Curriculum / Course Outline

BS Computer Science

National University of Modern Languages, Islamabad

Table of Contents

OBJECTIVES

The main objective of Computer Science program is to produce Computer Scientists having strong knowledge and understanding about theoretical concepts and comprehensive skills of computing tools to solve complex computing problems.

Vision Statement of the Department of Computer Science

To be a Leading knowledge hub to perform industry oriented research and produce responsible computer science professionals for positive contribution in society.

Program Mission – Bachelor of Computer Science

Fostering knowledge for research and innovation through latest computing technologies.

Program Educational Objectives

The program educational objectives for Bachelor of Science in Computer Science is to produce graduates who will:

PEO-1: Contribute in computing industry nationally and internationally and develop aptitude for analyzing problems and finding optimal solutions.

PEO-2: Solve real world problems through the use of modern computing tools.

PEO-3: Demonstrate effective written and verbal communication skills.

PEO-4: Establish ethical and moral values in professional life with an aim of learning new skills and technologies for a life-long learning.

Program Learning Outcomes

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

PLO 1: Academic Education: To prepare graduates as computing professionals.

PLO 2: Knowledge for Solving Computing Problems: Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and DOMAIN knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.

PLO 3: Problem Analysis: Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant DOMAIN disciplines.

PLO 4: Design/ Development of Solutions: Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PLO 5: Modern Tool Usage: Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

PLO 6: Individual and Team Work: Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.

PLO 7: Communication: Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.

PLO 8: Computing Professionalism and Society: Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice.

PLO 9: Ethics: Understand and commit to professional ethics, responsibilities, and norms of professional computing practice.

PLO 10: Life-long learning: Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

Areas Covered in BS in Computer Science

Course Group – Common Courses	Cr. Hrs.	% age
Computing – Core	46	35.38%
General Education	30	23.07%
Mathematics & Supporting Courses	12	09.23%
Common Courses	**88**	**67.68%**
Course Group – DOMAIN CS	**Cr. Hrs.**	**% age**
DOMAIN CS Core	18	13.84%
DOMAIN CS Electives	21	16.15%
DOMAIN CS courses	**39**	**29.99%**
Course Group – Elective Supporting CS	**Cr. Hrs.**	**% age**
Elective Supporting Courses	03	02.30%
Elective Supporting Course	**03**	**02.30**
TOTAL [Common + DOMAIN Courses]	**130**	**100%**

Common Courses for BS (COMPUTER SCIENCE)

1. Computing Core Courses – 35.38%

Course Title	Cr. Hrs.
Programming Fundamentals	3-1
Object Oriented Programming	3-1
Digital Logic & Design	2-1
Database Systems	3-1
Data Structures	3-1
Artificial Intelligence	2-1
COAL	2-1
Software Engineering	3-0
Operating System	2-1
Computer Networks	2-1
Analysis of Algorithm	3-0
Information Security	2-1
FYP-I	0-2
FYP-II	0-4
Total	**46 (30-16)**

2. General Education Courses – 23.07%

Course Title	Cr. Hrs.
Application of Info. & Comm. Technologies	2-1
Functional English	3-0
Islamic Studies	2-0

Applied Physics	2-1
Ideology and Constitution of Pakistan	2-0
Calculus and Analytical Geometry	3-0
Expository Writing	3-0
Civics and community engagement/ social services + Psychology	2-0
Discrete Structures	3-0
Professional Practices	2-0
Digital Marketing	2-0
Technology Entrepreneurship	2-0
Total	**30 (28-2)**

3. Mathematics and Supporting Courses – 9.23%

Course Title	**Cr. Hrs.**
Linear Algebra	3-0
Multi Variable Calculus	3-0
Statistics & Probability	3-0
Technical & Business Writing	3-0
Total	**12 (12-0)**

DOMAIN Courses for BS (COMPUTER SCIENCE)

4. Computer Science Domain CORE (Compulsory) courses – 13.84%

Course Title	**Cr. Hrs.**
Computer Architecture	2-1
Theory of Automata	3-0
Advanced DBMS	2-1
HCI and Computer Graphics	2-1
Compiler Construction	2-1
Parallel & Distributed Computing	2-1
Total	**18 (13-5)**

5. Computer Science Domain ELECTIVE courses – 16.15%

Course Title	**Cr. Hrs.**
CS Elec. - I, Web-Technology	2-1
CS Elec. - II, Advanced Programming (VP)	2-1
CS Elec. - III, Web Engineering	2-1
CS Elec. - IV, Numerical Analysis	2-1
CS Elec. - V, Mobile Application Development	2-1

CS Elec. - VI, Software Testing and Quality Assurance	2-1
CS Elec. - VII, Cloud Computing	2-1
Total	**21 (14-7)**

6. Computer Science Elective SUPPORTING courses – 2.30%

Course Title	**Cr. Hrs.**
Elec. Supporting – I, Accounting Fundamentals	3-0
Total	**3 (3-0)**

Scheme of Study for BS Computer Science

Semester – I

Code	Course Title	Cr. Hrs.	Pre-Requisites
CSIT-107	Application of Info. & Comm. Tech.	2-1	
CSPF-121	Programming Fundamentals	3-1	
ESFE-108	Functional English	3-0	
SSIS-109	Islamic Studies	2-0	
EEAP-110	Applied Physics	2-1	
SSIP-111	Ideology and Constitution of Pakistan	2-0	
MTPM-161	Math-I	3-0 (NC)	Pre-Medical Only
	TOTAL	**14-3 (17)**	

Semester – II

Code	Course Title	Cr. Hrs.	Pre-Requisites
CSOO-122	Object Oriented Programming	3-1	CSPF-121
MTCA-112	Calculus and Analytical Geometry	3-0	
ESEW-113	Expository Writing	3-0	ESFE-108
SSCE-114	Civics and Community Engagement	2-0	
CSDT-115	Discrete Structures	3-0	
MSAF-176	Elec. Supporting – I, Accounting Fundamentals	3-0	
MTPM-162	Math-II	3-0 (NC)	Pre-Medical Only
	TOTAL	**17-1 (18)**	

Semester – III

Code	Course Title	Cr. Hrs.	Pre-Requisites
CSDL-223	Digital Logic Design	2-1	
CSDS-224	Data Structures	3-1	CSOO-122
MTLA-201	Linear Algebra	3-0	MTCA-112
MTMC-202	Multi Variable Calculus	3-0	
CSDB-225	Database System	3-1	
	TOTAL	**14-3 (17)**	

Semester – IV

Code	Course Title	Cr. Hrs.	Pre-Requisites
CSAI-226	Artificial Intelligence	2-1	
CSSE-227	Software Engineering	3-0	
CSWT-263	CS Elec. - I, Web-Technology	2-1	
CSAP-264	CS Elec. - II, Advanced Programming (VP)	2-1	CSOO-122
CSPP-216	Professional Practices	2-0	
CSCO-228	Comp. Organization & Assembly Language	2-1	CSDL-223
	TOTAL	**13-4 (17)**	

Semester – V

Code	Course Title	Cr. Hrs.	Pre-Requisites
CSWE-365	CS Elec. - III, Web Engineering	2-1	CSWT-263
CSCA-341	Computer Architecture	2-1	CSCO-228
CSOS-329	Operating System	2-1	
MTSP-303	Statistics & Probability	3-0	
CSTA-342	Theory of Automata	3-0	
CSNA-366	CS Elec. - IV, Numerical Analysis	2-1	
	TOTAL	**14-4 (18)**	

Semester – VI

Code	Course Title	Cr. Hrs.	Pre-Requisites
CSAD-343	Adv. Database Management System	2-1	CSDB-225
CSAA-330	Analysis of Algorithms	3-0	CSDS-224
CSCN-331	Computer Networks	2-1	
CSMA-367	CS Elec. - V, Mobile Application Development	2-1	
ESTW-304	Technical & Business Writing	3-0	ESFE-108
CSDM-317	Digital Marketing	2-0	
	TOTAL	**14-3 (17)**	

Semester – VII

Code	Course Title	Cr. Hrs.	Pre-Requisites
CSCG-444	CS Elec. - IV, HCI & Computer Graphics	2-1	
SEST-468	CS Elec. - VI, Software Testing and Quality Assurance	2-1	CSSE-227
CSCC-445	Compiler Construction	2-1	CSTA-342
CSFP-499	Final Year Project – I	0-2	
CSDC-446	Parallel & Distributed Computing	2-1	CSOS-329
	TOTAL	**8-6 (14)**	

Semester – VIII

Code	Course Title	Cr. Hrs.	Pre-Requisites
CSCD-469	CS Elec. - VII, Cloud Computing	2-1	
CSFP-499	Final Year Project – II	0-4	CSFP-499
CSIS-432	Information Security	2-1	CSOS-329
MSTE-418	Technology Entrepreneurship	2-0	
	TOTAL	**6-6 (12)**	
	TOTAL CR. HRS.	**130**	

Detailed Course Outlines

Semester I

Application of Information and Communication Technologies

Course Code: CSIT-107

Semester	Credit Hours	Prerequisite
[BSCS-1]	[2+0]	[None]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Define** various types and components of computer including input/output devices, memory, storage media	C	C1 Knowledge	1
CLO-2	**Describe** different types of software from operating systems to system utilities and productivity apps	C	C2 Comprehension	2
CLO-3	**Describe** the basic concepts regarding computer networks, database management and computer security from a user point of view, components of computer including input/output devices, memory, storage media	C	C2 Comprehension	2

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Introducing Today's Technologies Computers, Devices, and the Web: Computing Components, Processors, Memory, the Cloud, and More. Input and Output Extending Capabilities of Computers and Mobile Devices. Digital Storage Preserving Content Locally and, on the Cloud. Operating Systems Managing, Coordinating, and Monitoring Resources, GUI and CLI with CLI commands and their usages. Storing and retrieving Information & Input/output media and devices. Communicating Digital Content Wired and Wireless Networks and Devices. Connecting and

Communicating Online the Internet, Websites, and Media. Computers and Mobile Devices Evaluating Options for Home and Work. Programs and Apps Productivity, Graphics, Security, and Other Tools. Digital Security, Ethics, and Privacy Threats, Issues, and Defenses. Building Solutions Database, System, and Application Development Tools. Numbering Systems: Binary, Octal, Decimal and Hexadecimal, Base inter conversions, Binary arithmetic operations.

Course Weekly Schedule
The course schedule for 17 weeks is detailed below.

Week	Topic
1	Technology, Types of Computers, Mobile & Game Devices, Data and Information, The Web, Web Searching, Online Social Networks, Internet Communications
2	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
3	Online: 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
4	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
5	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
6	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
7	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
8	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

Week	Topic
9	**Mid Term Exams**
10	Operating Systems, Operating System Functions, Starting Computers and Mobile Devices, Shutting Down Computers and Mobile Devices, providing a User Interface, Managing Programs, Managing Memory
11	Types of Operating Systems, Desktop Operating Systems, Windows/Mini Feature, Mac OS/Mini Feature, Unix, Linux, Chrome Os, Running Multiple, Systems, Android, iOS, Windows Phone Mobile versus Desktop Operating Systems
12	Communications, Networks, LANs, MANs, WANs, and PANs, Network Architectures, Communications Software, Communications Network, Communications Standards and Protocols
13	Communications Lines, Transmission Media, Physical Transmission Media, Twisted-Pair Cable, Coaxial Cable, Fiber-Optic Cable, Wireless, Infrared, Broadcast Radio, Cellular Radio, Microwaves
14	CH 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
15	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
16	What is data base and data base management system, Evolution of database management, Data Concepts and Characteristics, Data Organization
17	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 Textbooks

1. Discovering Computers, Shelly Cashman series, 2016.

Recommended Reference (Books/Websites/Articles)

1. Introduction to Computers, Peter Norton, 6th edition.
2. Understanding computers: today and tomorrow, comprehensive, Deborah Morley, Charles S. Parker, 15th Edition, Cengage Learning, 2014.
3. Using information technology, Brian K. Williams, Stacey C. Sawyer.

Application of Information and Communication Technologies-Lab

Course Code: CSIT-107L

Semester	Credit Hours	Prerequisite
[BSCS-1]	[0+1]	[None]

Course Description

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.

Course Learning Outcomes (CLOs) for Labs

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Explain** the purpose of MS Office (Word, Excel, Power point), Operate MS Office, Understanding of MS Office	C	C2 Comprehension	2
CLO-2	**Practice** the Tasks, discuss problems, participate and feedback of previous Labs in the form of lab reports	P	P3 Guided Response	5
CLO-3	Apply the understanding, operating, and designing to real problems, develop problem solving skills, promote creativity	A	A2 Responding	7

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Introducing Today's Technologies Computers, Devices, and the Web: Computing Components, Processors, Memory, the Cloud, and More. Input and Output Extending Capabilities of Computers and Mobile Devices. Digital Storage Preserving Content Locally and, on the Cloud. Operating Systems Managing, Coordinating, and Monitoring Resources, GUI and CLI with CLI commands and their usages. Storing and retrieving Information & Input/output media and devices. Communicating Digital Content Wired and Wireless Networks and Devices. Connecting and Communicating Online the Internet, Websites, and Media. Computers and Mobile Devices Evaluating Options for Home and Work. Programs and Apps Productivity, Graphics, Security, and

Other Tools. Digital Security, Ethics, and Privacy Threats, Issues, and Defenses. Building Solutions Database, System, and Application Development Tools. Numbering Systems: Binary, Octal, Decimal and Hexadecimal, Base inter conversions, Binary arithmetic operations.

Lab Weekly Schedule
The labs schedule for 17 weeks is detailed below. All lab CLOs shall be accessed in each lab.

Week	Topic
1	Introduction to the lab equipment and SOPs of the labs
2	Introduction to computer hardware and system information
3	Learning of different functions of Microsoft Word
4	Working with Insert tab (table, smart art , pictures, shapes)
5	Working with Insert tab (page no., header/footer, page break, symbols and equations comments, links, track changes.)
6	Working with Design and page layout tabs and table figure and contents.
7	Referencing, PDF conversion, views reviews
8	Report writing and CV making in Microsoft Word
9	**Mid Term Exams**
10	Introduction to Excel (different functions of Microsoft Excel)
11	Cell merging, sum, average, cell sizing, sorting swapping, designing, filters
12	Graph making, Chart making and formula implementation in Microsoft Excel
13	Pivot table in Microsoft Excel
14	Introduction to Power point
15	Designing presentation in Power point
16	Presentation making
17	**Lab Exam**

Recommended Textbooks
1. Discovering Computers, Shelly Cashman series, 2016.

Recommended Reference (Books/Websites/Articles)
1. Introduction to Computers, Peter Norton, 6th edition.
2. Understanding computers: today and tomorrow, comprehensive, Deborah Morley, Charles S. Parker, 15th Edition, Cengage Learning, 2014.
3. Using information technology, Brian K. Williams, Stacey C. Sawyer.

Programming Fundamentals

Course Code: CSPF-121

Semester	Credit Hours	Prerequisite
[BSCS-1]	[3+0]	[None]

Course Description

This course provides a basic introduction to computers and fundamental programming concepts and methods. Emphasis is on problem solving using algorithmic development methods; good programming practices and style. C++ is used as a tool in learning programming. Coding environments such as Visual Studio or DevC++ will be used for programming in class and lab. ITCP is designed to be a first course for students with little or no prior programming experience. It also includes the practice of all programming fundamental concepts and the additional language for practicing these concepts is C++, so that students will be able to solve any problem in any language.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Describe fundamental concepts of structured programming along with problem solving techniques and analytical thinking.	C	C2 Comprehension	2
CLO-2	Formulate C++ constructs to design solutions for small scale computational problems.	C	C3 Application	4
CLO-3	Analyze problem requirements to recognize what type of data and processes are involved in the solution.	C	C4 Analysis	3

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Course Materials

This course introduces advance aspects of Programming Fundamentals which includes:

- Writing C++ Program (The first c program if statements, If-else statements, nested if-else, Use of logical operators, the conditional operators)
- The Loop Control Structure (The for loop, Nesting of loops, Multiple initializations in the for loop, the while loop, The break statement, The continue statement, The do-while loop

- The Case Control Structure (Decisions using switch, Switch versus if-else ladder, the goto keyword)
- Functions (Function definition, passing values between functions, Functions declaration and prototypes)
- Arrays, Arrays (Declaration, Initialization, Accessing and processing one-Dimensional integer and char Arrays). Introduction to arrays and strings
- Pointers (Declaring, Initializing Pointer variables, Manipulating pointer variables)
- Structures (Declaration, Initializing object, Sample program of saving data using structure and search algorithm for structures)
- File Handling (Introduction to ifstream and ofstream, writing to /from file)

Course Weekly Schedule

The course schedule for 17 weeks is detailed below

Week	Topic
1	**Introduction**, Introduction to Programming Languages, Benefits gained and obtained from Programming Languages. Generations of Programming Languages, Use of different languages in different generations. Working of Compilers, and Linkers.
2	**Introduction to C/C++,** Advantages of using C/C++, Character set White space characters, Naming rules in C/C++, Data types, Data type sizes, Types of C/C++ Instructions.
3	**First program in C/C++,** Preprocessor directive, Function body, Statement terminator, Compiling and Executing the program.
4	**Variable definition and declaration**, Escape sequences, Arithmetic Operators, Relational Operators, Input gathering and Type casting. Library Functions
5	**Loops**, for loop, nested for loop, Using for loop with single and multiple statements, while and nested while loop.
6	The do while loop, Difference between while and do while loop, Decision making statements, if, if else and nested if else statements.

7	Using switch and break statements, Logical and Conditional Operators, Operators Precedence, continue and goto statements.
8	**Arrays, Array** Introduction, Defining and Initializing Arrays, Strings arrays. Arrays initialization, operations
9	**Mid Term Exams**
10	**Functions**, Functions Declaration. Function Calling, Function Definition, and Eliminating function declaration,
11	**Arrays and functions,** passing to functions, Passing arguments to functions (by value). Passing variables to functions, passing structure variables to functions, returning values from functions, Return statement.
12	**Overloading**, Overloaded functions and Examples, Inline functions.
13	**Structures**, defining structures and structure variables, accessing structure members, Combining structure specifier and definition.
14	Initializing Structure members, Enumerated data types,
15	**Pointers**, Pointers of Arrays, Pointer constants and pointer variables, Passing pointers as arguments, Pointer and Arrays
16	**File Handling**, Introduction to ifstream and ofstream, Writing to /from file, Simple programs: word count, sentence count.
17	**File Handling Practice Questions**

Recommended Textbooks

1. Deitel & Deitel, "C++ How to Program", 7th Edition
2. Ivor Horton, "Beginning C++", 3rd Edition, Wrox Publishers, 2005.
3. Lecture Notes

Reference Material

1. Turbo C++ , by Robert Lafore

Programming Fundamental -Lab

Course Code: CSPF-121L

Semester	Credit Hours	Prerequisite
[BSCS-1]	[0+1]	[None]

Course Description

This course provides a basic introduction to computers and fundamental programming concepts and methods. Emphasis is on problem solving using algorithmic development methods; good programming practices and style. C++ is used as a tool in learning programming. Coding environments such as Visual Studio or DevC++ will be used for programming in class and lab. ITCP is designed to be a first course for students with little or no prior programming experience. It also includes the practice of all programming fundamental concepts and the additional language for practicing these concepts is C++, so that students will be able to solve any problem in any language

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Practice** the basic concepts of control flow, syntax, and simple program's structure	P	P3 Guided Response	2
CLO-2	**Execute** small to medium scale programs to give problem solutions.	P	P4 Mechanism	4
CLO-3	**Contribute** individually or as a team member to work effectively.	A	A2 Responding	6

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces advance aspects of Programming Fundamentals which includes:
Intro to C++ (Programming Language), C++ Basics, Control Structures (Relational Operators, Logical Operators and Logical Expressions, Selection: if, if-else, nested if. Nested if-else. Switch statement), Loops, (Intro to Loops Types of loops, For-Loop-Syntax, While, Do while, break statement). Nested For Loop with examples and activities, Arrays (Declaration, Initialization, Accessing and processing one-Dimensional integer and char Arrays). Pointers (Declaring, Initializing Pointer variables, Manipulating pointer variables), Structures(Declaration,Initializing object, Sample program of saving data using structure and search algorithm for structures), File Handling(Introduction to ifstream and ofstream, Writing to /from file)

Course Weekly Schedule

The course schedule for 17 weeks is detailed below

Week	Topic
1	**Introduction** Introduction to Programming Languages, to dev c++ integrated development environment, installation of Dev C++. Introduction to Dec C++, text editor, menu bars, creating a new file, saving a file, compiling and execution of a program.
2	**First program in C/C** Writing first program in Dev C++, Code Explanation, Preprocessor Directive, main function, terminator, header file. Compiling and execution of a program. How to solve errors.
3	**Implementation of Multiple Data types** Simple Cout statement command, Cin command. Variable definition and declaration. Integer, floating point and double variable declaration, Using integers, float and double in programs.
4	**Implementation of Type casting/ library functions** What are Escape sequences. How they are used in a program. Arithmetic Operators, Relational Operators, Input gathering and Type casting. Using multiple Library Functions in a program.
5	**Implementation of Loops** Introduction to Loops, for loop, nested for loop, Using for loop with single and Multiple statements. Dry run and programming Examples of for loop. Introduction to while and nested while loop.
6	**Implementation of Loops** Implementation and Dry run of programming Examples for loop. The do while loop, Difference between while and do while loop,
7	**Implementation of Decision Making Statements** Decision making statements, if, if else and nested if else statements.
8	**Implementation of Switch Statements / logical and conditional operators** Using switch and break statements, Logical and Conditional Operators, Operators Precedence, continue and goto statements.
9	**Mid Term Exams**
10	**Implementing Arrays** Storage classes of variables, Automatic variables, External variables and Static variables, Defining and Initializing Arrays, Strings.

11	**Implementing of Passing Values within Functions and Arrays** Arrays initialization , operations, passing to functions, Multidimensional Arrays
12	**Implementing Functions** Functions Declaration. Function Calling, Function Definition, Eliminating function declaration, Passing arguments to functions (by value).
13	**Implementing Pass by Value in Functions** Passing variables to functions, Passing structure variables to functions Returning values from functions, Return statement. Returning structure variables, Passing arguments to functions
14	**Implementing Function Overloading** Overloaded functions, Inline functions. Practice Examples
15	**Implementation of Structures** Structures, Defining structures and structure variables, Accessing structure members, Combining structure specifier and definition, Initializing Structure members, Structures within structures, Enumerated data types
16	**Implementing Pointers** Pointers, Pointers of Arrays, Pointer constants and pointer variables, Passing pointers as arguments, Pointer and functions.
17	**File Handling**, Introduction to ifstream and ofstream, Writing to /from file, Simple programs: word count, sentence count.

Recommended Textbooks

1. Deitel & Deitel, "C++ How to Program", 7th Edition
2. Ivor Horton, "Beginning C++", 3rd Edition, Wrox Publishers, 2005.
3. Lecture Notes

Functional English

Course Code: ESFE-108

Semester	Credit Hours	Prerequisite
[BSCS-1]	[3+0]	[None]

Course Description

In this course, students will develop reading comprehension, writing, speaking and listening skills by providing rich language content. The teaching objectives and assessment criteria ensure confident delivery of all the core skills for second language learners. Course topics provide language practice and support to students and offer a record progress in both professional and non-professional field. The course is carefully crafted to provide optimum practice of English language for computer science students.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Identify** the parts of speech, phrase clause and sentence	C	C1 Knowledge	7
CLO-2	**Apply** the changes in voice and narration of the sentence	C	C3 Comprehension	7
CLO-3	**Use** English vocabulary and skills in writing paragraphs, essays, letters and applications	C	C3 Comprehension	7

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Parts of speech, Modals and Articles, Tenses and Conditional sentence, Types of Sentences, Change of voice, Change of Narration, Writing Strategies, Paragraph writing, Use of articles and Punctuation marks, Reading Comprehension, Essay Writing, Phonemes-vowels, consonants and diphthongs. Rules of Pronunciation, American and British sound differences, Rules of Spellings, Reading: extensive/intensive, skimming/scanning, letters to the editors, job applications

Course Weekly Schedule

The course schedule for 17 weeks are detailed below

Week	Topic
1	Parts of speech

Week	Topic
2	Modals and Articles
3	Tenses and Conditional sentence
4	Change of voice
5	Change of narration
6	Writing strategies
7	Paragraph writing
8	Phonemes-vowels, consonants
9	**Mid Term Exams**
10	Rules of Pronunciation, American and British sound differences, Rules of Spellings)
11	Rules of spellings and use of articles, Strategies for effective writing
12	Paragraph and Essay writing
13	Letters to the editors and job applications
14	Use of punctuation marks
15	Reading comprehension
16	Group discussion

Recommended Textbooks

1. High school English grammar and composition by Wren and Martin

Recommended Reference (Books/Websites/Articles)

1. College Writing Skills with reading by John Langan, Mc Graw-Hill, 5th Edition
2. https://www.britishcouncilfoundation.id/en/english/articles/british-and-american-english
3. https://www.butte.edu/departments/cas/tipsheets/readingstrategies/skimming_scanning
4. https://www.dyslexia-reading-well.com/44-phonemes-in-english.html
5. https://grammar.yourdictionary.com/punctuation/punctuation-rules-help.html

Islamic Studies

Course Code: SSIS-109

Course Description

Semester	Credit Hours	Prerequisite
[BSCS-1]	[2+0]	[None]

This course has been designed as a compulsory subject for the students of Bachelor's degree program. The course has 2 credit hours and carrying 100 marks. This course provides sufficient knowledge on faith & pillars of Islam than systems of Islam. The main objective of this course is to enhance knowledge of the students on Islam and their character building.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Discuss** basic concept of Islam (faith, pillars and systems etc.) and express their impact on society and describe the religion of Islam importance in the human life in the light of guidance provided by Quran and Sunnah	C	2 Comprehension	1
CLO-2	**Demonstrate** the challenges of modern science and contemporary world	C	3 Application	10
CLO-3	**Analyze** Islamic Ethics and code of personal practice in social life	C	4 Analysis	9

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Basic Themes of Quran, Introduction to Sciences of Hadith, Introduction to Islamic Jurisprudence, Primary & Secondary Sources of Islamic Law, Makken & Madnian life of the Prophet, Islamic Economic System, Political theories, Social System of Islam.

Course Weekly Schedule

The course schedule for 16 weeks is detailed below.

Week	Topic
1	Importance of Quran to be a noble human, Introduction of Quran, Fazail-e-Quran, Duties of a Muslim during recitation of the Quran, Importance of Understanding of the Quran

Week	Topic
2	Characteristics of true human being and a beloved servant of Al-Rehman (Surh al-Furqan 63-78) Humbleness in dealings/ walk, Focusing on the Vision, Spending nights in prayer, Pray for protection from the hell , Pray for the Family (spouse and child)
3	Social norms: Towards Rasool (ﷺ)/ elders & authorities (Surah Al-Hujrat 1-5) Lowering voice in front of Rasool ﷺ/ Authority, Presentation of matters in respectful words. , Manners of Calling Rasool ﷺ / Authority, Conduct of a human towards Media (al-Hujrat 5-8)
4	Why the Sunnah is important for a Human? Literal Meaning of the Sunnah, Importance of the Sunnah according to the Quran, Relativity among the Quran and the Sunnah
5	Twenty selected Ahadith with translation
6	Twenty selected Ahadith with translation
7	Islam in the Light of the Quran and Hadith(Theological Section) Tauheed, Risalat, Aakhrat
8	Islam in the Light of the Quran and Hadith (Teaching section) Prayer, Fasting, Charity (Zakat/Sadaqat), Hajj, Jihad
9	**Mid Term Exam**
10	Study of Seerat-un-Nabi(ﷺ) Makkah Life, Birth / early childhood, Before & after revelation of the Quran, The preaching and its different stages
11	Study of Seerat un Nabi (ﷺ)Madina Life; Hijrah; Qualities of the Leadership and the Nation ,Fatah-e-Makkah and conduct of the Prophet towards his opponents, Hajatul Wida
12	Importance of Quran to be a noble human Introduction of Quran, Fazail-e-Quran, Duties of a Muslim during recitation of the Quran, Importance of Understanding of the Quran
13	Characteristics of true human being and a beloved servant of Al-Rehman (Surh al-Furqan 63-78) Humbleness in dealings/ walk, Focusing on the Vision, Pray for the Family (spouse and child) , Spending within limits (wealth/time/education/ energies.
14	Pray Allah in hard times, Don't harm any thing in the universe , Don't make unlawful relations , Don't attend falsehood meetings , Pass by from irrelevant things
15	Social norms: Towards Rasool (ﷺ)/ elders & authorities (Surah Al-Hujrat 1-5) Lowering voice in front of Rasool ﷺ/ Authority Presentation of matters in respectful words , Manners of Calling Rasool ﷺ / Authority
16	Why the Sunnah is important for a Human? Literal Meaning of the Sunnah, Importance of the Sunnah according to the Quran, Relativity among the Quran and the Sunnah

Recommended Textbooks

1. Islamic education for BA B-SC B-COM. By M.D.Zafar. Aziz book depot Urdu Bazar Lahore
2. Islamic studies for BA B-SC B-COM. by Zia urRahman Ahmad Aziz book depot Urdu Bazar Lahore
3. Ali, K. (2006). A Study of Islamic History. Adam Publishers & Distributors. ISBN13: 9788174352286.

Recommended Reference (Books/Websites/Articles)

1. Islam in the light of the final testament and traditions by Shaukatomari Taurus Publications Karachi.
2. Islamic Ideology by Khalifa Abdul Hakim Institute of Islamic culture 2-club road, Lahore.
3. Whatever everyone should know about Islam and Muslims by Suzanne HaneefKazi publications 121 zulqarnain chambers Ganpat road Lahore

Applied Physics

Course Code: EEAP-110

Semester	Credit Hours	Prerequisite
[BSCS-1]	[2+0]	[None]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Apply** acquired knowledge to solve series and parallel resistor networks by using KVL and KCL	C	C3 Application	1
CLO-2	**Explain** and understand and the basic operation and working semiconductor devices	C	C2 Comprehension	1
CLO-3	**Apply** acquired knowledge to solve circuits which consists of semiconductor devices	C	C3 Application	1

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Charge, Negative and Positive charge, and Electric field, Basic concept of Voltage, Current and Resistor, Series and Parallel combinations of Resistors, Ohm's Law, KCL and KVL, Introduction of materials, conductor insulator semiconductor, electronic configuration, P type and N type materials, doping process, Introduction to diode theory, Approximations of diodes in circuits, some mathematical problems, Voltage and current relationship in diode, forward and reverse biasing of diodes, Zener diode and its applications, Rectifiers, Introduction to rectifiers, Half wave and full wave rectifier, Power supplies, Ripple factor and its calculations, Introduction of BJT and its operation, Collector characteristics of BJTs and region of operations, Continuation with BJT operation, Biasing of BJT, Common emitter configuration of BJT and concept of load line and q point, Continuation with load line and Q point with some problems, Emitter bias configuration and stability of Q point, Voltage divider bias configuration and its analysis, Introduction of JFETs and MOSFETs, Basic theory of JFETs and MOSFETs, Basic calculations of JFETs and MOSFETs.

Course Weekly Schedule

The course schedule for 17 weeks is detailed below

Week	Topic
1	Basis of Electricity, Charge, Negative and Positive charge, and Electric field, Basic concept of Voltage, Current and Resistor
2	Series and Parallel combinations of Resistors, Ohm's Law
3	KCL and KVL
4	Basis of Diode Theory, Introduction of materials, conductor insulator semiconductor, electronic configuration
5	P type and N type materials, doping process, Introduction to diode theory
6	Approximations of diodes in circuits, some mathematical problems. Voltage and current relationship in diode, forward and reverse biasing of diodes
7	Zener diode and its applications, Rectifiers
8	Introduction to rectifiers, Half wave and full wave rectifier
9	**Mid Term Exams**
10	Power supplies, Ripple factor and its calculations
11	Bipolar Junction Transistors, Introduction of BJT and its operation
12	Collector characteristics of BJTs and region of operations
13	Continuation with BJT operation
14	Biasing of BJT
15	Common emitter configuration of BJT and concept of load line and q point, Continuation with load line and Q point with some problems
16	Emitter bias configuration and stability of Q point, Voltage divider bias configuration and its analysis
17	Introduction of JFETs and MOSFETs, Basic theory of JFETs and MOSFETs, Basic calculations of JFETs and MOSFETs

Recommended Textbooks

1. Fundamentals of Physics (Extended), 10th edition, Resnick and Walker

Recommended Reference (Books/Websites/Articles)

1. Electronic Devices (Conventional Current Version), 10th Edition Thomas L. Floyd

Applied Physics -Lab

Course Code: EEAP-110L

Semester	Credit Hours	Prerequisite
[BSCS-1]	[0+1]	[None]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Explain** the basic laws of electronic circuits and semiconductor devices using the appropriate methods.	C	2 Comprehension	1
CLO-2	**Practice** fundamental circuit laws/principles and various applications of diodes and transistor to verify the behavior of electronic circuits.	P	3 Guided Response	1
CLO-3	**Contribute** individually or as a team member to work effectively.	A	2 Responding	6

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Charge, Negative and Positive charge, and Electric field, Basic concept of Voltage, Current and Resistor, Series and Parallel combinations of Resistors, Ohm's Law, KCL and KVL, Introduction of materials, conductor insulator semiconductor, electronic configuration, P type and N type materials, doping process, Introduction to diode theory, Approximations of diodes in circuits, some mathematical problems, Voltage and current relationship in diode, forward and reverse biasing of diodes, Zener diode and its applications, Rectifiers, Introduction to rectifiers, Half wave and full wave rectifier, Power supplies, Ripple factor and its calculations, Introduction of BJT and its operation, Collector characteristics of BJTs and region of operations, Continuation with BJT operation, Biasing of BJT, Common emitter configuration of BJT and concept of load line and q point, Continuation with load line and Q point with some problems, Emitter bias configuration and stability of Q point, Voltage divider bias configuration and its analysis, Introduction of JFETs and MOSFETs, Basic theory of JFETs and MOSFETs, Basic calculations of JFETs and MOSFETs. Design and Analysis of Clocked Sequential Circuits (Timing diagram), Designing Counters

Course Weekly Schedule

The course schedule for 16 weeks is detailed below

Week	Topic

1	• **Introduction to Lab Equipment & Components.**
	  • Introduction to Digital Electronic trainer, Multimeter, Oscilloscope, and function Generator.
	  • Introduction of Different Electronics components used in lab.

2	• **Error Analysis and graph drawing.**

3	• **To find resistance by color coding techniques and using digital multi-meter.**
	  • Calculate the resistance using color coding.
	  • Measure the calculated resistance using digital multi-meter.

4	• **Study of series and parallel resistance networks.**
	  • Study the characteristics of Series and parallel circuits.
	  • Calculate and Measure resistance in series and parallel circuits.

5	• **Verification of Ohm's Law.**
	  • Study of Resistance, Current and voltage relation using Ohm's Law.
	  • Calculate Resistance, Current and voltage in circuit and verify it using digital multimeter

6	• **Verify Kirchhoff's Voltage Law in the passive Circuit's elements.**
	  • Study of Kirchhoff's Voltage Law.
	  • Implementation of Kirchhoff's Voltage Law and verify it using digital multimeter.

7	• **Verify Kirchhoff's Current Law in the passive Circuit's elements.**
	  • Study of Kirchhoff's Current Law.
	  • Implementation of Kirchhoff's Current Law and verify it using digital multimeter.

8	• **Verify Voltage Divider Rule and Current Divider Rule in Passive circuits.**
	  • Study of Voltage Divider and Current Divider rule.
	  • Implementation of Voltage Divider Circuit and Current Divider. Verify it using digital multimeter.

9	**Mid Term Exams**

10	• **Charging and discharging of capacitors**
	  • Study of Different capacitors.
	  • Study of Charging and Discharging characteristics of capacitor.
	  • Implementation of circuit verifies it using digital/analog Oscilloscope.

11	• **Study of Diode Characteristics curve.**
	  • Study of Diode and its characteristics.
	  • Implementation of Diode circuit Study its characteristics using digital/analog Oscilloscope.

Week	Topic
12	**Open Ended Lab**

13	• **Study of Half wave rectifier and Full wave rectifier.**
	  • Study of Half wave rectifier and Full wave rectifier and its characteristics.
	  • Implementation of Half wave rectifier and Full wave rectifier. Verify its characteristics using digital/analog Oscilloscope.

14	**To observe Electrical Characteristics of Zener Diode and practice its use as Voltage Regulator**

15	• **To study and observe the output characteristics of Bipolar Junction Transistor (BJT)**
	  • Study of NPN and PNP Transistors and their characteristics.
	  • Testing of transistor and its type using a digital multimeter.

16	• **To study and perform the biasing of BJT, Base Biasing and Voltage Divider Bias configuration.**

Recommended Textbooks

1. Fundamentals of Physics (Extended), 10th edition, Resnick and Walker

Recommended Reference (Books/Websites/Articles)

1. Electronic Devices (Conventional Current Version), 10th Edition Thomas L. Floyd

Ideology and Constitution of Pakistan

Course Code: SSPS-113

Semester	Credit Hours	Prerequisite
[BSCS-1]	[2+0]	[None]

Course Description

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 Pakistani citizens to enable them function in a socially responsible manner.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Demonstrate enhanced knowledge of the basis of the ideology of Pakistan with special reference to the contributions of the founding fathers of Pakistan.	C	C2 Comprehension	1
CLO-2	Demonstrate fundamental knowledge about the Constitution of Pakistan 1973 and its evolution ith special reference to state structure	C	C3 Application	10
CLO-3	Explain about the guiding principles on rights and responsibilities of Pakistani citizens as enshrined in the Constitution of Pakistan 1973	C	C4 Analysis	10

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Course Weekly Schedule

The course schedule for 17 weeks is detailed below.

Week	Topic
1-4	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 1 857 till 1947).

Week	Topic
	Contributions of founding fathers of Pakistan in the freedom movement including but not limited to Allama Muhammad Iqbal, Muhammad Ali Jinnah., etc. Contributions of women and students in the freedom movement for separate homeland for Muslims of British India
5-8	Two-Nation Theory: Evolution of the Two-Nation Theory (Urdu-Hindi controversy, Pattition of Bengal, Simla Deputation 1 906, Allama Iqbal's Presidential Address 1930, Congress Ministries 1937 Lahore Resolution 1 940). •Role of communalism and religious differences
10,11	Introduction to the Constitution of Pakistan: Definition and importance of a constitution. Ideological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949). Overview of constitutional developments in Pakistan.
12,13	Constitution and State Structure: Structure of Government (executive, legislature, and judiciary). Distribution of powers between federal and provincial governments. 1 8th Amendment and its impact on federalism.
14,15	Fundamental Rights, Principles of Policy and Responsibilities: Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles 8-28). Overview of Principles of Policy (Articles 29-40). Responsibilities of the Pakistani citizens (Article 5).
16	Constitutional Amendments: Procedures for amending the Constitution. Notable constitutional amendments and their implications.

Recommended Textbooks

1. Idea of Pakistan" by Stephen P. Cohen.
2. Ideology of Pakistan" by Javed Iqbal.
3. Struggle for Pakistan" by 1 .1-1 . Qureshi.
4. Pakistan the Formative Phase" by Khalid Bin Sayeed.
5. Pakistan: Political Roots and Development" by Safdar Mahmood.
6. Ideology of Pakistan" by Sharif-ul-Mujahid.
7. Struggle for Pakistan: A Muslim Homeland and Global Politics" by Ayesha Jalal.
8. Jinnah, Pakistan and Islamic Identity: The Search for Saladin" by Akbar S. Ahmed.
9. Making of Pakistan: A Study in Nationalism" by K.K. Aziz.
10. Pakistan: A New History" by Ian Talbot.
11. Pakistan in the Twentieth Century: A Political History" by Lawrence Ziring.
12. Constitution of Pakistan 1973". Original.

13. Constitutional and Political Development of Pakistan" by Hamid Khan.
14. Parliament of Pakistan" by Mahboob Hussain.
15. Constitutional Development in Pakistan " by G. W. Choudhury.
16. Constitution-Mak ing in Pakistan: The Dynamics of Political Order" by G. W. Choudhury.

Recommended Reference (Books/Websites/Articles)

Pre-Math-I

Course Code: MTPM-161

Semester	Credit Hours	Prerequisite
[BSCS-1]	[Non Credit]	[Pre- Medical]

Course Description

The purpose of this course is to assist students from pre-medical background so that they will be able to continue their studies in computer science discipline without any hurdle.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL
CLO-1	Understand the concepts of sets, binary operations, and number theory a line, curves, functions, and be able to draw the graphs.	C	C2 Comprehension
CLO-2	Evaluate the limits, continuity, differentiation	C	C3 Application
CLO-3	Evaluate the limits, continuity, differentiation, and Integration.	C	C3 Application

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Introduction of Sets, types of sets
- Venn diagrams
- Number theory; Properties of real numbers and real line
- Coordinate plane
- Complex numbers properties and operations
- Introduction to functions, types of functions, graphs, the inverse of functions, slope tangent and normal.
- Introduction to limits
- Techniques of funding limits
- Continuous and discontinuous functions Partial Fraction
- Concept and idea of differentiation, Geometrical and Physical meaning of derivatives
- Rules of differentiation, Chain rule, Techniques of differentiation, Maxima and Minima of a function for single-variable

- Concavity
- Antiderivatives
- Concept, and idea of Integration Rules and techniques of integration
- The area under the curve a graphical perspective
- Definite Integrals
- Introduction to differential equations

Course Weekly Schedule
The course schedule for 17 weeks is detailed below

Week	Topic
1	Sets definition, types of sets,
2	Venn diagrams, Number theory
3	Properties of real numbers and real line, coordinate plane
4	Complex numbers, properties, and operations
5	Introduction to functions, Types of functions, graphs, the inverse of functions, slope tangent, and normal
6	Introduction to limits, Techniques of funding limits
7	Continuous and discontinuous functions
8	Partial Fraction
9	**Mid Term Exams**
10	Concept and idea of differentiation
11	Geometrical and Physical meaning of derivatives
12	Rules of differentiation, Chain rule, Techniques of differentiation,
13	Maxima and Minima of a function for single-variable, Concavity,
14	Antiderivatives, Concept, and idea of Integration
15	Rules and techniques of integration.
16	The area under the curve a graphical perspective, definite Integrals
17	Introduction to differential equations

Recommended Textbooks

1. Thomas and Finney- Calculus and Analytical Geometry, Edition 11, illustrated Publisher, Pearson Addison Wesley, 2007

Semester II

Object Oriented Programming

Course Code: CSOO-122

Semester	Credit Hours	Prerequisite
[BSCS-2]	[3+0]	[CSPF-121]

Course Description

The course introduces the students to the concepts and principles of Object Oriented Programming. The central theme will be about using object orientation in coming up with software with an emphasis on developing insights about how object orientation changes the way we conceptualize, design, develop and implement computer systems. This course prepares students for advanced programming courses. The course uses Java as the programming language and does not assume prior knowledge of the language. In addition to these a semester project of commercial worth will also be developed to implement the object orientation concepts.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Understand** principles of object oriented paradigm.	C	C2 Understanding	2
CLO-2	**Identify** the objects & their relationships to build object oriented solution	C	C4 Analysis	3
CLO-3	**Develop** object-oriented solutions for small systems	C	C6 Evaluation	4

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Introduction to object oriented design, history and advantages of object oriented design, introduction to object oriented programming concepts, classes, objects, data encapsulation, constructors, destructors, access modifiers, const vs non-const functions, static data members & functions, function overloading, operator overloading, identification of classes and their relationships, composition, aggregation, inheritance, multiple inheritance, polymorphism, abstract classes and interfaces, generic programming concepts, function & class templates, standard template library, object streams, data and object serialization using object streams, exception handling.

Course Weekly Schedule

The course schedule for 17 weeks are detailed below

Week	Topic
1	Procedural programming Vs object-oriented programming, Revision of Programming Fundamental Concepts. History of Java, Java programming environment, Fundamental programming structure in java, Lexical issues (white spaces, identifiers, literals, comments, separators and java keywords, Data types
2	Structure of Java program, Java Compilation Process Compiling and running a Java program Methods, Introducing methods, Method signatures, Arguments, and parameters
3	Introduction to classes and its importance Types of Classes Objects creation and handling, Anonymous object Utilizing methods of classes
4	Controlling access to members, Constructors, Constructor overloading, Static class members, Static methods
5	Inheritance, Types of Inheritance (Multiple , Multilevel, Hierarchical and Hybrid) Superclass and Subclass, Relationship between super class and subclass, Use of super keyword for using variables, function and constructor of super class
6	Polymorphism, Abstraction and Encapsulation Generalization, specialization, Aggregation, Composition Nested Classes, Run-time Polymorphism, Compile-time Polymorphism, Late binding and Early Binding.
7	Method overriding, use of super in override functions, using abstract classes, using final and protected keyword with inheritance, Abstract and non-abstract methods. Dynamic and dispatch methods.
8	Packages Defining package, Package access protection, Importing packages. Use of Object class.
9	**Mid Term Exams**
10	Interfaces, defining an interface, implementing and applying interfaces, Variables in interfaces, Interface with Multiple Inheritance
11	Exception Handling Fundamentals, Types of Exceptions, using exception clauses (try, catch, throw, throws and finally)
12	Graphical User Interface Components, Introduction to Swing. Controls Button, Labels, Text Fields, Text Area, Checkbox and Radio buttons Event Handling, The delegation event model (events, event sources and event listeners) Introduction to AWT, AWT classes
13	Creating a window program, working with graphics. Layout managers and menus, Control fundamentals

Week	Topic
14	Enums, Generics, Boxing, auto Boxing, Collections File Handling
15	Week For Open Ended Lab For Lab Final Exams, Projects, Presentations
16	Revision Week/Final Paper Discussion
17	Event Handling Practice

Recommended Textbooks

1. JAVA: The Complete Reference Object Oriented Programming by Herbert Schildt,11th Edition, McGraw-Hill Osborne Media; (2018)

Recommended Reference (Books/Websites/Articles)

1. Starting Out with C++ from Control Structures to Objects, 9th Edition, Tony Gaddis, Pearson; 8th edition (2014)
2. C++ How to Program, Deitel & Deitel, Pearson; 10th edition (2016)
3. Object Oriented Programming in C++ by Robert Lafore, 4th edition, ISBN-13: 978-0672323089, Sams; (2001)
4. Java: How to Program by Paul Deitel, Pearson College Div; 9th edition (2011)

Object Oriented Programming-Lab

Course Code: CSOO-122L

Semester	Credit Hours	Prerequisite
[BSCS-2]	[0+1]	[CSPF-121]

Course Description

The course introduces the students to the concepts and principles of Object Oriented Programming. The central theme will be about using object orientation in coming up with software with an emphasis on developing insights about how object orientation changes the way we conceptualize, design, develop and implement computer systems. This course prepares students for advanced programming courses. The course uses Java as the programming language and does not assume prior knowledge of the language. In addition to these a semester project of commercial worth will also be developed to implement the object orientation concepts.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Develop** programs using object-oriented programming concepts	C	C6 Evaluation	4
CLO-2	**Manipulate** the use of Java Complier and Eclipse IDE to create java applications	P	P3 Guided Response	5
CLO-3	**Develop** software solutions for different problems and construct software based application for it.	P	P6 Adaption	5

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Introduction to object oriented design, history and advantages of object oriented design, introduction to object oriented programming concepts, classes, objects, data encapsulation, constructors, destructors, access modifiers, const vs non-const functions, static data members & functions, function overloading, operator overloading, identification of classes and their relationships, composition, aggregation, inheritance, multiple inheritance, polymorphism, abstract classes and interfaces, generic programming concepts, function & class templates, standard template library, object streams, data and object serialization using object streams, exception handling.

Lab Weekly Schedule
The lab schedule for 17 weeks is detailed below. All lab CLOs shall be accessed in each lab.

Week	Topic
1	Introduction to Eclipse, Writing Java programs, Basic programming structure of Java
2	Methods, Method signatures, Parameters and Arguments
3	Classes and objects, Properties, and behavior
4	Constructors of classes and their utility, Constructor Overloading
5	Static Variables and Static Methods, Basic concept of Final Keyword
6	Encapsulation as concept and its implementation, Access modifiers, Data Hiding
7	Polymorphism through method overloading
8	Basic concept of inheritance, Parent and Child Classes
9	**Mid Term Exams**
10	Polymorphism through method overriding, Use of Super Keyword, Use of Protected
11	Use of Final Keyword with respect to inheritance, Final classes, Final methods
12	Object Casting and Dynamic Method Dispatch
13	Abstract Classes and Abstract Methods
14	Packages Defining package, Package access protection, Importing packages,
15	Interfaces, defining an interface, implementing interfaces, Variables in interfaces
16	Exception Handling Fundamentals, Types of Exceptions, using exception clauses (try, catch, throw, throws and finally)
17	Graphical User Interface Components, Introduction to AWT, AWT classes

Recommended Textbooks

1. JAVA: The Complete Reference Object Oriented Programming by Herbert Schildt,11th Edition, McGraw-Hill Osborne Media; (2018)

Recommended Reference (Books/Websites/Articles)

1. Starting Out with C++ from Control Structures to Objects, 9th Edition, Tony Gaddis, Pearson; 8th edition (2014)
2. C++ How to Program, Deitel & Deitel, Pearson; 10th edition (2016)
3. Object Oriented Programming in C++ by Robert Lafore, 4th edition, ISBN-13: 978-0672323089, Sams; (2001)
4. Java: How to Program by Paul Deitel, Pearson College Div; 9th edition (2011)

Calculus and Analytical Geometry

Course Code: MTCA-122

Semester	Credit Hours	Prerequisite
[BSCS-2]	[3+0]	[none]

Course Description

Calculus serves as the foundation of advanced subjects in all areas of mathematics. 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. This course covers in depth the differential calculus of function of single variable.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Apply** the concepts of graphs of the function, limits, and continuity to solve problems	C	C3 Application	1
CLO-2	**Solve** the problems related to derivation, maxima, and minima.	C	C3 Application	1
CLO-3	**Solve** the problems related to integration, and conic section	C	C3 Application	2

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

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

Course Weekly Schedule

The course schedule for 17 weeks is detailed below

Week	Topic
1	Introduction to functions, Even and Odd Functions, Domain and Range of Functions, Piecewise Continuous Functions, Periodic Functions
2	Increasing and Decreasing Functions, Graph of the functions
3	Limit of a function, Graphical approach, Properties of limits, Theorems of limits
4	Limits of various types of functions
5	Continuity of a function at a point, Continuous and discontinuous functions, Continuity by Graphical approach
6	Derivatives, geometrical meaning of the derivative, general Theorems of derivatives
7	Trigonometric functions, explicit and implicit functions and its derivatives, second order and higher order derivatives
8	Tangents and Normal Lines, Application of Derivatives, Max-Min Theorem, Absolute Extrema, Local Extrema, Concavity Examples
9	**Mid Term Exams**
10	Integration, Techniques of Integration, Basic Integration Formulas, Substitution method
11	Partial Fraction, Integration by Parts
12	Trigonometric Substitution
13	Riemann sums and Definite Integrals
14	Improper integrals
15	Properties of definite integral, Fundamental theorems of calculus
16	Application of Integration: Area under the curves, Solids of revolution
17	Straight lines in R3, Equations for planes

Recommended Textbooks

1. Calculus and analytical Geometry, Thomas and Finney, Pearson Addison Wesley, 2007, latest edition.

Recommended Reference (Books/Websites/Articles)

Advanced engineering mathematics, Erwin Kreyszig, John Wiley & Sons, 2019.

Expository Writing

Course Code: ESEW-113

Semester	Credit Hours	Prerequisite
[BSCS-2]	[3+0]	[ESFE-108]

Course Description

The course is designed to develop awareness, knowledge, skills and attitude of participants needed to deliver effective and professional communication. The objective of the course is to make the participants understand the theory of effective and good communication prior to preparing and delivering a presentation within a simulated context to have a persuasive impact on the audience.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Describe** basic concepts and terms about communication	C	C2 Comprehension	
CLO-2	**Explain** different types of communication, rules and principles for effective communication and report writing	C	C2 Comprehension	
CLO-3	**Apply** different techniques to prepare a memo, report or proposal	C	C2 Comprehension	
CLO-4	**Participate**/volunteer in group discussion and present the topic	A	A2 Responding	

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Definition, importance, components and seven Cs of communication. Ethical and Global Communication, Team Communication and job search communication, Process and principles of effective writing. Skills for taking notes in the class. Writing resume, cover letters and memos. Proposal writing. Types and importance of interviews, preparation for interviews, Types and importance of meetings, planning meetings, Manners and principles to participate in a meeting, presentation Skills-steps to prepare a presentation, ways of oral delivery, verbal and nonverbal strategies. Remedies to overcome stage fear. Types, purposes and characteristics of report writing. Tools for data collection. Abstract writing, referencing, citation. Definition, types and consequences of plagiarism. Remedies to avoid plagiarism.

Course Weekly Schedule

The course schedule for 16 weeks is detailed below

Week	Topic
1	Definition, Components,7Cs of Communication and importance of effective Communication
2	Ethical and Global Communication,
3	Team Communication and job search communication
4	Process of writing and principles of effective writing
5	Definition, types, purpose and format of memorandums
6	Types and importance of interviews, preparation for interviews
7	Giving interviews and steps after interviews
8	Types and importance of meetings, planning meetings
9	**Mid Term Exams**
10	Steps to prepare a presentation, ways to deliver an oral, verbal and nonverbal strategies message and Remedies to overcome the stage fear
11	Definition, types and consequences of plagiarism How to avoid plagiarism
12	Tools for data collection Designing a questionnaire, an interview and observation sheet
13	Abstract writing Referencing and citation
14	Types, purposes, format and characteristics of good reports
15	Writing resume and cover letters
16	Final Presentation

Recommended Textbooks

1. Effective business communication, H. A. murphy 8th edition.
2. Business English and communication, Lyn R. Clark and Kenneth Zimmer-8th edition.

Recommended Reference (Books/Websites/Articles)

1. Patterns of College Writing (4th edition). Laurie G. Kirszner and Stephen R. Mandell.
2. https://bizfluent.com/info-8373292-global-company.html

3. https://www.google.com/search?sxsrf=APwXEdfCiYwvVeWiVXe7lXRxftxy0EnEHA:1686801443426 3.
4. https://ohiostate.pressbooks.pub/engrtechcomm/part/job-search-communications/
5. https://haiilo.com/blog/team-communication/
6. https://human.libretexts.org/Courses/City

Univ. Elec. - I, Intro. to Psychology

Course Code: SSCE-114

Semester	Credit Hours	Prerequisite
[BSCS-2]	[3+0]	[None]

Course Description

The course will examine the different models upon which modern Psychology has been built, along with such things as the history and origins of psychology, research methods, biological aspects of psychology, human development, perception, consciousness, learning, personality theory, and psychological issues.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Identify** key components in the field of Psychology	C	C2 Comprehension	1
CLO-2	**Discuss** psychological concepts and techniques for practical problem solving	C	C3 Application	6
CLO-3	**Apply** basic Psychological concepts in their daily life (academic and personal)	C	C4 Analysis	10

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Introduction to Psychology
  - Nature and Application of Psychology with special reference to Pakistan.
  - Historical Background and Schools of Psychology (A Brief Survey)

- Methods of Psychology
  - Observation, Case History Method, Experimental Method, Survey Method
  - Interviewing Techniques

- Biological Basis of Behavior
  - Neuron: Structure and Functions
  - Central Nervous System and Peripheral Nervous System
  - Endocrine Glands

- Sensation, Perception and Attention
  - Sensation: Characteristics and Major Functions of Different Sensations, Vision: Structure and functions of the Eye and Audition: Structure and functions of the Ear.
  - Perception: Nature of Perception, Factors of Perception: Subjective, Objective and Social, Kinds of Perception: Spatial Perception (Perception of Depth and Distance), Temporal Perception; Auditory Perception.
  - Attention: Factors, Subjective and Objective, Span of Attention, Fluctuation of Attention and Distraction of Attention (Causes and Control)

- Motives
  - Definition and Nature, Classification
  - Primary (Biogenic) Motives: Hunger, Thirst, Defection and Urination, Fatigue, Sleep, Pain, Temperature, Regulation, Maternal Behavior, Sex
  - Secondary (Sociogenic) Motives: Play and Manipulation, Exploration and Curiosity, Affiliation, Achievement and Power, Competition, Cooperation, Social Approval and Self Actualization.

- Emotions
  - Definition and Nature
  - Physiological changes during Emotions (Neural, Cardial, Visceral, Glandular), Galvanic Skin
  - Response;
  - Pupilliometrics
  - Theories of Emotion
  - James Lange Theory; Cannon-Bard Theory
  - Schachter –Singer Theory

- Learning
  - Definition of Learning
  - Types of Learning: Classical and Operant Conditioning Methods of Learning: Trial and Error; Learning by Insight; Observational Learning

- Memory
  - Definition and Nature
  - Memory Processes: Retention, Recall and Recognition
  - Forgetting: Nature and Causes

- Thinking
  - Definition and Nature
  - Tools of Thinking: Imagery; Language; Concepts
  - Kinds of Thinking
  - Problem Solving; Decision Making; Reasoning

- Individual differences
  - Definition concepts of;
  - Intelligence, personality, aptitude, achievement.

Course Weekly Schedule
The course schedule for 17 weeks are detailed below

Week	Topic
1	Definition of Psychology, Sub-fields of Psychology
2	Structuralism, Functionalism, Gestalt, Neuroscience, Psychodynamic, Behavioral, Cognitive, Humanistic
3	Research Process, Hypothesis, Theory, Archival Research, Naturalistic Observation, Survey Research, Case Study, Correlation, Research, Experimental Research
4	Sensing the World Around Us, Absolute Thresholds: Detecting, What's Out There , Difference Thresholds: Noticing Distinctions Between Stimuli , Sensory Adaptation: Turning Down Our Responses
5	Constructing Our View of the World , The Gestalt Laws of Organization , Top-Down and Bottom-Up Processing
6	Depth Perception: Translating 2-D to 3-D , Perceptual Constancy , Motion Perception: As the World Turns, Perceptual Illusions: The Deceptions of Perceptions
7	Definition , Factors affecting , Types of attention (sustained, selective, and divided attention)
8	The Basics of Classical Conditioning , Applying Conditioning, Principles to Human Behavior, Extinction , Generalization and, Discrimination , Beyond Traditional Classical Conditioning:, Challenging Basic Assumptions
9	Mid Term Exams
10	Thorndike's Law of Effect , The Basics of Operant Conditioning:, Reinforcement and Punishment
11	Comparing classical and operant conditioning, Latent Learning , Observational Learning: Learning Through Imitation
12	Sensory Memory, Short-Term Memory, Working, Memory

Week	Topic
13	Long-Term Memory Recalling Long-Term Memories , Retrieval Cues , Levels of Processing Theory Explicit and Implicit Memory , Flashbulb Memories , Constructive Processes in Memory: lding the Past Why we forget?Proactive and Retroactive Interference: The Before and After of Forgetting Memory Dysfunctions: Afflictions of Forgetting
14	Thinking and Reasoning ,Problem Solving, What Is Intelligence?, Theories of Intelligence , The Biological Basis of Intelligence, Practical and Emotional, Intelligence Assessing Intelligence, Adaptive Testing
15	Explaining motivation , Understanding Emotional Experiences, The Functions of Emotions , Determining the Range of Emotions: Labelling Our Feelings, The Roots of Emotions: James-Lange theory, Cannon-Bard theory, Schahchter-Singer theory
16	Freud's Psychoanalytic Theory: Mapping the Unconscious Mind, Assessing Personality: Determining What Makes Us Distinctive
17	Stress: Reacting to Threat and Challenge , The High Cost of Stress , Coping with Stress , Promoting Health and Wellness: Following Medical Advice , Well-Being and Happiness

Recommended Textbooks

1. Feldman, R.S. (2010). Understanding psychology. New York: McGraw-Hill.
2. Myers, D. G. (2010). Introduction to Psychology (10th ed.)

Recommended Reference (Books/Websites/Articles)

1. Atkinson, R., & Smith, E. E. (2005). Introduction to Psychology (14th ed.)
2. Lahey, B. B. (2004). Psychology: An Introduction

Discrete Structures

Course Code: CSDT-115

Semester	Credit Hours	Prerequisite
[BSCS-2]	[3+0]	[None]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Apply** the elements of propositional logic statements and logical operations.	C	C3 Application	2
CLO-2	**Solve** basic problems demonstrating the understanding of fundamental for sets, functions, relations and counting principles	C	C2 Comprehension	3
CLO-3	**Apply** some properties to graphs, trees and related discrete structures, and be able to discover their relationship with practical examples	C	C3 Application	2

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

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

Course Weekly Schedule

The course schedule for 16 weeks are detailed below

Week	Topic
1	Introduction to Logic, Conditional Statement, converse, Contrapositive, Inverse,
2	Logic and bit operations, Proofs, valid and invalid arguments, Propositional Equivalences, Constructing new logical equivalences
3	Propositional logic, Translating from English into logical expressions involving propositions.
4	Predicates and Quantifiers, The universal quantifier, the existential quantifier, Nested Quantifier, Order of Quantifier.
5	Translating from English into logical expressions involving predicates and quantifiers.
6	Rules of Inference, Modus Ponens, Modus Tollens, Hypothetical Syllogism, Disjunctive Syllogism, Addition, Simplification, Conjunction, Resolution
7	Problem Solving Using Rules of Inference.
8	Proof by induction, proof by contraposition, proof by contradiction, proof by implication.
9	**Mid Term Exams**
10	Set theory, Set operations, Set identities and Proofs ,Set builder notation, Empty set, Null set, Singleton set, Proper and Improper subsets.
11	Applications and definition of functions, domain, co domain, image, range, preimage.
12	Sequence and summations, arithmetic progression, Special integer sequences, geometric progressions.
13	The basics of counting, applications, product rule, sum rule, complex counting problems.
14	Relations, Properties of relations, reflexive relations.
15	Types of graphs, Graph Terminology, adjacent vertices, degree of a vertex, Graph Models, Undirected graphs. Walk, path, trail, circuit, Euler Paths and Circuits, Hamilton Path and Circuits.
16	Introduction to Trees, Applications of Trees, Tree Traversal, Post Order, PreOrder and InOrder Traversals.

Recommended Textbooks

1. Epp, S. S. (1993). Discrete Mathematics with Applications, 5th Edition. Wadsworth Publishing Company. ISBN: 9780534096304.
2. Discrete Mathematics and Its Applications, 7th edition by Kenneth H. Rosen year 2012

Recommended Reference (Books/Websites/Articles)

1. Discrete mathematics with applications, Susanna S. Epp, 5th Edition, 2019.
2. Discrete mathematics, Richard Johnson Baugh, Global edition, 2018

Accounting Fundamentals

Course Code: MSAF-176

Semester	Credit Hours	Prerequisite
[BSCS-2]	[3+0]	[None]

Course Description

This Course teaches students how to properly read financial statements. The student will be able to read the three most common financial statements by the end of this course: the income statement, balance sheet, and statement of cash flows. Then the student can apply his knowledge in a business context.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Identify** why accounting is a necessary skill. Describe the key concepts and elements of accounting.	C	C1 Understanding	1
CLO-2	**Describe** accounting cycle: Preparation of Journal, ledger, trial balance, income statement, statement of retained earnings, statement of owner's equity and balance sheet.	C	C2 Analysis	2
CLO-3	**Demonstrate** accounting entries in different concerns like adjustments of entries, merchandising concerns etc.	C	C3 Evaluation	3

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Introduction to Accounting. Accounting Information. Types of Accounting Information. Role of Accounting Information in making decisions. Accounting Cycle. Accounting Period, Credit, Debit, Fiscal Year, How to balance the fundamental accounting equation; Debits and Credits; "T" Accounting; General Journal. Accrual Basis Accounting Applying Matching Principle and Realization Principle in recording expenses and Revenue. Trial Balance, Its Uses and Limitations. The Accounting Cycle. Journal, Ledgers and Trial balance. Financial Statements. Nature and general purpose of Financial Statements. Relevant Accounting Principles. Purpose of the Income Statement; Multi-Step Income Statement; Statement of Retained Earnings and Classified Balance Sheet. Relation of Income statement, Statement of Owner's Equity and Balance Sheet. Need for adjusting entries, Types of Adjusting Entries. Accumulated Depreciation. Book Value. Depreciate able Assets Converting liabilities to Revenue. Accruing uncollected revenue. Adjusted trial balance. Purpose of Adjusted Trial Balance. Closing The Temporary Accounts. GAAP(Generally

Accepted Accounting principles). Introduction to Merchandising Concerns. Journal Entries in Periodic & Perpetual Systems Accounting for Merchandising Concerns Cash and credit purchase transactions, Cost Transaction. Special cases in Merchandising Companies Net method. Special cases in Merchandising Companies Gross method. Merchandising Exercise. Practice of the entries for all merchandising concerns.

Course Weekly Schedule
The course schedule for 17 weeks is detailed below

Week	Topic
1	Introduction to Accounting. Accounting Information. Types of Accounting Information. Role of Accounting Information in making decisions. Importance of Accounting Information for internal and External users. Accounting Systems.
2	Basic Terms. Business and its types. Types of Accounts (Assets, Liabilities, Capital, Expense and Revenue. Types of Accounts. Accounting Cycle. Accounting Period, Credit, Debit, Fiscal Year,
3	How to balance the fundamental accounting equation; Debits and Credits; "T" Accounting; Double Entry Accounting; Transactions. Cash and credit transaction. Effect of Transactions on Accounting Equation. Source Documents; General Journal. Journalizing the events of increase in capital, increase and decrease in Assets and Liabilities.
4	General Journal. Accrual Basis Accounting Applying Matching Principle and Realization Principle in recording expenses and Revenue. General Journal and its relationship to ledger. Posting (Process of transferring information from the journal to the individual accounts in the Ledger. Types of Ledgers.
5	Trial Balance, Its Uses and Limitations. The Accounting Cycle. Journal, Ledgers and Trial balance.
6	Financial Statements. Nature and general purpose of Financial Statements. Relevant Accounting Principles. Purpose of the Income Statement; Multi-Step Income Statement; What are Retained Earnings, Revenue, Expenses, Net Income, Income Tax,
7	Statement of Retained Earnings and Classified Balance Sheet. Relation of Income statement, Statement of Owner's Equity and Balance Sheet.
8	Practice from journal to Balance Sheet. Accounting Cycle.
9	**Mid Term Exams**
10	Need for adjusting entries, Types of Adjusting Entries. The concept of Depreciation. Accumulated Depreciation. Book Value. Contra Asset Account. Depreciate able Assets. Useful Life. Converting Assets to Expenses; Prepaid Expenses, Accrued Expenses
11	Converting liabilities to Revenue. Accruing uncollected revenue. Adjusted trial balance. Purpose of Adjusted Trial Balance. Effects of Adjusting Entries on Financial Statements

Week	Topic
12	Preparing a Worksheet and its uses. Closing The Temporary Accounts. Preparation of After Closing Trial Balance.
13	GAAP(Generally Accepted Accounting principles). Introduction to Merchandising Concerns. Operating cycle of Merchandising Companies
14	Journal Entries in Periodic & Perpetual Systems Accounting for Merchandising Concerns
15	Cash and credit purchase transactions, Cost Transaction (Transportation cost), Purchases return and purchases Discount transaction journal entries.
16	Special cases in Merchandising Companies Net method. Special cases in Merchandising Companies Gross method. Credit terms, Cash discounts, Returns of Unsatisfactory
17	Merchandising Exercise. Practice of the entries for all merchandising concerns.

Recommended Textbooks

1. Financial & managerial accounting (The basis for business decisions), Meigs & Meigs, 15th edition, McGraw Hill/ Irwin, 2009.

Recommended Reference (Books/Websites/Articles)

1. Software Engineering, A practitioner's approach, Pressman R. S. & Maxim B. R., 8th Edition, McGraw-Hill, 2015.
2. Fundamentals of accounting, Libby & Libby, 8th edition, McGraw Hill, 2013.

Pre-Math-II

Course Code: MTPM-162

Semester	Credit Hours	Prerequisite
[BSCS-2]	[Non-credit]	[Pre-medical]

Course Description

The purpose of this course is to assist students from pre-medical background so that they will be able to continue their studies in computer science discipline without any hurdle.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Understand the concepts of System Linear Equations and operation of matrices	C	C1 Knowledge	2
CLO-2	Solve the Homogeneous and nonhomogeneous Systems of Equations	C	C2 Comprehension	2
CLO-3	Understand the concepts of vectors and fields.	C	C3 Application	2

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Introduction to linear algebra,
- Systems of Linear Equations;
- Solution of a system of linear equations;
- Concept of Matrices, and their types;
- Basic operation of Matrices;
- Techniques and concept of Matric multiplication
- Concept of the determinant of matric and Nonsingular Matrices;
- Inverse of a matrix and Cramer's Rule; Elementary row operation of a matrix;
- Echelon form and Gauss's elimination method;
- Reduce Echelon form and Gauss's Jordon elimination method;
- Elimination Method for solving system of linear equations;
- Homogeneous Systems of Equations Ax=0;
- Non- Homogeneous Systems of Equations Ax=b;

- Introduction to Vectors spaces; Dot product; Cross product; Gradient of a scalar field; Divergence of a vector field; Curl of a vector field;
- Concepts of Stokes's theorem and the Divergence theorem

Course Weekly Schedule
The course schedule for 17 weeks is detailed below

Week	Topic
1	Introduction to linear algebra, Systems of Linear Equations
2	Solution of a system of linear equations
3	Concept of Matrices, and their types
4	The basic operation of Matrices
5	Techniques and concept of Matric multiplication
6	Concept of the determinant of a matric and Nonsingular Matrices
7	The inverse of a matrix and Cramer's Rule
8	Elementary row operation of a matrix
9	**Mid Term Exams**
10	Echelon form and Gauss's elimination method
11	Reduce Echelon form and Gauss's Jordon elimination method
12	Elimination Method for solving system of linear equations
13	Homogeneous Systems of Equations Ax=0, Non- Homogeneous Systems of Equations Ax=b
14	Introduction to Vectors spaces, Dot product, Cross product
15	The gradient of a scalar field, Divergence of a vector field
16	The curl of a vector field
17	Concepts of Stokes's theorem and the Divergence theorem

Recommended Textbooks

1. Kreyszig, E., Stroud, K., & Stephenson, G. (2008). *Advanced engineering mathematics*. Integration. ISBN: 9781119571094.

Semester III

Digital Logic Design

Course Code: CSDL-223

Semester	Credit Hours	Prerequisite
[BSCS-3]	[2+0]	[EEAP-121 or None]

Course Description

The basic purpose of this course is to introduce the concepts and tools for design of digital electronic circuits using both combinational and sequential logic. Students will learn methods for systematically designing digital circuits that satisfy their functional specifications and will be able to develop application-specific logic designs in a structured, repeatable, convergent, and self-documenting manner. This course provides a modern introduction to logic design and the basic building blocks used in digital systems, in particular digital computers. It starts with a discussion of combinational logic: logic gates, minimization techniques, arithmetic circuits, and modern logic devices such as field programmable logic gates. The second part of the course deals with sequential circuits: flip-flops, synthesis of sequential circuits.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Identify and explain fundamental concepts of digital logic design including basic and universal gates, number systems, binary coded system, and Boolean algebra to interrelate with basic understanding of Boolean functions, logic diagram and truth table	C	C2 Comprehension	1
CLO-2	Demonstrate 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.	C	C3 Application	2
CLO-3	Design of small-scale combinational and sequential digital circuits	C	C5 Synthesis	4

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Binary Systems: Introduction to digital and analogue systems, Number Systems and Conversions, Arithmetic with number systems, Radix/r's Complement and Diminished radix/(r-1)'s Complements, Subtraction using r's Complements and (r-1)'s complement, Signed and unsigned number systems and their arithmetic, Binary Codes, Decimal Codes and Alphanumeric Codes
- Boolean Algebra and Logic Gates: Boolean Postulates and Theorems, Boolean Functions and their Complements, Sum of Min Terms and Product of Max Terms, Standard forms and Canonical Forms, Digital logic gates
- Gate level Minimization: Karnaugh maps, Multi-variable (2,3,4) K-maps, Product of Sum (POS) and Sum of Product (SOP) simplification, Don't care conditions, Digital Circuits using Basic and Universal Gates
- Combinational Logic: Analysis and Design Procedure, Code Converters, Adders and its types, Subtractors, Multiplier, Magnitude Comparator, Decoders and Encoders, Multiplexers and De-multiplexer
- Sequential Circuits: Latches (SR Latch,S'R' Latch, D Latch), Flip Flops (D Flip Flop, JK Flip Flop,SR Flip Flop, T Flip Flop), Characteristic Tables, Characteristic Equations., Design and Analysis of Clocked Sequential Circuits (Timing diagram), Designing Counters

Course Weekly Schedule

The course schedule for 17 weeks is detailed below

Week	Topic
1	Digital computers and information representation Fundamentals of Digital Logic system and Number system Introduction
2	Number system and conversions: decimal to any other base (binary, hexadecimal and octal numbers) conversion and vice versa. Hexadecimal to binary and octal to binary conversion.
3	Arithmetic operations (addition, subtraction and multiplication) using binary numbers, hexadecimal and octal numbers
4	Complements of Numbers: Radix/r's Complement and Diminished radix/(r-1)'s Complements, Subtraction using r's Complements and (r-1)'s complement
5	Signed and unsigned numbers representation (for the binary numbers), Binary codes: BCD, Excess-3 and gray code, Alpha numeric codes: ASCII character codes and uni code, Error detecting code and parity bit, Binary logics and logic gates.
6	Boolean algebra, Common Algebra postulates, Basic theorem, and properties, Boolean expression representation 1) Standard form: Sum of Min-term and product of Max-term form, 2) Canonical forms: Sum of product (SOP) and product of sum forms (POS), 3) Non-Standard forms, Two level implementation and multi-level implementation of Boolean expressions, Simplification of expression using Boolean algebra rules/theorems, Complement of a function

Week	Topic
7	Simplification of Boolean expression using K-map technique for 2 and 3 variables. (Examples: Combinational circuits implementation for 2 and 3 input variables using design procedure approach (i.e. Half adder and full adder))
8	Simplification of Boolean expression using K-map technique for 4 variables (in SOP and POS form), Prime implicant and Essential prime implicant. (Examples: Combinational Circuits implementation for 4 input variables)
9	**Mid Term Exams**
10	K-map technique: Don't care condition and simplification of incompletely specified function using k-map method (Examples: Implement BCD to binary convertor/Binary to BCD convertor using design procedure approach)
11	Combinatorial circuits: Analysis procedure and Design procedure examples: BCD to Excess-3 Code converter, BCD to gray code converter, Excess-3 to BCD Code converter, and gray to BCD code converter etc.
12	Design procedure examples: BCD to Seven segment decoder, Implementation of parity bit generator and checker
13	Binary adders: Half adder, Full adder, Ripple carry adder, and Carry look ahead adder, Binary adder and subtractor, Overflow
14	Binary multiplier, Magnitude comparator, Decoders and implementation of combinational circuits using decoder, Encoders.
15	Multiplexer (MUX) and De-multiplexer and its implementation, Sequential circuits and its types, Asynchronous sequential circuits and implementation of memory elements: Latches (S'R' latch, Enable SR latch and Transparent/D latch).
16	Synchronous sequential circuits and implementation of its memory elements: Flip Flops (Master slave D flip flop and JK flip flop) and their timing diagrams
17	Flip Flops (T Flip Flop), Timing consideration, Design of counters

Recommended Textbooks

1. Mano, M. M. (2017). *Digital Logic and Computer Design*. Pearson India. ISBN: 9789332586048.

Digital Logic Design-Lab

Course Code: CSDL-223L

Semester	Credit Hours	Prerequisite
[BSCS-3]	[0+1]	[EEAP-121L or None?]

Course Description

The basic purpose of this course is to introduce the concepts and tools for design of digital electronic circuits using both combinational and sequential logic. Students will learn methods for systematically designing digital circuits that satisfy their functional specifications and will be able to develop application-specific logic designs in a structured, repeatable, convergent, and self-documenting manner. This course provides a modern introduction to logic design and the basic building blocks used in digital systems, in particular digital computers. It starts with a discussion of combinational logic: logic gates, minimization techniques, arithmetic circuits, and modern logic devices such as field programmable logic gates. The second part of the course deals with sequential circuits: flip-flops, synthesis of sequential circuits.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Apply** the fundamental concepts of digital logic design to implement a combinational and sequential circuit.	C	C3 Application	3
CLO-2	**Practice** circuits by using discrete components and digital ICs.	P	P3 Complete Overt Response	3
CLO-3	**Contribute** individually or as a team member to work effectively.	A	A2 Responding	9

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Binary Systems: Introduction to digital and analogue systems, Number Systems and Conversions, Arithmetic with number systems, Radix/r's Complement and Diminished radix/(r-1)'s Complements, Subtraction using r's Complements and (r-1)'s complement, Signed and unsigned number systems and their arithmetic, Binary Codes, Decimal Codes and Alphanumeric Codes

- Boolean Algebra and Logic Gates: Boolean Postulates and Theorems, Boolean Functions and their Complements, Sum of Min Terms and Product of Max Terms, Standard forms and Canonical Forms, Digital logic gates
- Gate level Minimization: Karnaugh maps, Multi-variable (2,3,4) K-maps, Product of Sum (POS) and Sum of Product (SOP) simplification, Don't care conditions, Digital Circuits using Basic and Universal Gates
- Combinational Logic: Analysis and Design Procedure, Code Converters, Adders and its types, Subtractors, Multiplier, Magnitude Comparator, Decoders and Encoders, Multiplexers and De-multiplexer
- Sequential Circuits: Latches (SR Latch,S'R' Latch, D Latch), Flip Flops (D Flip Flop, JK Flip Flop,SR Flip Flop, T Flip Flop), Characteristic Tables, Characteristic Equations., Design and Analysis of Clocked Sequential Circuits (Timing diagram), Designing Counters

Lab Weekly Schedule

The course schedule for 16 weeks is detailed below

Week	Topic
1	**Introduction to Lab Equipment and verification of basic logic gates** • Introduction to digital trainer i.e. power supply, input-output ports, and different modules. Study logic gates and verify their truth tables.
2	**Introduction to Verilog and synapticad.** • Introduction to Verilog design methodologies and conventions. • Identifiers, number specification, and keywords used in Verilog. • Module structure and stimulus block in Verilog.
3	**Implementation of Demorgans Law, Distributive Law using gates and Verilog.** • Applications of Demorgans law and Distributive law using basic gates. • The HDL-based design language of de-morgans law and distributive law using Verilog.
4	**Simplified Boolean expression to a minimum number of literals using Logic gates and Verilog.** • Simplify Boolean expression using properties. • The HDL-based design language for simplified expressions using Verilog.
5	**Design and implementation of adders and subtractors using Logic gates and Verilog.** • Design and construct half adder, full adder, half subtractor and full subtractor circuits and verify the truth table using logic gates. • The HDL-based design language for adders and subtractors using Verilog.

Week	Topic
6	**Design and implementation of code converter using logic gates and Verilog.** • Design and implement 4-bit Binary to gray code converter and Gray to binary code converter. HDL based design language for gray code converters using verilog.
7	**Design and implementation of BCD to Excess-3 and Excess-3 to BCD converter using logic gates and verilog.** • Design and implement 4-bit BCD to Excess-3 and Excess-3 to BCD converter. • HDL based design language for Excess-3 converters using verilog.
8	**Open Ended Lab** • Design and implement the designated task using gates. HDL based design language for designated task using Verilog.
9	**Mid Term Exams**
10	**Design and implementation of magnitude comparator using logic gates and using Verilog.** • Design and implement 2 – Bit magnitude comparator using basic gates. • HDL based design language for 2-bit magnitude comparator using Verilog.
11	**Design and implementation of multiplexer and de-multiplexer using logic gates and Verilog.** • Design and implement multiplexer and demultiplexer using logic gates and study of IC 74150 and IC 74154. • HDL based design language for multiplexer and demultiplexer using Verilog.
12	**Design and implementation of encoder and decoder using logic gates and verilog.** • Design and implement encoder and decoder using logic gates and study of IC 7445 and IC 74147. HDL based design language for encoder and decoder using Verilog.
13	**Study of different types of flip flops using gates.** • Verify basic flip flops i.e. D-flip flop and JK flip flop using IC.
14	**Design and Implementation of shift register.** • Verify serial to parallel shift register using IC.
15	**Implementation of decade counter.** • Verify mod 10/decade counter using IC.

Week	Topic
16	Lab Exam

Recommended Textbook

1. Mano, M. M. (2017). *Digital Logic and Computer Design*. Pearson India. ISBN: 9789332586048.

Data Structures

Course Code: CSDS-224

Semester	Credit Hours	Prerequisite
[BSCS-3]	[3+0]	[CSOO-122]

Course Description

The purpose of this course is to build upon a strong understanding of "Data Structures and famous dealing algorithms". Also to give a practical approach to computer science students for a better view of what is going on beyond the desktop? Data storage policies, representations, operations, algorithms and above all a programming approach to data structures in C++.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Understand** the properties of various data structures and their usage in real world problems.	C	C2 Comprehension	2
CLO-2	**Demonstrate** the working of algorithms related to various data structures.	C	C3 Application	2
CLO-3	**Apply** appropriate data structure for modeling an optimized solution for a given problem.	C	C3 Application	3

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Abstract data types
- Arrays (properties, functions to manipulate array, searching and sorting algorithms)
- Singular Linked list (properties, functions and its significance)
- Doubly Link List (properties, related functions and its significance)
- Stack (properties, representation, related functions and its applications)
- Queue (properties, representation, related functions and its applications)
- Circular Queue (properties, representation, related functions and its applications)
- Priority Queue (properties, representation using linked list and array, related functions and its applications)
- Implementation of Stack and Queue using Link list
- Graphs (properties, related functions and algorithms such as Depth first search, breadth first search)

- Trees (types of trees, properties of various types of trees, related functions algorithms such as traversing, finding spanning tree and finding minimum spanning tree)
- Heap (properties, related functions and its applications)
- AVL Trees ((properties, related functions and its applications)
- Hashing (properties, related functions and its applications)

Course Weekly Schedule
The course schedule for 17 weeks is detailed below

Week	Topic
1	Brief introduction of different data structures with advantages and disadvantages Array data structure, representation of array in memory Searching algorithms such as Linear search and binary search on arrays data structure.
2	Sorting algorithm such as selection sort, bubble sort and insertion sort.
3	Introduction of Linked List, properties of linked list and comparison w.r.t array data structure. Traversing Function in linked list Insertion Functions in linked list: AddToHead(element) and AddToTail(element).
4	Insertion Functions in linked list, i.e., AddAfter(element), addBefore(element) and AddSorted(element). Deletion Functions in Linked list: Remove(element) and RemoveAll(), Shifting Function in Linked List: MovetoHead(element), and MoveToTail(element). Application and Advantages/Disadvantages of linked list with respect to array
5	Introduction of Two way linked list, its properties and comparison w.r.t singular linked list. Insertion and deletion functions in two way linked list (all functions covered in singular linked list needs to be covered with two way linked list also).
6	Applications and Advantages/Disadvantages of Two way linked Introduction of Stack, its properties and basic functions of Stack such as, push (element), pop(), isEmpty(), isFull(), and topValue(). Stack using array vs. stack using linked list
7	Brief overview of different applications of stack. Stack applications in detail: String reversal, Symbol balancing and evaluation of postfix expression
8	Stack applications in detail: conversion of mathematical expression using stack such as, Infix-to-postfix, Postfix-to infix, Postfix-to-prefix, Infix-to-prefix, Prefix-to-infix, and Prefix-to-postfix

Week	Topic
9	**Mid Term Exams**
10	Queue and its related functions such as Enqueue(element), Dequeue(), isEmpty(), isFull(), and isInlist(element). Queue using linked list along with related functions such as Enqueue(element), Dequeue(), isEmpty(), isFull(), and isInlist(element).
11	Queue using Circular array, its benefits, and related functions such as Enqueue(element), Dequeue(), isEmpty(), isFull(), and isInlist(element). Application of Circular queue. Priority Queue using Linked list and Multiple queues
12	Introduction to Graph Data Structure, its properties and Applications. Representation of Graphs as adjacency list and adjacency matrix Graph Algorithms: Depth-first search, breadth-first search, PRIMS and KRUSKAl algorithms for finding Minimum Spanning Tree
13	Introduction to trees, binary trees, representation of binary trees using array and linked list. Pre-order, In-order and post-order traversing operations in binary trees Introduction to Binary Search Tree (BST) along with Insertion operation in Binary Search Tree.
14	Searching and deletion operation in Binary Search Tree. Introduction to Heap, its representation and related operations such as Max heapify(), Min heapify(), Insert and Delete,
15	Introduction to AVL Trees, its properties, related operations for height balancing and applications.
16	Introduction to Hashing, its properties, representation, related functions and applications Hash functions: Division Method, Multiplication Method, Mid-square Method and Folding methods Collision Resolution Techniques: Linear Probing, Quadratic Probing and Separate Chaining
17	**End Term Exam**

Recommended Textbooks

1. Weiss, M. A. (2014). *Data structures and algorithm analysis in C++, 4th Edition.* Pearson. ISBN: 9780132847377.

Recommended Reference (Books/Websites/Articles)

1. Lafore, R. (2002). *Object-oriented programming in C++*, 4th Edition. Pearson Education. ISBN-10: 0672323087.
2. Lipschutz, S., & Pai, G. A. (2008). *Data Structures*. Tata McGraw-Hill Publishing Company Limited. ISBN: 0070380015.
3. R.S. Salaria (2013). *Data Structures: Theory, Problems and Algorithms, 1st Edition*. Khanna Publishing House. ISBN: 9789381068403.

Data Structures -Lab

Course Code: CSDS-224L

Semester	Credit Hours	Prerequisite
[BSCS-3]	[0+1]	[CSOO-122]

Course Description

The purpose of this course is to build upon a strong understanding of "Data Structures and famous dealing algorithms". Also to give a practical approach to computer science students for a better view of what is going on beyond the desktop? Data storage policies, representations, operations, algorithms and above all a programming approach to data structures in C++.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Implement** the abstract data types and algorithms related to various data structures.	P	P3 Guided Response	3
CLO-2	**Demonstrate** linear and non-linear data structures and related algorithms	P	P4 Mechanism	4
CLO-3	**Express** the experiments in the form of a LAB report	A	A3 Valuing	7

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Abstract data types
- Arrays (properties, functions to manipulate array, searching and sorting algorithms)
- Singular Linked list (properties, functions and its significance)
- Doubly Link List (properties, related functions and its significance)
- Stack (properties, representation, related functions and its applications)
- Queue (properties, representation, related functions and its applications)
- Circular Queue (properties, representation, related functions and its applications)
- Priority Queue (properties, representation using linked list and array, related functions and its applications)
- Implementation of Stack and Queue using Link list
- Graphs (properties, related functions and algorithms such as Depth first search, breadth first search)

- Trees (types of trees, properties of various types of trees, related functions algorithms such as traversing, finding spanning tree and finding minimum spanning tree)
- Heap (properties, related functions and its applications)
- AVL Trees ((properties, related functions and its applications)
- Hashing (properties, related functions and its applications)

Lab Weekly Schedule
The lab schedule for 16 weeks is detailed below. All CLOs shall be accessed in each lab.

Week	Topic
1	Array: Implementation of functions to perform insertion, deletion and linearly search in an array.
2	Array: Implementation of Array Data Structure: Functions to perform iterative binary search, recursive binary search and sorting such as selection sort, bubble sort and insertion sort. Function to Manipulate 2D array.
3	Singular linked list: Implementation of traversing and insertion functions in a Singular linked list. Implementation of Singular linked list as template.
4	Singular linked list: Implementation of deletion functions in singular linked list
5	Two way linked list: Implementation of traversing, insertion and deletion functions in a two way linked list with.
6	Stack: Implementation of Stack using Array and Linked List.
7	Stack: Implementation of function related to various application of Stack.
8	Open Ended Lab
9	**Mid Term Exams**
10	Queue: Implementation of Queue using Array and Linked List
11	Circular Queue: Implementation of Circular Queue
12	Graph: Implementation of Graph Data Structures along with DFS and BFS functions.
13	Binary Search Tree: Implementation of Insertion and traversing function in BST.
14	Binary Search Tree: Implementation of search and delete function in BST
15	Open Ended Lab
16	**Lab Exam**

Recommended Textbooks

1. Weiss, M. A. (2014). *Data structures and algorithm analysis in C++, 4th Edition.* Pearson. ISBN: 9780132847377.

Recommended Reference (Books/Websites/Articles)

1. Lafore, R. (2002). *Object-oriented programming in C++*, 4th Edition. Pearson Education. ISBN-10: 0672323087.
2. Lipschutz, S., & Pai, G. A. (2008). *Data Structures*. Tata McGraw-Hill Publishing Company Limited. ISBN: 0070380015.
3. R.S. Salaria (2013). *Data Structures: Theory, Problems and Algorithms, 1st Edition*. Khanna Publishing House. ISBN: 9789381068403.

Linear Algebra

Course Code: MTLA-201

Semester	Credit Hours	Prerequisite
[BSCS-3]	[3+0]	[MTCA-112]

Course Description

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

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Solve** a system of linear equations using Matrices	C	C3 Application	1
CLO-2	**Apply** the basic knowledge of vector spaces, eigenvalue and eigenvectors	C	C3 Application	1
CLO-3	**Solve** a system of linear equations using different methods	C	C3 Application	2

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

System of Linear Equations and Matrices: Introduction to system of linear equations, Matrix form of system of Linear Equations, Gaussian Elimination method, Gauss-Jorden Method, Consistent and inconsistent systems, Homogeneous system of equations. Vector Equations: Introduction to vector in plane, Vector in R^n, Vector form of straight line, Linear Combinations, Geometrical interpretation of solution of Homogeneous and Non-homogeneous equations, Applications of Linear Systems: Traffic Flow Problem, Electric circuit Problem, Economic Model, Linear transformations: Introduction to linear transformations, Matrix transformations, Domain and range of linear transformations, Geometric interpretation of linear transformations, Matrix of linear transformations, Inverse of a matrix: Definition of inverse of a matrix, Algorithm to find the inverse of matrices, LU factorization, Determinants: Introduction to determinants, Geometric meaning of determinants, Properties of determinants, Cramer Rule, Cofactor method for finding the inverse of a matrix, Vector Spaces: Definition of vector spaces, Subspaces, Spanning set, Null Spaces and column spaces of linear transformation, Linearly Independent sets and basis, Bases for

Null space, Dimension of a vector space EigenValues and Eigenvectors: Introduction to Eigenvalue and Eigenvectors, Computing the Eigenvalues, Properties of Eigenvalues, Diagonalization, applications of Eigenvalues. Numerical Linear Algebra, Gauss Elimination, Inner product, Cross product, Gram-Schmidt Process, QR – Decomposition, AV = b by LU - decomposition, Elimination Matrix, Orthogonal Matrices, Least square Vector, Least Square Error, Hessenberg's Theorem, Schur's theorem, Singular value Decomposition (SVD).

Course Weekly Schedule
The course schedule for 16 weeks are detailed below

Week	Topic
1	System of Linear Equations and Matrices: Introduction to the System of Linear Equations
2	System of linear equations, Consistent and inconsistent systems, and Matrix form of system of Linear Equations
3	Gaussian Elimination Method, Gauss-Jordan Method
4	Homogeneous system of equations, Linear Combinations
5	Applications of Linear Systems: Traffic Flow Problem, Electric circuit Problem
6	Determinants: Introduction to determinants, Geometric meaning of determinants, Properties of determinants, Cramer Rule, cofactor method for finding the inverse of a matrix
7	Vector Equations: Introduction to vector in plane, Vector in R^n, Vector form of straight line
8	Matrix transformations, Domain and range of linear transformations, Inverse of a matrix: Definition of inverse of a matrix
9	**MID-TERM EXAM**
10	Vector Spaces: Definition of vector spaces, Subspaces, Spanning set, Null Spaces and column spaces of linear transformation, Bases for Null space, Dimension of a vector space, Linearly Independent sets and basis
11	Introduction to Eigenvalue and Eigenvectors, Eigen values and Eigenvectors: Examples Computing the Eigenvalues, Properties of Eigenvalues
12	Gram-Schmidt Process: QR – Decomposition
13	Method of Least Square Error, Least Square Error
14	Elimination Matrix, LU – decomposition
15	Diagonalization

Week	Topic
16	Orthogonal Matrices, Schur's theorem, Hessenberg's Theorem
17	The Power Method, Singular value Decomposition (SVD)

Recommended Textbooks

1. Elementary Linear Algebra by Howard Anton
2. Applied Linear Algebra by Peter J. Olver, Chehrzad Shakiban Second Edition, 2018

Recommended Reference (Books/Websites/Articles)

1. Linear Algebra and its Applications by Gilbert Strang
2. Advanced Engineering Mathematics, Author Erwin Kreyszig, Tenth Edition, Publisher John Wiley & Sons, Limited, 2019

Multi Variable Calculus

Course Code: MTMC-202

Semester	Credit Hours	Prerequisite
[BSCS-3]	[3+0]	[None]

Course Description

The mathematics required to describe most "real life" systems involves functions of more than one variable, so the differential and integral calculus developed in a first course in Calculus must be extended to functions of more variables. In this course, the key results of one-variable calculus are extended to higher dimensions: differentiation, integration. The machinery developed can be applied to another generalization of one-variable Calculus, namely to multi variable calculus, and the course also provides an introduction to this subject.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Understand the basic concepts and know the basic techniques of differential and integral calculus of functions of several variables	C	C2 Comprehension	2
CLO-2	Apply the theory to calculate the gradients, directional derivatives, area of surfaces, and volume of solids	C	C3 Application	2
CLO-3	Solve problems involving maxima and minima, line integral and surface integral, and vector calculus	C	C3 Application	2

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Introduction to multivariable calculus, Level curves and graph of the functions.
- Understanding of limit and continuity of the function of several functions.
- Understanding of differentiation of functions of several variables. Higher order differentiations
- Chain rule of differentiation to calculate the derivatives of composite functions.
- Directional derivatives and gradient of the function
- Understanding of Maximum/minimum of the function of several variable and its application
- Lagrange Multipliers and Example

- Double integral over a region and its application to calculate volume of the close surface
- Double integral as an area of close region in 2D plane.
- Understanding of vector field and line integral
- Surface Integral and related theorems

Course Weekly Schedule
The course schedule for 17 weeks is detailed below

Week	Topic
1	Introduction to Multivariable function and Multivariable calculus
2	Level curves and graph of functions
3	Limit of several functions
4	Continuity of the function of several functions
5	Introduction to partial derivatives
6	Chain Rule of differentiation
7	Directional derivatives and the gradient
8	Maximum/minimum problems
9	**MID TERM EXAM**
10	Lagrange Multipliers and Example
11	Definition and example of Double Integration
12	Double integrals over general regions
13	Double integrals in polar coordinates
14	Triple integrals
15	Vector fields, Line integrals
16	Conservative Field and Green's Theorem.
17	Stoke's Theorem.

Recommended Textbooks

1. Thomas, Calculus, 11th Edition. Addison Wesley Publishing Company, 2005. (available in E-Library)
2. Multivariable Calculus, 6th edition James, Stewart 2007 Cengage Learning publishers. (available in E-Library

Database Systems

Course Code: CSDB-225

Semester	Credit Hours	Prerequisite
[BSCS-3]	[3+0]	[None]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Explain** fundamental database concepts.	C	C2 Comprehension	2
CLO-2	**Design** conceptual, logical and physical database schemas using various data models.	C	C5 Synthesis	4
CLO-3	**Identify** functional dependencies & resolve database anomalies by normalizing database tables.	C	C5 Synthesis	4

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Fundamental database concepts, Database approach vs file based system, database architecture, three level schema architecture, data independence, types of data model(relational data model, entity relationship model), Entity Relationship diagram, entity sets, attributes, relationship, attributes, schemas, tuples, domains Enhanced entity relationship model(EER diagram),relational and logical database design, , relation instances, keys of relations, integrity constraints, types of joins, functional dependencies, normal forms, Structured Query Language (SQL), data definition languages , sub-queries in SQL, Transaction Management ,data mining, data warehousing, NoSQL.

Course Weekly Schedule

The course schedule for 16 weeks is detailed below

Week	Topic
1	Course introduction, Fundamental database concepts: Data, data versus information, data, manual file processing, traditional file processing, disadvantages of manual and traditional file processing systems.
2	Database approach vs file-based system, Advantages and dis-advantages of database management system, components of DBMS environment.
3	Data Models (Relational Data Model, ER Data Model) Three level schema architecture (ANSI SPARC), external level, conceptual level, internal level, data independence, data dependence database languages overview
4	Modeling rules process in organization (overview of business rules, scope of business rules) types of business rules structure of business rules, constraints, types of keys (primary key, composite key, surrogate key and foreign key)
5	ERD vs business rules, modelling entities and attributes (entity and entity type, Strong vs weak entity, associative entity attributes and types of attributes) relationship type. Degree of relationship (unary/recursive, binary and ternary relationship) structural constraints (one to one, one to many, many to many), minimum and maximum cardinality.
6	Enhanced Entity–Relationship Modeling (EERD), data modeling concepts of the Enhanced Entity–Relationship model (super type, sub type, specialization and generalization
7	Specifying constraints in super type and sub type in Enhanced Entity–Relationship Modeling (EERD)
8	Logical database design and relational model (relations, relation keys, integrity constraints (domain constraint, entity integrity and referential integrity), transforming ERD and EERD into relations.
9	**Mid Term Exams**
10	Functional dependencies (Full functional dependency, partial functional dependency, transitive dependency)
11	Normalization process- 1NF, 2NF, 3NF, Denormalization, BCNF(optional), 4NF (optional)
12	Relational Algebra selection, Project Cartesian product, Union, Set difference, Join operation
13	Database recovery and security OR Introduction to data mining
14	Introduction to data mining (data ware housing, OLAP, OLTP)
15	NoSQL OR Database life cycle

Week	Topic
16	Transaction management (optional), Concurrency control (optional)

Recommended Textbooks

1. Modern database management, Jeffrey A. Hoffer, 12th Edition, Pearson, 2016.
2. Database systems: A practical approach to design, implementation, and management, Thomas Connolly and Carolyn Begg, 6th Edition, Pearson, 2015.

Recommended Reference (Books/Websites/Articles)

1. Database system concepts, Avi Silberschatz, Henry F. Korth and S. Sudarshan, 6th Edition, McGraw-Hill, 2010.
2. Database systems: Design, implementation and management, Carlos M. Coronel, 13th Edition, Cengage Learning, 2018.

Database Systems -Lab

Course Code: CSDB-225L

Semester	Credit Hours	Prerequisite
[BSCS-3]	[0+1]	[None]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Demonstrate** knowledge about the practical aspects of database systems	C	C2 Comprehension	2
CLO-2	**Manipulate** tools and techniques to solve problems by applying database concepts.	P	P3 Guided Response	5
CLO-3	**Report** the outcome of an experiment/task in standard format	A	A2 Responding	7

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Database Systems Lab covers types of data model(relational data model, entity relationship model), Entity Relationship diagram, entity sets, attributes, relationship, attributes, schemas, tuples, domains Enhanced entity relationship model(EER diagram),relational and logical database design, , relation instances, keys of relations, integrity constraints, types of joins, functional dependencies, normal forms, Structured Query Language (SQL), data definition languages , sub-queries in SQL, Relational Algebra and XPath.

Lab Weekly Schedule

The lab schedule for 16 weeks is detailed below. All CLOs shall be accessed in each lab.

Week	Topic
1	Introduction to DBMS and software installed in the Lab (Oracle, MySQL, MS-Access)
2	Constructing ERD using VISIO or Erwin (or any tool for ERD draw)

Week	Topic
3	ERD Lab continues.
4	Converting Logical Database design to Physical Database Design
5	DDL Queries (Create, Alter, Drop, Truncate, Rename)
6	DML Queries: Select, Select Distinct, Where, And Or Not, OrderBy, Cartesian
7	DML Queries: Join, Self Join, Min, Max, Sum, Avg, Count, GroupBy
8	DML Queries: Insert, Update, Delete, Nested Queries(IN, Not IN, Insert, Update, Delete)
9	**Mid Term Exam**
10	Introduction to RelaX and Relational Algebra(Selection, Projection, And, Not, Or)
11	RA Queries: Cartesian, Projection, Union, Intersection, Difference.
12	Normalization Lab Tasks
13	Introduction to XML database, Document Type Descriptor, and XPath (Nodes, Atomic Values, Items, Parent, children, siblings, ancestors)
14	XPath Queries: /, //,Or, =,!=, <=,<,>,>= @.
15	XPath Queries Practice.
16	**End Term Exam**

Recommended Textbooks

1. Database Systems: The Complete Book, Molina H.G, Ullman, J, and Widom J.
2. Modern database management, Jeffrey A. Hoffer, 12th Edition, Pearson, 2016.
3. Database systems: A practical approach to design, implementation, and management, Thomas Connolly and Carolyn Begg, 6th Edition, Pearson, 2015.

Semester IV

Artificial Intelligence

Course Code: CSAI-226

Semester	Credit Hours	Prerequisite
[BSCS-4]	[2+0]	[None]

Course Description

In this course we will talk about the past, present, and the future of AI. This course covers all the introductory topics to AI to get started on the path of becoming an AI specialist. In this course, the students will learn about the main philosophy, history, and approaches of AI as well as its applications. In this course, we will study the most fundamental knowledge for understanding AI. We will introduce some basic search algorithms for problem-solving; knowledge representation and reasoning; pattern recognition; fuzzy logic; and neural networks.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Explain** fundamental concepts related to Artificial Intelligence	C	C2 Comprehension	2
CLO-2	**Demonstrate** the working of algorithms related to various approaches of Artificial Intelligence.	C	C3 Application	3
CLO-3	**Analyze** artificial intelligence techniques for practical problem solving	C	C4 Analysis	5

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

What is artificial intelligence, the foundation, and the history of Artificial Intelligence? Concept of rationality, rational agents, agents and environment, Problems in AI. Problem-solving by searching, defining problems, categories of problems, Categories of the search algorithm, tree vs graph search, informed vs uninformed search, measuring the performance of problem-solving by search, BFS, DfS, uninformed cost search, informed search best first search heuristics, A* search. Beyond classical search, optimization problems, local search algorithm, hill climbing, online and offline search agents, unknown environment Adversarial search, games, optimal decision in games, minimax algorithm, alpha-beta pruning Constraint satisfaction problems, backtracking forward filtering, Arc consistency, ordering, logical agents, first-order logic, inference Introduction to machine learning and pattern recognition decision process, feature selection. Problems in pattern classification: overfitting model selection missing features, etc. problems in machine learning, the big four problems, (density estimation regression, clustering, and classification), Bayesian decision theory with and without prior knowledge, minimum error rate,

Supervised, unsupervised learning, reinforcement learning, The measure of accuracy, Receiver operating characteristic (ROC), confusion matrix, Artificial neural networks, Convolution neural networks, Deep learning.

Course Weekly Schedule

The course schedule for 17 weeks is detailed below

Week	Topic
1	What is artificial intelligence, the foundation, and the history of AI. Different factors/behaviors counted as Intelligent. How can we implement it in a computer system?
2	Application areas of AI.
3	Problem-solving by searching, defining problems, categories of problems. Classical Problem-solving Approach. State, Space, Search.
4	Searching and searching Algorithm. Categories of the search algorithm, tree vs graph search, informed vs uninformed search. Data-Driven vs. Goal-driven Search. Breadth-First Search & its Algorithm, Depth First Search & Algorithm. Comparison b\w Depth-First and Breadth-First Search. Non-deterministic search
5	Progressive deepening (An approach to improve the efficiency of depth-first search). Informed vs Uninformed Searching. Heuristics and Hill climbing to highlight the importance of heuristics. Best-first Search and Algorithm. Greedy search
6	Heuristics and Heuristic Evaluation Function. Heuristics for tic tac toe and 8 puzzle problem. What is Optimal searching? Why is it significant? Branch and Bound technique as an optimal approach over the best-first search.
7	A* procedure to improve the quality of heuristics. Constraint satisfaction problems, backtracking forward filtering,
8	What is Adversarial Search? What is meant by a look-ahead strategy? How look ahead strategy is implemented using Min Max? Min-Max algorithm and dry run. How Min-Max algorithm can be optimized? Alpha Beta Pruning as an efficient approach over the min-max procedure.
9	**Mid Term Exams**
10	What is an expert system? Comparison of a human expert and an expert system. Roles of an expert system. Components of an Expert system. Applications of an Expert system.
11	What is Machine Learning and its importance? Difference between machine learning and expert systems. What are the different categories of Machine learning? Terminologies of machine learning (Datasets, features, and model) Process of Machine learning (Data collection, feature selection, training, evaluation, fine-tuning, and application) Types of Machine learning

Week	Topic
12	Supervised learning with example, what is classification and some examples of the classifier? Different techniques to implement Machine learning? Introduction to Machine Learning Problems in pattern classification: overfitting model selection missing features, etc. problems in machine learning, the big four problems, (density estimation regression, clustering, and classification)
13	Bayesian decision theory with and without prior knowledge, minimum error rate, How Bayesian classifier classify input data with example (Continuous Data), KNN classifier with example
14	Unsupervised learning, Un-supervised learning with example, K- Means Clustering algorithm and it's working mathematically
15	The measure of accuracy, confusion matrix, Model evaluation parameters, Errors and accuracy (Type I and Type II errors)
16	Biologically Inspired Algorithm: Neural Networks and its working, how they are inspired from neural system

Recommended Textbooks

1. Artificial Intelligence A Modern Approach, Stuart J. Russell and Peter Norvig, 3rd edition, Pearson Education, Inc., year 2016.
2. Pattern Classification by Richard O. Duda, David G. Stork, Peter E.Hart, 2nd edition, John Wiley & sons, Inc., year 2012

Recommended Reference (Books/Websites/Articles)

1. Artificial Neural Networks and Information Theory by colin fyfe, 2nd Edition, year 2000.
2. Deep learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, the MIT press, year 2018

Artificial Intelligence -Lab

Course Code: CSAI-226L

Semester	Credit Hours	Prerequisite
[BSCS-4]	[0+1]	[None]

Course Description

In this course we will talk about the past, present, and the future of AI. This course covers all the introductory topics to AI to get started on the path of becoming an AI specialist. In this course, the students will learn about the main philosophy, history, and approaches of AI as well as its applications. In this course, we will study the most fundamental knowledge for understanding AI. We will introduce some basic search algorithms for problem-solving; knowledge representation and reasoning; pattern recognition; fuzzy logic; and neural networks.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Demonstrate** knowledge about the practical aspects of Artificial Intelligence	C	C2 Comprehension	2
CLO-2	**Design** the Intelligent algorithms in Python	P	P3 Guided Response	5
CLO-3	**Report** the outcome of an experiment/task in standard format	A	A2 Responding	7

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

What is artificial intelligence, the foundation, and the history of Artificial Intelligence? Concept of rationality, rational agents, agents and environment, Problems in AI. Problem-solving by searching, defining problems, categories of problems, Categories of the search algorithm, tree vs graph search, informed vs uninformed search, measuring the performance of problem-solving by search, BFS, DfS, uninformed cost search, informed search best first search heuristics, A* search. Beyond classical search, optimization problems, local search algorithm, hill climbing, online and offline search agents, unknown environment Adversarial search, games, optimal decision in games, minimax algorithm, alpha-beta pruning Constraint satisfaction problems, backtracking forward filtering, Arc consistency, ordering, logical agents, first-order logic, inference Introduction to machine learning and pattern recognition decision process, feature selection. Problems in pattern classification: overfitting model selection missing features, etc. problems in machine learning, the big four problems, (density estimation regression, clustering, and classification), Bayesian decision theory with and without prior knowledge, minimum error rate,

Supervised, unsupervised learning, reinforcement learning, The measure of accuracy, Receiver operating characteristic (ROC), confusion matrix, Artificial neural networks, Convolution neural networks, Deep learning.

Lab Weekly Schedule

The lab schedule for 17 weeks is detailed below. All lab CLOs shall be accessed in each lab.

Week	Topic
1	Introduction to Artificial intelligence and Python and Installation of Python IDE
2	Python programming (Syntax, printing, data types and variables, conditional loops)
3	Python programming (loops, functions, classes)
4	Python programming (lists, tuples, strings, dictionaries)
5	Intelligent Agents
6	Graph Search: Uninformed search and Informed search
7	Introduction to NumPy, Pandas, Scikit-learn and Matplotlib Python Packages
8	**Midterm Term Exams**
9	Introduction to Machine Learning, Deep learning and deep learning Frameworks (TensorFlow, Keras) in Python
10	Supervised machine Learning: Classification with K-Nearest Neighbors
11	Supervised machine Learning: Regression with K-Nearest Neighbors
12	Unsupervised machine learning: K-mean clustering
13	Implementation of Neural Networks (NN) in Python
14	Evaluation Metrics to evaluate machine learning algorithms
15	Final term assessment

Recommended Textbooks

1. Artificial Intelligence A Modern Approach, Stuart J. Russell and Peter Norvig, 3rd edition, Pearson Education, Inc., year 2016.
2. Pattern Classification by Richard O. Duda, David G. Stork, Peter E.Hart, 2nd edition, John Wiley & sons, Inc., year 2012

Recommended Reference (Books/Websites/Articles)

1. Artificial Neural Networks and Information Theory by colin fyfe, 2nd Edition, year 2000.
2. Deep learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, the MIT press, year 2018

Software Engineering

Course Code: SESE-227

Semester	Credit Hours	Prerequisite
[BSCS-4]	[3+0]	[None]

Course Description

In this course, students will learn about some of the most basic topics on software engineering. This course would cover the basic and agile software process models. It further goes into the details of different phases of these models as Requirements Engineering, Analysis, Design and Testing.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Describe** various software engineering processes and activities	C	C2 Understanding	2
CLO-2	**Explain** various software development processes/methodologies	C	C2 Understanding	2
CLO-3	**Analyze** software engineering key areas	C	C4 Analysis	3

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Nature of Software, Overview of Software Engineering, Professional software development, Software engineering practice, Software process structure, Software process models, Agile software Develop-ment, Agile process models, Agile development techniques, Kanban software development, lean software development, Requirements engineering process, Functional and non-functional require-ments, UML diagrams, Context models, behavioral models, model driven engineering, Architectural design, Design and implementation, Risk Management, Software testing and quality assurance, Pro-ject management, configuration management, Software Process improvement.

Course Weekly Schedule

The course schedule for 17 weeks is detailed below

Week	Topic
1	Software Crisis. What is a software? The Nature of Software, Defining Software, Software Application Domains, Legacy Software, The Changing Nature of

Week	Topic
	Software (web apps, mobile apps, cloud computing, product line software), Software Engineering, The Software Process, The Process Framework, Umbrella Activities, Software Engineering Principles.
2	Software Development Life Cycle, A Generic Process Model, Defining a Framework Activity, Software Process Flow, Identifying Task sets, Process Patterns, Process Assessment and Improvement
3	What is process Model?, process flow, prescriptive vs descriptive process models, Prescriptive Process Model; The Waterfall Model, Incremental Process Models, Evolutionary Process Models, Concurrent Models.
4	Specialized Process Models; Component-Based Development, The Formal Methods Model, Aspect-Oriented Software Development, The Unified Process, A Brief History, Phases of the Unified Process, Personal and Team Process Models, Personal Software Process, Team Software Process.
5	What Is Agility? Agile Software Development, Predictive vs descriptive, Agile manifesto, Agility and the Cost of Change, What Is an Agile Process?, Characteristics of Agile Software Development, Agility Principles, User Stories, template, good user stories, spike, user story writing workshop, story mapping
6	Agile Planning, concepts of effort, duration, accuracy, precision, relative, and absolute, estimation styles (planning porker, card sorting), velocity in agile, release planning its types, Scrum process model, Extreme Programming
7	Dynamics system development method, Feature driven development, Kanban, pair programming
8	Human aspects of software engineering (Software teams, stakeholders): Characteristics of a Software Engineer, The Psychology of Software Engineering, The Software Team, Team Structures, Agile Teams
9	**Mid Term Exams**
10	Software requirement engineering, Functional vs non-functional requirement, RE process, Developing Use case
11	Software Design and Modelling-Introduction to UML, use case modelling, Context Models (Data Flow Diagrams) and behavioral models (activity Diagram)
12	Architectural Design- Software Architecture, Architectural Styles Architectural Descriptions, Architectural Decisions, What is quality? Software quality, software

Week	Topic
	quality dilemma, achieving software quality, Review techniques, informal reviews, formal reviews, post mortem evaluation, software quality assurance, formal approaches to SQA, software reliability, Software process improvement- CMM and CMMI.
13	Software Testing fundamentals, testing types, testing levels
14	Risk Management: Reactive versus Proactive Risk Strategies, SoftwareRisks ,Risk Identification, Assessing Overall Project Risk, Risk Components and Drivers, Risk Projection, Developing a Risk Table, Assessing Risk Impact, Risk Refinement, Risk Mitigation, Monitoring, and Management, The RMMM Plan
15	Maintenance and Reengineering: Software Maintenance, Software Supportability, Reengineering, Business Process Reengineering, Business Processes , A BPR Model, Software Reengineering, A Software Reengineering Process Model, Software Reengineering Activities, Reverse Engineering ,Reverse Engineering to Understand Data, Reverse Engineering to Understand Processing, Reverse Engineering User Interfaces
16	Presentation Week

Recommended Textbook(s)

1. Sommerville, I. (2015). *Software engineering*, 10th Edition. Pearson. ISBN: 9780133943030.
2. Pressman, R. S., & Bruce R. Maxim, D. (2014). *Software Engineering: A Practitioner's Approach.* ISBN: 9780078022128.

Recommended Reference (Books/Websites/Articles)

1. The new software engineering, Sue Conger, 2008.

CS Elec. - I, Web-Technology

Course Code: CSWT-263

Semester	Credit Hours	Prerequisite
[BSCS-4]	[2+0]	[None]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Design interactive and responsive website using front-end technologies.	C	C5 Synthesis	1
CLO-2	Integrate server-side technologies for handling information.	C	C5 Synthesis	1
CLO-3	Utilize modern frameworks to increase the efficient and productivity.	C	C3 Application	1

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- HTML
- CSS
- JavaScript
- PHP
- Bootstrap
- Laravel and ReactJs

Course Weekly Schedule
The course schedule for 17 weeks is detailed below

Week	Topic
1	Introduction to HTML and CSS.
2	Introduction to JavaScript and PHP
3	Introduction to PHP OOP
4	Introduction to Bootstrap
5	Introduction to Laravel, Routes and Controllers
6	Views in Laravel and Blade templating engine
7	Databases, Eloquent, Models, Migrations, Seeders and Faker Factory
8	User authentication and authorization
9	**Mid Term Exam**
10	Laravel - RESTful APIs authentication
11	React Basics, ReactDOM and JSX
12	Props, States and Components
13	Redux
14	React Router
15	Consuming RESTful APIs created in Laravel
16	Project Demonstration/Presentations
17	Project Demonstration/Presentations

Recommended Textbooks

1. Meloni, J. C., & Kyrnin, J. (2018). *Sams Teach Yourself HTML, CSS, and JavaScript All in One, 3rd Edition*. Pearson Education. ISBN: 9780672338083.
2. Tatroe, K., & MacIntyre, P. (2020). *Programming PHP: Creating Dynamic Web Pages, 4th Edition*. O'Reilly Media, ISBN: 9781492054139.
3. Stauffer, M. (2019). *Laravel: Up & Running: A Framework for Building Modern PHP Apps, 2nd Edition*. O'Reilly Media. ISBN: 9781492041184.

CS Elec. – I, Web-Technologies -Lab

Course Code: CSWT-263L

Semester	Credit Hours	Prerequisite
[BSCS-4]	[0+1]	[None]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Designs a fully functional frontend for a web page based on a given scenario.	P	P6 Adaption	3
CLO-2	Construct a fully functional backend for a web page based on a given scenario.	P	P6 Adaption	4
CLO-3	Integrate the front and backend with the restful APIs using any advance framework..	P	P6 Adaption	4

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- HTML
- CSS
- JavaScript
- PHP
- Bootstrap
- Laravel and ReactJs

Lab Weekly Schedule
The course schedule for 16 weeks is detailed below

Week	Topic
1	**Creating development environment setup**
2	**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
3	**Learn to create tables using HTML** Designing registration form using HTML
4	**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. • Design complete layout of web page using HTML, CSS and CSS Grid.
5	Create a PHP MySQL CRUD application using MySQLi.
6	Create an Object Oriented Programming based PHP MySQL CRUD application using PDOs.
7	Create a PHP session based user authentication and authorization system also make sure to upload user photo at the time of registration.
8	**Mid Term Exams**
9	Validate a HTML form using JavaScript and display appropriate messages using DOM manipulation. Use fetch to display album title in an unordered list from the API https://jsonplaceholder.typicode.com/albums.

Week	Topic
10	Design responsive layout for a shopping catalog 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.
11	Use Laravel code first approach to create CRUD application using MySQL and Blade templating engine (Part 1).
12	Use Laravel code first approach to create CRUD application using MySQL and Blade templating engine (Part 2).
13	Create RESTful APIs for tasks table having columns id, text, day and reminder using Laravel.
14	Consuming GET API to display data in React application
15	Using POST and DELETE APIs in React application
16	**Final Term Exams**

Recommended Textbooks

1. Meloni, J. C., & Kyrnin, J. (2018). *Sams Teach Yourself HTML, CSS, and JavaScript All in One, 3rd Edition*. Pearson Education. ISBN: 9780672338083.
2. Tatroe, K., & MacIntyre, P. (2020). *Programming PHP: Creating Dynamic Web Pages, 4th Edition*. O'Reilly Media, ISBN: 9781492054139.
3. Stauffer, M. (2019). *Laravel: Up & Running: A Framework for Building Modern PHP Apps, 2nd Edition*. O'Reilly Media. ISBN: 9781492041184.

CS Elec. - II, Advance Programming (VP)

Course Code: CSAP-264

Semester	Credit Hours	Prerequisite
[BSCS-4]	[2+0]	[CSOO-122]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Implement** the solution for windows application.	C	C5 Synthesis	4
CLO-2	**Design** Asp.NET base web solution for dynamic content delivery and e-commerce solutions.	C	C5 Synthesis	4
CLO-3	**Adapt** an Asp.NET Core to enable applications to exchange data easily and securely using Model View Controller Model.	C	C5 Synthesis	5

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Introduction to Visual Programming
- C# and Windows Applications
- ADO.Net
- ASP.Net (Form, Master page etc.)
- Three layer architecture
- Stored Procedures
- LINQ
- Entity Frame Work
- Model View Controller
- Windows Communication Foundation

- ASP.Net Core

Course Weekly Schedule
The course schedule for 17 weeks is detailed below

Week	Topic
1	Visual Programming Basics, Introduction to Events; Fundamentals of Event-driven Programming Message handling, user interfaces, graphics device interface, Common Controls, Windows Management Introduction to Windows Form Application using Visual Studio. Simple Calculator and Scientific Calculator using Windows Form Application.
2	Database Connectivity of Windows Form application with SQL server. Use of ADO.Net for Insert, Update and Delete Records. Entity Data Model, Querying Database using LINQ to SQL, Data binding, Use of Data Grid View. Retrieving data from multiple tables.
3	Designing Centralized Database operations using DbConn class Search records using Connection-less approach Using Data Set, Data Table and Data Adapter using Connection-less Approach
4	Web Applications, Master Page, Web Pages Introduction to ASP.net Life Cycle, Web Form Application Development Overview of Front-end pages and applying a template using Master pages
5	Dynamic link libraries, Building Class Libraries, Using References Three-tier architecture including Properties, Presentation Layer, Business Layer, Data Access Layer
6	Creating Stored Procedures for CRUD operations and calling in visual application in a 3-tier architecture. Populating List boxes and Combo boxes with data tables Using Data Readers with Connection Oriented Approach
7	Assemblies, Private Assembly, Shared Assembly, Configuration Overview Reporting mechanism using RDLC reports in a 3-tier architecture Login and Signup using Web Form development in a 3-tier architecture Mange the User Access Level and design appropriate Master page and webpages. Session Management on multiple forms

Week	Topic
8	Dynamically display product catalogue in a 3-tier architecture Add functionality for Shopping Cart along with Add to Cart, View cart and delete item Validation for Required fields and formats. Validation Summary
9	**Mid Term Exams**
10	Entity Framework, Code first approach, Add/Update Model classes EF Migrations, Retrieve, edit, insert and delete records.
11	Threading and Synchronization, Delegates, Lambda Expressions, State Management Debugging application, Tracing Event Logs, Using the Boolean Switch and Trace Switch Classes Using Listeners, and Implementing Custom Listeners
12	Model View Controller Designing classes and properties in Model to generate Database using code first approach Index, Create, edit, delete and Details Actions Model binding
13	Collection Framework Use of LINQ to take data from collections and populate on Grid or List View.
14	Load json data from any Web API and use LINQ to JSON to read and display on grid. Save the record to database Table WCF / Web Service creation, deployment, debugging and calling at client side
15	Dot net Core, Entity Framework Core, Asp.NET Core web applications, applications and request life cycle with MVC and code-first approach
16	ASP.net Core Web APIs and its applicability for cross platform applications Introduction to Graph Query Language and its applicability
17	Introduction to Micro Service and its application scenarios Introduction Containerization (Docker)

Recommended Textbooks

1. Deitel, Harvey, and Paul Deitel. Visual C# How to Program. Prentice Hall Press, 6th Edition, (2016)
2. Pro C# 7 With .NET and .NET Core — Eighth Edition — Andrew Troelsen Philip Japikse, 2017.

3. Joseph Albahari, C# 10 in a Nutshell The Definitive Reference. " O'Reilly Media, Inc.", 2022.

CS Elec. - II, Advance Programming -Lab

Course Code: CSAP-264L

Semester	Credit Hours	Prerequisite
[BSCS-4]	[0+1]	[CSOO-122L]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Design** and implement the window forms based applications for a given scenario.	P	P7 Organization	4
CLO-2	**Construct** a fully functional Asp.NET based solution for a given scenario.	P	P7 Organization	4
CLO-3	**Design** a solution based on MVC based Asp.NET applications for a given scenario.	P	P7 Organization	4

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Introduction to Visual Programming
- C# and Windows Applications
- ADO.Net
- ASP.Net (Form, Master page etc.)
- Three layer architecture
- Stored Procedures
- LINQ
- Entity Frame Work
- Model View Controller
- Windows Communication Foundation

- ASP.Net Core

Course Weekly Schedule
The course schedule for 16 weeks is detailed below. All CLOs shall be accessed in each CLO.

Week	Topic
1	• Create a child class and parent class for calculator and scientific Calc, Create windows forms with Menus, buttons, etc. • Create Account class with public and private variables and props, Design Windows to get values and store in props and pass
2	• Database Connectivity of Windows Form application with SQL server. Use of ADO.Net for Insert, Update and Delete Records. • Entity Data Model, Querying Database using LINQ to SQL, Data binding, Use of Data Grid View. Retrieving data from multiple tables.
3	• Develop an employee page to perform Insert and Search the records, Design database in SQL server • Designing Centralized Database operations using DbConn class • Search records using Connection-less approach • Using Data Set, Data Table and Data Adapter using Connection-less Approach
4	• Web Applications, Master Page, Web Pages • Introduction to ASP.net Life Cycle, Develop a MasterPage in ASP.net, Apply AJAX and provide the data to web pages. Add pages in different Master Pages
5	• Dynamic link libraries, Building Class Libraries, Using References • Three-tier architecture including Properties, Presentation Layer, Business Layer, Data Access Layer
6	• Create a stored procedure and execute it in sql server to proof results of execution • Write code behind insert button to call stored procedure
7	• Create an rdlc file, add table and select columns, design header and footer of report. • Write code behind view report button to display list of all employees and print it.
8	• Using Data Readers using Connection Oriented Approach Add functionality for Shopping Cart along with Add to Cart, View cart and delete item
9	**Mid Term Exam**

Week	Topic
10	• Entity Framework, Code first approach, Add/Update Model classes Retrieve, edit, insert and delete records.
11	• Threading and Synchronization, • Using Listeners, and Implementing Custom Listeners
12	• Create a view class to show the results • Create controller class to utilise model and view, finally create a web form to utilize mvc.
13	• LINQ to Objects, LINQ to SQL, LINQ to DataSet • LINQ to XML, JSON to connect with XML and JSON based Data, like in Mongo DB etc.
14	• Load json data from any Web API and use LINQ to JSON to read and display on grid. Save the record to database Table • WCF / Web Service creation, deployment, debugging and calling at client side
15	• Dot net Core, Entity Framework Core, Asp.NET Core web applications, applications and request life cycle with MVC and code-first approach
16	• ASP.net Core Web APIs and its applicability for cross platform applications • Introduction to Graph Query Language and its applicability
17	• Introduction to Micro Service and its application scenarios • Introduction Containerization (Docker)

Recommended Textbooks

1. Deitel, Harvey, and Paul Deitel. Visual C# How to Program. Prentice Hall Press, 6th Edition, (2016)
2. Pro C# 7 With .NET and .NET Core — Eighth Edition — Andrew Troelsen Philip Japikse, 2017.
3. Joseph Albahari, C# 10 in a Nutshell The Definitive Reference. " O'Reilly Media, Inc.", 2022.

Professional Practices

Course Code: CSPP-216

Semester	Credit Hours	Prerequisite
[BSCS-4]	[2+0]	[None]

Course Description

A Computing graduate as professional has some responsibilities with respect to the society. It identifies key sources for information and opinion about professionalism and ethics. Historical, social context of Computing (SE, CS & IT). Professional activities; professional societies; professional ethics; professional competency and life-long learning. Uses, misuses, risks of software; information security & privacy. Business practices; intellectual property & software law (cyber law). Social responsibilities, software related contracts, Software Houses Management. This course will cover the basic professional ethics methodologies, computer ethics, ethical issues and social impact of these ethical issues in our lives. Students analyze, evaluate, and assess ethical and professional computing case studies.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Explain** various terms in Computer and General Ethics.	C	C2 Comprehension	9
CLO-2	**Apply** the IEEE / ACM Code of Ethics on various situations.	C	C3 Application	8
CLO-3	**Analyze** given situations for finding ethical, legal and religious issues and their solutions.	C	C4 Analysis	10

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- What is Computer Ethics? (Introduction)
- Overview of the ACM Code of Conduct
- Plagiarism and its types
- Intellectual Property
- Software Piracy
- Privacy and Anonymity
- Computer Reliability
- Computer Crime and Security

- The Structure and Anatomy of a Software House
- The Framework of Employee Relations Law and Changing Management Practices · Human Resource Management and IT, Health and Safety at Work, Software Liability, Liability and Practice
- Accountability and Auditing
- Bioinformatics and Computational Genomics

Course Weekly Schedule
The course schedule for 16 weeks are detailed below

Week	Topic
1	What is Computer Ethics? (Introduction) • Technology and Ethics w.r.t Islam • Computer Ethics vs morality • Ethical Decision Making in Computing
2	Computer Crime and Security • What is Computer Crime? • Who are Computer Criminals? • Computer Fraud • Deep Fake • Dark Web
3	Computer Crime and Security • Hackers and Hacking, Cracking • Computer Sabotage • Security, Legislation, and Education
4	ACM • ACM Code of Ethics and Professional Conduct, • Overview of all four parts • General Ethical Principles for IT Users • IT Professionals' Responsibilities • IT Leaders' Responsibilities • Compliance with the Code
5	• Plagiarism and its types • Copyright • Patent • The Basis of property law

Week	Topic
	• Legal Aspects
6	Intellectual Property • The Problem of Information ownership • Arguments For and Against proprietorship • Intellectual Property Rights • Protecting Intellectual Property • Free Software, Adware & Spyware • Pirated software Software Piracy • The Moral Implications of Software Piracy • Islamic Perspective of software piracy • Piracy vs Plagiarism
7	Privacy and Anonymity • The Invasion of Privacy • The Right of Privacy • Methods of Privacy Violation • Surveillance Technologies • Neighborhood Surveillance • Protecting Privacy
8	Computer Reliability • Can we trust computers? • What is Computer reliability? • Professional Responsibility • Software Liability • Solutions to the Problems
9	**Mid Term Exams**
10	Computer Crime and Security • Objectionable Material: What is it? How to protect children from accessing it. • Vulgarity: Pornography, Unethical Videography and Cyber Laws, Punishment. • Violence and Hatred: What is it? Cyber Laws, Punishment. • Blasphemy: What is it? Cyber Laws, Punishment. • Bitcoins: What is it? Cyber Laws, Punishment

Week	Topic
11	The Structure of Organizations • Anatomy of a Software House • Finance and Accounting
12	• The Framework of Employee Relations Law and Changing Management Practices • Accountability and Auditing • Human Resource Management and IT • JD (Job Descriptions) & Contracts
13	Computers and Health & Safety at Work • Medical Robots • Telemedicine
14	Ethical Concerns in: • Off-shore employment (anonymous) • Free lancing • FIA (roles)
15	Bioinformatics and computational genomics • Introduction & Basic issues • Judgments about individuals (Employment/ Insurance) • Ethical concern on ownership of genetic data
16	Bioinformatics and computational genomics • Ethical concerns in plants and animal's genomics Cloning, Genetic Engineering
17	**End Term Exams**

Recommended Textbooks

1. Computer Ethics by Deborah G. Johnson, Pearson (Latest Edition). ISBN 10: 0131112414
2. 2. Professional Issues in Software Engineering by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, CRC Press

Recommended Reference (Books/Websites/Articles)

1. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet by Sara Baase, Prentice Hall. ISBN-10: 0136008488
2. Applied Professional Ethics by Gregory R. Beabout, University Press of America (1993). ISBN-10: 0819193747

Computer Organization and Assembly Language

Course Code: CSCO-228

Semester	Credit Hours	Prerequisite
[BSCS-4]	[2+0]	[CSDL-223]

Course Description

This course is designed to introduce the student with foundation and working of computers. The basic functional units that reside inside it and their function as part of the unit. The student will learn about the multi-core processors and the parameters that measure the performance of a system. A useful technique called Pipelining will be exercised. The concept of cache memory along with the constraints are discussed. Finally Input/output techniques are introduced to the students.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Explain the major components of a computer, basics of computer organization and the interconnection between computer modules.	C	C1 Knowledge	1
CLO-2	Demonstrate the functions and internal working of Central Processing unit and Assembly Language.	C	C3 Application	2
CLO-3	Analyze the memory hierarchy, I/O modules, instruction set architecture (x86-64), addressing modes, formats and Assembly language techniques.	C	C4 Analysis	3

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Define Computer Organization, Hierarchy of Computer, Different functions of computer, A brief History of Computers
- Stored Program Concept, IAS computer, IC era, Moore's Law, Later Generations
- Designing for Performance, Multicore CPU
- Interrupts, Types, Cycles, Program flow control, Interrupt handler, cycle, multiple Interrupts
- System Interconnections, Bus Interconnection Scheme, Multiple buses, Types, bus elements
- Computer Memory System Overview, Memory Hierarchy, Characteristics of Memory

- Cache Memory Principles, Cache Hierarchy, Main memory Blocks to Cache Mapping, Elements of Cache Design
- Cache Addresses, Cache Size, Cache Hit & Miss, Mapping, Types of Cache Mapping, Direct, Associative, Set-Associative
- Replacement Algorithms, Write Policy, Write through, write back, Line Size, Block Size, Unified & Split Caches
- Semiconductor Memory, Organization, Characteristics of DRAM & SRAM, ROM Types
- External Devices, Module Function, Module Structure, Input / Output Modules, I/O Operation types,
- I/O Operation Methods Programmed I/O, Interrupt Driven I/O, Direct Memory Access

Course Weekly Schedule
The course schedule for 16 weeks is detailed below.

Week	Topic
1	Difference between Computer Organization and Architecture
2	A brief History of Computers, Computer Generations, CPU registers
3	Stored Program Concept, IAS computer and its registers, Arithmetic commands in Assembly
4	IC era, Moore's Law, Later Generations, Multicore CPU, C++ Conditionals conversion in Assembly
5	Designing for Performance, performance improvement, MIPS rate, Program Flow Control in Assembly
6	Interrupts, Types, Cycles, Interrupt handler, cycle, multiple Interrupts, Assembly Application Programs
7	Bus Interconnection Scheme, Multiple buses, Types, bus elements, Logical Operations in Assembly
8	Pipelining and Parnellism, Assembly Quiz
9	Computer Memory System Overview, Memory Hierarchy, Characteristics of Memory, Stack Operations Assembly
10	Cache Memory Principles, Cache Hierarchy, Main memory Blocks to Cache Mapping, Procedure Calls
11	Elements of Cache Design, Cache Addresses, Cache Size, Cache Hit & Miss, Mapping, Shift Operations
12	Cache Mapping, Direct, Associative, Set-Associative, Replacement Algorithms, File Handling Assembly
13	Write Policy, Write through, Write back, Line Size, Block Size, Unified & Split Caches, I/O in Assembly
14	External Devices, Module Function, Module Structure, Input / Output Modules, Keyboard/mouse handling
15	I/O Operation types, Programmed I/O, Interrupt Driven I/O, Direct Memory Access, BIOS access in Assembly
16	Project/Presentation & Revision

Recommended Textbooks

1. Stallings, W. (2015). *Computer Organization and Architecture: Designing for Performance, 10th Edition.* Pearson Prentice Halli. ISBN: 9789332570405.
2. Brey, B. B. (2009). *The Intel Microprocessors : Architecture, Programming, and Interfacing*. Pearson Education India. ISBN: 9788131726228.

Computer Organization and Assembly Language -Lab

Course Code: CSCO-228L

Semester	Credit Hours	Prerequisite
[BSCS-4]	[0+1]	[CSDL-223L]

Course Description

This course is designed to introduce the student with foundation and working of computers. The basic functional units that reside inside it and their function as part of the unit. The student will learn about the multi-core processors and the parameters that measure the performance of a system. A useful technique called Pipelining will be exercised. The concept of cache memory along with the constraints are discussed. Finally Input/output techniques are introduced to the students.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Introduction to Intel x86 Assembly Language and CPU simulator	C	C2 Comprehension	2
CLO-2	Understand the internal working of a microprocessor registers, ISA and interrupts	P	P3 Guided Response	2
CLO-3	Understanding of Assembly Language Programming Concepts for a microprocessor.	P	P4 Mechanism	4

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Define Computer Organization, Hierarchy of Computer, Different functions of computer, A brief History of Computers
- Stored Program Concept, IAS computer, IC era, Moore's Law, Later Generations
- Designing for Performance, Multicore CPU
- Interrupts, Types, Cycles, Program flow control, Interrupt handler, cycle, multiple Interrupts
- System Interconnections, Bus Interconnection Scheme, Multiple buses, Types, bus elements
- Computer Memory System Overview, Memory Hierarchy, Characteristics of Memory
- Cache Memory Principles, Cache Hierarchy, Main memory Blocks to Cache Mapping, Elements of Cache Design
- Cache Addresses, Cache Size, Cache Hit & Miss, Mapping, Types of Cache Mapping, Direct, Associative, Set-Associative

- Replacement Algorithms, Write Policy, Write through, write back, Line Size, Block Size, Unified & Split Caches
- Semiconductor Memory, Organization, Characteristics of DRAM & SRAM, ROM Types
- External Devices, Module Function, Module Structure, Input / Output Modules, I/O Operation types,
- I/O Operation Methods Programmed I/O, Interrupt Driven I/O, Direct Memory Access

Lab Weekly Schedule

The lab schedule for 16 weeks is detailed below. All CLOs shall be accessed in each lab.

Week	Topic
1	**Introduction to Assembly Language** To learn the basic commands, CPU registers and assembly language program structure.
2	**Arithmetic Operations** To learn the basic arithmetic commands and their use.
3	**Program Flow Control Instructions** To learn to change the sequence of execution of a program by using program flow control instructions.
4	**String Operations** To learn to display, input a string, copy, search and reverse a string.
5	**Assembly' Application Programs** To learn to write the following application codes: • Password protected application, used to sign-in to a computer. • Count the capital characters in a defined string. • Search and Replace a character in a string. • Count the 'Even' numbers in an entered string.
6	**Logical Operations:** To learn the basic 'logic commands' and their use.
7	**Shift and Rotate Instructions:** To learn the basic 'shift and rotate' instructions and their use.
8	**Defining and Using Procedures** To learn how to make procedures and perform procedure calls.
9	**Mid Term Exams**
10	**Stack Operations** To learn about runtime stack in Assembly

Week	Topic
11	**File Handling in Assembly** To learn how to deal with files in following ways: Opening File and reading file Detecting Next line in File and Counting Characters in File Writing to File, Appending File and Closing File
12	**BIOS Level Programming** To learn about Keyboard and Mouse control at BIOS level
13	**Graphics** To Graphics in Assembly.
14	**Interrupt Handling, Macros and Structures** Interrupt Handling Interrupt Vector Table Exceptions, Traps and Interrupts Divide by Zero Exception Overflow Exception Macros
15	**Input / Output - Parallel Port Operation** Getting introduced to parallel port, introduction to pin configuration of the port Learning how to address parallel port of computer through assembly and how to write on parallel port and how to read data from any external source. This lab is being designed to make the students enable to interface the microprocessor to external world and making them enable to control externally interfaced devices by microprocessor
16	**End Term Exams**

Recommended Textbooks

1. Stallings, W. (2015). *Computer Organization and Architecture: Designing for Performance, 10th Edition.* Pearson Prentice Halli. ISBN: 9789332570405.
2. Brey, B. B. (2009). *The Intel Microprocessors : Architecture, Programming, and Interfacing*. Pearson Education India. ISBN: 9788131726228.

Semester V

CS Elec. - I, Web-Technology

Course Code: CSWE-265

Semester	Credit Hours	Prerequisite
[BSCS-5]	[2+0]	[CSWT-263]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Design interactive and responsive website using front-end technologies.	C	C5 Synthesis	1
CLO-2	Integrate server-side technologies for handling information.	C	C5 Synthesis	1
CLO-3	Utilize modern frameworks to increase the efficient and productivity.	C	C3 Application	1

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- HTML
- CSS
- JavaScript
- PHP
- Bootstrap
- Laravel and ReactJs

Course Weekly Schedule
The course schedule for 17 weeks is detailed below

Week	Topic
1	Introduction to HTML and CSS.
2	Introduction to JavaScript and PHP
3	Introduction to PHP OOP
4	Introduction to Bootstrap
5	Introduction to Laravel, Routes and Controllers
6	Views in Laravel and Blade templating engine
7	Databases, Eloquent, Models, Migrations, Seeders and Faker Factory
8	User authentication and authorization
9	**Mid Term Exam**
10	Laravel - RESTful APIs authentication
11	React Basics, ReactDOM and JSX
12	Props, States and Components
13	Redux
14	React Router
15	Consuming RESTful APIs created in Laravel
16	Project Demonstration/Presentations
17	Project Demonstration/Presentations

Recommended Textbooks

4. Meloni, J. C., & Kyrnin, J. (2018). *Sams Teach Yourself HTML, CSS, and JavaScript All in One, 3rd Edition*. Pearson Education. ISBN: 9780672338083.
5. Tatroe, K., & MacIntyre, P. (2020). *Programming PHP: Creating Dynamic Web Pages, 4th Edition*. O'Reilly Media, ISBN: 9781492054139.
6. Stauffer, M. (2019). *Laravel: Up & Running: A Framework for Building Modern PHP Apps, 2nd Edition*. O'Reilly Media. ISBN: 9781492041184.

CS Elec. – I, Web-Technologies -Lab

Course Code: CSWT-263L

Semester	Credit Hours	Prerequisite
[BSCS-5]	[0+1]	[CSWT-263L]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Designs a fully functional frontend for a web page based on a given scenario.	P	P6 Adaption	3
CLO-2	Construct a fully functional backend for a web page based on a given scenario.	P	P6 Adaption	4
CLO-3	Integrate the front and backend with the restful APIs using any advance framework..	P	P6 Adaption	4

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- HTML
- CSS
- JavaScript
- PHP
- Bootstrap
- Laravel and ReactJs

Lab Weekly Schedule
The course schedule for 16 weeks is detailed below

Week	Topic
1	**Creating development environment setup**
2	**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
3	**Learn to create tables using HTML** Designing registration form using HTML
4	**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. Design complete layout of web page using HTML, CSS and CSS Grid.
5	Create a PHP MySQL CRUD application using MySQLi.
6	Create an Object Oriented Programming based PHP MySQL CRUD application using PDOs.
7	Create a PHP session based user authentication and authorization system also make sure to upload user photo at the time of registration.
8	**Mid Term Exams**
9	Validate a HTML form using JavaScript and display appropriate messages using DOM manipulation. Use fetch to display album title in an unordered list from the API https://jsonplaceholder.typicode.com/albums.

Week	Topic
10	Design responsive layout for a shopping catalog 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.
11	Use Laravel code first approach to create CRUD application using MySQL and Blade templating engine (Part 1).
12	Use Laravel code first approach to create CRUD application using MySQL and Blade templating engine (Part 2).
13	Create RESTful APIs for tasks table having columns id, text, day and reminder using Laravel.
14	Consuming GET API to display data in React application
15	Using POST and DELETE APIs in React application
16	**Final Term Exams**

Recommended Textbooks

4. Meloni, J. C., & Kyrnin, J. (2018). *Sams Teach Yourself HTML, CSS, and JavaScript All in One, 3rd Edition*. Pearson Education. ISBN: 9780672338083.
5. Tatroe, K., & MacIntyre, P. (2020). *Programming PHP: Creating Dynamic Web Pages, 4th Edition*. O'Reilly Media, ISBN: 9781492054139.
6. Stauffer, M. (2019). *Laravel: Up & Running: A Framework for Building Modern PHP Apps, 2nd Edition*. O'Reilly Media. ISBN: 9781492041184.

Computer Architecture

Course Code: CSCA-341

Semester	Credit Hours	Prerequisite
[BSCS-5]	[2+0]	[CSCO-228]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Understand the digital components of a computer system (registers, memory, bus), their general organization, interconnection along with the arithmetic and logic microoperations.	C	C2 Comprehension	1
CLO-2	Understanding the underlying concepts of instructions working with registers and memory, along with RISC and CISC characteristics.	C	C2 Comprehension	2
CLO-3	Demonstrate the ability to implement and verify designs of varying complexity at the register-transfer-level, ability to design a basic computer	C	C3 Application	3

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

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

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

Course Weekly Schedule

The course schedule for 16 weeks is detailed below.

Week	Topic
1	Introduction of Digital Components [Integrated Circuits, Decoders, Encoders, MUX]
2	Registers [Registers with Parallel Load], Shift Registers [Bidirectional Shift Registers with Parallel Load]
3	Register Transfer and Microoperations, Register Transfer Language, Register Transfer, Bus Transfer [Three-State Bus Buffers], Memory Transfers [Memory Read, Memory Write]
4	Arithmetic Microoperations, Binary Adder, Binary Adder-Subtractor, Binary Incrementor, Arithmetic Circuit
5	Logic Microoperations, List of Logic Microoperations, Hardware Implementation, Some Applications [selective-set, selective-complement, selective-clear]
6	Shift Microoperations [logical shift, circular shift, arithmetic shift], Hardware Implementation, Arithmetic Logic Shift Unit
7	Basic Computer Organization and Design, Instruction Codes [Stored Program Organization, Indirect Address], Computer Registers, List of Registers for the Basic Computer, Common Bus System

Week	Topic
8	Computer Instructions [Instruction format, Memory-reference instruction, Register-reference instruction, Input-output instruction, Instruction Set Completeness], Timing and Control
9	**Mid Term Exams**
10	Instruction Cycle [Fetch and Decode, Determine the Type of Instruction, Register Reference Instructions],
11	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]
12	Design of Basic Computer, Control Logic Gates, Control of Registers and Memory
13	Control of Single Flip Flops, Control of Common Bus
14	Central Processing Unit, General Register Organization [Control Word, Examples of Microoperations]
15	Stack Organization [Register Srock, Memory Stack, Reverse Polish Notation]
16	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
17	Overview of Pipeline and Vector Processing, throughput, multiple functional Units, SIMD, MIMD Instruction Pipeline [Example: Four-Segment Instruction Pipeline], Vector Operations

Recommended Textbooks

1. M. Morris Mano. 1993. Computer system architecture (3rd ed.). Prentice-Hall, Inc., USA.
2. M. Morris Mano and Charles Kime. 2007. Logic and Computer Design Fundamentals (4th. ed.). Prentice Hall Press, USA.
3. Vincent P. Heuring and Harry F. Jordan. 2003. Computer Systems Design and Architecture (2nd Edition). Prentice-Hall, Inc., USA.
4. David A. Patterson and John L. Hennessy. 2016. Computer Organization and Design: The Hardware Software Interface ARM Edition (1st. ed.). Morgan Kaufmann Publishers Inc., San Francisco, CA, USA.

Computer Architecture-Lab

Course Code: CSCA-341L

Semester	Credit Hours	Prerequisite
[BSCS-5]	[0+1]	[CSCO-228L]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**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.	C	C3 Application	2
CLO-2	**Practice** 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.	P	P3 Guided Response	5
CLO-3	**Design & contribute** individually or as a team member to work effectively. Write concise yet comprehensive technical reports that describe designs implemented at the register-transfer-level, and explain the testing strategy used to verify functionality.	P	P5 Complete Overt Response	4, 6

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Introduction to ModelSim to learn the basic simulator environment and components available.

- Common Bus System for 4 Registers
- Common Bus System for 4 Registers: Bus Line with three-state Buffers
- Arithmetic Microoperations, 4-bit Arithmetic Circuit
- Logic Microoperations, Shift Microoperations
- Arithmetic Logic Shift Unit
- Control Gate associated Registers: (Control of AR, Flipflop, AC, 16-but Common Bus),
- Design of Adder and Logic Circuit

Lab Weekly Schedule

The lab schedule for 16 weeks is detailed below. All CLOs shall be accessed in each lab.

Week	Topic
1	**Introduction to ModelSim** To learn the basic simulator environment and components available.
2	**Common Bus System for 4 Registers** Simulating the common bus system for 4 registers to transfer the information between the registers using multiplexers.
3	**Common Bus System for 4 Registers: Bus Line with three-state Buffers** Simulating the bus system with three-state gates instead of multiplexers.
4	**Arithmetic Microoperations** Simulating the arithmetic binary operations which include 4-bit binary Adder, Adder-Subtractor/ 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.
6	**Logic Microoperations** Simulating one stage of a logic circuit that generates the four basic logic microoperation AND, OR, XOR, Compliment.
7	**Shift Microoperations** Simulating 4-bit combinational circuit shifter with multiplexers.
8	**Arithmetic Logic Shift Unit** Simulating one stage of arithmetic logic shift unit that uses one stage of 4-bit arithmetic circuit and one stage of logic circuit from previous labs.
9	**Midterm exam**
10	**Control Gate associated Registers: (Control of AR)** Simulating the control of Address Register (AR) with control inputs Load (LD), Increment (INR) and Clear (CLR).
11	**Control of Single Flip-Flop** Simulating the control inputs for Interrupt Enable (lEN) using JK flip-flop.
12	**Control of 16-bit Common Bus** Register selection for 16-bit common bus using encoders

Week	Topic
13	**Control Gate associated Registers: (Control of AC)** Simulating the gate structure for controlling the Load (LD), Increment (INR) and Clear (CLR) of Accumulator Register (AC).
14	**Design of Adder and Logic Circuit** Simulating one stage of adder and logic circuit corresponding to one bit of AC
15	**Revision/Project**
16	**End term Examinations**

Recommended Textbooks

1. M. Morris Mano. 1993. Computer system architecture (3rd ed.). Prentice-Hall, Inc., USA.
2. Nikrouz Faroughi. 2014. Digital Logic Design and Computer Organization with Computer Architecture for Security (1st. ed.). McGraw-Hill Professional.
3. ModelSim® Tutorial, Software Version 6.4a, © 1991-2008 Mentor Graphics Corporation.

Operating System

Course Code: CSOS-329

Semester	Credit Hours	Prerequisite
[BSCS-5]	[3+0]	[None or CSDS-224]

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Understand** the characteristics of different structures of OS and identify the core	C	C2-Comprehension	1
CLO-2	**Explain** processes and threads, process management, IPC, Process Synchronization, Scheduling, and deadlocks.	C	C2-Comprehension	1
CLO-3	**Evaluate** algorithms used in Memory Management, disk management and File Systems.	C	C3-Application	2

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Introduction to Operating Systems, What is an OS, Single User Systems, Batch Systems, Multi programmed Systems, Time Sharing Systems, Multiprocessor Systems, Real Time Systems Computer System Structures (Computer System Operation, I/O Structure, Storage Structure, Storage Hierarchy, Hardware Protection) Operating System Structures (Operating Systems Concepts, System Calls) Processes & Threads (Process Concept, Process Scheduling, Operation

on Processes, Cooperating Processes, Threads) CPU Scheduling (Introduction to Scheduling, Scheduling Criteria, Scheduling Algorithms) Process Synchronization (The Critical Section Problem, Synchronization Hardware, Semaphores, Classical Problems of Synchronization) Deadlocks (Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Avoidance and Detection) Memory Management (Logical vs. Physical Address Space, Swapping, Contiguous Allocation, Paging, Segmentation, Segmentation with Paging) Virtual Memory (Demand Paging, Page Replacement, Page Replacement Algorithms, Allocation of frames, Thrashing) File System Interface and Implementation (File Concept, Access Methods, Directory Structure, Protection, File System Structure, Allocation Methods, Free Space Management, Directory Implementation)

Course Weekly Schedule

The course schedule for 17 weeks is detailed below

Week	Topic
1	Types of software, Application Software and System software, Application software categories, System software categories.
2	Introduction to OS, Single user, Multi user and Network OS, H/W dependent and independent OS, Important OS components, Kernel, Shell, Shell types
3	Type of services provided by OS, Uni- programming and Multi-programming, Uni-tasking and Multi-tasking, Uni- processing and Multi-processing.
4	Distributed systems and its types, Reason for building distributed systems,
5	SPOOLing, Buffering, Real-Time systems, Booting mechanism.
6	Process and process states. Process Control Block, Independent and Cooperating processes, Process and Threads, Hierarchy of processes.
7	Inter Process Communication, Process Synchronization, Race condition, Mutual exclusion, Critical section, Achieving process synchronization.
8	Scheduler and scheduling queues, Types of schedulers, CPU and I/O bound processes, Context switching, Criteria for comparing CPU scheduling algorithms.
9	Mid Term Exams
10	First Come First Served scheduling, Shortest Job First scheduling, Priority scheduling (Preemptive & Non-Preemptive), Round Robin scheduling.
11	Multi-level queue scheduling, Multi-level feedback queue (MLFBQ) scheduler, Multi-processor scheduling, and CPU Scheduling Algorithm evaluation.
12	Introduction to Deadlocks, Deadlock characterization, Deadlock prevention, Deadlock avoidance.
13	Introduction to Banker's Algorithm and importance of its usage, Deadlock detection in single resource of each resource type.

Week	Topic
14	Deadlock detection in multiple resources of each resource type, Deadlock Recovery, Techniques used to recover processes from deadlock.
15	Introduction of memory management, Swapping, Single partition allocation and Multiple partition allocation memory management schemes. Multiprogramming with Fixed partition.
16	Multiprogramming with Variable partition, First-Fit, Best-Fit, Next-Fit and Worst-Fit algorithms. External fragmentation, Compaction, Paging, Segmentation.
17	Virtual Memory, Demand Paging, Page Replacement, Page Replacement algorithms, Thrashing, Introduction to File System, Directory structure, Single and Two level directory, Tree structured directory, Acyclic graph directories, General graph directories, File protection.

Recommended Textbooks

1. Operating system by Albert Shilberschatz, Latest Edition, 2021

Recommended Reference (Books/Websites/Articles)

1. Modern Operating Systems, Andrew Tanenbaum, Thirteen Edition, Prentice Hall, 2021
2. Operating System by William Stalling, Latest Edition, 2021.

Operating System -Lab

Course Code: CSOS-329L

Semester	Credit Hours	Prerequisite
[BSCS-5]	[0+1]	[None or CSDS-224L]

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Demonstrate** Shell Scripts/ System Calls using Linux Operating System	C	C3 Application	2
CLO-2	**Apply** operating system concepts/ commands to perform various functions in Windows and Linux	P	P4 Mechanism	4
CLO-3	**Express** the experimental data in the appropriate format in the form of a LAB report	A	A3 Valuing	7

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Introduction to Operating Systems, What is an OS, Single User Systems, Batch Systems, Multi programmed Systems, Time Sharing Systems, Multiprocessor Systems, Real Time Systems Computer System Structures (Computer System Operation, I/O Structure, Storage Structure, Storage Hierarchy, Hardware Protection) Operating System Structures (Operating Systems Concepts, System Calls) Processes & Threads (Process Concept, Process Scheduling, Operation on Processes, Cooperating Processes, Threads) CPU Scheduling (Introduction to Scheduling, Scheduling Criteria, Scheduling Algorithms) Process Synchronization (The Critical Section Problem, Synchronization Hardware, Semaphores, Classical Problems of Synchronization) Deadlocks (Deadlock Characterization, Methods

for Handling Deadlocks, Deadlock Prevention, Avoidance and Detection) Memory Management (Logical vs. Physical Address Space, Swapping, Contiguous Allocation, Paging, Segmentation, Segmentation with Paging) Virtual Memory (Demand Paging, Page Replacement, Page Replacement Algorithms, Allocation of frames, Thrashing) File System Interface and Implementation (File Concept, Access Methods, Directory Structure, Protection, File System Structure, Allocation Methods, Free Space Management, Directory Implementation)

Lab Weekly Schedule

The course schedule for 17 weeks is detailed below

Week	Topic
1	Introduction to Linux. Advantages of Linux and different versions of UNIX. Tutorial on installation of Linux. Getting started with your Linux and general overview of the OS
2	A brief introduction to a few of the basic commands of Linux.
3	Exploring the Linux file system, including the basic concepts of files and directories and their organization in a hierarchical tree structure.
4	Overview of The Bourne Again Shell
5	Performing Basic File Management (copy command (cp), move command (mv), rm, touch). Directory utilities (mkdir, rmdir) and wildcard patterns.
6	An introduction to Processing of Text Streams using Text Processing Filters.
7	Parameters passing in Linux.
8	Use of Unix Streams, Pipes and Redirects.
9	**Mid Term Exams**
10	Implementation of Environment variables in Linux, Searching Text Files Using Regular Expressions (grep)
11	Programming Fundamentals, if-else, for, While, do while loop shell scripts.
12	Implementing Switch case structure, functions and Various Programming related exercises in Linux.
13	File handling in Linux using System calls.
14	Implementation of System calls using GCC Compiler in Linux.
15	fork (), getpid(), getppid(), wait(), opendir(), readdir(), closedir() system calls implementation using Linux.
16	Implementation of various CPU scheduling algorithms
17	Implementation of various CPU scheduling algorithms

Recommended Textbooks

1. Operating system by Albert shilberschatz, Latest Edition, 2021

Reference Books:

1. Modern Operating Systems, Andrew Tanenbaum, Thirteen Edition, Prentice Hall, 2021
2. Operating System by William Stalling, Latest Edition, 2021.

Statistics and Probability

Course Code: MTSP-303

Semester	Credit Hours	Prerequisite
[BSCS-5]	[3+0]	[None]

Course Description

This course provides an elementary introduction to probability and statistics with applications. Topics include: sample spaces, conditional probability, Bayes' rule, random variables, probability distribution of continuous and discrete random variables, inference, hypothesis testing, confidence intervals, linear and multiple regression.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Explain** fundamental concepts related to probability and statistics and graphical representation	C	C2 Comprehension	1
CLO-2	**Solve** problems by using probability formulas and probability distributions	C	C3 Application	1
CLO-3	**Apply** basic statistical techniques such as regression, curve fitting to engineering data	C	C3 Application	2

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Introduction to Statistics and Data Analysis, Statistical Inference, Samples, Populations, and the Role of Probability. Sampling Procedures. Discrete and Continuous Data. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes' Rule. Random Variables and Probability Distributions. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem. Discrete Probability Distributions. Continuous Probability Distributions. Fundamental Sampling Distributions and Data Descriptions: Random Sampling, Sampling Distributions, Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of S2, t-Distribution. Tests of Hypotheses. The Use of P Values for Decision Making in Testing Hypotheses (Single Sample & One- and Two Sample Tests), Linear Regression and Correlation. Least Squares and the Fitted Model, Multiple Linear Regression and Certain,

Nonlinear Regression Models, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators.

Course Weekly Schedule
The course schedule for 17 weeks is detailed below

Week	Topic
1	Introduction to Statistics and Data Analysis: Descriptive and inferential statistics, population and sample, Observations and variables, Types of variables, Data collection
2	Measure of central tendency and Measure of dispersion, quartiles for ungroup data, Graphical representation of data: dot plot, Stem leaf Display, Box and whisker plot
3	Introduction to Probability, concept of sets, Venn diagram, operation and algebra on sets, Cartesian product
4	Counting Sample Points, Sample Space, Events
5	Definition of probability axioms of probability, conditional probability, independent events,
6	Additive Rules and the Product Rule, Bayes' Rule
7	Random variables, Mathematical Expectation: Mean of a Random Variable, Variance of Random Variables,
8	Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem
9	**Mid Term Exams**
10	Discrete Probability Distributions: Binomial distribution, Poisson distribution
11	Continuous Probability Distributions: Normal distribution and standard normal distribution and its properties
12	Random Sampling, Sampling Distribution of Means and the Central Limit Theorem
13	Linear Regression Model using Matrices, Least Squares and the Fitted Model
14	Multiple Linear Regression, coefficient of correlation
15	Tests of Hypotheses: The Use of P Values for Decision Making in Testing Hypotheses, alpha level, significance
16	Sampling Distribution of S2
17	Chi-squared distribution, t-Distribution

Recommended Textbooks

1. Walpole, R. E., Myers, R. H., Myers, S. L., & Ye, K. (2017). Probability & Statistics for Engineers & Scientists: MyStatLab Update. Pearson. ISBN: 9780134508610.

Recommended Reference (Books/Websites/Articles)

1. Introduction to Statistical Theory by Sher Muhammad Chaudhry, Dr. Shahid Kamal, Ninth Edition 2013,
2. Probability and Statistics for Engineers and Scientists by Anthony J. Hayter.
3. Schaum's Outline of Probability and Statistics, by John Schiller, R. Alu Srinivasan and Murray Spiegel, McGraw-Hill; 3rd Edition (2008). ISBN-10:0071544259

Theory of Automata
Course Code: CSTA-342

Semester	Credit Hours	Prerequisite
[BSCS-5]	[3+0]	[None]

Course Description
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).

Course Learning Outcomes (CLOs)
The course learning outcome along with domain and taxonomy level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Design and derivation of regular languages using mathematical models	C	C4-Analysis	PLO-4
CLO-2	Design and derivation of non-regular languages using mathematical models	C	C4-Analysis	PLO-4
CLO-3	Design of Turing Machine.	C	C4-Analysis	PLO-4

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

Course Materials
Automata theory is the study of abstract computational devices. The purpose of this course is to understand the power and limitations of such devices via rigorous methods. We will study various models including finite automata, grammars, pushdown automata, and Turing machines. We will develop methods for classifying computational devices according to their computational power, and tools which will allow us to tell if a device is powerful enough to solve a given computational problem. Details of the topics is given below:
Finite State Models:
Language definitions preliminaries

- Descriptive Method
  - Regular expressions
  - Finite automata (NFA, DFA)
  - Transition graphs
  - Kleene's theorem
  - Union, Intersection & Complement of FA

  - DFA Minimization
  - Transducers (automata with output),
  - Pumping lemma
- Non Regular Language Grammars
  - Context free grammars
  - Derivations, derivation trees and ambiguity
  - Simplifying CFLs ,
  - Normal form grammars and parsing
  - Decidability
  - Push Down Automata
  - Context sensitive languages, grammars and linear bounded automata (LBA)
  - Chomsky's hierarchy of grammars
- Turing Machine
  - Turing Machines Theory
  - Post machine
  - Variations on TM
  - TM encoding
  - Universal Turing Machine
  - Defining Computers by TMs

Course Weekly Schedule
The course schedule for 16 weeks are detailed below

Week	Topic
1	Language definitions preliminaries, Descriptive Method
2	Regular expressions
3	Finite Automata, NFA, DFA
4	Transition graphs, TG to RE
5	Kleene's theorem, Union, Intersection & Complement of FA, DFA Minimization
6	Transducers (Mealy Machine, Moore Machine), Conversions
7	Regular languages vs Non regular languages, Properties of regular languages, Pumping Lemma
8	Context free grammars, Derivations, derivation trees and ambiguity
9	**Mid Term Exams**
10	Simplifying CFL, Normal form grammars and parsing, Decidability
11	Push Down Automata

Week	Topic
12	Context sensitive languages, Grammar, Linear bounded automata (LBA)
13	Chomsky's hierarchy of grammars
14	Turing Machine Theory, Post machine
15	Variations on TM, TM encoding
16	Universal Turing Machine, Defining Computers by TMs
17	Revision

Recommended Textbooks

1. The textbook for this course is Introduction to Automata Theory, 2nd edition, by Daneal I.A Cohen.
2. Automata, Computability and Complexity: Theory and Applications, by Elaine Rich, 2011
3. An Introduction to Formal Languages and Automata, By Peter Linz, 4th edition, Jones & Bartlett Publishers, 2006
4. Theory of Automata, Formal Languages and Computation, By S. P. Eugene, Kavier, 2005, New Age Publishers, ISBN (10): 81-224-2334-5, ISBN (13): 978-81-224-2334-1.
5. Introduction to Automata Theory, Languages, and Computation, John Hopcroft and Jeffrey Ullman, 2nd edition, 2001, Addison-Wesley.
6. Introduction to Languages and the Theory of Computation, By John C. Martin 3rd edition, 2002, McGraw-Hill Professional.

CS Elec. - IV, Numerical Analysis

Course Code: CSNA-366

Semester	Credit Hours	Prerequisite
[BSCS-5]	[2+0]	[None]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	COMPARE the different kinds of numerical methods and their advantages and limitations.	C	C4 Analysis	2
CLO-2	APPLY various numerical methods in real world problems.	C	C3 Application	2
CLO-3	EVALUATE the solution by selecting the best numerical method under the given scenario of a problem.	C	C6 Evaluation	2

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain.**

Course Materials

This course introduces the following topics to the students:

- Introduction, Advantages of Numerical Methods, Rounding off, 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.
- 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. Iterative Methods: Jacobi and Gauss-Seidel Methods.
- 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-eight Rules and Composite Rules.

Course Weekly Schedule
The course schedule for 16 weeks are detailed below:

Week	Topic
1	Introduction, Advantages of Numerical Methods, Approximations and Errors, Types and Sources of Errors.
2	Algorithm, Solutions of Algebraic and Transcendental Equations.
3	Numerical Solution of Nonlinear Equations: Bisection Method, The method of False Position.
4	Fixed Point Iteration Method, Newton-Raphson Method.
5	Secant Method, Order of Convergence of these methods.
6	Numerical Solution of System of Algebraic Linear Equations. Exact Methods: Gauss Elimination Method.
7	LU Decomposition Method.
8	Dolittle's, Crout's and Cholesky's Methods.
9	**Mid Term Exam**
10	Iterative Methods: Jacobi Method.
11	Gauss-Seidel Method.
12	Interpolation and Polynomial Approximation: Lagrange's formula.
13	Newton's difference formulae.
14	Numerical Differentiation.
15	Numerical Integration and Error Estimates: Trapezoidal Method.
16	Simpson's one-third and three-eight Rules.
17	Composite Rules.

Recommended Textbooks
1. Ahmed, Rana, F., Afzal, M. (2015). Elements of Numerical Analysis. National Book Foundation, Pakistan, ISBN: 9789693708165.
2. Süli, E., & Mayers, D. F. (2003). An Introduction to Numerical Analysis. Cambridge University Press. ISBN: 9780521007948.

3. Burden, R. L., & Faires, J. D. (2011). Numerical Analysis. Cengage Learning. ISBN: 9788131516546.

CS Elec. - IV, Numerical Analysis -Lab

Course Code: CSNA-366L

Semester	Credit Hours	Prerequisite
[BSCS-5]	[0+1]	[None]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	COMPARE the different kinds of numerical methods and their advantages and limitations.	C	C4 Analysis	2
CLO-2	APPLY various numerical methods in real world problems.	C	C3 Application	2
CLO-3	EVALUATE the solution by selecting the best numerical method under the given scenario of a problem.	C	C6 Evaluation	2

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain.**

Course Materials

This course introduces the following topics to the students:

- Introduction, Advantages of Numerical Methods, Rounding off, 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.
- 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. Iterative Methods: Jacobi and Gauss-Seidel Methods.
- 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-eight Rules and Composite Rules.

Course Weekly Schedule
The course schedule for 16 weeks are detailed below:

Week	Topic
1	Introduction, Advantages of Numerical Methods, Approximations and Errors, Types and Sources of Errors.
2	Algorithm, Solutions of Algebraic and Transcendental Equations.
3	Numerical Solution of Nonlinear Equations: Bisection Method, The method of False Position.
4	Fixed Point Iteration Method, Newton-Raphson Method.
5	Secant Method, Order of Convergence of these methods.
6	Numerical Solution of System of Algebraic Linear Equations. Exact Methods: Gauss Elimination Method.
7	LU Decomposition Method.
8	Dolittle's, Crout's and Cholesky's Methods.
9	**Mid Term Exam**
10	Iterative Methods: Jacobi Method.
11	Gauss-Seidel Method.
12	Interpolation and Polynomial Approximation: Lagrange's formula.
13	Newton's difference formulae.
14	Numerical Differentiation.
15	Numerical Integration and Error Estimates: Trapezoidal Method.
16	Simpson's one-third and three-eight Rules.
17	Composite Rules.

Recommended Textbooks

1. Ahmed, Rana, F., Afzal, M. (2015). Elements of Numerical Analysis. National Book Foundation, Pakistan, ISBN: 9789693708165.
2. Süli, E., & Mayers, D. F. (2003). An Introduction to Numerical Analysis. Cambridge University Press. ISBN: 9780521007948.

3. Burden, R. L., & Faires, J. D. (2011). Numerical Analysis. Cengage Learning. ISBN: 9788131516546.

Semester VI

Advanced Database Management System

Course Code: CSAD-343

Semester	Credit Hours	Prerequisite
[BSCS-6]	[2+0]	[CSDB-225]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Decide** on configuration issues related to database operation and performance.	C	C3 Application	2
CLO-2	**Analyze compare** and **evaluate** alternative database architectures in different application contexts.	C	C4 Analysis	3
CLO-3	**Analyze and optimize** complex queries through the interpretation of query execution plans and implementation of effective indexing strategies.	C	C5 Synthesis	3

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Introduction to advance data models such as object relational, object oriented. File organizations concepts, Transactional processing and Concurrency control techniques, Recovery techniques, Query processing and optimization, Database Programming (PL/SQL, T-SQL or similar technology), Integrity and security, Database Administration (Role management, managing database access, views), Physical database design and tuning, Distributed database systems, Emerging research trends in database systems, MONGO DB, NO SQL (or similar technologies).

Course Weekly Schedule

The course schedule for 16 weeks is detailed below

Week	Topic
1,2	Introduction to Advanced DBMS - Overview of course objectives and structure - Review of fundamental database concepts - Introduction to advanced topics in DBMS - Discussion on emerging trends in database management
3,4	- Normalization beyond 3NF - Handling de-normalization and performance considerations
5,6,7	Query Optimization and Performance Tuning - Query execution plan analysis - Indexing strategies for complex queries - Performance optimization techniques - Database caching and memory management
8,9	NoSQL databases and their use cases Integration of NoSQL databases with traditional DBMS
10,11	Distributed Databases - Concepts of distributed database systems - Replication and synchronization strategies - Consistency and availability trade-offs
12,13	Big Data - Introduction to Big Data concepts Types and characteristics Analytics, Application and lifecycle OLTP, OLAP and RTAP
14,15	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

Week	Topic
16	Emerging Trends - Discussion on blockchain in databases - Exploring graph databases and their applications - Final project presentations and demonstrations - Reflection on the course and future directions

Recommended Textbooks

1. **Database Management Systems** by Raghu Ramakrishnan and Johannes Gehrke.
2. **SQL Performance Explained** by Markus Winand.
3. **Big Data: A Revolution That Will Transform How We Live, Work, and Think** by Viktor Mayer-Schönberger and Kenneth Cukier.
4. **NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence** by Pramod J. Sadalage and Martin Fowler.

Advanced Database Management System Lab

Course Code: CSAD-343L

Semester	Credit Hours	Prerequisite
[BSCS-6]	[0+1]	[CSDB-225L]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Understanding** advance data models, technologies and approaches for building distributed database systems.	C	C2 Comprehension	2
CLO-2	**Applying** the models and approaches in order to become enabled to select and apply appropriate methods for a particular case	P	P1 Perception	4
CLO-3	To **develop** a database solution for a given scenario/ challenging problem in the domain of distributed database systems.	P	P5 Complex Overt Response	4

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Introduction to advance data models such as object relational, object oriented. File organizations concepts, Transactional processing and Concurrency control techniques, Recovery techniques, Query processing and optimization, Database Programming (PL/SQL, T-SQL or similar technology), Integrity and security, Database Administration (Role management, managing database access, views), Physical database design and tuning, Distributed database systems, Emerging research trends in database systems, MONGO DB, NO SQL (or similar technologies)

Lab Weekly Schedule

The lab schedule for 16 weeks is detailed below. All CLOs shall be accessed in each lab.

Week	Topic
1	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
2	Advanced SQL Queries - Complex Queries using Joins and subqueries - Using CASE statements and calculated fields
3	Normalization and Database Design - Exploring normalization beyond 3NF - Applying normalization rules to improve schema design - Converting normalized schema into SQL tables
5,6	Query Optimization - Introduction to query optimization techniques - Analyzing query execution plans - Identifying performance bottlenecks and possible optimizations
7	Indexing Strategies - Understanding different types of indexes - Creating and managing indexes - Evaluating the impact of indexes on query performance
8	Advanced SQL Techniques - Working with window functions for ranking and aggregation - Using Common Table Expressions (CTEs) and recursive queries - Handling semi-structured data with JSON functions
9	**Mid Term Exam**
10	Geospatial Data Handling - Introduction to geospatial data and applications - Performing spatial queries and calculations - Integrating geospatial data into the database

Week	Topic
11	NoSQL Databases and Hands-on with MongoDB/Firebase etc** Understanding NoSQL databases and their characteristics - Introduction to MongoDB and its document-based model
12	NoSQL Databases and Hands-on with MongoDB** - - CRUD operations and basic querying in MongoDB
13	NoSQL Databases - Advanced Features - Indexing and performance optimization in MongoDB - Aggregation framework for complex queries - Data modeling considerations in NoSQL databases
14	Data Security and Privacy - Exploring database security mechanisms - Implementing role-based access control - Encrypting data and ensuring data privacy
15	Data Security and Privacy - Exploring database security mechanisms - Implementing role-based access control - Encrypting data and ensuring data privacy
16	Final Projects and Presentations - Dedicated time for final project development - Weekly progress check-ins with instructor - Final project presentations and demonstrations

Recommended Textbooks

1. **Database Management Systems** by Raghu Ramakrishnan and Johannes Gehrke.
2. **SQL Performance Explained** by Markus Winand.
3. **Big Data: A Revolution That Will Transform How We Live, Work, and Think** by Viktor Mayer-Schönberger and Kenneth Cukier.
4. **NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence** by Pramod J. Sadalage and Martin Fowler.

Analysis of Algorithms

Course Code: CSAA-330

Semester	Credit Hours	Prerequisite
[BSCS-6]	[3+0]	[CSDS-224]

Course Description

This course is an advanced undergraduate course on design and analysis of algorithms. Topics such as role of algorithms in computing, Big-O, Big Ω, Big Θ, Recursion and Recurrence Relations, Loop Invariants, Sorting Algorithms, Search Algorithms, String Matching Algorithms, Heaps, Hashing, Graph Traversal Algorithms, Algorithm Design Techniques, Greedy Algorithms, Divide and Conquer and Dynamic Programming.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Understand the fundamental algorithms in computer science, given a problem, students would be able to explain the strategies and design algorithms.	C	C2 Understanding	2
CLO-2	Analyze the time and space complexity ofalgorithms using asymptotic notations.	C	C4 Analysis	3
CLO-3	Use of the strategies to solve a problem more efficiently and design algorithm for solving problems.	C	C3 Application	3

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Introduction to Course, Role of Algorithms, Algorithm and its attributes, Analyzing Algorithms
- Rate of Growth, Growth Functions, Asymptotic Analysis (Big-O, Big Ω, Big Θ)
- Prove Big-O, Big Ω, Big Θ using both Formal Mathematical Definitions and Limits
- Amortized Analysis
- P and NP class Problems
- Sorting Algorithms Analysis (Bubble Sort, Selection Sort)
- Searching Algorithms
- Recursion

- Method to Solve Recurrence Relation (Substitution Method)
- Recursion Tree Method, Master's Theorem
- Binary Search Tree
- Algorithm Design Techniques: Divide-and-Conquer: Merge-Sort , Quicksort, Randomized Quicksort and Complexity Analysis
- Heaps, Heap Sort along with Complexity Analysis
- String Matching Algorithms
- Hashing and Complexity
- Graph Traversal Algorithms and Complexity
- Greedy Algorithms (Minimum Spanning Tree: Prim's and Kruskal's Algorithm, Dijkstra'sAlgorithm)
- Dynamic programming (Bellman Ford Algorithm, All-Pairs Shortest Paths: Floyd-Warshall Algorithm) Dry run and Complexity Comparison

Course Weekly Schedule
The course schedule for 16 weeks is detailed below

Week	Topic
1	Introduction to Course, Role of Algorithms, Algorithm and its Attributes, Analyzing algorithms, Approaches to Analysis: Empirical Approach, Analytical, Algorithm Specification, RAM Computational Model, Computational Complexity
2	Rate of Growth, Growth Functions, Asymptotic analysis (Big-O, Big Ω, Big Θ)
3	Prove Big-O, Big Ω, Big Θ using both Formal Mathematical Definitions and Limits, Amortized Analysis. loop invariants
4	Masters Theorem and Examples, Substitution Method.
5	Sorting Algorithms: Selection Sort, Bubble Sort, Insertion Sort, Custom Sorting Algorithms
6	Recursion, Recurrence Relations, Method to Solve Recurrence Relation.
7	Recursion Tree Method
8	Binary Search Tree
9	**Mid Term Exams**
10	Algorithm Design Techniques.
11	Divide-and-conquer: Merge-Sort + Complexity Analysis
12	Quicksort, Randomized Quicksort + Complexity Analysis
13	Greedy algorithms (Minimum Spanning Tree: Prim's and Kruskal's Algorithm)
14	Single Source Shortest Path: Dijkstra's algorithm with analysis

Week	Topic
15	Dynamic programming (Bellman Ford Algorithm, All-Pairs Shortest Paths: Floyd-Warshall Algorithm)
16	Hashing, String Matching Algorithms
17	Graph Representation structure and associated complexity, Graph Traversal Algorithms

Recommended Textbooks

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

Computer Networks

Course Code: CSCN-331

Semester	Credit Hours	Prerequisite
[BSCS-6]	[2+0]	[None]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Describe** the key concepts and technologies of computer networks	C	C2-Understanding	2
CLO-2	**Analyze** the functions and services provided by each layer of Internet Protocol Stack and Categorize various networking devices according to their roles in different layers and protocols	C	C4-Analysis	2
CLO-3	**Evaluate** different scenario at datalink, network and transport layers of OSI model.	C	C6-Evaluation	4

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics:

- Protocol layers and service models. OSI and Internet protocols.
- What is the Internet. Concepts of delay, security, and Quality of Service (QoS).
- Application layer protocols and client-server model.
- Sockets programming in C (client-server and web server programs).
- Reliable data transfer. Stop-and-Go evaluation. TCP and UDP semantics and syntax.
- TCP RTT estimation. Principles of congestion control.
- Security. Overview of threats, cryptography, authentication, and firewalls. Discussion of project.
- Principles of routing. Link-state and distance vector. IP semantics and syntax.
- Link-state and distance vector routing.
- Link layer. Error detection. Multiple access protocols. IEEE 802.3 Ethernet.
- Switching and bridging. Media. Signal strength. Data encoding.

- Wireless and mobile networks.
- Network management including SNMP. Network troubleshooting. Hot topics such as SDN and IoT.
- Hot topics such as SDN and IoT.

Course Weekly Schedule
The course schedule for 17 weeks is detailed below

Week	Topic
1	Basic concepts of networking i.e. internet. Network edge and core description. Packet switched network, Circuit switch network concept. Delay, loss throughput
2	The concept of layered architecture modeling including OSI and the TCP/IP protocol suite. Client-server communications. Various network attacks. Numerical problems
3	Principles of application layer. Functioning of various application layer protocols including http, FTP, SMTP. Working of DNS.
4	Peer to peer applications. Socket programming with UDP and TCP
5	Introduction to Transport layer. Multiplexing and de-multiplexing techniques. Connectionless transport UDP
6	Principles of reliable data transfer. Connection oriented TCP
7	Flow control, RTT estimation. Flow control and congestion control mechanisms
8	Services of network layer i.e. routing and forwarding. Virtual circuit and datagram networks.
9	**Mid Term Exams**
10	Internal Structure of the Router. Introduction to IPv4 and IPv6. Subnetting, VLSM, Supernetting and ICMP.
11	Routing concepts. Concept of link state, distance vector routing and hierarchical routing. Intra-AS routing protocols i.e. OSPF, RIP. Numerical problems.
12	Introduction to services of link layer. Error detection and Correction techniques including parity check, checksum and CRC.
13	Media access control protocols. Switched local area networks i.e. Ethernet, link layer addressing, ARP and VLAN's and Link virtualization.
14	Introduction to wireless and Mobile networks. Wifi: 802.11 architecture, frame structure, protocol and mobility issues. Personal area networks i.e. Bluetooth and Zigbee. Introduction to GSM, LTE architecture and management.
15	Vertical and horizontal handoff. Mobile IP and mobility management issues such triangle routing problem.
16	Protocols of real-time conversational applications i.e. RTP and SIP, basics of networks security.

Week	Topic
17	Symmetric key cryptography and public key encryption.

Recommended Textbooks

1. Computer Networking: A Top-Down Approach, 6th edition, by James Kurose and Keith Ross (ISBN-13: 978-0133594140)

Recommended Reference (Books/Websites/Articles)

1. Data Communications and Networking, by Behrouz a. Ferouzan 4th edition, McGraw-Hill, 2007.

Computer Networks Lab

Course Code: CSCN-331L

Semester	Credit Hours	Prerequisite
[BSCS-6]	[0+1]	[None]

Course Description

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Demonstrate** knowledge about the practical aspects of Computer Networks	C	C3-Application	3
CLO-2	**Practice** network setups and trouble-shoot in simulation and practical environment	P	P3-Guided Response	4
CLO-3	**Report** the outcome of an experiment/task in a standard format	A	A2-Responding	7

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Internetworking functions of each layer of the OSI reference model and how they are performed in network devices
- Design, implementation, configuration, and monitoring of LAN and WAN services
- Functionality and operation of Cisco's IOS software
- Addition of routing protocols to a network configuration
- Functionality of network protocols including TCP/IP, IPX, and ICMP
- Configuration, monitoring, and verification of standard and extended access lists
- Segmentation of networks using routers, switches, and bridges

Lab Weekly Schedule

The course schedule for 16 weeks is detailed below

Week	Topic
1	Cables, Connectors, and Preparing Ethernet Cables
2	Understanding Network Commands
3	IP Addressing and Subnetting

Week	Topic
4	Configuring basic Switch: Switch configuration, Speed, and Duplex
5	Securing the Switch: Setting up telnet, MOTD banner, etc, Test telnet connection, Line VTY, Cisco Password Encryption, Cisco port security
6	Virtual LAN (VLANs): Create VLANs, Router On A Stick, Native VLAN, and Mismatch
7	Servers and CDP: DHCP server, Web Server, CDP Protocol
8	**Open Ended Lab**
9	Switch Redundant connections and Loops (STP)
10	Setting up basic Router Configurations: Setting up router names and passwords, Adding modules to a Router, Basic router configuration
11	Setting up Static Routes
12	Setting up Default Routes
13	Configuring WAN Connection: Serial connection, PPP encapsulation
14	Implementing and analyzing Router Information Protocol (RIP) ver. 2
15	Setting up an Enterprise level Network and testing connectivity, Access Lists
16	**Open Ended Lab**

Recommended Textbooks

1. Press, Cisco. "Cisco CCNA Exam# 640-507 Certification Guide." (2000).

CS Elec. - V, Mobile Application Development

Course Code: CSMA-367

Semester	Credit Hours	Prerequisite
[BSCS-6]	[2+0]	[None]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Understand** the life cycle of android applications	C	C2 Comprehension	2
CLO-2	**Design** interactive interface for mobile applications using various layouts	C	C6 Evaluation	4
CLO-3	**Develop** mobile applications for comprehensive systems using latest trends and practices	C	C6 Evaluation	4

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

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

Course Weekly Schedule

The course schedule for 17 weeks is detailed below

Week	Topic
1	Mobile Application Development Platforms, System installation (Android Studio)
2	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
3	Components of Android Project (Application Structure), Using code Completion Debugging Application, What activities are?
4	Android Studio Layout editor, component tree, Constraint view, layout properties
5	Activities, Layouts, layout attributes, Views. View Groups, layout Orientation, XML files (string, colors, values, dimen) in the project, Resource folders
6	Intents in Android
7	Calling build in intents, communication between activities
8	Fragments, Display Notifications
9	**Mid Term Exams**
10	Design interface with views
11	Displaying Pictures and menus with views
12	Data Persistence, Content providers
13	Messages (SMS, EMAIL), Location based services(Maps)
14	Networking, Establishing an HTTP Connection, Consuming Web Services using HTTP, Consuming JSON Services
15	Android Services, Create Own Services, Establishing Communication between a Service and an Activity Binding Activities to Services, Understanding Threading
16	Introduction to iOS Architecture and framework, Introduction to Xamarin/Flutter for cross platform development
17	Publishing, Android Applications, Mobile Programming Languages, Emerging Technologies.

Recommended Textbooks

1. Professional Android Application Development, Reto Meier, Wrox Programmer to Programmer, 3rd Edition (2014)
2. iOS Programming: The Big Nerd Ranch Guide, Conway, J., Hillegass, A., & Keur, C., 5th Edition (2015)

Recommended Reference (Books/Websites/Articles)

1. Android Programming: The Big Nerd Ranch Guides, Phillips, B. & Hardy, B., 3rd Edition (2017).

CS Elec. - V, Mobile Application Development -Lab

Course Code: CSMA-367L

Semester	Credit Hours	Prerequisite
[BSCS-6]	[0+1]	[None]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Develop** programs using fundamental concepts of mobile application development	C	C6 Evaluation	4
CLO-2	**Manipulate** the use of Android Studio for making mobile applications	P	P3 Guided Response	5
CLO-3	**Manipulate** the use of any technology to create a mobile application with database connectivity.	P	P3 Guided Response	5

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

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

Lab Weekly Schedule

The course schedule for 17 weeks is detailed below

Week	Topic
1	Introduction to Android Studio, Different features/components, and their use
2	Basic concept of layouts, Designing UI through XML
3	Code Classes, Events and Event Handling, Accessing UI components in code
4	Component tree, Constraint view, layout properties
5	Views, View Groups, layout Orientation, XML files (string, colors, values, dimen) in the project, Resource folders
6	Intents in Android
7	Calling build in intents, communication between activities
8	Fragments, Display Notifications
9	**Mid Term Exams**
10	Design interface with views
11	Displaying Pictures and menus with views
12	Data Persistence, Content providers
13	Messages (SMS, EMAIL), Location based services (Maps)
14	Networking, Establishing an HTTP Connection, Consuming Web Services using HTTP, Consuming JSON Services
15	Android Services, Create Own Services, Establishing Communication between a Service and an Activity Binding Activities to Services, Understanding Threading
16	Introduction to Xamarin/Flutter for cross platform development
17	Publishing, Android Applications

Recommended Textbooks

1. Professional Android Application Development, Reto Meier, Wrox Programmer to Programmer, 3rd Edition (2014)
2. iOS Programming: The Big Nerd Ranch Guide, Conway, J., Hillegass, A., & Keur, C., 5th Edition (2015)

Recommended Reference (Books/Websites/Articles)

1. Android Programming: The Big Nerd Ranch Guides, Phillips, B. & Hardy, B., 3rd Edition (2017)

Technical & Business Writing

Course Code: ESTW-304

Semester	Credit Hours	Prerequisite
[BSCS-6]	[3+0]	[ESFE-108]

Course Description

The purpose of this course is that students will learn about the mechanics of Writing Skills which will help them to write effectively and accurately. Course topics address both the technical aspects of writing skills and issues pertaining to formal documentation.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**State** purposes and qualities of reports	C	C1 Knowledge	7
CLO-2	**Apply** different techniques and principles to prepare a report	C	C3 Application	7
CLO-3	**Explain** different types of plagiarism	C	C2 Comprehension	7
CLO-4	**Participate** in presentations and volunteer to share your knowledge in the class	A	A2 Responding	6

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Technical writing-an essential job skills, types and purposes of reports, the research process, primary and secondary research, writing process at work-outlining, paraphrasing, sequencing. Proposals-types and Characteristics Proposals for research reports. Effective mechanics: spellings, abbreviations, caps Summarizing skills-writing summary an abstract, process of revising-editing , plagiarism, paraphrasing skills, short reports-IMRD reports, Recommendation reports, progress reports, long repots, business emails, quoting/referencing skills.

Weekly Schedule

The course schedule for 16 weeks is detailed below

Week	Topic
1	Technical writing-an essential job skills, types and purposes of reports

Week	Topic
2	The research process, primary and secondary research
3	writing process at work-outlining, paraphrasing, sequencing
4	Proposals-types and Characteristics
5	Proposals for research reports
6	Writing proposals for solutions/bids for technical projects
7	Summarizing skills-writing summary an abstract
8	Process of revising-editing, sentence errors
9	**Mid Term Exams**
10	Effective mechanics: spellings, abbreviations, caps
11	Short reports-types and format
12	IMRD reports and progress reports
13	Plagiarism-definition, types and techniques to avoid it.
14	Long reports contents, parts and format
15	Business emails, quoting/referencing skills,
16	Final presentations

Recommended Textbooks

1. Riordan, D. (2013). *Technical Report Writing Today*. Cengage Learning. ISBN: 9781133607380.

Recommended Reference (Books/Websites/Articles)

1. Hardesty, R. E. (2010). *Technical and Business Writing for Working Professionals*. Xlibris Corporation. ISBN: 9781456819408.

Digital Marketing

Course Code: CSDM-317

Semester	Credit Hours	Prerequisite
[BSCS-6]	[2+0]	[None]

Course Description

The course provides a framework to design and execute a winning SEO strategy and Digital Campaigns. Also enables students to leverage the power of Optimization techniques and online marketing to create awareness (upper funnel marketing) to realizing sales due to organic traffic.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Explain emerging trends in SEO/digital marketing and critically assess the use of digital marketing tools by applying relevant marketing theories and frameworks.	C	C2 Comprehension	3
CLO-2	Demonstrate cognitive knowledge of the skills required in conducting online research and research on online markets for identifying, assessing and selecting SEO techniques and digital marketing opportunities for a business.	C	C3 Application	3
CLO-3	Investigate and evaluate issues in adapting to globalized markets that are constantly changing and increasingly networked.	C	C4 Analysis	10

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Understand how to reach your target customers using SEO.
- Define the main elements of a well-optimized website.
- Utilize keyword research insights to understand user intent.
- Determine how to build and grow sustainable and qualified website traffic.
- Fundamental concepts of Marketing
- Setting the right "Campaign Objective"
- Overview of available Digital Platforms (Google Search, Youtube, Facebook, Instagram) and Digital properties they offer
- Tracking campaign success vs. selected KPI's (Key Performance Indicators)
- Creative Excellence – What makes an ad stand out

Course Weekly Schedule
The course schedule for 16 weeks is detailed below

Week	Topic
1	Introduction/Overview: SEO intro, History, Development and Growth of Search Engine in Cyber space. Pull Marketing, Purpose of SEO, How Google search engine works, Google Ranking, SEO success factors.
2-3	Keywords: Intro, Purpose, Types of keywords (primary, secondary, LSI keywords), Keyword Researching and Planner tools, Other 3rd party tools and desktop applications, Mapping keywords to webpage, Segregation of High and Low priority keywords, Excel file of Keywords, Uses of formulas to find Best Keywords.
4	OnPage SEO: Introduction, Basics of HTML, designing how to use Keywords, URL, Meta, Title, Description, Heading Tags, Content, images, ALT, video, Anchortext, HTML sitemaps, sitemaps creation tools, interlinking, Google search console and Bing Webmaster.
5	OffPage SEO: Introduction, Backlinks, gTLD and ccTLD, PageRank Algorithm, Local SEO, Social SEO
6	UI and UX: Introduction, difference between UI and Ux, UI/UX Critical Factors, UX conversion rate optimization, Conversion Matrices, Google search analytics.
7-8	Technical SEO: Introduction, Factors of Technical SEO, URL architecture, Page Speed Analysis, Page Speed Tools (GTMetrix, Pingdom, Google page speed checker), Test and Improved page speed, Mobile web crawling, Structured data usage and optimization, creating crawlable resources, Auditing internal links, reviewing sitemap
9	Local SEO: SEO strategies for localized business, social media back linking and marketing, Local SEO tools (Quora, Twitter, LinkedIn, Facebook, Google+, Pinterest), Online Reputation Management, Targeted Audience Strategy, Lead generation for local audience, Local SEO by Category(Niche, products, services), Schema for local addresses, local keywords and websites.
10	SEO Site Audit: Audit before launching the site, Domain name (Brand name generator, EMD for specific purpose), Brainstorming (Tools), Prototyping (Tools), Mockup maping (tools), Logo Suggestion-color scheme, Design and SEO UI/UX,Audit after launching website, onPage Audit, offPage Audit, Tools: Online free tools, Paid Tools, Desktop Applications, Audit Report. How to analyze and measure audit report, Reporting for client, Google Algorithm Updates, Search algorithm overview, google algorithm change, Google ML.
11	Search Engine Marketing-Adwords: Introduction and Types of SEM, Google PPC and Adwords, Fundamentals of Ad making, ad position, ad auction, Ad rank, ad formats, bidding, Google dashboard.

Week	Topic
12	Campaign creation-Adwords: Cost per Click, Costs per Impression, Cost per Acquisition, Keyword targeting and strategy, Enhanced cost per click, Keyword match types, Broad Phrase, Broad match (modifier, exact, negative), Keyword Performance high conversion.
13	Display Advertisement: Introduction (PPC, CPM), purpose and advantage of Display Ads Mapping, Marketing objectives, targeting methods, Display ad formats and tools, Remarketing of SEM, Reports and Optimizing display campaign.
14	Video Paid Ads: Video Paid Advertising, AdWords video ads, Platforms (youtube, instream), video discovery ads, bumper ads, how to create video ads, creation of CTA, overlay ads, Optimizing video ads, Ad reporting and Youtube analytics.
15	Shopping advertisement: Google shopping ads, product listing ad, ad formats, appearance on Goofle, Requirements of Advertisement, create shopping campaign on Google AdWord, Features of Google Shopping, PLA.
16	**End Term Exam**

Recommended Textbooks

1. Enge, E., Spencer, S., & Stricchiola, J. (2015). *The Art of SEO: Mastering Search Engine Optimization*. Zarrella, D. (2009). The Social Media Marketing Book. O'Reilly Media, Inc. ISBN: 9781491903650.
2. Kingsnorth, S. (2019). *Digital Marketing Strategy: An Integrated Approach to Online Marketing*. Kogan Page Limited. ISBN: 9780749484224

Semester VII

CS Elec. - IV, HCI & Computer Graphics

Course Code: CSCG-444

Semester	Credit Hours	Prerequisite
[BSCS-7]	[2+0]	[None]

Course Description

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 overs ore 3d graphics concepts like transformation, projections and rendering. Course topics include both the mathematical as well as technical aspects of developing graphics.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Understand and be familiar with current concepts in 3d graphics, along with the basic workflow of the graphics pipeline.	C	C1 Knowledge	2
CLO-2	Learn and implement basic graphics related Algorithms and techniques to create and manipulate 3d graphics.	C	C3 Application	3
CLO-3	Be able to create a simple 3D game in Unit 3d and be familiar with the basics of game development.	C	C3 Application	4

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces basic and standard aspects of Computer Graphics that are currently being practiced:

- CRT (Cathode Ray Tube) devices: DVST.
- Color Models: Pseudo Colors, True Colors, High colors and Deep colors
- Color Modes: Additive and Subtractive
- Transformations: 2D, 3D, HCS and Composite Transformations
- Projection: Affine and Solid Body
- World window to Viewport Transformations
- Line Drawing Algorithms: DDA (Digital differential algorithm)
- Bresenham's Line Drawing Algorithm
- Clipping Algorithms: Cohen Sutherland Clipping Algorithm

- Sutherland Hodgeman Clipping Algorithm
- Filling Algorithms: Scanline Filling Algorithm.
- 8-point filling Algorithm & 4-Point Filling Algorithm
- Rendering: Forward and Backward Rendering and rendering in Nature
- Lighting and Shading
- Texture Mapping: Minification and Magnification
- Ellipse and other Curves
- Visible Surface Detection: Painter's Algorithm
- Ray Tracing Algorithm
- Z-Buffer Algorithm & Revision

Course Weekly Schedule
The course schedule for 17 weeks is detailed below

Week	Topic
1	Introduction to HCI. History and Usages CRT (Cathode Ray Tube) devices: DVST.
2	Color Models: Pseudo Colors, True Colors, High colors and Deep colors. Human Cognition, Importance of Color models in visual perception
3	Color Modes: Additive and Subtractive. Metrics and Measures for Evaluation of the Interface.
4	Transformations: 2D, 3D, HCS and Composite Transformations.
5	Projection: Affine and Solid Body. Usability heuristics and principles of Usability testing.
6	World window to Viewport Transformations. Principles of good interaction design
7	Line Drawing Algorithms: DDA (Digital differential algorithm)
8	Bresenham's Line Drawing Algorithm
9	**Mid Term Exams**
10	Clipping Algorithms: Cohen Sutherland Clipping Algorithm
11	Sutherland Hodgeman Clipping Algorithm
12	Filling Algorithms: Scanline Filling Algorithm
13	8-point filling Algorithm & 4-Point Filling Algorithm

Week	Topic
14	Rendering: Forward and Backward Rendering and rendering in Nature, Vectors and 3d Geometry. Usability inspection methods, Usability testing methods.
15	Lighting and Shading Interaction Technologies, Usability in practice
16	Visual Design and Typography, Icon Design
17	Ellipse and other Curves

Recommended Textbooks

1. Hearn, D., Baker, M. P., & Carithers, W. (2014). *Computer Graphics with OpenGL*. Dorling Kindersley, India. ISBN: 9789332518711.
2. Gortler, S. J. (2012). *Foundations of 3D Computer Graphics*. MIT Press. ISBN: 9780262017350.
3. Hughes, J. F., Van Dam, A., McGuire, M., Foley, J. D., Sklar, D., Feiner, S. K., & Akeley, K. (2014). *Computer Graphics: Principles and Practice*. Addison-Wesley. ISBN: 9780321399526.
4. Akenine-Möller, T., Haines, E., & Hoffman, N. (2008). *Real-Time Rendering*. CRC Press. ISBN: 9781439865293.

CS Elec. - IV, HCI & Computer Graphics -Lab

Course Code: CSCG-444L

Semester	Credit Hours	Prerequisite
[BSCS-7]	[0+1]	[None]

Course Description

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 overs ore 3d graphics concepts like transformation, projections and rendering. Course topics include both the mathematical as well as technical aspects of developing graphics.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Create a 3D model in any modelling tool, light and shade it, add texture to it etc. and create a photorealistic scene.	P	P3 Guided Response	5
CLO-2	Be able to create programs in OpenGL using any library.	P	P3 Guided Response	5
CLO-3	The student should be able to Create work based on the HCI guidelines.	P	P3 Guided Response	5

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces basic and standard aspects of Computer Graphics that are currently being practiced:

- CRT (Cathode Ray Tube) devices: DVST.
- Color Models: Pseudo Colors, True Colors, High colors and Deep colors
- Color Modes: Additive and Subtractive
- Transformations: 2D, 3D, HCS and Composite Transformations
- Projection: Affine and Solid Body
- World window to Viewport Transformations
- Line Drawing Algorithms: DDA (Digital differential algorithm)
- Bresenham's Line Drawing Algorithm

- Clipping Algorithms: Cohen Sutherland Clipping Algorithm
- Sutherland Hodgeman Clipping Algorithm
- Filling Algorithms: Scanline Filling Algorithm.
- 8-point filling Algorithm & 4-Point Filling Algorithm
- Rendering: Forward and Backward Rendering and rendering in Nature
- Lighting and Shading
- Texture Mapping: Minification and Magnification
- Ellipse and other Curves
- Visible Surface Detection: Painter's Algorithm
- Ray Tracing Algorithm
- Z-Buffer Algorithm & Revision

Lab Weekly Schedule

The lab schedule for 13 weeks is detailed below. All CLOs shall be accessed in each lab.

Week	Topic
1	Introduction to OpenGL, Basic Structure of an OpenGL Program to draw a Single dot on the screen.
2	Design a System based on User centered approach. Perform Heuristic Evaluation on the design.
3	Calculate the Screen Complexity of an existing GUI and redesign the interface to minimize the screen complexity.
4	Write a program to capture the mouse click. Create a program that puts a red dot on the Output Window whenever the left mouse button is clicked. Learn how th glut callback functions work. What is the glutMouseFunc(). What is the parameter passed to the glutMotionFunc(). What parameters are automatically passed to the function called through the glutMouseFunct().
5	Write a program to capture the movement of the mouse using openGL. Create a program that draws a freehand line wherever the mouse moves if the left mouse button is clicked. Learn what the mouseMotionFunct() is and what are the parameters passed to the function called through glutMotionFunct().
6	Create a program to define a viewport within the output screen Understand what World Window and Viewport Transformation is. Create a custom output window number system and define viewports in it.
7	Design a Web Interface using the Gestalt Theory.
8	Create a 3d cube to that rotates with arrow keys. The arrow keys rotate the cube when they are pressed. Using the callback function to capture the arrow keypresses. Use transformation in OpenGL 3d perspective projection.
9	**Mid Term Exams**

Week	Topic
10	Understand how to design proper icons.
11	Program to implement the coghen Sutherland line clipping Algorithm The working of Cohen Sutherland Line clipping.
12	Program Create a Rigidbody in Unity3d. Understand the workflow in Unity3d and the layout of Unity3d. Create materials and adding Materials. Adding Scripts to move objects.
13	Demonstration of [SerializeField] in Unity 3d Controlling the Player through the keyboard Making the Camera follow the player. - Restarting the level through Keyboard keys.
14	Automatically reloading the scene. Adding tags to Objects, detection of collision and Exporting the game

Recommended Textbooks

1. Hearn, D., Baker, M. P., & Carithers, W. (2014). *Computer Graphics with OpenGL*. Dorling Kindersley, India. ISBN: 9789332518711.
2. Gortler, S. J. (2012). *Foundations of 3D Computer Graphics*. MIT Press. ISBN: 9780262017350.
3. Hughes, J. F., Van Dam, A., McGuire, M., Foley, J. D., Sklar, D., Feiner, S. K., & Akeley, K. (2014). *Computer Graphics: Principles and Practice*. Addison-Wesley. ISBN: 9780321399526.
4. Akenine-Möller, T., Haines, E., & Hoffman, N. (2008). *Real-Time Rendering*. CRC Press. ISBN: 9781439865293.

CS Elec. - VI, Software Testing and Quality Assurance

Course Code: SEST-468

Semester	Credit Hours	Prerequisite
[BSCS-7]	[2+0]	[None]

Course Description

This course focuses to give knowledge of quality and engineering concepts. Besides students will comprehend SQE phases (Software Quality Assurance Plan (SQAP), Quality Control (QC) and Measurement Models (MM)). For effective understanding all SQE concepts taught in the class are applied Application during the course of project.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Apply** acquired knowledge Software Quality Engineering concepts and standards	C	C3 Application	1
CLO-2	**Understand** and explain the basic operation to engineer quality in to software.	C	C3 Application	1
CLO-3	**Apply** acquired knowledge of Software Quality Assurance Plan (SQAP) and static and dynamic testing techniques for Quality Control (QC)	C	C3 Application	1

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course focuses upon in cooperating quality (whose conceptual understanding is established through quality standards e.g. ISO 9126) in to software. Software Quality Engineering (SQE) is an approach which starts from Software Quality Assurance Planning (SQAP). This is to prevent error injection in software. Since software development is a human dominating activity and humans are error prone due to which errors are injected in to software. Only way to maintain quality is therefore, to Control Quality (QC) through Testing. QC involves testing at static i.e. static artifacts e.g. SRS, design specifications and dynamic level e.g. source code. We then perform post mortem analysis to measure how well quality, as planned in SQAP, is implemented in QC. This is done through various measurement models e.g. McCalls quality model.

Course Weekly Schedule
The course schedule for 17 weeks is detailed below:

Week	Topic
1	Discussion of Course Plan Basic concept of software quality, Importance of software quality
2	Software Quality Standards ISO 9126, Software Quality attributes and characteristics
3	What Software Quality Assurance Planning (SQAP)
4	How can we develop (SQAP) e.g. techniques
5	What is Software Quality Control, Why do we need to Control Software Quality
6	OHT, Verification and Validation concepts
7	What is Static Testing Techniques, Why is it important
8	Types of Static Testing Techniques, Walkthroughs, Inspections, Formal and Informal Technical Reviews
9	**Mid Term Exams**
10	Types of Dynamic Testing Techniques, Dynamic Testing Techniques, Types of System Testing, Levels of Testing, Strategies of Testing
11	How to do testing, Test Case generation, Black Box Testing, Boundary Value Analysis, Equivalence Class Partitioning
12	Project Draft 1, White Box Testing, Source Code Coverage, Critical Path Testing, Statement Coverage, Branch Coverage, Conditional Coverage
13	Software Measurement Models, Why do we need to Measurement Software Quality, Project Evaluation of SQAP
14	Software Defect Categorization, How can we measure software quality, Project Evaluation of QC
15	Project Evaluation of QM, Test Result Evaluation
16	Project Presentations/ Report
17	Revision

Recommended Textbooks

Recommended Reference (Books/Websites/Articles)

1. http://books.google.com.pk/books?id=bOGknPAi1LIC&pg=PA52&dq=software+static+testing&hl=en&sa=X&ei=6k46VKy5Aca3OPqcgIgE&ved=0CGMQ6AEwCQ#v=onepage&q&f=true

2. http://books.google.com.pk/books?id=Ee8D8pUlJvUC&pg=PA178&dq=static+testing&hl=en&sa=X&ei=LhI6VJODEqWfygPPg4GoCw&ved=0CFUQ6AEwBw#v=onepage&q&f=true
3. http://www.softwaretestinghelp.com/how-to-test-software-requirements-specification-srs/
4. http://books.google.com.pk/books?id=ZOHrm02GFCEC&pg=PA10&dq=generic+testing+process&hl=en&sa=X&ei=ZxhiVJiWJsvKaLa9gpgF&ved=0CBwQ6AEwAA#v=onepage&q&f=true
5. http://users.csc.calpoly.edu/~jdalbey/205/Resources/grocerystore.html
6. https://books.google.com.pk/books?id=rG9_icQ5qs0C&pg=SL8-PA7&dq=cause+effect+graph+software+testing+example&hl=en&sa=X&ei=8P6gVKvSDcv1UsnLgvgM&ved=0CCMQ6AEwAjgU#v=onepage&q=cause%20effect%20graph%20software%20testing%20example&f=false

CS Elec. - VI, Software Testing and Quality Assurance -Lab

Course Code: SEST-468L

Semester	Credit Hours	Prerequisite
[BSCS-7]	[0+1]	[None]

Course Description

This course focuses to give knowledge of quality and engineering concepts. Besides students will comprehend SQE phases (Software Quality Assurance Plan (SQAP), Quality Control (QC) and Measurement Models (MM)). For effective understanding all SQE concepts taught in the class are applied Application during the course of project.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Apply** acquired knowledge Software Quality Engineering concepts and standards	C	C3 Application	1
CLO-2	**Understand** and explain the basic operation to engineer quality in to software.	C	C3 Application	1
CLO-3	**Apply** acquired knowledge of Software Quality Assurance Plan (SQAP) and static and dynamic testing techniques for Quality Control (QC)	C	C3 Application	1

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course focuses upon in cooperating quality (whose conceptual understanding is established through quality standards e.g. ISO 9126) in to software. Software Quality Engineering (SQE) is an approach which starts from Software Quality Assurance Planning (SQAP). This is to prevent error injection in software. Since software development is a human dominating activity and humans are error prone due to which errors are injected in to software. Only way to maintain quality is therefore, to Control Quality (QC) through Testing. QC involves testing at static i.e. static artifacts e.g. SRS, design specifications and dynamic level e.g. source code. We then perform post mortem analysis to measure how well quality, as planned in SQAP, is implemented in QC. This is done through various measurement models e.g. McCalls quality model.

Course Weekly Schedule
The course schedule for 17 weeks is detailed below:

Week	Topic
1	Discussion of Course Plan Basic concept of software quality, Importance of software quality
2	Software Quality Standards ISO 9126, Software Quality attributes and characteristics
3	What Software Quality Assurance Planning (SQAP)
4	How can we develop (SQAP) e.g. techniques
5	What is Software Quality Control, Why do we need to Control Software Quality
6	OHT, Verification and Validation concepts
7	What is Static Testing Techniques, Why is it important
8	Types of Static Testing Techniques, Walkthroughs, Inspections, Formal and Informal Technical Reviews
9	**Mid Term Exams**
10	Types of Dynamic Testing Techniques, Dynamic Testing Techniques, Types of System Testing, Levels of Testing, Strategies of Testing
11	How to do testing, Test Case generation, Black Box Testing, Boundary Value Analysis, Equivalence Class Partitioning
12	Project Draft 1, White Box Testing, Source Code Coverage, Critical Path Testing, Statement Coverage, Branch Coverage, Conditional Coverage
13	Software Measurement Models, Why do we need to Measurement Software Quality, Project Evaluation of SQAP
14	Software Defect Categorization, How can we measure software quality, Project Evaluation of QC
15	Project Evaluation of QM, Test Result Evaluation
16	Project Presentations/ Report
17	Revision

Recommended Textbooks (Not provided)

Recommended Reference (Books/Websites/Articles)

1. http://books.google.com.pk/books?id=bOGknPAi1LIC&pg=PA52&dq=software+static+testing&hl=en&sa=X&ei=6k46VKy5Aca3OPqcgIgE&ved=0CGMQ6AEwCQ#v=onepage&q&f=true

2. http://books.google.com.pk/books?id=Ee8D8pUlJvUC&pg=PA178&dq=static+testing&hl=en&sa=X&ei=LhI6VJODEqWfygPPg4GoCw&ved=0CFUQ6AEwBw#v=onepage&q&f=true
3. http://www.softwaretestinghelp.com/how-to-test-software-requirements-specification-srs/
4. http://books.google.com.pk/books?id=ZOHrm02GFCEC&pg=PA10&dq=generic+testing+process&hl=en&sa=X&ei=ZxhiVJiWJsvKaLa9gpgF&ved=0CBwQ6AEwAA#v=onepage&q&f=true
5. http://users.csc.calpoly.edu/~jdalbey/205/Resources/grocerystore.html
6. https://books.google.com.pk/books?id=rG9_icQ5qs0C&pg=SL8-PA7&dq=cause+effect+graph+software+testing+example&hl=en&sa=X&ei=8P6gVKvSDcv1UsnLgvgM&ved=0CCMQ6AEwAjgU#v=onepage&q=cause%20effect%20graph%20software%20testing%20example&f=false

Compiler Construction

Course Code: CSCC-445

Semester	Credit Hours	Prerequisite
[BSCS-7]	[2+0]	[CSTA-342]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Elaborate the process of Language understanding, architecture of a compiler, and function of its components.	C	C4 Analysis	2
CLO-2	Demonstrate appropriate formal notations to define a programming language.	C	C3 Application	2
CLO-3	Design and implement lexical, syntax semantics analyzers by using various algorithms.	C	C3 Application	4

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- High level languages and translators
- Phases of the compilation process
- Syntax and semantic specification of a language
- Chomsky's hierarchy of grammars
- Design and implementation of a lexical analyzer
- Top-down and bottom-up parsing strategies

- Ambiguous Grammars
- LL(k) and LR(k) grammars
- Recursive-descent and LL(1) parsing
- Left factoring and left recursion removal
- Simple precedence, SLR and LALR parsing
- Semantic Analysis, Attributed grammars
- Code generation from annotated parse tree and Code optimization

Course Weekly Schedule
The course schedule for 16 weeks are detailed below

Week	Topic
1	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
2	Lexical Analysis: type of words, Rule for Lexical analysis, Regular Expression for Lexical. RE➔NFA➔DFA
3	Lexical Rule Automation process. NFA➔DFA➔optimization➔ implementation, algorithms and code.
4	Lexical Rule Implementation issues, options and Algorithms.
5	Syntax Analysis: Context Free Grammar why and how. Ambiguity specific and generalized removal.
6	Top down vs bottom up. Top down Approach and Left factoring Recursive decent algorithm vs Predictive Parsing
7	Left Factoring and LL(k), Recursive decent
8	**Mid Term Examination**
9	Parsing Implementation, Top Down : LL(k), Recursive decent using parsing table Implementations
10	Bottom UP implementations, LR(k) , Stack Processing implementation algorithms
11	Type checking and semantic analysis …Rules working updation of parse table to semantic table and parse tree to semantic tree.
12	Intermediate code Generation from parse table
13	Code optimization
14	Target code and semantic Rules
15	Revision

Week	Topic
16	**End Term Examination**

Recommended Textbooks

1. Aho, A. V., Lam, M. S., Sethi, R., & Ullman, J. D. (2007). *Compilers: Principles, Techniques, & Tools*. Pearson/Addison Wesley. ISBN: 9780321486813.
2. Louden, K. C. (1997). *Compiler Construction: Principles and Practice*. PWS Publishing Company. ISBN: 9780534939724.
3. Grune, D., van Reeuwijk, K., Bal, H. E., Jacobs, C. J. H., & Langendoen, K. (2012). *Modern Compiler Design*. Springer New York. ISBN: 9781461446989.

Compiler Construction -Lab

Course Code: CSCC-445L

Semester	Credit Hours	Prerequisite
[BSCS-7]	[0+1]	[CSTA-342L]

Course Description

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.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Elaborate the process of Language understanding, architecture of a compiler, and function of its components.	C	C4 Analysis	2
CLO-2	Demonstrate appropriate formal notations to define a programming language.	C	C3 Application	2
CLO-3	Design and implement lexical, syntax semantics analyzers by using various algorithms.	C	C3 Application	4

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- High level languages and translators
- Phases of the compilation process
- Syntax and semantic specification of a language
- Chomsky's hierarchy of grammars
- Design and implementation of a lexical analyzer
- Top-down and bottom-up parsing strategies

- Ambiguous Grammars
- LL(k) and LR(k) grammars
- Recursive-descent and LL(1) parsing
- Left factoring and left recursion removal
- Simple precedence, SLR and LALR parsing
- Semantic Analysis, Attributed grammars
- Code generation from annotated parse tree and Code optimization

Course Weekly Schedule
The course schedule for 16 weeks are detailed below

Week	Topic
1	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
2	Lexical Analysis: type of words, Rule for Lexical analysis, Regular Expression for Lexical. RE➔NFA➔DFA
3	Lexical Rule Automation process. NFA➔DFA➔optimization➔ implementation, algorithms and code.
4	Lexical Rule Implementation issues, options and Algorithms.
5	Syntax Analysis: Context Free Grammar why and how. Ambiguity specific and generalized removal.
6	Top down vs bottom up. Top down Approach and Left factoring Recursive decent algorithm vs Predictive Parsing
7	Left Factoring and LL(k), Recursive decent
8	**Mid Term Examination**
9	Parsing Implementation, Top Down : LL(k), Recursive decent using parsing table Implementations
10	Bottom UP implementations, LR(k) , Stack Processing implementation algorithms
11	Type checking and semantic analysis …Rules working updation of parse table to semantic table and parse tree to semantic tree.
12	Intermediate code Generation from parse table
13	Code optimization
14	Target code and semantic Rules
15	Revision

Week	Topic
16	**End Term Examination**

Recommended Textbooks

1. Aho, A. V., Lam, M. S., Sethi, R., & Ullman, J. D. (2007). *Compilers: Principles, Techniques, & Tools*. Pearson/Addison Wesley. ISBN: 9780321486813.
2. Louden, K. C. (1997). *Compiler Construction: Principles and Practice*. PWS Publishing Company. ISBN: 9780534939724.
3. Grune, D., van Reeuwijk, K., Bal, H. E., Jacobs, C. J. H., & Langendoen, K. (2012). *Modern Compiler Design*. Springer New York. ISBN: 9781461446989.

Parallel & Distributed Computing

Course Code: CSDC-446

Semester	Credit Hours	Prerequisite
[BSCS-7]	[2+0]	[CSOS-329]

Course Description

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

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Learn** about the different parallel architecture, profiling and parallelization of code	C	C2 Comprehension	2
CLO-2	**Analytical** modeling and performance of parallel programs	C	C4 Analysis	4
CLO-3	**Analyze** complex problems with shared memory programming with OpenMP	C	C3 Application	3

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Introduction to parallel and distributed systems, tools, languages, architectural support from the application side
- Analysis and profiling of applications
- Shared memory concepts like Threads and OpenMP,
- Distributed memory point to point collectives, Parallel and Distributed Programming Paradigms
- Parallel and Distributed Algorithms
- Applications of Parallel and Distributed Computing, Multi-core, Client-server, GPU
- Heterogeneous Computing
- Advanced topics in Parallel & Distributed System

Course Weekly Schedule

The course schedule for 16 weeks is detailed below

Week	Topic
1	Introduction to parallel and distributed computing, Flynn's Classical Taxonomy and general parallelism terminologies
2	Platforms for parallel programming and types of parallelism, Amdahl's Law and profiling
3	Parallel Memory Architectures, Parallel programming models
4	Dependence Analysis
5	Designing parallel programs
6	Inter-process Communication, Message Passing System
7	Introduction to Multithreading, C++ Threads and Design Patterns
8	Shared Memory Parallel Programming: OpenMP,
9	**Mid Term Exams**
10	Programming with OpenMP
11	Distributed memory parallel programming, Heterogeneous distributed systems
12	Message Passing Interface (MPI)
13	GPU based Computing, Introduction to CUDA
14	Concurrency Control
15	Fault Tolerance
16	Asynchronous/synchronous computation/communication
17	Advanced topics in parallel and Distributed computing

Recommended Textbooks

1. Lin, C. (2008). Principles of Parallel Programming. Pearson Education India. ISBN: 9788131729526.
2. Coulouris, G. F., Dollimore, J., Kindberg, T., & Blair, G. (2012). Distributed Systems: Conceptsand Design. Addison-Wesley. ISBN: 9780132143011.
3. Rauber, T., & Rünger, G. (2013). Parallel Programming: for Multicore and Cluster Systems.Springer Science & Business Media. ISBN: 9783642378010.

Parallel & Distributed Computing -Lab

Course Code: CSDC-446L

Semester	Credit Hours	Prerequisite
[BSCS-7]	[0+1]	[CSOS-329L]

Course Description

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

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Apply and implement parallel and distributed memory algorithms using OpenMP, MPI, CUDDA	C	C3 Application	3
CLO-2	Practice the OpenMP, MPI, CUDDA	P	P3 Complete Overt Response	3
CLO-3	Contribute individually or as a team member to work effectively.	A	A2 Responding	9

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

OpenMP basic concepts along with practical examples, MPI basic concepts along with practical examples and CUDDA concepts along with practical examples

Course Weekly Schedule

The course schedule for 16 weeks is detailed below

Week	Topic
1	**Threads Work-sharing for OpenMP using 'Single and Section Constructs'** The objective of this lab is to implement work sharing among threads in OPENMP using single and section constructs.
2	**Use of Environment Variables in OpenMP API**

Week	Topic
	The objective of this lab is to familiarize the students with the usage of environment variables in OPENMP.
3	**Introduction to Socket Programming** The objective of this lab is to learn how to build client/server applications that communicate using sockets.
4	**Socket Programming with Multithreading** In this lab we will study about socket programming with multithreading.
5	**Multiprocessing for Parallel Processing** The objective of this lab is to implement multiprocessing to speed up the execution time for independent parallel processes.
6	**Threads Work-sharing for OpenMP using 'Single and Section Constructs'** The objective of this lab is to implement work sharing among threads in OPENMP using single and section constructs.
7	**Use of Environment Variables in OpenMP API** The objective of this lab is to familiarize the students with the usage of environment variables in OPENMP.
8	**Introduction to Socket Programming** The objective of this lab is to learn how to build client/server applications that communicate using sockets.
9	**Mid Term Exams**
10	**Basics of Message Passing Interface (MPI)** The objective of this lab is to introduce and familiarize the students with basic concepts of distributed memory programming using MPI.
11	**To Learn Communication between MPI processes** The objective of this lab is to familiarize the students with inter process communication using MPI.
12	**Familiarized with advance communication between MPI processes** The objective of this lab is to implement advance inter process communication using MPI.
13	**Study of MPI collective operations using 'Synchronization'** The objective of this lab is to implement collective communication using MPI.
14	**Study of MPI collective operations using 'Data Movement'** The objective of this lab is to implement collective communication operation using Data Movement in MPI.
15	**Study of MPI collective operations using 'Collective Computation'** The objective of this lab is to implement collective communication operation using Collective Computation in MPI.

Week	Topic
16	**To understand MPI Non-Blocking operation** The objective of this lab is to implement non-blocking operations in MPI.
17	**GPU Programming with CUDA and NUMBA** • The objective of this lab is to familiarize the students with GPU programming using CUDA and NUMBA.

Recommended Textbooks

1. Lin, C. (2008). *Principles of parallel programming*. Pearson Education India.
2. Foster, I. (1995). *Designing and building parallel programs: concepts and tools for parallel software engineering*. Addison-Wesley Longman Publishing Co., Inc..
3. Chandra, R. (2001). *Parallel programming in OpenMP*. Morgan kaufmann.
4. Gropp, W., Lusk, E., & Skjellum, A. (1999). *Using MPI: portable parallel programming with the message-passing interface* (Vol. 1). MIT press.
5. Sanders, J., & Kandrot, E. (2010). *CUDA by example: an introduction to general-purpose GPU programming*. Addison-Wesley Professional.
6. Cook, S. (2012). *CUDA programming: a developer's guide to parallel computing with GPUs*. Newnes.
7. Cheng, J., Grossman, M., & McKercher, T. (2014). *Professional CUDA c programming*. John Wiley & Sons.

Semester VIII

CS Elec. - VII, Cloud Computing

Course Code: CSCD-469

Semester	Credit Hours	Prerequisite
[BSCS-8]	[2+0]	[CSDC-446, CSOS-329]

Course Description

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

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Understanding of Cloud Computing Architecture	C	C2 Understanding	1
CLO-2	Analysis Design enterprise-to-carrier grade private and public cloud.	C	C4 Analysis	1
CLO-3	Evaluate privacy and security issues for cloud infrastructure and cloud applications	C	C5 Evaluating	1

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

Introduction to Cloud Computing, Delivering services from the cloud, Introduction to Virtualization, Network Basics for Cloud Computing, Storage Virtualization Basics, Cloud Computing Emerging Trends/Technologies, Role of Cloud in Digital transformation, Security Threats and Challenges in Cloud Computing, Architectural Concepts of Cloud Security and Design Requirements, Security Management in Cloud Computing, Network Security Management in Cloud, Load Balancing in Cloud, Cloud Security, Risk and Governance.

Course Weekly Schedule

The course schedule for 17 weeks is detailed below

Week	Topic
1	Review Traditional Computing Challenges and Concerns, Cloud Computing Concept, History, and Definitions, Cloud Reference Architecture, Advantages of Cloud Business Model
2	Differentiating types of clouds: public, private and hybrid, categorizing service types, Comparing vendor cloud products: Amazon, Google, Microsoft and others. Virtualization: Definition, Concepts, History, and Relationship to Cloud

Week	Topic
3	Virtualization: Benefits, Challenges, Risks, and Suitability to Organizations, Hypervisor: Role and Purpose in Virtualization and Various Hypervisor Types, Virtualization: Terminologies and the different Types of Virtualizations
4	Introduction to Compute Virtualization, Network Architecture for Virtualization, Physical Network for Virtualization, Storage Architecture for Virtualization
5	Physical Disk Types and Related Techniques, Centralized Storage vs. Distributed Storage, Virtualized Storage vs. NonVirtualized Storage, Introduction to VM Disks
6	Software Defined Networking (SDN), Network Functions Virtualization (NFV), Bring Your Own Device (BYOD) and MDM, Big Data and Big Data Analytics, Hadoop, NoSQL databases, their characteristics and types. Internet of Things (IoT) and its types.
7	OpenStack Overview & Components, OpenStack Dashboard Management, Authentication Management, Compute, Storage and Network Management, OpenStack Orchestration Management.
8	Security and Compliance in Cloud, Physical Security and Cloud Computing, Mid Term Review
9	**Mid Term Exams**
10	Describe cloud security reference architecture, Understand design principles of secure cloud computing, Identity and Access Management.
11	Data Classification, Data Security Lifecycle, Azure Foundations, Azure Marketplace, Azure Portal, Azure CLI, Cloud Shell
12	Network Security Management in the Cloud, Vulnerability, Patch Management, and Pen-Testing, Evolution, Deployment Models, Initial Setup / Boot strapping. Azure Architecture,
13	GFW Traffic flow, NGFW Access Policy Components, Firewall Deployment Modes, Virtualization, Filtering based on Applications (AVC) , File Blocking , SSL Decryption , Advanced Malware Protection (AMP)
14	BIG-IP initial setup (licensing, provisioning, and network configuration), BIG-IP local traffic configuration objects, Advanced Load Balancing Architecture in Cloud, Using dynamic load balancing methods,
15	Risk and Governance Definitions, Impact of Cloud Service Models, Impact of Cloud Deployment Models, Risk Management and Governance,
16	Course Revision, Semester Project and Presentations

Recommended Textbooks

1. Textbook: Marinescu, Dan (2017) Cloud Computing Theory and Practice (2nd Ed.)
2. Cloud Computing Implementation, Management, and Security by John W. house and James F. Ransome, Taylor and Francis Group, LLC (2010). ISBN 978-1-4398-0680-7.

Recommended Reference (Books/Websites/Articles)

1. IEEE Transactions on Cloud Computing
2. Journal of Cloud Computing: Advances, Systems and Applications (JoCCASA)
3. https://www.vmware.com/support/pubs/

4. https://docs.openstack.org
5. https://www.f5.com/services/resources
6. https://docs.fortinet.com/
7. https://www.cisco.com/c/en/us/tech
8. https://docs.microsoft.com/en-us/azure/
9. https://www.microsoft.com/mcp/
10. https://docs.aws.amazon.com/
11. https://support.huawei.com/enterprise/en/doc

CS Elec. - VII, Cloud Computing

Course Code: CSCD-469L

Semester	Credit Hours	Prerequisite
[BSCS-8]	[0+1]	[CSDC-446L, CSOS-329L]

Course Description

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

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Apply** vSphere. OpenStack, o Microsoft Azure Cloud.	C	C3 Application	3
CLO-2	**Practice** vSphere. OpenStack, o Microsoft Azure Cloud.	P	P3 Complete Overt Response	3
CLO-3	**Contribute** individually or as a team member to work effectively.	A	A2 Responding	9

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

vSphere Virtual Infrastructure, Installing vSphere Components, Creating Virtual Machines in vSphere, Configuring and Managing Virtual Networks, Configuring and Managing Virtual Storage, vCenter Server Architecture, Microsoft Azure Cloud,

Lab Weekly Schedule

The course schedule for 16 weeks is detailed below

Week	Topic
1	**Introduction vSphere Virtual Infrastructure** ● Overview of vSphere virtual infrastructure ● Installation of ESXi ● Configuring ESXi services

Week	Topic
2	**Creating Virtual Machines in vSphere** ● 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.
3	**Configuring and Managing Virtual Networks** ● 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
4	**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
5	**vCenter Server Architecture** ● Deploy and configure vCenter Server Appliance ● Use vSphere Web Client ● Backup and restore vCenter Server ● vCenter Server permissions and roles
6	**OpenStack Deployment** ● Compute, Storage and Network Management ● OpenStack Orchestration Management ● Image Management
7	**Virtual Machine 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
8	**Introduction to Microsoft Azure Cloud** ● Azure Foundations ● Azure Portal ● Azure CLI ● Cloud Shell
9	**Mid Term Exams**
10	**Introduction to Microsoft Azure Cloud** ● Creating a Free Azure Account ● Footprint and Structure ● Azure Services ● Web and Mobile

Week	Topic
11	**Introduction to Microsoft Azure Cloud** ● Databases ● Data and Analytics ● Security and Identity ● Monitoring and Management
12	**Introduction to Microsoft Azure Cloud** ● Creating Azure ● Resources. ● App Service ● Azure Container Instances ● Azure App Services
13	**Networking – Azure** ● Creating a Virtual Network Connection ● IP Addressing
14	**Authentication and Authorization – Azure** ● Azure Active Directory ● Create Azure AD Tenant ● Create Users and Groups ● Self-Service Password Reset
15	**Storage – Azure.** ● Creating a Storage Account ● Add Disk ● Disk Caching
16	**Semester Project**

Recommended Textbooks

1. Mastering VMware vSphere 6.7: Effectively deploy, manage, and monitor your virtual datacenter with VMware vSphere
2. AZ-900 Microsoft Azure Fundamentals
3. Hands-On Cloud Administration in Azure.

Information Security

Course Code: CSIS-432

Semester	Credit Hours	Prerequisite
[BSCS-8]	[2+0]	[CSOS-329]

Course Description

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 technology to implement security functions

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Explain** security services like confidentiality, Integrity and Availability as well as the related tools and technologies, security protocols and Standards.	C	C2 Comprehension	2
CLO-2	**Use** the appropriate techniques to tackle the problems in the discipline of information security.	C	C3 Application	3
CLO-3	**Develop** various security and risk management techniques for achieving information security and privacy.	C	C5 Synthesis	5

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Information security foundations, security design principles
- Security mechanisms
- Symmetric and asymmetric cryptography, encryption, hash functions, digital signatures, key management, authentication and access control
- Software security, vulnerabilities and protections
- Malware
- Database security
- Network security, firewalls, intrusion detection
- Security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics in information security, privacy and anonymity of data.

Course Weekly Schedule
The course schedule for 16 weeks is detailed below

Week	Topic
1	Introduction to Information Security, Security attacks, Security Services, Security Mechanisms
2	Cryptography Exhaustive Key search, Principles of Counting
3	Classical Encryption Techniques: Modular arithmetic, Ceaser Cipher, Mono alphabetic Ciphers, Frequency analysis attacks,
4	Classical Encryption Techniques: Substitution Techniques: Poly alphabetic ciphers, one-time Pad
5	Transposition Ciphers, Product ciphers: Rotor Machines
6	Secret Key Cryptography: History and implementation of AES
7	Secret Key Cryptography: Traffic confidentiality and placement of encryption function tools
8	Principles of public-key cryptography RSA algorithm
9	**Mid Term Exams**
10	Digital signatures and certificates Digital signatures
11	Placement of Encryption Function End to end, Link to Link, Key Distribution and Management Key distribution using Secret key cryptography, For link encryption, For E2E encryption, Key Management, Diffie-Hellman Key Exchange
12	Authentication Mechanisms, Passwords, Hashing and Salting techniques, Biometrics, Security Tokens, Two Factor Authentication, Authentication Protocols: Kerberos, X.509 Certificates
13	Access Control, Types of Access Controls, Discretionary , Mandatory Access Control, Bell La Padula, Access Biba
14	Attacks and Malicious Software Sniffing, Spoofing, Replay attacks, TCP/IP Hijacking, Attacks on Encryption, Password Guessing, Software Exploitation, Social Engineering, Distributed Denial of Service Attacks Malware, Anti-Virus Software

Week	Topic
15	Firewalls, Types of Firewalls, Attacks and Countermeasures, Application Level Gateways, Bastion Host, Configuration DMZ Network, Intrusion Detection & Response
16	Software Vulnerabilities, buffer overflow, stack buffer overflow working, shell code, defenses Database Security Threats, computer-based-controls, security in Oracle/MS Access DBMSs And Web Security, SQL Injection Attack Risk Management What is Risk Management?, Business Risks, Risk Management Models Qualitative Vs. Quantitative Risk Management, Tools
17	Privacy and Anonymity of Data

Recommended Textbooks

1. Stallings, W. (2022). Cryptography and network security: principles and practice. Pearson. ISBN: 9789332585225.
2. Maymi, F., & Harris, S. (2016). CISSP All-in-One Exam Guide, 7th Edition. McGraw-Hill Education. ISBN: 9780071849272.

Information Security-Lab

Course Code: CSIS-432L

Semester	Credit Hours	Prerequisite
[BSCS-8]	[0+1]	[CSOS-329]

Course Description

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 technology to implement security functions

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	**Apply** the fundamental concepts of digital logic design to implement a combinational and sequential circuit.	C	C3 Application	3
CLO-2	**Practice** circuits by using discrete components and digital ICs.	P	P3 Complete Overt Response	3
CLO-3	**Contribute** individually or as a team member to work effectively.	A	A2 Responding	9

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

- Binary Systems: Introduction to digital and analogue systems, Number Systems and Conversions, Arithmetic with number systems, Radix/r's Complement and Diminished radix/(r-1)'s Complements, Subtraction using r's Complements and (r-1)'s complement, Signed and unsigned number systems and their arithmetic, Binary Codes, Decimal Codes and Alphanumeric Codes
- Boolean Algebra and Logic Gates: Boolean Postulates and Theorems, Boolean Functions and their Complements, Sum of Min Terms and Product of Max Terms, Standard forms and Canonical Forms, Digital logic gates
- Gate level Minimization: Karnaugh maps, Multi-variable (2,3,4) K-maps, Product of Sum (POS) and Sum of Product (SOP) simplification, Don't care conditions, Digital Circuits using Basic and Universal Gates

- Combinational Logic: Analysis and Design Procedure, Code Converters, Adders and its types, Subtractors, Multiplier, Magnitude Comparator, Decoders and Encoders, Multiplexers and De-multiplexer
- Sequential Circuits: Latches (SR Latch,S'R' Latch, D Latch), Flip Flops (D Flip Flop, JK Flip Flop,SR Flip Flop, T Flip Flop), Characteristic Tables, Characteristic Equations., Design and Analysis of Clocked Sequential Circuits (Timing diagram), Designing Counters

Lab Weekly Schedule

The course schedule for 16 weeks is detailed below

Week	Topic
1	**Introduction to Lab Equipment and verification of basic logic gates** • Introduction to digital trainer i.e. power supply, input-output ports, and different modules. • Study logic gates and verify their truth tables.
2	**Introduction to Verilog and synapticad.** • Introduction to Verilog design methodologies and conventions. • Identifiers, number specification, and keywords used in Verilog. • Module structure and stimulus block in Verilog.
3	**Implementation of Demorgans Law, Distributive Law using gates and Verilog.** • Applications of Demorgans law and Distributive law using basic gates. • The HDL-based design language of de-morgans law and distributive law using Verilog.
4	**Simplified Boolean expression to a minimum number of literals using Logic gates and Verilog.** • Simplify Boolean expression using properties. • The HDL-based design language for simplified expressions using Verilog.
5	**Design and implementation of adders and subtractors using Logic gates and Verilog.** • Design and construct half adder, full adder, half subtractor and full subtractor circuits and verify the truth table using logic gates. • The HDL-based design language for adders and subtractors using Verilog.
6	**Design and implementation of code converter using logic gates and Verilog.** • Design and implement 4-bit Binary to gray code converter and Gray to binary code converter. • HDL based design language for gray code converters using verilog.

Week	Topic
7	**Design and implementation of BCD to Excess-3 and Excess-3 to BCD converter using logic gates and verilog.** • Design and implement 4-bit BCD to Excess-3 and Excess-3 to BCD converter. • HDL based design language for Excess-3 converters using verilog.
8	**Open Ended Lab** • Design and implement the designated task using gates. • HDL based design language for designated task using Verilog.
9	**Mid Term Exams**
10	**Design and implementation of magnitude comparator using logic gates and using Verilog.** • Design and implement 2 – Bit magnitude comparator using basic gates. • HDL based design language for 2-bit magnitude comparator using Verilog.
11	**Design and implementation of multiplexer and de-multiplexer using logic gates and Verilog.** • Design and implement multiplexer and demultiplexer using logic gates and study of IC 74150 and IC 74154. • HDL based design language for multiplexer and demultiplexer using Verilog.
12	**Design and implementation of encoder and decoder using logic gates and verilog.** • Design and implement encoder and decoder using logic gates and study of IC 7445 and IC 74147. • HDL based design language for encoder and decoder using Verilog.
13	**Study of different types of flip flops using gates.** • Verify basic flip flops i.e. D-flip flop and JK flip flop using IC.
14	**Design and Implementation of shift register.** • Verify serial to parallel shift register using IC.
15	**Implementation of decade counter.** • Verify mod 10/decade counter using IC.

Recommended Textbooks

Mano, M. M. (2017). *Digital Logic and Computer Design*. Pearson India. ISBN: 9789332586048.

For LAB following links are useful

https://omscs.gatech.edu/sites/default/files/documents/course_page_docs/syllabi/cs_6265_syllabus_and_schedule_2023-2.pdf
https://tc.gts3.org/cs6265/2023-summer/cal.html

Technology Entrepreneurship

Course Code: MSTE-418

Semester	Credit Hours	Prerequisite
[BSCS-8]	[2+0]	[None]

Course Description

This course puts a strong emphasis on the development of a real world, workable, implementable business plan that applies the proper methods, techniques and skills needed for successfully developing and growing a new venture. While some theory will be explored, the major thrust of this course will be to ensure that the primary product of the course, the Business Plan, and other assignments which have immediate and real world application.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT LEVEL	PLO
CLO-1	Apply acquired the knowledge of entrepreneurship process, techniques of generating ideas	C	C3 Application	1
CLO-2	Understand the five forces model and prepare the business plan.	C	C3 Application	1
CLO-3	Apply the creative sources of financing and funding, importance of intellectual property.	C	C2 Creativity	2

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Course Materials

This course introduces the following topics to students:

Entrepreneurship Introduction, Meanings/Definition, Nature, Features, Scope, Pros and Cons, Commercialize New Ideas, Differences and Similarities between a Businessman and an Entrepreneur, Competitive Advantage of organizations having Entrepreneurial Edge, identifying and validating good opportunities and then creating, communicating, and capturing value from those opportunities over time, Firms in corporate and non-profit settings, Real World Examples, Prospects for Entrepreneurs in Pakistan, Need for Entrepreneurial Education and Activities.

Course Weekly Schedule

The course schedule for 16 weeks are detailed below

Week	Topic
1	Introduction to Entrepreneurship, Nature and Importance of Entrepreneurship, Myths about Entrepreneurship

Week	Topic
2	Types of entrepreneurial ventures, Process of entrepreneurship
3	Developing Successful Business Ideas, Recognizing Opportunities and Generating Ideas, Finding gaps
4	Techniques for generating ideas and the process of generating creative ideas.
5	Industry and Competitor Analysis, Industry Trends
6	The Five Forces Model and Competitor Analysis
7	Writing a Business Plan, The Business Plan and prepare Outline of the Business Plan
8	Presenting the Business Plan to Investors
9	**Mid Term Exams**
10	Building a New-Venture Team and Creating New Venture Team
11	Rounding Out the Team, Customer Advisory Board
12	Getting Funding or Financing, The Importance of Funding or Financing and Sources of Equity Funding
13	Sources of Debt Financing, Creative Sources of Financing
14	The Importance of Intellectual Property, Patents and Trade Marks
15	Copyrights and Trade Secrets
16	What is franchising and how does it work?
17	Establishing a franchise system, Buying a franchise, Presentations

Recommended Textbooks

1. Entrepreneurship: Successfully launching new ventures, Bruce R. Barringer, 4th Edition, Pearson, 2016.
2. Kuratko, D. F. (2016). *Entrepreneurship: Theory, process, and practice*. Cengage Learning. **(Latest Edition)**

Recommended Reference (Books/Websites/Articles)

1. Innovation and entrepreneurship, Peter F. Drucker, Harper Collins, 2006.
2. Patterns of entrepreneurship, Jack M Kaplan, Wiley, 2006.
3. Entrepreneurship–A recipe for economic development, Naqi, Dr. S. M, 2002.

Final Year Project

Course Code: CSFP-499

Description

Semester	Credit Hours	Prerequisite
[BSCS-7/8]	[0+6]	[CSPF-141, CSOO-142, CSVP-368, CSWP-265, CSDB-346]

This course is designed as finale project which requires students to demonstrate technical, theoretical and presentation skills at levels which are aligned with professional software engineering practices. It is needed that students will apply their knowledge of computing throughout the course such as development of requirements, design and implementation to develop a software solution to a real-world problem from conception to completion. In this part, students propose a practically useful project, and develop a document which consists of project plan and software design document.

Course Learning Outcomes (CLOs)

The course learning outcome along with domain and BT level are listed below

S. #	CLO STATEMENT	DOMAIN	BT Level	PLO
CLO-1	Identify the problem or deficiency in the existing software product, system or concept	C	C2 Comprehension	1
CLO-2	Apply knowledge of computing to formulate a problem statement and requirements (functional and non-functional) based on research literature and existing systems.	C	C3 Application	2
CLO-3	Propose the different components of a software project and model requirements to generate system design based on the proposed components.	C	C5 Synthesis	3
CLO-4	Construct the proposed software project using suitable tools based on the appropriate algorithms/APIs/DB schema	P	P5 Complete Overt Response	5
CLO-5	Produce test results (based on test cases) of various modules of the developed project	P	P4 Mechanism	4

CLO-6	Justify the application of the proposed solutions for the betterment of Society	C	C6 Evaluation	8
CLO-7	Demonstrate development of solutions effectively through written and oral mode with the aid of multimedia tools.	A	A4 Organization	7
CLO-8	Demonstrate the originality and relevance of document's content to the project	A	A3 Valuing	9
CLO-9	Show professional team coordination and communication	A	A3 Valuing	6
CLO-10	Demonstrate and defend understanding of tools and techniques used in the development of the developed project	C	C3 Application	10

*** BT= Bloom's Taxonomy, C=Cognitive Domain, P=Psychomotor Domain, A= Affective Domain**

Marks weightage of CLOs according to Rubrics and Assessment Artifacts

Final Year Project (FYP) is evaluated out of 200 marks at three different stages; proposal, progress evaluation and final defense. Proposal and progress are evaluated out of 40 marks each, final defense is evaluated out of 90 marks whereas, the remaining 30 marks awarded by supervisor according to the designed rubrics. Marks distribution at each stage of evaluation with respect to FYP CLOs and assessment artifacts of each CLO are as follow

S. #	FYP Proposal (40)	FYP Progress (40)	Final Defense (90)	Supervisor Evaluation (30)	Assessment Artifacts
CLO-1	**4**				Proposal presentation /Proposal report
CLO-2	**12**	**6**			Proposal presentation /Proposal report
CLO-3	**2**	**6**			Progress presentation / Progress report
CLO-4	**4**	**16**	**8**		Final report/ Prototype
CLO-5			**44**		Final report

CLO-6	**4**				Presentation
CLO-7	**8**	**8**	**8**	**5**	Project code/Presentation
CLO-8	**4**	**2**	**6**	**10**	Final report
CLO-9	**2**	**2**	**8**	**10**	Presentation
CLO-10			**16**	**5**	Presentation

Rubrics

Rubrics for Final Year Project (FYP) Evaluation

Final Year Project (FYP) is a 6 credit hour course. It is evaluated out of 200 marks. FYP is evaluated at three different stages; proposal evaluation, progress evaluation and final evaluation. Proposal and progress are evaluated out of 40 marks each, final defense is evaluated out of 90 marks whereas, the remaining 30 marks awarded by supervisor according to the designed rubrics.

Rubrics to Evaluate FYP Proposal

Proposal will be evaluated out of 40 marks according to the following rubrics.

Domain	CLOs	Criteria	Marginal	Adequate	Good	Excellent
			10-25%	26-50%	51-75%	76-100%
Cognitive	CLO1	Problem understanding [4 marks]	Very little understanding regarding problem domain.	Some understanding regarding problem domain. Need clarification about some aspects of the problem domain.	Good understanding regarding problem domain. Need little clarification.	Excellent understanding regarding problem domain.
	CLO2	Literature review / Existing systems [6 marks]	The presented evidence is of low relevance with questionable accuracy.	The evidence is relevant, accurate and covers several aspects of the project.	Good coverage with relevant and accurate support.	Evidence is with higher degree of relevance and originality.
	CLO2	Problem statement [4 marks]	The project problem statement is unclearly described.	The project problem statement is somehow unclearly described.	The project problem statement is almost clearly described.	The project problem statement is clearly described.

	CLO3	Validity of the proposed solution [2 marks]	Solution is ambiguous.	Solution solves about 50% aspects of problem statement effectively.	Solution solves problem about 75% aspects of problem statement effectively.	Solution solves problem in most effective manner using proper techniques.
Psychomotor	CLO4	Motivation behind tools and technologies [4 marks]	Very little understandin g of the suitable tools and technologies applicable to the problem domain.	Some understanding of the suitable tools and technologies applicable to the problem domain.	Good understanding of the suitable tools and technologies applicable to the problem domain.	Excellent understanding of latest tools and technologies applicable to the problem domain.
Cognitive	CLO2	Innovative idea [2 marks]	Presented solution is a replica of the existing solution with about 25% new features.	Presented solution is a replica of the existing solution with about 50% new features.	Presented solution is a replica of the existing solution with about 75% new features.	Presented solution is a novel idea.
	CLO6	Social/professi onal benefits [4 marks]	Social and professional impact is marginally discussed.	Social and professional impact is adequately discussed.	Social and professional impact is discussed in detail.	Social and professional impact is discussed in detail with references.
Affective	CLO8	Document format [4 marks]	Poorly formatted with many grammatical mistakes.	Partially formatted with some grammatical mistakes.	Well formatted with few grammatical mistakes.	Well formatted with almost no grammatical mistakes.

	CLO7	Communication skills [4 marks]	Answer at least one question correctly. Need clarification.	Answer most questions correctly. Need clarification sometimes.	Answer most questions correctly and concisely.	Handle difficult questions with ease and confidence. Illustrative explanation.
	CLO7	Organization and preparation [4 marks]	Bare organization and preparation. Lack of confidence and familiarity in some parts of the presentation.	Basic organization and preparation. Confident in only some parts of the presentation.	Good organization and preparation. Confident in most parts of the presentation.	Excellent organization and preparation. Confident and relaxed in the whole presentation.
	CLO9	Attire [2 marks]	Barely acceptable attire.	Appropriate attire.	Good attire.	Excellent attire.

Rubrics to Evaluate FYP Progress

Progress will be evaluated out of 40 marks according to the following rubrics.

Domain	CLOs	Criteria	Marginal	Adequate	Good	Excellent
			10-25%	26-50%	51-75%	76-100%
Cognitive	CLO2	Requirements elicitation process [2 marks]	Unclearly defined and not properly followed.	Suitable process is defined but not followed.	Suitable process is defined but partially followed.	Suitable process is defined and followed with evidence.
	CLO3	Definition of user interactions (use cases, use case diagram etc.) [2 marks]	Incorrectly defined with low coverage.	Incorrectly defined with high coverage.	Correctly defined with low coverage.	Correctly defined with high coverage.

	CLO2	Description of functional of non-functional requirements (Correct: Unambiguous, Complete, Verifiable and Consistent) [4 marks]	Incorrectly defined with low coverage.	Incorrectly defined with high coverage.	Correctly defined with low coverage.	Correctly defined with high coverage.
	CLO3	Selection of software architecture/framework/design methodology [4 marks]	Architecture /design methodology is not suitable.	Architecture/design methodology partially defined and represented.	Suitable architectural pattern/design methodology is defined and clearly represented.	Suitable architectural pattern/design methodology is defined and clearly represented with proper justification.
Psychomotor	CLO4	Data representation diagrams/dataset/data (ERD, JSON schema/models /algorithms) [2 marks]	Not suitable without justification.	Not suitable with justification.	Suitable without justification.	Suitable with justification.
	CLO4	Process flow (system flow diagram) [2 marks]	Incorrect without description.	Incorrect with description.	Correct without description.	Correct with description.
	CLO4	Design models (class, sequence, component diagrams) /Data training & testing models [2 marks]	Incorrect without description.	Incorrect with description.	Correct without description.	Correct with description.
	CLO4	40% project implementation (based on no. of modules to be implemented) [8 marks]	Implementation is 25% of the required 40%.	Implementation is 50% of the required 40%.	Implementation is 75% of the required 40%.	Implementation is 100% of the required 40%.

	CLO4	User interface design [2 marks]	Look and feel of user interface is poor according to HCI standards.	Look and feel of user interface is satisfactory according to HCI standards.	Look and feel of user interface is good according to HCI standards.	Look and feel of user interface is excellent according to HCI standards.
Affective	CLO8	Document format [2 marks]	Poorly formatted with many grammatical mistakes.	Partially formatted with some grammatical mistakes.	Well formatted with few grammatical mistakes.	Well formatted with almost no grammatical mistakes.
	CLO7	Communication skills [4 marks]	Answer at least one question correctly. Need clarification.	Answer most questions correctly. Need clarification sometimes.	Answer most questions correctly and concisely.	Handle difficult questions with ease and confidence. Illustrative explanation.
	CLO7	Organization and preparation [4 marks]	Bare organization and preparation. Lack of confidence and familiarity in some parts of presentation.	Basic organization and preparation. Confident in only some parts of the presentation.	Good organization and preparation. Confident in most parts of the presentation.	Excellent organization and preparation. Confident and relaxed in the whole presentation.
	CLO9	Attire [2 marks]	Barely acceptable attire.	Appropriate attire.	Good attire.	Excellent attire.

Rubrics to Evaluate FYP Final Defense

Final defense will be evaluated out of 90 marks according to the following rubrics.

Domain	**CLOs**	**Criteria**	**Marginal**	**Adequate**	**Good**	**Excellent**
			10-25%	**26-50%**	**51-75%**	**76-100%**

Psychomotor	CLO5	Software Testing (testing methodology, test case design etc.) [4 marks]	Software verification and validation has been applied on about 25% of the project implementation.	Software verification and validation has been applied on about 50% of the project implementation.	Software verification and validation has been applied on about 75% of the project implementation.	Software verification and validation has been applied on about 100% of the project implementation.
Cognitive	CLO10	Coding standards / conventions [8 marks]	Very little understanding of the usage of coding standards.	Some understanding and usage of coding standards.	Good understanding and usage of coding standards.	Excellent understanding and usage of coding standards.
	CLO10	Understanding of implemented algorithms/APIs/DB schema etc. [8 marks]	Poor understanding of implementation.	Some understanding of implementation.	Good understanding of implementation.	Excellent understanding of implementation.
Psychomotor	CLO4	Used suitable tools and technologies [8 marks]	Very little understanding of the suitability of the used technology.	Some understanding of the suitability of the used technology.	Good understanding of the suitability of the used technology.	Excellent understanding of the suitability of the used technology.
Cognitive	CLO5	Implementation according to the proposed solution [32 marks]	25% implementation is according to proposed solution.	50% implementation is according to proposed solution.	75% implementation is according to proposed solution.	100% implementation is according to proposed
Affective	CLO9	Team coordination [6 marks]	Poor team coordination and poor work division.	Poor team coordination and work division is satisfactory.	good team coordination and work division is satisfactory.	Excellent in team coordination and work division.
Psychomotor	CLO5	User interface design [8 marks]	Look and feel of user interface is poor according to HCI standards.	Look and feel of user interface is satisfactory according to HCI standards.	Look and feel of user interface is good according to HCI standards.	Look and feel of user interface is excellent according to HCI standards.

Affective	CLO8	Document format [6 marks]	Poorly formatted with many grammatical mistakes.	Partially formatted with some grammatical mistakes.	Well formatted with few grammatical mistakes.	Well formatted with almost no grammatical mistakes.
	CLO7	Communication skills [4 marks]	Answer at least one question correctly. Need clarification.	Answer most questions correctly. Need clarification sometimes.	Answer most questions correctly and concisely.	Handle difficult questions with ease and confidence. Illustrative explanation.
	CLO7	Organization and preparation [4 marks]	Bare organization and preparation. Lack of confidence and familiarity in some parts of the presentation.	Basic organization and preparation. Confident in only some parts of the presentation.	Good organization and preparation. Confident in most parts of the presentation.	Excellent organization and preparation. Confident and relaxed in the whole presentation.
	CLO9	Attire [2 marks]	Barely acceptable attire.	Appropriate attire.	Good attire.	Excellent attire.

Rubrics Followed by Supervisor to Evaluate FYP

FYP supervisor will evaluate the project out of 30 marks according to the following rubrics.

Domain	CLOs	Criteria	Marginal	Adequate	Good	Excellent
			10-25%	26-50%	51-75%	76-100%
Cognitive	CLO10	Understanding of implemented algorithms/APIs/DB schema etc. [5 marks]	Poor understanding of the implementation.	Some understanding of the implementation.	Good understanding of the implementation.	Excellent understanding of the implementation.
Affective	CLO9	Project ownership [5 marks]	No ownership. Depend solely on the input from the supervisor	Limited ownership. Mainly depend on the input from the supervisor to make progress.	Good ownership. Contribute in discussion during meetings.	Excellent ownership. Self-initiatives to make the progress.

			to make progress.			
	CLO8	Document format [5 marks]	Poorly formatted with many grammatical mistakes.	Partially formatted with some grammatical mistakes.	Well formatted with few grammatical mistakes.	Well formatted with almost no grammatical mistakes.
	CLO9	Team coordination [5 marks]	Poor team coordination and poor work division.	Poor team coordination and work division is satisfactory.	Good team coordination and work division is satisfactory.	Excellent in team coordination and work division.
	CLO7	Communicatio n skills [5 marks]	Answer at least one question correctly. Need clarification.	Answer most questions correctly. Need clarification sometimes.	Answer most questions correctly and concisely.	Handle difficult questions with ease and confidence. Illustrative explanation.
	CLO8	Professional ethics [5 marks]	Demonstrate poor discipline, punctuality, and manners.	Demonstrate limited discipline, punctuality, and manners.	Demonstrate good discipline, punctuality, and manners.	Demonstrate excellent discipline, punctuality, and manners.

Rubrics for Lab Evaluation

In computer science discipline, two kinds of labs are conducted, i.e. software based labs and hardware based labs, depending on the course. According to the nature of lab conduct, separate rubrics are followed to evaluate software based labs and hardware based labs. The designed rubrics are applicable to CLOs which are mapped either to psychomotor domain or affective domain only.

Rubrics to Evaluate Software Based Labs

Rubrics to evaluate software based labs are as follow

Performance	Outstanding Performance	Good Performance	Average Performance	Below Average Performance	Unsatisfactory Performance	BT Level	PLO	Marks Obtained
	(5)	(4)	(3)	(2)	(0-1)			
Conducting Experiment [a]	Students present a clear and concise plan/ solution to solve the problem. The code is completely functional with complete steps producing the correct outputs.	Students present a clear and concise plan/ solution to solve the problem The code is functional with complete steps producing the outputs with acceptable error.	Students require effective guidance to present a clear and concise plan/ solution to solve the problem. The code is partially functional or has missing steps producing the outputs with a minor error.	Students require effective guidance to present a clear and concise plan/ solution to solve the problem. The code has substantial errors and has missing steps producing the outputs with errors.	The student fails to present a coherent plan to solve the problem. The student fails to code with complete steps to get the correct outputs.	**P3**	**5**	
Individual &Teamwork [b]	An active cooperation develops among group members to support the execution of the experiment as a team and individually.	Cooperation among group members to support the execution of the experiment as a team and individually was reasonable.	Shows average cooperation with the group members as a team and as an individual to perform the experiment.	Frequent conflict occurs among the group members as a team and as an individual to perform the experiment.	Negatively affects the other group members and creates hindrance in successful performance or completion of experiment as an individual or as a team member.	**A2**	**9**	

Rubrics to Evaluate Hardware Based Labs

Rubrics to evaluate hardware based labs are as follow

Performance	Outstanding Performance	Good Performance	Average Performance	Below Average Performance	Unsatisfactory Performance	BT Level	PLO	Marks Obtained
	(5)	(4)	(3)	(2)	(0-1)			
Conducting Experiment [a]	A careful selection of equipment under supervision of instructor for effective operation, task completion, data collection and display of results.	A careful selection of equipment under supervision of instructor for task completion, data collection and display of results with acceptable errors.	Carefully examines the equipment, under supervision of instructor with minor errors in data collection and display of results.	Selection of equipment under supervision of instructor is done but perform experiment with substantial error.	Incapable to select the suitable equipment and inaccurate equipment operation, data collection resulting in all errors.	**P3**	**5**	
Individual &Teamwork [b]	An active cooperation develops among group members to support the execution of the experiment as a team and individually.	Cooperation among group members to support the execution of the experiment as a team and individually was reasonable.	Shows average cooperation with the group members as a team and as an individual to perform the experiment.	Frequent conflict occurs among the group members as a team and as an individual to perform the experiment.	Negatively affects the other group members and creates hindrance in successful performance or completion of experiment as an individual or as a team member.	**A2**	**9**	

Assessment of Theory and Lab:

Theory and lab both will be evaluated out of 100, separately. The detail distribution of 100 marks for theory and lab is given in the following tables.

Marks Distribution for Theory

Evaluation Methods	Theory weight (%)	
Quizzes	5-10	= 25
Assignments	5-10	
Project / Presentation	5-10	
Mid Term	25	
Final Term	50	
Total	**100**	

Marks Distribution for Lab

Evaluation Methods	Lab weight (%)
Internal Evaluation/ Lab Reports	60
Project /Open Ended Labs	15
Final Term Exam	25
Total	**100**

Grading Policy

Student performance in each subject will be awarded with grads according to the following grading policy

Grade	A+	A	B+	B	C+	C	D+	D	F
%age	>=90	80-89	75-79	70-74	65-69	60-64	55-59	50-54	<50
GPA	4.00	4.00	3.50-3.99	3.00-3.49	2.50-2.99	2.00-2.49	1.50-1.99	1.00-1.49	0.00