQ, and PDB. Machine Learning in Bioinformatics: Feature extraction, classification, clustering, prediction, model evaluation, and introductory use of scikit-learn for biological problems. Applications and Tool Evaluation: Selection, application, and evaluation of bioinformatics, modeling, simulation, and machine learning tools.		
Suggested Instructional/ Reading Material	1. Bioinformatics: Sequence and Genome Analysis – David W. Mount 2. Introduction to Bioinformatics – Arthur Lesk 3. Bioinformatics and Functional Genomics – Jonathan Pevsner 4. Essential Bioinformatics – Jin Xiong 5. Python for Bioinformatics – Sebastian Bassi		

Course Title	Digital Marketing & E-Commerce		
Course Code	ID-251		
Credit Hours	3 (3,0)		
Category	Interdisciplinary		
Prerequisite	CC-112 Programming Fundamentals		
Co-Requisite	None		
Follow Up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain fundamental concepts of digital marketing and e-commerce	C2 (Understand)	1
	CLO2: Apply digital marketing strategies (SEO, SEM, social media). Design and manage e-commerce websites. Integrate payment gateways and understand transactions	C3 (Apply)	2,3,4,5
	CLO3: Analyze digital marketing data using analytics tools	C4 (Analyze)	3,4,5,6
	CLO4: Evaluate ethical, legal, and security issues. Assess emerging trends in digital marketing	C6 (Evaluate)	5
Syllabus	Introduction to Bioinformatics: Introduction to Digital Marketing & E-Commerce, Evolution of digital marketing, Traditional vs digital marketing, Overview of e-commerce models (B2B, B2C, C2C, C2B). E-Commerce Fundamentals: E-commerce architecture, Online marketplaces, Business models (Amazon, Alibaba, Shopify). Website Planning & Development: Domain, hosting, CMS, UX/UI basics, E-commerce website structure. Search Engine Optimization (SEO): On-page and off-page SEO, Keyword research, Technical SEO basics. Search Engine Marketing (SEM) & Advertising: Google Ads basics, Pay-per-click (PPC), Campaign setup and optimization. Social Media Marketing: Platforms (Facebook, Instagram, LinkedIn), Content strategies, Influencer marketing. Content & Email Marketing: Content creation strategies, Blogging and copywriting, Email campaigns and automation. Web Analytics: Google Analytics, Metrics (CTR, conversion rate, bounce rate), Data-driven decision making. Payment Systems & Security: Payment gateways, SSL, encryption, Cybersecurity in e-commerce. Legal & Ethical Issues: Privacy laws, Intellectual property, Consumer protection. Emerging Trends: Mobile commerce (m-commerce), AI & personalization, Future of digital marketing		
Suggested Instructional/ Reading Material	1. Digital Marketing – Dave Chaffey & Fiona Ellis-Chadwick 2. E-Commerce 2021: Business, Technology, Society – Kenneth C. Laudon & Carol Guercio Trave 3. Digital Marketing Essentials – Jeff Larson & Stuart Draper 4. Social Media Marketing – Tracy L. Tuten & Michael R. Solomon 5. E-Commerce Fundamentals and Applications – Henry Chan		

5) 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)		