

CURRICULUM OF COMPUTER SCIENCE

(2025)



**RAWALPINDI WOMEN UNIVERSITY,
RAWALPINDI**

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1. Departmental Vision

"Empower women to excel in computer science and drive technological innovation through a dynamic learning environment focused on academic excellence, interdisciplinary research, and practical skills."

2. Departmental Mission

"To cultivate a dynamic learning environment that empowers women in computer science through academic excellence, innovative research, and practical skills, fostering leadership, economic independence, and sustainable growth."

3. Program Educational Objectives

3.1. Professional Competence and Technical Proficiency:

Demonstrate professional competence by applying their computing knowledge and technical skills to solve real-world problems and design innovative solutions.

3.2. Complex Problem-Solving and Innovation:

Develop the ability to think critically and solve complex problems through innovative approaches, considering societal, environmental, and ethical implications.

3.3. Lifelong Learning and Adaptability:

To commit lifelong learning and continuous professional development, staying current with emerging trends and advancements in the computing field.

3.4. Ethical Responsibility and Societal Impact:

Demonstrate ethical responsibility and a commitment to societal impact by understanding the broader implications of their work and leading initiatives that benefit communities..

3.5. Program Learning Outcomes

Table 1 PLO's

Sr.	Learning Objective	Statement
PLO-1	Academic Education	Provide graduates with a strong foundation for professional practice and advanced studies in computing.
PLO-2	Knowledge for Solving Computing Problems	Apply computer science theory and software development principles to build effective computing solutions.

PLO-3	Problem Analysis	Systematically analyze complex computing problems, employing principles of computing and relevant interdisciplinary knowledge to identify, model, and articulate appropriate solutions.
PLO-4	Design/Development of Solutions	Design, implement, and evaluate computing-based systems, processes, components, or programs to meet specified requirements within diverse disciplinary and application contexts.
PLO-5	Modern Tool Usage	Identify, select, and apply contemporary computing tools, techniques, and methodologies, with a critical awareness of their assumptions, limitations, and applicability to complex computing activities.
PLO-6	Individual and Team Work	Function effectively in diverse teams, demonstrating leadership, collaboration, and accountability in the planning and execution of computing projects.
PLO-7	Communication	Communicate effectively in both technical and non-technical contexts, producing clear documentation and delivering oral and written presentations suited to professional computing environments.
PLO-8	Computing Professionalism and Society	Demonstrate an informed awareness of professional, legal, ethical, and societal responsibilities and make judicious decisions in computing practice based on this understanding.
PLO-9	Ethics	Exhibit integrity, ethical reasoning, and adherence to professional codes of conduct in all computing practices and decision-making processes.
PLO-10	Lifelong Learning	Recognize the necessity of, and demonstrate the ability to engage in, continuous professional development and

		independent learning in the ever-evolving field of computing science.
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3.6.Mapping of PEO's to PLO's

Table 2 Mapping of PEO's to PLO's

PLOs	PEO 1 (Professional Competence and Technical Proficiency)	PEO 2 (Complex Problem-Solving and Innovation)	PEO 3 (Lifelong Learning and Adaptability)	PEO 4 (Ethical Responsibility and Societal Impact)
PLO-1	✓			
PLO-2	✓	✓		
PLO-3	✓	✓		
PLO-4	✓	✓		
PLO-5	✓	✓		
PLO-6	✓	✓		
PLO-7	✓	✓		
PLO-8	✓	✓		✓
PLO-9				✓
PLO-10			✓	

4. Mapping of Courses to PLO's

BS Computer Science

			Academic Education	Knowledge for Solving Computing Problems	Problem Analysis	Design/Development of Solutions	Modern Tool Usage	Individual and Team Work	Communication	Computing Professionalism and Society	Ethics	Lifelong Learning
Sr. No.	Course Code	Course Title	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
<i>Computing-Core Courses</i>												
1	CS-122	Programming Fundamentals	✓	✓	✓	✓						
2	CS-318	Computer Organization and Assembly language	✓	✓		✓						
3	CS-125	Object Oriented Programming	✓	✓	✓	✓						
4	CS-210	Data Structures	✓	✓	✓	✓						
5	CS-201	Software Engineering	✓	✓	✓	✓	✓	✓				
6	CS-203	Database Systems	✓	✓	✓	✓	✓					
7	CS-208	Computer Networks	✓	✓	✓	✓	✓					
8	CS-319	Information Security	✓	✓			✓					
9	CS-316	Operating systems	✓	✓	✓	✓	✓					

10	CS-126	Digital Logic and Design	✓	✓		✓						
11	CS-206	Artificial Intelligence	✓	✓	✓	✓	✓					
12	CS-413	Analysis of Algorithms	✓	✓	✓	✓						
13	CS-499	Capstone Project	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Mathematics and Supporting Courses (Interdisciplinary/ Allied) Courses

1	MTH-107	Multivariable Calculus	✓									✓
2	MTH-111	Elementary Linear Algebra	✓									✓
3	STA-106	Introduction to Probability and Statistics	✓	✓								✓
4	ENG-104	Business and Technical Writing							✓			✓

Elective Supporting Courses

1	ECO-101	Introduction to Economics	✓		✓				✓	✓	✓	✓
2	MGT-105	Introduction to Digital Marketing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

General Education Requirement as per HEC UG Education Policy Courses

1	CS-107	Application of Information and Communication Technologies	✓	✓		✓	✓					✓
2	CS-110	Functional English							✓			✓
3	CS-111	Expository Writing							✓			✓
4	CS-123	Discrete Structures (Quantitative Reasoning – II)	✓	✓	✓							✓

5	MTH-104	Calculus and Analytical Geometry (Quantitative Reasoning – I)	✓									✓
6	ISL-101/ETH-101	Islamic Studies/Ethics									✓	✓
7	PAK-103	Ideology and Constitution of Pakistan								✓	✓	✓
8	MGT-104	Introduction to Management (Social Sciences)			✓			✓	✓	✓		✓
9	PHY-103	Natural Sciences (Applied Physics)	✓	✓		✓	✓					✓
10	CS-209	Professional Practices (Arts and Humanities)					✓	✓	✓	✓	✓	✓
11	CCE-497	Civic and Community Engagement						✓	✓	✓	✓	✓
12	PAK-104	Pakistan Studies	✓							✓	✓	✓
13	MGT-108	Entrepreneurship		✓	✓	✓	✓	✓	✓	✓	✓	✓

Domain Core Courses

1	CS-317	Theory of Automata	✓	✓	✓							
2	CS-207	Advance Database Management Systems	✓	✓	✓	✓	✓					
3	CS-322	HCI and Computer Graphics	✓	✓	✓	✓	✓			✓	✓	
4	CS-321	Computer Architecture	✓	✓	✓	✓	✓					
5	CS-320	Compiler Construction	✓	✓	✓	✓	✓					
6	CS-409	Parallel and Distributed Computing	✓	✓	✓	✓	✓	✓				

Domain Elective Courses

1	IT-310	Web Technologies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
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2	CS-408	Mobile Application Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	CS-410	Advanced Programming	✓	✓	✓	✓	✓					✓
4	CS-411	Numerical Analysis	✓	✓	✓	✓						✓
5	CS-407	Web Engineering	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	IT-311	Cyber Security	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	CS-412	Software Verification and Validation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	CS-323	Object Oriented Analysis and Design	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	CS-308	Game Development	✓	✓	✓	✓	✓	✓	✓	✓		✓
10	CS-309	Visual Programming	✓	✓	✓	✓	✓		✓			✓
11	IT-306	Software Quality Assurance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12	CS-311	Data Mining	✓	✓	✓	✓	✓			✓		✓
13	CS-312	Software Project Management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
14	CS-315	Digital Image Processing	✓	✓	✓	✓	✓					✓
15	CS-404	Data Science	✓	✓	✓	✓	✓			✓		✓
16	CS-405	Computer Graphics	✓	✓	✓	✓	✓			✓		✓
17	CS-406	Cloud Computing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

5. Admission Criteria for BSCS

As per approved Admission Policy RWU notified vide Notification No. RWU/VC/01/341; dated: 10th Mar, 2023.

6. Division and Distribution of Courses for BSCS

S#	Areas	Credit Hours	Courses
1	Computing Core	46	13
2	Domain Core	18	6
3	Domain Elective	21	7
4	Mathematics and Supporting Courses (Interdisciplinary/ Allied)	12	4
5	Elective Supporting Courses	3	1
6	Mandatory	5	3
7	General Education Requirement	33	13
	Totals	138	47

Total Credit Hours: 138

Duration: 4 Years

Semester Duration: 16 - 18 Weeks

Semesters: 8

Course Load Per Semester: 15 - 18 Credit Hours

7. Scheme of Studies for BS CS (Regular Semester)

Semester	Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
First	ENG-110	Functional English	General Education	Nil	3
	PAK-103	Ideology and Constitution of Pakistan	General Education	Nil	2
	PHY-103	Applied Physics	General Education	Nil	2
	PHY-103L	Applied Physics (Lab)	General Education	Nil	1
	MTH 104	Calculus and Analytical Geometry (QR I)	General Education	Nil	3
	CS-122	Programming Fundamentals	Computing Core	Nil	3
	CS-122L	Programming Fundamentals (Lab)	Computing Core	Nil	1
	CS-107	Application of Information and Communication Technologies	General Education	Nil	2
	CS-107L	Application of Information and Communication Technologies (Lab)	General Education	Nil	1
	Total				18
Second	CS-209	Professional Practices (Arts and Humanities)	General Education	Nil	2
	CS-125	Object Oriented Programming	Computing Core	Programming Fundamentals	3
	CS-125L	Object Oriented Programming (Lab)	Computing Core	Programming Fundamentals	1
	CS-126	Digital Logic Design	Computing Core	Nil	2
	CS-126L	Digital Logic Design (Lab)	Computing Core	Nil	1
	MTH 107	Multivariable Calculus	Interdisciplinary/ Allied	Calculus and Analytical Geometry	3
	CS-123	Discrete Structures (QR-II)	General Education	Nil	3

	UHQ-101 /ETH-103	Understanding of Holy Quran-I/Ethics-I	Mandatory	Nil	1
	ISL-101/ETH-101	Islamic Studies/Ethics	General Education	Nil	2
	Total				18
Third	CS-208	Computer Networks	Computing Core	Nil	2
	CS-208L	Computer Networks (Lab)	Computing Core	Nil	1
	CS-210	Data Structures	Computing Core	Object Oriented Programming	3
	CS-210L	Data Structures (Lab)	Computing Core	Object Oriented Programming	1
	STA 106	Introduction to Probability and Statistics	Interdisciplinary/ Allied	Nil	3
	CS-203	Database Systems	Computing Core	Nil	3
	CS-203L	Database Systems (Lab)	Computing Core	Nil	1
	UHQ-102 /ETH-104	Understanding of Holy Quran-II/Ethics-II	Mandatory	Nil	1
	CS-201	Software Engineering	Computing Core	Nil	3
	Total				18
Forth	MGT-108	Entrepreneurship	General Education	Nil	2
	PAK-104	Pakistan Studies	General Education	Nil	2
	MGT-104	Introduction to Management (Social Sciences)	General Education	Nil	3
	CS-207	Advance Database Management Systems	Domain Core	Database Systems	2
	CS-207L	Advance Database Management Systems (Lab)	Domain Core	Database Systems	1
	ENG-111	Expository Writing	General Education	Nil	3
	MTH-111	Elementary Linear Algebra	Interdisciplinary/Allied	Calculus and Analytical Geometry	3
	CCE-497	Civic and Community Engagement	General Education	Nil	2

	Total				18
Fifth	CS-316	Operating Systems	Computing Core	Data Structures	2
	CS-316L	Operating Systems (Lab)	Computing Core	Data Structures	1
	CS-206	Artificial Intelligence	Computing Core	Object Oriented Programming	2
	CS-206L	Artificial Intelligence (Lab)	Computing Core	Object Oriented Programming	1
	CS-318	Computer Organization and Assembly Language	Computing Core	Digital Logic Design	2
	CS-318L	Computer Organization and Assembly Language (Lab)	Computing Core	Digital Logic Design	1
		Domain Elective 1	Domain Elective	Nil	3
	CS-319	Information Security	Computing Core	Nil	2
	CS-319L	Information Security (Lab)	Computing Core	Nil	1
	CS-317	Theory of Automata	Domain Core	Nil	3
	Total				18
Sixth	CS-320	Compiler Construction	Domain Core	Theory of Automata	2
	Cs-320L	Compiler Construction (Lab)	Domain Core	Theory of Automata	1
		Domain Elective 2	Domain Elective	Nil	3
	CS-321	Computer Architecture	Domain Core	Computer Organization and Assembly Language	2
	CS-321L	Computer Architecture (Lab)	Domain Core	Computer Organization and Assembly Language	1
		Domain Elective 3	Domain Elective	Nil	3
	CS-322	HCI and Computer Graphics	Domain Core	Nil	2
	CS-322L	HCI and Computer Graphics (Lab)	Domain Core	Nil	1
	Total				15
Seventh	INT-499	Internship	Mandatory	Nil	3
	CS-413	Analysis of Algorithms	Computing Core	Data Structures	3

		Elective Supporting Course	Social Sciences	Nil	3
		Domain Elective 4	Domain Elective	Nil	3
		Domain Elective 5	Domain Elective	Nil	3
	ENG 104	Business and Technical Writing	Interdisciplinary/Allied	Nil	3
	CP-499	Capstone project	Computing Core	Nil	6
	Total				18
Eighth	CP-499	Capstone project	Computing Core	Nil	6
		Domain Elective 6	Domain Elective	Nil	3
		Domain Elective 7	Domain Elective	Nil	3
	CS-409	Parallel and Distributed Computing	Domain Core	Operating Systems	2
	CS-409L	Parallel and Distributed Computing (Lab)	Domain Core	Operating Systems	1
	Total				15
Total Credit Hours: 138					

8. Scheme of Studies for BS CS (Lateral Entry Annual System)

Fifth	CS-125	Object Oriented Programming	Computing Core	Programming Fundamentals	3
	CS-125L	Object Oriented Programming (Lab)	Computing Core	Programming Fundamentals	1
	CS-209	Professional Practices (Arts and Humanities)	General Education	Nil	2
	CS-201	Software Engineering	Computing Core	Nil	3
	CS-318	Computer Organization and Assembly Language	Computing Core	Digital Logic Design	2
	CS-318L	Computer Organization and Assembly Language (Lab)	Computing Core	Digital Logic Design	1
		Domain Elective 1	Domain Elective	Nil	3
	CS-319	Information Security	Computing Core	Nil	2
	CS-319L	Information Security (Lab)	Computing Core	Nil	1
	CS-317	Theory of Automata	Domain Core	Nil	3
	Total				21
Sixth	CS-206	Artificial Intelligence	Computing Core	Object Oriented Programming	2
	CS-206L	Artificial Intelligence (Lab)	Computing Core	Object Oriented Programming	1
	CS-409	Parallel and Distributed Computing	Domain Core	Object Oriented Programming	2
	CS-409L	Parallel and Distributed Computing (Lab)	Domain Core	Object Oriented Programming	1
		Domain Elective 2	Domain Elective	Nil	3
		Domain Elective 3	Domain Elective	Nil	3
	CCE-497	Civic and Community Engagement	General Education	Nil	2
		Domain Elective 4	Domain Elective	Nil	3
	CS-210	Data Structures	Computing Core	Object Oriented Programming	3

	CS-210L	Data Structures (Lab)	Computing Core	Object Oriented Programming	1
	Total				21
Summer	STA-106	Introduction to Probability and Statistics	Interdisciplinary/ Allied	Nil	3
	CS-322	HCI and Computer Graphics	Domain Core	Nil	2
	CS-322L	HCI and Computer Graphics- (Lab)	Domain Core	Nil	1
	CS-123	Discrete Structures (QR-II)	General Education	Nil	3
	Total				9
Seventh	INT-499	Internship	Mandatory	Nil	3
	CS-413	Analysis of Algorithms	Computing Core	Nil	3
		Domain Elective 5	Domain Elective	Nil	3
	CS-320	Compiler Construction	Domain Core	Theory of Automata	2
	CS-320L	Compiler Construction (Lab)	Domain Core	Theory of Automata	1
	CS-321	Computer Architecture	Domain Core	Computer Organization and Assembly Language	2
	CS-321L	Computer Architecture (Lab)	Domain Core	Computer Organization and Assembly Language	1
	ENG-104	Business and Technical Writing	Interdisciplinary/ Allied	Nil	3
	CP-499	Capstone Project	Computing Core	Nil	6
	Total				18
Eighth	CP-499	Capstone Project	Computing Core	Nil	6
		Domain Elective 6	Domain Elective	Nil	3
		Domain Elective 7	Domain Elective	Nil	3
	MGT-104	Introduction to management (Social Science)	General Education	Nil	3
	MGT-108	Entrepreneurship	General Education	Nil	2
	PAK-104	Pakistan Studies	General Education	Nil	2
	Total				19

Total Credit Hours: 88 --> 88+50= 138

9. Scheme of Studies for BS CS (Lateral Entry Semester System)

	Course Code	Course Name	Course Type	Pre Requisite	Credit Hours
Fifth	CS-209	Professional Practices (Arts and Humanities)	General Education	Nil	2
	CS-201	Software Engineering	Computing Core	Nil	3
	CS-318	Computer Organization and Assembly Language	Computing Core	Digital Logic Design	2
	CS-318L	Computer Organization and Assembly Language (Lab)	Computing Core	Digital Logic Design	1
		Domain Elective 1	Domain Elective	Nil	3
	CS-319	Information Security	Computing Core	Nil	2
	CS-319L	Information Security (Lab)	Computing Core	Nil	1
	CS-317	Theory of Automata	Domain Core	Nil	3
	Total				17
Sixth	CS-206	Artificial Intelligence	Computing Core	Object Programming Oriented	2
	CS-206L	Artificial Intelligence (Lab)	Computing Core	Object Programming Oriented	1
	CS-409	Parallel and Distributed Computing	Domain Core	Object Programming Oriented	2
	CS-409L	Parallel and Distributed Computing (Lab)	Domain Core	Object Programming Oriented	1
		Domain Elective 2	Domain Elective	Nil	3
		Domain Elective 3	Domain Elective	Nil	3
		Domain Elective 4	Domain Elective	Nil	3
	CCE-497	Civic and Community Engagement	General Education	Nil	2
	CS-210	Data Structures	Computing Core	Object Programming Oriented	3
	CS-210L	Data Structures (Lab)	Computing Core	Object Programming Oriented	1
	Total				21

Seventh	INT-499	Internship	Mandatory	Nil	3	
	CS-413	Analysis of Algorithms	Computing Core	Nil	3	
	ENG-104	Business and Technical Writing	Interdisciplinary/Allied	Nil	3	
		Domain Elective 5	Domain Elective	Nil	3	
	CS-320	Compiler Construction	Domain Core	Theory of Automata	2	
	Cs-320L	Compiler Construction (Lab)	Domain Core	Theory of Automata	1	
	CS-321	Computer Architecture	Domain Core	Computer Organization and Assembly Language	2	
	CS-321L	Computer Architecture (Lab)	Domain Core	Computer Organization and Assembly Language	1	
	CP-499	Capstone Project	Computing Core	Nil	6	
	Total					18
Eighth	CP-499	Capstone Project	Computing Core	Nil	6	
		Domain Elective 6	Domain Elective	Nil	3	
		Domain Elective 7	Domain Elective	Nil	3	
	CS-322	HCI and Computer Graphics	Domain Core	Nil	2	
	CS-322L	HCI and Computer Graphics-(Lab)	Domain Core	Nil	1	
	MGT-108	Entrepreneurship	General Education	Nil	2	
	Total					17
Total Credit Hours: 73 --> 73+65= 138						

10. List of Computing Core Courses

Sr#	Course Code	Course Title	Pre- Reqs	Cr Hr.
1	CS-122	Programming Fundamentals		3
2	CS-122L	Programming Fundamentals (Lab)		1
3	CS-125	Object Oriented Programming	Programming Fundamentals	3
4	CS-125L	Object Oriented Programming (Lab)	Programming Fundamentals	3
5	CS-203	Database Systems		3
6	CS-203L	Database Systems (Lab)		1
7	CS-106	Digital Logic Design		2
8	CS-106L	Digital Logic Design (Lab)		1
9	CS-210	Data Structures	Object Oriented Programming	3
10	CS-210L	Data Structures (Lab)	Object Oriented Programming	1
11	CS-319	Information Security		2
12	CS-319L	Information Security (Lab)		1
13	CS-206	Artificial Intelligence	Object Oriented Programming	2
14	CS-206L	Artificial Intelligence (Lab)	Object Oriented Programming	1
15	CS-208	Computer Networks		2
16	CS-208L	Computer Networks (Lab)		1
17	CS-201	Software Engineering		3
18	CS-318	Computer Organization and Assembly Language	Digital Logic Design	2
19	CS-318L	Computer Organization and Assembly Language (Lab)	Digital Logic Design	1

20	CS-316	Operating Systems	Data Structures	3
21	CS-316L	Operating Systems (Lab)	Data Structures	1
22	CS-413	Analysis of Algorithms	Data Structures	3
23	CP-499	Capstone Project		6

11. Course Outlines for Computing Core Courses

Programming Fundamentals

BS-Computer Science

Course Code: CS-122

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objective of course is to introduce a disciplined approach to Problem solving methods and algorithm development. The aim is to teach the syntax and vocabulary of a modern programming language like C++. The significant philosophies and logical programming, including models or I/O, processing, and all related terminology will be taught. Simple programs will be constructed, using a number of different logical, calculation and algorithm.

Learning Outcomes

- **Understand** fundamental concepts of structured programming along with problem solving techniques and analytical thinking **(C2 – PLO 2)**.
- **Analyze** problem requirements to recognize what type of data and processes are involved in solution **(C4– PLO 2)**.
- **Apply** basic concepts to alter and expand short programs and algorithms. Writing pseudo-codes and simple program development using standard control structures and functions **(C3 – PLO 1)**.
- **Design** module-based approach to gratify those requirements, and organize program code for implementation **(C6 – PLO 1)**.

Course Outline

Unit 1. Introduction, Declarations, Control Structures

Analyzing, implementation, testing and debugging, Object oriented programming languages, What is C, Getting Started with C, Computer Program Engineering,

Decision Control structure (if statement, Multiple Statements within if, if-else statement, Nested if-else's), logical operators Hierarchy and conditional operators.

Unit 2. Loops, Statements, Functions

Loops structure (while, do while, for loop), break statement, continue statement, goto statement, case control structure, Decisions using switch, Function (prototype, declaration, calling, function body), User & system defined functions, Why use functions, Parameters, arguments, Passing values between functions, Scope rule of functions, Advanced features of functions, Call by value and call by reference, Recursion , Fibonacci series, Recursion vs. iteration.

Unit 3. Arrays & Pointers

What are arrays, Array initialization, Bounds checking, Passing array elements to functions, Passing an entire array to a function, More the one dimension, Initializing A 2-Dimensional array, Memory map of 2-Dimensional array, Three Dimensional arrays, Puppeting on string, What are strings, More about string., Pointers overview, Return data from function, Pointer and array, Pointers and strings, Double indirection ,Pointers to pointers , Pointer and array, Pointers and strings, Double indirection.

Unit 4. Searching and Sorting

Searching Algorithms, Sorting Algorithms, Graphics in C.

Unit 5. Structures & File Handling

Why use structures, Declaring a structures, Accessing structures elements, How structures elements are stored, Array of structures, Additional features of structures, Uses of structures, Unions, Unions of structures, Structures and pointers, Files, Types of Disk I/O, Standard Input/output, Binary Mode and Text Mode, Record Input/Out, Random access, Error condition, System-level Input/output.

Recommended Books/Reference Material

1. Bin Uzayr, S. (2022). Mastering C++ Programming Language: A Beginner's Guide. CRC Press.

2. Deitel, H., & Deitel, P. C. (2021). How to program. Pearson.
3. Deitel, P., & Deitel, H. (2022). C++ 20 for Programmers: An Objects-Natural Approach. Pearson.
4. Doyle, B. (2014). C# Programming: from problem analysis to program design. Cengage Learning.
5. Gaddis, T. (2008). Starting Out with Programming Logic and Design, 2/e. Pearson Education India.
6. Gregoire, M. (2021). Professional C++. John Wiley & Sons.
7. Hanly, J. R., & Koffman, E. B. (2007). Problem solving and program design in C. Pearson Education India.
8. Lafore, R. (1997). Object-oriented programming in C++. Pearson Education.

Programming Fundamentals LAB

BS-Computer Science

Course Code: CS-122L

Credit Hours: 01

Pre-requisite: Nil

Objectives

This course helps the students to understand basic knowledge of visual studio and computer programs and capable of designing different C language programs and flowcharts.

Learning Outcomes

- **Implement** fundamental knowledge and understanding of computer programming using C Language program constructs **(PLO 1)**.
- **Demonstrate** the use of software tool, Microsoft Visual Studio for program development in C Language **(PLO 1)**.
- **Apply** the knowledge of C programming to develop small-to-moderate scale software applications and use Visual Studio software tool for program testing and debugging **(PLO 1)**.
- **Execute** module-based approach to gratify those requirements, and organize program code for implementation **(PLO 1)**.

Course Outline

Unit 1. Introduction to Framework

Installation of visual studio, Variable Declaration and Initialization, Programming Syntax, Decision Control structure (if statement, Multiple Statements within if, if-else statement, Nested if-else's).

Unit 2. Loops, Statements, Functions

Loops structure (while, do while, for loop), break statement, continue statement, goto statement, case control structure, Decisions using switch, Function, User & system defined functions, Parameters, arguments, Passing values between functions, Call by value and call by reference, Recursion , Fibonacci series.

Unit 3. Arrays & Pointers

Array initialization, Bounds checking, Passing array elements to functions, Passing an entire array to a function, More the one dimension, Initializing A 2-Dimensional array, Three Dimensional arrays, Puppeting on string, Return data from function, Pointer and array, Pointers and strings, Double indirection, Pointers to pointers.

Unit 4. Searching and Sorting

Searching Algorithms, Sorting Algorithms, Graphics in C.

Unit 5. Structures & File Handling

Declaring a structures, Accessing structures elements, How structures elements are stored, Array of structures, Uses of structures, Unions, Unions of structures, Structures and pointers, Files, Standard Input/output, Binary Mode and Text Mode, Record Input/Out.

Recommended Books/Reference Material

1. Bin Uzayr, S. (2022). Mastering C++ Programming Language: A Beginner's Guide. CRC Press.
2. Deitel, P., & Deitel, H. (2022). C++ 20 for Programmers: An Objects-Natural Approach. Pearson.

3. Doyle, B. (2014). C# Programming: from problem analysis to program design. Cengage Learning.
4. Gaddis, T. (2008). Starting Out with Programming Logic and Design, 2/e. Pearson Education India.
5. Gregoire, M. (2021). Professional C++. John Wiley & Sons.
6. Hanly, J. R., & Koffman, E. B. (2007). Problem solving and program design in C. Pearson Education India.
7. Lafore, R. (1997). Object-oriented programming in C++. Pearson Education.
8. Weisfeld, M. (2008). The object-oriented thought process. Pearson Education.
- Wu, C. T. (2006). An Introduction to object-oriented programming with Java TM. Mcgraw-Hill Incorporated.

Computer Organization and Assembly Language

BS-Computer Science

Course Code: CS-318

Credit Hours: 02

Pre-requisite: Digital Logic Design

Objectives

The main objective of this course is to introduce the organization of computer systems and usage of assembly language for optimization and control. Emphasis is 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 able to: Identify the major components of computer architecture, and explain their purposes and interactions. Simulate the internal representation of data, and show how data is stored and accessed in memory. Explain the relationships between hardware architecture and its instruction set, and simulate micro-programs. Explain the Instruction Execution Cycle. Explain the differences and relationships among high-level, assembly, and machine languages. Write well-modularized computer programs in an assembly language, implementing decision, repetition, and procedure structures. Write moderately complex assembly language subroutines and interfacing them to any high language.

Learning Outcomes

- **Understand** the major components of a computer, basics of computer organization and the interconnection between computer modules (**C2 – PLO 1**).
- **Demonstrate** the functions and internal working of Central Processing unit and Assembly Language (**C3 – PLO 1**).
- **Analyze** the memory hierarchy, I/O modules, instruction set architecture (x86-64), addressing modes, formats and Assembly language techniques (**C4 – PLO 2**).

Course Outline

Unit 1. Introduction

Introduction about computer Organization, assembly language, Comparison of low level and high level languages, Registers types (General) (16-bit): General purpose register, Special purpose register, Introduction and usage of RAM, Processor, Registers, System Bus, Instruction Execution Cycle, Assembly and Machine Language, Assembler, Linker and Link Libraries, Programmer's View of a Computer System, RISC and CISC architecture, Physical address calculation, Basic Memory Organization, CPU organization..

Unit 2. Top Level View of Computer Function and Interconnection, Assembler

Instruction Cycle, Execute Cycle, Interrupts, Interrupt Cycle, Memory Connection, Input / Output Connection, CPU Connection, MASM, MIPS, Defining Data in MASM Assembler.

Unit 3. Elements of Assembly Language, Functions

Integer Constants, Integer Expressions, Real Number Constants, Character Constants, String Constants, Reserved Words, Identifiers, Directives, Instructions, The NOP (No Operation) Instruction, Adding and Subtracting Integer, INC and DEC Instructions, NEG Instruction, How to move integer number in register? Adding and subtracting numbers in registers, Declaration and initialization of variables, Moving data from variable to register, Data Definition Statement, BYTE

and SBYTE Data , WORD and SWORD Data, Defining DWORD and SDWORD Data, Knowledge about different data types.

Unit 4. Operations, Array & Loops

Division and Multiplication in Assembly , Jumps Based on Specific Flags, Jumps Based on Equality, Simple jump statements, Jumps based on specific condition, Some code examples, Practice on MASM in class.

Unit 5. Procedures, File Operations

Procedures: Labels in procedures, Stack, Runtime Stack, Conditional Control Flow Directives, Compound Expressions, Data Representation & Conversion.

Recommended Books/Reference Material

1. Britton, R. (2002). MIPS assembly language programming.
2. Bryant, R. E., & O'Hallaron, D. R. (2011). Computer systems: a programmer's perspective. Prentice Hall.
3. Hohl, W., & Hinds, C. (2014). ARM Assembly Language: Fundamentals and Techniques.
4. Irvine, K. R. (2003). Assembly language for Intel-based computers (pp. 601-608). Prentice Hall.
5. Mano, M. M. (1993). Computer system architecture. Prentice-Hall, Inc.
6. Null, L. (2023). The essentials of computer organization and architecture. Jones & Bartlett Learning.
7. Stallings, W. (2010). Computer organization and architecture designing for performance eighth edition.
8. Streib, J. T. (2020). Guide to assembly language: a concise introduction. Springer Nature.
9. Tanenbaum, A. S. (2016). Structured computer organization. Pearson Education India.

Computer Organization and Assembly Language LAB

BS-Computer Science

Course Code: CS-318L

Credit Hours: 01

Pre-requisite: Digital Logic Design

Objectives

The course aims to understand how device dependent programming can be performed. To understand the programming model of Intel 8086 and above processors. To be able to develop low level programs for an Intel based machine. This course includes detailed discussion on various topics, Comparison of Low Level and High Level Languages, Basic Organization of a Conceptual Computer, Organization of an Intel based Micro Computer, Programming Model of Intel 8086 and above, Memory Organization, Intel Based Computers and Addressing Modes, programs with Interactive Input and Output , utilizing of arithmetic and logical expressions ,Transfer Instructions, Unconditional & Conditional Program Transfer Instructions, Procedure and Recursion, String instruction, Software Interrupt, Intercepting Interrupts, and File operations.

Learning Outcomes

- **Demonstrate** Intel x86 Assembly Language and CPU simulator (**PLO 5**).
- **Understand** the internal working of a microprocessor registers, ISA and interrupts (**C2 – PLO 2**).
- **Understand** Assembly Language Programming Concepts for a microprocessor (**C2 – PLO 2**).

Course Outline

Unit 1. Introduction to Framework

Comparison of low level and high level languages Registers types (General) (16-bit) : General purpose register ,Special purpose register, Introduction and usage of RAM, Processor, Registers, System Bus, Instruction Execution Cycle, Assembly and Machine Language, Assembler, Linker and Link Libraries.

Unit 2. Computer Function and Interconnection, Assembler

Instruction Cycle , Execute Cycle , Interrupts, Interrupt Cycle MASM, MIPS, Basic about MASM, Working on MASM, A sample Hello World Program, Defining Data in MASM Assembler, Practical implementation of Add Commands, Practical implementation of Subtract Commands.

Unit 3. Implementation of Functions

Adding and subtracting numbers in registers, Declaration and initialization of variables, Moving data from variable to register, Data Definition Statement, BYTE and SBYTE Data , WORD and SWORD Data, Defining DWORD and SDWORD Data, Knowledge about different data types, Getting input from user, Printing string on screen, Getting character value form user, Displaying character value.

Unit 4. Operations, Array & Loops

Jumps Based on Specific Flags, Jumps Based on Equality, Simple jump statements, Jumps based on specific condition, Practice on MASM in class, Byte Array, Word Array, DWORD Array, LOOP, Simple LOOP, LOOPZ, LOOPE, LOOPNZ, LOOPNE.

Unit 5. Procedures, File Operations

Procedures: Labels in procedures, Stack, Runtime Stack, Conditional Control Flow Directives, Compound Expressions, Data Representation & Conversion, Opening a file, closing a file, Reading a file, writing a file, seeking a file.

Recommended Books/Reference Material

1. Britton, R. (2002). MIPS assembly language programming.
2. Bryant, R. E., & O'Hallaron, D. R. (2011). Computer systems: a programmer's perspective. Prentice Hall.
3. Hohl, W., & Hinds, C. (2014). ARM Assembly Language: Fundamentals and Techniques.
4. Irvine, K. R. (2003). Assembly language for Intel-based computers (pp. 601-608). Prentice Hall.
5. Mano, M. M. (1993). Computer system architecture. Prentice-Hall, Inc...

6. Null, L. (2023). The essentials of computer organization and architecture. Jones & Bartlett Learning.
7. Stallings, W. (2010). Computer organization and architecture designing for performance eighth edition.
8. Streib, J. T. (2020). Guide to assembly language: a concise introduction. Springer Nature.
9. Tanenbaum, A. S. (2016). Structured computer organization. Pearson Education India.

Object Oriented Programming

BS-Computer Science

Course Code: CS-125

Credit Hours: 03

Pre-requisite: Programming Fundamentals

Objectives

This course teaches object-oriented programming to those who have learnt basic programming concepts and are ready to learn in-depth programming. It focuses on object-oriented programming using C++. The main concepts discussed are: Objects, Data Abstraction, Data Encapsulation, Polymorphism, and Inheritance. The C++ language constructs will be taught that are used to implement these concepts. For example, Classes, Overloaded Operators, Overridden Methods, Friend Functions, Virtual Functions, and Templates, etc.

Learning Outcomes

- **Explain** knowledge of underlying concepts of object-oriented paradigm (**C2 – PLO 2**).
- **Develop** an understanding of object-oriented design artifacts and their mapping to object-oriented programming (**C6 – PLO 4**).
- **Design** and implement object-oriented solutions for small systems involving single/multiple objects (**C6 – PLO 4**).

Course Outline

Unit 1. Characteristics of Object-Oriented Languages, Structures & Functions

Beginning of programming, Structured programming, Object oriented programming, Objects, Classes, Inheritance, Reusability, Data abstraction, Data encapsulation, Introduction to .NET and Visual Studio, Structure basics, Structure within structures, Structures in detail, Enumerations, Simple functions, Passing arguments to functions, Returning values from functions, Reference arguments, Overloaded functions, Recursion, Inline functions, Default arguments, Const function arguments.

Unit 2. Object & Classes

Basics of class and objects with real world example, with programming example, Data member and C++ objects as data types, Constructors, Destructors, Access specifier, Object as function arguments, Overloaded constructors, Member functions defined outside class, Objects as arguments, The default copy constructor, Returning objects from function, Class, object and memory, Static class data, Const and classes, Const member function, Const objects, Identifying class attributes, Array fundamentals, Array as class members, Array of objects.

Unit 3. String & Operator Overloading, Inheritance, Pointers

Standard string class, Input/output with strings, Finding & Modifying string objects, Comparing string objects, Overloading unary operator, Overloading binary operator, Data conversion, Conversion between basic types, Conversion between objects and basic types, Derived class and base class, Public, private and protected classes, Accessing base class members, ,The protected class specifier, Derived class constructor, Overriding member functions, Class hierarchies, Scope resolution with overridden functions, Public and private inheritance, Access combinations, Access specifier, Level of inheritance, Multiple inheritance, Ambiguity in multiple inheritance. Containership: classes within classes, Composition and aggregation, Inheritance and program development Pointer basics concepts, Addresses and pointers, The address of operator , Pointer and arrays, Pointers and functions, Pointers and c type string, Memory management, The new operator, The delete operator, Pointers to objects, Pointers to pointers..

Unit 4. Virtual Functions & Polymorphism

Normal member function accessed with and without pointer, Virtual member function accessed with and without pointer, Abstract class and pure virtual function, Late binding, Friend functions, Friend classes, Static functions, The 'this' pointer (Pointer to object, Virtual functions, Pure virtual functions, Type of polymorphism, Compile time and run time, Function overloading, Operator overloading.

Unit 5. Multi File Programs, Templates & Exceptions

Reasons for multi file programs, creating a multi file program, Function overloading, Operator overloading, Header file, Directory, Projects, Function templates, Class templates, why do we need exception, Exception syntax.

Recommended Books/Reference Material

1. Barbara, S. B. L. J. L., & Moo, E. (2013). C++ Primer.
2. Budd, T. (2008). Introduction to object-oriented programming. Pearson Education India.
3. Deitel, H., & Deitel, P. C. (2021). How to program. Pearson.
4. Deitel, P. J., & Deitel, H. M. (2018). C++ how to program: introducing the new C++ 14 standard.
5. Gabbrielli, M., & Martini, S. (2023). Programming languages: principles and paradigms. Springer Nature.
6. Gaddis, T., Walters, J., & Muganda, G. (2016). Starting out with C++ early objects. Pearson.
7. Horton, I. (2011). Ivor Horton's Beginning Java. John Wiley & Sons.
Lafore, R. (1997). Object-oriented programming in C++. Pearson Education.
8. Weisfeld, M. (2008). The object-oriented thought process. Pearson Education.

Object Oriented Programming LAB

BS-Computer Science

Course Code: CS-125L

Credit Hours: 01

Pre-requisite: Programming Fundamentals

Objectives

This course emphasis on intensive study of object-oriented programming using C++. Abstract data types, object instantiation, inheritance, polymorphism, composition, member access control, templates, overloaded operators, exception handling, use of C++ headers, and class libraries will be studied.

Learning Outcomes

- **Explain** knowledge of underlying concepts of object-oriented paradigm (C2 – PLO 2).
- **Develop** an understanding of object-oriented design artifacts and their mapping to object-oriented programming (C6 – PLO 4).
- **Design** and implement object-oriented solutions for small systems involving single/multiple objects (C6 – PLO 4).

Course Outline

Unit 1. Introduction to .NET and Visual Studio Framework

Objects, Classes, Inheritance, Reusability, Data abstraction, Data encapsulation, Structure basics, Structure within structures, Enumerations, Simple functions, Passing arguments to functions, Returning values from functions, Reference arguments, Overloaded functions, Recursion, Inline functions, Default arguments, Const function arguments.

Unit 2. Object & Classes

C++ objects as data types, Constructors, Destructors, Access specifier, Object as function arguments, Overloaded constructors, Member functions defined outside class, Objects as arguments, Returning objects from function, Class, object and memory, Static class data, Const and classes, Const member function, Array fundamentals.

Unit 3. String & Operator Overloading, Inheritance, Pointers

Standard string class, Input/output with strings, Finding & Modifying string objects, Comparing string objects, Overloading unary operator, Overloading binary operator, Data conversion, Conversion between basic types, Conversion between objects and basic types, Derived class and base class, Public, private and protected classes, Accessing base class members, ,The protected class specifier, Derived class constructor, Overriding member functions, Class hierarchies, Scope resolution with overridden functions, Public and private inheritance, Access combinations, Access specifier, Level of inheritance, Multiple inheritance, Ambiguity in multiple inheritance. Containership: classes within classes, Composition and aggregation, Inheritance and program development Pointer basics concepts, Addresses and pointers, The address of operator , Pointer and arrays, Pointers and functions, Pointers and c type string, Memory management, The new operator, The delete operator, Pointers to objects, Pointers to pointers..

Unit 4. Virtual Functions & Polymorphism

Normal member function accessed with and without pointer, Virtual member function accessed with and without pointer, Abstract class and pure virtual function, Late binding, Friend functions, Friend classes, Static functions, The ‘this’ pointer (Pointer to object, Virtual functions, Pure virtual functions, Type of polymorphism, Compile time and run time, Function overloading, Operator overloading.

Unit 5. Multi File Programs, Templates & Exceptions

Reasons for multi file programs, creating a multi file program, Function overloading, Operator overloading, Header file, Directory, Projects, Function templates, Class templates, Why do we need exception, Exception syntax.

Recommended Books/Reference Material

1. Barbara, S. B. L. J. L., & Moo, E. (2013). C++ Primer.
2. Budd, T. (2008). Introduction to object-oriented programming. Pearson Education India.
3. Deitel, H., & Deitel, P. C. (2021). How to program. Pearson.

4. Deitel, P. J., & Deitel, H. M. (2018). C++ how to program: introducing the new C++ 14 standard.
5. Gabbrielli, M., & Martini, S. (2023). Programming languages: principles and paradigms. Springer Nature.
6. Gaddis, T., Walters, J., & Muganda, G. (2016). Starting out with C++ early objects. Pearson.
7. Horton, I. (2011). Ivor Horton's Beginning Java. John Wiley & Sons.
- Lafore, R. (1997). Object-oriented programming in C++. Pearson Education.
8. Weisfeld, M. (2008). The object-oriented thought process. Pearson Education.

Data Structures

BS-Computer Science

Course Code: CS-202

Credit Hours: 03

Pre-requisite: Object Oriented Programming

Objectives

A detailed study of Basic Structures commonly used in Data Processing, Implementation (in C++) and Applications of basic data structures. A Comparative study of different Sorting and Searching Techniques. This course will focus on data structures and algorithms for manipulating them. Data structures for storing information in table's lists, stacks, queues, trees and graphs will be covered. Basic algorithms for creating, manipulating and using these structures will also be discussed. Different types of searching and sorting technique will also be introduced and will be compared. Students will carry out a number of programming assignments, which will emphasize various aspects of data organization and manipulation process.

Learning Outcomes

- **Implement** various data structures and their algorithms (C3 – PLO 2).
- **Apply** them in implementing simple applications (C3 – PLO 2).
- **Analyze** simple algorithms and determine their complexities (C4 – PLO 3).
- **Apply** the knowledge of data structure to other application domains (C3 – PLO 2).

- **Design** new data structures and algorithms to solve problems (C6 – PLO 4).

Course Outline

Unit 1. Introduction, Array & Stack

Introduction to Course, Review of Object Oriented Programming Concepts, Data Structures, Abstract Data Type, Revision of arrays, Polynomial as ADT, Stack, The Stack ADT, Expressions, Postfix & Prefix Notation Infix to postfix and prefix conversion Postfix and prefix evaluation.

Unit 2. Queue, Recursion and Link List

Queue (array implementation) Variation of Queue ADT i.e. Circular and Double Ended Queue. Applications of Queues, Recursive Definition and Processes, Direct and Indirect Recursion, Binary Search and Towers of Hanoi as example, Writing Recursive Programs, conversion of recursive algorithms into iterative algorithms, Linear Single Link List, and Linked Stacks and Queues, Containers and Iterators, Linear Linked list Iterator, Linear Doubly Link List, Circular Lists: Singly and Doubly and Its Iterator.

Unit 3. List Based Data Structure, Trees & Heap

Array-based implementation of all List-based Data Structures, Overview of Composite Data Structures: Multi-Stack, Multi-Queue, Generalized List, etc. Introduction to Trees, Tree Terminology, Logical construction and Representation of Trees, Introduction to Binary Tree ADT, Mathematical properties, Array Implementation of Binary Trees (Insertion and Traversing), Link Implementation of Binary Trees, Heaps (MinHeap and MaxHeap) and heaps as an priority queues, Min-Max Heap.

Unit 4. AVL Trees & Spanning Trees, Graphs

AVL trees and insertion, Deletion Operation in AVL trees, Introduction to graph and related terminology, Elementary Graph Operations, Minimum cost spanning trees, balanced search trees theoretical Comprehension of insertion/deletion.

Unit 5. Trees Insertion and Deletion, Sorting

Tree Deletion, Tree Insertion/Deletion, B-Trees Insertion/deletion, Hashing and Overflow Handling, Introduction to sorting types and Techniques.

Recommended Books/Reference Material

1. Carrano, F. (2011). Data Structures and Abstractions with Java. Prentice Hall Press.
2. Dale, N. B. (2003). C++ plus data structures. Jones & Bartlett Learning.
3. Drozdek, A. (2012). Data Structures and algorithms in C++. Cengage Learning.
4. Gottschling, P. (2021). Discovering Modern C++. Addison-Wesley Professional.
5. Hubbard, J. R. (2021). Programming with C++.
Langsam, Y., Augenstein, M. J., & Tenenbaum, A. M. (1996). Data Structures using C and C++. Prentice Hall Press.
6. Mutongwa, S. M., & Abeka, S. (2019). A Comparative Study of C, C++, C# and Java Programming Languages: Underpinning Structure Equation Modeling, Data Structures and Algorithm.
7. Parker, A. (2018). Algorithms and Data Structures in C++. Routledge.
8. Weiss, M. A. (2014). Data structures and algorithm analysis in C++, 4th Edition. Pearson. ISBN: 9780132847377

Data Structures LAB

BS-Computer Science

Course Code: CS-202L

Credit Hours: 01

Pre-requisite: Object Oriented Programming

Objectives

Main objective of this course is to enable students to understand and implement common data structures and algorithms to manipulate those data structures using C++ techniques. Emphasis will be on a lot of practice in writing codes to implement all the major data structures.

Learning Outcomes

- **Implement** the abstract data types and algorithms related to various data structures (**PLO 2**).
- **Demonstrate** linear and non-linear data structures and related algorithms (**PLO 2**).
- **Organize** the experiments in the form of a LAB report (**PLO 7**).

Course Outline

Unit 1. Introduction to Framework, Array & Stack

Review of Object Oriented Programming Concepts, Data Structures, Abstract Data Type, Revision of arrays, and Polynomial as ADT, Stack, The Stack ADT, Expressions, and Postfix & Prefix Notation Infix to postfix and prefix conversion Postfix and prefix evaluation.

Unit 2. Queue, Recursion and Link List

Queue (array implementation) Variation of Queue ADT i.e. Circular and Double Ended Queue. Applications of Queues, Recursive Definition and Processes, Direct and Indirect Recursion, Binary Search and Towers of Hanoi as example, Writing Recursive Programs, conversion of recursive algorithms into iterative algorithms, Linear Single Link List, and Linked Stacks and Queues, Containers and Iterators, Linear Linked list Iterator, Linear Doubly Link List, Circular Lists: Singly and Doubly and Its Iterator.

Unit 3. List Based Data Structure, Trees & Heap

Array-based implementation of all List-based Data Structures, Overview of Composite Data Structures: Multi-Stack, Multi-Queue, Generalized List, etc., Logical construction and Representation of Trees, Introduction to Binary Tree ADT, Mathematical properties, Array Implementation of Binary Trees (Insertion and Traversing), Link Implementation of Binary Trees, Heaps (MinHeap and MaxHeap).

Unit 4. AVL Trees & Spanning Trees, Graphs

AVL trees and insertion, Deletion Operation in AVL trees, Introduction to graph and related terminology, Elementary Graph Operations, Minimum cost spanning trees, Balanced search trees.

Unit 5. Trees Insertion and Deletion, Sorting

Tree Deletion, Tree Insertion/Deletion, B-Trees Insertion/deletion, Hashing and Overflow Handling, Introduction to sorting types and Techniques, Review of course.

Recommended Books/Reference Material

1. Carrano, F. (2011). Data Structures and Abstractions with Java. Prentice Hall Press.
2. Dale, N. B. (2003). C++ plus data structures. Jones & Bartlett Learning.
3. Drozdek, A. (2012). Data Structures and algorithms in C++. Cengage Learning.
4. Gottschling, P. (2021). Discovering Modern C++. Addison-Wesley Professional.
5. Hubbard, J. R. (2021). Programming with C++.
Langsam, Y., Augenstein, M. J., & Tenenbaum, A. M. (1996). Data Structures using C and C++. Prentice Hall Press.
6. Mutongwa, S. M., & Abeka, S. (2019). A Comparative Study of C, C++, C# and Java Programming Languages: Underpinning Structure Equation Modeling, Data Structures and Algorithm.
7. Parker, A. (2018). Algorithms and Data Structures in C++. Routledge.
8. Weiss, M. A. (2014). Data structures and algorithm analysis in C++, 4th Edition. Pearson. ISBN: 9780132847377

Software Engineering

BS-Computer Science

Course Code: CS-201

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course aims to develop the students' knowledge of basic software terminologies, software life cycle activities, software process models and information systems. The students will also be familiarized with the UML to model software development.

Learning Outcomes

- **Describe** various software engineering processes and activates (C2 – PLO 2).
- **Apply** the system modeling techniques to model a medium size software system (C3 – PLO 4).
- **Apply** software quality assurance and testing principles to medium size software systems (C3 – PLO 4).
- **Discuss** key principles and common methods for software project management such as scheduling, size estimation, cost estimation and risk analysis (C2 – PLO 7).

Course Outline

Unit 1. Introduction

The Scope of Software Engineering, Definition and Introduction to software engineering. History of SE, The Software: Software characteristics, Types of software, difference between S/W engineering and CS and System Engineering, Ethical responsibilities, Software Processes, CMM and its level.

Unit 2. Process Models

A layered technology, S/W Processes Models , Reuse Oriented Software Engineering .Software Process Activities, Software Specification, Software Design and Implementation .Software Validation, Software Evolution. Coping with change. Software Requirement, Functional and nonfunctional requirement, Requirements Specification, Requirement elicitation and analysis, Requirement Evolution.

Unit 3. Introduction to UML

Software Modeling, UML Notations, Use case Diagram, Class Diagram, Activity Diagram, State machine diagram.

Unit 4. Application Architectures

Architectural Design, Architectural Views, And Architectural Patterns: Layered Systems, Repository Systems, Client Server System, And Application Architectures: Transaction Processing Systems, Information Systems, Language Processing Systems, Software Design, and Object Oriented Design, Design Patterns.

Unit 5. Testing & Management

Project Management Concepts, Software Testing, Development Testing: Unit Testing, Component Testing, System Testing, Test Driven Development, Release Testing: Cyclomatic Complexity, Software Configuration Management, Risk Management.

Recommended Books/Reference Material

1. Foster, E., & Towle Jr, B. (2021). Software engineering: a methodical approach. Auerbach Publications.
2. Pressman, R. S. (2005). Software engineering: a practitioner's approach. Palgrave macmillan.
3. Pressman, R. S., & Bruce R. Maxim, D. (2014). Software Engineering: A Practitioner's Approach. ISBN: 9780078022128.
4. Sommerville, I. (2015). Software engineering, 10th Edition. Pearson. ISBN: 9780133943030.
5. Tsui, F., Karam, O., & Bernal, B. (2022). Essentials of software engineering. Jones & Bartlett Learning.

Analysis of Algorithms

BS-Computer Science

Course Code: CS-413

Credit Hours: 03

Pre-requisite: Data Structures

Objectives

Design algorithms using different algorithms design techniques i.e. Divide and Conquer, Dynamic Programming, Greedy Algorithms & Backtracking. Analyze Algorithms (estimate upper & lower bounds without coding and running the algorithms) and compare the efficiency of different algorithms for a problem. Implement and test algorithms. Logically think and develop problem solving skills.

Learning Outcomes

- **Explain** what is meant by “best”, “expected”, and “worst” case behavior of an algorithm (C2 – PLO 3).
- **Identify** the characteristics of data and/or other conditions or assumptions that lead to different behaviors (C2 – PLO 3).
- **Execute** informally the time and space complexity of simple algorithms (C3 – PLO 2).
- **Apply** strategies (brute-force, greedy, divide-and conquer, and dynamic programming) to solve an appropriate problem (C3 – PLO 4).
- **Solve** problems using graph algorithms, including single source and all-pairs shortest paths, and at least one minimum spanning tree algorithm (C3 – PLO 4).

Course Outline

Unit 1. Introduction

Introduction, Algorithm Design, Data Structures, Efficiency, Analysis of Algorithms, Mathematical Review, Mathematical Analysis of Algorithms, types of functions, Order of Growth and Asymptotic Notations.

Unit 2. Sorting Algorithms

Selection Sort algorithm, Insertion Sort algorithm, Divide and Conquer Algorithms, Merge Sort algorithm, Quick Sort algorithm, Bucket Sort algorithm, Radix Sort algorithm, Counting Sort algorithm. Heap Sort Algorithms, Heap operations and Heap sort Algorithm analysis, Heap insertion and deletion.

Unit 3. Binary Search Tree & Hashing

Binary Search Tree Basics, Tree Searching Algorithms and Analysis, Analysis of Insertion and Deletion, Algorithms in BST and Hashing Basics, Hash functions, Analysis of Collision Resolution Techniques in Hashing.

Unit 4. Dynamic Programming & Greedy Algorithms

Dynamic Programming – 0-1 Knap Sack, Fractional Knap Sack, Longest Common Subsequence, Shortest Path Finding, Matrix Chain Multiplication Greedy Algorithms – Prim's Algorithm and Kruskal Algorithm, Dijkstra's Algorithm, Huffman Coding.

Unit 5. NP-Completeness, Randomized Algorithms

NP-Completeness - Polynomial time verification, Reducibility, NP-Completeness Proofs. Randomized Algorithms--Particle Swarm Optimization, Genetic Algorithms, And Differential Evolution.

Recommended Books/Reference Material

1. Allen, W. M. (2007). Data structures and algorithm analysis in C++. Pearson Education India.
2. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2022). Introduction to algorithms. MIT press.
3. Erickson, J. (2023). Algorithms.
4. Levitin, A. (2008). Introduction to design and analysis of algorithms, 2/E. Pearson Education India.
5. Sedgewick, R., & Wayne, K. (2011). Algorithms (4th edn). Google Scholar Google Scholar Digital Library Digital Library.
6. Thomas H, C., Charles, E., Ronald L, R., & Clifford, S. (2009). Introduction to Algorithms Third Edition.

Artificial Intelligence

BS-Computer Science

Course Code: CS-206

Credit Hours: 02

Pre-requisite: Object Oriented Programming

Objectives

Artificial Intelligence (AI) is a constantly and actively growing and changing field. In this course, students will learn the basics of modern AI as well as some of the representative applications of AI. This course introduces students to the basic knowledge representation, problem solving, and learning methods of artificial intelligence. Upon completion, students should be able to develop intelligent systems by assembling solutions to concrete computational problems; understand the role of knowledge representation, problem solving, and learning in intelligent-system engineering; and appreciate the role of problem solving, vision, and language in understanding human intelligence from a computational perspective.

Learning Outcomes

- Know various AI search algorithms (tree search, uninformed, informed, and heuristic), understand different types of AI agents, and know how to build simple knowledge-based systems **(PLO 2)**.
- Ability to apply knowledge representation, reasoning, and machine learning techniques to real-world problems **(PLO 4)**.

Course Outline

Unit 1. Introduction

What is AI, Major AI areas, Intelligent Agents: Agents and environments, Rationality? PEAS (Performance measure, Environment, Actuators, Sensors), Environment types, Agent Types, Problem solving through uninformed search: Breadth First Search, Depth First Search, Iterative DFS, Comparison of Search Algorithms.

Unit 2. Problem Solving Through Informed Search, Expert Systems

Problem solving through informed search: Heuristically Informed Methods, Hill Climbing, Beam Search, Best First Search, A*Procedure, Adversarial Search, Min-Max Procedure, Static Evaluation Function, Alpha Beta Pruning, Expert Systems:

Knowledge Base Expert System Their Types and Application, Working of Expert Systems with its different components.

Unit 3. Neural Networks, Back Prop Algorithms

Binary Expert Systems: Developing an Expert System, Identifying the problem, forward and Backward Chaining. Neural Network: Introduction to Artificial Neural Networks (ANN), ANN Applications, Topologies of ANN, Single Layer perception (SLP).

Unit 4. Genetic Algorithm, Fuzzy System, Classification

Genetic Algorithm: Introduction to Evolutionary Computing, Genetic Algorithm (GA), Genetic operators (Crossover and Mutation) and its applications. Fuzzy System: Fuzzy Set Theory, Fuzzy Inference, And Classification: Decision Tree, Bayes Classification

Unit 5. Machine Learning, Introduction to Computer Vision, Mining Frequent Patterns

Machine Learning: Introduction to Learning, Supervised Machine Learning: Unsupervised Learning, K-means Clustering Algorithm, and Introduction to Computer Vision (CV), Pattern Recognition, Mining Frequent Patterns, Association and Correlation.

Recommended Books/Reference Material

1. Finlay, J. (2020). An introduction to artificial intelligence. Crc Press.
2. Joshi, P. (2017). Artificial intelligence with python. Packt Publishing Ltd.
3. Le, D., Chung, K., Quach, S., & Thaichon, P. (2022). Introduction to artificial intelligence (AI). Artificial Intelligence for Marketing Management.
4. Luger, G. F. (2005). Artificial intelligence: structures and strategies for complex problem solving. Pearson education.
5. Mehrotra, D. (2019). Basics of artificial intelligence & machine learning. Notion Press.
6. Miller, B. N., Ranum, D. L., & Anderson, J. (2019). Python programming in context. Jones & Bartlett Learning.

Artificial Intelligence LAB

BS-Computer Science

Course Code: CS-206L

Credit Hours: 01

Pre-requisite: Object Oriented Programming

Objectives

Study the applications of AI and agent-based approach to AI and First-order predicate calculus, logical reasoning and problem-solving using Prolog language. To study and discuss various techniques and algorithms of AI used in general problem solving, optimization problems, constraint satisfaction problems, and game programming. Familiarize students with various sub-areas of AI, such as expert systems, natural language processing and machine learning.

Learning Outcomes

- **Explain** artificial intelligence, its characteristics and its application areas (**C2 – PLO 2**).
- **Formulate** real-world problems as state space problems, optimization problems or constraint satisfaction problems (**PLO 3**).
- **Implement** appropriate algorithms and AI techniques to solve complex problems (**PLO 4**).
- **Develop** an expert system by using appropriate tools and techniques (**PLO 4**).

Course Outline

Unit 1. Problem Solving

Problem solving (2 jug puzzles, 3 jug puzzles, lion man puzzles, vacuum cleaner puzzle. Implementation of 2 jug puzzles, 3 jug puzzles, lion man puzzles, vacuum cleaner puzzle using DFS and BFS.

Unit 2. Cost Search Algorithm Implementation

Implementation of A* and Uniform cost search algorithms to solve problems.
Implementation of different games using game search tree algorithms

Unit 3. Game Search Algorithm Implementation

Implementation of different games using game search tree algorithm Solution of 8 queen problem using genetic algorithm.

Unit 4. 8 Queen Problem and Prolog Language

Solution of 8 queen problem using genetic algorithm. Learning Prolog language for Logic Practice of Prolog and Lisp.

Unit 5. K Means Clustering Algorithm and Neural Networks

Implementation of K mean clustering algorithm. Implementation of single layer neural network.

Recommended Books/Reference Material

1. Finlay, J. (2020). An introduction to artificial intelligence. Crc Press.
2. Joshi, P. (2017). Artificial intelligence with python. Packt Publishing Ltd.
3. Le, D., Chung, K., Quach, S., & Thaichon, P. (2022). Introduction to artificial intelligence (AI). Artificial Intelligence for Marketing Management.
4. Luger, G. F. (2005). Artificial intelligence: structures and strategies for complex problem solving. Pearson education.
5. Mehrotra, D. (2019). Basics of artificial intelligence & machine learning. Notion Press.
6. Miller, B. N., Ranum, D. L., & Anderson, J. (2019). Python programming in context. Jones & Bartlett Learning.

Digital Logic Design

BS-Computer Science

Course Code: CS-126

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course will provide an introduction to the fundamental concepts and techniques underlying the construction of digital systems. The course covers design of digital systems using standard, small, and medium scale integrated circuits. The main emphasis is on the

theoretical concepts and systematic synthesis techniques that can be applied to the design of practical digital systems.

Learning Outcomes

- **Discuss** knowledge related to the concepts, tools and techniques for the design of digital electronic circuits (**C2 – PLO 2**).
- **Demonstrate** the skills to design and analyze both combinational and sequential circuits using a variety of techniques (**C3 – PLO 4**).
- **Apply** the acquired knowledge to simulate and implement small-scale digital circuits (**C3 – PLO 5**).
- **Understand** the relationship between abstract logic characterizations and practical electrical implementations (**C2 – PLO 1**).

Course Outline

Unit 1. Characteristics of Object-Oriented Languages, Structures & Functions

Introduction, Digital Systems and Information, Digital World, Analog Vs Digital, Number Systems; Base 2, Base 8, Base 16 , Binary Conversion Between Different Bases, Two's Complement, Binary Arithmetic Codes.

Unit 2. Logic Gates, K-Map

Combinational Logic Circuits, Gates (AND, OR, XOR etc), Combinational Logic Circuits, Boolean Algebra, Duality Principle, Combinational Logic, Standard Forms., SOP and POS Forms , Min term, Max term, Canonical SOP, Canonical POS, Multiple Level Circuit Optimization, K-MAP, K-MAP Manipulation, Three Four Variable MAP , NAND NOR Gate Implementation, XOR Gate Implementation, Odd Function.

Unit 3. Combinational Circuits

Combinational Logic Design Using Building Blocks: Multiplexers, DE multiplexers, Decoders, Encoders, Arithmetic Functions: Adders-Sub tractors

Arithmetic Functions (continued): Binary Multiplication, Contraction, Incrementing, and Decrementing.

Unit 4. Sequential Circuits

Basic Latches, S-R Latch, and Master –Slave Flip-Flops, Edge Triggered Flip-Flops, Sequential Circuits: Flip-Flops, D FFs, and Sequential Circuits: JK and T Flip Flops, Finite State Machines: Analysis.

Unit 5. Finite State Machines

Finite State Machines: State Table, Design, State Diagram, Applications, Diagram Model, Building Blocks, Programmable Implementation of Functions: PLA, PAL, ROM, Presentation and demonstrations of course project, Revision /Future perspective of the Course.

Recommended Books/Reference Material

1. Brown, S., & Vranesic, Z. (2008). EBOOK: Fundamentals of Digital Logic. McGraw Hill.
2. Floyd, T. L. (2009). Instructor's Resource Manual to Accompany Digital Fundamentals Tenth Edition. Pearson Prentice Hall.
3. Floyd, T. L. (2015). Digital Fundamentals, by Pearson. Pearson Education India.
4. LaMeres, B. J. (2023). Introduction to logic circuits & logic design with VHDL. Springer Nature.
5. Mano, M. M. (2017). Digital logic and computer design. Pearson Education India.
6. Roth Jr, C. H., Kinney, L. L., & John, E. B. (2020). Fundamentals of logic design. Cengage Learning.
7. Tocci, R. J. (1991). Digital systems: principles and applications. Pearson Education India.

Digital Logic Design LAB

BS-Computer Science

Course Code: CS-126L

Credit Hours: 01

Pre-requisite: Nil

Objectives

This course will describe and identify fundamental concepts of digital logic design including basic and universal gates, number systems, and binary coded systems, basic components of combinational and sequential circuits. It will transform the acquired knowledge to apply techniques related to the design and analysis of digital electronic circuits including Boolean algebra and multi-variable Karnaugh map methods. It will also analyze small-scale combinational and sequential digital circuits, design small-scale combinational and synchronous sequential digital circuit using Boolean algebra and K-maps.

Learning Outcomes

- **Discuss** knowledge related to the concepts, tools and techniques for the design of digital electronic circuits (**C2 – PLO 2**).
- **Demonstrate** the skills to design and analyze both combinational and sequential circuits using a variety of techniques (**PLO 4**).
- **Perform** the acquired knowledge to simulate and implement small-scale digital circuits (**PLO 5**).
- **Understand** the relationship between abstract logic characterizations and practical electrical implementations (**C2 – PLO 1**).

Course Outline

Unit 1. Introduction to Gates

Familiarization and verification of basic logic gates using ICs.

Unit 2. Verification of Basic Identities of Boolean Algebra

Verification of basic identities of Boolean algebra: Identity Law, Null (or Dominance) Law, Idempotent Law, Inverse Law, Double Complement Law, Associative Property, Distributive Property, etc.

Unit 3. Introduction to Combinational Circuit Modeling

Introduction to Combinational Circuit Modeling & Implementation of basic and universal gates.

Unit 4. Implementation of Half Adder and Full Adder

Implementation and Verification of half adder and full adder using basic gates and using universal gates. Implementation and verification of half adder. Implementation and verification of Full adder.

Unit 5. Implementation of BCD

Implementation of BCD to seven segment converter. Implementation of BCD to excess-3 code conversion. Implementation and verification of 4 x 1 multiplexer and 1 x 4 DE multiplexer circuits. RS flip-flop and D flip-flop using NAND gates.

Recommended Books/Reference Material

1. Brown, S., & Vranesic, Z. (2008). EBOOK: Fundamentals of Digital Logic. McGraw Hill.
2. Floyd, T. L. (2009). Instructor's Resource Manual to Accompany Digital Fundamentals Tenth Edition. Pearson Prentice Hall.
3. Floyd, T. L. (2015). Digital Fundamentals, by Pearson. Pearson Education India.
4. LaMeres, B. J. (2023). Introduction to logic circuits & logic design with VHDL. Springer Nature.
5. Mano, M. M. (2017). Digital logic and computer design. Pearson Education India.
6. Roth Jr, C. H., Kinney, L. L., & John, E. B. (2020). Fundamentals of logic design. Cengage Learning.
7. Tocci, R. J. (1991). Digital systems: principles and applications. Pearson Education India.

Database Systems

BS-Computer Science

Course Code: CS-203

Credit Hours: 03

Pre-requisite: Nil

Objectives

This module introduces the basic concepts of databases and database management systems. Help students understand benefits that can be attained by using both Relational Database Management System and NoSQL. It Enable students to become comfortable in designing databases and schemas, plus writing both simple and complex queries (SQL and XPath) to manipulate database.

Learning Outcomes

- **Explain** fundamental database concepts (C2 – PLO 2).
- **Design** conceptual, logical and physical database schemas using various data models (C6 – PLO 4).
- **Identify** functional dependencies & resolve database anomalies by normalizing database tables (C2 – PLO 3).

Course Outline

Unit 1. Introduction to Database Approach, Database System Models

Data, Processing & Information, The Role of Data in Business, Meta Data & Meta Meta Data, The Database , Evaluation of Database, Types of Files, Traditional File Processing Systems, Database Approach, Advantages & Disadvantages, Components of the DBMS Environment, Centralized Database, Personal Computer Database, Client/Server database, Distributed Database, Teleprocessing, Concept and Evaluation Of Database Models, Flat file Model, Hierarchical model, Network Model, Relational Model, Object Relational Model, Object Based data Model, ANSI-SPARC Architecture: External Level, Conceptual Level, Internal Level.

Unit 2. Database Design Fact Finding Techniques

Data Modeling, Phases of Database Design, DBMS Selection, Implementation, Testing, Data Administration & Database Administration, Data Administration, Database Administration, Comparison, Database Analysis, Uses of Fact-Finding Techniques, Fact Finding Techniques, Examining Documentation, Interviewing, Observation, Research, Questionnaires, A worked Example, Logical Design, Conceptual Database Design, Introduction to Entity-Relational model, Relationship Types: Degree of Relationship Type

Unit 3. Specialization/Generalization for EERD

Simple & Composite Attributes, Single Valued & Multi-Valued Attributes, Derived Attributes, Keys, Strong & Weak Entity Types, Attributes on Relationships, Cardinality and Participation Constraint, Super Classes & Sub Classes, Super Class / Sub Class Relationships, Attributes Inheritance, Specialization Process, Generalization Process, Constraints on, Specialization/Generalization, Aggregation, Composition, Normalization: First Normal Form, Second Normal Form: Full Functional Dependency, Third Normal Form: Transitive Dependency, Boyce-Codd Normal Form, Fourth Normal Form, Multi-valued Dependency, Fifth Normal Form (5 NF), Lossless-Join Dependency.

Unit 4. Data Integrity and Overview of SQL

Types of Data integrity (Entity Integrity, Domain Integrity, Referential Integrity, User-defined Integrity), Constraints (PRIMARY KEY Constraint, UNIQUE Constraint, IDENTITY Property, DEFAULT Definition, FOREIGN Key Constraint, CHECK Constraint)

Unit 5. Transaction Management, Deadlocks

File organization and storage structure, Unordered File, Ordered File, Hash Files, Hash Functions, Types of Indexes, Indexed sequential Files, Secondary indexes, Multilevel indexes, B+ trees, Clustered, Non Clustered Indexes, Threats, Counter Measures: Authorization, Views, Backup and Recovery, Integrity, Encryption, RAID, Transaction and Scheduling, Concurrent Execution of Transactions, Serializability, Lock-Based Concurrency Control, Deadlocks, Incremental Log with

Deferred Updates, Incremental Log with immediate Updates, Concurrency Control, Deadlock detection, Deadlock prevention, Time stamping, Data Warehousing & Data Mining Concepts.

Recommended Books/Reference Material

1. Date, C. J. (2019). Database design and relational theory: normal forms and all that jazz. Apress.
2. Foster, E., & Godbole, S. (2022). Database systems: a pragmatic approach. Auerbach Publications.
3. Meier, A., & Kaufmann, M. (2019). SQL & NoSQL databases. Berlin/Heidelberg, Germany: Springer Fachmedien Wiesbaden.
4. Besta, M., Gerstenberger, R., Peter, E., Fischer, M., Podstawski, M., Barthels, C., . & Hoefler, T. (2023). Demystifying graph databases: Analysis and taxonomy of data organization, system designs, and graph queries. ACM Computing Surveys, 56(2), 1-40.

Database System LAB

BS-Computer Science

Course Code: CS-203L

Credit Hours: 01

Pre-requisite: Nil

Objectives

This module introduces the basic concepts of databases and database management systems. Help students understand benefits that can be attained by using both Relational Database Management System and NoSql. It Enable students to become comfortable in designing databases and schemas, plus writing both simple and complex queries (SQL and XPath) to manipulate database

Learning Outcomes:

- **Explain** fundamental database concepts (C2 – PLO 2).
- **Design** conceptual, logical and physical database schemas using various data models (C6 – PLO 4).

- **Identify** functional dependencies & resolve database anomalies by normalizing database tables (C2 – PLO 3).

Course Outline

Unit 1. Introduction to DBMS Tools

Overview of DBMS Tools, The Role of Data in Business, Meta Data & Meta Meta Data, The Database Limitations, Database Approach, Centralized Database, Personal Computer Database, Client/Server database, Distributed Database, Teleprocessing, Concept and Evaluation of Database Model, Flat file Model, Hierarchical model, Network Model, Relational Model, Object Relational Model, Object Based data Model

Unit 2. Database Design

Data Modeling, Phases of Database Design, DBMS Selection, Implementation, Testing, Data Administration & Database, Logical Design, Conceptual Database Design, Introduction to Entity-Relational model, Entity Types, Relationship Types: Degree of Relationship Type, Recursive Relationship.

Unit 3. Introduction to SQL

History of SQL, Importance & Environment of SQL, Categories of SQL Commands (DML, DDL, DCL), Create a Database, Creating Tables, Altering Table, Dropping Table, Creating Views, removing views, Restrictions on Views, Updating Views.

Unit 4. Implementation of SQL

The SELECT Clause, The FROM Clause, The WHERE Clause, Relational Operators, Logical Operators, Wildcard Characters, Understanding the NULL values and Expressions, ORDER BY Clause, Aggregate Functions in SQL, The GROUP BY Clause, The HAVING Clause, Sub Query, Types of Sub Query, Nested Sub query, Single row sub query, Multiple row sub query, Correlated Subquery, Parameters Queries, Multi Table Queries, Joins (Inner join, Outer Join, Left outer join, Right outer join), EXISTS and NOT EXISTS, Combining Results Tables, (UNION, INTERSECTION, EXCEPT), Changing the Content of Tables

using Action Queries (The INSERT table Statement, The DELETE table Statement, The UPDATE table Statement.

Unit 5. Implementation to Physical Database Design

Basic concepts, Unordered File, Ordered File, Hash Files, Hash Functions, Types of Indexes, Indexed sequential Files, Secondary indexes, Multilevel indexes, B+ trees, Backup and Recovery, Integrity, Encryption, RAID, Lock-Based Concurrency Control, Deadlocks, Incremental Log with Deferred Updates, Concurrency Control, Deadlock detection & prevention.

Recommended Books/Reference Material

1. Date, C. J. (2019). Database design and relational theory: normal forms and all that jazz. Apress.
2. Foster, E., & Godbole, S. (2022). Database systems: a pragmatic approach. Auerbach Publications.
3. Meier, A., & Kaufmann, M. (2019). SQL & NoSQL databases. Berlin/Heidelberg, Germany: Springer Fachmedien Wiesbaden.
4. Besta, M., Gerstenberger, R., Peter, E., Fischer, M., Podstawski, M., Barthels, C., . & Hoefler, T. (2023). Demystifying graph databases: Analysis and taxonomy of data organization, system designs, and graph queries. ACM Computing Surveys, 56(2), 1-40.

Computer Networks

BS-Computer Science

Course Code: CS-208

Credit Hours: 02

Pre-requisite: Nil

Objectives

To give understanding on how current flows through the p-n junction and relating this phenomenon to the characteristics and operation of the diodes, bipolar and field-effect transistors.

Learning Outcomes:

- **Explain** fundamental concepts of data communication and computer networks (C2 – PLO 1).
- **Explain** the layered architecture approach with reference to OSI Model (C2 – PLO 2).
- **Examine** the characteristics of different transmission media (C4 – PLO 3).
- **Implement** the IP addressing concepts and subnetting skills (P2 – PLO 4).
- **Apply** hands on experience of basic Computer Utility Tools (C3 – PLO 5).
- **Explain** Network Simulation and Analysis Tools (Opnet, NS2...) (C2 – PLO 5).

Course Outline

Unit 1. Introduction to Data Communications and Computer Networks, Protocol Layering

Data Communications, Communication Tasks, Data Representation (Text, Numbers, Images, Audio, Video), Data Flow (Simplex, Half Duplex, Full Duplex), Computer Networks, Network Criteria, Connection Types, Network Types, LAN (Wired and Wireless LAN), WAN (Circuit and Packet switch), Protocols and Standards:, Protocols and Standards, Syntax, Semantics, Timing, De facto, De Jure, Some Standard Organizations, Principles of protocol layering, Logical Connections, Layered Architecture, TCP/IP Protocol Suite: Overview of TCP/IP Protocol Suite and Addressing, OSI model.

Unit 2. Fundamentals of Data and Signals, Transmission Media

Analog and Digital Data, Periodic and Aperiodic Signals, Analog Signals, Sine Wave, Peak, Amplitude, Period and Frequency, Phase, Time and Frequency Domains, Composite Signals, Digital Signals, Bit Interval and Bit Rate, Analog and digital transmission, Treatment of Signals, Comparison of Digital and Analog Signals, Transmission Impairments, Attenuation, Distortion, Noise and its Types, Channel Capacity, Nyquist and Shannon Capacity Formula, Data Rate Limits, Performance, Guided Transmission Media: Twisted Pair, Coaxial Cable, Physical Structure, Connector Types, Applications, Fiber Optic physical structure, Guided

and Unguided Transmission media: Fiber Optic Propagation Modes, Connector Types, Applications, Ground Propagation, Unguided Propagation, Line of sight Propagation, Wireless Transmission Waves, Radio Waves, Unguided Transmission media.

Unit 3. Conversions & Multiplexing

Digital Data, Digital Signals, Line Coding, Unipolar, Polar, Bipolar, Techniques, NRZ-L, NRZI, Bipolar-AMI, Pseudoternary, Manchester, Differential Manchester, Analog Data, Digital Signals, Sampling, Pulse Amplitude Modulation (PAM), Pulse Code Modulation (PCM), Delta Modulation (DM), Parallel Transmission, Serial Transmission, Asynchronous and synchronous transmission, Digital Data, Analog Signals, Bit Rate and Baud Rate, Techniques, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Quadrature Amplitude Modulation (QAM), Analog Data, Analog Signals, Amplitude Modulation, Frequency Modulation, Phase Modulation, Frequency Division Multiplexing, Time Division Multiplexing, Interleaving and Bit Padding

Unit 4. Switching & Error Detection, Internetworking Devices, Internet Protocol (IP)

Circuit-Switched Networks, Datagram Networks, Virtual Circuit Networks, Types of Errors, Single bit and Burst Error, Parity Check (Single and Block Parity), Cyclic Redundancy Check (CRC), Cyclic Redundancy Check (CRC) , Checksum, Flow and Error Control, Protocols of Noiseless and Noisy Channels, Internetworking Devices, Internetworking Devices, Routers, Overview of TCP/IP Installation and Configuration of TCP/IP Protocol, Windows ,Components , Device Driver Management ,LAN Design Different Scenarios., Internet Protocol (IP), Comparison of IPv4 and IPv6 Headers, IP Addressing: Internet Address, Class full Addressing, Classes and Blocks, Masking.

Unit 5. Sub Netting, Protocols & Issues

Sub netting, Classless Addressing, Variable Length Blocks, Process-to- Process Communication, Addressing at Transport Layer, Connection Oriented Vs Connectionless Service, Reliable Vs Unreliable, User Datagram Protocol (UDP),

Title , Control Protocol (TCP), Application Layer, Client-Server Model , WWW, Application Layer:, DNS, Electronic Mail, FTP, Network Security Issues:, Basic overview of Cryptography and Security in Internet, Real Time Networking of devices using cables made in last session and file sharing and security, Wireless LAN Devices Orientation and implementation.

Recommended Books/Reference Material

1. Bertsekas, D., & Gallager, R. (2021). Data networks. Athena Scientific.
2. Dorlan, P. L. (2016). An introduction to computer networks. Autoedición.
3. Forouzan, B. A. (2012). Data Communications and Networking Global Edition 5e. McGraw Hill.
4. West, J. (2022). Data Communication and Computer Networks: A Business User's Approach. Cengage Learning.

Computer Networks LAB

BS-Computer Science

Course Code: CS-208L

Credit Hours: 01

Pre-requisite: Nil

Objectives

To introduce basic network devices and LAN technologies. To provide fundamental concepts of switched networks. To provide the IP addressing concepts and subnetting skills. To provide the necessary skills for LAN implementation.

Learning Outcomes:

- **Explain** fundamental concepts of data communication and computer networks (C2 – PLO 1).
- **Explain** the layered architecture approach with reference to OSI Model (C2 – PLO 2).
- **Examine** the characteristics of different transmission media (C4 – PLO 3).
- **Implement** the IP addressing concepts and subnetting skills (P2 – PLO 4).
- **Apply** hands on experience of basic Computer Utility Tools (C3 – PLO 5).

- **Explain** Network Simulation and Analysis Tools (Opnet, NS2...) (C2 – PLO 5).

Course Outline

Unit 1. Disk Management & Configuration of TCP/IP Protocol

Disk Management, Partition Magic, Data Recovery Tools, Backup Tools, Ghost Utility for Quick Installation, Deep Freeze Software, Installation and Configuration of TCP/IP Protocol, Windows Components, Device, Driver Management

Unit 2. Exploration of System Unit hardware

Exploration of System Unit hardware (hand on plug and play), Networking Devices Orientation and Comparisons of their Features, Cabling Using the EIA Standards, Straight, Cross over, Rollover using Twisted pair cable.

Unit 3. Orientation of Simulation Tools

Real Time Networking of devices using cables made in last session and file sharing and security, Orientation of Simulation Tools (Boson Sim/ Packet Tracer/ Opnet/ NS2/ENSP) Orientation of Simulation Tools (Boson Sim/ Packet Tracer/ Opnet/ NS2/ENSP)

Unit 4. LAN Design Different Scenarios

Network Design and Management Issues and Challenge, IT Infrastructure Basics, LAN Design Different Scenarios.

Unit 5. LAN Implementation

LAN Implementation using Ethernet Technologies, LAN Implementation using Ethernet Technologies, Wireless LAN Devices Orientation and implementation.

Recommended Books/Reference Material

1. Bertsekas, D., & Gallager, R. (2021). Data networks. Athena Scientific.
2. Dorlan, P. L. (2016). An introduction to computer networks. Autoedición.
3. Forouzan, B. A. (2012). Data Communications and Networking Global Edition 5e. McGraw Hill.

4. West, J. (2022). Data Communication and Computer Networks: A Business User's Approach. Cengage Learning.

Operating systems

BS-Computer Science

Course Code: CS-316

Credit Hours: 02

Pre-requisite: Data Structures

Objectives

Course Description This course is about learning and understanding the overview of the Operating Systems. A computer cannot be used and operated without an operating system. There are many operating systems available now a days that can be installed and used in order to operate a system. Installing and using a particular operating system also depends on the factors, like cost, availability, hardware and usage etc. Furthermore, operating system used on mobile devices are different from the ones that we use on desktop and laptop systems. In this course, students will learn about i) different operating systems available in the market, ii) what are the major components available in an operating system, iii) what is the significance of those components, and iv) how they are designed and developed.

Learning Outcomes:

- **Understand** the characteristics of different structures of OS and identify the core (C2 – PLO 1).
- **Explain** processes and threads, process management, IPC, Process Synchronization, Scheduling, and deadlocks (C2 – PLO 2).
- **Evaluate** algorithms used in Memory Management, disk management and File Systems (C5 – PLO 3).

Course Outline

Unit 1. Introduction

What Operating Systems Do, Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations,

Process Management, Memory Management, Storage Management, Protection and Security, Distributed Systems, Special-Purpose Systems, Computing Environments

Unit 2. Operating System Structures, Processes

Operating System Services, User Operating System Interface, System Calls, Types of System Calls, System Programs, Operating System Design and Implementation, Operating System Structure, Virtual Machines, Operating System Generation, System Boot, Process Concept, Process Scheduling, Operations on Processes, Cooperating Processes, Inter-process Communication, Communication in Client-Server Systems

Unit 3. CPU Scheduling & Deadlocks

Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Real-Time Scheduling, Thread Scheduling, Operating Systems Examples The Deadlock Problem, System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock

Unit 4. Memory Management, Threads, File System Interface

Background, Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation Example: The Intel Pentium. Threads concepts, User level threads, kernel level threads, mapping of threads, File Concept, Access Methods, Directory Structure, File-System Mounting, File Sharing, Protection

Unit 5. Security and Linux System

The Security Problem, Program Threats, System and Network Threats, Cryptography as a Security Tool, User Authentication, Firewalling to Protect Systems and Networks, Computer-Security Classifications, an Example: Windows XP, Introducing Linux, Installing Troubleshooting and Configuring Linux.

Recommended Books/Reference Material

1. Hausenblas, M. (2022). Learning modern Linux: a handbook for the Cloud native practitioner.
2. Jaeger, T. (2022). Operating system security. Springer Nature.
3. Silberschatz, A., & Galvin, P. B. (2013). Operatings System Concepts.

Operating systems LAB

BS-Computer Science

Course Code: CS-316L

Credit Hours: 01

Pre-requisite: Data Structures

Objectives

This course is about learning and understanding the overview of the Operating Systems. A computer cannot be used and operated without an operating system. There are many operating systems available now a day that can be installed and used in order to operate a system. Installing and using a particular operating system also depends on the factors, like cost, availability, hardware and usage etc. Furthermore, operating system used on mobile devices are different from the ones that we use on desktop and laptop systems. In this course, students will learn about different operating systems available in the market, what the major components available in an operating system are, what the significance of those components is, and how they are designed and developed.

Learning Outcomes:

- **Demonstrate** Shell Scripts/ System Calls using Linux Operating System **(PLO 2)**.
- **Execute** operating system concepts/ commands for various functions in Windows and Linux **(PLO 5)**.
- **Combine** the experimental data in the appropriate format in the form of a LAB report **(PLO 7)**.

Course Outline

Unit 1. Introduction to OS

Installation of linux, configuration of Framework. Computer-System Architecture, Operating-System Structure, Operating-System Operations.

Unit 2. Operating System Structures, Processes

Operating System Services, User Operating System Interface, System Calls, Types of System Calls, System Programs, Operating System Design and Implementation, Operating System Structure, Virtual Machines, Operating System Generation, System Boot, Process Concept, Process Scheduling, Operations on Processes, Cooperating Processes, Inter-process Communication, Communication in Client-Server Systems

Unit 3. CPU Scheduling & Deadlock

Basic Concepts, Scheduling Criteria, Implementation of Scheduling Algorithms, Multiple Processor Scheduling, Real-Time Scheduling, Thread Scheduling, Operating Systems Examples. The Deadlock Problem, System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock

Unit 4. Memory Management, Threads, File System Interface

Background, Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation Example: The Intel Pentium. Threads concepts, User level threads, kernel level threads, mapping of threads, File Concept, Access Methods, Directory Structure, File-System Mounting, File Sharing, Protection

Unit 5. The Linux System

Program Threats, System and Network Threats, Cryptography as a Security Tool, User Authentication, Implementing Security Defenses, Firewalling to Protect Systems and Networks, Computer-Security Classifications, An Example: Windows XP, Introducing Linux, Installing Troubleshooting and Configuring Linux

Recommended Books/Reference Material

1. Hausenblas, M. (2022). Learning modern Linux: a handbook for the Cloud native practitioner.
2. Jaeger, T. (2022). Operating system security. Springer Nature.
3. Silberschatz, A., & Galvin, P. B. (2013). Operatings System Concepts.

Information Security

BS-Computer Science

Course Code: CS-319

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course introduces students with basics of information security, in both management aspect and technical aspect. Students understand various types of security incidents and attacks, and learn methods to prevent, detect and react incidents and attacks. It also covers basics of cryptography which are one of the key technologies to implement security functions.

Learning Outcomes:

- **Explain** security services like confidentiality, Integrity and Availability as well as the related tools and technologies, security protocols and Standards **(C2 – PLO 2)**.
- **Apply** the appropriate techniques to tackle the problems in the discipline of information security **(C3 – PLO 3)**.
- Develop various security and risk management techniques for achieving information security and privacy **(C6 – PLO 4)**.

Course Outline

Unit 1. Model of Info Security, Encryption Techniques

Basic notions of confidentiality, integrity, availability, Model of Info Security, Types of Attacks, Classical Encryption Techniques, Symmetric Encryption Principals, Substitution techniques, Caesar Cipher, Monoalphabetic Ciphers,

Play fair Cipher, Hill Cipher, Polyalphabetic Ciphers, Transposition Techniques

Unit 2. The Data Encryption Standard

Stream Ciphers and Block Ciphers, The Feistel Cipher, The Data Encryption Standard, The Avalanche Effect, Timing Attacks, Differential and Linear Cryptanalysis, DES Design Criteria, Design of Function F, Key Schedule Algorithm, Multiple Encryption and Triple DES, Double DES, Electronic Code Book, Cipher Block Chaining Mode

Unit 3. Modes, Cryptosystems

Cipher Feedback Mode, Output Feedback Mode, Counter Mode, Public-Key Cryptosystems, Applications for Public-Key Cryptosystems, Requirements for Public-Key Cryptography, Public Key Cryptanalysis, The RSA Algorithm, Computational Aspects, The Security of RSA, Applications of Cryptographic Hash Functions, Message Authentication Digital Signatures, Attacks and Forgeries, Direct Digital Signature.

Unit 4. Authentication & Security, Intrusion Detection

Symmetric Key Distribution Using Symmetric Encryption. Laws, regulations, and professional organizations in information security. Role of access control in computer-based information systems, approaches to control remote and dial-up access by authenticating and authorizing users. Requirements to ensure the privacy of personnel data. Categories and models of intrusion detection and prevention systems

Unit 5. Risk Management

Define risk management, risk identification, and risk control. Describe how risk is identified and assessed, Log Maintenance

Recommended Books/Reference Material

1. Chitadze, N. (2023). Basic Principles of Information and Cyber Security. In Analyzing New Forms of Social Disorders in Modern Virtual Environments (pp. 193-223). IGI Global.

2. Pachghare, V. K. (2019). Cryptography and information security. PHI Learning Pvt. Ltd.
3. Smith, R. E. (2019). Elementary information security. Jones & Bartlett Learning.
4. Whitman, M. E., & Mattord, H. J. (2021). Principles of information security. Cengage learning.

Information Security LAB

BS-Computer Science

Course Code: CS-319L

Credit Hours: 01

Pre-requisite: Nil

Objectives

This course introduces students with basics of information security, in both management aspect and technical aspect. Students understand various types of security incidents and attacks, and learn methods to prevent, detect and react incidents and attacks. It also covers basics of cryptography which are one of the key technologies to implement security functions.

Learning Outcomes:

- **Explain** security services like confidentiality, Integrity and Availability as well as the related tools and technologies, security protocols and Standards **(C2 – PLO 2)**.
- **Implement** the appropriate techniques to tackle the problems in the discipline of information security **(PLO 5)**.
- Develop various security and risk management techniques for achieving information security and privacy **(C6 – PLO 4)**.

Course Outline

Unit 1. Model of Info Security, Encryption Techniques

Basic notions of confidentiality, integrity, availability, Model of Info Security, Types of Attacks, Classical Encryption Techniques, Symmetric Encryption Principals, Substitution techniques, Caesar Cipher, Monoalphabetic Ciphers, Play fair Cipher, Hill Cipher, Polyalphabetic Ciphers, Transposition Techniques

Unit 2. The Data Encryption Standard

Stream Ciphers and Block Ciphers, The Feistel Cipher, The Data Encryption Standard, The Avalanche Effect, Timing Attacks, Differential and Linear Cryptanalysis, DES Design Criteria, Design of Function F, Key Schedule Algorithm, Multiple Encryption and Triple DES, Double DES, Electronic Code Book, Cipher Block Chaining Mode

Unit 3. Modes, Cryptosystems

Cipher Feedback Mode, Output Feedback Mode, Counter Mode, Public-Key Cryptosystems, Applications for Public-Key Cryptosystems, Requirements for Public-Key Cryptography, Public Key Cryptanalysis, The RSA Algorithm, Computational Aspects, The Security of RSA, Applications of Cryptographic Hash Functions, Message Authentication Digital Signatures, Attacks and Forgeries, Direct Digital Signature

Unit 4. Authentication & Security, Intrusion Detection

Symmetric Key Distribution Using Symmetric Encryption. Laws, regulations, and professional organizations in information security. Role of access control in computer-based information systems, approaches to control remote and dial-up access by authenticating and authorizing users. Requirements to ensure the privacy of personnel data. Categories and models of intrusion detection and prevention systems

Unit 5. Risk Management

Define risk management, risk identification, and risk control. Describe how risk is identified and assessed, Log Maintenance

Recommended Books/ Reference Material

1. Chitadze, N. (2023). Basic Principles of Information and Cyber Security. In Analyzing New Forms of Social Disorders in Modern Virtual Environments (pp. 193-223). IGI Global.
2. Pachghare, V. K. (2019). Cryptography and information security. PHI Learning Pvt. Ltd.
3. Smith, R. E. (2019). Elementary information security. Jones & Bartlett Learning.
4. Whitman, M. E., & Mattord, H. J. (2021). Principles of information security. Cengage learning.

12. List of Domain Core Courses

Sr. No.	Course Code	Course Title	Pre-Requisite	Credit Hours
1	CS-317	Theory of Automata	Nil	3
2	CS-207	Advance Database Management Systems	Database Systems	2
3	CS-207L	Advance Database Management Systems (Lab)	Database Systems	1
4	CS-322	HCI and Computer Graphics	Nil	2
5	CS-322L	HCI and Computer Graphics (Lab)	Nil	1
6	CS-321	Computer Architecture	Computer Organization and Assembly Language	2
7	CS-321L	Computer Architecture (Lab)	Computer Organization and Assembly Language	1
8	CS-320	Compiler Construction	Theory of Automata	2
9	CS-320L	Compiler Construction (Lab)	Theory of Automata	1
10	CS-409	Parallel and Distributed Computing	Object Oriented Programming	2
11	CS-409L	Parallel and Distributed Computing (Lab)	Object Oriented Programming	1

13. Course Outlines for Domain Core Courses

Advance Database Management Systems

BS-Computer Science

Course Code: CS-207

Credit Hours: 02

Pre-requisite: Database systems

Objectives

Advanced Database Management Systems is an extension to “Database Systems” course. The aim of the course is to enhance the previous knowledge of database systems by deepening the understanding of the theoretical and practical aspects of the database technologies, and showing the need for distributed database technology to tackle deficiencies of the centralized database systems. Moreover, it focuses to introduce the basic principles and implementation techniques of distributed database systems, and expose emerging research issues in database systems and application development.

Learning Outcomes

- **Argue** configuration issues related to database operation and performance (C5 – PLO 3).
- **Analyze**, compare and evaluate alternative database architectures in different application contexts (C4 – PLO 2).
- **Examine** complex queries through the interpretation of query execution plans and implementation of effective indexing strategies (C4 – PLO 5).

Course Outline

Unit 1. Introduction to Advanced Database Management System

Introduction to Advanced DBMS. Review of fundamental database concepts. Introduction to advanced topics in DBMS. Discussion on emerging trends in database management. Normalization beyond 3NF. Handling de-normalization and performance considerations.

Unit 2. Query Optimization and Performance Tuning

Query execution plan analysis, Indexing strategies for complex queries and Performance optimization techniques. Database caching and memory management.

NoSQL databases and their use cases. Integration of NoSQL databases with traditional DBMS.

Unit 3. Distributed Databases and Big data

Concepts of distributed database systems. Replication and synchronization strategies. Consistency and availability trade-offs. Big data Types and characteristics. Analytics, Application and lifecycle. OLTP, OLAP and RTAP.

Unit 4. Data Security and Privacy

Advanced authentication and authorization mechanisms. Encryption techniques for data at rest and in transit. Data masking and anonymization. Compliance with data privacy regulations.

Unit 5. Blockchain in Databases

Discussion on blockchain in databases. Exploring graph databases and their applications.

Recommended Books/Reference Material

1. Foster, E., & Godbole, S. (2022). Database systems: a pragmatic approach. Auerbach Publications.
2. Mayer-Schönberger, V., Cukier, K. (2013). Big Data: A Revolution That Will Transform How We Live, Work, and Think. United Kingdom: Houghton Mifflin Harcourt.
3. Ramakrishnan, R., Gehrke, J. (2000). Database Management Systems. United States: McGraw-Hill.
4. Ray, C. (2020). Advanced Database System. (n.p.): Independently Published.
5. Sadalage, P. J., Sadalage, P., Fowler, M. (2012). NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence. United Kingdom: Pearson Education
6. Winand, M. (2012). SQL Performance Explained: Everything Developers Need to Know about SQL Performance. Austria: M. Winand.

Advance Database Management Systems LAB

BS-Computer Science

Course Code: CS-207L

Credit Hours: 01

Pre-requisite: Database systems

Objectives

Advanced Database Management Systems Lab is an extension to “Database Systems” course. The aim of the course is to enhance the previous knowledge of database systems by deepening the understanding of the theoretical and practical aspects of the database technologies, and showing the need for distributed database technology to tackle deficiencies of the centralized database systems. Moreover, it focuses to introduce the basic principles and implementation techniques of distributed database systems, and expose emerging research issues in database systems and application development.

Learning Outcomes

- **Understand** advance data models, technologies and approaches for building distributed database systems **(C2 – PLO 1)**.
- **Apply** the models and approaches in order to become enabled to select and apply appropriate methods for a particular case **(PLO 2)**.
- **Develop** a database solution for a given scenario/ challenging problem in the domain of distributed database systems **(PLO 4)**.

Course Outline

Unit 1. Introduction to SQL Basics and Advanced Queries

Introduction to Lab Environment and SQL Basics. Setting up the lab environment and tools. Review of Basic SQL queries: DDL & DML. Creating and manipulating tables. Complex Queries using Joins and subqueries. Using CASE statements and calculated fields.

Unit 2. Normalization and Optimization Techniques

Exploring normalization beyond 3NF. Applying normalization rules to improve schema design. Converting normalized schema into SQL tables. Introduction to

query optimization techniques. Analyzing query execution plans. Identifying performance bottlenecks and possible optimizations.

Unit 3. Indexing Strategies and Advanced SQL Techniques

Understanding different types of indexes. Creating and managing indexes. Evaluating the impact of indexes on query performance. Working with window functions for ranking and aggregation. Using Common Table Expressions (CTEs) and recursive queries. Handling semi-structured data with JSON functions.

Unit 4. Geospatial Data Handling and Mongo DB

Introduction to geospatial data and applications. Performing spatial queries and calculations. NoSQL Databases and Hands-on with MongoDB/Firebase. Understanding NoSQL databases and their characteristics. Introduction to MongoDB and its document-based model. CRUD operations and basic querying in MongoDB. Indexing and performance optimization in MongoDB. Aggregation framework for complex queries. Data modeling considerations in NoSQL databases.

Unit 5. Database security and privacy

Exploring database security mechanisms. Implementing role-based access control. Encrypting data and ensuring data privacy. Exploring database security mechanisms. Implementing role-based access control - Encrypting data and ensuring data privacy.

Recommended Books/Reference Material

1. Foster, E., & Godbole, S. (2022). Database systems: a pragmatic approach. Auerbach Publications.
2. Mayer-Schönberger, V., Cukier, K. (2013). Big Data: A Revolution That Will Transform How We Live, Work, and Think. United Kingdom: Houghton Mifflin Harcourt.
3. Ramakrishnan, R., Gehrke, J. (2000). Database Management Systems. United States: McGraw-Hill.

4. Ray, C. (2020). Advanced Database System. (n.p.): Independently Published.
5. Sadalage, P. J., Sadalage, P., Fowler, M. (2012). NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence. United Kingdom: Pearson Education
6. Winand, M. (2012). SQL Performance Explained: Everything Developers Need to Know about SQL Performance. Austria: M. Winand.

Theory of Automata

BS-Computer Science

Course Code: CS-317

Credit Hours: 03

Pre-requisite: Nil

Objectives

Unlike most courses in Computer Science, this course is not directly about programming. Rather, it introduces some of the models, like automata and grammars that are useful in many applications. The theories of undecidability and intractability are there to remind us that there are certain things we would like to solve by computation, but which are either impossible (undecidable) or are possible but cannot be solved efficiently (intractable).

Learning Outcomes

- **Design** and derivation of regular languages using mathematical models (**C6 – PLO 4**).
- **Design** and derivation of non-regular languages using mathematical models (**C6 – PLO 4**).
- **Design** of Turing Machine (**C6 – PLO 4**).

Course Outline

Unit 1. Introduction to Finite Automata and Regular Expressions

Language definitions preliminaries, Descriptive Method, Regular expressions, Finite Automata, NFA, DFA, Transition graphs, TG to RE, Kleene's theorem,

Union, Intersection & Complement of FA, DFA Minimization, Transducers (Mealy Machine, Moore Machine), Conversions

Unit 2. Regular Languages

Regular languages vs Non regular languages, Properties of regular languages, Pumping Lemma, Decision properties: membership, equivalence, emptiness, finiteness, containment. Closure properties: union, concatenation, complementation, intersection, reversal, homomorphism and inverse homomorphism.

Unit 3. Context Free Grammars

Context free grammars, Derivations, derivation trees and ambiguity. Simplifying CFL, Normal form grammars and parsing, Decidability.

Unit 4. Pushdown Automata

Push Down Automata, Context sensitive languages, grammars and linear bounded automata (LBA), Chomsky's hierarchy of grammars, Conversion of PDA and CFG.

Unit 5. Turing Machines

Turing Machines Theory, Post machine, Variations on TM, TM encoding, Universal Turing Machine, Defining Computers by TMs.

Recommended Books/Reference Material

1. Automata theory and computability. (2021). (n.p.): Book Rivers.
2. Cohen, D. I. A. (1997). Introduction to computer theory. United Kingdom: Wiley.
3. Education.Homenda, W., Pedrycz, W. (2022). Automata Theory and Formal Languages. Germany: De Gruyter.
4. Hopcroft, J. E. (2008). Introduction to Automata Theory, Languages, and Computation. India: Pearson
5. Linz, P. (2006). An Introduction to Formal Languages and Automata. United Kingdom: Jones and Bartlett Publishers.
6. Rich, E. (2007). Automata, Computability and Complexity. United Kingdom: Pearson Prentice Hall.

HCI & Computer Graphics

BS-Computer Science

Course Code: CS-322

Credit Hours: 02

Pre-requisite: Nil

Objectives

In this course, students will learn about some of the advanced and emerging topics in 3D graphics along with the classic graphics algorithms and the standard phases in the graphics pipeline. This course covers 3D graphics concepts like transformation, projections and rendering. Course topics include both the mathematical as well as technical aspects of developing graphics.

Learning Outcomes

- **Understand** and be familiar with current concepts in 3D graphics, along with the basic workflow of the graphics pipeline (C2 – PLO 1).
- **Implement** basic graphics related Algorithms and techniques to create and manipulate 3D graphics (C3 – PLO 5).
- **Create** a simple 3D game in Unity 3D and be familiar with the basics of game development (C6 – PLO 4).

Course Outline

Unit 1. Introduction to HCI and Color Models

Introduction to HCI. History and Uses CRT (Cathode Ray Tube) devices: DVST. Color Models: Pseudo Colors, True Colors, High colors and Deep colors. Human Cognition, Importance of Color models in visual perception. Color Modes: Additive and Subtractive. Metrics and Measures for Evaluation of the Interface.

Unit 2. Transformations and Projections

Transformations: 2D, 3D, HCS and Composite Transformations. Projection: Affine and Solid Body. Usability heuristics and principles of Usability testing. World window to Viewport Transformations. Principles of good interaction design.

Unit 3. Line Drawing and Clipping Algorithms

Line Drawing Algorithms: DDA (Digital differential algorithm). Bresenham's Line Drawing Algorithm. Clipping Algorithms: Cohen Sutherland Clipping Algorithm. Sutherland Hodgeman Clipping Algorithm.

Unit 4. Filling Algorithms

Filling Algorithms: Scanline Filling Algorithm. 8-point filling Algorithm & 4-Point Filling Algorithm.

Unit 5. Rendering, Lighting and Shading

Rendering: Forward and backward rendering and rendering in Nature, Vectors and 3d Geometry. Usability inspection methods, Usability testing methods. Lighting and Shading Interaction Technologies, Usability in practice.

Unit 6. Polynomial Curves and Surfaces

Polynomial curves and surfaces, approximation techniques such as polynomial curves, bezier curves, spline curves and surfaces, animation as a sequence of still images. Visual Design and Typography, Icon Design. Ellipse and other Curves.

Recommended Books/Reference Material

1. Akenine-Moller, T., Haines, E., & Hoffman, N. (2019). Real-time rendering. AK Peters/crc Press.
2. Gordon, V. S., & Clevenger, J. L. (2020). Computer graphics programming in OpenGL with C++. Mercury Learning and Information.
3. Clevenger, J. L., & Gordon, V. S. (2021). Computer Graphics Programming in OpenGL with C+. Mercury Learning.
4. Kosarevsky, S., & Latypov, V. (2021). 3D Graphics Rendering Cookbook: A comprehensive guide to exploring rendering algorithms in modern OpenGL and Vulkan. Packt Publishing Ltd.

HCI and Computer Graphics LAB

BS-Computer Science

Course Code: CS-322L

Credit Hours: 01

Pre-requisite: Nil

Objectives

In this course, students will learn about some of the advanced and emerging topics in 3D graphics along with the classic graphics algorithms and the standard phases in the graphics pipeline. This course covers 3D graphics concepts like transformation, projections and rendering. Course topics include both the mathematical as well as technical aspects of developing graphics.

Learning Outcomes

The students will be able to

- **Create** a 3D model in any modelling tool, light and shade it, add texture to it etc. and create a photorealistic scene **(PLO 5)**.
- **Create** programs in OpenGL using any library **(PLO 4)**.
- **Create** work based on the HCI guidelines **(PLO 7)**.

Course Outline

Unit 1. Introduction to HCI and Color Models

Introduction to HCI. History and Usages CRT (Cathode Ray Tube) devices: DVST. Color Models: Pseudo Colors, True Colors, High colors and Deep colors. Human Cognition, Importance of Color models in visual perception. Color Modes: Additive and Subtractive. Metrics and Measures for Evaluation of the Interface.

Unit 2. Transformations and Projections

Transformations: 2D, 3D, HCS and Composite Transformations. Projection: Affine and Solid Body. Usability heuristics and principles of Usability testing. World window to Viewport Transformations. Principles of good interaction design.

Unit 3. Line drawing and Clipping Algorithms

Line Drawing Algorithms: DDA (Digital differential algorithm). Bresenham's Line Drawing Algorithm. Clipping Algorithms: Cohen Sutherland Clipping Algorithm. Sutherland Hodgeman Clipping Algorithm.

Unit 4. Filling Algorithms

Filling Algorithms: Scanline Filling Algorithm. 8-point filling Algorithm & 4-Point Filling Algorithm.

Unit 5. Rendering, Lighting and Shading

Basic rendering: rendering in nature, i.e., the emission and scattering of light and its relation to numerical integration, affine and coordinate system transformations, ray tracing, visibility and occlusion, including solutions to this problem such as depth buffering, painter's algorithm, and ray tracing, the forward and backward rendering equation. Usability inspection methods, Usability testing methods. Lighting and Shading Interaction Technologies, Usability in practice.

Unit 6. Polynomial Curves and Surfaces

Polynomial curves and surfaces, approximation techniques such as polynomial curves, bezier curves, spline curves and surfaces, animation as a sequence of still images. Visual Design and Typography, Icon Design. Ellipse and other Curves.

Recommended Books/Reference Material

1. Akenine-Moller, T., Haines, E., & Hoffman, N. (2019). Real-time rendering. AK Peters/crc Press.
2. Gordon, V. S., & Clevenger, J. L. (2020). Computer graphics programming in OpenGL with C++. Mercury Learning and Information.
3. Clevenger, J. L., & Gordon, V. S. (2021). Computer Graphics Programming in OpenGL with C+. Mercury Learning.

4. Kosarevsky, S., & Latypov, V. (2021). 3D Graphics Rendering Cookbook: A comprehensive guide to exploring rendering algorithms in modern OpenGL and Vulkan. Packt Publishing Ltd.

Computer Architecture

BS-Computer Science

Course Code: CS-321

Credit Hours: 02

Pre-requisite: Computer Organization and Assembly language

Objectives

This course deals with computer architecture as well as computer organization and design. Computer architecture is concerned with the structure and behavior of the various functional modules of the computer and how they interact to provide the processing needs of the user. Computer organization is concerned with the way the hardware components are connected together to form a computer system. Computer design is concerned with the development of the hardware for the computer taking into consideration a given set of specifications. The aim is to explain and learn the architecture of basic computer and microprogrammed control unit.

Learning Outcomes

- **Understand** the digital components of a computer system (registers, memory, bus), their general organization, interconnection along with the arithmetic and logic micro operations **(C2 – PLO 1)**.
- **Understand** the underlying concepts of instructions working with registers and memory, along with RISC and CISC characteristics **(C2 – PLO 2)**.
- **Demonstrate** the ability to implement and verify designs of varying complexity at the register-transfer-level, ability to design a basic computer **(C3 – PLO 4)**.

Course Outline

Unit 1. Introduction to Digital Components

Introduction of Digital Components (Integrated Circuits, Decoders, Encoders, MUX, Registers [Registers with Parallel Load], Shift Registers [Bidirectional Shift Registers with Parallel Load]).

Unit 2. Register Transfer and Microoperations

Register Transfer and Microoperations (Register Transfer Language, Register Transfer, Bus and Memory Transfers [Three-State Bus Buffers, Memory Read, Memory Write], Arithmetic Microoperations [Binary Adder, Binary Adder-Subtractor, Binary Incrementor, Arithmetic Circuit], Logic Microoperations [List of Logic Microoperations, Hardware Implementation, Some Applications], Shift Microoperations [Hardware Implementation], Arithmetic Logic Shift Unit).

Unit 3. Design and Control of Basic Computer

Basic Computer Organization and Design (Instruction Codes [Stored Program Organization, Indirect Address], Computer Registers [Common Bus System], Computer Instructions [Instruction Set Completeness], Timing and Control, Instruction Cycle [Fetch and Decode, Determine the Type of Instruction, Register Reference Instructions], Memory Reference Instructions [AND to AC, ADD to AC, LDA: Load to AC, STA: Store AC, BUN: Branch Unconditionally, BSA: Branch and Save Return Address, ISZ: Increment and Skip If Zero. Control Flowchart]), Design of Basic Computer [Control Logic Gates, Control of Registers and Memory, Control of Single Flip Flops, Control of Common Bus].

Unit 4. Instruction Set Architecture

Central Processing Unit, General Register Organization [Control Word, Examples of Microoperations], Stack Organization [Register Stack, Memory Stack, Reverse Polish Notation], Instruction Formats [Three-Address Instructions, Two-Address Instructions, One-Address Instructions, Zero-Address Instructions, RISC Instructions], Reduced Instruction Set Computer (RISC), CISC Characteristics, RISC Characteristics.

Unit 5. Overview of Pipeline

Overview of Pipeline and Vector Processing, Throughput, multiple functional Units, SIMD, MIMD Instruction Pipeline [Example: Four-Segment Instruction Pipeline], Vector Operations.

Recommended Books/Reference Material

1. Computer System Architecture. (2007). India: Pearson Education.
2. DUMAS II, J. D., Dumas, J. D. (2021). Computer Architecture: Fundamentals and Principles of Computer Design, Second Edition. United Kingdom: CRC Press.
3. Heuring, V. P., Jordan, H. F., Murdocca, M. (1997). Computer Systems Design and Architecture. United Kingdom: Addison-Wesley.
4. Mano, M. M., Kime, C. R. (2004). Logic and Computer Design Fundamentals. United Kingdom: Pearson/Prentice Hall.
5. Patterson, D. A., Hennessy, J. L. (2012). Computer Organization and Design: The Hardware/Software Interface. Germany: Elsevier Science.
6. Wang, S. P. (2021). Computer Architecture and Organization: Fundamentals and Architecture Security. Singapore: Springer Nature Singapore.

Computer Architecture LAB

BS-Computer Science

Course Code: CS-321L

Credit Hours: 01

Pre-requisite: Computer Organization and Assembly Language

Objectives

This course is designed to understand the hardware operation of digital computers. The course aims to simulate the working of various digital components used in the organization and design of digital computers. The experiments simulated in the lab show the detailed steps that a designer must go through in order to design an elementary basic computer. The goal is to understand the role of each major hardware component of a computer system and their synergistic interaction with each other.

Learning Outcomes

- **Apply** the fundamental concepts of digital logic design to simulate the hardware operations of various digital components used in the organization and design of digital computers (**PLO 4**).
- **Execute** the steps that a designer must go through in order to design an elementary basic computer. Simulation of microoperations to understanding the working of instructions with registers, computer bus and memory (**PLO 5**).
- **Contribute** individually or as a team member to work effectively (**PLO 6**).
- Write concise yet comprehensive technical reports that describe designs implemented at the register-transfer-level, and explain the testing strategy used to verify functionality (**PLO 7**).

Course Outline

Unit 1. Introduction to ModelSim

To learn the basic simulator environment and components available. Common Bus System for 4 Registers: Simulating the common bus system for 4 registers to transfer the information between the registers using multiplexers. Common Bus System for 4 Registers: Bus Line with three-state Buffers. Simulating the bus system with three-state gates instead of multiplexers.

Unit 2. Arithmetic Microoperations

Simulating the arithmetic binary operations which include 4-bit binary Adder, AdderSubtractor/ 4-bit binary Incrementor. 5 4-bit Arithmetic Circuit Simulating the arithmetic microoperations (4-bit binary Adder, Adder-Subtractor/ 4-bit binary Incrementor done in previous lab) in one composite arithmetic circuit. Logic Microoperations Simulating one stage of a logic circuit that generates the four basic logic microoperation AND, OR, XOR, Complement.

Unit 3. Shift Micro Operations

Simulating 4-bit combinational circuit shifter with multiplexers. Simulating one stage of arithmetic logic shift unit that uses one stage of 4-bit arithmetic circuit and one stage of logic circuit.

Unit 4. Control of AR, Flipflop, 16-bit common bus register

Simulating the control of Address Register (AR) with control inputs Load (LD), Increment (INR) and Clear (CLR). Simulating the control inputs for Interrupt Enable (IEN) using JK flip-flop. Control of 16-bit Common Bus Register selection for 16-bit common bus using encoders.

Unit 5. Design of Adder and Logic Circuit

Simulating the gate structure for controlling the Load (LD), Increment (INR) and Clear (CLR) of Accumulator Register (AC). Design of Adder and Logic Circuit
Simulating one stage of adder and logic circuit corresponding to one bit of AC.

Recommended Books/Reference Material

1. Faroughi, N. (2014). Digital Logic Design and Computer Organization with Computer Architecture for Security. United Kingdom: McGraw-Hill Education.
2. Pedroni, V. A. (2020). Circuit Design with VHDL. United Kingdom: MIT Press.
3. Yadin, A. (2020). Computer Systems Architecture. United Kingdom: CRC Press LLC.

Compiler Construction

BS-Computer Science

Course Code: CS-320

Credit Hours: 02

Pre-requisite: Theory of Automata

Objectives

The objectives of the course are to study the principles of compiler construction. We will understand various aspects of compiler construction by simply writing a small yet complete compiler. Writing a compiler is an exciting project that would challenge programming as well as organizational skills. At the end of the course students should understand the overall

structure of a compiler and will know significant details of a number of important techniques commonly used. They will be aware of the way in which language features raise challenges for compiler builders.

Learning Outcomes

- **Discuss** the process of Language understanding, architecture of a compiler, and function of its components (C2 – PLO 1).
- **Demonstrate** appropriate formal notations to define a programming language (C3 – PLO 2).
- **Design** lexical, syntax semantics analyzers by using various algorithms (C6 – PLO 4).
- **Implement** lexical, syntax semantics analyzers by using various algorithms (C3 – PLO 5).

Course Outline

Unit 1. Introduction

Structure of a Compiler, Phases of a Compiler, Lexical Analyzer, Input Buffering, Specifications of Tokens, Recognitions of Tokens, Regular Expressions, Finite Automata, Transition Table, Transition Graph.

Unit 2. Grammars

Definitions of Grammars, Derivations, Parse trees, Ambiguity, Associativity and Precedence of Operators. Syntax Analysis, Role of the Parser, Eliminating Ambiguity, Eliminating Left Recursion, Left Factoring.

Unit 3. Parsing

Top-Down Parsing, Recursive-Decent Parsing. First and Follow Sets. LL (1) Grammars, Non-recursive Predictive Parsing, Bottom-Up Parsing, Reductions. Shift-Reduce Parsing, LR-Parsing, LR (0) Parsers. Shift-Reduce Conflicts. SLR (1) Parsers. LR (1) Parsers. LALR Parsing.

Unit 4. Semantic Analysis

Intermediate Code Generation, Three Address Code. Semantic Analysis. Type Checking and Environments, Type Conversions (implicit vs explicit). Back patching, Switch Statements, Storage Organization, Stack Allocation of Space.

Unit 5. Management and Optimization

Heap Management. Code Generation, Design of a code Generator. Target Language, Addresses in the Target Code. Basic Blocks and Flow Graphs. Optimization of Basic Blocks.

Recommended Books/Reference Material

1. Aho, A. V., Lam, M. S., Sethi, R., Ullman, J. D. (2007). Compilers: Principles, Techniques, and Tools (2nd Edition). United Kingdom: Addison-Wesley.
2. COMPILER DESIGN. (2022). (n.p.): PHI Learning Pvt. Ltd.
3. Grune, D., vanReeuwijk, K., Bal, H. E., Jacobs, C. J., Langendoen, K. (2012). Modern Compiler Design. Germany: Springer New York.
4. Singh, A. (2020). Compiler Design: Simply In Depth. (n.p.): Amazon Digital Services LLC - Kdp.
5. Watson, D. (2017). A Practical Approach to Compiler Construction. Germany: Springer International Publishing.

Compiler Construction LAB

BS-Computer Science

Course Code: CS-320L

Credit Hours: 01

Pre-requisite: Theory of Automata

Objectives

Understand the role of front-end and back-end of a compiler. Recognize different types of grammars. Understand and define grammars in BNF, syntax diagrams, regular expressions. Define tokens using the notation of regular expressions. Convert regular expressions into finite automata. Implement a lexical analyzer. Define a programming language syntax using a CFG. Construct a parse tree for a given program. Differentiate between top-down and bottom-up

parsing strategies. Understand LL (k) and LR (k) grammars. Write a top-down parser using recursive-descent and LL (1) parsing methods. Understand simple-precedence, operator precedence and SLR parsing methods. Understand semantic analysis (type checking, scope checking etc.) Understand various types of runtime environments. Understand code generation techniques. Understand code optimization techniques.

Learning Outcomes

- **Discuss** the process of Language understanding, architecture of a compiler, and function of its components (C2 – PLO 1).
- **Demonstrate** appropriate formal notations to define a programming language (C3 – PLO 2).
- **Design** lexical, syntax semantics analyzers by using various algorithms (C6 – PLO 4).
- **Implement** lexical, syntax semantics analyzers by using various algorithms (C3 – PLO 5).

Course Outline

Unit 1. Introduction to Compiler, Lexical Analysis and Regular Expressions

Translation process, Language Characteristics, High Level Language properties, Rules and its importance, Machine understandable code Properties, Passes options of compiler, Phases of compiler, Lexical Analysis, type of words, Rule for Lexical analysis, Regular Expression for Lexical. RE\NFA\DFA, Lexical Rule Automation process. NFA\DFA\optimization\ implementation, algorithms and code.

Unit 2. Syntax Analysis

Lexical Rule Implementation issues, options and Algorithms. Syntax Analysis: Context Free Grammar why and how. Ambiguity specific and generalized removal. Top down vs bottom up. Top down Approach and Left factoring Recursive decent algorithm vs Predictive Parsing.

Unit 3. Left Factoring

Left Factoring and LL(k), Recursive decent, parsing Implementation, Top Down : LL(k), Recursive decent using parsing table Implementations.

Unit 4. Stack Processing

Bottom UP implementations, LR(k) , Stack Processing implementation algorithms.
Type checking and semantic analysis, Rules working updation of parse table to semantic table and parse tree to semantic tree.

Unit 5. Code Generation and Optimization

Intermediate code Generation from parse table, Code optimization, Target code and semantic Rules.

Recommended Books/Reference Material

1. COMPILER DESIGN. (2022). (n.p.): PHI Learning Pvt. Ltd.
2. Grune, D., vanReeuwijk, K., Bal, H. E., Jacobs, C. J., Langendoen, K. (2012). Modern Compiler Design. Germany: Springer New York.
3. Singh, A. (2020). Compiler Design: Simply In Depth. (n.p.): Amazon Digital Services LLC - Kdp.
4. Watson, D. (2017). A Practical Approach to Compiler Construction. Germany: Springer International Publishing.

Parallel & Distributed Computing

BS-Computer Science

Course Code: CS-409

Credit Hours: 02

Pre-requisite: Operating Systems OR Object Oriented Programming

Objectives

The goal of this course is to introduce students to the principles and paradigm of parallel and distributed systems, algorithm and applications.

Learning Outcomes

- **Explain** different parallel architecture, profiling and parallelization of code (**C2 – PLO 1**).
- **Execute** Analytical modeling of parallel programs (**C3 - PLO 2**).

- **Analyze** complex problems with shared memory programming with OpenMP (**C4 – PLO 3**).

Course Outline

Unit 1. Introduction

Software architectures: threads and shared memory, processes and message passing, distributed shared memory (DSM), distributed shared data (DSD).

Unit 2. Parallel Algorithms

Concurrency and synchronization (review), Data and work partitioning, Common parallelization strategies, Granularity, Load balancing, Examples: parallel search, parallel sorting, etc.

Unit 3. Shared Memory Programming

Threads, P threads, Locks and semaphores.

Unit 4. Distributed Memory Programming

Distributed-Memory Programming, MPI, Google's Map Reduce, Hadoop.

Unit 5. Other Parallel Programming Systems

Tread Marks: Distributed shared memory. Aurora: Scoped behavior and abstract data types. S Enterprise: Process templates.

Recommended Books/Reference Material

1. Coulouris, G., Dollimore, J., Kindberg, T., Blair, G. (2013). Distributed Systems: International Edition. United Kingdom: Pearson Education.
2. Lin, C. (2008). Principles of Parallel Programming. India: Pearson Education.
3. Parallel Computing: Technology Trends. (2020). Netherlands: IOS Press.
4. Peters, T. (2023). Parallel Python with Dask: Perform distributed computing, concurrent programming and manage large dataset. India: GitforGits.

5. Rauber, T., Rünger, G. (2013). Parallel Programming: For Multicore and Cluster Systems. Germany: Springer Berlin Heidelberg.

Parallel and Distributed Computing LAB

BS-Computer Science

Course Code: CS-409L

Credit Hours: 01

Pre-requisite: Operating Systems OR Object Oriented Programming

Objectives

The goal of this course is to introduce students to the principles and paradigm of parallel and distributed systems, algorithm and applications.

Learning Outcomes

- **Implement** parallel and distributed memory algorithms using OpenMP, MPI, CUDDA (C3 – PLO 5).
- **Practice** the OpenMP, MPI, CUDDA (PLO 5).
- **Contribute** individually or as a team member to work effectively (PLO 6).

Course Outline

Unit 1. Threads Work Sharing, OpenMP API

Threads Work-sharing for OpenMP using ‘Single and Section Constructs’. To implement work sharing among threads in OPENMP using single and section constructs. Use of Environment Variables in OpenMP API. To familiarize the students with the usage of environment variables in OPENMP.

Unit 2. Socket Programming

Introduction to Socket Programming to learn how to build client/server applications that communicate using sockets. Socket Programming with multithreading.

Unit 3. Basics of Message Passing Interface (MPI)

Introduce and familiarize the students with basic concepts of distributed memory programming using MPI. To Learn Communication between MPI processes. Familiarize the students with inter process communication using MPI.

Unit 4. MPI Collective Operations

Implement collective communication using MPI. Implement collective communication operation using Data Movement in MPI. Implement collective communication operation using Collective Computation in MPI.

Unit 5. MPI Non-Blocking Operation and GPU Programming

Implement non-blocking operations in MPI. GPU Programming with CUDA and NUMBA. Familiarize the students with GPU programming using CUDA and NUMBA.

Recommended Books/Reference Material

1. Coulouris, G., Dollimore, J., Kindberg, T., Blair, G. (2013). Distributed Systems: International Edition. United Kingdom: Pearson Education.
2. Lin, C. (2008). Principles of Parallel Programming. India: Pearson Education.
3. Parallel Computing: Technology Trends. (2020). Netherlands: IOS Press.
4. Peters, T. (2023). Parallel Python with Dask: Perform distributed computing, concurrent programming and manage large dataset. India: GitforGits.
5. Rauber, T., Rünger, G. (2013). Parallel Programming: For Multicore and Cluster Systems. Germany: Springer Berlin Heidelberg.

14. List of Domain Elective Courses of CS

Sr. No.	Course Code	Course Title	Pre-Requisite	Credit Hours
1	IT-310	Web Technologies	Nil	2
2	IT-310L	Web Technologies (Lab)	Nil	1
3	CS-408	Mobile Application Development	Nil	2
4	CS-408L	Mobile Application Development (Lab)	Nil	1
5	CS-410	Advanced Programming	Object Oriented Programming	2
6	CS-410L	Advanced Programming (Lab)	Object Oriented Programming	1
7	CS-411	Numerical Analysis	Nil	2
8	CS-411L	Numerical Analysis (Lab)	Nil	1
9	CS-407	Web Engineering	Nil	2
10	CS-407L	Web Engineering (Lab)	Nil	1
11	IT-311	Cyber Security	Nil	2
12	IT-311L	Cyber Security (Lab)	Nil	1
13	CS-412	Software Verification and Validation	Nil	2
14	CS-412L	Software Verification and Validation (Lab)	Nil	1
15	CS-323	Object Oriented Analysis and Design	Programming Fundamentals	1
16	CS-323L	Object Oriented Analysis and Design (Lab)	Programming Fundamentals	2
17	CS-308	Game Development	Nil	3
18	CS-309	Visual Programming	Object Oriented Programming	3
19	IT-306	Software Quality Assurance	Software Engineering	3
20	CS-311	Data Mining	Nil	3
21	CS-312	Software Project Management	Software Engineering	3

22	CS-315	Digital Image Processing	Nil	3
23	CS-404	Data Science	Nil	3
24	CS-405	Computer Graphics	Nil	3
25	CS-406	Cloud Computing	Nil	3

15. Course Outlines for Domain Elective Courses

Web Technologies

BS-Computer IT

Course Code: IT-310

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is designed to provide the student with foundational web programming knowledge and skills for interactive and dynamic website building. The student will learn about the web programming as a development platform through the use of popular front-end technologies: HTML, CSS, JavaScript, Bootstrap, jQuery and ReactJs. Moreover, the student will learn to plan, design, construct, and integrate server-side components of modern web applications. For back-end the students will learn PHP with MVC based framework such as Laravel. This will allow students to create websites that store, access, and use data which is stored in the database by exploring SQL queries and Object–relational mapping (ORM). By the end of this course a strong foundation will be laid for full-stack development in the carrier of the student.

Learning Outcomes

- **Design** interactive and responsive website using front-end technologies (C6 – PLO 4).
- **Implement** server-side technologies for handling information (C3 - PLO 5).
- **Apply** modern frameworks to increase the efficient and productivity (C3 – PLO 5).

Course Outline

Unit 1. HTML

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, XHTML 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.

Unit 2. CSS and Javascript

Active Browser Pages: JavaScript, DHTML, AJAX. JSON, Approaches to Web Application Development. Programming in any Scripting language. Search Technologies. Search Engine Optimization. XML Query Language, Semantic Web, Future Web Application Framework.

Unit 3. PHP

Introduction to PHP.

Unit 4. Bootstrap

Introduction to Bootstrap.

Unit 5. Laravel and ReactJs

Introduction to Laravel, Routes and Controllers. Views in Laravel and Blade templating engine. Databases, Eloquent, Models, Migrations, Seeders and Faker Factory. User authentication and authorization. Laravel - RESTful APIs authentication. React Basics, ReactDOM and JSX. Props, States and Components. Redux. React Router. Consuming RESTful APIs created in Laravel.

Recommended Books/Reference Material:

1. Meloni, J. C. (2016). Sams teach yourself HTML, CSS, and JavaScript all in one. Pearson Education India.
2. Stauffer, M. (2023). Laravel: Up & Running. "O'Reilly Media, Inc."

3. Tatroe, K., & MacIntyre, P. (2020). Programming PHP: Creating dynamic web pages. O'Reilly Media.

Web Technologies LAB

BS-IT

Course Code: IT-310L

Credit Hours: 01

Pre-requisite: Nil

Objectives

This course is designed to provide the student with foundational web programming knowledge and skills for interactive and dynamic website building. The student will learn about the web programming as a development platform through the use of popular front-end technologies: HTML, CSS, JavaScript, Bootstrap, jQuery and ReactJs. Moreover, the student will learn to plan, design, construct, and integrate server-side components of modern web applications. For back-end the students will learn PHP with MVC based framework such as Laravel. This will allow students to create websites that store, access, and use data which is stored in the database by exploring SQL queries and Object–relational mapping (ORM). By the end of this course a strong foundation will be laid for full-stack development in the carrier of the student.

Learning Outcomes

- **Design** a fully functional frontend for a web page based on a given scenario **(PLO 4)**.
- **Construct** a fully functional backend for a web page based on a given scenario **(PLO 4)**.
- **Integrate** the front and backend with the restful APIs using any advance framework **(PLO 5)**.

Course Outline

Unit 1. HTML

Creating development environment setup. Learning the following HTML tags for web pages required for front-end. HTML5 page structure. HTML headings. Anchor link, Line break Paragraph Image Div. Ordered and unordered list tags. Learn to create tables using HTML. Designing registration form using HTML.

Unit 2. CSS and Javascript

Designing first page of website using HTML and CSS. Design the navigation bar using CSS property display: flex. Enhance the cosmetic look of HTML table using CSS. Design a contact form by customizing HTML form with input controls. Add alignment of form: In center vertically and horizontally regard less of screen size.

Unit 3. PHP

Create a PHP MySQL CRUD application using MySQLi. Create an Object-Oriented Programming based PHP MySQL CRUD application using PDOs.

Unit 4. Bootstrap

Design responsive layout using Bootstrap grid, card, and helper classes. Design a pop-up contact us form using Bootstrap form controls, modal, and helper classes. Use Bootstrap carousel with controls, indicators and captions to display a company's portfolio in shape of images and text on them.

Unit 5. Laravel and ReactJs

Use Laravel code first approach to create CRUD application using MySQL and Blade templating engine. Use Laravel code first approach to create CRUD application using MySQL and Blade templating engine. Create RESTful APIs for tasks table having columns id, text, day and reminder using Laravel. Consuming GET API to display data in React application. Using POST and DELETE APIs in React application.

Recommended Books/Reference Material:

1. Meloni, J. C. (2016). Sams teach yourself HTML, CSS, and JavaScript all in one. Pearson Education India.
2. Stauffer, M. (2023). Laravel: Up & Running. "O'Reilly Media, Inc."
3. Tatroe, K., & MacIntyre, P. (2020). Programming PHP: Creating dynamic web pages. O'Reilly Media.

Mobile Application Development

BS-Computer Science

Course Code: CS-408

Credit Hours: 2

Pre-requisite: Nil

Objectives

The main objective of mobile development is creating applications and any other kind of software specific to mobile devices, including tablets. Mobile development seeks to optimize functionality and user experience on mobile devices, as there are important differences between mobile and desktop UX. This course aims to introduce students to the following concepts and cognitive skills.

Learning Outcomes

- **Understand** the life cycle of android applications (**C2 – PLO 1**).
- **Design** interactive interface for mobile applications using various layouts (**C6 – PLO 4**).
- **Develop** mobile applications for comprehensive systems using latest trends and practices (**C6 – PLO 4**).

Course Outline

Unit 1. Introduction

Mobile Application Development Platforms, System installation (Android Studio) , Android Architecture and framework, What is Android, The various Android

devices on the market, The Android Market application store, How to develop your first Android application ,Components of Android Project (Application Structure), Using code Completion Debugging Application, What activities are?

Unit 2. Android Studio Layout Editor

Android Studio Layout editor, component tree, Constraint view, layout properties, Activities, Layouts, layout attributes, Views. View Groups, layout Orientation, XML, files (string, colors, values, dimen) in the project, Resource folders, Intents in Android, Calling build in intents, communication between activities.

Unit 3. Fragments

Display Notifications, Design interface with views, Displaying Pictures and menus with views .Data Persistence, Content providers, Messages (SMS, EMAIL), Location based services (Maps).

Unit 4. Networking

Establishing an HTTP Connection, Consuming Web Services using ,HTTP, Consuming JSON Services , Android Services, Create Own Services, Establishing Communication between a Service and an Activity ,Binding Activities to Services, Understanding Threading.

Unit 5. Architecture and Frameworks

Introduction to iOS Architecture and framework, Introduction to Xamarin/Flutter for cross platform development , Publishing, Android Applications, Mobile Programming Languages, Emerging Technologies.

Recommended Books /Reference Material

1. AFREEN, C. F. (2021). Mobile Applications Development. Book Rivers.
2. Android Programming: The Big Nerd Ranch Guides, Phillips, B. & Hardy, B., 3rd Edition (2017).

3. Burd, B., & Mueller, J. P. (2020). Android application development all-in-one for dummies. John Wiley & Sons.
4. iOS Programming: The Big Nerd Ranch Guide, Conway, J., Hillegass, A., & Keur, C., 5th Edition (2015).
5. Lewis, S., & Dunn, M. (2019). Native mobile development: a cross-reference for iOS and Android. O'Reilly Media.
6. Professional Android Application Development, Reto Meier, Wrox Programmer to Programmer, 3rd Edition (2014).

Mobile Application Development LAB

BS-Computer Science

Course Code: CS-408L

Credit Hours: 01

Pre-requisite: Nil

Objectives

Objective of mobile development is creating applications and any other kind of software specific to mobile devices, including tablets. Mobile development seeks to optimize functionality and user experience on mobile devices, as there are important differences between mobile and desktop UX. This course aims to introduce students to the following concepts and cognitive skills.

Learning Outcomes

- **Develop** programs using fundamental concepts of mobile application development (**PLO 4**).
- **Manipulate** the use of Android Studio for making mobile applications (**PLO 5**).
- **Manipulate** the use of any technology to create a mobile application with database connectivity (**PLO 5**).

Course Outline

Unit 1. Introduction

Mobiles Application Development Platform, Android OS: Architecture, Framework and Application Development.

Unit 2. iOS

Architecture, Framework; Application Development with Windows Mobile; Eclipse; Fragments; Calling Built-in Applications using Intents; Displaying Notifications; Components of a Screen; Adapting to Display Orientation; Managing Changes to Screen Orientation; Utilizing the Action Bar.

Unit 3. Interfacing

Creating the User Interface; Listening for UI Notifications; Views; User Preferences; Persisting Data; Sharing Data; Sending SMS Messages; Getting Feedback; Sending E-mail; Displaying Maps; Consuming Web Services Using HTTP; Web Services: Accessing and Creating; Threading; Publishing, Android Applications; Deployment on App Stores; Mobile Programming Languages; Challenges with Mobility and Wireless Communication; Location-aware Applications; Performance/Power Tradeoffs; Mobile Platform Constraints.

Unit 4. Emerging Technologies.

Introduction to Xamarin/Flutter for cross platform development, Publishing, Android Applications. Creating the User Interface; Listening for UI Notifications; Views; User Preferences; Persisting Data; Sharing Data; Sending SMS Messages; Getting Feedback; Sending E-mail; Displaying Maps; Consuming Web Services Using HTTP; Web Services: Accessing and Creating; Threading; Publishing, Android Applications; Deployment on App Stores; Mobile Programming Languages; Challenges with Mobility and Wireless Communication; Location-aware Applications; Performance/Power Tradeoffs; Mobile Platform Constraints.

Unit 5. Emerging Technologies.

Introduction to Xamarin/Flutter for cross platform development, Publishing, Android Applications.

Recommended Books /Reference Material

1. AFREEN, C. F. (2021). Mobile Applications Development. Book Rivers.
2. Android Programming: The Big Nerd Ranch Guides, Phillips, B. & Hardy, B., 3rd Edition (2017).
3. Burd, B., & Mueller, J. P. (2020). Android application development all-in-one for dummies. John Wiley & Sons.
4. iOS Programming: The Big Nerd Ranch Guide, Conway, J., Hillegass, A., & Keur, C., 5th Edition (2015).
5. Lewis, S., & Dunn, M. (2019). Native mobile development: a cross-reference for iOS and Android. O'Reilly Media.
6. Professional Android Application Development, Reto Meier, Wrox Programmer to Programmer, 3rd Edition (2014).

Advanced Programming

BS-Computer Science

Course Code: CS-410

Credit Hours: 02

Pre-requisite: Object Oriented Programming

Objectives:

This course will provide the different elements of a visual programming language as building blocks to develop correct, coherent programs. To develop a Program using the fundamental software development process, including design, coding, documentation, testing, and debugging. This course will also develop the ability to analyze problems, develop conceptual designs that solve those problems, and transform those designs to Visual Programs.

Learning Outcomes:

- **Apply** the different elements of a visual programming language as building blocks to develop correct, coherent programs (**C3 – PLO 3**).
- **Implement** using the fundamental software development process, including design, coding, documentation, testing, and debugging (**C3 – PLO 3**).
- **Analyze** problems, develop conceptual designs that solve those problems, and transform those designs to Visual Programs (**C4 –PLO 4**).

Course Outline

Unit 1. Visual Programming Basics

Visual Programming Basics; Introduction to Events; Fundamentals of Event-driven Programming, message handling, user interfaces, graphics device interface, painting and drawing, windows management, input devices, resources, string and menu resource, dialogs and windows controls, common controls, dynamic link libraries.

Unit 2. Network Programming and Building Class Libraries

Threads and synchronization, network programming, Building Class Libraries at the Command Line, Class Libraries, Using References, Assemblies, Private Assembly Deployment, Shared Assembly Deployment, Configuration Overview, Configuration Files, Programmatic Access to Configuration.

Unit 3. SDK Tools

Using SDK Tools for Signing and Deployment, Metadata, Reflection, Late Binding, Directories, Files, Serialization, Attributes, Memory Management and Garbage Collection, Threading and Synchronization, Asynchronous Delegates, Application Domains, Marshal by Value, Marshal by Reference.

Unit 4. Configuring Security

Authentication and Authorization, Configuring Security, Code Access Security, Code Groups, Evidence, Permissions, Role-Based Security, Principals and Identities.

Unit 5. Using Data Sets and Interacting with XML Data

Using Data Readers, Using Data Sets, Interacting with XML Data, Tracing Event Logs, Using the Boolean Switch and Trace Switch Classes, Print Debugging Information with the Debug Class, Instrumenting Release Builds with the Trace Class, Using Listeners, and Implementing Custom Listeners.

Recommended Books/Reference Material

1. Deitel, P., & Deitel, H. (2016). Visual C# how to program. Pearson.
2. Griffiths, I. (2012). Programming C# 5.0: Building Windows 8, Web, and Desktop Applications for the .NET 4.5 Framework. " O'Reilly Media, Inc.".
3. Liberty, J. (2005). Programming C#: building .NET applications with C. " O'Reilly Media, Inc.".
4. Price, M. J. (2021). C# 10 and .NET 6—Modern Cross-Platform Development: Build apps, websites, and services with ASP.NET Core 6, Blazor, and EF Core 6 using Visual Studio 2022 and Visual Studio Code. Packt Publishing Ltd.
5. Troelsen, A., & Japikse, P. (2017). Pro C# 7: With .NET and .NET Core (Vol. 1328). Apress.
6. Troelsen, A., & Japikse, P. (2021). Pro C# 9 with .NET 5: Foundational Principles and Practices in Programming. Apress.

Advance Programming LAB

BS-Computer Science

Course Code: CS-410

Credit Hours: 01

Pre-requisite: Object Oriented Programming

Objectives:

The purpose of this course to provide the foundational knowledge of visual programming and skills for event driven application building. Introduce the students to Graphical User Interfaces and applications in a Windows as well as in Web environment. To enable them to plan, design, construct, and integrate applications by using C#, ASP.Net and their frameworks.

Learning Outcomes:

- **Design** and implement the window forms-based applications for a given scenario (**P5 –PLO 4**).
- **Construct** a fully functional Asp.NET based solution for a given scenario (**PLO 4**).
- **Design** a solution based on MVC based Asp.NET applications for a given scenario (**PLO 4**).

Course Outline

Unit 1. Introduction to Visual Programming

Different type of Visual Programming, Graphical User Interface The need of Visual Programming , Rapid Application Development (RAD) Tools, Advantages of Visual Programming, Disadvantages of Visual Programming, Discuss the transformation in computing, internet and application development, Identify the need for .NET ,Explain the role of CLR and Intermediate Language ,Describe the core components of Microsoft .NET, Features of VS.Net Shared IDE, Introduction to C++, C#, Vb.Net, HTML, Javascript VBscript and ASP.NET

Unit 2. Working with WinForms and Controls

Introduction to Class Libraries , Properties and Methods, Events and Event Handlers, Winforms GUI , Form (Properties, Methods and Events) , Controls in Winform 5 Advanced User Interface Enhancement ,Dialog Boxes , Types of Dialog Boxes , Visual Effect in Winform 6 Error Handling in Winforms , Exception ,Types of Errors ,Exception Classes ,Properties of Exceptions Handling Exceptions , ErrorProvider Control 7 MDI Applications, Single Document Interface, Multiple Document Interface, Designing an MDI application , Activating and Deactivating Windows.

Unit 3. Introduction to ADO.Net

Data Access Components ODBC ,OLE DB , ADO ,ADO.NET , Benefits of ADO.NET , ADO.Net Architecture ,Components of ADO.Net ,DataSet , DataTable ,DataView , Connection Object ,Command Object.

Unit 4. Introduction to Web Applications and ASP.NET

Describe Web applications , Describe the Web application development cycle , Discuss Active Server Pages , Enumerate the features of ASP.NET ,Enumerate the features of ASP.NET 2.0 11 ASP.NET and HTTP , Request/Response Programming , HttpRequest Class , HTTP Collections HttpResponse Class ,

Redirection , HttpUtility Class 12 Web Applications and Web Services Using Visual Studio , Using Visual Web Developer , Visual Studio Forms Designer , Using Components ,Shadow Copying , Using the Global.asax File , Data Binding 13 State Management and Web Applications , Session State ,Application State , Multithreading Issues ,Cookies 14 Server Controls ,HTML Server Controls, Web Forms Server Controls , Rich Controls ,Validation Controls.

Unit 5. ASP.NET Configuration and Security Fundamentals

Configuration Overview, Authentication and Authorization, Forms Authentication, Windows Authentication, Security and ASP.NET Services in C#, Services in Windows, How services works in windows, Implementing a simple service in C#, How to implement UML class diagram through DLL.

Recommended Books\Reference Material

1. Deitel, P., & Deitel, H. (2016). Visual C# how to program. Pearson.
2. Griffiths, I. (2012). Programming C# 5.0: Building Windows 8, Web, and Desktop Applications for the .NET 4.5 Framework. " O'Reilly Media, Inc."
3. Liberty, J. (2005). Programming C#: building .NET applications with C. " O'Reilly Media, Inc."
4. Price, M. J. (2021). C# 10 and .NET 6—Modern Cross-Platform Development: Build apps, websites, and services with ASP. NET Core 6, Blazor, and EF Core 6 using Visual Studio 2022 and Visual Studio Code. Packt Publishing Ltd.
5. Troelsen, A., & Japikse, P. (2017). Pro C# 7: With .net and .net Core (Vol. 1328). Apress.
6. Troelsen, A., & Japikse, P. (2021). Pro C# 9 with .NET 5: Foundational Principles and Practices in Programming. Apress.

Web Engineering

BS-Computer Science

Course Code: CS-407

Credit Hours: 02

Pre-requisite: Nil

Objectives

Web engineering focuses on the methodologies, techniques, and tools that are the foundation of Web application development and which support their design, development, evolution, and evaluation.

Learning Outcomes

- **Discuss** how web standards impact software development (C2 – PLO 8).
- **Describe** the constraints that the web puts on developers (C2 – PLO 8).
- **Design** a simple web application (C6 – PLO 4).
- **Support** an existing web application against a current web standard (C5 – PLO 5).

Course Outline

Unit 1. Introduction

Introduction to Web programming languages (e.g., HTML5, CSS 3, Java Script, PHP/JSP/ASP.Net)

Unit 2. Design Principles of Web Based Applications

Design principles of Web based applications, Web platform constraints, Software as a Service (SaaS), Web standards, Responsive Web Design.

Unit 3. Web Applications

Web Applications, Browser/Server Communication, Storage Tier, Cookies and Sessions, Input Validation, Full stack state management, Web App Security - Browser Isolation.

Unit 4. Network Attacks

Network attack, Session Attacks, Large scale applications, Performance of Web Applications, Data Centers, Web Testing and Web Maintenance.

Unit 5. Laravel and ReactJs

Introduction to Laravel, Routes and Controllers. Views in Laravel and Blade templating engine. Databases, Eloquent, Models, Migrations, Seeders and Faker Factory. User authentication and authorization. Laravel - RESTful APIs authentication. React Basics, ReactDOM and JSX. Props, States and Components. Redux. React Router. Consuming RESTful APIs created in Laravel.

Recommended Books/Reference Material

1. An, K., & Tilevich, E. (2021, May). Communicating web vessels: Improving the responsiveness of mobile web apps with adaptive redistribution. In International Conference on Web Engineering (pp. 388-403). Cham: Springer International Publishing.
2. Chopra, R. (2016). Web Engineering. PHI Learning Pvt. Ltd...
3. Chopra, R., Kapoor, K., Madan, S., & Sibal, R. (2020). Improving quality of web applications deployed on cloud. Journal of Information and Optimization Sciences, 41(6), 1299-1308.
4. Mendes, E., & Mosley, N. (Eds.). (2006). Web engineering. Springer Science & Business Media.
5. Pressman, R., & Lowe, D. (2008). Web Engineering: A practitioner's approach. McGraw-Hill, Inc.

Web Engineering LAB

BS-Computer Science

Course Code: CS-407L

Credit Hours: 01

Pre-requisite: Nil

Objectives

Web engineering focuses on the methodologies, techniques, and tools that are the foundation of Web application development and which support their design, development, evolution, and evaluation

Learning Outcomes

- **Discuss** how web standards impact software development (**C2 – PLO 8**).
- **Describe** the constraints that the web puts on developers (**C2 – PLO 8**).
- **Design** a simple web application (**PLO 4**).
- **Execute** an existing web application against a current web standard (**PLO 5**).

Course Outline

Unit 1. Introduction

Introduction to Web programming languages (e.g., HTML5, CSS 3, Java Script, PHP/JSP/ASP.Net)

Unit 2. Design Principles of Web Based Applications

Design principles of Web based applications, Web platform constraints, Software as a Service (SaaS), Web standards, Responsive Web Design.

Unit 3. Web Applications

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, XHTML 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 Applications, Browser/Server Communication, Storage Tier, Cookies and Sessions, Input Validation, Full stack state management, Web App Security - Browser Isolation.

Unit 4. Network Attacks

Network attack, Session Attacks, Large scale applications, Performance of Web Applications, Data Centers, Web Testing and Web Maintenance.

Unit 5. Laravel and ReactJs

Introduction to Laravel, Routes and Controllers. Views in Laravel and Blade templating engine. Databases, Eloquent, Models, Migrations, Seeders and Faker Factory. User authentication and authorization. Laravel - RESTful APIs authentication. React Basics, ReactDOM and JSX. Props, States and Components. Redux. React Router. Consuming RESTful APIs created in Laravel.

Recommended Books/Reference Material

1. An, K., & Tilevich, E. (2021, May). Communicating web vessels: Improving the responsiveness of mobile web apps with adaptive redistribution. In International Conference on Web Engineering (pp. 388-403). Cham: Springer International Publishing.
2. Chopra, R. (2016). Web Engineering. PHI Learning Pvt. Ltd...
3. Chopra, R., Kapoor, K., Madan, S., & Sibal, R. (2020). Improving quality of web applications deployed on cloud. Journal of Information and Optimization Sciences, 41(6), 1299-1308.
4. Mendes, E., & Mosley, N. (Eds.). (2006). Web engineering. Springer Science & Business Media.
5. Pressman, R., & Lowe, D. (2008). Web Engineering: A practitioner's approach. McGraw-Hill, Inc.

Numerical Analysis

BS-Computer Science

Course Code: CS-411

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course will enable students to provide various kinds of numerical methods to solve linear and non-linear equations and to perform a systematical analysis of the problems and their solutions. In addition, it will help them to make the right decision to choose the most appropriate numerical method according to the given conditions of every problem by doing a careful analysis.

Learning outcome:

- **Compare** the different kinds of numerical methods and their advantages and limitations (C4 – PLO 3).
- **Apply** various numerical methods in real world problems (C3 – PLO 2).
- **Evaluate** the solution by selecting the best numerical method under the given scenario of a problem (C5 – PLO 5).

Course Outline

Unit 1. Introduction of Numerical Methods

Introduction, Advantages of Numerical Methods, Rounding off, Approximations and Errors, Types and Sources of Errors. Algorithm, Solutions of Algebraic and Transcendental Equation.

Unit 2. Numerical Solution of Nonlinear Equations

Bisection Method, The Method of False Position, Fixed Point Iteration Method. Newton-Raphson Method, Secant Method, Order of Convergence of these methods.

Unit 3. Exact Methods

Gauss Elimination Method, LU Decomposition Method, Dolittle's, Crout's and Cholesky's Methods. Iterative Methods: Jacobi and Gauss-Seidel Methods. Numerical Solution of System of Algebraic Linear Equations. Exact Methods: Gauss Elimination Method.

Unit 4. Interpolation and Polynomial Approximation

Lagrange's and Newton's difference formulae Numerical Differentiation. Numerical Integration and Error Estimates: Trapezoidal Method. Simpson's one-third and three-eighth Rules. Composite Rules.

Recommended Books\Reference Material

1. Ahmed, Rana, F., Afzal, M. (2015). Elements of Numerical Analysis. National Book Foundation, Pakistan, ISBN: 9789693708165.
2. Burden, R. L., & Faires, J. D. (2011). Numerical Analysis. Cengage Learning. ISBN: 9788131516546
3. Epperson, J. F. (2021). An introduction to numerical methods and analysis. John Wiley & Sons.
4. Leader, J. J. (2022). Numerical analysis and scientific computation. CRC Press.
5. Linz, P. (2019). Theoretical numerical analysis. Courier Dover Publications.
6. Süli, E., & Mayers, D. F. (2003). An Introduction to Numerical Analysis. Cambridge University Press. ISBN: 9780521007948. Scheme of Studies for BS (Computer Science) 2023 139

Numerical Analysis LAB

BS-Computer Science

Course Code: CS-411L

Credit Hours: 01

Pre-requisite: Nil

Objectives:

This course will enable students to provide various kinds of numerical methods to solve linear and non-linear equations and to perform a systematical analysis of the problems and their solutions. In addition, it will help them to make the right decision to choose the most appropriate numerical method according to the given conditions of every problem by doing a careful analysis.

Learning outcome:

- **Compare** the different kinds of numerical methods and their advantages and limitations (C4 – PLO 3).

- **Apply** various numerical methods in real world problems (**PLO 2**).
- **Evaluate** the solution by selecting the best numerical method under the given scenario of a problem (**C5 – PLO 5**).

Course Outline

Unit 1. Introduction, Advantages of Numerical Methods

Approximations and Errors, Types and Sources of Errors. Algorithm, Solutions of Algebraic and Transcendental Equations. Numerical Solution of Nonlinear Equations: Bisection Method, The method of False Position. Fixed Point Iteration Method.

Unit 2. Newton-Raphson Method, Secant Method

Order of Convergence of these methods. Numerical Solution of System of Algebraic Linear Equations. Exact Methods: Gauss Elimination Method. LU Decomposition Method. Dolittle's, Crout's and Cholesky's Methods.

Unit 3. Iterative Methods

Jacobi Method. Gauss-Seidel Method. Interpolation and Polynomial Approximation: Lagrange's formula. Newton's difference formulae.

Unit 4. Numerical Differentiation

Numerical Integration and Error Estimates: Trapezoidal Method. Simpson's one-third and three-eighth Rules. Composite Rules.

Recommended Books\Reference Material

1. Ahmed, Rana, F., Afzal, M. (2015). Elements of Numerical Analysis. National Book Foundation, Pakistan, ISBN: 9789693708165.
2. Burden, R. L., & Faires, J. D. (2011). Numerical Analysis. Cengage Learning. ISBN: 9788131516546
3. Epperson, J. F. (2021). An introduction to numerical methods and analysis. John Wiley & Sons.
4. Leader, J. J. (2022). Numerical analysis and scientific computation. CRC Press.

5. Linz, P. (2019). Theoretical numerical analysis. Courier Dover Publications.
6. Süli, E., & Mayers, D. F. (2003). An Introduction to Numerical Analysis. Cambridge University Press. ISBN: 9780521007948. Scheme of Studies for BS (Computer Science)
2023 139

Software Project Management

BS-Computer Science

Course Code: CS-312

Credit Hours: 3

Pre-requisite: Software Engineering

Objectives

Understand the fundamental principles of software project management & have a good knowledge of responsibilities of project manager. Be familiar with the different methods and techniques used for project management. Be able to apply the knowledge in an effective manner.

Learning outcomes

- **Develop** Software projects (**C6 – PLO 4**).
- **Implement** project scheduling, plan the resources, carry out the staffing, track the progress, apply software metrics, manage and motivate the team, and manage the crisis situation (**C3 – PLO 6**).

Course Outline

Unit 1. Introduction

Introduction – Project Management (PM) Fundamentals – The PM Field and job market – People, Process, Product, Technology, and Overview of Project Management – Planning, Tracking, & measurement – Organizational structures, Project charter – Statement of Work, Request for Proposal (RFP).

Unit 2. Planning Phase

Development lifecycle models ,Matching lifecycles to projects ,Project plans, Project selection ,Project Financial Analysis ,Net Present Value, Return on Investment, Payback Analysis Models ,Weight Scoring Model.

Unit 3. Estimation and Budgeting

Effort Estimation, Cost Estimation, Scheduling, Project network diagram fundamentals, PERT techniques, Gantt charts, Critical chain scheduling, Risk and Change Management, Risk management, Change control ,More MS-Project.

Unit 4. Development Management

Team models , Requirements process ,Configuration management ,Software metrics , Programming languages & tools ,Managing conflict and motivating,Project Control – Status reporting ,Project metrics , Earned value analysis ,Communications Techniques ,Process Improvement – MS Project: (a) Resource leveling (b) Other views.

Unit 5. System Test Process

Test specifications , Black box and white box testing ,Test scripts ,Unit and integration testing , Acceptance test specifications ,Test tools,Final Phases & Other Issues ,Project Recovery ,Documentation, Cutover/Migration, Post Project Reviews, Closing ,Project Success ,Management support ,Expectations ,Success metrics.

Recommended Books/References Material

1. Chemuturi, M., & Cagley, T. M. (2010). *Mastering software project management: Best practices, tools and techniques*. J. Ross Publishing.
2. Cobb, C. G. (2023). *The project manager's guide to mastering Agile: Principles and practices for an adaptive approach*. John Wiley & Sons.
3. Nicholas, J. M., & Steyn, H. (2020). *Project management for engineering, business and technology*. Routledge.
4. Schwalbe, K. (2015). *Information technology project management*. Cengage Learning.

Cloud Computing

BS-Computer Science

Course Code: CS-406

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course introduces students to fundamentals of cloud computing and software development for cloud platforms. It covers topics such as cloud basic architecture, virtualization, and architecture of cloud systems, programming for the cloud, resource management, as well as privacy and security issues.

Learning Outcomes

- **Apply** vSphere, OpenStack, Microsoft Azure Cloud (**C3 – PLO 5**).
- **Practice** vSphere, OpenStack, o Microsoft Azure Cloud (**A5 – PLO 5**).
- **Contribute** individually or as a team member to work effectively (**C2 – PLO 6**).

Course Outline

Unit 1. Introduction vSphere Virtual Infrastructure

Introduction vSphere Virtual Infrastructure, Overview of vSphere virtual infrastructure Installation of ESXi, Configuring ESXi services. VSphere Virtual

Infrastructure. Discuss the latest virtual machine hardware and its features, Explain the importance of VMware Tools™, Deploy and configure virtual machines and templates, Identify virtual machine disk format. Describe, create, and manage standard switches, Configure virtual switch security and load-balancing policies, explain the importance of VMware Tools™, Describe the virtual switch connection types.

Unit 2. Configuring and Managing Virtual Storage

Introduce storage protocols and storage device types. Create and manage VMFS and NFS datastores, describe the new features of VMFS 6.7. Deploy and configure vCenter Server Appliance, use vSphere Web Client, Backup and restore vCenter Server, vCenter Server permissions and roles. Compute, Storage and Network Management, OpenStack Orchestration Management, Image Management. Use templates and cloning to deploy new virtual machines, Modify and manage virtual machines, Clone a virtual machine, Remove virtual machines from the vCenter Server inventory and datastore.

Unit 3. Introduction to Microsoft Azure Cloud

Azure Foundations , Azure Portal, Azure CLI, Cloud Shell , Creating a Free Azure Account , Footprint and Structure , Azure Services , Web and Mobile , Databases , Data and Analytics , Security and Identity , Monitoring and Management . Creating Azure Resources. App Service, Azure Container Instances, Azure App Services

Unit 4. Networking – Azure

Creating a Virtual Network Connection, IP Addressing, Azure Active Directory, Create Azure AD Tenant, Create Users and Groups, Self-Service Password Reset, Creating a Storage Account, Add Disk, Disk Caching.

Unit 5. Introduction to Cloud Computing

Introduction to cloud computing, Cloud security threats and vulnerabilities, Cloud security models (SaaS, PaaS, IaaS), Cloud security technologies and tools. Mobile device security threats, Mobile device management (MDM), secure mobile application development, Mobile data encryption.

Recommended Books/Reference Material

1. Gavanda, M., Mauro, A., Valsecchi, P., & Novak, K. (2019). *Mastering VMware vSphere 6.7: Effectively deploy, manage, and monitor your virtual datacenter with VMware vSphere 6.7*. Packt Publishing Ltd.
2. Ruparelia, N. B. (2023). *Cloud computing*. Mit Press.
3. Toroman, M. (2018). *Hands-On Cloud Administration in Azure: Implement, monitor, and manage important Azure services and components including IaaS and PaaS*. Packt Publishing Ltd.
4. Trofimczuk, D., Ahola, H., & Aunimo, L. (2022). Case study: Microsoft Azure Cloud experiences in teaching at Haaga-Helia University of Applied Sciences.

Cyber Security

BS-IT

Course Code: IT-311

Credit Hours: 2

Pre-requisite: Nil

Objectives

To develop experts that can plan, implement, and monitor cyber security mechanisms to help ensure the protection of information technology assets. To develop graduates that can identify, analyze, and remediate computer security breaches.

Learning Outcomes

- **Understand** malware, social engineering, and advanced persistent threats (APTs) (C2 – PLO 8).

- **Develop** a comprehensive understanding of key cybersecurity technologies and best practices, including network security, cryptography, identity and access management, and cloud security (**C6 – PLO 5**).
- **Apply** this knowledge to real-world scenarios, such as securing web applications and mobile devices (**C3 – PLO 2**).

Course Outline

Unit 1. Introduction to Cybersecurity

Introduction to Cybersecurity, Cyber security Importance, Differences between Information security and cybersecurity, Ethical hacking concepts and scope, Evolution of cyber-attacks, Types of cyber-attacks, Impact of cyber-attacks on individuals and organizations, penetration testing process.

Unit 2. Information Security & Cybersecurity

Virtual Private Networks (VPNs), Cryptography, Symmetric and Asymmetric key encryption, Public key infrastructure (PKI). Information security frameworks, Web and Web application security threats, secure web protocols (HTTPS, SSL/TLS), Cross-site scripting (XSS) and SQL injection attacks, secure coding practices.

Unit 3. Introduction to Security Threats

Introduction to cloud computing, Cloud security threats and vulnerabilities, Cloud security models (SaaS, PaaS, IaaS), Cloud security technologies and tools. Mobile device security threats, Mobile device management (MDM), secure mobile application development, Mobile data encryption.

Unit 4. Threat Intelligence and Hunting

Identity and access management (IAM) overview, IAM components (authentication, authorization, etc.), Single sign-on (SSO), Identity federation and trust models. Introduction to threat intelligence and hunting, Threat intelligence sources and

collection techniques, Threat hunting strategies and tools, Cybersecurity threat sharing and collaboration.

Unit 5. Cyber Security Ethics in Emerging Trends

Cybersecurity governance frameworks, Cybersecurity risk management, Cybersecurity metrics and measurements, Cybersecurity incident response planning. Overview of emerging trends and technologies in cybersecurity, Artificial intelligence and machine learning in cybersecurity, Blockchain and cybersecurity, Internet of Things (IoT) security. Ethics in cybersecurity decision-making, Ethical hacking and penetration testing, Legal and regulatory issues in cybersecurity, Intellectual property and copyright laws in cybersecurity, Liability and responsibility in cybersecurity incidents.

Recommended Books/Reference Material

1. Rahman, N. A. A., Sairi, I. H., Zizi, N. A. M., & Khalid, F. (2020). The importance of cybersecurity education in school. *International Journal of Information and Education Technology*, 10(5), 378-382.
2. Shoemaker, D., Sigler, K., & Shoemaker, T. (2023). *Teaching Cybersecurity: A Handbook for Teaching the Cybersecurity Body of Knowledge in a Conventional Classroom*. CRC Press.
3. Whitman, M. E., & Mattord, H. J. (2021). *Principles of information security*. Cengage learning.

Cyber Security LAB

BS-Computer Science

Course Code: IT-311L

Credit Hours: 01

Pre-requisite: Information Security

Objectives

To develop experts that can plan, implement, and monitor cyber security mechanisms to help ensure the protection of information technology assets. To develop graduates that can identify, analyze, and remediate computer security breaches.

Learning Outcomes

- **Understand** malware, social engineering, and advanced persistent threats (APTs) (C2 – PLO 8).
- **Develop** a comprehensive understanding of key cybersecurity technologies and best practices, including network security, cryptography, identity and access management, and cloud security (C6 – PLO 5).
- **Apply** this knowledge to real-world scenarios, such as securing web applications and mobile devices (C3 – PLO 2).

Course Outline

Unit 1. Introduction to Cybersecurity

Introduction to Cybersecurity, Cyber security Importance, Differences between Information security and cybersecurity, Ethical hacking concepts and scope, Evolution of cyber-attacks, Types of cyber-attacks, Impact of cyber-attacks on individuals and organizations, penetration testing process.

Unit 2. Information Security & Cybersecurity

Virtual Private Networks (VPNs), Cryptography, Symmetric and Asymmetric key encryption, Public key infrastructure (PKI). Information security frameworks, Web and Web application security threats, secure web protocols (HTTPS, SSL/TLS), Cross-site scripting (XSS) and SQL injection attacks, secure coding practices.

Unit 3. Introduction to Security Threats

Introduction to cloud computing, Cloud security threats and vulnerabilities, Cloud security models (SaaS, PaaS, IaaS), Cloud security technologies and tools. Mobile

device security threats, Mobile device management (MDM), secure mobile application development, Mobile data encryption.

Unit 4. Threat Intelligence and Hunting

Identity and access management (IAM) overview, IAM components (authentication, authorization, etc.), Single sign-on (SSO), Identity federation and trust models. Introduction to threat intelligence and hunting, Threat intelligence sources and collection techniques, Threat hunting strategies and tools, Cybersecurity threat sharing and collaboration.

Unit 5. Cyber Security Ethics in Emerging Trends

Cybersecurity governance frameworks, Cybersecurity risk management, Cybersecurity metrics and measurements, Cybersecurity incident response planning. Overview of emerging trends and technologies in cybersecurity, Artificial intelligence and machine learning in cybersecurity, Blockchain and cybersecurity, Internet of Things (IoT) security. Ethics in cybersecurity decision-making, Ethical hacking and penetration testing, Legal and regulatory issues in cybersecurity, Intellectual property and copyright laws in cybersecurity, Liability and responsibility in cybersecurity incidents.

Recommended Books/Reference Material

1. Rahman, N. A. A., Sairi, I. H., Zizi, N. A. M., & Khalid, F. (2020). The importance of cybersecurity education in school. *International Journal of Information and Education Technology*, 10(5), 378-382.
2. Shoemaker, D., Sigler, K., & Shoemaker, T. (2023). *Teaching Cybersecurity: A Handbook for Teaching the Cybersecurity Body of Knowledge in a Conventional Classroom*. CRC Press.
3. Whitman, M. E., & Mattord, H. J. (2021). *Principles of information security*. Cengage learning.

Digital Image Processing

BS-Computer Science

Course Code: CS-315

Credit Hours: 03

Pre-requisite: Nil

Objectives

To learn the fundamental concepts of Digital Image Processing. To study basic image processing operations. To understand image analysis algorithms. To expose students to current applications in the field of digital image processing.

Learning Outcomes

- **Develop and implement** algorithms for digital image processing (**C6 – PLO 4**).
- **Apply** image processing algorithms for practical object recognition applications (**C3 – PLO 2**).

Course Outline

Unit 1. Introduction

The human visual system, electromagnetic system, working and components inside digital camera, pixels.

Unit 2. Image representation

Image representation, sampling, quantization, mathematics of image formation, convolution, camera projection.

Unit 3. Image Processing

Point-based image processing, Fourier theory, image filtering in spatial and frequency domain, wavelets, image registration documentation,

Unit 4. Morphological operations and Feature Detection

Morphological operations, color models, multispectral images, feature detection.

Unit 5. Image Segmentation

Point, Line, and Edge Detection, Thresholding, Region-Based Segmentation ,implementation in Matlab, Segmentation Using Morphological Watersheds Object recognition, Descriptors: boundaries, regions, global Pattern recognition as applied to images, Object/scene/activity categorization, Object detection, Supervised classification algorithms, Probabilistic models for sequence data, Deep learning, convolutional neural networks Visual attributes, Active learning ,Dimensionality reduction ,Non-parametric methods and big data.

Recommended Books/Reference Material

1. Thanki, R. M., & Kothari, A. M. (2019). Digital image processing using SCILAB. Springer International Publishing.
2. Umbaugh, S. E. (2022). Digital Image Processing and Analysis: Digital Image Enhancement, Restoration and Compression. Crc Press.
3. Umbaugh, S. E. (2023). Digital image processing and analysis: computer vision and image analysis. CRC Press.

Game Development

BS-Computer Science

Course Code: CS-308

Credit Hours: 03

Pre-requisite: Nil

Objectives

Define the principles of game design and development. Gain programming capability to develop games. Learn to structure and define the duties of the game development team. Practice art creation, music and animations and various tools needed to create assets. Apply the mathematics

and physics to game design. Apply basic artificial intelligence to developing computer games. Manage porting issues on various platforms.

Learning Outcomes

- **Understand** the concept of a Game Engine (**C2 – PLO 1**).
- **Demonstrate** knowledge of the Unity Game Engine interface (**C3 – PLO 5**).
- **Demonstrate** knowledge of the Integrated Development Environment (IDE) of computer programming (**C3 – PLO 5**).
- **Demonstrate** knowledge of the various interface components that compromise the Integrated Development Environment (IDE) of Unity (**C3 – PLO 5**).
- **Apply** the programming structure learned in Visual Basic language as a basis for learning JavaScript and C# scripting language to manage, manipulate, and animate the game objects in Unity (**C3 – PLO 2**).

Course Outline

Unit 1. Introduction

Explore the world of Game Engines/Unity the game engine of choice/Unity Interface/Install Unity software. Layout and Creating Scenes/Transitions and Manipulation of Objects.

Unit 2. C# Programming: The Language of Choice

Introduction to C# programming language; creating your first script. Features to add to knowledge base: Sprite Renderer, Prefab creation, Collision Detection, Score management; Create a game environment – navigate camera, design play area, create & collect objects, display score, build the game.

Unit 3. Simple Movement and Input

Simple Movement, Simple Rotation and Scaling, Easy Input Handling in Unity, Parent-Child Objects, Sorting Layers, Tagging Game Objects, Collision Layers,

Prefabs, Creating and Destroying Objects, Controlling Object Lifespans with Invoke.

Unit 4. Organizing Game Objects

Simple Movement, Simple Rotation and Scaling, Easy Input Handling in Unity, Parent-Child Objects, Sorting Layers, Tagging Game Objects, Collision Layers, Prefabs, Creating and Destroying Objects, Controlling Object Lifespans with Invoke.

Unit 5. Animation

Simple Unity Animation, Animator States, Scripting Animations, Animations and Colliders.

Recommended Books/Reference Material

1. Cossu, S. M. (2019). Game development with GameMaker Studio 2: Make your own games with gamemaker language. Apress.
2. Hautala, N. (2021). Creating Emotional VR Game Narrative: Experimental Game Design Research (Master's thesis).
3. Tarhan, A. K. (2022). Game Design as a Pedagogic Tool: The Future of STEM Education.

Visual Programming

BS-Computer Science

Course Code: CS-309

Credit Hours: 03

Pre-requisite: Object Oriented Programming

Objectives

This course will provide the different elements of a visual programming language as building blocks to develop correct, coherent programs. To develop a Program using the fundamental software development process, including design, coding, documentation, testing, and debugging. This course will also develop the ability to analyze problems, develop conceptual designs that solve those problems, and transform those designs to Visual Programs.

Learning Outcomes

- **Implement** different elements of a visual programming language as building blocks to develop correct, coherent programs (**C3 – PLO 4**).
- **Develop** using the fundamental software development process, including design, coding, documentation, testing, and debugging (**C6 – PLO 2**).
- **Analyze** problems, develop conceptual designs that solve those problems, and transform those designs to Visual Programs (**C4 – PLO 3**).

Course Outline

Unit 1. Visual Programming Basics

Visual Programming Basics; Introduction to Events; Fundamentals of Event-driven Programming, message handling, user interfaces, graphics device interface, painting and drawing, windows management, input devices, resources, string and menu resource, dialogs and windows controls, common controls, dynamic link libraries.

Unit 2. Network Programming and Building Class Libraries

Threads and synchronization, network programming, Building Class Libraries at the Command Line, Class Libraries, Using References, Assemblies, Private Assembly Deployment, Shared Assembly Deployment, Configuration Overview, Configuration Files, Programmatic Access to Configuration.

Unit 3. SDK Tools

Using SDK Tools for Signing and Deployment, Metadata, Reflection, Late Binding, Directories, Files, Serialization, Attributes, Memory Management and Garbage Collection, Threading and Synchronization, Asynchronous Delegates, Application Domains, Marshal by Value, Marshal by Reference.

Unit 4. Configuring Security

Authentication and Authorization, Configuring Security, Code Access Security, Code Groups, Evidence, Permissions, Role-Based Security, Principals and Identities.

Unit 5. Using Data Sets and Interacting with XML Data

Using Data Readers, Using Data Sets, Interacting with XML Data, Tracing Event Logs, Using the Boolean Switch and Trace Switch Classes, Print Debugging Information with the Debug Class, Instrumenting Release Builds with the Trace Class, Using Listeners, and Implementing Custom Listeners.

Recommended Books/Reference Material

1. Asadi, F. (2023). Installation of Microsoft® Visual Studio®. In Essentials of C Programming with Microsoft® Visual Studio® (pp. 1-17). Cham: Springer Nature Switzerland.
2. Deitel, H., & Deitel, P. C. (2021). How to program. Pearson.
3. Deitel, P., & Deitel, H. (2022). C++ 20 for Programmers: An Objects-Natural Approach. Pearson.
4. Soon, W., & Cox, G. (2020). Aesthetic programming: A handbook of software studies (p. 298). Open Humanities Press.

Data Mining

BS-Computer Science

Course Code: CS-311

Credit Hours: 03

Pre-requisite: Nil

Objectives

Introduce students to the basic concepts and techniques of Data Mining. Develop skills of using recent data mining software for solving practical problems.

Learning Outcomes

- **Explain** the importance of Data Mining as a new discipline in the IT field (**C2 – PLO 1**).
- **Use** the various kinds of Data Mining Tasks (**C3 – PLO 5**).
- **Apply** data mining to solve real life problems (**C3 – PLO 2**).

Course Outline

Unit 1. Data Preprocessing

Data representation, Data summarization, Data cleaning, Data integration and transformation.

Unit 2. Association Rule Mining

The Apriori algorithm, FP-Growth Algorithm. Class based Association Rules.

Unit 3. Classification

Decision tree induction, Attribute Selection Measures, Decision tree measures, K-Nearest Neighbor, Naïve Bayes, Vibe of Assignments. Belief Network, Neural Networks.

Unit 4. Clustering

Introduction, K-Means, Hierarchical, DB-Scan. Features Selection.

Unit 5. Web Mining

Introduction, Fingerprinting, HITS algorithm.

Recommended Books/Reference Material

1. Chakraborty, S., Islam, S. H., & Samanta, D. (2022). Introduction to Data Mining and Knowledge Discovery. In *Data Classification and Incremental Clustering in Data Mining and Machine Learning* (pp. 1-22). Cham: Springer International Publishing.
2. Data, V. (2019). T 4.50 Course: Data Mining and Applications [T-WIWI-103066]. *Module Handbook*.
3. Han, J., Pei, J., & Tong, H. (2022). *Data mining: concepts and techniques*. Morgan kaufmann.
4. Hanjo, L. (2023). Data Mining: Concepts, Models, Methods, and Algorithms.

Data Science

BS-Computer Science

Course Code: CS-404

Credit Hours: 03

Pre-requisite: Nil

Objectives

The Data Science course offers: In-depth knowledge of Data Science Life Cycle and Machine Learning Algorithms. Comprehensive knowledge of various tools and techniques for Data Transformation. The capability to perform Text Mining and Sentimental analyses on text data and gain an insight into Data Visualization and Optimization techniques. The exposure too many real-life industry-based projects which will be executed in R Studio and python. Projects which are diverse in nature covering media, healthcare, social media, aviation and HR. Rigorous involvement of an SME throughout the Data Science Training to learn industry standards and best practices.

Learning Outcomes

- **Implement** Text Mining and Sentimental analyses on text data and gain an insight into Data Visualization and Optimization techniques (**C3 – PLO 2**).
- **Implement** many real-life industry-based projects which will be executed in R Studio and python (**C3 – PLO 4**).

Course Outline

Unit 1. Introduction to Data Science

Introduction: What is Data Science? Big Data and Data Science hype – and getting past the hype, Exploratory Data Analysis and the Data Science Process, Exploratory Data Analysis: Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA. Exploratory Data Analysis: The Data Science Process, Case Study: Real Direct (online real estate firm), Statistical Inference: Populations and samples, Statistical Inference: Statistical modeling, probability distributions, fitting a model.

Unit 2. Data Visualization

Statistical Inference: Intro to R and Python , Data Visualization: Basic principles, ideas and tools for data visualization , Data Visualization: Examples of inspiring (industry) projects- Exercise: create your own visualization of a complex dataset , Introduction to machine learning: Linear regression and regularization , Introduction to machine learning Model selection and evaluation , Classification: decision trees, SVM, kNN, Ensemble methods: random forests, Intro to probability: Naïve Bayes and logistic regression.

Unit 3. Clustering, Machine Learning Algorithms

Clustering: k-means, hierarchical clustering, Dimensionality reduction: PCA and SVD. One More Machine Learning Algorithm and Usage in Applications Motivating application: Filtering Spam, Why Linear Regression and k-NN are poor choices for Filtering Spam, Naive Bayes and why it works for Filtering Spam, Data

Wrangling: APIs and other tools for scrapping the Web, Feature Generation and Feature Selection (Extracting Meaning from Data).

Unit 4. Features Generations, Text Mining and Recommendation Systems

Feature Generation (brainstorming, role of domain expertise, and place for imagination). Feature Selection algorithms, Filters; Wrappers; Decision Trees; Random Forests, Text mining and information retrieval, Recommendation Systems: Building a User-Facing Data Product, Recommendation Systems: Algorithmic ingredients of a Recommendation Engine, Recommendation Systems: build your own recommendation system.

Unit 5. Mining Social-Network Graphs, Big Data, & Data Science and Ethical Issues

Mining Social-Network Graphs Mining Social-Network Graphs: Clustering of graphs, Direct discovery of communities in graphs, Big Data: Big data storage and retrieval, Big data distributed computing, Data Science and Ethical Issues Discussions on privacy, security, ethics, A look back at Data Science, Next-generation data scientists Recommended Books/Reference Material.

Recommended Books/Reference Material

1. Bruce, P., Bruce, A., & Gedeck, P. (2020). Practical statistics for data scientists: 50+ essential concepts using R and Python. O'Reilly Media.
2. Efron, B., & Hastie, T. (2021). Computer age statistical inference, student edition: algorithms, evidence, and data science (Vol. 6). Cambridge University Press.
3. Kabacoff, R. (2022). R in action: data analysis and graphics with R and Tidyverse. Simon and Schuster.
4. Wickham, H., Çetinkaya-Rundel, M., & Grolemund, G. (2023). R for data science. "O'Reilly Media, Inc."

Computer Graphics

BS-Computer Science

Course Code: CS-405

Credit Hours: 3

Pre-requisite: Nil

Objectives

In this course the students will be comprehend the structure of modern computer graphics systems. Understand the basic principles of implementing computer graphics fundamentals and compare key algorithms for modelling and rendering graphical data. This course will also develop design and problem solving skills with applications to computer graphics.

Learning Outcomes

- **Explain** the basic principles of implementing computer graphics fundamentals (C2 – PLO 1).
- **Compare** key algorithms for modelling and rendering graphical data (C4 – PLO 3).
- **Develop** design and problem-solving skills with applications to computer graphics (C6 – PLO 2).
- **Construct** interactive computer graphics programs using OpenGL (C6 – PLO 4).

Course Outline

Unit 1. Fundamental Concepts

Fundamental Concepts: forward and backward rendering (i.e., ray-casting and rasterization), applications of computer graphics: including game engines, cad.

Unit 2. Visualization and standard graphics APIs

Visualization, virtual reality, polygonal representation, basic radiometry, similar triangles, and projection model, use of standard graphics APIs (see HCI GUI construction).

Unit 3. Rendering Basics

Basic rendering: rendering in nature, i.e., the emission and scattering of light and its relation to numerical integration, affine and coordinate system transformations, ray tracing, visibility and occlusion, including solutions to this problem such as depth buffering, painter's algorithm, and ray tracing, the forward and backward rendering equation.

Unit 4. Triangle rasterization and application of spatial data structures

Simple triangle rasterization, rendering with a shader-based API, texture mapping, including minification and magnification (e.g., trilinear MIP-mapping), application of spatial data structures to rendering, sampling and anti-aliasing, scene graphs and the graphics pipeline; geometric modeling: basic geometric operations such as intersection calculation, proximity tests

Unit 5. Polynomial Curves and Surfaces

Polynomial curves and surfaces, approximation techniques such as polynomial curves, bezier curves, spline curves and surfaces, animation as a sequence of still images.

Recommended Books/Reference Material

1. Dilshodov, A., & Adxamjonov, M. (2023). Application of the opengl library in the course of programming and computer simulation. Engineering problems and innovations.
2. Eck, D. J. (2021). Introduction to Computer Graphics.
3. Segal, M., & Akeley, K. (2021). The OpenGL Graphics System: A Specification (Version 4.6 (Core Profile)-October 22, 2019). The Khronos Group Inc.[cit. 2020-12-05]. Dostupné z: https://www.khronos.org/registry/OpenGL/specs/gl/glspec46_core.pdf.
4. Segal, M., & Akeley, K. (2022). The OpenGL® Graphics System: A Specification (Version 4.6 (Core Profile)-May 5, 2022).

Object Oriented Analysis and Design

BS-Computer Science

Course Code: CS-323

Credit Hours: 02

Pre-requisite: Programming Fundamentals

Objectives

In this course the students will be comprehend the technical approach for analyzing, designing a system by applying the object-orientated concepts, and develops a set of graphical system models during the development life cycle of the software. OOAD in modern software engineering is typically conducted in an iterative and incremental way. In this course, the students will learn how to produce detailed object models and designs from system requirements; use the modeling concepts provided by UML; identify use cases and expand into full behavioral designs; expand the analysis into a design ready for implementation and construct designs that are reliable.

Learning Outcomes

- **Understand** how to gather the requirements for a software application **(C2 – PLO 3)**.
- **Differentiate** between functional and nonfunctional requirements, and express the requirements in the form of use cases **(C4 – PLO 3)**.
- **Develop** the appropriate classes from the requirements and define their responsibilities, behaviors, interrelationships, and internal structures **(C6 – PLO 4)**.
- **Construct** UML use case, class, and sequence diagrams to document and communicate the analysis results **(C6 – PLO 7)**.
- **Apply** the results of analysis to implement the classes and interfaces **(C3 – PLO 2)**.

Course Outline

Unit 1. Introduction to Object Technology

Principles of Modeling, and Principles of Object Orientation. Introduction to UML, Unification, UML Diagrams, Unified Process & Rational Unified Process, RUP

Disciplines, Case Study Analysis and Basics, Case Study, About Inception, Feasibility and Risk Analysis.

Unit 2. Understanding Requirements, Requirements Types

System Use Case Diagram, Use Case Table, Activity Diagram, Supplementary Specifications, Vision Document, Glossary, Rational Rose Overview, Use Case & Activity Diagram Modeling in Rational Rose. Elaboration Phase of RUP; Configuration Management; System Sequence Diagram, Domain Model: Identifying Business Classes, Associations, Implementation of System Sequence & Domain Model: Use Case Operational Contracts, Business Sequence, Analysis Sequence & Collaboration Diagrams. Use Case Dependencies, Analysis Use Case Diagram, Implementation of Sequence, Collaboration, Analysis Use Case Diagram. State Chart Diagrams and Implementation.

Unit 3. Design Patterns: GRASP: Information Expert, Creator, Cohesion & Coupling and Controller.

Use Case Realization Using GRASP Patterns, Design Model: Determining Visibility. Modeling Generalization, Creating Design Class Diagram, Mapping Data Model to Domain Model.

Unit 4. Implementation of Design Class Diagram

Coding patterns. Mapping Design to Code. More Patterns for Assigning Responsibilities, Polymorphism, Pure Fabrication, Indirection, Protected Variation. Design Patterns: Adapter, Factory. Singleton. Composition, and Façade and Discuss Remaining Patterns.

Unit 5. Design Patterns

Design Patterns: Adapter, Factory. Singleton. Composition, and Façade and Discuss Remaining Patterns.

Recommended Books/Reference Material

1. Jahan, M., Abad, Z. S. H., & Far, B. (2021). Generating sequence diagram from natural language requirements. In *2021 IEEE 29th International Requirements Engineering Conference Workshops (REW)* (pp. 39-48). IEEE.
2. Lupasc, A. (2021). Use of Unified Modeling Language in the Development of Object-Oriented Information Systems. *Annals of the University Dunarea de Jos of Galati: Fascicle: I, Economics & Applied Informatics*, 27(3).
3. Ponde, S. (2022). Object Oriented Analysis and Design.
4. Valacich, J. S., George, J. F., & Valacich, J. S. (2022). Modern systems analysis and design (2017). *Google Scholar Google Scholar Digital Library Digital Library*.

Object Oriented Analysis and Design LAB

BS-Computer Science

Course Code: CS-323L

Credit Hours: 01

Pre-requisite: Programming Fundamentals

Objectives

In this course the students will be comprehend the technical approach for analyzing, designing a system by applying the object-orientated concepts, and develops a set of graphical system models during the development life cycle of the software. OOAD in modern software engineering is typically conducted in an iterative and incremental way. In this course, the students will learn how to produce detailed object models and designs from system requirements; use the modeling concepts provided by UML; identify use cases and expand into full behavioral designs; expand the analysis into a design ready for implementation and construct designs that are reliable.

Learning Outcomes

- **Understand** how to gather the requirements for a software application (**C2 – PLO 3**).

- **Differentiate** between functional and nonfunctional requirements, and express the requirements in the form of use cases (**C4 – PLO 3**).
- **Develop** the appropriate classes from the requirements and define their responsibilities, behaviors, interrelationships, and internal structures (**C6 – PLO 4**).
- **Construct** UML use case, class, and sequence diagrams to document and communicate the analysis results (**C6 – PLO 7**).
- **Apply** the results of analysis to implement the classes and interfaces (**C3 – PLO 2**).

Course Outline

Unit 1. Introduction to Object Technology

Principles of Modeling, and Principles of Object Orientation. Introduction to UML, Unification, UML Diagrams, Unified Process & Rational Unified Process, RUP Disciplines, Case Study Analysis and Basics, Case Study, About Inception, Feasibility and Risk Analysis.

Unit 2. Understanding Requirements, Requirements Types

System Use Case Diagram, Use Case Table, Activity Diagram, Supplementary Specifications, Vision Document, Glossary, Rational Rose Overview, Use Case & Activity Diagram Modeling in Rational Rose. Elaboration Phase of RUP; Configuration Management; System Sequence Diagram, Domain Model: Identifying Business Classes, Associations, Implementation of System Sequence & Domain Model: Use Case Operational Contracts, Business Sequence, Analysis Sequence & Collaboration Diagrams. Use Case Dependencies, Analysis Use Case Diagram, Implementation of Sequence, Collaboration, Analysis Use Case Diagram. State Chart Diagrams and Implementation.

Unit 3. Design Patterns: GRASP: Information Expert, Creator, Cohesion & Coupling and Controller.

Use Case Realization Using GRASP Patterns, Design Model: Determining Visibility. Modeling Generalization, Creating Design Class Diagram, Mapping Data Model to Domain Model.

Unit 4. Implementation of Design Class Diagram

Coding patterns. Mapping Design to Code. More Patterns for Assigning Responsibilities, Polymorphism, Pure Fabrication, Indirection, Protected Variation. Design Patterns: Adapter, Factory. Singleton. Composition, and Façade and Discuss Remaining Patterns.

Unit 5. Design Patterns

Design Patterns: Adapter, Factory. Singleton. Composition, and Façade and Discuss Remaining Patterns.

Recommended Books/Reference Material

1. Jahan, M., Abad, Z. S. H., & Far, B. (2021). Generating sequence diagram from natural language requirements. In *2021 IEEE 29th International Requirements Engineering Conference Workshops (REW)* (pp. 39-48). IEEE.
2. Lupasc, A. (2021). Use of Unified Modeling Language in the Development of Object-Oriented Information Systems. *Annals of the University Dunarea de Jos of Galati: Fascicle: I, Economics & Applied Informatics*, 27(3).
3. Ponde, S. (2022). Object Oriented Analysis and Design.
4. Valacich, J. S., George, J. F., & Valacich, J. S. (2022). Modern systems analysis and design (2017). *Google Scholar Google Scholar Digital Library Digital Library*.

Software Verification and Validation

BS-Computer Science

Course Code: CS-412

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course focuses on software verification and validation throughout the software life cycle. Topics covered in this course will include reviews, inspections, formal verification, testing techniques, and testing frameworks.

Learning Outcomes

- **Apply** the concepts and theory related to software verification and validation (C3 – PLO 2).
- **Identify** different testing techniques and design test plans, develop test suites, and evaluate test suite coverage (C2 – PLO 5).
- **Use** testing frameworks and testing tools (C3 – PLO 5).

Course Outline

Unit 1. Basic Concepts in Software Verification and Validation

Bugs, errors, fault, Inspections, Reviews, Walkthroughs, Desk-checking.

Unit 2. Software Testing Techniques

Black box and White Box Testing. Testing types, testing strategies.

Unit 3. Test Adequacy and Coverage Criteria

Test suite, Test case generating, types of unit test and integration testing, statement coverage and coverage types.

Unit 4. Automated Testing Tools and Techniques

Testing tools and technologies.

Unit 5. Testing Lifecycle and Test Management

Recommended Books/Reference Material

1. Araujo, H., Mousavi, M. R., & Varshosaz, M. (2023). Testing, validation, and verification of robotic and autonomous systems: a systematic review. *ACM Transactions on Software Engineering and Methodology*, 32(2), 1-61.
2. Beyer, D. (2023, April). Competition on software verification and witness validation: SV-COMP 2023. In *International Conference on Tools and Algorithms for the Construction and Analysis of Systems* (pp. 495-522). Cham: Springer Nature Switzerland.
3. Jalil, S., Rafi, S., LaToza, T. D., Moran, K., & Lam, W. (2023, April). Chatgpt and software testing education: Promises & perils. In *2023 IEEE International Conference on Software Testing, Verification and Validation Workshops (ICSTW)* (pp. 4130-4137). IEEE.
4. Seligman, E., Schubert, T., & Kumar, M. A. K. (2023). *Formal verification: an essential toolkit for modern VLSI design*. Elsevier.

Software Verification and Validation LAB

BS-Computer Science

Course Code: CS-412L

Credit Hours: 01

Pre-requisite: Nil

Objectives

This course focuses on software verification and validation throughout the software life cycle. Topics covered in this course will include reviews, inspections, formal verification, testing techniques, and testing frameworks.

Learning Outcomes

- **Apply** the concepts and theory related to software verification and validation (**C3 – PLO 2**).
- **Identify** different testing techniques and design test plans, develop test suites, and evaluate test suite coverage (**C2 – PLO 5**).
- **Use** testing frameworks and testing tools (**C3 – PLO 5**).

Course Outline

Unit 1. Basic Concepts in Software Verification and Validation

Bugs, errors, fault, Inspections, Reviews, Walkthroughs, Desk-checking.

Unit 2. Software Testing Techniques

Black box and White Box Testing. Testing types, testing strategies.

Unit 3. Test Adequacy and Coverage Criteria

Test suite, Test case generating, types of unit test and integration testing, statement coverage and coverage types.

Unit 4. Automated Testing Tools and Techniques

Testing tools and technologies.

Unit 5. Testing Lifecycle and Test Management

Non-functional testing. Formal methods for software verification

Recommended Books/Reference Material

1. Araujo, H., Mousavi, M. R., & Varshosaz, M. (2023). Testing, validation, and verification of robotic and autonomous systems: a systematic review. *ACM Transactions on Software Engineering and Methodology*, 32(2), 1-61.
2. Jalil, S., Rafi, S., LaToza, T. D., Moran, K., & Lam, W. (2023, April). Chatgpt and software testing education: Promises & perils. In *2023 IEEE International Conference*

on Software Testing, Verification and Validation Workshops (ICSTW) (pp. 4130-4137). IEEE.

3. Seligman, E., Schubert, T., & Kumar, M. A. K. (2023). *Formal verification: an essential toolkit for modern VLSI design*. Elsevier.
4. Beyer, D. (2023, April). Competition on software verification and witness validation: SV-COMP 2023. In *International Conference on Tools and Algorithms for the Construction and Analysis of Systems* (pp. 495-522). Cham: Springer Nature Switzerland.

Software Quality Assurance

BS-IT

Course Code: IT-306

Credit Hours: 03

Pre-requisite: Software Engineering

Objectives

This course will provide the software testing and software quality assurance principles. Students will learn to prepare test case and test suites for completely testing all aspects of a system under test (SUT). They can analyze which of the software testing techniques are relevant for a particular case and know software reliability analysis tools and techniques.

Learning Outcomes

- **Apply** software testing and software quality assurance principles (C3 – PLO 2).
- **Develop** test case and test suites for completely testing all aspects of a system under test (SUT) (C6 – PLO 4).
- **Analyze** which of the software testing techniques are relevant for a particular case and know software reliability analysis tools and techniques (C4 – PLO 3).

Course Outline

Unit 1. Introduction to Software Quality

Software Quality, Software Quality Attributes, Quality Engineering., Testing: Concepts, Issues, and Techniques, Software testing lifecycle. Testing Scopes. Testing Approaches. Testing Concepts. Test Planning Process.

Unit 2. Introduction to Testing 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.

Unit 3. Testing Techniques

Domain and combinatorial testing, Unit and integration testing, Acceptance testing, Test automation, Slicing, Software reliability models and engineering, Introduction, Exponential model.

Unit 4. Reliability and Quality Models

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.

Unit 5. Introduction to 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.

Recommended Books/Reference Material.

1. Araujo, H., Mousavi, M. R., & Varshosaz, M. (2023). Testing, validation, and verification of robotic and autonomous systems: a systematic review. *ACM Transactions on Software Engineering and Methodology*, 32(2), 1-61.
2. Bejani, S., & Keymanesh, A. H. (2023). A novel way to identify effective test-case in software testing. *Electronic and Cyber Defense*, 11(2), 103-116.
3. Beyer, D. (2023, April). Competition on software verification and witness validation: SV-COMP 2023. In *International Conference on Tools and Algorithms for the Construction and Analysis of Systems* (pp. 495-522). Cham: Springer Nature Switzerland.
4. Hussein, K. (2023). Testing front-end architecture.
5. Jalil, S., Rafi, S., LaToza, T. D., Moran, K., & Lam, W. (2023, April). Chatgpt and software testing education: Promises & perils. In *2023 IEEE International Conference on Software Testing, Verification and Validation Workshops (ICSTW)* (pp. 4130-4137). IEEE.
6. Seligman, E., Schubert, T., & Kumar, M. A. K. (2023). *Formal verification: an essential toolkit for modern VLSI design*. Elsevier.

16. List of Mathematics and Supporting Courses (Interdisciplinary/ Allied)

Sr#	Course Code	Course Title	Pre-Requisite	Credit Hours
1	MTH-107	Multivariable Calculus	Calculus and Analytical Geometry	3 (3-0)
2	MTH-111	Elementary Linear Algebra	Nil	3 (3-0)
3	STA 106	Introduction to Probability and Statistics	Nil	3 (3-0)
4	ENG 104	Business and Technical Writing	Nil	3 (3-0)

17. Course Outlines for Mathematics and Supporting Courses (Interdisciplinary/ Allied)

Multivariable Calculus

Course Code: MTH-107

Credit Hours: 03

Pre-requisite: Calculus and Analytical Geometry

Objectives

To provide foundation and basic ground for multivariable calculus and analytical background with multi variables.

Learning Outcomes

After completion of this course; the students will be able to

- Understand the basic concepts and know the basic techniques of differential and integral calculus of functions of several variables.(PLO 2)
- Apply the theory to calculate the gradients, directional derivatives, arc length of curves, area of surfaces, and volume of solids (PLO 4).
- Solve problems involving maxima and minima, line integral and surface integral, and vector calculus (PLO 3).

Course Outline

Unit 1. Function of Several variables

Function of two or more variables. Limits, calculating limits using limits Laws. Continuity, examples.

Unit 2. Partial Derivatives

Partial derivatives. Differentiability and differentials and chain rule.

Unit 3. Multiple Integrals

Double Integrals, Double Integrals over nonrectangular regions and in polar coordinates. Triple Integrals.

Unit 4. Vector Calculus

Line and surface integrals, Green's theorem, Green's theorem. Stoke's theorem.

Unit 5. Fourier series, Laplace and Z-Transform

Fourier series, Functions of any period $P=2L$. Even and odd functions. Half Range expansions. Fourier transform. Laplace transform. Z-transform.

Recommended Books/Reference Material

1. Anton, H., Bivens, I. C., Davis, S. (2022). *Calculus: Single Variable*. United States: Wiley.
2. Helfgott, M. (2023). *Calculus for the Natural Sciences*. United States: Society for Industrial and Applied Mathematics, Wiley.
3. HughesHallett, D., Gleason, A. M., McCallum, W. G. (2020). *Calculus, Single and Multivariable*. United Kingdom: Wiley.
4. Stewart, J., Clegg, D.K., and Watson, S. (2020). *Calculus: Early Transcendentals. Cengage Learning*.
5. Thomas, G. B., Finney, R. L., Weir, M. D., & Giordano, F. R. (2003). *Thomas' calculus*. Reading: Addison-Wesley.

Elementary Linear Algebra

Course Code: MTH-111

Credit Hour: 03

Prerequisite: Nil

Objectives

Students should be familiar with the basics of Linear algebra which is a branch of mathematics that deals mainly with properties of matrices, vector spaces and linear transformations.

Learning Outcomes

- The students must be familiar with the properties of matrices in solving the linear equations and how these are useful in linear transformations between the vector spaces **(PLO 2)**.
- The students can use this skill set in different fields of computer sciences and information technology **(PLO 5)**.

Course Outline

Unit 1. Algebra of Matrices

Matrices, squares of Matrices, trace, powers of matrices, polynomials in matrices, invertible matrices. Orthogonal matrix, normal matrix. Hermitian matrix, unitary matrix, (Complex). Normal Matrix. Block matrices.

Unit 2. System of Linear Equations

System of linear equations and its solutions. Equivalent systems. Elementary operations echelon and reduced echelon form, inverse of matrix using elementary row operations, Solution of linear systems. Gauss-Jordan method and Gaussian elimination method.

Unit 3. Determinants

Determinants of matrix of order two and three, Definition of determinants of the same order, computing of determinants. Definition of higher order determinants, properties, expansion and applications of determinants.

Unit 4. Vector Spaces, Eigen values and Eigenvectors

Vector's basic definitions, Vector addition and scalar multiplication. Dot and cross product. Orthogonality. Definition and examples of vector spaces, subspaces. Linear combination spanning. Linear independence and dependence. Eigen values and eigenvectors. Diagonalization.

Unit 5. Inner Product Spaces

Definition and examples. Properties and Projection. Angle and orthogonality.
Cauchy inequality.

Recommended Books/Reference Material

1. Anton, H., & Rorres, C. (2013). *Elementary linear algebra: applications version*. John Wiley & Sons.
2. Lyche, T. (2020). *Numerical Linear Algebra and Matrix Factorizations*. Springer Nature
3. Rorres, C. (2006). *Elementary linear algebra*. Mississauga, Ont.: Wiley.
4. Strang, G. (2022). *Introduction to linear algebra*. Wellesley-Cambridge Press.
5. Shapiro, H. (2015). *Linear algebra and matrices*. AMS, Providence, Rhode Island.

Business and Technical Writing

Course Code: ENG-104

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objective of the Business and Technical Writing course is to equip participants with the essential skills needed to communicate effectively in professional settings. Through this course, individuals learn to convey complex technical information in a clear, concise, and reader-friendly manner. Emphasis is placed on developing proficiency in various business writing formats, such as reports, proposals, and emails, as well as mastering the art of creating user-friendly technical documentation. The goal is to empower participants with the ability to produce high-quality written communication that enhances clarity, professionalism, and overall effectiveness in both business and technical contexts.

Learning Outcomes

- Mastering the art of crafting clear and concise business documents **(PLO 7)**.

- Developing proficiency in various business writing formats, including reports, proposals, and emails **(PLO 7)**.
- Acquiring skills to communicate complex technical information in a reader-friendly manner **(PLO 7)**.
- Creating effective and user-friendly technical documentation **(PLO 7)**.
- Enhancing professionalism in written communication for business and technical contexts **(PLO 7)**.
- Gaining the ability to tailor messages to diverse audiences and purposes **(PLO 7)**.
- Practicing critical editing and revision techniques for polished and error-free documents **(PLO 7)**.

Course Outline

Unit 1. Introduction to Business and Technical Writing

Overview of the importance of effective communication in professional settings. Understanding the audience and purpose in business and technical contexts. Key principles of clarity, conciseness, and professionalism in writing. Employment interviews (types of interviews, preparation for interviews, follow up communication in interviews) Communication in team (group work business project)

Unit 2. Business Writing Fundamentals

Exploring various business writing formats: memos, emails, and reports. Crafting professional and persuasive messages for different purposes. Techniques for organizing and structuring business documents effectively. Memoranda and Proposal Writing.

Unit 3. Technical Writing Essentials

Introduction to technical writing principles and conventions. Conveying complex technical information in a clear and accessible manner. Creating user-friendly technical documentation, including manuals and guides. Business Correspondence,

Formal Letters (Letters of inquiry, order, complaint, invitation, business request, Replies to queries and requests)

Unit 4. Document Design and Visual Elements

Importance of document design in enhancing readability and user experience. Incorporating visual elements such as graphs, charts, and images. Balancing text and visuals for optimal communication impact.

Unit 5. Editing and Revision Techniques

Strategies for proofreading and editing written content. Addressing common errors and improving overall writing quality. Peer review and collaborative editing for constructive feedback.

Unit 6. Tailoring Messages to Diverse Audiences

Adapting communication style for different audiences and purposes. Consideration of cultural and contextual factors in business and technical writing. Final project: Applying learned skills to create a comprehensive business or technical document tailored for a specific audience. Presentations, how to present a business proposal. Presentations, Do's and don'ts of a good presentation.

Recommended Books/Reference Material

1. Bailey Jr, E. P. (1997). *The plain English approach to business writing*. Oxford University Press.
2. Bargiela-Chiappini, F., & Nickerson, C. (2014). Business writing as social action. In *Writing Business* (pp. 1-32). Routledge.
3. Canavor, N. (2021). *Business writing for dummies*. John Wiley & Sons.
4. Dwyer, J., & Hopwood, N. (2019). *The business communication handbook*. Cengage AU.

5. Hollis-Turner, S., & Scholtz, D. (2010). Business writing in academic and workplace contexts. *Southern African Linguistics and Applied Language Studies*.
6. Jenkins, S., & Hinds, J. (1987). Business letter writing: English, French, and Japanese. *TESOL quarterly*, 21(2), 327-349.
7. Van Laan, K. (2022). *The insider's guide to technical writing*. XML Press.

Introduction to Probability and Statistics

Course Code: STA-106

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main purpose of the course is to enable students to understand the significance of statistics in the real world, particularly in the field of other sciences. The course focuses on the methods of collection presentation and analysis of data using measures of central tendency and measures of dispersion. Furthermore, the course focuses on basic principles of probability and probability distributions for discrete and continuous random variables.

Learning Outcomes

- Students will be capable to explain the random variables, discrete and continuous random variables, and their probability distributions **(PLO 2)**.
- Students will gain understanding to apply the probability distribution on scientific studies and interpret the results of statistical analyses accurately and effectively **(PLO 2)**.
- Student will understand the basic statistical concepts and able to calculate and explain measures of central tendency and dispersion **(PLO 2)**.
- Students will be able to present the data using suitable graph, chart, and diagram **(PLO 7)**.

Course Outline

Unit 1. Introduction to Statistics & Presentation of Data

Introduction Statistics, important statistical terms, variable, data & data collection. Classification and tabulation of data. Frequency distribution, its construction and

other related concepts. Graphical Presentation: Simple bar chart, Component & Multiple bar chart, Pie chart, Histogram, Frequency polygon and Ogive.

Unit 2. Measures of Central Tendency

Mean, Median & Mode for ungrouped and grouped data, quartiles, deciles and percentiles for ungrouped & grouped data.

Unit 3. Measures of Dispersion

Absolute and relative measures of dispersion for ungrouped and grouped data. Moments about mean. Measures of skewness and kurtosis. Moment-ratios.

Unit 4. Probability & Probability Distributions

Introduction to probability theory, types of events. Functions of classical probability with real world problems. Numerical examples of probability. Concept of random variable, discrete and continuous random variables. Binomial probability distribution & its numerical examples

Unit 5. Discrete and Continuous Probability Distributions

Binomial probability distribution & its numerical examples. Hyper geometric probability distribution & its numerical examples. Poisson probability distribution & numerical examples related to it. Normal distribution, numerical examples with direct & inverse use of area table for standard normal distribution.

Recommended Books/Reference Material

1. [Carlton](#), M.A., & Devore, [J.L.](#) (2020). *Probability with STEM applications*, (3rd ed.). Wiley.
2. Chaudhry S.M., & Kamal. S. (2018). *Introduction to statistical theory part 1*. Lahore, Pakistan: Ilmi Kitab Khana.
3. Hogg, R., McKean, J., & Craig, A. (2021). *Introduction to mathematical statistics*, (8th ed.). Boston: Pearson Education.
4. Mendenhall, W., Beaver, R. J., & Beaver, B. M. (2012). *Introduction to probability and statistics*. Cengage Learning.

5. Mood, A.M., Graybill, F.A., & Boes, D.C. (1974). *Introduction to the theory of statistics*, (3rd ed.). New York: McGraw Hill.
6. Scheaffer, R. L., Mulekar, M., & McClave, J. T. (2010). *Probability and statistics for engineers*. Cengage Learning.
7. Walpole, R. E. (2002). *Introduction to statistics*, (7th ed.). New York: Macmillan publishing company.
8. Walpole, R.E., Myers, R.H., & Myers, S.L. (1998). *Probability and statistics for engineers and scientist*, (6th ed.). New York: Prentice Hall.
9. Weiss, N. A., & Hassett, M. J. (1999). *Introductory statistics*. Boston: Addison-Wesley.

18. List of Elective Supporting Courses of CS

Sr#	Course Code	Course Title	Pre-Requisite	Credit Hours
1	ECO-101	Introduction to Economics	Nil	3
2	MGT-105	Introduction to Digital Marketing	Nil	3

19. Course Outlines for Elective Supporting Courses of CS

Introduction to Economics

BBA-Business Administration

Course Code: ECO-101

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course is designed to give an understanding of economic laws and their application. The course addresses behavior of individuals, firms in the economy and major macroeconomic issues in different markets environment, and making students aware of the day to day changing market

conditions. They will learn how to use different economic instruments to apply in their practical field works.

Learning outcomes:

After studying this course, the student will be able to understand, comprehend and analyze:

- The Economic problem of allocation and distribution of resources **(PLO 1)**.
- The factors that determine demand and supply **(PLO 2)**.
- The concept of elasticity of demand and supply **(PLO 2)**.

Course Outline

Unit 1. Basic Economic Concepts

Economics: Basic Themes and Nature. Micro versus Macro Economics. Positive versus Normative economics. Economic problem of resource allocation. Economics relevance to business organizations. Nature, scope and importance of Economics, Scarcity and choice. Opportunity cost, Factors of production, Production possibility frontier.

Unit 2. Demand and Supply Analysis

The demand functions. Changes in demand. The supply functions. Changes in supply. Equilibrium of Supply & Demand. Elasticity of demand/supply and its measurement.

Unit 3. Elasticity

Concept of elasticity, Price elasticity of demand, Income elasticity of demand, Cross Elasticity of Demand, Price elasticity of supply, Applications of elasticity. Shifts in demand and supply curves.

Unit 4. Theories- Utility Theory, Theory of Firm

Consumer behavior, Preferences, Utility function, Law of increasing and decreasing marginal utility, Law of equi-marginal utility.

Unit 5. Production Analysis

Basic production concepts. Total, Average and Marginal Product. Returns to scale. Short-run and long-run production. Least-cost factor combination. Producer equilibrium.

Unit 6. Cost and Revenue Analysis

Various cost concepts. The cost of production: Short-run cost, long-run cost. Revenue and revenue curves: Total, average and marginal revenues. Profit-Maximization.

Unit 7. Market Structures and Pricing

Market and its forms. Price and out-put under perfect competition. Price and out-put under monopoly, duopoly, oligopoly and monopolistic competition.

Unit 8. Resource Allocation

Role of the government in market efficiency. The theory of Marginal Productivity. Market demand for resources.

Recommended Books/ Reference Material

1. Besanko, D., & Braeutigam, R. (2020). *Microeconomics*. John Wiley & Sons.
2. Browning, E. K., & Zupan, M. A. (2022). *Microeconomics: Theory and applications*. John Wiley & Sons.
3. Gans, J., King, S., Byford, M., & Mankiw, G. (2023). *Principles of Microeconomics 9e*. Cengage AU.
4. Mankiw, N. G., Kneebone, R. D., & McKenzie, K. J. (2020). *Principles of microeconomics*. Nelson Education Ltd.
5. Nicholson, W., & Snyder, C. M. (2021). *Intermediate microeconomics and its application*. Cengage Learning.

Introduction to Digital Marketing

BBA- Business Administration

Course Code: MGT-105

Credit Hours: 03

Pre-requisite: Nil

Objectives

The aim of the this course is to provide students with the knowledge about business advantages of the digital marketing and its importance for marketing success; to develop a digital marketing plan; to make SWOT analysis; to define a target group; to get introduced to various digital channels, their advantages and ways of integration; how to integrate different digital media and create marketing content; how to optimize a Web site and SEO optimization; how to create Google AdWords campaigns; social media planning; to get basic knowledge of Google Analytics for measuring effects of digital marketing and getting insight of future trends that will affect the future development of the digital marketing. The application of the gained knowledge, skills and competences will help future managers in forming digital marketing plan in order to manage a digital marketing performance efficiently.

Learning outcomes

- Develop and implement Internet marketing strategies **(PLO 6)**.
- Critically appraise the application of the Internet in marketing **(PLO 7)**.
- Apply the marketing concepts in an online environment **(PLO 2)**.

Course Outline

Unit 1. Introduction of the Digital Marketing, Creating Initial Digital Marketing Plan

Digital vs. real marketing, Digital marketing channels, The Opportunity-Mega trends, Content management, SWOT analysis, Target group analysis.

Unit 2. Strategic E-marketing and SEO Optimization

Writing the SEO content, E-business models, Consumers online characteristics.

Unit 3. Site Design Basics

Four cornerstone approach, Personas and scenarios, how to write project briefs, Site design usability, Usability Best Practices, Domain name management.

Unit 4. Introduction to CRM

CRM platform, CRM models, CRM strategy.

Unit 5. Introduction to Web Analytics and Marketing Communications

Factors for Segmentation. Selecting the target market. Developing the positioning and target market strategies. Different trends. Rules of doing e-business. E-business application in the market.

Unit 6. Business Opportunities and Social Media

Instagram options, Optimization of Instagram profiles, Integrating Instagram with a Web Site and other social networks, keeping up with posts, Linked-in options, creating campaigns on LinkedIn, analyzing visitation on LinkedIn, YouTube Advertising, YouTube Analytics, Facebook Ads, Creating Facebook Ads, Ads Visibility, E-mail marketing.

Unit 7. Digital Marketing Impact on Society

Its impact and way forward in the society.

Recommended Books/ Reference Material

1. Chaffey, D., & Smith, P. R. (2022). *Digital marketing excellence: planning, optimizing and integrating online marketing*. Taylor & Francis.
2. Deiss, R., & Henneberry, R. (2020). *Digital marketing for dummies*. John Wiley & Sons.
3. Hall, S. (2023). *B2B digital marketing strategy: how to use new frameworks and models to achieve growth*. Kogan Page Publishers.
4. Kingsnorth, S. (2022). *Digital marketing strategy: an integrated approach to online marketing*. Kogan Page Publishers.
5. Zahay, D. (2020). *Digital marketing management: A handbook for the current (or future) CEO*. business expert press.

20. List of General Education Requirement Courses of CS

Sr#	Course Code	Course Title	Pre-Requisite	Credit Hours
1	CS-107	Application of Information and Communication Technologies	Nil	2
2	CS-107L	Application of Information and Communication Technologies (Lab)	Nil	1
3	ENG-110	Functional English	Nil	3
4	ENG-111	Expository Writing	Nil	3
5	CS-123	Discrete Structures (Quantitative Reasoning – II)	Nil	3
6	MTH-104	Calculus and Analytical Geometry (Quantitative Reasoning – I)	Nil	3
7	ISL-101/ETH-101	Islamic Studies/ Ethics	Nil	2
8	PAK-103	Ideology and Constitution of Pakistan	Nil	2
9	MGT-104	Social Sciences (Example: Introduction to Management)	Nil	3
10	PHY-103	Natural Sciences (Applied Physics)	Nil	2
11	PHY-103L	Natural Sciences (Applied Physics (Lab))	Nil	1
12	CS-209	Professional Practices (Arts and Humanities)	Nil	2
13	CCE-497	Civic and Community Engagement	Nil	2
14	MGT-108	Entrepreneurship	Nil	2
15	PAK-104	Pakistan Studies	Nil	2

21. Course Outlines for General Education Requirement Courses of CS

Application of Information and Communication Technologies

BS-Computer Science

Course Code: CS-107

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course provides a very broad range of topics and prepares the students for various domains in computing that they will face in upcoming semesters. This course is very comprehensive as it provides every student a set of productivity tools that they will be able to use for the rest of their lives. It provides knowledge and skills for use of computing and communication technologies to solve real life problems. This is an introductory course about Information and Communication Technologies that includes ICT terminologies, hardware and software components, the internet and World Wide Web, and ICT based applications.

Learning Outcomes

- **Define** various types and components of computer including input/output devices, memory, storage media (**C1 – PLO 1**).
- **Describe** different types of software from operating systems to system utilities and productivity apps (**C2 – PLO 2**).
- **Describe** the basic concepts of computer networks, database management and computer security from a user point of view, components of a computer including input/output devices, memory, storage media (**C2 – PLO 5**).

Course Outline

Unit 1. Technology

Types of Computers, Mobile & Game Devices, Data and Information, The Web, Web Searching, Online Social Networks, Internet Communications. Digital Security and Privacy, Viruses and Other Malware, Privacy, Health Concerns, Environmental Issues, Programs and Apps, Operating Systems, Applications,

Installing and Running Programs, Developing Programs and Apps, Communications and Networks, Wired and Wireless Communications, Networks, Technology Uses, Government, Finance, Retail, Entertainment, Health Care, Science, Travel, Publishing, Manufacturing, Technology Users.

Unit 2. Online Web

The Internet, Websites and Media, The Internet, Evolution of the Internet, connecting to the Internet, Internet Service Providers, How Data Travels the Internet, IP & MAC Addresses and Domain Names, The World Wide Web, Navigating the Web, Web Addresses, Web Apps and Mobile Apps. Types of Websites, Digital Media on the Web, Graphics, Audio, Video, Plug-Ins, Other Internet Services, Email, Email Lists, Internet Messaging, Chat Rooms, Online Discussions, VoIP, FTP, Netiquette.

Unit 3. Evaluating Computers and Mobile Devices

Mobile Computers and Desktops, Laptops, Tab and Other Mobile Computers, Handheld Computers, Desktops and All-in-Ones, Servers, Terminals, Point-of-Sale Terminals, Wearable Devices, Game Devices, Embedded Computers. Inside the Case, The Motherboard, Processors, The Control Unit, The Arithmetic Logic Unit, Machine Cycle, Registers, The System Clock, Personal Computer and Mobile Device Processors, Processor Cooling, The Internet of Things, Cloud Computing, Cloud Computing Services. Memory, Bytes and Addressable Memory, Types of Memory, RAM, Cache, ROM, Flash Memory, CMOS, Memory Access Times, Adapters, Adapter Cards, USB Adapters, Buses, Bus Width, Types of Buses, Power Supply and Batteries, Data Representation & Number System.

Unit 4. Programs and Apps

Role of the Operating System, Obtaining Software, Installing Software, Categories of Programs and Apps, Multimedia and Interest Applications, Communications Applications, File, Disk, and System Management Tools.

Unit 5. Digital Security Ethics, and Privacy: Threats, Issues, and Defenses

Digital Security Risks, Cybercrime, Internet and Network Attacks Malware, Botnets, Encryption, Digital Signatures and Certificates, Hardware Theft, Vandalism, and Failure. Backing Up — The Ultimate Safeguard, Wireless Security, Ethics and Society, information Accuracy, Intellectual Property Rights, Codes of Conduct, Cookies, Phishing, Spyware and Adware, Social Engineering, Privacy Laws, Employee Monitoring, Content Filtering. What is data base and data base management system, Evolution of database management, Data Concepts and Characteristics, Data Organization. Operating Systems, Operating System Functions, Starting Computers and Mobile Devices, Shutting Down Computers and Mobile Devices, providing a User Interface, Managing Programs, Managing Memory.

Recommended books/reference material:

1. Campbell, J. T., Freund, S. M., Frydenberg, M., Last, M. Z., & Pratt, P. J. (2016). Shelly
2. Hafez, K., Skinner, A., & Grüne, A. (2022). Foundations of Global Communication: A Conceptual Handbook. Routledge.
3. Hawkrige, D. (2022). New information technology in education. Taylor & Francis.
4. Pearlson, K. E., Saunders, C. S., & Galletta, D. F. (2024). Managing and using information systems: A strategic approach. John Wiley & Sons.

Application of Information and Communication Technologies LAB

BS-Computer Science

Course Code: CS-107L

Credit Hours: 01

Pre-requisite: Nil

Objectives

This course provides a very broad range of topics and prepares the students for various DOMAINS in computing that they will face in upcoming semesters. This course is very comprehensive as it provides every student a set of productivity tools that they will be able to use for the rest of their lives. It provides knowledge and skills for use of computing and communication technologies to solve real life problems. This is an introductory course about Information and Communication

Technologies that includes ICT terminologies, hardware and software components, the internet and World Wide Web, and ICT based applications.

Learning Outcomes

- **Define** various types and components of computer including input/output devices, memory, storage media (**C1 – PLO 1**).
- **Describe** different types of software from operating systems to system utilities and productivity apps (**C2 – PLO 2**).
- **Describe** the basic concepts of computer networks, database management and computer security from a user point of view, components of a computer including input/output devices, memory, storage media (**C2 – PLO 5**).

Course Outline

Unit 1. Technology

Introduction to the lab equipment and SOPs of the labs. Introduction to computer hardware and system information. Introduction to the Web, Web Searching, Online Social Networks, Internet Communications. Digital Security and Privacy, Viruses and Other Malware, Privacy.

Unit 2. Online Web

IP & MAC Addresses and Domain Names, the World Wide Web, Navigating the Web, Web Addresses, Web Apps and Mobile Apps. Types of Websites, Digital Media on the Web, Graphics, Audio, Video, Plug-Ins, Other Internet Services, Email, Email Lists, Internet Messaging, Chat Rooms, Online Discussions, VoIP, FTP, Netiquette.

Unit 3. Evaluating Computers and Mobile Devices

Inside world: The Motherboard, Processors, The Control Unit, The Arithmetic Logic Unit, Machine Cycle, Registers, The System Clock, Personal Computer and Mobile Device Processors, Processor Cooling, The Internet of Things, Cloud Computing, Cloud Computing Services. Memory, Bytes and Addressable Memory, Types of Memory, RAM, Cache, ROM, Flash Memory, CMOS, Memory Access

Times, Adapters, Adapter Cards, USB Adapters, Buses, Bus Width, Types of Buses, Power Supply and Batteries, Data Representation & Number System.

Unit 4. Programs and Apps

File, Disk, and System Management Tools. MS office

Unit 5. Digital Security Ethics, and Privacy: Threats, Issues, and Defenses

Digital Security Risks, Cybercrime, Internet and Network Attacks Malware, Botnets, Encryption, Digital Signatures and Certificates, Hardware Theft, Vandalism, and Failure, Backing Up — The Ultimate Safeguard, Wireless Security, Ethics and Society, information Accuracy, Intellectual Property Rights, Codes of Conduct, Cookies, Phishing, Spyware and Adware, Social Engineering, Privacy Laws, Employee Monitoring, Content Filtering, What is data base and data base management system, Evolution of database management, Data Concepts and Characteristics, Data Organization, Operating Systems, Operating System Functions, Starting Computers and Mobile Devices, Shutting Down Computers and Mobile Devices, providing a User Interface, Managing Programs, Managing Memory.

Recommended books/reference material:

1. Campbell, J. T., Freund, S. M., Frydenberg, M., Last, M. Z., & Pratt, P. J. (2016).
2. Hafez, K., Skinner, A., & Grüne, A. (2022). Foundations of Global Communication: A Conceptual Handbook. Routledge.
3. Hawkrige, D. (2022). New information technology in education. Taylor & Francis.
4. Pearlson, K. E., Saunders, C. S., & Galletta, D. F. (2024). Managing and using information systems: A strategic approach. John Wiley & Sons.

Functional English

General Education Courses

Course Code: ENG-110

Credit Hours: 03

Pre-requisite: Nil

Objectives

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 communication aspects including professional writing, public speaking, and everyday conversation. Ensuring that students are equipped in 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

- Apply enhanced English communication skills through effective use of word choices, grammar and sentence structure **(PLO 7)**.
- Comprehend a variety of literary non-literary written and spoken texts in English **(PLO 7)**.
- Effectively express information, ideas and opinions in written and spoken English **(PLO 7)**.
- Recognize inter-cultural variations in the use of English language and to effectively adapt their communication style and content based on diverse cultural and social contexts **(PLO 7)**.

Course Outline

Unit 1. Introduction

Ice breaking Activities. Types and modes of Communication. Intrapersonal, Intrapersonal and group Communication.

Unit 2. Rules for Structure of Sentences

Types of sentences. Punctuation and Spelling, Vocabulary. Lexical and functional categories. Structural kind of sentences: simple, compound, complex. Synthesis of sentences.

Unit 3. Concept of Time and Tense (present, past, future).

Discussion: General topics and everyday conversation. Concept of Voice: active and passive voice. Functional use of Voice in different situations. Discussion: General topics and everyday conversation.

Unit 4. Direct and Indirect Reporting.

Discussion: General topics and everyday conversation, describing things persons, places, pictures, events etc. Salutation & Greeting, Introduction, Asking and answering questions. Discussion: General topics and everyday conversation.

Unit 5. Practicing Everyday Conversation

Request and Permission, Agreement and Disagreement. Apologizing, Expressing likes and Dislikes, expressing opinion. Expressing approval, Disapproval, Discussion: General topics and everyday conversation.

Unit 6. Articulating Expression

Expressing appreciation, regret, and indifference. Expressing certainty, uncertainty, and obligation. Expressing suggestion, warning, Expressing possibility, impossibility & logical conclusion. Discussion: General topics and everyday conversation.

Unit 7. Art of Inviting

Accepting, declining invitation. Expressing & inquiring about preferences. Stating intentions and Making Plans. Giving directions. Instructing people how to do things.

Unit 8. Discussing Past and Present

Future prospects. Talking about the past.

Recommended books/ Reference material

1. Azar, B. S. (2003). *Fundamentals of English grammar*. Longman.
2. Beebe, S. A., Beebe, S. J., & Ivy, D. K. (2010). *Communication: Principles for a lifetime* (p. 483). Boston, MA: Allyn & Bacon.
3. Eastwood, J. (1994). *Oxford guide to English grammar*. Oxford University Press.
4. Floyd, K., & Cardon, P. (2023). *Business and Professional Communication*. McGraw-Hill US Higher Ed USE.)
5. Kortmann, B. (2020). *English linguistics: essentials*. Springer Nature.
6. Langan, J. (2001). *College writing skills with readings*. New York.
7. Murphy, R. (2003). *English grammar in use*. Cambridge: Cambridge University Press.
8. Sharma, Gajendra Dutt (2023) *A Comprehensive Resource Book of Functional English*, OEP, New Delhi.
9. Thomson, A. J., & Martinet, A. V. (2015). *A practical English grammar*. New York: Oxford University Press.
10. Wren, P. C., & Martin, H. (2000). *English grammar and Composition*. New Delhi: S Chand & Company Ltd.

Expository Writing

General Education Course

Course Code: ENG-111

Credit Hours: 03

Pre-requisite: Nil

Objectives

Expository Writing is a sequential undergraduate course aimed at refining writing skills in various contexts. Building upon the foundation building pre-requisite course, Functional English, this course will enhance students' basic skills 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

- Understand the essentials of the writing process integrating pre-working, drafting, editing and proofreading to produce well-structured essays **(PLO 7)**.
- Uphold ethical practices to maintain originality in expository writing **(PLO 9)**.

Course Outline

Unit 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.

Unit 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.). Proofreading (fine-tuning of the draft). Peer review and feedback (providing and receiving critique).

Unit 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

Unit 4. Types of Expository Writing

Description, Illustration, Classification. Cause and effect (exploring causal relationships and outcomes). Process analysis (explaining step-by-step procedures). Comparative analysis (analyzing similarities and differences

Unit 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.

Unit 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)

Recommended books/ Reference material

1. Axelrod, R. B., & Cooper, C. R. (2010). *The St. Martin's guide to writing*. Macmillan.
2. Faigley, L., Selzer, J., Enoch, J., & Wible, S. (2009). *Good reasons with contemporary arguments*. Pearson Longman.
3. Floyd, K., & Cardon, P. (2023). *Business and Professional Communication*. McGraw-Hill US Higher Ed USE.
4. Graff, G., Birkenstein, C., & Maxwell, C. (2014). *They say, I say: The moves that matter in academic writing* (p. 245). Gildan Media Corp Book Publisher.
5. Johnson-Sheehan, R., Paine, C., & Paine, C. (2010). *Writing today*. Pearson Education India.
6. Keizer, E. (2015). *A functional discourse grammar for English*. Oxford University Press.
7. Rosenwasser, D., & Stephen, J. (2011). *Writing analytically*. Cengage Learning Press.
8. Straaijer, R. (2018). Modern English usage from Britain to America: Bryan Garner follows Henry Fowler from A Dictionary of Modern American English Usage to Garner's Modern English Usage. *English Today*, 34(4), 39-47.
9. Wachal, R. S. (2000). The Elements of Style, by William Strunk, Jr., and EB White; and A Dictionary of Modern American Usage, by Bryan A. Garner. *American speech*, 75(2), 199-207.
10. Williams, J. M., & Bizup, J. (2022). *Lessons in clarity and grace*. Pearson.

Calculus and Analytical Geometry

Course Code: MTH-104

Credit Hours: 03

Pre-requisite: Nil

Objectives

Calculus serves as the foundation of advanced subjects in all areas of mathematics. This is the first course of Calculus. The objective of this course is to introduce students to the fundamental concepts of limit, continuity, differential and integral calculus of functions of one variable.

Learning Outcomes

Upon successful completion of this course,

- The students will be able to understand the concepts of limit and continuity **(PLO 1)**.
- The students will be able to calculate derivatives. They can understand the concept of integration **(PLO 2)**.

Course Outline

Unit1. Limits and Continuity

Limit of a function, graphical approach, Properties & theorems of limits, limits of polynomials and rational and transcendental functions, limits at infinity, infinite Limits, one-sided limits, continuity.

Unit 2. Derivatives

The derivative as a function, the derivative as a rate of change, derivatives of products, quotients and negative powers, derivatives of trigonometric, polynomials, implicit differentiation, higher derivatives.

Unit 3. Applications of Derivatives

Applications of derivatives, Relative extreme and optimization. Mean value theorem. Intermediate forms and L' Hospital rule.

Unit 4. Techniques of Integration

The fundamental theorem of Integral calculus. The substitution rule. Integrals of elementary, hyperbolic, trigonometric, logarithmic and exponential functions. Integration by parts. Integration by partial fractions. Improper integrals.

Unit 5. Applications of Integration

Definite Integrals. Volume. Surface of revolution. Arc length. Applications to Economics, Physics, Engineering and Biology.

Recommended Books/Reference Material

1. Anton, H. Bivens, I.C., and Davis, S. (2021). *Calculus*. John Wiley and Sons.
2. Ayres, F., and Mendelson, E. (2009). *Calculus*. Schaum's Outlines.
3. Hughes-Hallett, D., Gleason, A.M., and McCallum, W.G. (2020). *Calculus: Single and Multivariable*. John Wiley and Sons.
4. Stewart, J., Clegg, D.K., and Watson, S. (2020). *Calculus: Early Transcendentals*. Cengage Learning.
5. Thomas, G. B., Finney, R. L., Weir, M. D., & Giordano, F. R. (2003). *Thomas' calculus*. Reading: Addison-Wesley.

Ideology and Constitution of Pakistan

Course Code: PAK-103

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is designed to provide students with a fundamental exploration of the ideology and the constitution of Pakistan. The course focuses on the underlying principles, beliefs, and aspirations that have been instrumental in shaping the creation and development of Pakistan as a sovereign state. Moreover, the course will enable students to understand the core provisions of the

Constitution of the Islamic Republic of Pakistan concerning the fundamental rights and responsibilities of Pakistan citizens to enable them function in a socially responsible manner.

Learning Outcomes

- Demonstrate enhanced knowledge of the basis of the ideology of Pakistan with special reference to the contributions of the founding fathers of Pakistan **(PLO 8)**.
- Demonstrate fundamental knowledge about the Constitution of Pakistan 1973 and its evolution with special reference to state structure **(PLO 8)**.
- Explain about the guiding principles on rights and responsibilities of Pakistani citizens are enshrined in the Constitution of Pakistan 1973 **(PLO 8)**.

Course Outline

Unit 1. 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 or separate homeland.

Unit 2. Two-Nation Theory:

Evolution of the Two-Nation Theory (Urdu-Hindi controversy. Partition of Bengal. Simla Deputation 1906, Allama Iqbal Presidential Address 1930, Congress Ministries 1937 Lahore Resolution 1940). Role of communalism and religious differences.

Unit 3. Introduction to the Constitution of Pakistan:

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

Unit 4. Constitution and State Structure

Structure of government (executive, legislature, and judiciary). Distribution of powers between federal and provincial governments. 18th Amendment and its impact of federalism.

Unit 5. Fundamental Rights, Principles of Policy and Responsibilities

Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles 19-28). Overview of Principles of Policy (Articles 29-40). Responsibilities of the Pakistani citizen.

Unit 6 Constitutional Amendments:

Procedures for amending the Constitution. Notable constitutional amendments and their implications.

Recommended Books/Reference Material

1. Ahmed, A. S. (1997). *Jinnah, Pakistan and Islamic Identity: The Search for Saladin*. Routledge.
2. Aziz, K. K. (2002). *The Making of Pakistan: A Study of Nationalism*. Sang-e-Meel Publishers.
3. Choudhury, G. W. (1969). *Constitution-Making in Pakistan: The Dynamics of Political*. Columbia: University of British.
4. Cohen, S. P. (2004). *The Idea of Pakistan*. Washington: Brookings Institution Press.
5. Hussain, M. (2020). *The Parliament of Pakistan*. London:Oxford University press.
6. Iqbal, J. (2005). *Ideology of Pakistan*. Sang-e-Meel.
7. Jalal, A. (2014). *The Struggle for Pakistan: A Muslim Homeland and Global Politics*. Belknap Press: An Imprint of Harvard University Press.
8. Khan, H. (2020). *Constitutional and Political Development of Pakistan*. London: Oxford University Press.
9. Mahmood, S. (2003). *Pakistan: Political Roots and Development*. Sterling: University

of Michigan.

10. Mujahid, S. u. (2001). *Ideology of Pakistan*. Progressive Publishers.
11. Qureshi, I. H. (1965). *The Struggle for Pakistan*. Karachi: University of Karachi Press.
12. Sayeed, K. B. (1960). *Pakistan: The Formative Phase*. London: Oxford University Press
13. Talbot, I. (2015). *Pakistan: A New History*. London: Oxford University Press.
14. *The Constitution of Pakistan 1973*. Original text. Retrieved from website: National Assembly: https://na.gov.pk/uploads/documents/1333523681_951.pdf
15. Ziring, L. (2000). *Pakistan in the Twentieth Century: A Political History*. London: Oxford University Press.

Introduction to Management

BBA- Business Administration

Course Code: MGT-104

Credit Hours: 03

Pre-requisite: Nil

Objectives

This is an introductory course about the management of organizations. It provides instructions on principles of management that have general applicability to all types of enterprises; basic management philosophy and decision making; principles involved in planning, organizing, leading, and controlling; and recent concepts in management. The principles learned in this course will allow the student to effectively work with and through others in an organization.

Learning outcomes:

By the end of this course, students will:

- Be able to enhance their expertise in managing organizations **(PLO 1)**.
- Be able to understand the relevance of the management principles and theories, for local settings **(PLO 3)**.
- Be able to comprehend knowledge on the reality regarding management **(PLO 8)**.

Course Outline

Unit 1. Introduction to Management

Organization, The management Process.

Unit 2. The History and Evaluation of Management

Organizational theories and different approaches to management.

Unit 3. The Organizational Culture and The Manager, Motivation Its Theories

The internal/external environment and the Manager. Current issues in Motivation.

Unit 4. Foundations and Basic Elements of Planning

Process of planning and MBO. SWOT Analysis Effective strategic planning. Strategic management process.

Unit 5. Organizational Structure, Team work and Group Behavior

Types of organizational structures. Case Decision-making. The process of Control the Control Standards. Case of Controlling, Case of team and team work.

Unit 6. Decision Making Process, Leadership and Its Characteristics

The manager's role as decision maker. Leadership styles and behaviors.

Unit 7. Managing Change & Basics of Strategic Management

Define the importance of change management and explain where it fits in the four management functions. Explain the steps managers can take to implement planned change. Explain why people resist change. Apply attitude change strategies. HRM and staffing.

Unit 8: Nature & Importance of Communication

Recognize the part communication plays in the 4 management functions •
Assess basic communication skills.

Recommended Books/ Reference Material

1. Gupta, M. J., Chaturvedi, S., Prasad, R., & Ananthi, N. (2022). *Principles and practice of management*. (AGPH Books).
2. Jones, G. R., & George, J. M. (2019). *Essentials of contemporary management*. McGraw-hill.
3. Robbins, S. P., DeCenzo, D., Coutler, M., & Woods, M. (2022). *Management: the essentials*. University Of Tasmania.
4. Prasad, L. M. (2020). *Principles and practice of management*. Sultan Chand & Sons.
5. Singh, C., & Khatri, A. (2024). *Principles and Practices of Management and Organizational Behavior*. Taylor & Francis.

Applied Physics

Course code: PHY-103

Credit Hours: 02

Pre-requisite: Nil

Objectives

The main objective of the course is to provide basic information about Mechanics, Electricity, Magnetism, Electromagnetism, Waves and oscillations, optics, Electronics to the technology students. The course gives the students a sound knowledge of Physics with its applications to problems of practical nature.

Learning Outcomes

- Understanding basic concepts of units, vectors, and scalars, along with measurements and uncertainties **(PLO 2)**.
- Application of Newton's laws of motion, work, kinetic energy, and gravitation in various scenarios **(PLO 4)**.
- Exploring electricity concepts, including conductors, insulators, electrostatic force, capacitors, dielectrics, and DC circuits **(PLO 5)**.

- Study of magnetism, covering magnetic fields, force, energy, inductors, and magnetic materials. Additionally, an introduction to semiconductors, including energy levels, hole concept, and PNP/NPN junction transistors and LEDs (**PLO 9**).

Course Outline

Unit 1. Physics Fundamentals

Basic concept of units, vectors and scalars, measurements and uncertainties, Addition of vectors by graphical and component method. Multiplication of vectors, vectors in three dimensions,

Unit 2. Newton's Laws and Relativity

Newton's laws of motion and their applications, Work and Kinetic Energy, Gravitation, Circular motion, projectile motion, orbits of planets, linear and angular momenta, basic concepts of general and special theory of relativity.

Unit 3. Electricity

Conductors and Insulators, Electrostatic Force, Capacitors and Dielectrics, Capacitance, Energy store in capacitor (Capacitor as memory device), DC Circuits, Measuring V, I, R, RC Circuits.

Unit 4. Magnetism

Magnetic Fields, , Magnetic Force, Magnetic Field, Magnetic Field Energy, inductors and inductance, energy stored in inductor (inductor as memory device) magnetic materials.

Unit 5. Semiconductors

Semi-Conductors Energy levels in a semi-conductor, Hole concept, Intrinsic and Extrinsic regions, PNP, NPN junction Transistor, LEDs.

Recommended Books/Reference Material

1. Beiser A. & Hademenos G. J. (2012). *Applied physics*. McGraw Hill.

2. Giambattista A. Richardson B. M. C. & Richardson R. C. (2020). *Physics*. McGraw-Hill Education.
3. Halliday, D., Resnick, R., & Walker, J. (2021). *Fundamentals of physics*, Extended (12th ed.). Wiley.
4. Hecht E. (2021). *College physics*. McGraw Hill Education.
5. Serway, R. A., & Jewett, J. W. (2018). *Physics for scientists and engineers* (10th ed.). Cengage Learning.

Applied Physics Lab

Course code: PHY-103L

Credit Hours: 01

Pre-requisite: Nil

Objectives

The course objectives are to enable students to comprehend and apply fundamental principles of measurement, elasticity, electrical circuits, and logic gates. They should develop the ability to conduct experiments, analyze data, and manipulate instruments for various measurement and electrical applications, fostering a solid foundation in experimental physics and electronics.

Learning Outcomes

- Demonstrate a solid understanding of fundamental principles in applied physics, including mechanics, thermodynamics, and electromagnetism **(PLO 2)**.
- Apply mathematical and computational techniques to analyze and solve real-world problems in various branches of applied physics **(PLO 4)**.
- Develop practical skills in laboratory experiments, data acquisition, and analysis, enhancing the ability to apply theoretical concepts to hands-on situations **(PLO 5)**.
- Communicate effectively, both orally and in writing, about complex physics concepts, experimental results, and their applications in practical scenarios **(PLO 7)**.

Course Outline

1. Study and understand the working principle of Vernier caliper and Screw Gauge.
2. Study Hooke's Law using the mass-spring system, determining the stiffness (k -value) of the spring.
3. Investigate the relationship between the length of a pendulum and its period of oscillation.
4. Determine the internal resistance of a galvanometer using the half deflection method.
5. Experiment with various resistors and voltage sources to verify Ohm's law ($V = IR$) by measuring voltage, current, and resistance in a circuit.
6. Convert a galvanometer into a voltmeter.
7. Convert a galvanometer into an ammeter.
8. Study the series and parallel configurations of capacitors and resistors and verify binary truth tables using logic gates.

Recommended Books/Reference Material

1. Giambattista A. Richardson B. M. C. & Richardson R. C. (2020). *Physics*. McGraw-Hill Education.
2. Halliday, D., Resnick, R., & Walker, J. (2021). *Fundamentals of physics*, Extended (12th ed.). Wiley.
3. Hecht E. (2021). *College physics*. McGraw Hill Education.
4. Loyd, D. H. (2008). *Physics laboratory manual*. Thomson Higher Education.
5. Smith, W. F. (2020). *Experimental physics: principles and practice for the laboratory*. Taylor and Francis.
6. Wilson, J. D., & Hernández-Hall, C. A. (2014). *Physics laboratory experiments*. Cengage Learning.

Professional Practice

BS-Computer Science

Course code: CS-209

Credit Hours: 02

Pre-requisite: Nil

Objectives

Understand and appreciate the meaning of ethics, values and attitudes. Be guided in their ethical thinking and considerations as they relate in the cyber world. Be aware of the different ethical dilemma/issues in the cyber world. Appreciate and internalize the code of conduct of an I. T. Professional. Be familiar with the various Laws that penalizes cybercrimes.

Learning Outcomes

- **Understand** the Principle of Management and Industrial Relation (C2 – PLO 1).
- **Understand** of the engineer's responsibilities to the Profession (C2 – PLO 6).
- **Understand** professional codes of conduct to day-to-day situations that arise in business (C2 – PLO 6).
- **Practice** of government legislation affecting work, e.g. safety, health (PLO 8)
- **Develop** Soft Skills (C6 – PLO 8).

Course Outline

Unit 1. Introduction

What is the Profession/Vocation, Professional, Professionalism, Self-Marketing as a Professional Life Management, Benefits and Obstacles to Life Management, How to make Successful life, Individual Grooming. Goal Setting Techniques Self-Management: Time Management, Benefits and Obstacles to Effective Time Management, 7 Habits of Highly Effective People.

Unit 2. Effective Leadership, Groups and Teams

Effective Leadership Process: What is Leadership, Roles and Activities of a Leader, Leadership Skills Groups and Teams: Groups and Teams, Benefits of Teamwork, Types of Group? Profession Basics: What is the Profession/Vocation, Professional, Professionalism, Self-Marketing as a Professional?

Unit 3. Computing Profession

Computing Profession: What is Computing, Different Domain of Computing and their Objectives Computing Core Skills: Domain of IT in Computing: IT Core Areas and Future of IT Accreditation Bodies and Professional Societies Historical

, Social and Economic context of Computing Professional Ethics ACM code of ethics and professional Code of Conduct ACM/IEEE Software Engineering code of Ethics and Professional Practices.

Unit 4. Professional Practice Concepts

Performance through Job Design: Job , Career and career path, Soft Skills Basics: Skills for Competitive Edge for this fast pace World, Interviews, Types of Interviews, Interview Techniques , Resume Writing Presentations: Powerful Presentation Techniques and Powerful Presentation Skills Meetings: Components of Effective and Productive Meetings, Organogram, Entrepreneurship and Entrepreneur. Software Industries and Software Houses.

Unit 5. Computer Misuse and Criminal Law

Computer Misuse and Criminal Law: Cyber Law, Cyber Crime, Misuse of Computing Information Security and privacy Health and Safety at Work Intellectual Property Rights, Copy Rights, Patents. Concept of Social Responsibilities.

Recommended Books/Reference Material

1. Dodig-Crnkovic, G., & Feldt, R. (2009). Professional and Ethical Issues of Software Engineering Curricula. 2010.
2. Foster, E., & Towle Jr, B. (2021). Software engineering: a methodical approach. Auerbach Publications.
3. Mann, S. (2023, December). Searching for Computing's Soul: Professional Practice and the Future of Computing Education. In Proceedings of the 16th Annual ACM India Compute Conference.

Discrete Structures

BS-Computer Science

Course code: CS-123

Credit Hours: 03

Pre-requisite: Nil

Objectives

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.

Learning Outcomes

- **Apply** the rules of Discrete Mathematics to Computer Science (C3 – PLO 1).
- **Understand** various strategies for composing mathematical proofs (C2 – PLO 2).
- **Apply** various strategies for composing mathematical proofs (C3 – PLO 2).

Course Outline

Unit1. Introduction

Sets, Methods to represent them, Set Operations, Functions, Domain and Range, One to One, Onto and Bijective Functions, Relations, Inverse and Composition of functions. Some important Functions, Sequences, Summations.

Unit2. Logics

Introduction to Logics, Propositions and Predicates, Logical Operators, Propositional Equivalences, Predicates and Quantifiers, Rules of Inference, Methods of proofs.

Unit3. Algorithms & Number Theory

Algorithms, Searching Algorithms and Sorting Algorithms, Number Theory, Direct Proofs, proofs by contradiction, Mathematical Reasoning: Proof Strategy, Sequences and Summations

Unit 4. Graphs & Trees

Graphs, Graph Terminologies and some special types of graphs, Representing Graphs, Connectivity of Graphs, Applications of Trees, Tree Traversal, Spanning Trees, Minimum Spanning Trees.

Unit 5. Relations

Relations, Mathematical Induction and recursion Problems, Relations and Their Properties, n-ary Relations and Their Applications, Representing Relations.

Recommended Books/Reference Material

1. Kenneth, O. (2019). Elements of modern mathematics. Dover Publications.
2. O'Regan, G. (2021). Guide to discrete mathematics. Springer International Publishing.
3. West, D. B. (2021). Combinatorial mathematics. Cambridge University Press.

Islamic Studies

Course Code: ISL-101

Credit Hours: 02

Pre-Requisites: Nil

Objectives

Students will be able to demonstrate enhanced knowledge of Islamic Fundamentals, beliefs, practices, historical development, spiritual values and Ethical Principles. Describe Basic sources of Islamic Law and their application in daily life. Also, Identify and discuss contemporary issues being faced by the Muslim world Including Social Challenges, Gender Role and Interfaith dialogue.

Learning Outcomes

- Evaluate and discuss their understanding about the beliefs, history and Ethical values of Islam **(PLO 8)**.
- Be able to apply and relate the Articles of faith in their life according to present world **(PLO 7)**.
- Be able to analyze the importance of Quran and Sunnah in their life and also to refute many relating misconceptions **(PLO 10)**.
- Engage in Discussions and write about Contemporary issues specifically related to Women **(PLO 10)**.

Course Outline:

Unit 1. Introduction to Islam

Definition of Islam and its core Beliefs (Tawheed, Akhirat and Risalat), Pillars of Islam and their significance (Tawheed, Prayers, Fasting, Zakat & Hajj), The Holy Quran (Introduction, Revelation & Compilation), Sunnah & Hadith (Introduction, Revelation & Compilation)

Unit 2. Seerah of the Holy Prophet pbuh

Life of Prophet pbuh in Makkah, Life of Holy Prophet pbuh in Medina, Diverse roles of Holy Prophet pbuh (individual, leader, peacemaker, educator etc)

Unit 3. Islamic History and Civilization

World before Islam, The Rashidun Caliphate and its expansion, Contributions of Muslim Scientists and Philosophers.

Unit 4. Islamic Jurisprudence

Fundamental sources of Islamic Jurisprudence, Major Schools of Islamic Jurisprudence, Significance & principle of Ijtihad

Unit 5. Family & Society in Islam

Status and Rights of Women in Islam, Marriage, Family & Gender roles in Muslim Society, Family values and Structure in Muslim Society

Unit 6. Islam & Modern world

Relevance of Islam in Modern World. (Islamophobia, Interfaith dialogue & Multiculturalism), Islamic viewpoint towards socio-cultural and technological changes.

Recommended Books/Reference Material

1. Ahmed, Dr. A. (1996). *Women & Social Justice: An Islamic Paradigm*, The Islamic Foundation UK
2. Ahmed, K. (1971) *Islami Nazria e Hayat*, Karachi University press.
3. Ahmed, K. (1980). *Islam, Its meaning & message*, The Islamic Foundation UK.
4. Al-Mubarikpuri, M. S. (2002), *Al Raheeq ul Makhtoom (The Sealed Nector)*, Dar ul Salam.

5. Al-Suhaym, Dr. M.B., A. (2006) *Islam, Its foundation & concepts*, Darussalam
6. An Introduction to Islamic Theology by John Renard.
7. Bokhari, A.S, Zafar, M.D., Prof. Shakir, A.S. (2021). *A textbook of Islamic Education*, Akram Printing Press, Lahore.
8. Hussain, M. *The Five Pillars of Islam: A Framework for Islamic Values and Character building*, Kube Publishing, The Islamic Foundation UK
9. Maududi, Abul A. (2008). *Islamic Civilization Foundations, Beliefs & Principles*, Kube Publishing, Islamic Foundation UK
10. Maududi, Abul. A. (2007). *Towards understanding Islam*, The Islamic foundation UK
11. Phillip, Dr. A. A., B. (2018) *Islamic Studies*, International Islamic Publishing House.
12. Prof. Dr. Chaudary, M.N., Prof. Malik, M.A (2022). *Tafheem e Islamiyat*, Qureshi Brothers Publishers, Lahore.

Ethics (in lieu of Islamic Studies)

Course Code: ETH-101

Course Title: Ethics

Credit Hours: 2

Pre-Requisite: Nil

Objectives:

Upon successful completion of the course, students will be able to know the basics of Ethics & Morality and develop Ethical approach, Identify the concept of Ethics in Different Religions & Relate the ethical values with their lives business ethics, journalism ethics etc.

Learning Outcomes:

- Students will be able to demonstrate their understanding about the meaning of Ethics and Morality **(PLO 8)**.
- Analyze the Similarities and Differences between ethical teachings of various religions **(PLO 6)**.
- Develop sense of belongingness to the ethical values as a student, being member of the society etc **(PLO 9)**.

Course Outline:

Unit 1: Meaning and Scope of Ethics

Meaning and Definition of Ethics and Morality, Difference between Ethics and Morality, Relation of Ethics with: Religion, Science, Law.

Unit 2: Historical development of Morality

Instinctive Moral Life, Customary Morality, Reflective Morality.

Unit 3: Moral Theories, Moral Ethics and Society

Hedonism (Mill), Intuitionism (Butler), Kant's Moral Theory, Freedom and Responsibility, Tolerance, Justice, Punishment.

Unit 4: Moral Teaching of Major Religions

Judaism, Christianity, Islam, Islam and Minorities.

Unit 5: Professional Ethics

Medical Ethics, Ethics of Student, Ethics of Teacher, Business Ethics.

Recommended Books/ Reference Material:

1. R. Shafer-Landau. (2020). *The Fundamentals of Ethics*, 5th Edition.
2. S. Blackburn. (2021). *Ethics: A Very Short Introduction (Very Short Introductions)* 2nd Edition.
3. S. Liautaud, L. Sweetingham. (2022). *The Power of Ethics: How to Make Good Choices in a Complicated World*.
4. S. M. Cahn, P. Markie. (2019). *Ethics: History, Theory, and Contemporary Issues*, 7th Edition.

Civic and Community Engagement

Course Code: CCE-497

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is designed to provide students with fundamental knowledge about civics, citizenship and community engagement. In this course the students will learn about the essential of civil society, government, civic responsibilities, inclusivity and effective ways to participate in shaping the society which will help them apply the theoretical knowledge to the real-world situation to make a positive impact on their communities.

Learning Outcomes

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

- Demonstrate fundamental understanding of civics, government, citizenship and civil society **(PLO 6)**.
- Understand the concept of community and recognize the significance of community engagement for individuals and groups **(PLO 9)**.
- Recognize the importance of diversity and inclusivity for societal harmony and peaceful co-existence **(PLO 8)**.

Course Outline

Unit 1. Civics and Citizenship

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

Unit 2. State, Government and Civil Society

Structure and function of government in Pakistan. The relationship between democracy and civil society. Right to vote and importance of political participation and representation.

Unit 3. Rights and Responsibilities

Overview of fundamental rights and liberties of citizens under constitution of Pakistan 1973. Civic responsibilities and duties. Ethical consideration in civic engagement (accountability, non-violence, peaceful dialogue, civility etc.).

Unit 4. 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.

Unit 5. Advocacy and Activism

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

Unit 6. Digital Citizenship and Technology

The use of digital platform for civic engagement. Cyber ethics and responsible use of social media. Digital divides and disparities (access, usage, socio-economic, geographic etc.) and their impact on citizenship.

Unit 7. 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 social harmony and peaceful co-existence.

Suggested Practical Activities (Optional)

Apart 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 captured the lived experiences and perspectives of diverse individuals.
2. **Community Event Planning:** Student can organize a community event or workshop that addresses a specific issue or foster community interaction. This could be a health fair, environmental cleanup, cultural festival or educational workshop
3. **Service Learning:** Student 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 population.

4. **Cultural Exchange Activities:** Student 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.

Recommended Books/Reference Material

1. Džankić, J., & VINK, M. P. (2022). Citizenship & migration.
2. Kymlicka, W. and Norman, W. (2010). *Citizenship in Diverse Societies*. University Press, United Kingdom.
3. Mackert, J., & Turner, B. S. (2017). The Transformation of Citizenship, Volume 2. Boundaries of Inclusion and Exclusion.
4. Mattson, K. (2017). *Digital Citizenship in Action: Empowering Students to Engage in Online Communities*. : International Society for Technology in Education, United Kingdom.
5. McGraw-Hill Education, (2009). *Civics Today: Citizenship, Economics, & You*, Student Edition. United States.
6. Weinstock, D. (2017). Citizenship and Cultural Diversity. The Oxford Handbook of Citizenship.
7. Youniss, J. and Levine, J. (2009). *Engaging Young People in Civic Life*. Vanderbilt University Press, Ukraine.

Entrepreneurship

BBA

Course Code: MGT-108

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is basically designed to enhance entrepreneurial attitude among students by imparting confidence in them, by having them hands on experience of small entrepreneurial activity. This will contribute towards economic development of Pakistan, as these students will soon be in the market and will be contributing in the economy in a better way through entrepreneurial activities.

Learning Outcomes

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

- Better understand themselves and their suitability to be an entrepreneur.
- Better understand the marketing and sales concepts and strategies, engaging customers, building the brand, and driving revenues.

Course Outline

Unit 1. The Challenge of Entrepreneurship

The World of the Entrepreneur. What is an Entrepreneur? The Benefits of Entrepreneurship. The Potential Drawbacks of Entrepreneurship. Behind the Boom: Feeding the Entrepreneurial Fire. The Cultural Diversity in Entrepreneurship. The Power of “Small” Business. Putting Failure into Perspective. The Ten Deadly Mistakes of Entrepreneurship. How to Avoid the Pitfalls

Unit 2 Inside the Entrepreneurial Mind: From Ideas to Reality

Creativity, Innovation, and Entrepreneurship. Creativity – Essential to Survival. Creative Thinking. Barriers to Creativity. How to Enhance Creativity. The Creative Process. Techniques for Improving the Creative Process. Protecting Your Ideas

Unit 3. Designing a Competitive Business Model and Building a Solid Strategic Plan

Building a Competitive Advantage. The Strategic Management Process. Formulate strategic options and select the appropriate strategies. The Balanced Scorecard

Unit 4. Conducting a Feasibility Analysis and Crafting a Winning Business Plan

Conducting a Feasibility Analysis. Why Develop a Business Plan?

The Elements of a Business Plan. What Lenders and Investors Look for in a Business Plan. Making the Business Plan Presentation

Unit 5. Forms of Business Ownership The Entrepreneur Interview – Discussion

The Sole Proprietorship. Other Forms of Ownership

Unit 6. Franchising and the Entrepreneur

Types of Franchises. The Benefits of Buying a Franchise. The Drawbacks of Buying a Franchise. Franchising and the Law. The Right Way to Buy a Franchise. Trends Shaping Franchising

Unit 7. Buying an Existing Business

Buying an Existing Business. Steps in Acquiring a Business. Evaluating an Existing Business: The Due Diligence Process. Methods for Determining the Value of a Business. Negotiating the Deal

Unit 8. Building a Powerful Marketing Plan

Building a Guerrilla Marketing Plan. Pinpointing the Target Market. Determining Customer Needs and Wants Through Market Research. Plotting a Guerrilla Marketing Strategy: How to Build a Competitive Edge

Unit 9. E-Commerce and the Entrepreneur Phase II Discussion

Factors to Consider before Launching into E-Commerce. Ten Myths of E-Commerce. Strategies for E-Success. Designing a Killer Web Site. Tracking Web Results. Ensuring Web Privacy and Security

Unit 10. Pricing Strategies

Three Potent Forces: Image, Competition, and Value. Pricing Strategies and Tactics. Pricing Strategies and Methods for Retailers. The Impact of Credit on Pricing

Unit 11. Creating a Successful Financial Plan

Basic Financial Statements. Projected Financial Statements. Ratio Analysis. Interpreting Business Ratios. Breakeven Analysis

Unit 12. Managing Cash Flow

Cash Management. Cash and Profits. The Cash Budget. The “Big Three” of Cash Management

Unit 13. Sources of Financing: Debt and Equity Phase III Discussion

Planning for Capital Needs. Sources of Equity Financing. Corporate Venture Capital. Sources of Debt Capital. Federally Sponsored Programs. Small Business Administration (SBA)

Unit 14. Choosing the Right Location and Layout

Location: A Source of Competitive Advantage. Location Criteria for Retailers and Service Businesses. Location Options for Retail and Service Businesses. The Location Decision for Manufacturers. Layout and Design Considerations. Layout: Maximizing Revenues, Increasing Efficiency, or Reducing Cost

Unit 15. Global Opportunities

Why Go Global? Strategies for Going Global. The Exporting Process. Barriers to International Trade. International Trade Agreements

Recommended Books/ Reference Material

1. “Essentials of entrepreneurship and small business management” by Scarborough, Norman M & Jefferey R.Cornwall.
2. "Entrepreneurship: A Real-World Approach" by Rhonda Abrams.

PAKISTAN STUDIES

GER

Course Code: PAK-104

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is designed to provide students with a comprehensive exploration of Pakistan's identity, spanning geographical, historical, and cultural dimensions. It delves into the diverse landscapes, ancient civilizations, and rich cultural heritage that define Pakistan. Moreover, it examines the socio-cultural and political transformations in Pakistan over time including democratic transitions and military interventions. The aim of this course is to inculcate in students a nuanced understanding of Pakistan's past, present, and potential future trajectories, enabling them to critically evaluate the complex dynamics shaping the nation's development.

Learning Outcomes

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

- Have enhanced knowledge of the geographical, historical, and political aspects of Pakistan.
- Understand the society and culture of Pakistan.
- Understand and explain the socio-economic developments in Pakistan.
- Explore contemporary issues and challenges faced by Pakistan and their implications for the future.

Course Outline

Unit 1. Introduction to Pakistan

Geographical location and significance. Historical background: Ancient civilizations in the region. Factors leading to the creation of Pakistan.

Unit 2 Political History of Pakistan

Formative phase. Military interventions and democratic transitions.

Unit 3. Geography of Pakistan

Physiography: Mountains, plains, plateaus, deserts, valleys and coastal areas. River systems: Indus River and its tributaries. Climatic regions of Pakistan.

Unit 4. Society and Culture of Pakistan

Socio-cultural diversity. Languages and literature of Pakistan

Unit 5. Economic Development of Pakistan

Agriculture and industrial sectors of Pakistan. Economic challenges of Pakistan.

Unit 6. Contemporary Issues

Foreign relations of Pakistan. Security challenges: terrorism, extremism, and regional conflicts. Environmental problems and sustainable development (SDGs). Media and social change.

Recommended Books/ Reference Material

1. "Jinnah of Pakistan" by Stanley Wolpert
2. "The Sole Spokesman: Jinnah, the Muslim League, and the Demand for Pakistan" by Ayesha Jalal
3. "The struggle for Pakistan" by Ishtiaq Husain Qureshi
4. "Pakistan, the Formative Phase, 1857-1948" by Khalid B. Sayeed
5. "Pakistan Studies: A Book of Readings" by Sikandar Hayat
6. "Constitutional and Political History of Pakistan" by Hamid Khan
7. "Trek to Pakistan" by Ahmad Saeed and Kh. Mansur Sarwar
8. "Pakistan: A Modern History" by Ian Talbot
9. "Politics in Pakistan: The Nature and Direction of Change" by Khalid B. Sayeed
10. "Physical Geography of Pakistan" by Umar Jahangir

11. "A Geography of Pakistan: Environment, People, and Economy" by Fazle Karim Khan
12. "Pakistan's Foreign Policy: An Historical Analysis" by S. M. Burke
13. "Separatism in East Pakistan" by Rizwan Ullah Kokab
14. "Being Pakistani: Society, Culture and the Arts" by Raza Rumi
15. "Pakistan's Cultural Heritage: Socio-Economic and Technological Aspects" edited by Abdul Jabbar Khan
16. "Language and Politics in Pakistan" by Tariq Rahman
17. "Sociology" by Horton and Hunt
18. "Pakistan in the Twentieth Century: A Political History" by Lawrence Ziring
19. "Economic Development of Pakistan" by Ishrat Husain
20. "Issues in Pakistan's Economy" by S. Zaidi

22. List of Mandatory Courses of CS

Sr#	Course Code	Course Title	Pre-Requisite	Credit Hours
1	UHQ-101/ ETH-103	Understanding of Holy Quran-I/ Ethics-I	Nil	1
2	UHQ-102/ ETH-104	Understanding of Holy Quran-II/ Ethics-II	Nil	1
3	INT-499	Internship	Nil	3

23. Course Outlines for Mandatory Courses of CS

Understanding of Quran/ Fehm e Quran

Course Title: Understanding of Quran - I

Course Code:

Credit Hours: 1

Contact Hours: 3 per week

Weeks: 15-16 (45-48 hours)

Pre-Requisites: Nill

Course Objectives:

This course will enable the students to understand the Holy Quran by learning Arabic in a simple and easy way. Through relating their basic Urdu vocabulary with Quran, and without engaging them in complex Arabic Grammer, Sarf or Balagha. Students will gradually build the skills to read and understand Quranic verses directly—without needing translation. The course focuses on making Arabic accessible for everyone, even those with no prior background.

Learning Outcomes:

This course will enable the students to:

1. Develop the ability to understand basic words of the Quran, phrases and sentences that do not contain verbs (unit 1 to 5 of Muallim ul Quran Book) and then sentences having present tense (first half of unit 6 of Muallim ul Quran Book).
2. Acquire a strong foundation for understanding long verses of the Quran with clarity.
3. Comprehend Quranic vocabulary, particles (operative & non operative particles), compounds (Adjective & Possessive compound), pronouns (singular & plural) and types of plurals through hundreds of Quranic sentences.
4. Recognize and understand different styles of Quranic sentences, including nominal sentence, emphatic sentence, double emphatic sentence, negative sentence, interrogative sentence, oath –based sentences.
5. Strengthen understanding of fundamental Quranic linguistic styles, expressions and idioms.
6. Understand at least 30 to 40 % of each page of the Holy Quran.

Course Outline:

Unit 1: Simple Quranic Words

Muallim ul Quran: Book 1: Unit: Lesson 1-19

Unit 2: Words that comes before (The simple Quranic words)

Muallim ul Quran: Book 1: Unit#2: Lesson 1-13

Unit 3: Quranic words in terms of their relationship and characteristics

Muallim ul Quran: Book 1: Unit#3: Lesson 1-10

Unit 4: Singular Pronouns

Muallim ul Quran: Book 2: Unit#4: Lesson 1-17

Unit 5: Singular pronouns & Demonstrative Pronouns

Muallim ul Quran: Book 2: Unit#5: Lesson 1-23

Unit 6: Present Tense

Muallim ul Quran: Book 3: Unit#6: Lesson 1-5

Reference Books:

1- بشير، دكتور. عبيد الرحمن - معلم القرآن - اسلام آباد: دار العلم، ٢٠٢٤. جلد ١، ٢ & ٣

Ethics (in lieu of Understanding of Quran)

Course Title: Ethics-I

Course Code:

Credit hours: 1

Contact Hours: 3 per week

Weeks: 15-16 (45-48 hours)

Pre-Requisites: Nill

Objectives

Upon successful completion of the course, students will be able to know the basics of ethics, & know how to develop an ethical approach. Also, analyze the importance of ethical and ethical values for a human being. And identify the Semitic & Non-Semitic Religions. Moreover, develop the concept of Ethics in Semitic & Non-Semitic religions. Also, analyze the similarities and differences between ethical teachings of various religions.

Learning Outcomes:

- Students will be able to demonstrate their understanding about the concept of ethics & ethical approach.

- Analyze the difference between the concept of Ethics in Sematic and Non-Sematic religions.

Course Outline:

Unit 1: Introduction and Importance of Ethics & Basic Ethical Principles

Definition of Ethics, Importance of Ethics, Beneficence, Non-maleficence, Autonomy, Justice as basic Ethical behaviors.

Unit 2: Theories of Moral Standards

Moral Standards as Law, Moral Standards as Pleasure, Moral standards as Perfection. (Theories of Various Philosopher such as Kant, Spencer, John S. Mackenzie etc)

Unit 3: The concept of Ethics in Major Religions- Christianity, Judaism

Introduction of the Religion, Its Basic Concepts and major ethical teachings.

Unit 4: The concept of Ethics in Major Religions- Hinduism & Buddhism

Introduction of the Religion, Its Basic Concepts and major ethical teachings.

Unit 5: The concept of Ethics in Major Religions- Islam

Introduction of the Religion, Its Basic Concepts and major ethical teachings.

References/Recommended Books:

Books

1. Davis, N.K. (2023). *Elements of Ethics*, Legare Street Press.
2. Edmonds, D. (2019). *Ethics and the Contemporary World*, Taylor & Francis,
3. Hastings, J. Alexander, J. Gray S.L. (2023). *The Encyclopedia of Religion and Ethics*, Creative Media Partners, LLC
4. Robinson, D. Garratt C. (2008). *Introducing Ethics-a Graphic Guide*, Icon Books Ltd.Uk.
5. اخلاق اور فلسفہ اخلاق، سیوہاروی، حفظ الرحمن، ندوة المصنفین، دہلی، ۱۹۷۶
6. دنیا کے بڑے مذاہب، فاروقی، عماد الحسن، مکتبہ جامعہ لمیٹڈ، دہلی، ۱۹۸۶

Websites & Articles

1. Articles on Ethics www.infotrac-college.com
2. Brown. (2017). The ethical dimensions of Global Environmental Issues. American Academy of Arts and Sciences. Retrieved July 7 ,2017 from amacad.org
3. Business Ethics Magazine www.business-ethics.com/annual.htm
4. Bussmann, J. (2016). Top 9 ethical Issues in artificial intelligence. Retrieved 7 July2017 from world Economic Forum weforum.org
5. Ethics and Religion, Shefali Narange <http://www.paperpublications.org/>
6. <http://www.jstor.com/stable/resrep12025.7>
7. <http://www.learnwell.org/ethicalproblems.htm>
8. Institute for Global Ethics www.globalethics.org
9. Klimes, Rudolf e. (2000). Ethical Problems.

10. Ten Ethical Problems of the Present World <https://www.lifepersona.com/10-ethical-problems-of-the-present-world>
11. Ward, Stephen J.A (March 2005). “Philosophical Foundations for Global Journalism Ethics” Journal of Mass Media Ethics:20(1)

Understanding of Quran/ Fehm e Quran

Course Title: Understanding of Quran - II

Course Code:

Credit Hours: 1

Contact Hours: 3 per week

Weeks: 15-16 (45-48 hours)

Pre-Requisites: Nil

Course Objectives:

This course will enable the students to understand the Holy Quran by learning Arabic in a simple and easy way. Through relating their basic Urdu vocabulary with Quran, and without engaging them in complex Arabic Grammar, Sarf or Balagha. Students will gradually build the skills to read and understand Quranic verses directly—without needing translation. The course focuses on making Arabic accessible for everyone, even those with no prior background.

Learning Outcomes:

This course will enable the students to:

1. Directly comprehend hundreds of Quranic sentences & verses.
2. Understand at least 80 to 85 % of each page of the holy Quran.
3. Understand common verses across different Quranic topics.
4. Achieve proficiency in the basic and advance linguistic aspects of the Arabic language.
5. Understand the difference between Quranic verbs in various forms, such as present, past and imperative.
6. Develop the ability to understand long verses of the holy Quran independently and then comprehend their interpretation.

Course Outline:

Unit 1: Past Tense

Muallim ul Quran: Book 4: Unit#7: Chapter 1: Lesson 1-9

Unit 2: Past Tense

Muallim ul Quran: Book 4: Unit#7: Chapter 2: Lesson 1-7

Unit 3: Past Tense

Muallim ul Quran: Book 4: Unit#7: Chapter 3: Lesson 1-9

Unit 4: Past Tense

Muallim ul Quran: Book 5: Unit#7: Chapter 4: Lesson 1-5

Unit 5: Past Tense & Passive Voice

Muallim ul Quran: Book 5: Unit#7: Chapter 5 - 9

Unit 6: imperative Verbs for Singulars

Muallim ul Quran: Book 6: Unit#8: Lesson 1-8

Reference Books:

1- بشير، دكتور. عبید الرحمن - معلم القرآن - اسلام آباد: دار العلم، ۲۰۲۴. جلد ۳، ۴، ۵، ۶

Ethics (in lieu of Understanding of Quran)

Course Title: Ethics-II

Course Code:

Credit hours: 1

Contact Hours: 3 per week

Weeks: 15-16 (45-48 hours)

Pre-Requisites: Nil

Objectives

Upon successful completion of the course, students will be able to have better understanding of ethics in various walks of life like in workplace, in business, journalism etc. Moreover, they will be able to be familiarize with Contemporary World's Ethical Issues. And, try to develop answers about them.

Learning Outcomes:

- Students will be able to demonstrate their understanding about the importance of ethics in their lives today.
- Identify Contemporary World's Ethical Issues.
- Create problem solving for these contemporary Ethical issues.

Course Outline:

Unit 1: Professional Ethics & Bioethics

Meaning of Work/Professional Ethics, Professional Ethics and Human Values, Elements of professional Ethics:

Person attitude, Beliefs about work, Positive Attributes (honesty, integrity, dedication, commitment, responsibility, interpersonal relationship)

Genetic engineering, Organ Donation, Cloning, Head Transplant

Unit 2: Ethical Conduct in Business Ethics & it's important

Types of Business Ethics, Common Business Ethical Challenges

Conflict of interest, honesty & integrity, whistle blowing, loyalty vs truth

Unit 3: Journalism

Principles of Ethical Journalism:

Truth & Accuracy, Independence, Fairness & Impartiality, Humanity, Public Accountability

Unit 4: Environmental Ethics

Core Principles of environmental ethics:

Justice & sustainability, Sufficiency & compassion, Solidarity & public participation, Pollution prevention.

Current issues of environmental ethics:

Pollution, The depletion of natural resources, Loss of biodiversity, Destruction of ecosystem, Global climate change

Unit 5: Social Inequalities

Meaning of Social Inequalities, Issues related to social inequality

Difference in source of income, Health care, Freedom of speech, Gender inequality, Toxic workplace culture, Education, Political representation & participation

Unit 6: Social Media Ethics

Facebook, YouTube, WhatsApp, Instagram, TikTok, Snapchat, LinkedIn, X

Current Ethical issues in social media:

Plagiarism, Fake news, Harassment, Photo ethics, Post without caution, inappropriate behavior privacy

References/Recommended Books:

Books

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2. Edmonds, D. (2019). *Ethics and the Contemporary World*, Taylor & Francis,
3. Hastings, J. Alexander, J. Gray S.L. (2023). *The Encyclopedia of Religion and Ethics*, Creative Media Partners, LLC
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Websites & Articles

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3. Business Ethics Magazine www.business-ethics.com/annual.htm
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6. <http://www.jstor.com/stable/resrep12025.7>
7. <http://www.learnwell.org/ethicalproblems.htm>
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