Curriculum / Scheme of Studies

of

Bachelor of Science in Information Technology

(BS Information Technology)

(2023)

University of Education, Lahore

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1. Introduction to BS Information Technology Program

BS Information Technology program is the study of programming, databases, networking, web based systems, human-computer interaction, and cybersecurity to meet the modern requirements of technology in business, health sector, government, education, banking and finance, security and other organizations. This program provides the skills and knowledge to find solutions that connects people, information, and the modern technologies according to the growing requirements of industry. This discipline exhibits the use of computers and communication systems to store, retrieve, study, transmit, manipulate data and send information. It plays a prominent role in businesses by supporting day-to-day operations and helps drive productivity. The program is designed to devise new ways for students who aim to pursue their careers in the growing and demanding field of Information Technology. The main focus of the program is to address the business challenges of 21st century by solving technical problems and generating new opportunities with modern technology.

Information technology program provides the opportunity to the students to acquire the knowledge of implementing the combination of software and hardware that is used to perform the essential tasks that people need and use on an everyday basis. Students in this program obtain the fundamental knowledge and practical skills to solve computing technology problems and meet industry requirements. The different sub-areas within Information Technology include but are not limited to automation, analytics, artificial intelligence, cloud computing, communications, networks, security, software/application development, and internet of things.

2. Program Vision Statement

The vision of this program is to provide state of the art teaching and learning environment to the students with strong understanding of IT and computing based business problems for pursuing successful careers in the growing field of Information Technology at national and international levels.

3. Program Mission Statement

The mission of the program is to educate the students with excellence in applying advanced technical knowledge to develop and design innovative solutions to meet the requirements, challenges and evolution of IT organizations and industry. We prepare our graduates for successful careers with a comprehensive understanding of foundations of Information Technology and the issues related to ethics, professionalism and social responsibilities related to the practice of their profession to provide their services to the community.

4. Program Educational Objectives (PEOs)

The graduates of BS Information Technology Program will develop into IT professionals who will be:

- **PEO 1:** Applying fundamental information technology concepts and practices to solve computing and IT problems

- **PEO 2:** Capable of implementing technological skills for designing, maintaining, and managing systems, components, or processes of Information Technology infrastructure to meet the specified and growing requirements of IT industry
- **PEO 3:** Contributing positively with strong understanding of ethical, professional and social issues and responsibilities related to the practice of their profession
- **PEO 4:** Working and communicating effectively as an individual and a member or leader in a team with multi-disciplinary settings while working as an IT professional in organization and industry
- **PEO 5:** Having the ability to continue professional development, lifelong learning, research and higher degrees in information technology and related fields.

5. Curricula Consideration

During the revision of the Curricula two major guidelines have been considered (ACM and Seoul Accord). However, in some cases the main focus of these guidelines is mostly traditional IT program.

5.1. Association of Computing Machinery (ACM) - Guidelines

Association of Computing Machinery (ACM), USA is the largest body in the world for computer scientists. Its membership is spread over the entire globe. It has a pool of highly reputed professionals which meet after a few years to assess the directions being taken by the computing discipline. In view of its assessment, it identifies knowledge areas and also their relative importance in the years to come. Thus, ACM shows the path to follow to the computing academia and professionals all over the world. Computing curricula are designed keeping in view following identified knowledge areas of ACM [ref # ACM 2013 curriculum report]. It has been tried to reasonably cover all knowledge areas without compromising the flexibility needed for a national model curriculum. The mapping of these key knowledge areas with the courses are given in table below.

- AL -Algorithms and Complexity
- AR -Architecture and Organization
- CN -Computational Science
- DS -Discrete Structures
- GV -Graphics and Visual Computing
- HCI -Human-Computer Interaction
- IAS -Information Assurance and Security
- IM -Information Management

- IS -Intelligent Systems
- NC -Networking and Communications
- OS -Operating Systems
- PBD - Platform-based Development
- PD -Parallel & Distributed Computing
- PL -Programming Languages
- SDF -Software Development Fundamentals
- SE -Software Engineering
- SF -Systems Fundamentals
- SP -Social Issues and Professional Issues

The following knowledge areas have been addressed with the major computing courses.

5.2. Knowledge Areas in ACM CS 2013 Curriculum

Sr. #	Knowledge Area	CS 2013		ACM 2013 Subjects Taught in Various Universities	NCEAC Revised 2023 Subjects in Core
		Tier-1	Tier-2		
1	AL-Algorithms and Complexity	19	9	Algorithms; Algorithms and Data Structures; Algorithm Design and Analysis	Data structures, Analysis of Algorithms, Theory of Automata
2	AR-Architecture and Organization	0	16	Intro to Computer Architecture; DLD; Computer Engineering	DLD, Computer Org & Assembly Language, Computer Architecture
3	CN-Computational Science	1	0	eScience; Modeling and Simulation; Computer Graphics	HCI & Computer Graphics; (Elective: Numerical Analysis)
4	DS-Discrete Structures	37	4	Discrete Mathematics; Mathematical Foundations of CS;	Discrete Structures, Probability & Statistics

				Probability for CS; Discrete Structures 1; Discrete Str 2	
5	GV-Graphics and Visualization	2	1	Computer Graphics; Computer Graphics	HCI & Computer Graphics; (Elective: Computer Graphics)
6	HCI-Human-Computer Interaction	4	4	Human Computer Interaction	HCI & Computer Graphics
7	IAS-Information Assurance and Security	3	6	Computer Systems Security	Information Security; (Elective: Cyber Security)
8	IM-Information Management	1	9	Database Systems	Database Systems; Adv Database Management Sys
9	IS-Intelligent Systems	0	10	Artificial Intelligence Programming; Artificial Intelligence	Artificial Intelligence
10	NC-Networking and Communication	3	7	Introduction to Computer Networking; Computer Networks	Computer Networks
11	OS-Operating Systems	4	11	Operating Systems	Operating Systems
12	PBD-Platform-based	0	0		(Electives: Web Technology {ASP, Javascript}, Visual Prog {C#}, Mobile App Dev {React/Flutter/Kotlin/Swift})
13	PD-Parallel and	5	10	Parallel Programming Principle and Practice;	Parallel & Distributed Computing
14	PL-Programming Languages	8	20	Introduction to Compilers; Compilers; Introduction to Programming; Programming Languages	Programming Fundamentals, OOP, Compiler Construction

15	SDF-Software Development Fundamentals	43	0	Java Programming I; Introduction to Program Design: Introduction to Programming; OOP	Programming Fundamental, Object Oriented Programming, Data Structures
16	SE-Software Engineering	6	22	Software Engineering	Software Engineering
17	SF-Systems Fundamentals	18	9	Computer Systems and Networks; Great Ideas in Computer Architecture; System Programming	DLD, Computer Networks, Computer Architecture
18	SP-Social Issues and Professional Practice	11	5	Ethics in Technology; Technology Consulting in the Community	Professional Practices
	Total Core Hours	**165**	**143**		
		308			

6. Outcome Based Education (OBE) System and Seoul Accord

Keeping in view the latest transformation from knowledge-based education philosophy to Outcome based education (OBE) system, the OBE model based on Seoul Accord has also been considered. 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).

Sr. #	Program Learning Outcomes (PLOs)	Computing Professional Graduate
1	Academic Education	To prepare graduates as computing professionals
2	Computing Problems Knowledge for Solving	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.
3	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.

4	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.
5	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.
6	Individual and Team Work	Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.
7	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.
8	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.
9	Ethics	Understand and commit to professional ethics, responsibilities, and norms of professional computing Practice.
10	Life-long Learning	Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

7. Curriculum Model for Bachelor of Science in Information Technology

The generic structure for computing degree program given before is mapped with the BSIT program in the following tables.

Generic Structure for Computing Disciplines:

Areas	Credit Hours	Courses
Computing Core	46	14
Domain Core	18	6
Domain Elective	21	7
Allied	15	5
General Education Requirement	30	12
Internship	3	1
Totals	**133**	**45**

Mapping of BSIT Program on the Generic Structure:

Sr. #	Code	Prerequisite	Course Title	Domain	Credit Hours
Computing Core (46/133) 14 Courses					
1	COMP1112		Programming Fundamentals	Core	4 (3+1)
2	COMP2111	Programming Fundamentals (COMP1112)	Object Oriented Programming	Core	4 (3+1)
3	COMP2114		Database Systems	Core	4 (3+1)
4	PHYS4129		Digital Logic and Design	Core	3 (2+1)
5	COMP2117	Object Oriented Programming (COMP2111)	Data Structures	Core	4 (3+1)
6	COMP2120		Information Security	Core	3 (2+1)
7	COMP2121		Artificial Intelligence	Core	3 (2+1)
8	COMP2119		Computer Networks	Core	3 (2+1)
9	COMP2112		Software Engineering	Core	3 (3+0)
10	COMP2118	Digital Logic and Design (PHYS4129)	Computer Organization and Assembly Language	Core	3 (2+1)
11	COMP3142	Data Structures (COMP2117)	Operating Systems	Core	3 (2+1)
12	COMP4121	Data Structures (COMP2117)	Analysis of Algorithms	Core	3 (3+0)
13	ITEC4145		IT- Final Year Project - I	Core	3 (0+3)
14	ITEC4146	IT- Final Year Project - I (ITEC4145)	IT- Final Year Project - II	Core	3 (0+3)
Domain Core (18/133) 6 Courses					
15	COMP3144		Web Technologies	Domain Core	3 (2+1)
16	COMP3143	Information Security (COMP2120)	Cyber Security	Domain Core	3 (2+1)
17	ITEC3126	Database Systems (COMP2114)	DB Administration & Management	Domain Core	3 (2+1)
18	ITEC3127	Computer Networks (COMP2119)	System & Network Administration	Domain Core	3 (2+1)
19	ITEC3128		Information Technology Infrastructure	Domain Core	3 (2+1)
20	COMP4122	Operating	Parallel & Distributed Computing	Domain	3 (2+1)

		Systems (COMP3142)		Core	
Domain Elective (21/133) 7 Courses					
21	ITEC3129		Virtual Systems & Services	Domain Elective	3 (2+1)
22	COMP3147	Computer Organization and Assembly Language (COMP2118)	Computer Architecture	Domain Elective	3 (2+1)
23	ITEC4147		Network Security	Domain Elective	3 (2+1)
24	ITEC3130		Enterprise Systems	Domain Elective	3 (2+1)
25	ITEC3111	Web Technologies (COMP3144)	Web Engineering	Domain Elective	3 (2+1)
26	COMP3148		Theory of Automata	Domain Elective	3 (2+1)
27	COMP3145		HCI & Computer Graphics	Domain Elective	3 (2+1)
28	ITEC3131		Software Project Management	Domain Elective	3 (2+1)
29	COMP4123		Cloud Computing	Domain Elective	3 (2+1)
30	ITEC4148		Software Requirements Engineering	Domain Elective	3 (2+1)
31	COMP4124		Mobile Application Development 1	Domain Elective	3 (2+1)
Allied Courses (15/133) 5 Courses					
32	MATH3122	Calculus and Analytic Geometry (MATH1129)	Multivariable Calculus	Allied	3 (3+0)
33	MATH3114	Calculus and Analytic Geometry (MATH1129)	Linear Algebra	Allied	3 (3+0)
34	STAT2115		Introduction to Statistics	Allied	3 (3+0)
35	ITEC4152		Technical and Business Writing	Allied	3 (3+0)
36	BUSA1113		Fundamentals of Accounting	Allied	3 (3+0)
General Education Requirement as per HEC UG Education Policy (30/133) 12 Courses					
37	COMP1116		Applications of Information and Communication Technologies	GER	3 (2+1)
38	ENGL1114		Functional English	GER	3 (3+0)

39	ENGL1120		Expository Writing	GER	3 (3+0)
40	MATH1129	Pre-Calculus-I and Pre-Calculus-II	QR-1 (Calculus and Analytic Geometry)	GER	3 (3+0)
41	MATH2113	Pre-Calculus-I and Pre-Calculus-II	QR-2 (Discrete Mathematics)	GER	3 (3+0)
42	ISLA1111/HUMN1111		Islamic Studies/Ethics	GER	2 (2+0)
43	PAKS1119		Ideology and Constitution of Pakistan	GER	2 (2+0)
44	BUSA2118		Social Sciences (Foundations of Management)	GER	2 (2+0)
45	PHYS1124		Natural Sciences (Applied Physics)	GER	3 (2+1)
46	ITEC4112		Arts & Humanities (Professional Practices)	GER	2 (2+0)
47	POLS2111		Civics and Community Engagement	GER	2 (2+0)
48	BUSA1114		Introduction to Entrepreneurship	GER	2 (2+0)
Internship as per HEC UG Education Policy (3/133) 1 Course					
49	INTN6112		Internship		3 (0+3)

8. List of Courses for other disciplines to take Computer Science as Minor

Sr. #	Code	Prerequisite	Course Title	Credit Hours (Contact Hours)
1	COMP1112		Programming Fundamentals	4 (3+1)
2	COMP2111	Programming Fundamentals (COMP1112)	Object Oriented Programming	4 (3+1)
3	COMP2114		Database Systems	4 (3+1)
4	COMP2117	Object Oriented Programming (COMP2111)	Data Structures	4 (3+1)
5	COMP2120		Information Security	3 (2+1)
6	COMP2121		Artificial Intelligence	3 (2+1)
7	COMP2119		Computer Networks	3 (2+1)
8	COMP2112		Software Engineering	3 (3+0)
9	COMP3142	Data Structures (COMP2117)	Operating Systems	3 (2+1)
10	COMP4121	Data Structures (COMP2117)	Analysis of Algorithms	3 (3+0)

- The course **"Seerat of the Holy Prophet Muhammad (SAW)-ISLA1122**" bearing course code ISLA1122 with 2(2+0) Credit Hours is compulsory. Its lectures will be recorded in digital form and available to all students. Students may study (online) this course in any semester and will be examined online too. This course will be considered as Non-Credited.

Note: Students from other disciplines may take 12 credit hours from the list of Minor Courses

9. Semester/Study Plan for BSIT

Course Codes will be assigned considering codes generated in University of Education Lahore Information System (UE, Lahore). The course code for remaining courses will be generated after the approval of Academic Council.

Semester 1					
Sr. #	**Code**	**Prerequisite**	**Course Title**	**Domain**	**Credit Hours (Contact Hours)**
1	COMP1112		Programming Fundamentals	Core	4 (3+1)
2	COMP1116		Applications of Information and Communication Technologies	GER	3 (2+1)
3	MATH1129	Pre-Calculus I and Pre-Calculus II (For pre-medical students)	QR 1 (Calculus and Analytic Geometry)	GER	3 (3+0)
4	ENGL1114		Functional English	GER	3 (3+0)
5	PHYS1124		Applied Physics	GER	3(2+1)
6	ISLA1111/ HUMN1111		Islamic Studies / Ethics	GER	2 (2+0)
Total					**18 (15+3)**

Semester 2					
Sr. #	**Course Code**	**Prerequisite**	**Course Title**	**Domain**	**Credit Hours**
7	COMP2111	Programming Fundamentals (COMP1112)	Object Oriented Programming	Core	4 (3+1)
8	MATH2113	Pre-Calculus I and Pre-Calculus II (For pre-medical students)	QR 2 (Discrete Mathematics)	GER	3 (3+0)
9	ENGL1120		Expository Writing	GER	3 (3+0)
10	MATH3122	Calculus and Analytic Geometry (MATH1129)	Multivariable Calculus	Allied	3 (3+0)

11	PAKS1119		Ideology and Constitution of Pakistan	GER	2 (2+0)
12	PHYS4129		Digital Logic and Design	Core	3 (2+1)
	ISLA1120/ ISLA1121		ترجمہ قرآن کورس / وحدت ادیان اور مذاہب عالم		Non-Credit
Total					**18 (16+2)**

Semester 3					
Sr. #	**Course Code**	**Prerequisite**	**Course Title**	**Domain**	**Credit Hours**
13	ITEC4112		Professional Practices	GER	2(2+0)
14	COMP2117	Object Oriented Programming (COMP2111)	Data Structures	Core	4 (3+1)
15	COMP2118	Digital Logic and Design (PHYS4129)	Computer Organization and Assembly Language	Core	3 (2+1)
16	COMP2119		Computer Networks	Core	3 (2+1)
17	MATH3114	Calculus and Analytic Geometry (MATH1129)	Linear Algebra	Allied	3 (3+0)
18	BUSA2118		Foundations of Management	GER	2 (2+0)
Total					**17 (14+3)**

Semester 4					
Sr. #	**Course Code**	**Prerequisite**	**Course Title**	**Domain**	**Credit Hours**
19	BUSA1114		Introduction to Entrepreneurship	GER	2 (2+0)
20	POLS2111		Civics and Community Engagement	GER	2 (2+0)
21	COMP2120		Information Security	Core	3 (2+1)
22	COMP2121		Artificial Intelligence	Core	3 (2+1)
23	COMP2112		Software Engineering	Core	3 (3+0)
24	COMP2114		Database Systems	Core	4 (3+1)
	ISLA1120/ ISLA1121		ترجمہ قرآن کورس / وحدت ادیان اور مذاہب عالم		Non Credit
Total					**17 (14+3)**

Semester 5					
Sr. #	**Course Code**	**Prerequisite**	**Course Title**	**Domain**	**Credit Hours**

25	COMP3142	Data Structures (COMP2117)	Operating Systems	Core	3 (2+1)
26	ITEC3126	Database Systems (COMP2114)	DB Administration & Management	Domain Core	3 (2+1)
27	ITEC3127	Computer Networks (COMP2119)	System & Network Administration	Domain Core	3 (2+1)
28	STAT2115		Introduction to Statistics	Allied	3 (3+0)
29	COMP3143	Information Security (COMP2120)	Cyber Security	Domain Core	3 (2+1)
30	COMP3144		Web Technologies	Domain Core	3 (2+1)
Total					**18 (13+5)**

Semester 6					
Sr. #	**Course Code**	**Prerequisite**	**Course Title**	**Domain**	**Credit Hours**
31	ITEC3128		Information Technology Infrastructure	Domain Core	3 (2+1)
32	XXXXXXXX		Domain Elective-I	Domain Elective	3 (2+1)
33	XXXXXXXX		Domain Elective-II	Domain Elective	3 (2+1)
34	XXXXXXXX		Domain Elective-III	Domain Elective	3 (2+1)
35	XXXXXXXX		Domain Elective-IV	Domain Elective	3 (2+1)
36	COMP4121	Data Structures (COMP2117)	Analysis of Algorithms	Core	3 (3+0)
	ISLA1120/ ISLA1121		ترجمہ قرآن کورس / وحدت ادیان اور مذاہب عالم		Non Credit
Total					**18 (13+5)**

Semester 7					
Sr. #	**Course Code**	**Prerequisite**	**Course Title**	**Domain**	**Credit Hours**
37	INTN6112		Internship		3 (0+3)
38	XXXXXXXX		Domain Elective-V	Domain Elective	3 (2+1)
39	XXXXXXXX		Domain Elective-VI	Domain Elective	3 (2+1)
40	ITEC4145		IT- Final Year Project - I	Core	3 (0+3)
41	ITEC4152		Technical and Business Writing	Allied	3 (3+0)
Total					**15 (7+8)**

Semester 8					
Sr. #	**Course Code**	**Prerequisite**	**Course Title**	**Domain**	**Credit Hours**

42	COMP4122	Operating Systems (COMP3142)	Parallel & Distributed Computing	Domain Core	3 (2+1)
43	XXXXXXXX		Domain Elective-VII	Domain Elective	3 (2+1)
44	ITEC4146	IT- Final Year Project - I (ITEC4145)	IT- Final Year Project - II	Core	3 (0+3)
45	BUSA1113		Fundamentals of Accounting	Allied	3 (3+0)
	ISLA1120/ ISLA1121		ترجمہ قرآن کورس / وحدت ادیان اور مذاہب عالم		Non Credit
Total					**12 (7+5)**

10. Eligibility Criteria, Duration of the Program and Award of Degree

- Minimum 50% marks in Intermediate/12 years schooling/A- Level (HSSC) or Equivalent with Mathematics are required for admission in BS Information Technology Program.
  **Equivalency certificate by IBCC will be required in case of education from some other country or system.*
- FSc pre-medical students are also eligible but the students have to pass deficiency courses (Pre-Calculus-I and Pre-Calculus-II / Equivalent). These deficiency mathematics courses are the prerequisite of other mathematical courses to ensure that the students have completed their deficiency in first year of their studies. Additionally, courses will be considered as non-credited courses.
- At minimum 133 credit hours are required for award of BSIT degree.
- The minimum duration for completion of BSIT degrees is four years. The maximum period of degree completion will be followed as per University of Education Lahore policy.
- A minimum 2.0 CGPA (Cumulative Grade Point Average) on a scale of 4.0 is required for award of BS Information Technology Degree.
- After successfully completing 04 semesters in the BSIT program, students may exit with an Associate Degree in Information Technology, subject to meeting all requirements for the award of the associate degree. These requirements include fulfilling the required Credit Hours, achieving a minimum CGPA, and completing compulsory courses or as per the approved university policy. However, students must complete minimum requirements as per University rules to be eligible for the Associate Degree.

Note

- The Internship of six to eight weeks is mandatory requirement for the award of degree. Students will take an Internship 3(0+3) course during summer vacations after sixth semester, and the result of this course will be added in the seventh semester.
- Department offers the following options of minor/major from the available subjects at University of Education, Lahore subject to the approval of the concerned statutory body upon recommendation of the concerned department.

1. Single Major
2. Single Major with one Minor
3. Single Major with two Minor
4. Double Major*

*Additional semester(s) will be required to complete the degree requirements in case two majors are offered provided that the total duration to complete the undergraduate/ equivalent degree program does not go beyond the maximum duration prescribed in HEC semester guidelines. Where two majors have common courses, a student can get exemption for maximum of 30 credit hours for the second major.

- The requirements and pre-requisites for a minor shall be determined by the concerned department provided that a minor must not be less than 12 credit hours.

11. Course Contents

Course Name: ***Programming Fundamentals***
Course Code: COMP1112
Credit Hours: 4 (3+1)
Pre-requisites: None

Course Introduction:

This course provides fundamental concepts of programming to freshmen. The courses is pre-requisite to many other courses, therefore, students are strongly advised to cover all contents and try to achieve CLOs to the maximum possible level. The course may be taught as language independent. Further, it is up to the university to choose any language for the practical/Lab purpose but that must be latest and market oriented.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand basic problem solving steps and logic constructs	C2 (Understand)
CLO-2	Apply basic programing concepts	C3 (Apply)
CLO-3	Design and implement algorithms to solve real world problems	C3 (Solve)

Course Outline:

Introduction to problem solving, a brief review of Von-Neumann architecture, Introduction to programming, role of compiler and linker, introduction to algorithms, basic data types and variables, input/output constructs, arithmetic, comparison and logical operators, conditional statements and execution flow for conditional statements, repetitive statements and execution flow for repetitive statements, lists and their memory organization, multi-dimensional lists, introduction to modular programming, function definition and calling, stack rolling and unrolling, string and string operations, pointers/references, static and dynamic memory allocation, File I/O operations.

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

1. Starting out with Programming Logic & Degins, 4th Edition, Tony Gaddis,
2. The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie
3. Object Oriented Programming in C++ by Robert Lafore
4. C How to Program, 7th Edition by Paul Deitel & Harvey Deitel
5. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly & Elliot B. Koffman

Course Name: ***Object Oriented Programming***
Course Code: COMP2111
Credit Hours: 4 (3+1)
Pre-requisites: Programming Fundamentals

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand principles of object oriented paradigm.	C2 (Understand)
CLO-2	Identify the objects & their relationships to build object oriented solution	C3 (Identify)
CLO-3	Model a solution for a given problem using object oriented principles	C3 (Apply)
CLO-4	Examine an object oriented solution	C4 (Examine)

Course Outline:

Introduction to object oriented design, history and advantages of object oriented design, introduction to object oriented programming concepts, classes, objects, data encapsulation, constructors, destructors, access modifiers, const vs non-const functions, static data members

& functions, function overloading, operator overloading, identification of classes and their relationships, composition, aggregation, inheritance, multiple inheritance, polymorphism, abstract classes and interfaces, generic programming concepts, function & class templates, standard template library, object streams, data and object serialization using object streams, exception handling.

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

1. Java: How to Program, 9th Edition by Paul Deitel
2. Beginning Java 2, 7th Edition by Ivor Horton
3. An Introduction to Object Oriented Programming with Java, 5th Edition by C. Thomas Wu
4. Starting Out with C++ from Control Structures to Objects, 9th Edition, Tony Gaddis
5. C++ How to Program, 10th Edition, Deitel & Deitel.
6. Object Oriented Programming in C++, 3rd Edition by Robert Lafore
7.

Course Name: ***Data Structures***
Course Code: COMP2117
Credit Hours: 4 (3+1)
Pre-requisites: Object Oriented Programming

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Implement various data structures and their algorithms and apply them in implementing simple applications	C3 (Apply)
CLO-2	Analyze simple algorithms and determine their complexities.	C5 (Analyze)
CLO-3	Apply the knowledge of data structure to other application domains.	C3 (Apply)
CLO-4	Design new data structures and algorithms to solve problems.	C6 (Design)

Course Outline:

Abstract data types, complexity analysis, Big Oh notation, Stacks (linked lists and array implementations), Recursion and analyzing recursive algorithms, divide and conquer algorithms, Sorting algorithms (selection, insertion, merge, quick, bubble, heap, shell, radix, bucket), queue, dequeuer, priority queues (linked and array implementations of queues), linked list & its various types, sorted linked list, searching an unsorted array, binary search for sorted arrays, hashing and indexing, open addressing and chaining, trees and tree traversals, binary search trees, heaps, M-way tress, balanced trees, graphs, breadth-first and depth-first traversal, topological order, shortest path, adjacency matrix and adjacency list implementations, memory management and garbage collection.

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

1. Data Structures and Algorithm Analysis in Java by Mark A. Weiss

2. Data Structures and Abstractions with Java by Frank M. Carrano & Timothy M. Henry
3. Data Structures and Algorithms in C++ by Adam Drozdek

4. Data Structures and Algorithm Analysis in C++ by Mark Allen Weiss
   Java Software Structures: Designing and Using Data Structures by John Lewis and Joseph Chase

Course Name: ***Computer Organization and Assembly Language***
Course Code: COMP2118
Credit Hours: 3 (2+1)
Pre-requisites: Digital Logic and Design

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Acquire the basic knowledge of computer organization computer architecture and assembly language	C2 (Understand)
CLO-2	Understand the concepts of basic computer organization, architecture, and assembly language techniques	C2 (Understand)
CLO-3	Solve the problems related to computer organization and assembly language	C3 (Apply)

Course Outline:

Introduction to computer systems: Information is bits + context, programs are translated by other programs into different forms, it pays to understand how compilation systems work, processors read and interpret instructions stored in memory, caches matter, storage devices form a hierarchy, the operating system manages the hardware, systems communicate with other systems using networks; Representing and manipulating information: information storage, integer representations, integer arithmetic, floating point; Machine-level representation of programs: a historical perspective, program encodings, data formats, accessing information, arithmetic and logical operations, control, procedures, array allocation and access, heterogeneous data structures, putting it together: understanding pointers, life in the real world: using the gdb debugger, out of-bounds memory references and buffer overflow, x86-64: extending ia32 to 64 bits, machine-level representations of floating-point programs; Processor architecture: the Y86 instruction set architecture, logic design and the Hardware Control Language (HCL), sequential Y86 implementations, general principles of pipelining, pipelined Y86 implementations

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

1. Computer System Architecture, M. Morris Mano, Latest Edition,
2. Assembly Language Programming for Intel- Computer, Latest Edition
3. Computer Systems: A Programmer's Perspective, 3/E (CS:APP3e), Randal E. Bryant and David R.O' Hallaron, Carnegie Mellon University
4. Robert Britton, MIPS Assembly Language Programming, Latest Edition,

Course Name: ***Digital Logic and Design***
Course Code: PHYS4129
Credit Hours: 3 (2+1)
Pre-requisites: None

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Acquire knowledge related to the concepts, tools and techniques for the design of digital electronic circuits	C2 (Understand)
CLO-2	Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques	C5 (Analyze)
CLO-3	Apply the acquired knowledge to simulate and implement small-scale digital circuits	C3 (Apply)
CLO-4	Understand the relationship between abstract logic characterizations and practical electrical implementations.	C2 (Understand)

Course Outline: (or use any other standard and latest books)

Number Systems, Logic Gates, Boolean Algebra, Combination logic circuits and designs, Simplification Methods (K-Map, Quinn Mc-Cluskey method), Flip Flops and Latches, Asynchronous and Synchronous circuits, Counters, Shift Registers, Counters, Triggered devices & its types. Mealy machines and Moore machines. Binary Arithmetic and Arithmetic Circuits, Memory Elements, State Machines. Introduction Programmable Logic Devices (CPLD, FPGA) Lab Assignments using tools such as Verilog HDL/VHDL, MultiSim.

Reference Materials:

1. Digital Fundamentals by Floyd, 11/e.

2. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e

Course Name: ***Operating Systems***
Course Code: COMP3142
Credit Hours: 3 (2+1)
Pre-requisites: Data Structures

Course Introduction:

To help students gain a general understanding of the principles and concepts governing the functions of operating systems and acquaint students with the layered approach that makes design, implementation and operation of the complex OS possible.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems	C2 (Understand)
CLO-2	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	C5 (Evaluate)
CLO-3	Demonstrate the knowledge in applying system software and tools available in modern operating systems.	C3 (Demonstrate)

Course Outline:

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.

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

1. Operating Systems Concepts, 9th edition by Abraham Silberschatz
2. Modern Operating Systems, 4th edition by Andrew S. Tanenbaum
3. Operating Systems, Internals and Design Principles, 9th edition by William StallingsWu

Course Name: ***Database Systems***
Course Code: COMP2114
Credit Hours: 4 (3+1)
Pre-requisites: None

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

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain fundamental database concepts.	C2 (Explain)
CLO-2	Design conceptual, logical and physical database schemas using different data models.	C5 (Design)
CLO-3	Identify functional dependencies and resolve database anomalies by normalizing database tables.	C2 (Identify)
CLO-4	Use Structured Query Language (SQL) for database definition and manipulation in any DBMS	C4 (Use)

Course Outline:

Basic database concepts, Database approach vs. file based system, database architecture, three level schema architecture, data independence, relational data model, attributes, schemas, tuples, domains, relation instances, keys of relations, integrity constraints, relational algebra, selection, projection, Cartesian product, types of joins, normalization, functional dependencies, normal forms, entity relationship model, entity sets, attributes, relationship, entity-relationship diagrams, Structured Query Language (SQL), Joins and sub-queries in SQL, Grouping and aggregation in SQL, concurrency control, database backup and recovery, indexes, NoSQL systems.

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

1. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg

2. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom

3. Database System Concepts, 6th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan.

4. Database Management Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke

Course Name: ***Information Security***
Course Code: COMP2120
Credit Hours: 3 (2+1)
Pre-requisites: None

Course Introduction:

This course provides a broad overview of the threats to the security of information systems, the responsibilities and basic tools for information security, and the levels of training and expertise needed in organizations to reach and maintain a state of acceptable security. It covers concepts and applications of system and data security. Areas of particular focus include secure network design, implementation and transition issues, and techniques for responding to security breaches.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain key concepts of information security such as design principles, cryptography, risk management, and ethics	C2 (Explain)
CLO-2	Discuss legal, ethical, and professional issues in information security	A2 (Discuss)
CLO-3	Apply various security and risk management tools for achieving information security and privacy	C3 (Apply)
CLO-4	Identify appropriate techniques to tackle and solve problems in the discipline of information security	C4 (Identify)

Course Outline:

Information security foundations, security design principles; security mechanisms, symmetric and asymmetric cryptography, encryption, hash functions, digital signatures, key management, authentication and access control; software security, vulnerabilities and protections, malware, database security; network security, firewalls, intrusion detection; security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics in information security, privacy and anonymity of data.

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

1. Computer Security: Principles and Practice, 3rd edition by William Stallings
2. Principles of Information Security, 6th edition by M. Whitman and H. Mattord
3. Computer Security, 3rd edition by Dieter Gollmann
4. Computer Security Fundamentals, 3rd edition by William Easttom
5. Official (ISC)2 Guide to the CISSP CBK, 3rd edition

Course Name: ***Computer Networks***
Course Code: COMP2119
Credit Hours: 3 (2+1)
Pre-requisites: None

Course Introduction:

This course introduces the basic concept of computer network to the students. Network layers, Network models (OSI, TCP/IP) and protocol standards are part of the course.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Describe the key terminologies and technologies of computer networks	C2 (Describe)
CLO-2	Explain the services and functions provided by each layer in the Internet protocol stack.	C2 (Explain)
CLO-3	Identify various internetworking devices and protocols and their functions in a networking	C4 (Identify)
CLO-4	Analyze working and performance of key technologies, algorithms and protocols	C4 (Analyze)
CLO-5	Build Computer Network on various Topologies	P3 (Build)

Course Outline:

Introduction and protocols architecture, basic concepts of networking, network topologies, layered architecture, physical layer functionality, data link layer functionality, multiple access techniques, circuit switching and packet switching, LAN technologies, wireless networks, MAC addressing, networking devices, network layer protocols, IPv4 and IPv6, IP addressing, sub netting, CIDR, routing protocols, transport layer protocols, ports and sockets, connection establishment, flow and congestion control, application layer protocols, latest trends in computer networks.

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

1. Computer Networking: A Top-Down Approach Featuring the Internet, 6th edition by James F. Kurose and Keith W. Ross
2. Computer Networks, 5th Edition by Andrew S. Tanenbaum
3. Data and Computer Communications, 10th Edition by William Stallings
4. Data Communication and Computer Networks, 5th Edition by Behrouz A. Forouzan

Course Name: ***Software Engineering***
Course Code: COMP2112
Credit Hours: 3 (3+0)
Pre-requisites: None

Course Introduction:

This course introduces the basic concepts of software engineering. It describes software process models, quality assurance, testing, configuration, design and implementation concepts.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Describe various software engineering processes and Activates.	(Describe)
CLO-2	Apply the system modeling techniques to model a medium size software systems.	(Apply)
CLO-3	Apply software quality assurance and testing principles to medium size software systems.	(Apply)
CLO-4	Discuss key principles and common methods for software project management such as scheduling, size estimation, cost estimation and risk analysis.	(Discuss)

Course Outline:

Nature of Software, Overview of Software Engineering, Professional software development, Software engineering practice, Software process structure, Software process models, Agile software Development, Agile process models, Agile development techniques, Requirements engineering process, Functional and non-functional requirements, Context models, Interaction models, Structural models, behavioral models, model driven engineering, Architectural design, Design and implementation, UML diagrams, Design patterns, Software testing and quality assurance, Software evolution, Project management and project planning, configuration management, Software Process improvement.

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

1. Software Engineering, Sommerville I., 10th Edition, Pearson Inc., 2014

2. Software Engineering, A Practitioner's Approach, Pressman R. S.& Maxim B. R., 8th Edition, McGraw-Hill, 2015.

Course Name: ***Analysis of Algorithms***
Course Code: COMP4121
Credit Hours: 3 (3+0)
Pre-requisites: Data Structures

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain what is meant by "best", "expected", and "worst" case behavior of an algorithm	C2 (Explain)
CLO-2	Identify the characteristics of data and/or other conditions or assumptions that lead to different behaviors.	C4 (Identify)
CLO-3	Determine informally the time and space complexity of simple algorithms	C4 (Determine)
CLO-4	List and contrast standard complexity classes.	C4 (Analyze)
CLO-5	Use big O, Omega, Theta notation formally to give asymptotic upper bounds on time and space complexity of algorithms	C3 (Use)
CLO-6	Use of the strategies (brute-force, greedy, divide-and-conquer, and dynamic programming) to solve an appropriate problem	C3 (Use)
CLO-7	Solve problems using graph algorithms, including single-source and all-pairs shortest paths, and at least one minimum spanning tree algorithm.	C3 (Solve)
CLO-8	Trace and/or implement a string-matching algorithm	C3 (Implement)

Course Outline:
Introduction; role of algorithms in computing, Analysis on nature of input and size of input Asymptotic notations; Big-O, Big Ω, Big Θ, little-o, little-ω, Sorting Algorithm analysis, loop invariants, Recursion and recurrence relations; Algorithm Design Techniques, Brute Force Approach, Divide-and-conquer approach; Merge, Quick Sort, Greedy approach; Dynamic programming; Elements of Dynamic Programming, Search trees; Heaps; Hashing; Graph algorithms, shortest paths, sparse graphs, String matching; Introduction to complexity classes.

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

1. Introduction to Algorithms (3rd edition) by Thomas H. Corman, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein
2. Algorithm Design, (1st edition, 2013/2014), Jon Kleinberg, Eva Tardos,
3. Algorithms, (4th edition, 2011), Robert Sedgewick, Kevin Wayne

Course Name: ***Artificial Intelligence***
Course Code: COMP2121
Credit Hours: 3 (2+1)
Pre-requisites: 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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the fundamental constructs of Python programming language.	C2 (Understand)
CLO-2	Understand key concepts in the field of artificial intelligence	C2 (Understand)
CLO-3	Implement artificial intelligence techniques and case studies	C3 (Apply)

Course Outline:

An Introduction to Artificial Intelligence and its applications towards Knowledge Based Systems; Introduction to Reasoning and Knowledge Representation, Problem Solving by Searching (Informed searching, Uninformed searching, Heuristics, Local searching, Min-max algorithm, Alpha beta pruning, Game-playing); Case Studies: General Problem Solver, Eliza, Student, Macsyma; Learning from examples; ANN and Natural Language Processing; Recent trends in AI and applications of AI algorithms. Python programming language will be used to explore and illustrate various issues and techniques in Artificial Intelligence.

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

1. Russell, S. and Norvig, P. “Artificial Intelligence. A Modern Approach”, 3rd ed, Prentice Hall, Inc., 2015.
2. Norvig, P., “Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp”, Morgan Kaufman Publishers, Inc., 1992.
3. Luger, G.F. and Stubblefield, W.A., “AI algorithms, data structures, and idioms in Prolog, Lisp, and Java”, Pearson Addison-Wesley. 2009.
4. Severance, C.R., 2016. “Python for everybody: Exploring data using Python 3.” CreateSpace Independent Publ Platform.
5. Miller, B.N., Ranum, D.L. and Anderson, J., 2019. “Python programming in context.” Jones & Bartlett Pub.
6. Joshi, P., 2017. “Artificial intelligence with python.” Packt Publishing Ltd.

Course Name: ***Web Technologies***
Course Code: COMP3144
Credit Hours: 3 (2+1)
Pre-requisites: None

Course Introduction:
In this course, the origins of hypermedia, World Wide Web and current and future developments on the Web have been discussed. The architecture of the Internet and various protocols such as the Hypertext Transfer Protocol (HTTP, client and server-side issues in web architectures, Web 2.0 and Rich Internet Applications (RIAs), latest HTML5, XML technologies and applications are presented. JavaScript is introduced and CSS3, the Semantic Web, web search, security and privacy.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Sound understanding of basic web technology architectures	C2 (Understand)
CLO-2	Application of syntax and semantics of several Markup languages for use in information communication.	C3 (Apply)

Course Outline:

Introduction to Web Applications, TCP/IP Application Services. Web Servers: Basic Operation, Virtual hosting, Chunked transfers, Caching support, Extensibility. SGML, HTML5, CSS3. XML Languages and Applications: Core XML, XHTML, XHTM MP. Web Service: SOAP, REST, WML, XSL. Web Services: Operations, Processing HTTP Requests, Processing HTTP Responses, Cookie Coordination, Privacy and P3P, Complex HTTP Interactions, Dynamic Content Delivery. Server Configuration. Server Security. Web Browsers Architecture and Processes. Active Browser Pages: JavaScript, DHTML, AJAX. JSON, Approaches to Web Application Development. Programing in any Scripting language. Search Technologies. Search Engine Optimization. XML Query Language, Semantic Web, Future Web Application Framework.

Reference Materials:

1. Learning PHP, MySQL, JavaScript, and CSS, A Step-by-Step Guide to Creating Dynamic Websites By Robin Nixon, O'Reilly Media; Second Edition edition (September 3, 2012). ISBN-10: 1449319262
2. Web Technologies: A Computer Science Perspective by Jeffrey C. Jackson, Prentice Hall; 1st Edition (August 27, 2006). ISBN-10: 0131856030
3. Web Technologies by Uttam Kumar Roy, Oxford University Press, USA (June 13, 2011). ISBN-10: 0198066228
4. Web Application Architecture: Principles, protocols and practices by Leon Shklar and Richard Rosen, Wiley; 2nd Edition (May 5, 2009). ISBN-10: 047051860X.

Course Name: ***Cyber Security***
Course Code: COMP3143
Credit Hours: 3 (2+1)
Pre-requisites: Information Security

Course Introduction:
This course provides students an introduction to common cyber security threats, vulnerabilities, and risks related to web applications, networks, software and mobile applications. The course provides basic concepts and terminology used in the information and cyber security fields. Moreover, it will also enable students to differentiate between the various forms of malware and how they affect computers and networks.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Identify computer system threats	C2 (Understand)
CLO-2	Identify Malware attacks, and understand the stages of attack and payloads.	C2 (Understand)
CLO-3	Implement various cryptographic techniques and simulate attack scenarios	C3 (Apply)

Course Outline:

Introduction to Cyber security; Networks and the Internet; cyber threat landscape; understanding security; information security Principles (Confidentiality, Integrity, Availability); Information Security Terminology; Who are the attackers; Advanced Persistent Threat (APT); Malware, types of malware; Attacks using malware; Malware Attack Lifecycle: Stages of Attack; Social engineering attacks; types of payload; Industrial Espionage in Cyberspace; Basic cryptography; Web application attacks; Database security; Cyber kill chain; Privacy and anonymity; Network security; Software security; Mobile device security; Mobile app security; Cyber Terrorism and Information Warfare; Introduction to Digital Forensics; Digital Forensics Categories.

Reference Materials:

1. Computer Security Fundamentals by Chuck Easttom, 4th edition or latest
2. Security+ Guide to Network Security Fundamentals, by Mark Ciampa, 5th Edition
3. Security in Computing by C.P. Pfleeger, Prentice-Hall, 4th Edition or Latest

Course Name: ***System & Network Administration***
Course Code: ITEC3127
Credit Hours: 3 (2+1)
Pre-requisites: Computer Networks

Course Introduction:
This course will provide an overview of systems and network administration. It will provide an understanding of system and network administration tasks, practices and the implementation and maintenance of standard services.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Describe the key technologies of system and network administration	C2 (Describe)
CLO-2	Analyze the different services of Linux	C2 (Understand)
CLO-3	Understand the configuration of network management tools	C2 (Understand)
CLO-4	Apply the active directory concept and tasks	C3 (Apply)
CLO-5	Understand redundancy and clustering of machines	C2 (Understand)

Course Outline:

Introduction: Setting up and Managing User Accounts, Securing Resources with NTFS Permissions. Administering Shared Folders, Using Windows 8/8.1/10 Tools: Working with Services, Using Event Viewer, Using Scheduled Tasks, Using Remote Desktop and Remote Assistance, Linux File System: Linux File System Layout, Running Command and Getting Help, The what is Command, The –help Option, System Manual Pages, System Info Pages, The man Command, The info Command, Managing Linux Files, Directories, and Archives, Managing Users in Linux, Vi and Joe Editor: Overview, Starting Vi and Vim, Three Modes of Vi and Vim, Cursor Movement, Entering Insert Mode, Leaving Insert Mode, Change, Delete and Yank, Paste, Undo Changing, Searching for Text, Saving and Exiting, Software Management in Linux: The Red Hat Package Manager, Adding, Removing Packages, Update Packages, Querying and Verifying Packages. Configuration of Network Management Tools: Understanding Network Management, Analysis Tools, Web based Configurations, Traffic Management, Configuring DNS Server and Clients, Configuring DHCP Server and Clients Managing Web Services: Benefits of Using IIS, Key IIS Services, IIS Backup, Troubleshooting IIS, Virtual hosting, Types of virtual hosting, Active Directory: Introduction to Active Directory, Understanding Active Directory Concepts and Administration Tasks, Planning the Active Directory Infrastructure Design. Administering Active Directory, Installing and Managing Domains, Trees, and Forests: Creating Multiple Domains, Trees, and Forests, Renaming and Restructuring Domains, and Renaming Domain Controllers, Farming and Clustering: Understanding redundancy and clustering of machines, working with clustering tools like pacemaker and vrrp, load balancing Containers, Working with Kubernette, Planning and configuration of Clustering Planning a Microsoft Exchange Server Infrastructure, Configuring an Exchange Server Infrastructure, Introduction and Installation of Squid Server, Advance Network Equipment Configurations.

Reference Materials:
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. Red Hat Enterprise Linux 6 Bible: Administering Enterprise Linux Systems by WilliamvonHagen,2011
3. Studyguide for Practice of System and Network Administration by Thomas A. Limoncelli, Cram101; 2nd Edition (2011).ISBN-10:1428851755
4. Networking Systems Design and Development by Lee Chao, CRC Press; 1st Edition (December 21, 2009). ISBN-10:142009159X(TB2)
5. The Complete Reference Red Hat Enterprise Linux and Fedora Edition by Richard Peterson and Ibrahim Haddad, McGraw Hill Osborne Media; 1st Edition,2004.

Course Name: ***Information Technology Infrastructure***
Course Code: ITEC3128
Credit Hours: 3 (2+1)
Pre-requisites: None

Course Introduction:
This course will describe the fundamental concepts of information technology infrastructure including building blocks, system management, software systems, hardware, database, networks, security and operating system.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Describe the key concepts of information technology infrastructure	C2 (Describe)
CLO-2	Perform various tasks of IT system management	C3 (Apply)
CLO-3	Understand service delivery, support, storage and security management	C2 (Understand)

Course Outlines:

Overview: Definitions, Infrastructure management activities, Evolutions of Systems since 1960s (Mainframes-to-Midrange-to-PCs-to-Client-server computing-to-New age systems) and their Management, growth of internet, current business demands and IT systems issues, complexity of today's computing environment, Total cost of complexity issues, Value of Systems management for business. Factors to consider in designing IT organizations and IT infrastructure, Determining customer's Requirements, Identifying System Components to manage, Exist Processes, Data, applications, Tools and their integration, Patterns for IT systems management, Introduction to the design process for information systems. Current computing environment: Complexity of current computing, multiple technologies, multiple vendors, multiple users, e- Waste disposal, Total cost of ownership. IT system Management: Common tasks in IT system management, approaches for organization Management, Models in IT system design, IT management systems context diagram, patterns for IT system Management, Information system costs and benefits, Capital budgeting for information system, Real Options pricing models, Limitation of financial models. Service Delivery Processes: IT services continuity management, Capacity management, Availability management and service desk. Service Support Management: Service support process, Configuration Management. Incident management. Problem management, Change management, Release management. Storage Management: backups, Archive, Recovery, Disaster recovery. Space management, Hierarchical storage management, Network attached storage, Storage area network, bare Machine recovery, data retention, database protection. Security Management: Introduction Security, Identity management, Single sign-on, Access Management. Basics of network security, LDAP fundamentals, Intrusion detection, firewall, security information management. IT Ethics: Introduction to Cyber Ethics, Intellectual Property, Privacy and Law, Computer Forensics, Ethics and Internet, Cyber Crimes.

Reference Materials:

1. IT Infrastructure Architecture: Infrastructure building blocks and concepts by Sjaak Laan, Lulu.com (November 5, 2011).ISBN-10:1447881281

2. IT Infrastructure and its Management by Prof Phalguni Gupta, Tata McGraw Hill Education Private Limited (October 6, 2009). ISBN-10:0070699798

3. IT Architecture for Dummies by Kalani Kirk Hausman and Susan Cook, For Dummies; 1st Edition (November 9, 2010). ISBN-10:0470554231

Course Name: ***Parallel & Distributed Computing***
Course Code: COMP4122
Credit Hours: 3 (2+1)
Pre-requisites: Operating Systems

Course Outline:

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the concepts of parallel and distributed computing	C2 (Understand)
CLO-2	Design portable programs for parallel or distributed architectures using Message-Passing Interface (MPI) library	C6 (Design)
CLO-3	Analyze complex problems with shared memory	C3 (Analyze)

Course Introduction:
This is a theory course directed at non-theory students with the standard undergrad background. The goal is to survey the key theory topics that every computer science graduate student should know. In about two weeks for each selected topic, we will gain insights into the basics and study one two example in depth.
Asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, synchronization, and tools (Cuda, Swift, Globus, Condor, Amazon AWS, OpenStack, Cilk, gdb, threads, MPICH, OpenMP, Hadoop, FUSE).

Reference Materials:

1. Distributed Systems: Principles and Paradigms, A. S. Tanenbaum and M. V. Steen, Prentice Hall, 2nd Edition, 2007

2. Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet, K Hwang, J Dongarra and GC. C. Fox, Elsevier, 1st Ed.

Course Name: ***DB Administration & Management***
Course Code: ITEC3126
Credit Hours: 3 (2+1)
Pre-requisites: Database Systems

Course Introduction:
This course provides the fundamental concepts and skills for database administration and management. It provides the information to setup, maintain, and troubleshoot the latest Version of ORACLE database server.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the concepts of data base administration	C2 (Understand)
CLO-2	Describe the functionality of database management concepts	C2 (Describe)
CLO-3	Perform various tasks related to database administration and management	C3 (Perform)

Course Outline:
Introduction: Introduction to oracle family, Relational DBMS concepts, Exploring SQL, Role of DBA in organization. Exploring the Database Server: Database architecture, Single instance vs. multi instance database architecture, Memory structures, and Process structures. Oracle Installation and Database Creation: Install the Oracle software by using the Oracle Universal Installer (OUI), Create a database by using the database configuration assistant, The instance, The Database, and the data dictionary. Managing the Oracle Instance: Stages of Database startup and shutdown, Database initialization parameters, Alert log and trace files, Data dictionary and dynamic performance views, Configuring the Oracle Network Environment: Configure and manage the Oracle network, Use the Oracle shared server architecture. Managing Database Storage Structures: Understand tables paces and data files, The Oracle data storage model, Segments, Extents, Blocks and rows, Automatic Storage Management (ASM), Create and manage table spaces, Create, Alter and drop table space, Manage space in tablespaces. Administering User Security: Create and manage database user accounts, Grant and revoke privileges, System privileges, Object privileges, Create and manage roles, Create and manage profiles. Managing Schema Objects: Create and modify tables, Users, User accounts, Schemas, and Schema Objects, Naming schema objects, Object namespaces, Data types, Creating tables, Manage constraints, Create indexes, Create and use temporary tables. Managing Data and Concurrency: Manage data using DML, Database transactions, Executing SQL statements, Transaction control, COMMIT, ROLLBACK, SAVEPOINT, Monitor and resolve locking conflicts. Managing Undo Data: Explain the purpose of undo, understand how transactions generate undo, manage undo, Flashback Query, Creating and managing undo table spaces. Implementing Oracle Database Security: Database security and principle of least privilege, Work with standard Database auditing. Database Maintenance: Use and manage optimizer statistics, Use and manage the automatic workload repository, Use the advisory framework, Manage alerts and thresholds. Performance Management: Use automatic memory Management, Use memory Advisors, Troubleshoot invalid and unusable objects. Backup and Recovery Concepts: Types of failure, Ways to tune instance recovery, Importance of checkpoints, Redo log files, Flash recovery area. Performing Database

Backups: Create consistent Database backups, Backup your Database without shutting it down, Create incremental backups, Automate database backups, Manage backups, View backup reports, and monitor the flash recovery area. Performing Database Recovery: Overview of data Recovery advisor, Use data Recovery advisor to perform recovery. Moving Data: Describe and use methods to move data (SQL Loader, Directory objects, External Tables), Explain the general architecture of Oracle Data pump, Use data pump export and import to move data between Oracle Databases.

Reference Materials:

1. John Watson, (2008) OCA Oracle Database 11g: Administration I Exam Guide, McGraw-Hill Osborne Media,1st edition.

2. Craig S. Mullins (2002), Database Administration: The Complete Guide to Practices and Procedures, Addison Wesley, ISBN: 0201741296.

3. Donald K. Burleson (2002), Oracle9i UNIX Administration Handbook, McGraw- Hill, ISBN: 007222304.

4. C. J. Date (1994), DatabaseSystems,Addison-Wesley.

5. Korth and Silberschatz (2007), Database Systems Concepts, McGraw Hill. Peter Rob, Course Technology; 8th edition.

6. Dan Wood, Chris Leiter, Paul Turley, (2006).Beginning SQL Server 2005 Administration, Wrox.

7. Peter Rob, Carlos Coronel. (2007). Database Systems: Design, Implementation, and Management, Course Technology, 8th edition.

Course Name: ***Virtual Systems & Services***
Course Code: ITEC3129
Credit Hours: 3 (2+1)
Pre-requisites: None

Course Introduction:
In this course, the concepts of virtualization have been described. This course presents the fundamental concepts of virtual machines, managing storage and copying virtual machines, virtual systems, hypervisors, virtualization of CPU and memory, virtual networks and security.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the fundamental concepts of virtual systems and machines	C2 (Understand)
CLO-2	Describe NAT, Bridge, Host-only network adapters in a virtual machine for designing the virtual networks.	C2 (Describe)
CLO-3	Understand the concepts of hypervisors, limitations and configuration	C2 (Understand)
CLO-4	Apply virtual machine concepts for implementation in various virtual environments	C3 (Apply)

Course Outline:
Understanding Virtualization: Introduction to virtual systems, Describing Virtualization, Microsoft Windows Drives Server Growth, Explaining Moore‟s Law, Understanding the Importance of Virtualization, Examining Today‟s Trends, Virtualization and Cloud Computing, Virtualizing Servers, Virtualizing Desktops. Virtualizing Applications, Exploring the History of Hypervisors: Understanding Type 1 Hypervisors Understanding Type 2 Hypervisors, Understanding the Role of a Hypervisor: Holodecks and Traffic Cops, Resource Allocation, Comparing Today's Hypervisors: VMware ESX, Citrix Xen, Microsoft Hyper-V, Other Solutions, Understanding Virtual Machines: Describing a Virtual Machine. Examining CPUs in a Virtual Machine., Examining Memory in a Virtual Machine, Examining Network Resources in a Virtual Machine, Examining Storage in a Virtual Machine, Understanding How a Virtual Machine Works, Working with Virtual Machines , Understanding Virtual Machine Clones., Understanding Templates, Understanding Snapshots, Understanding OVF, Understanding Containers, Building a New Virtual Machine: Thinking about VM Configuration, Creating a First VM Installing Windows on a Virtual Machine, Loading Windows into a Virtual Machine, Understanding Configuration Options. Optimizing a New Virtual Machine , Installing Linux on a Virtual Machine , Understanding Configuration Options, Optimizing a New Linux Virtual Machine , Managing CPUs for a Virtual Machine , Understanding CPU Virtualization, Configuring VM CPU Options , Tuning Practices for VM CPUs Choosing Multiple CPUs vs. a Single CPU Hyper-Threading :Working with Intel and AMD Servers, Managing Memory for a Virtual Machine, Understanding Memory Virtualization, Configuring VM Memory Options, Tuning Practices for VM Memory, Calculating Memory Overhead, Managing Storage for a Virtual Machine: Managing Storage for a Virtual Machine: Understanding Storage Virtualization, Configuring VM Storage Options, Tuning Practices for VM Storage Managing Networking for a Virtual Machine, Understanding Network Virtualization, Internal Virtualization, External Virtualization Configuring VM Network Options, Network Address Translation (NAT),

Bridged networking, Internal networking, Host-only networking, NAT with Port-forwarding Enabling, Disabling, Adding, and Removing Host Virtual Adapters Tuning Practices for Virtual Networks, Copying a Virtual Machine: Copying a Virtual Machine: Cloning a Virtual Machine, Working with Templates, Saving a Virtual Machine State, Creating a Snapshot, Merging Snapshots Managing Additional Devices in Virtual Machines, Using Virtual Machine Tools Understanding Virtual Devices, Understanding Availability, Increasing Availability. Protecting a Virtual Machine, Understanding Applications in a Virtual Machine, Examining Virtual Infrastructure Performance Capabilities, Understanding Virtual Appliances, Open Stack and Containers. Types of Virtualization, The future of virtualization, Hosted/Virtual/Cloud Desktops, Network Virtualization (SDN and Storage Virtualization, User Virtualization Hybrid hypervisor / containers where containers are used for high performance network tasks.

Reference Materials:

1. Handbook of Virtual Environments: Design, Implementation, and Applications (Human Factors and Ergonomics), Edited by Kay M Stanney, Lawrence Erlbaum Associates Virtual Reality Technology by GRIGORE
2. Matthew Portnoy -Virtualization Essentials-Sybex (2016)
3. Virtualization from Desktop to the Enterprise, Chris Wolf and Erick M. Halter, Latest Edition
4. Virtual Machines: Versatile Platforms for Systems and Processes, Elsevier, S. Jim Smith, N. Ravi, 2005.
5. The Definitive Guide to the Xen Hypervisor, David Chisnall, Latest Edition
6. Windows Server 2012 Hyper-V Installation and Configuration Guide, Aidan Finn, Michel Luescher, Patrick Lownds, 2013
7. Xen Hypervisor Case Study - Designing Embedded Virtualized Intel® Architecture Platforms
8. The Java Virtual Machine Specification, Java SE 7 Edition, Addison-Wesley, Tim Lindholm (2013)

Course Name: ***Mobile Application Development 1***
Course Code: COMP4124
Credit Hours: 3 (2+1)
Pre-requisites: None

Course Introduction:
This course discusses the principles and issues associated with mobile application development using Android as the development platform. The course covers all the basic functionality to get started, as well as experienced knowledge of unique features of Android to enhance existing products or create innovative new ones. Topics covered will include Android application components, UI design, data storage and latest SDK features. Students will develop their own apps in Java using Android Studio in their semester-long projects. Prior knowledge of object oriented programming is required

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Discuss different architectures & framework for Mobile Application development	C1 (Discuss)
CLO-2	Develop mobile applications using current software development environments.	C3 (Develop)
CLO-3	Compare the different performance tradeoffs in mobile application development.	C3 (Compare)

Course Outline:
Android development platform: Development platform architecture, Installing the Android ADT (Android Development Tools), Installing the Android SDK (Software Development Kit), Creating AVDs (Android Virtual Devices), Using ADT tools from the command line. Activities, Intents, Fragments: Using styles and themes, Displaying dialog windows, Displaying progress bars, Using intents and intent filters, Fragment life cycle. Android User Interface: Creating views and view groups, Making layouts, Linear, Absolute, Table, Relative, Frame, Scroll view, Changing screen orientation, Using action bars, Creating UI controls with Java. Android Views: Basic views, text view, button, edit, checkbox, radio, List views, List fragments, Image views, Using menus with views. Database and Data Persistence: Saving and loading user preferences, Persisting data to files, Creating and using a database. Content Providers: Creating and using content providers. Messaging: Creating and using SMS messages. Google Maps API: Getting location data, Displaying maps. Networking: Working with web services using HTTP, Socket programming, Apache Cordova (Phonegap): Cordova architecture, Creating UI with HTML and CSS, Controlling the UI with JavaScript. Publishing Android Apps: Deploying Android packages (APKs).

Reference Materials:
1. Beginning Android 4 Application Development. John Wiley & Sons, Lee, W. M., 2012.
2. Beginning Android 4, Apress. ISBN: 1430239840, Allen, G., 2011.

3. Beginning Android game, Zechner. M., Apress, ISBN:1430230428, 2011.

4. Pro Android 4, Apress, ISBN: 1430239301, Satya, Maclean. D, 2012.

5. Professional Android 4 Application Development, Meier. R & Reto, Wiley,ISBN:1118237226, 2012.

6. Professional Android application development, Reto Meier, Wrox Programmer to Programmer, 2015.
7. iOS Programming: The Big Nerd Ranch Guide, Conway, J., Hillegass, A., & Keur, C., 5th Edition, 2014.
8. Android Programming: The Big Nerd Ranch Guides, Phillips, B. & Hardy, B., 2nd Edition, 2014.

Course Name: ***Theory of Automata***
Course Code: COMP3148
Credit Hours: 3 (2+1)
Pre-requisites: None

Course Introduction:

This course introduces the fundamental concepts of theory of automata and formal languages. It describes grammar, finite automaton, regular expressions, formal language, pushdown automaton and other concepts. It introduces the study of abstract machines and the computation problems that can be solved by using these machines.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain and manipulate the different concepts in automata theory and formal languages such as formal proofs, automata, regular expressions, Turing machines etc.	C2 (Understand)
CLO-2	Prove properties of languages, grammars and automata with rigorously formal mathematical methods	C2 (Understand)
CLO-3	Design of automata, RE and CFG	C3 (Apply)
CLO-4	Transform between equivalent NFAs, DFAs and REs	C3 (Apply)
CLO-5	Define Turing machines performing simple tasks	C2 (Understand)
CLO-6	Differentiate and manipulate formal descriptions of languages, automata and grammars with focus on regular and context-free languages, finite automata and regular expressions.	C3 (Apply)

Course Outline:

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.

Reference Materials:

1. Introduction to computer theory, Daniel I. A. Cohen, 2nd Edition
2. Automata, Computability and Complexity: Theory and Applications, by Elaine Rich, 2011
3. An Introduction to Formal Languages and Automata, by Peter Linz, 4th edition, Jones & Bartlett Publishers, 2006
4. Theory of Automata, Formal Languages and Computation, by S. P. Eugene, Kavier, 2005, New Age Publishers

Course Name: ***Computer Architecture***
Course Code: COMP3147
Credit Hours: 3 (2+1)
Pre-requisites: Computer Organization and Assembly Language

Course Introduction:
The course aims to develop an understanding of design of computer systems and components, Processor design, instruction set design, and addressing; control structures and microprogramming; memory management, caches, and memory hierarchies; and interrupts and I/O structures, Pipelining of processor Issues and Hurdles, exception handling, Parallelism, Multiprocessor Systems.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand functionality of major components of a computer system like CPU, control unit, memory, I/O and storage.	C2 (Explain)
CLO-2	Understand principles of instruction set design including RISC architectures and basic assembly programming	C3 (Discuss)
CLO-3	Understand pipelining and parallelism features applied in single processor, multiple processors and multicore architectures	C4 (Apply)
CLO-3	Solve the problems related to computer architecture	C3 (Apply)

Course Outline:

Digital Hardware Design: Transistors, Digital logic, Hardware description languages (Verilog). Instruction Set Architecture: Instruction types and mixes, Addressing, RISC vs. CISC, Exceptions. Scalar Pipelines: Data dependencies, Static scheduling, Performance. VLIW Pipelines: Local scheduling, Loop unrolling, Software pipelining, Trace scheduling, Deferred exceptions, Predicated execution, IA64. Dynamic Pipelines: Dynamical scheduling, Register renaming, Speculative execution, Trace cache. Thread-Level Parallelism: Cache coherency, Sequential consistency, Multithreading, Symmetric multiprocessing, Transactional memory. Data-Level Parallelism: GPU programming.

Reference Materials:

1. Hennessy, Patterson, Morgan & Kauffman (2006) Computer Architecture: A Quantitative Approach by Series. (4th. Edition).
2. Dubois et al. (2012). Parallel Computer Organization and Design, Cambridge University Press.
3. Shen, J. P. & Lipasti. H. M. (2005). Modern Processor Design: Fundamentals of Superscalar Processors. (1st edition). McGraw-Hill.
4. Patterson & Hennessy, Morgan & Kauffman Series (2008). Computer Organization Design. (4th. Edition)

Course Name: ***Web Engineering***
Course Code: ITEC3111
Credit Hours: 3 (2+1)
Pre-requisites: Web Technologies

Course Introduction:

This course introduces the methods and techniques used in Web-based applications development develops an understanding of the concepts, principles, strategies, methodologies and processes involve in web applications development.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Discuss how web standards impact software development.	C1 (Describe)
CLO-2	Describe the constraints that the web puts on developers.	C2 (Understand)
CLO-3	Design and Implement a simple web application.	C4 (Apply)
CLO-4	Review an existing web application against a current web standard.	C4 (Apply)

Course Outline:

Web programming languages (e.g., HTML5, CSS 3, Java Script, PHP/JSP/ASP.Net), Design principles of Web based applications, Web platform constraints, Software as a Service (SaaS), Web standards, Responsive Web Design, Web Applications, Browser/Server Communication, Storage Tier, Cookies and Sessions, Input Validation, Full stack state management, Web App Security - Browser Isolation, Network Attacks, Session Attacks, Large scale applications, Performance of Web Applications, Data Centers, Web Testing and Web Maintenance.

Reference Materials:

1. Web Engineering, Rajiv Chopra, Prentice-Hall of India, 2016
2. Web Engineering, Emilia Mendes and Nile Mosley, Springer Verlag, 2010.
3. Web Engineering: A Practitioners' Approach, Roger S. Pressman, McGraw Hill, 2008.
4. Dynamic HTML: The Definitive Reference: A Comprehensive Resource for XHTML, CSS, DOM, JavaScript 3rd Edition, O'Reilly Media 2007.
5. JavaScript: The Definitive Guide, 8th Edition, David Flanagan. O'Reilly Media. 2014.

Course Name: ***Network Security***
Course Code: ITEC4147
Credit Hours: 3 (2+1)
Pre-requisites: None

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

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand network security threats and methods for security networks	C2 (Understand)
CLO-2	Able to secure wired networks by deploying various methods	C3 (Apply)
CLO-3	Able to secure wireless networks by deploying various methods	C3 (Apply)

Course Outline:

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

Reference Materials:

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

Course Name: ***Software Project Management***
Course Code: ITEC3131
Credit Hours: 3 (2+1)
Pre-requisites: None

Course Introduction:

This course introduces the basic concepts of software project management. The purpose of the course is to develop the skills of the Project Manager to manage a software project to a successful conclusion. This course includes the modules like identify the process, document the plans, track the progress, control the products and cultivate teamwork.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain the principles of the project lifecycle and identification of opportunities to work with learners on relevant and appropriate project scenarios.	C2 (Explain)
CLO-2	Describe the issues related to project management and its application in the real world.	C2 (Describe)
CLO-2	Describe the project management techniques for IT projects to initiate, plan, execute and evaluate a project and work in teams to create a project plan.	C2 (Describe)
CLO-3	Compare various strategies for managing projects as per requirements.	C4 (Compare)

Course Outline:

Introduction Software Project: Classification of project types, Scope triangle, Project risk Vs business value, The S curve. Five phases of project management life cycle. WBS: Work Breakdown Structure. Estimate activity duration, five methods of Estimating Activity Duration, Elapsed Time Vs Productive time. PMI Process Groups & Knowledge Areas, Project Planning and Project Scheduling: Project Proposal Project Networks: Critical Path Method (CPM), Build the project network, Analysis of the project network, Network Analysis, Critical Path Analysis. PERT: GANTT Chart, Using MS-Project to draw GANTT chart, Project Metrics & Software Project Estimation Software Project Metrics: Metrics & Indicators, Software measurement: Size Oriented Metrics, Function- Oriented Metrics. Software Project Estimation: Decomposition Techniques, Software Sizing, Problem-Based Estimation, Cost Estimation, Size Estimation: COCOMO Model, Function Point Analysis, Project Staffing, Project Monitoring and Control: Project Staffing and Personnel Planning, Software project Teams, Risk Identification, Analysis and Management, Earned Value Analysis. Configuration Management, Software Project Monitoring and Control: Earned Value Analysis for Project Monitoring and Control. Project Quality Assurance and Risk Management: Software Project Quality Assurance Plans, SQA Process, Software Project Quality Standards, Overview of Project Configuration Management, Project Risk Management.

Reference Materials:

1. Software Engineering- A practitioner‘s approach, Roger S. Pressman, 5th Ed.
2. Software Project Management, Bob Hughes, Mike Cotterell 5th Edition
3. Integrated Approach to Software Engineering, Punkaj Jalote
4. Introduction to the Personal Software Process, Watts. S. Humphrey
5. Information Technology Project Management: Providing measurable organizational value, Jack Marchewka, John Wiley &Sons

Course Name: ***Enterprise Systems***
Course Code: ITEC3130
Credit Hours: 3 (2+1)
Pre-requisites: None

Course Introduction:
The course introduces the fundamental concepts of enterprise systems modules: manufacturing, supply chain management (SCM), financials, projects, human resource management, and customer relationship management (CRM).

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Describe the positioning strategies, product development practices, platform strategies, and distribution strategies of enterprise systems vendors	C2 (Describe)
CLO-2	Analyze the rationale for selecting enterprise systems as a component of an organization's IT architecture	C4 (Analysis)
CLO-3	Understand the application of enterprise systems to support supply chain management platforms	C2 (Understand)
CLO-4	Understand the development of analytical capabilities from enterprise systems.	C2 (Understand)

Course Outline:

Introduction to enterprise systems modules, The evolution of software systems for planning and control in manufacturing companies, Material requirements planning, Manufacturing resource planning, Enterprise Resource Planning (ERP) Systems: Basic methods and common features of ERP Systems, The market for ERP Systems, Systems Diagramming and the Process Map. ERP Life Cycle: Planning and Package Selection. Implementation and Operation and Maintenance, ERP Modules: a- Customer Relationship Management (CRM) systems: Basic methods and common features of CRM systems, The market for CRM systems, Selected functions of the my SAP CRM system, Information warehouses Architectures, interfaces, and integration issues, Present state of ERP, SCM, and CRM applications and possible developments in the near future case studies. b- Supply Chain Management (SCM) systems: Basic methods and common features of SCM systems, the market for SCM systems selected procedures of the mySAP SCM system APO. c-ERP Financials, types of finance, introduction to financial reports, inputs and outputs financial systems, A/c payables, A/c Receivables, general ledger, basic introduction with mySAP financial module d- Business Intelligence and Performance Management Corporate performance management (CPM), CPM pyramid, Components of BI, Importance of Data Analysis for decision making.

Reference Materials:
1. Modern ERP: Select, Implement & Use Today's Advanced Business Systems by Marianne Bradford, lulu.com (October 19, 2009).ISBN-10:0557012910.

2. Managerial Issues of Enterprise Resource Planning Systems by David Olson, McGraw-Hill/Irwin; 1st Edition (September 10, 2003).ISBN-10:0072861126.

3. Enterprise Resource Planning by Bret Wagner by Ellen Monk, Course Technology; 3rd Edition (February 4, 2008).ISBN-10:1423901797

4. ERP Systems by Dimpi Srivastava and AartiBatra, I K International Publishing House (February 15, 2010).ISBN-10:9380578148

Course Name: ***Cloud Computing***
Course Code: COMP4123
Credit Hours: 3 (2+1)
Pre-requisites: None

Course Introduction:
The overall aim of this module is to introduce students to the theory, practice, and advance techniques associated with implementing large-scale distributed computing systems in Service-Oriented Architectures (SOA).

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain the core issues of cloud computing such as security, privacy, consistency and interoperability	C2 (Explain)
CLO-2	Develop and deploy cloud application using popular cloud platforms	C3 (Apply)
CLO-3	Compare the key trade-offs between multiple design approaches used for cloud systems.	C3 (Compare)

Course Outline:

Cloud Computing Basics: Emergence and evolution of cloud computing, overview of cloud computing, global nature of cloud, cloud- based service offerings, characteristics, benefits of cloud model, challenges. Cloud Computing Services Model: Web services delivered from the cloud, Communication-as-a-Service (CaaS), Monitoring as-a-Service (MaaS), Platform-as-a- Service (PaaS), Software-as-a-Service (SaaS), Infrastructure as a Service (IaaS). Cloud Computing Deployment Model: Private, Public, Community and Hybrid deployment models. Cloud Infrastructure: Cloud computing at Amazon, Google, and Windows Azure, open source software platforms for private cloud, legal issues, and service level agreements Virtualization: Building Cloud networks, Virtualization, Federation, Layering, VMs, Virtual machine monitors. Security: Common standards in cloud computing, cloud security alliance, SAS 70, ISO270001.

Reference Materials:

1. Cloud Computing: Theory and Practice, Dan C. Marinescu, latest Edition, Morgan Kaufmann.

2. Cloud Computing, Sandeep Bhowmik, Cambridge University Press, latest edition

3. Cloud Computing Implementation, Management, and Security, John .W. R., James F & Ransome, (2010), Taylor & Francis Group: ISBN978-1-4398-0680-7.

4. Cloud Computing Explained: Implementation Handbook for Enterprises, J. Rhoton (2009), Recursive Press.ISBN-10:0956355609.

Course Name: ***Software Requirements Engineering***
Course Code: ITEC4148
Credit Hours: 3 (2+1)
Pre-requisites: None

Course Introduction:
In this course, the concepts of requirement engineering have been described. This course presents the process to process communication, requirement validation, management and techniques.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the basic concepts of requirement engineering	C2 (Understand)
CLO-2	Describe requirements elicitation, analysis, negotiation, validation, management and other activities in requirements engineering.	C2 (Describe)
CLO-3	Describe requirement management, validation and techniques	C2 (Understand)
CLO-4	Explain modeling techniques applicable in requirement engineering	C2 (Understand)
CLO-5	Apply various techniques of requirement engineering to solve real world problems	C3 (Apply)

Course Outline:

Introduction: Introduction to Requirements Engineering, Software Requirements, classification of requirements, Requirements process, Levels/layers of requirements, Requirement characteristics Process-to- Process Communication And Circuit Switching: Analyzing quality requirements, Software requirements in the context of systems engineering, Requirement evolution, requirement traceability, requirement prioritization, trade-off analysis, risk analysis and impact analysis, Requirements Management: Requirement management, interaction between requirement and architecture, Requirement elicitation, elicitation sources and techniques, Requirement specification and documentation, specification sources and techniques Requirements validation and techniques: Requirements validation and techniques, Management of Requirements, Introduction to Management, Requirements Management Problems Requirements engineering for agile methods: Managing Requirements in an Acquisition Organization, Supplier Organizations, Product Organizations, Requirements engineering for agile methods.

Reference Materials:
1. Software Requirements, Wiegers K. &Beatty J., 3rd Ed. Microsoft Press, 2013.
2. Requirements Engineering, Elizabeth Hull, Ken Jackson and Jeremy Dick. 3rd Ed, Springer-Verlag London Limited, 2011.
3. Requirements Engineering and Management for Software Development Projects, Chemuturi M., Springer New York, 2013.

Course Name: ***Multivariable Calculus***
Course Code: MATH3122
Credit Hours: 3 (3+0)
Pre-requisites: Calculus and Analytic Geometry

Course Introduction:

This course has been designed to provide foundation and basic ground for multivariable calculus and analytical background with multi variables.

Course Outline:

Functions of Several Variables and Partial Differentiation. Multiple Integrals, Line and Surface Integrals. Green's and Stoke's Theorem. Fourier Series: periodic functions, Functions of any period P-2L, Even & odd functions, Half Range expansions, Fourier Transform; Laplace Transform, Z-Transform.

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

1. Multivariable Calculus, 6th edition James, Stewart 2007 Cengage Learning publishers.
2. Calculus and Analytical Geometry, 6th edition. Swokowski, Olinick and Pence. 1994.Thomson Learning EMEA, Ltd.
3. Multivariable Calculus, 5th edition Howard, A. Albert, H. 1995, John Wiley.

Course Name: ***Linear Algebra***
Course Code: MATH3114
Credit Hours: 3 (3+0)
Pre-requisites: Calculus and Analytic Geometry

Course Description: Linear algebra is the study of vector spaces and linear transformations. The main objective of this course is to help students learn in rigorous manner, the tools and methods essential for studying the solution spaces of problems in Mathematics, engineering, the natural sciences, and social sciences and develop mathematical skills needed to apply these to the problems arising within their field of study; and to various real-world problems.

Course Content:

Vectors: Vectors In R_n and C_n, Linear Combination of Vectors, Dot (Inner) Product, Angle between Vectors, Projections, Cauchy-Schwarz Inequality, Minkowski's Inequality, Hyperplanes, Lines, Vectors in (Spatial Vectors), Cross Product, Lagrange's Identity.

Matrix Operations: Matrices, Trace, Powers of Matrices, Polynomials in Matrices, Invertible Matrices, Orthogonal Matrices, Normal Matrices, Hermitian Matrices, Unitary Matrices, Block Matrices.

Systems of Linear Equations: Homogeneous and Non- Homogeneous System of Linear Equations and its Solutions, Equivalent Systems, Elementary Operations, Gaussian Elimination, Echelon and Reduced Echelon Forms, Row Equivalence, Elementary Matrices, Lu Decomposition.

Determinants: Determinants, Properties of Determinants, Minors and Cofactors, Classical Adjoint, Cramer's Rule, Principal Minors, Block Matrices and Determinants, Evaluation of Determinants and Inverses Using Row Operations

Vector Spaces: Introduction to Vector Spaces, Linear Combinations, Spanning Sets, Subspaces, Linear Dependence and Independence, Basis and Dimension, Rank of Matrices, Direct Sums, Coordinate Vectors.

Eigenvalues and Eigenvectors: Characteristic Polynomial, Cayley-Hamilton Theorem, Eigenvalues and Eigenvectors, Diagonalizable Matrices, Diagonalization, Symmetric Matrices, Minimal Polynomial.

Linear Transformations: Introduction to Linear Transformations, Kernel, and Image of a Linear Transformations, Rank and Nullity Theorem, Singular and Nonsingular Linear Mappings, Isomorphisms, Matrix Representations of a Linear Transformation, Change of Basis, Similar Matrices

Inner Product Spaces: Definition, Orthonormal Bases, The Concept of Length, Angle, and Distance. Some Inequalities Related to Inner Product Spaces, Gram Schmidt's Process of Normalization.

Recommended Books

1. *Lipschutz, S. and Lipson, M. (2009). Linear Algebra. New York, McGraw-Hill*
2. *Kolman, B. (2007). Elementary Linear Algebra with Applications. Toronto, Pearson.*
3. *Anton, H. (2005). Elementary Linear Algebra. John Wiley & Sons*
4. *Lay D.C. (2012) Linear Algebra and its Applications, 4th Edition*

Course Name: ***Introduction to Statistics***
Course Code: STAT2115
Credit Hours: 3 (3+0)
Course Objectives:

- To Develop Understanding for the Basic Concepts of Statistics.
- To Prepare the Students for the Advanced Courses in the Field of Statistics Like Statistical Inference, Sampling, Hypothesis Testing etc.
- At the End of Course, Students Should Have Capability of Critical Thinking about the Data and which Techniques Could be used for Analysis.

Course Content:

Scope of Statistics, Introduction to Basic Concepts of Statistics Like Descriptive and Inferential Statistics, Population, Sample, Parameter, Statistic, Types of Data and the Scales of Measurement, Frequency Distribution and Graphical Representation of Data (Bar Chart, Pie Chart, Histogram, Frequency Polygon and Frequency Curve, Cumulative Frequency Polygon), Measures of Central Tendency, Quantiles, Absolute and Relative Measures of Dispersion, Moments, Skewness and Kurtosis, Basic Concepts of Probability, Counting Rules (Multiplication Principle, Permutation and Combination), Probability Spaces, Laws of Probability, Conditional Probability, Bayes' Theorem, Discrete and Continuous Random Variables, Probability Distributions of Random Variables (Binomial Distribution, Poisson Distribution, Hypergeometric Distribution, Uniform Distribution, Exponential Distribution, Normal Distribution Etc.), Overview of Sampling Like Sample Design, Sampling Frame, Sampling and Non-Sampling Errors, Sampling Distributions for Mean, Proportion, Difference of Means and Difference of Proportions, Overview of Hypothesis Testing and Regression Analysis.

Recommended Books:

1. Bluman, A. G. *Elementary Statistics: A Step-by-Step Approach,* McGraw-Hill, 2012.

2. Mood, A. M., Graybill, F. A. & Boes, D.C. *Introduction to The Theory of Statistics*, McGraw-Hill, New York (1997).

Course Name: ***Applications of Information and Communication Technologies***
Course Code: COMP1116
Credit Hours: 3 (2+1)

Description:

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 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:

By the end of this course, students will be able to:

1. Explain the fundamental concepts, components, and scope of Information and Communication Technologies (ICT)
2. Identify uses of various ICT platforms and tools for different purposes.
3. Apply ICT platforms and tools for different purposes to address basic needs in different domains of daily, academics, and professional life.
4. Understand the ethical and legal considerations to use of ICT platforms and tools.

Syllabus

1. Introduction to Information and Communication Technologies
- Components of Information and Communication Technologies (basis of hardware, software, ICT platforms, networks, local, and cloud data storage etc.)
- Scope of Information and Communication Technologies (use of ICT in education, business, governance, health care, digital media and entertainment, etc.)
- Emerging technologies and future trends.

2. Basic ICT Productivity Tools:
- Effective use of popular search engines (e.g., Google, Bing, etc.) to explore World Wide Web.
- Formal Communication Tools and etiquettes (Gmail, Microsoft Outlook, etc.).
- Microsoft Office Suites (word, Excel, PowerPoint).
- 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 Office 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 (Linkedln, Facebook, Instagram, etc.).

3. ICT in Education :
- Working with learning management systems (Moodle, Canvas, Google Classrooms, etc.).
- Sources of online education courses (Coursera, edX, Udemy, Khan Acadmey, etc.).

- Interactive multimedia and virtual classrooms.

4. 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, Marham, etc.)

5. ICT in Personal Finance and Shopping:

- Online banking and financial management tools (.lazzCash, Easypaisa, Zong PayMax, 1LINK and MNET, keenu Wallet, etc.).
- E-commerce platforms (Darazpk, Telemart, Shophive, etc.).

6. Digital Citizenship and Online Etiquette:

- Digital identity and online reputation.
- Netiquette and respectful online communication.
- Cyberbullying and online harassment.

7. Ethical Considerations in Use of ICT Platforms and Tools:

- 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 shared through ICT platforms is free from misinformation, fake news, and manipulation).

Practical Requirements

As part of the overall learning requirements, the course will include:

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), and spreadsheet software (cg, 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 Materials

- "Discovering Computers" by Vermaat, Shaffer, and Freund.
- "GO! with Microsoft Office" Series by Gaskin, Vargas, and McLellan.
- "Exploring Microsoft Office" Series by Grauer and Poatsy.
- "Computing Essentials" by Morley and Parker.
- "Technology in Action" by Evans, Martin. and Poatsy

Course Title: ***Functional English***
Course Code: ENGL1114
Credit Hours: 3 (3+0)
Prerequisite(s): None

Course Description:

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.

Learning outcomes:

By the end of this course, students will be able to:

1. Apply enhanced English communication skills through effective use of word choices, grammar and sentence structure.
2. Comprehend a variety of literary/non-literary written and spoken texts in English.
3. Effectively express information, ideas and opinions in written and spoken English.

Syllabus:

1. 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
2. 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.)
3. Effective Communication:
   - Principles of communication (clarity, coherence, conciseness, courteousness, correctness, etc.)
   - Structuring documents (introduction, body, conclusion and formatting)

- Inclusivity in communication (gender-neutral language, stereotypes, cross-cultural communication, etc.)
- Public speaking (overcoming stage fright, voice modulation and body language)
- Presentation skills (organization content, visual aids and engaging the audience)
- Informal communication (small talk, networking and conversational skills)
- Professional writing (business e-mails, memos, reports, formal letters, etc.)

PRACTICAL REQUIREMENT

As part of the overall learning requirements, students will also be exposed to relevant simulations, role-plays and real-life scenarios and will be required to apply skills acquired throughout the course in the form of a final project.

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. "Understanding and Using English Grammar" by Betty Schrampfer Azar.
2. "English Grammar in Use" by Raymond Murphy.
3. "The Blue Book of Grammar and Punctuation" by Jane Straus.
4. "English for Specific Purposes: A Learning-Centered Approach" by Tom Hutchinson and Alan Waters.
5. "Cambridge English for Job-hunting" by Colm Downes.
6. "Practical English Usage" by Michael Swan.
7. "Reading Literature and Writing Argument" by Missy James and Alan P. Merickel.
8. "Improving Reading: Strategies, Resources, and Common Core Connections" by Jerry Johns and Susan Lenski.
9. "Comprehension: A Paradigm for Cognition" by Walter Kintsch.
10. "Communication Skills for Business Professionals" by J.P. Verma and Meenakshi Raman.

Course Name: Ideology and Constitution of Pakistan
Course Code: PAKS1119
Credit Hours: 2 (2+0)
Pre-requisites: None

Specific Objectives of course: 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 oi Pakistani citizens to enable them function in a socially responsible manner.

Course Outline:

Introduction to the Ideology of Pakistan:

- Definition and significance of ideology.
- Historical context 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 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).
- Role of communalism and religious differences.

Introduction to the Constitution of Pakistan:

- Definition and importance of a constitution.
- Ideological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949).
- Overview of constitutional developments in Pakistan.

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 Rights, 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 Pakistani citizens (Article 5).

Constitutional Amendments:

- Procedures for amending the Constitution.

- Notable constitutional amendments and their implications.

Recommended Readings:

- Akbar S. Ahmed. Jinnah. Pakistan and Islamic Identity: The Search for Saladin
- Burki, Shahid Javed. (1980). State & Society in Pakistan. Macmillan Press Ltd.
- Chawla, M. Iqbal. (2011). Wavell and the dying days of the Raj: Britain's penultimate viceroy in India. OUP.
- G. W. Choudhury. (n.d.). Constitutional development in Pakistan, new edition, Peace Publication.
- G.W. Choudhury. Constitution-Making in Pakistan: The Dynamics of Political Order
- Hamid Khan. Constitutional and Political Development of Pakistan" by
- Ian Talbot. Pakistan: A New History
- Javed Iqbal. Ideology of Pakistan
- K.K. Aziz.The Making of Pakistan: A Study in Nationalism
- Khalid Bin Sayeed. Pakistan the Formative Phase
- Khan, H. (2001). Constitutional and political history of Pakistan. OUP.
- l.H. Qureshi. The Struggle for Pakistan
- Lawrence Ziring. Pakistan in the Twentieth Century: A Political History
- M.R Kazimi. (2023). Pakistan Studies. Karachi, OUP.
- Mahboob Hussain. The Parliament of Pakistan"
- Safdar Mahmood. Pakistan: Political Roots and Development
- Sharif-ul-Mujahid. Ideology of Pakistan
- Stephen P. Cohen. The Idea of Pakistan
- The Constitution of Pakistan 1973. Original.
- Zahid, Ansar. (1980). History & Culture of Sindh. Karachi: Royal Book Compan

Course Name: ***Discrete Mathematics***
Course Code: MATH2113
Credit Hours: 3 (3+0)
Pre-requisites: Pre-Calculus I and Pre-Calculus II (For pre-medical students)

Course Objectives:

This course will help the students translate verbal statements into symbolic ones by using the elements of mathematical logics. Further, this course will also help develop better reasoning power, problem-solving skills and logical thinking.

Course Content:
Mathematical Reasoning: Sets, Subsets, Algebra of Sets, Propositions and Compound Statements, Basic Logical Operations, Propositional Logic and its Applications with Statement Problems (Including Propositions and Truth Tables, Tautologies and Contradictions, Conditional and Bi-conditional Statements, Arguments, Propositional Functions, Quantifiers, Negation of Quantified Statements Etc.), Relations, Equivalence Relations, Partial Ordering Relations, Functions, Recursively Defined Functions,
Combinatorics: Basics of Counting Methods, Combinations, Permutations, Pigeonhole Principal, Graphs and its Types, Graphs Isomorphism, Trees, Connectivity, Eulerian and Hamiltonian Paths, Spanning Trees and Shortest Path Problem, Revisiting the Graphs of Power Function, Floor Function, Increasing Function and Decreasing Function, Big O, Little O and Omega Notations, Orders of the Polynomial Functions
Recommended Books:
1. Rosen, K.H., 1999. Discrete Mathematics & Applications. McGraw-Hill.
2. Susanna, S.E., 2018. Discrete Mathematics with Applications.
3. Lipschutz, S., 2016. Schaum's Outlines of Theory and Problems of Discrete Mathematics

Course Name: ***Calculus and Analytic Geometry***
Course Code: MATH1129
Credit Hours: 3 (3+0)
Pre-requisites: Pre-Calculus I and Pre-Calculus II (For pre-medical students)

Course Introduction:

To provide foundation and basic ground for calculus and analytical geometry background.

Course Outline:

Limits and Continuity; Introduction to functions, Introduction to limits, Techniques of funding limits, Indeterminate forms of limits, Continuous and discontinuous functions and their applications, Differential calculus; Concept and idea of differentiation, Geometrical and Physical meaning of derivatives, Rules of differentiation, Techniques of differentiation, Rates of change, Tangents and Normals lines, Chain rule, implicit differentiation, linear approximation, Applications of differentiation; Extreme value functions, Mean value theorems, Maxima and Minima of a function for single-variable, Concavity, Integral calculus; Concept and idea of Integration, Indefinite Integrals, Techniques of integration, Riemann sums and Definite Integrals, Applications of definite integrals, Improper integral, Applications of Integration; Area under the curve, Analytical Geometry; Straight lines in R3, Equations for planes.

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

1. Calculus and Analytic Geometry by Kenneth W. Thomas.

2. Calculus by Stewart, James.

3. Calculus by Earl William Swokowski; Michael Olinick; Dennis Pence; Jeffery A. Cole

Course Name: ***Islamic Studies***
Course Code: ISLA1111
Credit Hours: 2 (2+0)
Pre-requisites: None

Introduction/Compulsory Foundation Course

This course is designed to provide students with a comprehensive overview of the fundamental aspects of Islam, its beliefs, practices, history and influence on society. It will further familiarize the students with a solid foundation in understanding Islam from an academic and cultural perspective. Through this course, students will have an enhanced understanding of Islam's multifaceted dimensions which will enable them to navigate complex discussions about Islam's historical and contemporary role, fostering empathy, respect, and informed dialogue.

Course Learning Outcomes

By the end of this course, students will be able to:

1. Demonstrate enhanced knowledge of Islamic foundational beliefs, practices, historical development, spiritual values and ethical principles.
2. Describe basic sources of Islamic law and their application in daily life.
3. Identify and discuss contemporary issues being faced by the Muslim world including social challenges, gender roles and interfaith interactions.

Syllabus

1. Introduction to Islam:
    - Definition of Islam and its core beliefs.
    - The Holy Quran (introduction, revelation and compilation).
    - Hadith and Sunnah (compilation, classification, and significance).
    - Key theological concepts and themes (Tawhid, Prophethood, Akhirah etc.).
2. Sirah of the Holy Prophet (Peace Be Upon Him) as Uswa-i-Hasana:
    - Life and legacy of the Holy Prophet PBUH.
    - Diverse roles of the Holy Prophet PBUH (as an individual, educator, peace maker, leader etc.).
3. Islamic History and Civilization:
    - World before Islam.
    - The Rashidun Caliphate and expansion of Islamic rule.

- Contribution of Muslim scientists and philosophers in shaping world civilization.

4. Islamic Jurisprudence (Fiqh):

- Fundamental sources of Islamic jurisprudence.
- Pillars of Islam and their significance.
- Major schools of Islamic jurisprudence.
- Significance and principles of Ijtihad.

5. Family and Society in Islam:

- Status and rights of women in Islamic teachings.
- Marriage, family, and gender roles in Muslim society.
- Family structure and values in Muslim society.

6. Islam and the Modern World:

- Relevance of Islam in the modern world (globalization, challenges and prospects).
- Islamophobia, interfaith dialogue, and multiculturalism.
- Islamic viewpoint towards socio-cultural and technological changes.

Suggested Instructional/Reading Materials

- *"The Five Pillars of Islam: A Journey Through the Divine Acts of Worship" by Muhammad*
- *Mustafa Al-Azami.*
- *"The Five Pillars of Islam: A Framework for Islamic Values and Character Building" by*
- *Musharraf Hussain.*
- *"Towards Understanding Islam" by Abul A' la Mawdudi.*
- *"Islami Nazria e Hayat" by Khurshid Ahmad.*
- *"An Introduction to Islamic Theology" by John Renard.*
- *"Islamic Civilization Foundations Belief & Principles" by Abul A' la Mawdudi.*
- *"Women and Social Justice: An Islamic Paradigm" by Dr. Anis Ahmad.*
- *"Islam: Its Meaning and Message" by Khurshid Ahmad.*

Note: This course is compulsory for Muslim and optional for non-Muslim undergraduate students. Non-Muslim students can opt for any course of at least the same or more credits in subjects such as religious studies, ethics, theology, comparative religion, Christian ethics, etc

Course Name: ***Ethics***
Course Code: HUMN1111
Credit Hours: 2 (2+0)
Pre-requisites: None

Course Objectives:

- This course will serve as an introduction to religious ethics in general and to personal ethics in particular.
- You will consider the positions of historical thinkers as well as contemporary philosophers.
- You will gain understanding of specific topics in character building.

Topics

1. What is Ethics?
2. Religious Ethics: A Comparative Study
3. Ethical Values
   i. Hinduism
   ii. Budhism
   iii. Zoroasterianism
   iv. Judaism
   v. Christianity and Islam
4. Ethics: Philosophical Perspective
   i. Ram ChanderJi
   ii. Mahatma Gandhi
   iii. Siddharta
   iv. Amanual Kant
   v. Saint Paul
   vi. Flourence Nightingale
   vii. Aurbindu Ghoos
   viii. Imam Ghazali
5. Mannerism
   i. Good Manners
   ii. Bad Manners
6. Ethics: Social Perspective
   i. Role of Family
   ii. Role of Community
   iii. Role of EducationalInstitutions
7. Defense Mechanism

i. Conscience

a. Sin

b. Self-Ego

ii. Law

a. Crime

iii. Character Building

8. Prejudice

9. Regionalism

10. Provincialism

Recommended Books:

- *Ethical Theory: An Anthology 5th ed. Russ Shafer -Landau. Wiley-Blackwell.2013*
- *The Fundamentals of Ethics 2nd ed. Russ Shafer-Landau. Oxford University Press. 2011.*

Note: In addition to the above, any other text or book referred by Instructor can also be included

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Course Name: ***Introduction to Entrepreneurship***
Course Code: BUSA1114
Credit Hours: 2 (2+0)
Pre-requisites: None

Description

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 to seize the identified opportunities for initiating ventures and successfully navigating the challenges that come with starting a business and managing it. The course covers topics relevant to entrepreneurship including setting up and initiation 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 I 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

By the end of this course, students shall have:

1. Knowledge of fundamental entrepreneurial concepts, skills and process:
2. Understanding of different personal, social and financial aspects associated with entrepreneurial activities;
3. Basic understanding of regulatory requirements to set up an enterprise in Pakistan, with special emphasis on exports;
4. Ability to apply knowledge, skills and abilities acquired in the course to develop a feasible

Course Content:

1) Introduction to Entrepreneurship:

- **a)** Definition and concept of entrepreneurship:
- **b)** Why to become an entrepreneur?
- **c)** Entrepreneurial process;
- **d)** Role of entrepreneurship in economic development.

2) Entrepreneurial Skills:

- **a)** Characteristics and qualities of successful entrepreneurs (including stories of successes and failures).
- **b)** Areas of essential entrepreneurial skills and abilities such as creative and critical thinking innovation and risk taking.

3) Opportunity Recognition and Idea Generation:

- **a)** Opportunity identification, evaluation and exploitation:
- **b)** Innovative ideas generation techniques for entrepreneurial ventures.

4) Marketing and Sales

- **a)** Target market identification and segmentation;
- **b)** Four P's of Marketing;
- **c)** Developing a marketing strategy;
- **d)** Branding.

5) Financial Literacy:

- **a)** Basic concepts of income, savings and investments;
- **b)** Basic concepts of assets, liabilities and equity;
- **c)** Basic concepts of revenue and expenses:
- **d)** Overview of cash-flows;
- **e)** Overview of banking products including Islamic modes of financing:
- **f)** Sources of funding for startups (angel financing, debt financing, equity financing etc.)

6) Team Building for Startups:

- **a)** Characteristics and features of effective teams
- **b)** Team building and effective leadership for startups.

7) Regulatory Requirements to Establish Enterprises in Pakistan:

- **a)** Types of enterprises (e.g., sole proprietorship; partnership; private limited companies etc.):
- **b)** Intellectual property rights and protection;
- **c)** Regulatory requirements to register an enterprise in Pakistan, with special emphasis on export firms:
- **d)** Taxation and financial reporting obligation.

Practical Requirements:

As part of the overall learning requirements, students shall be tasked with creating and presenting a comprehensive business plan at the end of the course for a hypothetical or real business idea. This practical exercise shall allow them to apply the knowledge, skills and abilities acquired in the course to develop a feasible business plan and where possible explore the possibility of implementing the plan with support and assistance from established business-persons and entrepreneurs.

Suggested Instructional/Reading Material:

- *"Entrepreneurship: Successfully Launching New Ventures" by Bruce R. Barringer and R. Duane Ireland.*
- *"Entrepreneurship: Theory, Process, and Practice" by Donald F. Kuratko.*
- *"New Venture Creation: Entrepreneurship for the 21st Century" by Jeffry A. Timmons, Stephen Spinelli Jr., and Rob Adams.*
- *"Entrepreneurship: A Real-World Approach" by Rhonda Abrams.*
- *"The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries.*
- *"Effectual Entrepreneurship" by Stuart Read, Saras Sarasvathy, Nick Dew, Robert Wiltbank, and Anne-Valérie Ohlsson*

Course Name: ***Expository Writing***
Course Code: ENGL1120
Credit Hours: 3 (3+0)
Pre-requisites: None

Course Description:

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.

Learning outcomes:

By the end of this course, students will be able to:

1. Understand the essentials of the writing process integrating pre-writing, drafting, editing and proof reading to produce well-structured essays.
2. Demonstrate mastery of diverse expository types to address different purposes and audiences.
3. Uphold ethical practices to maintain originality in expository writing.

Syllabus:

1. 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
2. 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)
3. 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)
4. Essay Organization and Structure:
   - Description
   - Illustration
   - Classification
   - Cause and effect (exploring causal relationships and outcomes)

- Process analysis (explaining step-by-step procedures)
- Comparative analysis (analyzing similarities and differences)

5. 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

6. 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 APPLICATIONS AND CAPSTONE PROJECT

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 MATERIALS

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

Course Name: ***Fundamentals of Accounting***
Course Code: *BUSA1113*
Credit Hours: 3 (3+0)
Pre-requisites: None

Learning Outcomes:

After studying this course, the students will be able to:

- Uunderstand the significance, objectives, scope and use of accounting information
- Explore conceptual issues related to accounting and ethics,
- Comprehend the basic accounting concepts and conventions and qualitative aspect of financial report
- Develop an understanding of what the basic financial reports communicate to its readers and how they are prepared in business

Course Outline:

Introduction to Accounting and Business:
Nature of Business and Accounting, Types of Businesses, Types of Business Organization, Users of Accounting Information, Role of Ethics in Business, Role of Accounting in Business, Profession of Accounting

Fundamental Accounting Concepts, Principles and Policies:
The Business Entity Concept, The Reliability (or Objectivity) principle, Historical Cost Convention, Substance Over Form, The Fair Value Principle, The Going Concern Assumptions, The Realization Principle, The Matching Principle, Money Measurement (Stable Dollar Assumption), Materiality

Financial Statements:
Business Transactions and The Accounting Equation, Effects of Business Transactions on Accounting Elements, Set of Financial Statements, Definition of Income Statement, Components of Income Statement : Revenues, Expenses, Gains and Losses, Accounting for Revenues and Expenses, Statement of Owner‘s Equity,Definition of Balance Sheet, Components of Balance Sheet: Assets, Liabilities, Equity, Statement of Cash Flows, Operating, Investing and Financing Activities, Direct Method, Interrelationships Among Financial Statements

The Recording Process:
Accrual Basis and Cash Basis of Accounting, Chart of Accounts, Phases in Accounting Cycle, Account and its Recording Process, Types of Accounts – Permanent and Temporary, Double Entry Book Keeping System, Rules of Debit and Credit, Introduction to General Journal and Special Journals, T-Ledger, Posting Journal Entries to Accounts, Analyzing and Summarizing Transactions in Accounts, Normal Balances of Accounts, Need and Objective of Trial Balance, Preparing Trial Balance

The Adjusting Process:
Types of Adjusting Entries, Recording Adjusting Entries – Deferrals, Recording Adjusting Entries – Accruals, Depreciation Expense, Summary of Adjustment Process, Nature, Purpose and Preparation of Adjusted Trial Balance Completing the Accounting Cycle: Flow of Accounting Information, Journalizing and Posting, Closing Entries, PostClosing Trial Balance,

Adequate Disclosure and Types of Information to be Disclosed, Income Statement, Statement of Owner‘s Equity, Balance Sheet, Illustrations and Questions

Accounting for Merchandising Operations:

Service Companies and Merchandising Companies, Operating Cycle of Merchandising Companies, Income Statement of Merchandising Companies, Perpetual Inventory System, Periodic Inventory System, Merchandising Transactions, Transactions related to Sales and Purchase, Evaluating the Performance of Merchandising Companies

Reference Materials:

1. Financial & Managerial Accounting, Williams , Haka , Bettner, Prentice Hall
2. Business Accounting, I, Fank Woods
3. Financial Accounting and Reporting, Barry Elliot ,Jame Elliot, Prentice Hall
4. Financial Accounting, A. Mukherjee and M. Hanif

Course Name: ***Civics and Community Engagement***
Course Code: POLS2111
Credit Hours: 2 (2+0)
Pre-requisites: None

Course Description:

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 Objectives:

The overall objectives of this course are to:

- Teach students about the significance and role of active citizenship for the promotion of a harmonious and developed society
- Educate students about the importance of skills and aptitude of community linkages in developing a sustainable society
- Highlight the importance of community involvement for a tolerant and productive citizenship and society
- Provide an opening to the students for developing their civic bond with the community

Learning outcome:

1. By the end of this course, students will be able to:
2. Demonstrate fundamental understanding of civics, government, citizenship and civil society.
3. Understand the concept of community and recognize the significance of community engagement for individuals and groups.
4. Recognize the importance of diversity and inclusivity for societal harmony and peaceful co-existence.

Course Contents:

1. 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.

2. Civics and Citizenship
   - Concepts of civics, citizenship, and civic engagement.
   - Foundations of modern society and citizenship.
   - Types of citizenship: active, participatory, digital, etc.

3. 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.

4. 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, peace dialogue, civility, etc.)

5. 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.

6. Advocacy and Activism
   - Public discourse and public opinion
   - Role of advocacy in addressing social issues.
   - Social action movements.

7. 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.

8. 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 PRACTICAL ACTIVITIES (OPTIONAL)

As part of the overall learning requirements, the course may have one or a combination of the following practical activities:

1. Community Storytelling: Students can collect and share stories from community members. This could be done through oral histories, interviews, or multimedia presentations that capture the lived experiences and perspectives of diverse individuals.
2. Community Event Planning: Students can organize a community event or workshop that addresses a specific issue or fosters community interaction. This could be a health fair, environmental cleanup, cultural festival, or educational workshop.
3. Service-Learning: Students can collaborate with a local nonprofit organization or community group. They can actively contribute by volunteering their time and skills to address a particular community need, such as tutoring, mentoring, or supporting vulnerable populations.
4. Cultural Exchange Activities: Students can organize a cultural exchange event that celebrates the diversity within the community. This could include food tastings, performances, and presentations that promote cross-cultural understanding.

SUGGESTED INSTRUCTIONAL / READING MATERIALS

- "Civics Today: Citizenship, Economics, & You" by McGraw-Hill Education
- “Citizenship in Diverse Societies" by Will Kymlicka and Wayne Norman.
- "Engaging Youth in Civic Life" by James Youniss and Peter Levine.
- "Digital Citizenship in Action: Empowering Students to Engage in Online Communities" by Kristen Mattson.
- "Globalization and Citizenship: In the Pursuit of a Cosmopolitan Education" by Graham Pike and David Selby.
- "'Community Engagement: Principles, Strategies, and Practices" by Becky J. Feldpausch and Susan M. Omilian.
- "Creating Social Change: A Blueprint for a Better World" by Matthew Clarke and Marie-Monique Steckel
- “Nationhood and the Nationalities in Pakistan, Economic and Political Weekly by Alavi, H. (1989).
- ‘Imagined Communities: Reflections on the Origin and Spread of Nationalism by Anderson’, B. R. O. (1991)
- ‘The Idea of a Pakistani Nationhood’, Polity by Syed, A. H. (1980)

Course Title: **Pre-Calculus-I**
Course Code: MATH1127
Credit Hours: **3(3+0)**
Prerequisite(s): **None**

Aims and Objectives:

This subject develops the concepts of Mathematics and its applications in daily life. The students are taught different mechanisms as well as issuesat different levels are discussed.

Course Contents:

Introduction of Mathematics

History, Applications of mathematics, Number systems

SETS and Functions

Set, All type of sets, Operations on sets, Complex Numbers and its methods of simplification, Polar form of complex number, Functions and their types, Inverse of function, Graphs, Relevant Problems and their solutions

Matrices and Determinants

Matrix, all types of matrices, Operations on matrices, Determinants of 2 x 2 and 3 x 3 matrix, Solution of simultaneous linear equations by using matrices, Elementary Row and Column operation on a matrix, Echelon and Reduced Echelon forms of Matrices, System of Linear equations, Homogeneous Linear equation, Cramer' s rule, Relevant Problems and their solutions

Quadratic Equations

Introduction, Solution of Quadratic Equations, Polynomial Function, Remainder Theorem and its applications, Relevant Problems and their solutions

Partial Fractions

Rational fraction, Proper rational fraction, Improper rational fraction, Resolution of all types of fraction, Relevant Problems and their solutions

Mathematical Induction and Binomial Theorem

Binomial theorem and its application on different types of functions, Relevant Problems and their solutions

Fundamentals of Trigonometry

Introduction, Units of Measures of Angles, Angles in Standard Position, Trigonometric Functions, Trigonometric Functions of any angle, Fundamental Identities of Geometric Functions, Signs of Trigonometric Functions, The value of Trigonometric Functions of Acute Angles 30^0 , 45^0 and 60^0, The value of Trigonometric Functions of Angles 0^0, 90^0, 180^0, 270^0, 360^0, Proves of Fundamental Identities with different types of functions, Half angle Identities, Sum, Difference and product of Sines and Cosines, Period of Trigonometric Functions, Relevant Problems and their solutions

Recommended Textbook:

Thomas Calculus 12th Edition

Reference Books and Material:

Complete solution in PDF form

Course Title: **Pre-Calculus-II**
Course Code: MATH1128
Credit Hours: **3(3+0)**
Prerequisite(s): Pre-Calculus-I

Aims and Objectives:

This subject develops the concepts of Mathematics and its applications in daily life. The students are taught different mechanisms as well as issues at different levels are discussed.\

Course Contents:

Introduction of Mathematics
History, Applications of mathematics

Functions, Limits and Continuity

Definition of Functions, Graph of Algebraic Functions, Polynomial Functions, Linear Function, Identity Function, Constant Function, Rational Function, Explicit Function, Implicit Function, Exponential Function, Logarithmic Function, Trigonometric Functions, Inverse Trigonometric Functions, Parametric form of Function, Even Function, Odd Function, Composition of Functions, Definition of Limit, Limit Theorems, Application of Limit on Algebraic and Geometric Function, Continuity of a Function, Relevant Problems and their solutions

Differentiation

Independent and Dependent variables, Average rate of change, Derivative and slop, By Definition Derivative, Rules of Derivation, Derivation of Algebraic and Geometric Functions, Taylor' Theorem, Relevant Problems and theirsolutions

Integration

Introduction of Integration, Formulas of Integration, Simple problems related with Integration, Relevant Problems and their solutions

Integration

Integration by parts, Integration by substitution method, Integration involving limit, Area of region bounded by the curve, Relevant Problems and their solutions

Introduction to Analytical Geometry

Quadrants, The Distance Formula, Slop of straight line, Equation of a straight Line, Intercepts form, Translation and Rotation of axes, Relevant Problems and their solutions

Conic Section

Introduction, General form of an Equation of a Circle, Center, Radius and Diameter of a Circle, Relevant Problems and their solutions, The Equation ofa Circle when end points of its diameter are given, Relevant Problems and their solutions

Recommended Textbook:
Howard Anton 10th Edition

Course Name: ***Applied Physics***
Course Code: PHYS1124
Credit Hours: 3 (2+1)
Pre-requisites: None

Objectives:

The main objectives of this course is to provide knowledge of wide variety of electric and magnetic phenomena, their relevant mathematics, atomic level phenomena and their applications.

Course Outlines:

Electrostatics and Magnetism: Coulombs Law, Electrostatic potential energy of discrete charges, Continuous charge distribution, Gauss's Law, Electric field around conductors, Dielectric Magnetic fields, Magnetic force on current, Hall effect, Biot- Savart Law, Ampere's Law, Fields of rings and coils, Magnetic dipole, Diamagnetism, Para magnetism and Ferromagnetism.
Waves and Oscillations: Reflection and Refraction of light waves, Total internal reflection, Double slit interference, Interference from thin films, Diffraction, Polarization of electromagnetic waves.
Semi-Conductors: Semi-Conductors Energy levels in a semi-conductor, Hole concept, Intrinsic and Extrinsic regions, PNP, NPN junction Transistor, LEDs Modern Physics, Inadequacy of classical physics, Plank's explanations of black body radiation.
Modern physics: Photo electric effect, Compton effect, Bohr's theory of Hydrogen atom. Nuclear stability and radioactivity.
Nuclear Physics: Alpha decay, Beta decay, Gamma decay attenuation, Fission, Energy release, Nuclear Fusion
List of Experiments: (At least 3 experiments should be performed), Measuring moments of inertia of different bodies; disc, hollow and solid cylinders. The Harmonic Oscillation of Helical springs-parallel and series connection of spring Value of g using a compound pendulum or simple pendulum. Verification of Ohm's law. Determine the speed of sound using Sonometer/Air column. Determine the refractive index with help of prism/glass plate

Recommended books:

- Fundamentals of Physics (Extended), 10th edition, Resnick and Walker
- Narciso Garcia, Arthur Damask, Steven Schwarz, ―Physics for Computer Science students‖, Springer Verlag, 199
- Instructor of respective course may add two books.

Course Name: ***Professional Practices***
Course Code: ITEC4112
Credit Hours: 2 (2+0)
Pre-requisites: None

Course Introduction:

A Computing graduate as professional has some responsibilities with respect to the society. This course develops student understanding about historical, social, economic, ethical, and professional issues related to the discipline of Computing. It identifies key sources for information and opinion about professionalism and ethics. Students analyze, evaluate, and assess ethical and professional computing case studies.

Course Outline:

Historical, social, and economic context of Computing (software engineering, Computer Science, Information Technology); Definitions of Computing (software engineering, Computer Science, Information Technology) subject areas and professional activities; professional societies; professional ethics; professional competency and life-long learning; uses, misuses, and risks of software; information security and privacy; business practices and the economics of software; intellectual property and software law (cyber law); social responsibilities, software related contracts, Software house organization. Intellectual Property Rights, The Framework of Employee Relations Law and Changing Management Practices, Human Resource Management and IT, Health and Safety at Work, Software Liability, Liability and Practice, Computer Misuse and the Criminal Law, Regulation and Control of Personal Information. Overview of the British Computer Society Code of Conduct, IEEE Code of Ethics, ACM Code of Ethics and Professional Conduct, ACM/IEEE Software Engineering Code of Ethics and Professional Practice. Accountability and Auditing, Social Application of Ethics.

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

1. Professional Issues in Software Engineering by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, CRC Press; 3rd Edition (2000). ISBN-10: 0748409513
2. Computer Ethics by Deborah G. Johnson, Pearson; 4th Edition (January 3, 2009). ISBN-10: 0131112414
3. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet (3rd
4. Edition) by Sara Baase, Prentice Hall; 3rd Edition (2008). ISBN-10: 0136008488
5. Applied Professional Ethics by Gregory R. Beabout, University Press of America (1993). ISBN-10: 0819193747.

Course Name:	**Foundations of Management**
Course Code:	BUSA2118
Credit Hours:	2(2+0)
Prerequisite(s):	None

Specific Objectives of course:

This 2-credit hour course is designed to provide non-business students with a comprehensive introduction to management principles, with a focus on understanding organizations and businesses. The course will cover various aspects of management, including the roles and functions of managers, the historical development of management theories, the concept of the environment in which organizations operate, decision-making processes, and the core functions of planning, organizing, leading, and controlling. Additionally, students will be introduced to different types of businesses and their key characteristics.

Learning Outcomes:

By the end of this course, students will be able to:

1. Define the concept of management and explain the significance of managers in organizations.
2. Describe the managerial functions of planning, organizing, leading, and controlling and their role in achieving organizational objectives.
3. Understand the different roles and skills required of managers and how they contribute to effective leadership.
4. Trace the historical development of management theories and identify their impact on modern management practices.
5. Analyze the influence of the external environment on managerial decision-making and organizational performance.

Detailed outline

Introduction to Management

- Definition and significance of management
- Overview of key management functions and roles

Short History of Management

- Classical management approaches (scientific management and administrative management)
- Contemporary management theories (systems theory, contingency theory)

Managerial Functions - Planning
- Importance of planning in management
- Types of plans: strategic, tactical, and operational
- Decision making: rational vs intuitive
- Goal-setting and decision-making in the planning process

Managerial Functions - Organizing
- Principles of organizational structure
- Delegation of authority and responsibility
- Departmentalization and coordination within organizations

Organizational Structure and Design
- Types of organizational structures
- Factors influencing organizational design
- Mechanistic vs. organic structures

Managerial Functions – Leading
- Theories of leadership and leadership styles
- Motivation and employee engagement
- Communication and effective leadership

Managerial Functions – Controlling
- The control process and its significance
- Types of control measures and their application
- Addressing deviations and corrective actions

Introduction to Organizations and Types of Businesses
- Overview of organizations and their characteristics
- Types of businesses: Sole proprietorship, partnership, corporation, and more
- Advantages and disadvantages of different business types

Understanding the Organizational Environment
- Internal and external environmental factors
- Environmental analysis and adaptation
- Strategic planning in a dynamic environment

Recommended Books:

1. Management by Courtland L. Bovee
2. Management by Stephen P. Robbins and Mary Coulter

Note: In addition to the above, any other text or book referred by Instructor can also be included.

Course Name: ***HCI & Computer Graphics***
Course Code: COMP3145
Credit Hours: 3 (2+1)
Pre-requisites: None

Course Introduction:
This course introduces the fundamental concepts of human computer interaction and computer graphics. It describes the implications of human understanding on the usability of computer systems and the importance of understanding the context of use. This course will also develop design and problem solving skills with applications to computer graphics.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Describe the concepts of human understanding on the usability of computer systems and the importance of understanding the context of use.	C2 (Describe)
CLO-2	Explain the basic principles of implementing computer graphics fundamentals	C2 (Explain)
CLO-3	Analyze and identify usability issues in User interfaces according to the standards.	C4 (Analysis)
CLO-4	Develop the design and problem solving skills with applications to computer graphics	C3(Develop)
CLO-5	Construct interactive computer graphics programs	C3 (Apply)

Course Outline:
The Human: Input-output channels, Human memory, Thinking, Reasoning, Problem solving, Emotions, Individual differences, Psychology and design of interacting systems. **The Computer:** Introduction, Text entry devices, Positioning, Pointing, and drawing, Display devices, Devices for virtual reality and 3D interaction, Physical controls, Sensors and special devices, Paper printing and scanning, Memory, Processing and networks. The Interaction: Models of interaction, Frameworks and HCI, Ergonomics, Interaction styles, Elements of the WIMP interfaces, Interactivity, Context of interaction, Experience. Usability Paradigm and Principles: Introduction, Paradigms for interaction. Interaction Design Basics: Introduction, What is design, Process of design, User focus, Navigation design, Screen design and layout, Iteration and prototyping. HCI in Software Process: Introduction, Software life cycle, Usability engineering, Iterative design and prototyping, Design rationale. Design rules, Prototyping, Evaluation techniques, Task analysis, Universal design and User support and Computer Supported Cooperative Work: Guidelines, Golden rules and heuristics, HCI patterns, Choosing an evaluation method, Requirements of user support, Applications, Design user support systems. Introduction to Groupware, Pervasive and Ubiquitous Applications: Introduction, Groupware systems, Implementation of synchronous groupware, Ubiquitous computing. History of **Computer Graphics**, Graphics architectures and software, Imaging, Pinhole camera, Human vision, Synthetic camera, Modeling vs. rendering. OpenGL: Architecture, Displaying simple two-dimensional geometric objects, Positioning systems, Working in a windowed environment. Color: Color perception, color models (RGB, CMY, HLS), color transformations. Color in OpenGL. RGB and indexed color. Input: Working in a network environment, client-server computing; input measure, event, sample and request input, using callbacks, picking. Geometric

transformations: Affine transformations (translation, rotation, scaling, shear), homogeneous coordinates, concatenation, current transformation and matrix stacks. Three Dimensional Graphics: Classical three dimensional viewing, Specifying views, Affine transformation in 3D, Projective transformations. Ray tracing. Shading: Illumination and surface modeling, Phong shading model, Polygon shading. Rasterization: Line drawing via Bresenham's algorithm, clipping, polygonal fill, BitBlt. Introduction to hidden surface removal (z buffer). Discrete Techniques: Buffers, reading and writing bitmaps and pixel maps, texture mapping, compositing.

Reference Materials:

1. Janet E. Finlay, Leeds Metropolitan. (2000). Human-Computer Interaction, Alan Dix, Computing Dept, Lancaster University, Birmingham Publisher: PrenticeHall.
2. Ben Shneiderman, University of Maryland Catherine Plaisant. (2010). Designing the User Interface: Strategies for Effective Human-Computer Interaction, 4/E, University Maryland. Publisher: Addison-Wesley.
3. Computer Graphics with Open GL (4th Edition) by Donald D. Hearn, Prentice Hall, 2010, ISBN-10: 0136053580.
4. Foundations of 3D Computer Graphics by S. J. Gortler, The MIT press, 2012.
5. Fundamentals of Computer Graphics, 3rd Edition, A K Peters, 2009.
6. Computer Graphics: Principles and Practice, 3rd Edition

Course Name: ***Technical and Business Writing***
Course Code: ITEC4152
Credit Hours: 3 (3+0)
Pre-requisites: None

Course Introduction

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

Course Outline:

Overview of technical reporting, use of library and information gathering, administering questionnaires, reviewing the gathered information; Technical exposition; topical arrangement, exemplification, definition, classification and division, casual analysis, effective exposition, technical narration, description and argumentation, persuasive strategy, Organizing information and generation solution: brainstorming, organizing material, construction of the formal outline, outlining conventions, electronic communication, generation solutions. Polishing style: paragraphs, listening sentence structure, clarity, length and order, pomposity, empty words, pompous vocabulary, document design: document structure, preamble, summaries, abstracts, table of contents, footnotes, glossaries, cross referencing, plagiarism, citation and bibliography, glossaries, index, appendices, typesetting systems, creating the professional report; elements, mechanical elements and graphical elements. Reports: Proposals, progress reports, Leaflets, brochures, handbooks, magazines articles, research papers, feasibility reports, project reports, technical research reports, manuals and documentation, thesis. Electronic documents, Linear verses hierarchical structure documents.

Reference Material

1. Technical Report Writing, by Pauley and Riordan, Houghton Mifflin Company, 8th Edition.

2. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill

Course Title: **Internship**
Course Code: INTN6112
Credit Hours: **3(0+3)**
Prerequisite(s): **None**

Internship Policy

Internship Requirement	UE includes an internship, as a mandatory part for BSCS/BSIT/BSCS Post ADP/ BSIT Post ADP programs. Students may need to complete a minimum duration of practical training in relevant field.
Internship Placement	UE has a Student Counseling Center (SCC) that assists students in finding Internship opportunities. The SCC may collaborate with local industries, Companies or organizations for the student's internship placements.
Internship Duration	Minimum duration is 6 weeks.
Academic Credit	Its mandatory for degree with credit hours 3(0+3)
Evaluation & Assessment	Upon completion of internship, students are required to submit internship report and completion certificate that reflects experiences in relevant field.
Eligibility Criteria	As per university policy.
Internship Supervision	Faculty members will be assigned a group of students and he/she will visit Internee students once during internship period and shall take written feedback from Industry regarding skill set of the students and submit a written report to the coordinator regarding his/her visit.

Evaluation Criteria

Evaluation	Contribution
Site Supervisor Evaluations	40%
Students Reports	30%
Faculty Supervisor Evaluation (Student internship report and completion certificate)	25%
Student's activity log completion	05%

Seerat of the Holy Prophet Muhammad (SAW)

Title	Description
Semester	Student can opt this course in any Semester
Nature of Course	Regular
Course Code	ISLA2211
No. of Cr. Hrs.	2 (2+0)
Total Teaching weeks	16 Weeks
Objectives of the Course	۱۔طلباءکومطالعۂ سیرتﷺ کی ضرورت واہمیت سے آگاہ کرنا ۲۔ نبی کریمﷺ کےکردارکوواضح کرنا ۳۔نبوت کےموقع پراقوام عالم کی عمومی صورت حال سے آگاہ کرنا ۴۔طلباءکوعرب وی کی معاشرت،سیاست،مذہب سے آگاہ کرنا

Course Description

S.No.	Title	Description
1	سیرۃالنبی ﷺ کے مصادر: تعارف واہمیت	مطالعہ سیرت کی معاشرتی و سماجی اہمیت ۲۔ مطالعہ سیرت کی معاشی و سیاسی اہمیت ۳۔ مطالعہ سیرت کی عقلی و منطقی اور استدلالی حوالے سے اہمیت ۴۔ مطالعہ سیرت کے شخصیت و کردار پر اثرات
2	پیغمبر اسلام ﷺ کی مکی زندگی کا مطالعہ کیوں کیاجائے؟	مادی اور بنیادی ذرائع ۲۔ ماحول اور حالات ۳۔ اعلان خدائی مشن کے لئے محمد ﷺ کا انتخاب ۴۔ حرب فجار اور حلف الفضول
3	اعلان نبوت کی تاریخ کی تبلیغ واشاعت	۱ہجرت حبشہ۲۔ معاشرتی بائیکاٹ ۳۔ معراج اور معجزات
4	اسلام میں خواتین کا کردار	۱۔ اسلام میں خواتین کا کردار قبل ازہجرت ۲۔ اسلام میں خواتین کا کردار بعد ازہجرت ۳۔ قومی شیرازہ بندی میں عورت کا کردار
5	ہجرت مدینہ اور انصار و مہاجر	۱۔مؤاخات مدینہ کی عصر حاضر میں اہمیت ۲۔ میثاق مدینہ کے تناظر میں مہاجر و انصاری کے سماج

مع اشرتی ئعلقات		
ات زبوی کےسیاسی اوردفاعی اثرات ۲۔ غزوات نبوی کےمعاشی اثرات ۳۔ غزوات زبوی کےسماجی اوردعوئی اثرات	غزوات زبوی کےاثرات	6
۱۔ یہودسےئعلقات ۲۔ مشرکین اورمنافقین سےئعلقات ۳۔قبائل عرب سےئعلقات	صلی اللہ علیہ وسلم کے داخلیسیاسی اقدامات	7
۱۔ غیرملکی سربراہوںسےحضورصلی اللہ علیہ وسلم کی مراسالت ۲۔ غیرملکیوں کےساتھ وفودکاتبادلہ ۳۔ ندحم مکہدعوت اسالمی کافروغ ۴۔حضورصلی اللہ علیہ وسلم کی خارجی سیاست کےاثرات	اللہ علیہ وسلم کےخارجیئعلقات	8
۱۔ غیرمسلم رعایا کا تحفظ اور سیرت طیبہ: ایک مطالعہ ۲۔ اقلیتوں کے حقوق کا سیرتی مطالعہ ۳۔ اسالمی ریاست میں غیر مسلموں کے حقوق و فرائض ۴۔اقلیتوں کےحقوق اور اسالموفوبیا	ت	9
۱۔ عہدنبوی کاعسکری ومعاشی نظام ۲۔ عہدنبوی کاعدلیہ نظام ۳۔ عہدنبوی کاانتظامیہ	عہدنبوی۔ ئعلیمی مطالعہ	01
علم کے لیے ایک اجتماعیت کا قیام ۲۔ خواتین کے لیے تعلیم کا اہتمام ۳۔ نسل نو کے لیے تعلیم کا انتظام ۴۔ تزکیہ و تربیت کا اہتمام	نبی کریم ﷺ کی تعلیمی جدوجہد	00

نصابی کتب

نمبرشمار	نام مؤلف	نام کتاب
0	ابن ہشام	السیرۃالنبویۃ
2	موالناشبلی نعمانی،سیدسلیمان ندوی	سیرۃالنبی صلی اللہ علیہ وسلم
3	قاضی محمدسلیمان منصورپوری	رحمۃاللعالمین
4	موالناسیدابوالحسن علی ندوی	نبی رحمت صلی اللہ علیہ وسلم
5	ڈاکٹرسیدمظہرصدیقی	عہدنبوی کانظام حکومت
6	ڈاکٹرعلی اکبرالدخیل	انسان کامل

حوالہ جاتی کتب

نمبرشمار	نام مؤلف	نام کتاب
1	ڈاکٹر اکرم الضیاءالعمری	السیرۃ النبویۃ الصحیحۃ
2	مولانا عبدالرؤف داناپوری	اصح السیر
3	مولانا صفی الرحمن مبارکپوری	الرحیق المختوم
4	پیر محمد کرم شاہ الازہری	ضیاءالنبی صلی اللہ علیہ وسلم
5	سید ابوالاعلیٰ مودودی	سیرت سرورعالم صلی اللہ علیہ وسلم
6	پروفیسر رب نواز	آنحضور ﷺ کی تعلیمی جدوجہد

12. FYP Deliverable 1 and Deliverable 2 Guidelines

FYP Deliverable 1 and Deliverable 2

Name of Deliverable	Contents	Remarks
Deliverable-I	• **Project Proposal** • **Chapter-1**: Gathering & Analyzing Information • **Chapter-2:** Software Requirement Specification (Sample Attached) • **Chapter-3:** Analysis • **Chapter-4:** Design	Deliverable I should be submitted in the second last week of the 7th/3rd Semester of BS/ BS (Post ADP)/MSC.
Deliverable-II	• **Chapter-5:** Graphical User Interfaces • **Chapter-6:** Testing • **Chapter-7:** Conclusion and Future Work • Complete Running Application	Deliverable II should be submitted in the second last week of 8th/4th Semester of BS/ BS (Post ADP)/M.Sc.

TABLE OF CONTENTS

(Required Chapters of Project Documentation)

TITLE AND DESCRIPTION:

- Inner Title Page
- Statement of Submission
- Declaration
- Plagiarism undertaken
- Acknowledgment
- Abstract

CHAPTER NO. 1: Gathering & Analyzing Information

- Introduction
- Problem Statement
- Goal & Objectives
- Research Questions
- Methodology
    - Available Methodologies
    - Chosen Methodology
    - Reasons for Chosen Methodology
- Definitions, Acronyms, and Abbreviations

CHAPTER NO. 2: Software Requirement Specification

- Stakeholders Characteristics
- Domain Requirements
- Functional Requirements
- Non-Functional Requirements

CHAPTER 3: Analysis [Use Case Description and Use Case Model]

CHAPTER 4: Design [with Description of each diagram]

- Architecture Diagram
- ERD
- Data Flow diagram (Levels 0 and 1)
- Class Diagram
- Sequence Diagram

CHAPTER 5: Graphical User Interfaces

- (Mock-ups of the working software application)

CHAPTER 6: Testing

- Introduction
- Test Scenario (Sample Attached)
- Test Plan
- Definition of Test Cases
  Test Cases Specifications
  Test Cases Results for:
  - Black Box Test Cases
  - White Box Test Cases.

CHAPTER 7: Conclusion and Future Work

References (APA 6 Edition Style)

Appendix

Note: One credit of lab means 3 contact hours, which means students will spend three hours in the lab for each credit earned.

Note: The prerequisites, Pre-Calculus-I and Pre-Calculus-II, for mathematics courses are applicable only to individuals who have not previously studied mathematics in their prior degree.