



فناؤنڈیشن یونیورسٹی اسلام آباد
FOUNDATION UNIVERSITY ISLAMABAD

Catalogue Book

**Bachelor of Science in Software Engineering
(BSSE)**

Based on

HEC Curriculum 2023

Department of Software Engineering

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Bachelors of Sciences in Software Engineering (BSSE)

Software Engineering is the discipline of developing and maintaining software systems that behave reliably and efficiently, and are affordable to develop and maintain. However, more recently it has evolved in response to the increased importance of software in safety-critical applications and to the growing impact of large and expensive software systems in a wide range of situations. The following describes an overview of Software Engineering.

- To provide software development practices requires more than just the underlying principles of computer science; it offers the rigor that the engineering disciplines bring to the reliability and trustworthiness of the artefacts.
- Software Engineering is different in character from other engineering disciplines, due to both the intangible nature of software and to the discontinuous nature of software operation.
- It seeks to integrate the science of Computer Science with the engineering principles developed for tangible and physical phenomena.

1. Areas Covered in BSSE Degree Program

BSSE is a four-year program that comprises of 8 regular semesters and each semester is based on 18 weeks (including 2 x exam weeks). Students are required to complete minimum of 133 credits to complete his/her degree. The division of the subject areas covered under this program are as follows.

Areas	Credit Hours	Courses
Computing Core	46	14
Domain Core	18	6
Domain Elective	21	7
Mathematics & Supporting Courses	12	4
Elective Supporting Courses	3	1
General Education Requirement	30	12
Internship	3	NA
Total	133	44

2. Mapping of BSSE Program on the Generic Structure

#	Sem #	Code	Pre-Reqs	Course Title	Dom	Cr Hr
Computing Core (46/130) 14 Courses						
1	1	CS1xx		Programming Fundamentals	Core	4 (3-3)
2	2	CS1xx	PF	Object Oriented Programming	Core	4 (3-3)
3	2	CS1xx		Database Systems	Core	4 (3-3)
4	2	CS1xx		Digital Logic Design	Core	3 (2-3)
5	3	CS2xx	OOP	Data Structures	Core	4 (3-3)
6	3	CS2xx		Information Security	Core	3 (2-3)
7	3	CS2xx		Artificial Intelligence	Core	3 (2-3)
8	3	CS2xx		Computer Networks	Core	3 (2-3)
9	3	CS2xx		Software Engineering	Core	3 (3-0)
10	4	CS2xx	DLD	Computer Organization & Assembly Language	Core	3 (2-3)
11	5	CS3xx		Operating Systems	Core	3 (2-3)
12	7	CS4xx	DS	Analysis of Algorithms	Core	3 (3-0)
13	7	CS4xx		Final Year Project - I	Core	2 (0-6)
14	8	CS4xx	FYP-I	Final Year Project - II	Core	4 (0-12)
Domain Core (18/130) 6 Courses						
15	4	CS2xx		Software Design & Architecture	Domain Core	3 (3-0)
16	4	CS2xx		Software Construction & Development	Domain Core	3 (2-3)
17	5	CS3xx		Software Project Management	Domain Core	3 (2-3)
18	5	CS3xx		Software Quality Engineering	Domain Core	3 (2-3)
19	6	CS3xx		Software Requirement Engineering	Domain Core	3 (2-3)
20	6	CS3xx		Parallel & Distributed Computing	Domain Core	3 (2-3)
Domain Elective (21/130) 7 Courses						
21	5	CS3xx		Software Verification and Validation (Testing & QA)	Domain Elective	3 (2-3)
22	5	CS3xx		Object Oriented Analysis & Design	Domain Elective	3 (2-3)
23	6	CS3xx		Computer Architecture	Domain Elective	3 (2-3)
24	6	CS3xx		Theory of Automata	Domain Elective	3 (3-0)
25	6	CS3xx		HCI & Computer Graphics	Domain Elective	3 (2-3)
26	6	CS3xx		Web Technologies	Domain Elective	3 (2-3)
27	7	CS4xx		Advanced Database Management	Domain Elective	3 (3-0)
.				Web Engineering	Domain Elective	3 (2-3)
.				Data Science	Domain Elective	3 (2-3)
.				Software Re-Engineering	Domain Elective	3 (2-3)
Mathematics & Supporting Courses (12/130) 4 Courses						
28	2	MT1xx	CAG	Multivariable Calculus	Maths	3 (3-0)
29	2	MT1xx	CAG	Linear Algebra	Maths	3 (3-0)
30	3	MT2xx		Probability & Statistics	Maths	3 (3-0)
31	7	EW4xx	ECC	Technical & Business Writing	EW	3 (3-0)
Elective Supporting Courses (3/130) 1 Course						
32	7	SS1xx		Social Science (Example: Introduction to Marketing)	SS	3 (3-0)
.		SS1xx		Social Science (Example: Financial Accounting)	SS	3 (3-0)
General Education Requirement as per HEC UG Education Policy (30/130) 12 Courses						
33	1	GE1xx		Application of Information & Communication Technologies	GER	3 (2-3)
34	1	GE1xx		Functional English	GER	3 (3-0)
35	2	GE1xx	ECC	Expository Writing	GER	3 (3-0)
36	1	GE1xx		Quantitative Reasoning – 1 (Discrete Structures)	GER	3 (3-0)
37	1	GE1xx		Quantitative Reasoning – 2 (Calculus and Analytic Geometry)	GER	3 (3-0)
38	4	GE2xx		Islamic Studies	GER	2 (2-0)
39	8	GE4xx		Ideology and Constitution of Pakistan	GER	2 (2-0)
40	4	GE2xx		Social Sciences (Example: Introduction to Management)	GER	2 (2-0)
41	4	GE2xx		Natural Sciences (Applied Physics)	GER	3 (2-3)
42	8	GE4xx		Arts & Humanities (Professional Practices)	GER	2 (2-0)
43	8	GE4xx		Civics and Community Engagement	GER	2 (2-0)
44	7	GE4xx		Entrepreneurship	GER	2 (2-0)

3. Proposed Study Plan (Semester-wise breakdown)

SEMESTER-1			
Course Code	Course Title	Credits Hrs	Prerequisite
CSC1011	Programming Fundamentals (PF)	4 (3+1)	None
GER1100	Application of Information & Communication Technologies	3 (2+1)	None
GER1500	Introduction to Management	2 (2+0)	None
GER1303	Discrete Structures	3 (3+0)	None
GER1304	Calculus and Analytic Geometry (CAG)	3 (3+0)	None
GER1200	Functional English	3 (3+0)	None
Total Credit Hours		18 (00+18=18)	

SEMESTER-2			
Course Code	Course Title	Credits Hrs	Prerequisite
CSC1012	Object Oriented Programming (OOP)	4 (3+1)	PF
GER2400	Islamic Studies	2 (2+0)	None
EEN1012	Digital Logic Design	3 (2+1)	None
MTH1002	Multivariable Calculus	3 (3+0)	CAG
STT1001	Probability & Statistics	3 (3+0)	None
GER2700	Professional Practices	2 (2+0)	None
Total Credit Hours		17 (18+17=35)	

SEMESTER-3			
Course Code	Course Title	Credits Hrs	Prerequisite
CSC2034	Data Structures	4 (3+1)	OOP
GER2402	Civics and Community Engagement	2 (2+0)	None
SEN2001	Software Engineering	3 (3+0)	None
MTH2022	Linear Algebra	3 (3+0)	CAG
CSC2062	Human Computer Interaction (Domain Elective 1)	3 (2+1)	None
GER2401	Ideology and Constitution of Pakistan	2 (2+0)	None
Total Credit Hours		17 (35+17=52)	

SEMESTER-4			
Course Code	Course Title	Credits Hrs	Prerequisite

GER2800	Entrepreneurship	2 (2+0)	None
SEN2022	Software Design & Architecture – (Domain Core 1)	3 (3+0)	None
SEN2061	Software Construction & Development – (Domain Core 2)	3 (2+1)	None
GER2600	Applied Physics	3 (2+1)	None
GER1201	Expository Writing	3 (3+0)	Functional English
CSC2122	Computer Networks	3 (2+1)	None
Total Credit Hours		17 (52+17=69)	

SEMESTER-5

Course Code	Course Title	Credits Hrs	Prerequisite
CSC3112	Operating Systems	3 (2+1)	DS
CSC3023	Database Systems	4 (3+1)	None
SEN3011	Software Requirement Engineering – (Domain Core 3)	3 (2+1)	None
	Domain Elective 2	3 (2+1)	None
	Domain Elective 3	3 (2+1)	None
Total Credit Hours		16 (69+16=85)	

SEMESTER-6

Course Code	Course Title	Credits Hrs	Prerequisite
SEN3051	Software Project Management – (Domain Core 4)	3 (2+1)	None
SEN3033	Software Quality Engineering – (Domain Core 5)	3 (2+1)	None
CSC3002	Parallel & Distributed Computing – (Domain Core 6)	3 (2+1)	None
CSC3125	Information Security	3 (2+1)	None
CSC3052	Artificial Intelligence	3 (2+1)	OOP
Total Credit Hours		15 (85+15=100)	

SEMESTER-7

Course Code	Course Title	Credits Hrs	Prerequisite
SEN4996	Final Year Project - I	2 (0+2)	70 Credit Hrs + Passed Software Design and Architecture, and appeared in Appeared in Database systems
CSC4032	Analysis of Algorithms	3 (3+0)	DS
	Elective Supporting Course (Example: Introduction to Marketing)	3 (3+0)	None
CSC4014	Computer Organization & Assembly Language	3 (2+1)	DLD
	Domain Elective 4	3 (2+1)	None
Total Credit Hours		14 (100+14=114)	

SEMESTER-8

Course Code	Course Title	Credits Hrs	Prerequisite
SEN4997	Final Year Project - II	4 (0+4)	FYP-1
ENG4021	Technical & Business Writing	3 (3+0)	Functional English
	Domain Elective 5	3 (2+1)	None
	Domain Elective 6	3 (2+1)	None
	Domain Elective 7	3 (2+1)	None
Total Credit Hours		16 (114+16=130)	

SUMMER

Course Code	Course Title	Credits Hrs	Prerequisite
SEN 3991	Internship	3 (0+3)	None
Total Credit Hours		3 (130+3=133)	

4. Course Outline/Book/Reference Material

➤ Application of Information & Communication Technologies

Credit Hours: 3 (2,1)

Contact Hours: 2-3

Prerequisites: None

Course Introduction: This is an introductory course in Computer Science designed for beginners. Apart from leading the participants through a whirlwind history of computing, the course also develops a feel for web programming through a series of lectures that help the students develop their own web page. Main objective of the course is to build an appreciation for the fundamental concepts in computing and to become familiar with popular PC productivity software.

CLO No. Course Learning Outcomes

CLO-1	Understand basics of computing technology
CLO-2	Do number systems conversions and arithmetic
CLO-3	Have knowledge of types of software
CLO-4	Have knowledge of computing related technologies

Bloom Taxonomy

C1 (Knowledge)
C2 (Understand)
C2 (Understand)
C3 (Apply)

Course Outline:

Brief history of Computer, Four Stages of History, Computer Elements, Processor, Memory, Hardware, Software, Application Software its uses and Limitations, System Software its Importance and its Types, Types of Computers (Super, Mainframe, Mini and Micro Computer), Introduction to CBIS (Computer Based Information System), Methods of Input and Processing, Class2. Organizing Computer Facility, Centralized Computing Facility, Distributed Computing Facility, Decentralized Computing Facility, Input Devices. Keyboard and its Types, Terminal (Dump, Smart, Intelligent), Dedicated Data Entry, SDA (Source Data Automation), Pointing Devices, Voice Input, Output Devices. Soft- Hard Copies, Monitors and its Types, Printers and its Types, Plotters, Computer Virus and its Forms, Storage Units, Primary and Secondary Memories, RAM and its Types, Cache, Hard Disks, Working of Hard Disk, Diskettes, RAID, Optical Disk Storages (DVD, CD ROM), Magnetic Types, Backup System, Data Communications, Data Communication Model, Data Transmission, Digital and Analog Transmission, Modems, Asynchronous and Synchronous Transmission, Simplex. Half Duplex, Full Duplex Transmission, Communications, Medias (Cables, Wireless), Protocols, Network Topologies (Star, Bus, Ring), LAN, LAN, Internet, A Brief History, Birthplace of ARPA Net, Web Link, Browser, Internet Services provider and Online Services Providers, Function and Features of Browser, Search Engines, Some Common Services available on Internet.

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

1. Charles S. Parker, Understanding Computers: Today and Tomorrow, Course Technology, 25 Thomson Place, Boston, Massachusetts 02210, USA
2. Livesley, Robert Kenneth. An introduction to automatic digital computers. Cambridge University Press, 2017.
3. Zawacki-Richter, Olaf, and Colin Latchem. "Exploring four decades of research in Computers & Education." Computers & Education 122 (2018): 136-152.
4. Sinha, Pradeep K., and Priti Sinha. Computer fundamentals. BPB publications, 2010.
5. Goel, Anita. Computer fundamentals. Pearson Education India, 2010.

➤ **Programming Fundamentals**

Credit Hours: 4 (3,1)

Contact Hours: 3-3

Prerequisites: None

Course Introduction:

This course provides fundamental concepts of programming to freshmen. The course 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 programming 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

Teaching Methodology:

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

Course Assessment:

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

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

➤ Functional English

Credit Hours: 3 (3,0)

Contact Hours: 3-0

Prerequisites: None

Course Introduction:

This is first course in English to the Bachelor of Science students and covers all the fundamental concept of English composition and comprehension. The course is designed in such a way that students can use this knowledge to further enhance their language skills in English. The course aims at enhancing students' skill and competence in communicating their ideas in writing and speaking in English language. It will primarily focus on four areas of language to help the students achieve proficiency in language use, develop skills in listening comprehension, improve reading efficiency, use the conventions of standard written English with skill and assertion, build-up vocabulary, and clearly and accurately reproduce specific data. It will illustrate the force and effectiveness of simple and direct English.

CLO No. Course Learning Outcomes

Bloom Taxonomy

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Course Outline:

Paragraph and Essay Writing, Descriptive Essays; Sentence Errors, Persuasive Writing; How to give presentations, Sentence Errors; Oral Presentations, Comparison and Contrast Essays, Dialogue Writing, Short Story Writing, Review Writing, Narrative Essays, Letter Writing

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

1. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.
2. A Textbook of English Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000

➤ Calculus and Analytical Geometry

Credit Hours: 3 (3,0)

Contact Hours: 3-0

Prerequisites: None

Course Introduction:

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

CLO No. Course Learning Outcomes

Bloom Taxonomy

- - -

Course Outline:

Limits and Continuity; Introduction to functions, Introduction to limits, Techniques of finding 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 R^3 , 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.

➤ **Software Design and Architecture**

Credit Hours:3 (2-1)

Contact Hours: 2-3

Prerequisites: -

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1.	Understand the role of design and its major activities within the OO software development process, with focus on the Unified process.	C1
CLO-2.	Comprehend the advantages of consistent and reliable software design.	C2
CLO-3.	Design OOD models and refine them to reflect implementation details	C3
CLO-4.	Apply and use UML to visualize and document the design of software systems.	C4
CLO-5.	Implement the design model using an object-oriented programming language.	C5

* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

Software Design Concepts, Design principles, Object-Oriented Design with UML, System design and software architecture, Object design, Mapping design to code, User interface design, Persistent layer design, Web applications design, State machine diagrams and modeling, Agile software engineering, Design Patterns, Exploring inheritance, Interactive systems with MVC architecture, Software reuse. Architectural design issues, , Software Architecture, Architectural Structures & Styles-, Architectural Patterns, Architectural & Design Qualities, Quality Tactics, Architecture documentation, Architectural Evaluation, Model driven development.

Teaching Methodology:

Lecturing, Written and Lab Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home and Lab Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Software Engineering: A Practitioner’s Approach, Roger S. Pressman, Bruce R. Maxim, 8th Ed, McGraw-Hill Education, 2015.
2. Object-Oriented Analysis, Design and Implementation, Brahma Dathan, Sarnath Ramnath, 2nd Ed, Universities Press, India, 2014.
3. Software Modeling and Design: UML, Use Cases, Patterns, and Software Architectures, Hassan Gomaa, Cambridge University Press, 2011.
4. Head First Design Patterns, Eric Freeman, Elisabeth Freeman, Kathy Sierra and Bert Bates, O’Reilly Media, Inc. 2004.

➤ **Software Construction and Development**

Credit Hours: 3 (2,1)

Contact Hours: 2-3

Prerequisites:

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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Course Content:

Software development process, Software engineering process infrastructure, Software engineering process improvement, Systems engineering life cycle models, Process implementation, Levels of process definition, Life cycle model characteristics, Individual and team software process, Lehman's Laws, code salvaging, and configuration management. Martin Fowler's refactoring concepts and their application to small projects. Apply Michael Feathers' "legacy code" concepts. Exception handling, making methods robust by having them check their inputs sent from calling objects. Software configuration management, Release management, Software configuration management processes, Software deployment processes, Distribution and backup, Evolution processes and activities, Basic concepts of evolution and maintenance, Working with legacy systems, Refactoring, Error handling, exception handling, and fault tolerance. Personal reviews (design, code, etc.), Peer reviews (inspections, walkthroughs, etc.).

Teaching Methodology:

Lecturing, Written and Lab Assignments, Project, Report Writing

Course Assessment:**Reference Materials:**

1. Clean Code: A Handbook of Agile Software Craftsmanship, Robert C. Martin, Prentice Hall, 2008.
2. The Pragmatic Programmer: From Journeyman to Master, Andrew Hunt and David Thomas, Addison-Wesley Professional, 1999.
3. Working Effectively with Legacy Code, Michael C. Feathers. Pearson Education, Prentice-Hall, 2004.
4. Refactoring: Improving the Design of Existing Code, Martin Fowler, Addison-Wesley Professional. 1999.

➤ **Applied Physics**

Credit Hours: 3 (2,1)

Contact Hours: 2-3

Pre-requisites: None

Course Introduction:

The course introduces students with the basic concept of Physics and electronics. Students are also taught Physics laws and other associate topics to prepare them for the advanced level courses in this area. The focus of the course on electric force and its applications and related problems, conservation of charge, charge quantization, Electric fields due to point charge and lines of force and many other useful topics.

CLO No. Course Learning Outcomes**Bloom Taxonomy**

- -

Course Outline:

Electric force and its applications and related problems, conservation of charge, charge quantization, Electric fields due to point charge and lines of force. Ring of charge, Disk of charge, A point charge in an electric field, Dipole in a n electric field, The flux of vector field, The flux of electric field, Gauss' Law, Application of Gauss' Law, Spherically symmetric charge distribution, A charge isolated conductor, Electric potential energy, Electric potentials, Calculating the potential from the field and related problem Potential due to point and continuous charge distribution, Potential due to dipole, equipotential surfaces, Calculating the field from the potential , Electric current, Current density, Resistance, Resistivity and conductivity, Ohm's law and its applications, The Hall effect, The magnetic force on a current, The BiotSavart law, Line of B, Two parallel conductors, Amperes' s Law, Solenoid, Toroids, Faraday's experiments, Faraday's Law of Induction, Lenz's law, Motional emf, Induced electric field, Induced electric fields, The basic equation of electromagnetism, Induced Magnetic field, The displacement current, Reflection and Refraction of light waves, Total internal reflection, Two source interference, Double Slit interference, related problems, Interference from thin films, Diffraction and the wave theory, related problems, Single-Slit Diffraction, related problems, Polarization of electromagnetic waves, Polarizing sheets, related problems.

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

1. Fundamentals of Physics (Extended), 10th edition, Resnick and Walker
2. Narciso Garcia, Arthur Damask, Steven Schwarz., “Physics for Computer Science Students”, Springer Verlag, 1998

➤ **Multivariable Calculus**

Credit Hours: 3(3,0)

Contact Hours: 3-3

Prerequisites: Calculus and Analytical Geometry

CLO No. Course Learning Outcomes

Bloom Taxonomy

- | | | |
|--------|--|--|
| CLO-1. | Understand the basic concepts and know the basic techniques of differential and integral calculus of functions of several variables; | |
| CLO-2. | Apply the theory to calculate the gradients, directional derivatives, arc length of curves, area of surfaces, and volume of solids; | |
| CLO-3. | Solve problems involving maxima and minima, line integral and surface integral, and vector calculus; | |

Course Content:

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.

Teaching Methodology:

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

Course Assessment:

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

Reference Materials:

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.

➤ **Object Oriented Programming**

Credit Hours: 4 (3,1)

Contact Hours: 3-3

Prerequisites: 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

➤ **Expository Writing**

Credit Hours: 3 (3,0)

Contact Hours: 3-0

Pre-requisites: Functional English

Course Introduction:

The course introduces students to the communications so they can effectively communicate their message. The course also covers how to make an effective presentation both written and verbal. Various modern techniques of communication and presentation skills are covered in this course. Further the course aims to enhance students' linguistic command, so they could communicate effectively in diversified socio-cultural situations; create larger stretches of interactive text in speech and writing; and identify and repair any instances of potential communication break-up.

CLO No. Course Learning Outcomes

Bloom Taxonomy

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Course Outline:

Principles of writing good English, understanding the composition process: writing clearly; words, sentence and paragraphs; Comprehension and expression; Use of grammar and punctuation. Process of writing, observing, audience collecting, composing, drafting and revising, persuasive writing, reading skills, listening skills and comprehension, skills for taking notes in class, skills for exams; Business communications; planning messages, writing concise but with impact. Letter formats, mechanics of business, letter writing, letters, memo and applications, summaries, proposals, writing resumes, styles and formats, oral communications, verbal and non-verbal communication, conducting meetings, small group communication, taking minutes. Presentation skills; presentation strategies, defining the objective, scope and audience of the presentation, material gathering material organization strategies, time management, opening and concluding, use of audio-visual aids, delivery and presentation.

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

1. Practical Business English, Collen Vawdrey, 1993, ISBN = 0256192740
2. Effective Communication Skills: The Foundations for Change, John Nielsen, 2008, ISBN = 1453506748
3. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.
4. A Textbook of English Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000

➤ **Discrete Structures**

Credit Hours: 3 (3,0)

Contact Hours: 3-0

Prerequisites: None

Course Introduction:

Introduces the foundations of discrete mathematics as they apply to Computer Science, focusing on providing a solid theoretical foundation for further work. Further, this course aims to develop understanding and appreciation of the finite nature inherent in most Computer Science problems and

structures through study of combinatorial reasoning, abstract algebra, iterative procedures, predicate calculus, tree and graph structures. In this course more emphasis shall be given to statistical and probabilistic formulation with respect to computing aspects.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs and Trees etc.	C2 (Understand)
CLO-2	Apply formal logic proofs and/or informal, but rigorous, logical reasoning to real problems, such as predicting the behavior of software or solving problems such as puzzles	C3 (Apply)
CLO-3	Apply discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography	C3 (Apply)
CLO-4	Differentiate various discrete structures and their relevance within the context of computer science, in the areas of data structures and algorithms, in particular	C4 (Differentiate)

Course Outline:

Mathematical reasoning, propositional and predicate logic, rules of inference, proof by induction, proof by contraposition, proof by contradiction, proof by implication, set theory, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings, function composition, inverse functions, recursive functions, Number Theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations. Algorithms, Searching and Sorting Algorithms, elements of graph theory, planar graphs, graph coloring, Graph Algorithms, euler graph, Hamiltonian path, rooted trees, traversals.

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

1. Discrete Mathematics and Its Applications, 7th edition by Kenneth H. Rosen
2. Discrete Mathematics with Applications, 4th Edition by Susanna S. Epp
3. Discrete Mathematics, 7th edition by Richard Johnson Baugh
4. Discrete Mathematical Structures, 4th edition by Kolman, Busby & Ross
5. Discrete and Combinatorial Mathematics: An Applied Introduction by Ralph P. Grimaldi
6. Logic and Discrete Mathematics: A Computer Science Perspective by Winifred Grassman

➤ **Software Engineering**

Credit Hours: 3 (3,0)

Contact Hours: 3-0

Prerequisites: None

Course Introduction: -

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Describe various software engineering processes and activates	C1 (Describe)
CLO-2	Apply the system modeling techniques to model a medium size software systems	C3 (Apply)
CLO-3	Apply software quality assurance and testing principles to medium size software systems	C3 (Apply)
CLO-4	Discuss key principles and common methods for software project management such as scheduling, size estimation, cost estimation and risk analysis	C2 (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.

➤ **Islamic Studies**

Credit Hours: 2 (2,0)

Contact Hours: 2-0

Prerequisites: None

Course Introduction:

To provide Basic information about Islamic Studies. To enhance understanding of the students regarding Islamic Civilization. History of Islam, understanding of the worship and its usefulness. The basic concept of Quran Pak: wisdom, patience, loyalty. The comparative analysis of Islam with other religions. The Concept and Value of Haqooq ul Ibad (Bandon Kay Haqooq) in Islam. What is the rights of people in Islamic Point of View. Islamic point of view about other religions.

CLO No. Course Learning Outcomes

Bloom Taxonomy

- | | | |
|-------|---|--|
| CLO-1 | To further enhance the knowledge of Islam | |
| CLO-2 | To understand the basic concept of Islam and Quran Pak | |
| CLO-3 | To understand the concept of Haqooq ul ibad in the light of Quran | |
| CLO-4 | To know the importance of Islamic concept about other religions | |

Course Outline:

Basic Themes of Quran, Introduction to Sciences of Hadith, Introduction to Islamic Jurisprudence, Primary & Secondary Sources of Islamic Law, Makken & Madnian life of the Prophet, Islamic Economic System, Political theories, Social System of Islam. Definition of Akhlaq. The Most Important Characters mentioned in the Holy Qur’an and Sunnah, SIDQ (Truthfulness) Generosity Tawakkul (trust on Allah) Patience Taqwa (piety). Haqooq ul ibad in the light of Quran & Hadith - the important characteristic of Islamic Society.

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

1. Introduction to Islam by Dr Hamidullah, Papular Library Publishers Lahore
2. Principles of Islamic Jurisprudence by Ahmad Hassan, Islamic Research Institute, IIUI
3. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services

➤ **Data Structures**

Credit Hours: 4 (3,1)

Contact Hours: 3-3

Prerequisites: OOP

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 trees, 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

➤ **Software Requirement Engineering**

Credit Hours: 3 (2,1)

Contact Hours: 2-3

Prerequisites: -

CLO No. Course Learning Outcomes

Bloom Taxonomy

- - -

Course Content:

Introduction to Requirements Engineering, Software Requirements, classification of requirements, Requirements process, Levels/layers of requirements, Requirement characteristics, 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, 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, Management of Requirements, Introduction to Management, Requirements Management Problems , Managing Requirements in an Acquisition Organization, Supplier Organizations, Product Organizations, Requirements engineering for agile methods.

Teaching Methodology:

Lecturing, Written and Lab Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home and Lab Assignments, Quizzes, Project, Presentations, Final Exam

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.

➤ Linear Algebra

Credit Hours: 3 (3,0)

Contact Hours: 3-0

Prerequisites: Calculus and Analytical Geometry

Course Introduction:

To provide fundamentals of solution for system of linear equations, operations on system of equations, matrix properties, solutions and study of their properties

CLO No. Course Learning Outcomes

Bloom Taxonomy

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-

-

Course Outline:

Algebra of linear transformations and matrices. determinants, rank, systems of equations, vector spaces, orthogonal transformations, linear dependence, linear Independence and bases, eigenvalues and eigenvectors, characteristic equations, Inner product space and quadratic forms.

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

1. Elementary Linear Algebra by Howard Anton
2. Linear Algebra and its Applications by Gibert Strang

➤ Operating Systems

Credit Hours: 3 (2,1)

Contact Hours: 2-3

Prerequisites: Data Structures

Course Introduction:

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

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 Stallings

➤ Database Systems

Credit Hours: 4 (3,1)

Contact Hours: 3-3

Prerequisites: 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 subqueries 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

➤ Probability & Statistics

Credit Hours: 3 (3,0)

Contact Hours: 3-0

Prerequisites: None

Course Introduction:

To introduce the concepts of data analysis, presentation, counting techniques, probability and decision making.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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Course Outline:

Introduction to Statistics and Data Analysis, Statistical Inference, Samples, Populations, and the Role of Probability. Sampling Procedures. Discrete and Continuous Data. Statistical Modeling. Types of Statistical Studies. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes' Rule. Random Variables and Probability Distributions. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem. Discrete Probability Distributions. Continuous Probability Distributions. Fundamental Sampling Distributions and Data Descriptions: Random Sampling, Sampling

Distributions, Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of S^2 , t-Distribution, F-Quantile and Probability Plots. Single Sample & One- and Two-Sample Estimation Problems. Single Sample & One- and Two-Sample Tests of Hypotheses. The Use of P-Values for Decision Making in Testing Hypotheses (Single Sample & One- and Two-Sample Tests), Linear Regression and Correlation. Least Squares and the Fitted Model, Multiple Linear Regression and Certain, Nonlinear Regression Models, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators.

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

1. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, Pearson; 9th Edition (January 6, 2011). ISBN-10: 0321629116
2. Probability and Statistics for Engineers and Scientists by Anthony J. Hayter, Duxbury Press; 3rd Edition (February 3, 2006), ISBN-10:0495107573
3. Schaum's Outline of Probability and Statistics, by John Schiller, R. Alu Srinivasan and Murray Spiegel, McGraw-Hill; 3rd Edition (2008). ISBN-10:0071544259

➤ **Computer Networks**

Credit Hours: 3 (2,1)

Contact Hours: 2-3

Prerequisites: 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

➤ Technical & Business Writing

Credit Hours: 3 (3,0)

Contact Hours: 3-0

Prerequisites: Functional English

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.

CLO No.

Course Learning Outcomes

Bloom Taxonomy

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, crossreferencing, plagiarism, citation and bibliography, glossaries, index, appendices, typesetting systems, creating the professional report; elements, mechanical elements and graphical elements. Reports: Proposals, progress reports, Leaflets, brochures, handbooks, magazines articles, research papers, feasibility reports, project reports, technical research reports, manuals and documentation, thesis. Electronic documents, Linear verses hierarchical structure documents.

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

1. Technical Report Writing, by Pauley and Riordan, Houghton Mifflin Company, 8th Edition.
2. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill.

➤ Software Quality Engineering

Credit Hours: 3 (2,1)

Contact Hours: 2-3

Prerequisites: -

CLO No.

Course Learning Outcomes

Bloom Taxonomy

Course Content:

Software Quality, Software Quality Attributes, Quality Engineering., Testing: Concepts, Issues, and Techniques, Software testing lifecycle., Testing Scopes., Testing Approaches., Testing Concepts., Test Planning Process, Introduction to testing process, Requirement of software test planning, Testing documentation, Reporting and historical data recording., Software testing techniques, Testing philosophies , Testing strategies, Model based testing, Software testing techniques, Testing using models, Domain and combinatorial testing, Unit and integration testing, Acceptance testing, Test automation, Slicing, Software reliability models and engineering, Introduction, Exponential model., Reliability growth models, Modeling process, Software inspections, Software reviews, Inspection checks and metrics, Quality Models, Models for quality assessment, Product quality metrics, Quality Measurements,

In-Process metrics for software testing, In-Process quality management, Effort/outcome models, System testing, Introduction to sub-system testing, From functional to system aspects of testing, System testing, Introduction to system testing, Scenarios development, System testing, Use-cases for testing, Specification-based testing, Open issues on software testing

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

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

Reference Materials:

1. Paul Jorgensen, Software Testing, A Craftsman's Approach, 4th Ed. CRC Press, Taylor and Francis Group, 2015
2. Bernard Homes, Fundamentals of Software Testing, ISTE, Wiley, 2012
3. Software Engineering, "Ian Sommerville, 9th Edition, Addison Wesley, 2011

➤ **Information Security**

Credit Hours: 3 (2,1)

Contact Hours: 2-3

Prerequisites: 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

➤ **Professional Practices**

Credit Hours: 2 (2,0)

Contact Hours: 2-0

Prerequisites: 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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	-

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. 2. Computer Ethics by Deborah G. Johnson, Pearson; 4th Edition (January 3, 2009). ISBN10: 0131112414
3. 3. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet (3rd Edition) by Sara Baase, Prentice Hall; 3rd Edition (2008). ISBN-10: 0136008488
4. 4. Applied Professional Ethics by Gregory R. Beabout, University Press of America (1993). ISBN-10: 0819193747

➤ **Software Project Management**

Credit Hours: 3 (2,1)

Contact Hours: 2-3

Prerequisites: -

CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	-

Course Content:

Introduction to Software Project Management, Project Management concepts, Project Management Tools, PMI's Knowledge areas, PMI Framework, PMI Process Groups. Understanding Organizations. Project Planning, Project Evaluation, Selection of an Appropriate Approach in Project, Software Effort Estimation, Activity Planning, Risk Management, Evaluating the Risks to the Schedule, Risk Control, Configuration Management and Maintenance, Environment for Configuration Control, Resource Allocation, Monitoring & Control, Review and Evaluation, Challenges of Outsourcing in Project Management

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

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

Reference Materials:

1. Software Project Management, Bob Hughes and Mike Cotterell, McGraw-Hill Education; 5th Edition (2009).
2. A Guide to the Project Management Body of Knowledge, 5th Edition (PMBOK Guides),
3. Mastering Software Project Management: Best Practices, Tools and Techniques, Murali K. Chemituri and Thomas M. Cagley Jr., J. Ross Publishing, 2010
4. Effective Project Management: Traditional, Agile, Extreme, Robert K. Wysocki, Wiley; 6th Edition, 2011

➤ **Parallel and Distributed Computing**

Credit Hours: 3 (2,1)

Contact Hours: 2-3

Prerequisites: Object Oriented Programming, Operating Systems

Course Introduction:

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Learn about parallel and distributed computers	-
CLO-2	Write portable programs for parallel or distributed architectures using Message-Passing Interface (MPI) library	-
CLO-3	Analyze complex problems with shared memory programming with openMP	-

Course Outline:

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.

➤ **Artificial Intelligence**

Credit Hours: 3 (2,1)

Contact Hours: 2-3

Prerequisites: Object Oriented Programming

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, Minmax algorithm, Alpha beta pruning, Game-playing); Case Studies: General Problem Solver, Eliza, Student, Macsyma; Learning from examples; ANN and Natural Language Processing; Recent trends in AI and applications of AI algorithms. Python programming language will be used to explore and illustrate various issues and techniques in Artificial Intelligence.

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

➤ **Analysis of Algorithms**

Credit Hours: 3 (3,0)

Contact Hours: 3-0

Prerequisites: 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 |
| CLO-2 | Identify the characteristics of data and/or other conditions or assumptions that lead to different behaviors |
| CLO-3 | Determine informally the time and space complexity of simple algorithms |
| CLO-4 | List and contrast standard complexity classes |
| CLO-5 | Use big O, Omega, Theta notation formally to give asymptotic upper bounds on time and space complexity of algorithms |
| CLO-6 | Use of the strategies(brute-force, greedy, divide-andconquer, and dynamic programming) to solve an appropriate problem |
| CLO-7 | Solve problems using graph algorithms, including singlesource and all-pairs shortest paths, and at least one minimum spanning tree algorithm |
| CLO-8 | Trace and/or implement a string-matching algorithm |

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

➤ **Computer Organization and Assembly Language**

Credit Hours: 3 (2,1)

Contact Hours: 2-3

Prerequisites: Digital Logic 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,

➤ **Digital Logic Design**

Credit Hours: 3 (2,1)

Contact Hours: 2-3

Prerequisites: 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	-
CLO-2	Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques	-
CLO-3	Apply the acquired knowledge to simulate and implement small-scale digital circuits	-
CLO-4	Understand the relationship between abstract logic characterizations and practical electrical implementations	-

Course Outline:

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: (or use any other standard and latest books)

1. Digital Fundamentals by Floyd, 11/e.
2. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e.

➤ Ideology and Constitution of Pakistan

Credit Hours: 2 (2,0)

Contact Hours: 2-0

Prerequisites: None

Course Introduction:

Pakistan studies is an important course at this university in which students study about their motherland. The following are the specific objective of the course

- To develop vision of Historical Perspective, Government, Politics, Contemporary Pakistan, ideological background of Pakistan.
- To study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	To educate students about the history of Pakistan	
CLO-2	To educate student about the various pillar of the state	
CLO-3	To educate student Government and politics	

Course Outline:

Historical background of Pakistan: Muslim society in Indo-Pakistan, the movement led by the societies, the downfall of Islamic society, the establishment of British Raj- Causes and consequences. Political evolution of Muslims in the twentieth century: Sir Syed Ahmed Khan; Muslim League; Nehru; Allama Iqbal: Independence Movement; Lahore Resolution; Pakistan culture and society, Constitutional and Administrative issues, Pakistan and its geo-political dimension, Pakistan and International Affairs, Pakistan and the challenges ahead.

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

1. The Emergence of Pakistan, Chaudary M., 1967
2. The making of Pakistan, Aziz. 1976
3. A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988