Institute of Information and Communication Technology
B. Sc. (Engg.) in Software Engineering
Shahjalal University of Science & Technology
Sylhet-3114, Bangladesh

Curriculum/Syllabus for B. Sc. (Engg.) in Software Engineering Program
Session: 2022-23

Vision

To create future leaders and entrepreneurs who can accelerate progress in information and technology by exploring new dimensions to represent Bangladesh in global platforms.

Mission

M1. To create new knowledge through research and exploration of latest technological advancements by producing highly skilled graduates.

M2. To conduct short and long term programs to develop technologically skilled person from different aspects of society.

M3. To identify local and regional concerns that can be fulfilled by means of specialized wisdom.

M4. To provide professional guidance, technical assistance and take on cooperative projects with public and private organizations and industries.

Program Name: B.Sc. (Engg.) in Software Engineering

Program Educational Objectives (PEO)

Program Educational Objectives (PEOs) are broad statements that describe what graduates are expected to attain within a few years of graduation. Program educational objectives are based on the needs of the program's constituencies.

The entity has recently set the following PEOs for the B.Sc.(Engg.) program in Software Engineering.

PEO1. To provide students with a strong foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze Software Engineering related problems and to prepare them for graduate studies, industrial Research and Development, consultancy and higher learning.

PEO2. To develop an intuition to analyze the software requirements, understand the technical specifications, design and provide novel engineering solutions and efficient product designs.

PEO3. To provide exposure to emerging cutting edge technologies and adequate real life training opportunities to work as efficient teams on multidisciplinary projects with effective communication skills and leadership qualities.

PEO4. To develop the professional skills necessary for students to build a successful career and work with values and social concern bridging the digital divide and meeting the requirements of local and multinational companies.

PEO5. To promote life-long learning and to introduce student awareness on the professional ethics and codes of professional practice.

PEO to Mission Statement Mapping

Mission/PEO	PEO1	PEO2	PEO3	PEO4	PEO5
M1	X	X	X		
M2	X	X	X	X	
M3				X	X
M4			X		X

Program Learning Outcome (PLO)

After graduation from our program in SWE, the graduates will be able to:

PLO	Category	Description
PLO 01	**Engineering Knowledge**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PLO 02	**Problem Analysis**	Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PLO 03	**Design/Development of Solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal and environmental concerns.
PLO 04	**Investigation**	Conduct investigations of complex problems, considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
PLO 05	**Modern Tool Usage**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PLO 06	**The Engineer and Society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PLO 07	**Environment and Sustainability**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

PLO 08	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PLO 09	**Individual and Team Work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PLO 10	**Communication**	Communicate effectively on complex engineering activities with the engineering community and with society at large. Some of them are, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PLO 11	**Project Management and Finance**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PLO 12	**Lifelong Learning**	Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Objectives (PEO/PO) to Program Learning Outcome (PLO) Mapping

PLO/PEO	PEO1	PEO2	PEO3	PEO4	PEO5
PLO1	**X**	**X**	**X**		
PLO 2	**X**	**X**			
PLO 3	**X**	**X**		**X**	
PLO 4			**X**	**X**	**X**
PLO 5	**X**	**X**			
PLO 6			**X**	**X**	
PLO 7				**X**	**X**
PLO 8				**X**	
PLO 9	**X**	**X**		**X**	**X**
PLO 10	**X**	**X**		**X**	**X**
PLO 11	**X**	**X**		**X**	**X**
PLO 12	**X**	**X**	**X**	**X**	**X**

Graduate Profile:

Graduate profiles are descriptions of attributes, or knowledge, skills and attitudes, which a university community intends its graduates will develop through their study to equip them for their future education or employment. Students graduating from the department of SWE, IICT, SUST should have gained the following attributes.

a. Intellectual skills in Science and Engineering
b. Practical and problem solving skills
c. Numeracy and analytical skills

d. Entrepreneurship and innovation skills
e. Communication skills
f. Interpersonal, teamwork and leadership skill
g. Self-management & personal development skills
h. Commitment to community, country and humanity

Semester wise Curriculum Breakdown:

One-semester credit hour represents one class hour or two laboratory hours per week. An academic semester represents 13 weeks of classes exclusive to final exams. Semester wise breakdown of the curriculum structure for 2020-21 session are shown in the next page.

BSc (Engg.) in Software Engineering
Session: 2022-23

First Year: 1st Semester				
Course No	**Course Title**	**Hours/Week Theory + Lab**	**Credits**	**Prerequisite**
SWE 0613-1121	Structured Programming Language	3 + 0	3	
SWE 0613-1122	Structured Programming Language Lab	0 + 3	1.5	
SWE 0541-1123	Discrete Mathematics	3 + 0	3	
EEE 0712-1101W	Basic Electrical and Electronic Circuits	3 + 0	3	
EEE 0712-1102W	Basic Electrical and Electronic Circuits Lab	0 + 3	1.5	
MAT 0541-1105W	Coordinate Geometry and Calculus	3 + 0	3	
ENG 0231-1101W	Effective Communication in English	2 + 0	2	
ENG 0231-1102W	English Language Lab 1	0 + 2	1	
SSS 0312-1100	History of The Emergence of Independent Bangladesh	3 + 0	3	
	Total	**17 + 08 = 25**	**21**	

First Year: 2nd Semester				
Course No	**Course Title**	**Hours/Week Theory + Lab**	**Credits**	**Prerequisite**
SWE 0613-1225	Introduction to Software Engineering	3 + 0	3	
SWE 0613-1227	Data Structure	3 + 0	3	SWE 0613-1121
SWE 0613-1228	Data Structure Lab	0 + 4	2	SWE 0613-1122
PHY 0533-1203W	Mechanics, Wave, Heat & Thermodynamics	3 + 0	3	
MAT 0541-1207W	Linear and Abstract Algebra	3 + 0	3	
STA 0542-1201W	Basic Statistics and Probability	3 + 0	3	
SOC 0314-1203W	Sociology for Engineers	3 + 0	3	
SWE 0610-1250	Project Work-I	0 + 4	2	
	Total	**18 + 8= 26**	**22**	

Second Year: 1st Semester				
Course No	**Course Title**	**Hours/Week Theory + Lab**	**Credits**	**Prerequisite**
SWE 0613-2122	Introduction to Competitive Programming	0 + 4	2	
SWE 0613-2123	Object Oriented Programming	3 + 0	3	SWE 0613-1121
SWE 0613-2124	Object Oriented Programming Language Lab	0 + 4	2	SWE 0613-1122
SWE 0613-2125	Software Requirement Engineering	2 + 0	2	
SWE 0613-2126	Software Requirement Engineering Lab	0 + 3	1.5	
CSE 0613-2119W	Computer Architecture	3 + 0	3	
BUS 0411-2101W	Cost and Management Accounting	3 + 0	3	
ECO 0311-2105W	Principles of Economics	3 + 0	3	
	Total	**14 + 11 = 25**	**19.5**	

Second Year: 2nd Semester				
Course No	**Course Title**	**Hours/Week Theory + Lab**	**Credits**	**Prerequisite**
SWE 0613-2227	Theory of Computation	2 + 0	2	
SWE 0613-2229	Algorithm Design & Analysis	3 + 0	3	SWE 0613-1227
SWE 0613-2230	Algorithm Design & Analysis Lab	0 + 3	1.5	SWE 0613-1228
SWE 0541-2231	Numerical Analysis	2 + 0	2	
SWE 0541-2232	Numerical Analysis Lab	0 + 3	1.5	
SWE 0613-2233	Operating Systems and System Programming	3 + 0	3	
SWE 0613-2234	Operating Systems and System Programming lab	0 + 3	1.5	
SWE 0488-2235	Ethics and Cyber Law	2 + 0	2	
SWE 0688-2237	Management Information System	2 + 0	2	
SWE 0610-2250	Project Work –II	0 + 4	2	
	Total	**14 + 13 = 27**	**20.5**	

Third Year: 1st Semester				
Course No	**Course Title**	**Hours/Week Theory + Lab**	**Credits**	**Prerequisite**
SWE 0613-3121	Software Architecture and Design Patterns	3 + 0	3	
SWE 0613-3122	Software Architecture and Design Patterns Lab	0 + 3	1.5	
SWE 0619-3123	Artificial Intelligence	3 + 0	3	

SWE 0619-3124	Artificial Intelligence Lab	0 + 3	1.5	
SWE 0612-3127	Database Management System	3 + 0	3	
SWE 0612-3128	Database Management System Lab	0 + 4	2	
SWE 0612-3130	Web Technologies	0 + 4	2	
CSE 0612-3113W	Computer Networking	3 + 0	3	
CSE 0612-3114W	Computer Networking Lab	0 + 3	1.5	
	Total	**12 + 17 = 29**	**20.5**	

Third Year: 2nd Semester				
Course No	**Course Title**	**Hours/Week Theory + Lab**	**Credits**	**Prerequisite**
SWE 0612-3225	Distributed System	2 + 0	2	
SWE 0612-3226	Distributed System Lab	0 + 3	1.5	
SWE 0613-3231	Software Usability and Metrics	2 + 0	2	
SWE 0613-3233	Software Verification and Validation	2 + 0	2	
SWE 0613-3234	Software Verification and Validation Lab	0 + 3	1.5	
SWE 0611-3242	Technical Writing And Presentation	0 + 4	2	
SWE 0619-3243	Machine Learning	3 + 0	3	
SWE 0619-3244	Machine Learning Lab	0 + 3	1.5	
BUS 0414-3201W	Entrepreneurship Development	2 + 0	2	
SWE 0610-3250	Project Work-III	0 + 4	2	
	Total	**11 + 17 = 28**	**19.5**	

Fourth Year: 1st Semester				
Course No	**Course Title**	**Hours/Week Theory + Lab**	**Credits**	**Prerequisite**
SWE 0613-4125	Software Project Management	2 + 0	2	
SWE 0613-4126	Software Project Management Lab	0 + 2	1	
SWE 0612-4129	Information and Network Security	2 + 0	2	
SWE 0612-4130	Information and Network Security Lab	0 + 3	1.5	
SWE 0688-4131	Human Computer Interaction	2 + 0	3	
SWE 0688-4132	Human Computer Interaction Lab	0 + 3	1.5	
SWE 06**	Option	3 + 0	3	
SWE 06**	Option Lab	0 + 3	1.5	
SWE 0610-4150	Thesis/Project	0 + 8	4	
	Total	**10 + 19 = 29**	**19.5**	

Fourth Year: 2nd Semester				
Course No	**Course Title**	**Hours/Week Theory + Lab**	**Credits**	**Prerequisite**
SWE 0613-4220	Internship	0 + 36	18	
SWE 0610-4160	Comprehensive Viva Voce	---	1	
	Total	**0 + 36 = 36**	**19**	

Optional Courses				
Course No	**Course Title**	**Hours/Week Theory + Lab**	**Credits**	**Prerequisite**
SWE 0613-4123	Computer Graphics and Image Processing	3 + 0	3	
SWE 0613-4124	Computer Graphics and Image Processing Lab	0 + 3	1.5	
SWE 0613-4133	Advanced Data Structure and Algorithm	3 + 0	3	
SWE 0613-4134	Advanced Data Structure and Algorithm Lab	0 + 3	1.5	
SWE 0619-4135	Neural Network and Deep Learning	3 + 0	3	
SWE 0619-4136	Neural Network and Deep Learning Lab	0 + 3	1.5	
SWE 0612-4136	Advanced Database System	3 + 0	3	
SWE 0612-4138	Advanced Database System Lab	0 + 3	1.5	
SWE 0688-4139	Bioinformatics	3 + 0	3	
SWE 0688-4140	Bioinformatics Lab	0 + 3	1.5	
SWE 0613-4141	Natural Language Processing	3 + 0	3	
SWE 0613-4142	Natural Language Processing Lab	0 + 3	1.5	
SWE 0612-4143	Cloud Computing	3 + 0	3	
SWE 0612-4144	Cloud Computing Lab	0 + 3	1.5	
SWE 0613-4151	Introduction to DevOps	3 + 0	3	
SWE 0613-4152	Introduction to DevOps Lab	0 + 3	1.5	
SWE 0612-4153	Introduction to Cryptography	3 + 0	3	
SWE 0612-4154	Introduction to Cryptography Lab	0 + 3	1.5	
SWE 0688-4155	Applied Data Science	3 + 0	3	
SWE 0688-4156	Applied Data Science Lab	0 + 3	1.5	
SWE 0612-4157	Contemporary Course on Software Engineering	3 + 0	3	
SWE 0612-4158	Contemporary Course on Software Engineering Lab	0 + 3	1.5	

Total Credits offered: 161.5
Credits required for graduation: 161.5
Major courses offered: 120.5 credits
Non-major courses offered: 41 credits

Teaching and Assessment Strategy

A student will be evaluated continuously in the courses system, for theoretical classes s/he will be assessed by class participation, assignments, quizzes, mid-semester examinations and final examination. For laboratory work s/he will be assessed by observation of the student at work, viva-voce during laboratory works, from his/her written reports and grades of examinations designed by the respective course teacher and the examination committee.

1. Distribution of Marks:
The marks of a given course will be as follows:

Class Attendance	10%
Assignments and Mid-Semester Examinations	20%
Class Performance	10%
Final Examination	60%

2. Class Attendance:
The marks for class participation will be as follows:

Attendance (Percentage)	Marks	Attendance (Percentage)	Marks	Attendance (Percentage)	Marks
95 and above	10	80 to 84	7	65 to 69	4
90 to 94	9	75 to 79	6	60 to 64	3
85 to 89	8	70 to 74	5	Less than 60	0

A student will not be allowed to appear at the examination of a course if his/her class attendance in that course is less than 50%.

3. Assignments and Mid-Semester Examinations:
There should be at least two mid-semester examinations for every course. The course teacher may decide the relative marks distribution between the assignments, tutorial and mid-semester examinations, however at least 50% contribution should come from the mid-semester examinations. The answer script should be returned to the students as it is valuable to their learning process.

4. Final Examination:
The final examination will be conducted as per the Semester Examination Ordinance.

(a) **Duration of the Final Examination:** There will be a 3-hour final examination for every course of 3 credits or more after the 13th week from the beginning of the semester. Courses less than 3 credits will have final examination of duration 2 hours.

(b) **Evaluation of Answer Script:** The students of the School of Applied Sciences and Technology will have two answer scripts to answer separate questions during final examination. Two separate examiners will grade the two scripts separately and the marks will be added together to get the final mark.

Grading System

1. Letter Grade and Grade Point:
Letter Grade and corresponding Grade-Point for a course will be awarded from the roundup marks of individual courses as follows:

Numerical Grade	Letter Grade	Grade Point
80% and above	A+	4.00
75% to less than 80%	A	3.75
70% to less than 75%	A-	3.50
65% to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	C-	2.00
Less than 40%	F	0.00

2. Calculation of Grades

GPA:
Grade Point Average (GPA) is the weighted average of the grade points obtained in all the courses completed by a student in a semester.

CGPA:
Cumulative Grade Point Average (CGPA) of only major and both major and second major degree will be calculated by the weighted average of every course of previous semesters along with the present semester. For clearing graduates if the roundup value of the third digit after decimal is nonzero the second digit will be incremented by one. A student will also receive a separate CGPA for his second major courses.

F Grades:
A student is given an 'F' grade if he fails or is absent in the final examination of a course. If a student obtains an 'F' grade his grade will not be counted for GPA and s/he has to repeat the course. An 'F' grade will be in his/her record and s/he will not be eligible for Distinction.

Distinction:
Candidates for four-year Bachelor degree will be awarded the degree with Distinction if his/her overall CGPA is 3.75 or above. However, a student will not be considered for Distinction if (a) s/he is not a regular student (has semester drop, incomplete courses in any semester or break of study) (b) has 'F' grade in one or more courses.

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COURSE PROFILE

First Year First Semester

Course Title:	Structured Programming Language
Credits:	3.0
Course No.:	SWE 0613-1121
Credit Hours:	3 hours/week
Rationale:	This course helps the students to get familiarized with basic concepts of computer programming and development tools. Also Structured Programming Language course covers the syntax and semantics of the "C" language as well as data types offered by the language which allow the students to write their own programs using standard language infrastructure regardless of the hardware or software platform.
Objectives:	● To give students a basic understanding of computer hardware and how a computer works. ● To teach students the basic terminology used in computer programming ● To facilitate necessary knowledge about writing, compiling and debugging programs in C language ● To enhance the ability of the students to write programs involving decision structures, loops and functions ● To make the students understand the concepts and usage of pointers and also the difference between call by value and call by reference ● To help students understand basic data structures and their implementation. Also how they might be applied to solve real-world problems. ● To teach students good programming practices and how to build up their own logics and how to implement them.
Course Contents:	**Programming Language:** Basic concept, Overview of programming languages, Problem Solving Techniques and Data Flow Diagram. **C-Language:** Preliminaries, Program constructs, variables and data types in C. Input and output. Character and formatted I/O; Arithmetic Expressions and Assignment statements; Control statement, Loops and Nested loops; break, continue, goto, Decision making; Arrays, Functions; Arguments and local variables, Calling Functions and arrays. Recursion and Recursive functions; Structures within structure. Automatic, external, static variable, Files; File functions for sequential and Random I/O. Pointers; Pointers and structures, union; Pointer and functions; Pointer and arrays; Operation and Pointer; Pointer and memory addresses; Operations on Bits; Bit Operation; Bit field; Advanced features; Preprocessor and Macros, enumeration, Standard library.

Recursion: Basic idea of recursion (3 laws-base case, call itself, move towards base case by state change), tracing output of a recursive function, applications: factorial, fibonacci, tower of Hanoi, merge sort, permutation, combination.

Sorting: Insertion sort, selection sort, bubble sort, merge sort, quick sort, distribution sort (counting sort, radix sort, bucket sort).

Searching: Linear search, binary Search, application of Binary Search- finding element in a sorted array, finding nth root of a real number, solving equations.

Stack and Queue: Basic stack operations (push/pop/peek), stack-class implementation using Array and linked list, in-fix to postfix expressions conversion and evaluation, balancing parentheses using stack, basic queue operations (enqueue, dequeue), circular queue/ dequeue, queue-class implementation using array and linked list, application- Josephus problem, palindrome checker using stack and queue.

Course Learning Outcomes (CLOs):

CLO 1	Apply problem-solving techniques to design and develop efficient algorithms for various programming tasks.
CLO 2	Develop programs using C programming language and apply the concepts of variables, data types, control statements, arrays, functions, pointers, and file handling.
CLO 3	Analyze and implement recursive functions and sorting and searching algorithms to solve complex problems.
CLO 4	Implement stack and queue data structures and apply them to solve problems such as infix to postfix conversion, evaluating postfix expressions, and balancing parentheses.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	2	2	2	2	2	2	2	2	2	2	2	3
CLO 2	3	2	2	3	3	3	3	3	3	2	2	3
CLO 3	2	2	2	1	1	1	2	2	2	2	2	3
CLO 4	2	2	1	1	1	1	1	1	1	1	1	3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, P
CLO2	CL, T, OR, GD, PrbL, PjrL	A, P, RW
CLO3	CL, T, OR, PrbL, PjrL	A, P, RW

CLO4	GD, PrbL, PrjL, BL	V, P, RW

Assessment Strategy:

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Course Introduction:** Basic concept of Programming Language and Overview of programming languages	Lectures, Presentations, and Discussion	Quiz	CLO1
2-3	Problem Solving Techniques and Data Flow Diagram	Lectures, Presentations, and Case Studies	Case Study, Assignment and a Quiz	CLO1
4-5	**C-Language:** Preliminaries, Program constructs, variables, and data types in C. Input and output. Character and formatted I/O	Lectures, Presentations, and Hands-on programming exercises	Programming Assignments and a Quiz	CLO2
6-7	Arithmetic Expressions and Assignment statements; Control statement, Loops, and Nested loops; break, continue, goto, Decision making.	Lectures, Presentations, and Hands-on programming exercises	Programming Assignments and a Quiz	CLO2
8-9	Arrays, Functions; Arguments and local variables, Calling Functions, and arrays. Recursion and Recursive functions; Structures within structure.	Lectures, Presentations, and Hands-on programming exercises	Programming Assignments and a Quiz	CLO2, CLO3
10-11	Automatic, external, static variable, Files; File functions for sequential and Random I/O. Pointers; Pointers and structures, union; Pointer and functions;	Lectures, Presentations, and Hands-on programming exercises	Programming Assignments and a Quiz	CLO2

		Pointer and arrays; Operation and Pointer; Pointer and memory addresses; Operations on Bits; Bit Operation; Bit field;			
	12-13	Advanced features; Preprocessor and Macros, enumeration, Standard library.	Lectures, Presentations, and Hands-on programming exercises	Programming Assignments and a Quiz	CLO2
	14	Stack and Queue: Basic stack operations (push/pop/peek), stack-class implementation using Array and linked list, infix to postfix expressions conversion and evaluation, balancing parentheses using stack, basic queue operations (enqueue, dequeue), circular queue/ dequeue, queue-class implementation using array and linked list, application- Josephus problem, palindrome checker using stack and queue.	Lectures, Presentations, and Hands-on programming exercises	Programming Assignments and a Quiz	CLO4
Text Books	1. Schaum's Outline of Programming with C by Byron S. Gottfried 2. C: The Complete Reference by Herbert Schildt				

Course Title:	Structured Programming Language Lab
Credits:	1.5
Course No.:	SWE 0613-1122
Credit Hours:	3 hours/week
Rationale:	This course helps the students to get familiarized and implement the basic concepts of computer programming using various development tools and editors. Also Structured Programming Language Lab courses allow the students to analyze the syntax and semantics of the "C" language as well as data types offered by the language by writing their own programs using standard language infrastructure regardless of the hardware or software platform.

<table>
<tr><td>Objectives:</td><td>

To train students to work with C++ compilers and run programs on the computer.
Foster the analytical and critical knowledge to build up logic and implement them using C.
To facilitate necessary knowledge about designing programs involving decision structures, loops and functions
To develop skills to debug codes by giving an in depth idea about different syntax errors, exceptions and how to fix them.
To provide the knowledge of pointers and also the difference between call by value and call by reference
Helping the students to write code using good programming practices.

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<tr><td>Course Contents:</td><td>
Programming Language: Basic concept, Overview of programming languages, Problem Solving Techniques and Data Flow Diagram.

C-Language: Preliminaries, Program constructs, variables and data types in C. Input and output. Character and formatted I/O; Arithmetic Expressions and Assignment statements; Control statement, Loops and Nested loops; break, continue, go to, Decision making; Arrays, Functions; Arguments and local variables, Calling Functions and arrays. Recursion and Recursive functions; Structures within structure. Automatic, external, static variable, Files; File functions for sequential and Random I/O. Pointers; Pointers and structures, union; Pointer and functions; Pointer and arrays; Operation and Pointer; Pointer and memory addresses; Operations on Bits; Bit Operation; Bit field; Advanced features; Preprocessor and Macros, enumeration, Standard library.

Recursion: Basic idea of recursion (3 laws-base case, call itself, move towards base case by state change), tracing output of a recursive function, applications: factorial, Fibonacci, tower of Hanoi, merge sort, permutation, combination.

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Searching: Linear search, binary Search, application of Binary Search- finding element in a sorted array, finding nth root of a real number, solving equations.

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</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>
<table>
<tr><td>CLO 1</td><td>Develop programming skills using the C programming language to solve problems and implement algorithms covered in the lecture course.</td></tr>
<tr><td>CLO 2</td><td>Analyze, design, and implement data structures such as stacks, queues, and arrays using C programming language.</td></tr>
<tr><td>CLO 3</td><td>Use recursion to solve problems, sort data, and search for elements in arrays and other data structures.</td></tr>
<tr><td>CLO 4</td><td>Develop skills in debugging, testing, and troubleshooting programs written in C programming language.</td></tr>
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<tr><td>Mapping of CLOs with Program</td><td>Mapping of Course Learning Outcomes to Program Learning Outcomes</td></tr>
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Learning Outcomes (PLOs):

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	2	2	2	2	2	2	2	2	2	2	2	3
CLO 2	3	2	2	3	3	3	3	3	3	2	2	3
CLO 3	2	2	2	3	3	3	2	2	2	2	2	3
CLO 4	2	2	1	1	1	1	1	1	1	1	1	3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to C programming language	Lecture and demonstration	Quiz	CLO1
2	Variables and data types in C	Lecture and demonstration	Exercise and Quiz	CLO1
3	Control statements and loops in C	Lecture and demonstration	Exercise and Quiz	CLO1
4	Functions in C	Lecture and demonstration	Exercise and Quiz	CLO1, CLO3
5	Arrays and pointers in C	Lecture and demonstration	Exercise and Quiz	CLO1, CLO3
6	Recursion in C	Lecture and demonstration	Exercise and Quiz	CLO2, CLO3
7	Sorting algorithms in C	Lecture and demonstration	Exercise and Quiz	CLO2

	8	Searching algorithms in C	Lecture and demonstration	Exercise and Quiz	CLO2
	9	Stacks and queues in C	Lecture and demonstration	Exercise and Quiz	CLO2
	10	Linked lists in C	Lecture and demonstration	Exercise and Quiz	CLO2
	11	Trees in C	Lecture and demonstration	Exercise and Quiz	CLO2
	12	File handling in C	Lecture and demonstration	Exercise and Quiz	CLO1, CLO4
	13	Debugging and testing in C	Lecture and demonstration	Exercise and Quiz	CLO1, CLO4
	14	Implement sorting and searching algorithms using arrays, pointers, and structures in C. Develop programs using stacks and queues to solve problems.	Lecture and demonstration	Exercise, Quiz and Lab Report	CLO3, CLO4
Text Books	1. Schaum's Outline of Programming with C by Byron S. Gottfried 2. C: The Complete Reference by Herbert Schildt				

Course Title:	Discrete Mathematics
Credits:	3
Course No.:	SWE 0541-1123
Credit Hours:	3 hours/week
Rationale:	This course is designed to introduce first-year CSE students to the fundamental concepts of discrete mathematics. Through this course, they will gain familiarity with mathematical ideas of relevance to engineering on a rigorous footing. Along the way, they are expected to achieve proficiency in logical reasoning and analytical thinking.
Objectives:	● Help them conceptualize basic theories in mathematical reasoning and appreciate the precision of language and rigor required for mathematics. ● Help them conceptualize basic theories in combinatorial analysis to be able to solve counting problems. ● To facilitate necessary knowledge about how to work with discrete data structures like graphs and trees.

<table>
<tr><td></td><td>

To facilitate necessary knowledge about algorithmic techniques and to be able to implement them in computer programs.
Apply the knowledge of discrete mathematics in real-life problems using modeling.

</td></tr>
<tr><td>Course Contents:</td><td>Set, Relations, Functions: Set, Function, Representing Relations, Equivalence Relations.
Propositional Calculus: Propositions, Predicate and Quantifier.
Algorithms: Complexity, Divisions, Algorithm, Application of Number Theory.
Recursion: Sequences and summations, Recursive Definition and algorithm.
Combinatorial Analysis: Permutation and Combination, Divide and Conquer Algorithms, Generating Functions.
Graphs: Representation, Isomorphism, Connectivity, Euler and Hamilton path, Shortest path, Planer, Coloring.
Trees: Spanning trees, Rooted Trees, Binary Trees, Huffman Trees.
Boolean Algebra: Number System, Boolean Function, representing Boolean Function, Logic gate, Minimization of Circuits.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>
<table>
<tr><td>CLO 1</td><td>Explain the basic concepts of set, algorithm, combinatorics, logic, graphs, trees, and boolean algebra</td></tr>
<tr><td>CLO 2</td><td>Apply mathematical knowledge and logical reasoning to solve different problems</td></tr>
<tr><td>CLO 3</td><td>Compare multiple algorithms to solve any specific problems in terms of time complexity</td></tr>
<tr><td>CLO 4</td><td>Design new problems and expected solutions based on the knowledge they have gathered discussing in a group</td></tr>
</table>
</td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td>
Mapping of Course Learning Outcomes to Program Learning Outcomes
<table>
<tr><th>CLO /PLO</th><th>PLO1</th><th>PL02</th><th>PLO3</th><th>PLO4</th><th>PLO5</th><th>PLO6</th><th>PLO7</th><th>PLO8</th><th>PLO9</th><th>PLO10</th><th>PLO11</th><th>PLO12</th></tr>
<tr><td>CLO 1</td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CLO 2</td><td></td><td></td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CLO 3</td><td></td><td>X</td><td></td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CLO 4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and</td><td>
<table>
<tr><th>CLO</th><th>Teaching Learning Strategy</th><th>Assessment Strategy</th></tr>
<tr><td>CLO 1</td><td>Lectures</td><td>Quiz, Class Test, Final Exam</td></tr>
<tr><td>CLO 2</td><td>Lectures, Group Discussion, TPS (Think-Pair-Share)</td><td>Assignment, Class Test, Final Exam</td></tr>
</table>
</td></tr>
</table>

Assessment Strategy:

CLO 3	Lectures, Demonstrations, Problem Solving Tasks, Complexity Analysis Comparison, TPS	Assignment, Class Test, Final Exam
CLO 4	Brainstorming, Decision Making Tasks	Group Tasks, Assignments

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Sets, Sequence and Functions	Lectures	Class Test, Quiz, Final Exam	CLO 01
2	Elementary Logic	Lectures	Class Test, Quiz, Final Exam	CLO 01
3	Elementary Logic	Lectures	Class Test, Quiz, Final Exam	CLO 01
4	Relations	Lectures	Class Test, Quiz, Final Exam	CLO 01
5	Induction and Recursion	Lectures	Assignment, Final Exam, Class Test	CLO 01, CLO2, CLO3
6	Counting	Lectures	Assignment, Final Exam, Class Test	CLO 01, CLO2
7	Introduction to Graphs and Trees	Lectures	Assignment, Final Exam, Class Test	CLO2
8	Introduction to Graphs and Trees	Lectures, TPS	Class Test, Final Exam, Assignment, Group Task	CLO 03, CLO4
9	Recursion, Trees and Algorithms	Lectures	Class Test, Final Exam, Assignment, Group Task	CLO 02
10	Recursion, Trees and Algorithms	Lectures, TPS	Class Test, Final Exam, Assignment, Group Task	CLO 03, CLO4

	11	Boolean Algebra	Lectures, Industry Talk/Demonstration	Class Test, Final Exam, Assignment, Group Task	CLO 01, CLO2
	12	Discrete Probability	Lectures	Class Test, Final Exam, Assignment, Group Task	CLO 01, CLO2
	13	Digraphs	Lectures	Class Test, Final Exam, Assignment, Group Task	CLO 01, CLO2
	14	Discussion on Problem Formulation	Lectures, Demonstration	Class Test, Final Exam, Assignment, Group Task	CLO 04
	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)				
Text Books	1. Discrete Mathematics and Its Applications by Kenneth H. Rosen				

Course Title	Basic Electrical and Electronic Circuits
Credits	3.0
Course No	EEE 0712-1101W
Contact Hours	3 hours/week
Rationale	The aim of this course is to provide basic knowledge of the principles and practices of different types of circuit analysis techniques to analyze simple and complex circuits. It also provides ideas about AC networks, including phasor and impedance diagrams. This course endeavors to build on this knowledge and further expand student's skills in analyzing and designing circuits involving transistors, diodes, operational amplifiers and basic logic gates. The course focuses on developing fundamental ideas and basic concepts on electrical equipment and electronic devices. The course covers practical experiments on the topics of digital electronics including Number Theory, Boolean Algebra and Logic Circuits. Upon completion, students should be able to construct, analyze, verify, and troubleshoot electrical and digital circuits using appropriate techniques and test equipment.
Objective	● To facilitate the basic concepts of electrical charge, voltage, current and power ● To help students develop basic knowledge of DC circuit behavior. ● Acquaint the students with the techniques of solving different types of circuits by network theorem. ● To help students conceptualize basic AC circuits.

<table>
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Accumulate basic knowledge about the basics of diode, transistors, op-amps and their applications
To develop student's skills for analysis and design of analog circuits such as amplifiers.
To develop the skills to solve mathematical problems of simple and complex electrical circuits.
To introduce the basic principle operations, device and circuit characteristics of diodes and BJT, JFET and MOSFET transistors.
To provide the basic idea about semiconductor theory
To provide the knowledge to apply Boolean algebra and logic gates to solve logic functions.

</td></tr>
<tr><td>Course Content</td><td>
Circuit variables and elements: Voltage, current, power, energy, independent and dependent sources, and resistance.
Basic laws: Ohm's law, Kirchhoff's current and voltage laws.
Simple resistive circuits: Series and parallel circuits, voltage and current division, wye-delta transformation.
Techniques of circuit analysis: Nodal and mesh analysis including super node and super mesh.
Network theorems: Source transformation, Thevenin's, Norton's and Superposition theorems with applications in circuits having independent and dependent sources, maximum power transfer condition and Reciprocity theorem.
Energy storage elements: Inductors and capacitors, series-parallel combination of inductors and capacitors.
Responses of RL and RC circuits: Natural and step responses.
Sinusoidal functions: Instantaneous current, voltage, power, effective current and voltage, average power, phasors and complex quantities, impedance, real and reactive power, power factor.
Analysis of single-phase AC circuits: Series and parallel RL, RC and RLC circuits, nodal and mesh analysis, application of network theorems in AC circuits.
P-N junction as a circuit element: Intrinsic and extrinsic semiconductors, operational principle of p-n junction diode, contact potential, current-voltage characteristics of a diode, Diode circuits: Half wave and full wave rectifiers, rectifiers with filter capacitor.
Bipolar Junction Transistor (BJT) as a circuit element: current components, BJT characteristics and regions of operation, BJT as an amplifier, biasing the BJT for discrete circuits, small signal equivalent circuit models, BJT as a switch, Bipolar junction transistor construction, common emitter, common base, common collector configuration, operating point of BJT, Fixed bias circuit, Emitter stabilized bias circuit, Voltage divider bias.
Digital Logic Design: Binary logic, Boolean algebra, De Morgan's theorem, Basic Logic gates, Universal gate, Logic gate applications
</td></tr>
<tr><td>Course Learning Outcome</td><td>
After the successful completion of the course, the student will be able to-
<table>
<tr><td>CLO1</td><td>Explain the Basic concepts of Electrical Circuits.</td></tr>
<tr><td>CLO2</td><td>Solve and analyze the electrical circuits using different analysis methods and theorems</td></tr>
<tr><td>CLO3</td><td>Understand and explain the idea of AC networks and phasor.</td></tr>
<tr><td>CLO4</td><td>Explain the basics of diodes, transistors and their applications.</td></tr>
<tr><td>CLO5</td><td>Interpret different diode and transistor modes.</td></tr>
<tr><td>CLO6</td><td>Implement logic gates and Boolean algebra in practical circuit</td></tr>
</table>
</td></tr>
<tr><td>Mapping of Course Learning Outcomes to Program Outcomes</td><td>
<table>
<tr><th></th><th>PLO 1</th><th>PLO 2</th><th>PLO 3</th><th>PLO 4</th><th>PLO 5</th><th>PLO 6</th><th>PLO 7</th><th>PLO 8</th><th>PLO 9</th><th>PLO 10</th><th>PLO 11</th><th>PLO 12</th></tr>
</table>
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</table>

CLO 1	1		1					2				
CLO 2	1	2					2					
CLO 3	1										1	
CLO 4	1	2		1		2			1			
CLO 5	2	1								1		1
CLO 6	1				1							

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures	Class Test, Final Exam
CLO 2	Lectures, Assignments	Class Test, Final Exam
CLO 3	Lectures, Demonstration	Class Test, Final Exam
CLO 4	Lectures	Assignment, Final Exam
CLO 5	Lectures	Class Test, Final Exam
CLO 6	Demonstration, Lectures, Project Design, Home Work	Class Test, Final Exam, Assignment

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLO
01	Circuit variables and elements	Lectures	Class Test, Final Exam	CLO 1
02	Basic laws	Lectures		CLO 1
03	Simple resistive circuits	Lectures		CLO 1
04	Techniques of circuit analysis	Lectures, Assignments		CLO 2
05	Network theorems	Lectures, Assignments		CLO 2
06	Network theorems	Lectures, Assignments		CLO 2
07	Energy storage elements	Lectures, Demonstration	Assignment, Final Exam	CLO 3
08	Sinusoidal functions	Lectures, Demonstration		CLO 3
09	Analysis of single-phase AC circuits	Lectures, Demonstration	Class Test, Final Exam, Assignment	CLO 3
10	P-N junction as a circuit element	Lectures		CLO 4
11	Bipolar Junction Transistor (BJT)	Lectures		CLO 5
12	Bipolar Junction Transistor (BJT)	Lectures		CLO 5
13	Digital Logic Design	Lectures		CLO 6
14	Application of Logic gate	Lectures		CLO 6

Textbook	1. Introductory Circuit Analysis by Robert L. Boylestad 2. Electronic Devices and Circuit Theory by Robert L. Boylestad 3. Alternating Current Circuits by Russel M. Kerchner, George F. Corcoran 4. Digital Fundamentals-Thomas L. Floyd

Course Title	Basic Electrical and Electronic Circuits Lab
Credits	1.5
Course No	EEE 0712-1102W
Contact Hours	3 hours/week
Rationale	In this course, students will perform experiments to verify practically the theories and concepts learned in EEE-101W. Theoretical knowledge is incomplete without hands-on experiments using the basic components and measuring devices used in electrical circuit analysis. This course teaches the fundamentals of electrical circuits, the application of circuit laws, theorems and measuring techniques for DC circuits. It contains experiments investigating the performance characteristics of diodes and different types of diode circuits. It contains a broad idea of transistors and their applications. The course covers practical experiments on the topics of digital electronics including: Number Theory, Boolean algebra, Logic Circuits, and Logic Minimization Techniques.
Objective	The objectives of the course are ● To facilitate the necessary knowledge to implement dc circuits application in real-time environment ● Enable students with network analysis techniques to solve different types of circuits. ● To understand the transient analysis and steady-state analysis of a capacitor and inductor in a network. ● Help students to develop the ability in building AC electrical circuits and perform experiments on them. ● To provide the knowledge to apply Boolean algebra to solve logic functions. ● Help students conceptualize the basics of logic family.
Course Content	In this course, students will perform experiments to verify practically the theories and concepts learned in EEE 101W. **Lab 1-2**: To familiarize students with the operation of different electrical instruments including measuring Equipment: Multi-meter, Frequency meter and Oscilloscope. **Lab 3-7**: To verify the following theorems: KCL and KVL theorem, Superposition theorem, Thevenin's theorem, Norton's theorem and Maximum power transfer theorem. **Lab 8**: Diode Circuit and Half-wave rectifier **Lab 9**: AC circuit, frequency measurement and lead-lag measurement. **Lab 10**: Basic transistor circuits **Lab 11:**To construct circuits using logic gates: AND, OR, NOT, NAND, NOR, XOR **Lab 12:** To verify different kinds of applications of Boolean algebra. **Lab 13**: Lab test. **Lab 14**:Quiz

Course Learning Outcome

After the successful completion of the course, the student will be able to-

CLO 1	Explain the basic operation of different types of electrical instruments and measuring devices.
CLO 2	Implement network theorems and laws for different types of circuit analysis.
CLO 3	Measure the AC quantities in single phase circuit
CLO 4	Construct rectifier circuits using diode.
CLO 5	Manipulate logic expressions using binary Boolean algebra.
CLO 6	Demonstrate team-based personal, leadership and communication skills, and magnify their moral

Mapping of Course Learning Outcomes to Program Outcomes

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PLO 10**	**PLO 11**	**PLO 12**
CLO 1	1											1
CLO 2	2							1				
CLO 3	2	1							1		1	
CLO 4	2		1			1				1		
CLO 5	2			2	1			1			1	
CLO 6	1											1

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching Learning Strategy**	**Assessment Strategy**
CLO 1	Lectures, Demonstration	Viva, Quiz, Laboratory Test
CLO 2	Demonstration	Laboratory Test
CLO 3	Lectures, Demonstration	Viva, Quiz, Laboratory Test
CLO 4	Lectures, Demonstration	Viva, Quiz, Laboratory Test
CLO 5	Lectures, Demonstration	Laboratory Test, , Quiz, Viva
CLO 6	Lectures, Demonstration	Viva

Textbooks

1. Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O. Sadiku
2. Introductory Circuit Analysis by Robert L. Boylestad
3. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashlesky
4. Microelectronic Circuits- Sedra/Smith
5. Digital logic and Computer Design – M. Morris Mano

<table>
<tr><td>Course Title:</td><td>Coordinate Geometry and Calculus</td></tr>
<tr><td>Credits:</td><td>3.0</td></tr>
<tr><td>Course No.:</td><td>MAT 0541-1105W</td></tr>
<tr><td>Credit Hours:</td><td>3 hours/week</td></tr>
<tr><td>Rationale:</td><td>In an increasingly complex world, mathematical thinking, understanding, and skill are more important than ever. MAT 105W will show students how to simplify many types of complex problems using matrix algebra and vector geometry. Students who major in the sciences or engineering are often required to study Coordinate Geometry and Calculus. This course provides a solid foundation for further study in mathematics, the sciences, and engineering.</td></tr>
<tr><td>Objectives:</td><td>1. Engage students in sound mathematical thinking and reasoning
2. Provide a setting that prepares students to read and learn mathematics on their own
3. Enhance and reinforce the student’s understanding of concepts through the use of technology when appropriate</td></tr>
<tr><td>Course Contents:</td><td>Coordinate geometry: Equations for straight lines, circles, parabola, ellipse and hyperbola, pair of straight lines; general equations of second degree. Coordinates in three dimensions: equations for straight lines and planes in space; spheres, cylinders and cones.

Differential Calculus: Functions, limits and continuity, Physical meaning of derivative of a function; higher order derivatives; Leibnitz’s theorem; Rolle’s theorem; mean value theorem; Taylor’s theorem; Taylor’s and Maclaurin’s series; maximum and minimum values of functions;; partial and total derivatives; Euler’s theorem.

Integral Calculus: Physical meaning of integration of a function; evaluation of indefinite and definite integrals, fundamental theorem of integral calculus and its application to definite integrals; improper integrals; evaluation of area and volume of solid of revolution by integration.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>On completion of the course, the student will be able to-

<table>
<tr><td>CLO 1</td><td>understand the basic concepts of Equations for straight lines, circles, parabola, ellipse and hyperbola, pair of straight lines</td></tr>
<tr><td>CLO 2</td><td>recognize limit, continuity, differential coefficients of various functions and various theorems on calculus.</td></tr>
<tr><td>CLO 3</td><td>determine maxima and minima of a function</td></tr>
<tr><td>CLO 4</td><td>evaluate definite and indefinite integrals through different methods.</td></tr>
<tr><td>CLO 5</td><td>evaluate areas and volumes by integration in different types of equations in Cartesian and polar coordinates.</td></tr>
</table></td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td>Mapping of Course Learning Outcomes to Program Learning Outcomes

<table>
<tr><th>CLO /PLO</th><th>PLO1</th><th>PL02</th><th>PLO3</th><th>PLO4</th><th>PLO5</th><th>PLO6</th><th>PLO7</th><th>PLO8</th><th>PLO9</th><th>PLO10</th><th>PLO11</th><th>PLO 12</th></tr>
<tr><td>CLO 1</td><td>X</td><td></td><td></td><td></td><td></td><td>X</td><td>X</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CLO 2</td><td>X</td><td>X</td><td></td><td>X</td><td></td><td>X</td><td>X</td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
</table>

	CLO 3	**X**					**X**	**X**					
	CLO 4	**X**		**X**	**X**		**X**	**X**	**X**				
	CLO 5	**X**	**X**				**X**	**X**					

Text Books	**Books Recommended**: 1. Howard Anton and Chris Rorres: Elementary linear algebra with applications, ninth edition **Reference:** 1. Thomas and Finney: Calculus with Analytic Geometry

Course Title:	Effective Communication in English
Credits:	02
Course No.:	ENG 0231-1101W
Credit Hours:	2 hours / week
Rationale:	This course is expected to develop two basic skills i.e. reading and writing. A variety of reading strategies and texts will be used to effectively develop first year students' academic reading skills thereby facilitating their future study. Also, the course focuses on developing the writing skills of students by familiarizing them with grammar rules, providing them with practice and enabling them to demonstrate the accurate use of grammar in their writing.
Objectives:	● To enable students to write with accuracy. ● To facilitate effective and comprehensible writing. ● To raise awareness of common errors that occur in writing. ● To develop students' ability to understand write-ups on issues of general concern. ● To improve the vocabulary of learners for effective communication.
Course Contents:	**a) Reading** ● Different Reading Strategies ● Guessing Meaning from the Context ● Critical Reading (Analyze) ● Critical Reading (Synthesize) ● Critical Reading (Evaluate) ● Annotation ● Summary Writing **Materials** ● A selection of 08-10 editorials and reports from newspapers/magazines/journals,etc. ● Reading texts in New Headway Upper Intermediate Student's Book (Current edition) ● Selected passages from recommended books ● A selection of other materials may be supplied as handouts by the instructor as necessary

b) Writing

- Forms and functions of different word categories (noun, verb, adjective, etc.)
- Aspects and uses of tense
- Subject-verb agreement
- Use of infinitive, gerund, present participle, past participle, modals, causatives, conditionals, subjunctives, modals.
- Use of sentence connectors/ cohesion markers/ punctuation
- Effective combination of sentences (simple, complex, compound)
- Developing a paragraph

Course Learning Outcomes (CLOs):

At the end of the course, students will be able to

CLO 1	apply grammar rules
CLO 2	express oneself correctly by using appropriate words, phrases, sentences or ideas
CLO 3	critically reflect on a text (grasp abstract ideas and interpret them effectively, arrive at well-reasoned conclusions and solutions)
CLO 4	Create using earned knowledge both independently and in collaboration with peer groups
CLO 5	Demonstrate a comprehension of subject knowledge and its subsequent use

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	**PLO1**	**PL02**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO 12**
CLO 1	**3**	**3**	**3**				**3**		**3**			
CLO 2	**3**	**3**	**3**				**3**		**3**			
CLO 3	**3**	**3**	**3**				**3**		**3**			
CLO 4	**3**	**3**	**3**				**3**		**3**			

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

COs	**Teaching-Learning Strategy**	**Assessment Strategy**
CO 1	TL 01, TL 02 TL 05	CA 01/CA 02, CA 03/CA 04
CO 2	TL 01, TL 02 TL 05	CA 01/CA 02, CA 04/CA 05
CO 3	TL 01, TL 02 TL 05	CA 04/CA 05
CO 4	TL 02	CA 05

	CO 5	TL 01, TL 02 TL 05,06	CA 01/CA 02

APPENDIX C: Examples of the Teaching-Learning & Assessment Strategy

Code	**Teaching-learning (TL) strategy**	**Code**	**Assessment Strategy**
TL 01	Lecture using board/LCD projectors/OHP projectors		Continuous assessment (CA)
TL 02	Assignment/project/seminar/workshop/tutorial	CA 01	Midterm Examination 1
TL 03	Laboratory/Other teaching aids (Audio-visual: film and documentaries, virtual classroom, etc.)	CA 02	Midterm Examination 2
TL 04	Guest lectures/industrial visit/field visit	CA 03	Quiz
TL 05	Self-learning using reference books/research articles/case study/other online materials	CA 04	Assignment
TL 06	Simulation/field demonstration	CA 05	Presentation (Individual/group) /Viva-voce

Evaluation	● IELTS, TOEFL and other standardized testing formats for assessing the level of reading skill will be followed. Test items may be as follows: fill in blanks, true/false, multiple choice/ matching word meanings/ information transfer/matching titles with relevant paragraphs in the text, etc. ● Reading skill will be tested on two reading texts. One reading text will be taken from one of the selections students have already read during the semester. The other reading text will be similar in terms of contents and difficulty but will not have been previously discussed.
Text Books	● Tibbits, E. E., editor. Exercises in Reading Comprehension. Longman, 2013. ● Liz and John Soars. New Headway Upper Intermediate Student's Book. Oxford University Press, 2014. ● Payle, Michael. Cliff's TOEFL Preparation Guide. 12th ed., Cliffs Notes Inc., 2019. ● Other Resources recommended by course instructors

<table>
<tr><td>Course Title:</td><td>English Language Lab-I</td></tr>
<tr><td>Credits:</td><td>1</td></tr>
<tr><td>Course No.:</td><td>ENG 0231-1102W</td></tr>
<tr><td>Credit Hours:</td><td>2 hours/week</td></tr>
<tr><td>Rationale:</td><td>This course is designed to improve the speaking and listening skills of students in the English language. Emphasis is laid on proper pronunciation for accurate articulation and recognition of speech sounds as well as correct stress, intonation and language use in varied situations.</td></tr>
<tr><td>Objectives:</td><td>● To enable students' understanding of the variations in pronunciation.
● To teach proper pronunciation and accurate articulation.
● To facilitate appropriate stress and intonation in speech.
● To encourage use of English effectively in everyday situations.
● To ensure overall improvement of oral communication through listening and speaking.</td></tr>
<tr><td>Course Contents:</td><td>(a) Speaking
● Articulators
● English Phonetic Alphabet (British and American) and International Phonetic Alphabet (IPA)
● Stress rules of English
● Intonation rules and functions of intonation
● Communication styles and cultural context
● Fluency, mistakes, misunderstandings, audience, taboos, self-esteem, confidence
● Activities: dialogue, debate, extempore speech, interview, role-play

(b) Listening
● Basics of listening
● Various types of pronunciation
● IPA, RP, transcription
● Different accents and intonation patterns
● Activities for meaning-focused listening
● Information transfer strategies
● Listening practice through selection of audio clips</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>At the end of the course, students will be able to<table><tr><td>CLO 1</td><td>read the symbols of the International Phonetic Alphabet used to represent the sounds of the English language</td></tr><tr><td>CLO 2</td><td>apply appropriate intonation and stress patterns in English words and sentences</td></tr><tr><td>CLO 3</td><td>interpret information accurately</td></tr><tr><td>CLO 4</td><td>collaborate and apply intonation and stress patterns.</td></tr><tr><td>CLO 5</td><td>produce continuous speech clearly and convincingly</td></tr></table></td></tr>
<tr><td>Mapping of CLOs with Program Learning</td><td>Mapping of Course Learning Outcomes to Program Learning Outcomes</td></tr>
</table>

Outcomes (PLOs):

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3	3	3				3		3			
CLO 2	3	3	3				3		3			
CLO 3	3	3	3				3		3			
CLO 4	3	3	3				3		3			

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	TL 01, TL 02 TL 05	CA 01/CA 02, CA 03/CA 04
CO 2	TL 01, TL 02 TL 05	CA 01/CA 02, CA 04/CA 05
CO 3	TL 01, TL 02 TL 05	CA 04/CA 05
CO 4	TL 02	CA 05
CO 5	TL 01, TL 02 TL 05,06	CA 01/CA 02

APPENDIX C: Examples of the Teaching-Learning & Assessment Strategy

Code	Teaching-learning (TL) strategy	Code	Assessment Strategy
TL 01	Lecture using board/LCD projectors/OHP projectors		Continuous assessment (CA)
TL 02	Assignment/project/seminar/workshop/tutorial	CA 01	Midterm Examination 1
TL 03	Laboratory/Other teaching aids (Audio-visual: film and documentaries, virtual classroom, etc.)	CA 02	Midterm Examination 2

	TL 04	Guest lectures/industrial visit/field visit	CA 03	Quiz
	TL 05	Self-learning using reference books/research articles/case study/other online materials	CA 04	Assignment
	TL 06	Simulation/field demonstration	CA 05	Presentation (Individual/group) /Viva-voce
Evaluation	● IELTS, TOEFL and other standardized testing formats for assessing the level of listening skill will be followed. Test items may be as follows: fill in blanks, true/false, multiple choice/ matching word meanings/ information transfer/matching, etc. ● Speaking skill will be tested through dialogue, debate, extempore speech, presentation, role-play, etc.			
Text Books	● Anderson, Anne C., et al.*Listening*.Oxford University Press, 1988. ● Anderson, Kenneth, et al. *Study Speaking*. Cambridge University Press, 2007. ● Hancock, Mark. *English Pronunciation in Use*. Cambridge University Press, 2004. ● Jones, Daniel. *Cambridge English Pronunciation Dictionary*. Cambridge University Press, 2011. Richards, Jack C., and David Bohlke. *Speak Now: 1*. Oxford University Press, 2013. ● Richards, Jack C., et al. *Person to Person*. Oxford University Press, 2007. ● Roach, Peter. *English Phonetics and Phonology*. Cambridge University Press, 2009.			

Course Title:	History of the Emergence of Independent Bangladesh
Credits:	3
Course No.:	SSS 0312-1100
Credit Hours:	3 hours / week
Course Description	This is a special compulsory course for all students of Bachelor program of Shahjalal University of Science and Technology, Sylhet. This course deals with the interrelated themes and topics that are essential to understand the emergence of Bangladesh.
Objectives:	The objectives of this course in general are to make students understand the causes of Liberation War, growth and development of Bengali nationalism and identity, national emancipation of the Bangalis. The specific course objectives are: 1. To give an idea about the War of Liberation and freedom fighters 2. To clarify the role of different sections of people in the War of Liberation 3. To explain the role of Bangabandhu in Liberation War 4. To give an idea about the sacrifices of martyrs for the motherland.
Course Learning	*Upon successful completion of the course, students will be able to* **CLO1.** Explain fundamental characteristics of politics of East Pakistan from 1947 to 1971;

<table>
<tr><td>Outcomes (CLOs):</td><td>CLO2. Gather knowledge on the post-colonial nationalist resistance during Pakistan period and the background of the establishment of Bangladesh;
CLO3. Describe the disintegration of East-West Pakistan and emergence of new nation state, Bangladesh;
CLO4. Understand the nature and dynamics of different political movements of Pakistan from 1947 to 1971 and evaluate the contributions of various actors;
CLO5. Evaluate the role of Bangabandhu Sheikh Mujibur Rahman in the creation of independent Bangladesh.</td></tr>
<tr><td>Teaching and Assessment</td><td>Teaching Strategies
The course materials are delivered through certain teaching-learning activities such as lectures, reading, assignments, exercise and workshop papers.

Assessment Strategies
<table>
<tr><th>No.</th><th>Description</th><th>Mark</th></tr>
<tr><td>1</td><td>Class attendance</td><td>10</td></tr>
<tr><td>2</td><td>Midterm test</td><td>20</td></tr>
<tr><td>3</td><td>Class Evaluation</td><td>10</td></tr>
<tr><td>4</td><td>Final Exam</td><td>60</td></tr>
</table>
Coursework = 40% of the overall mark, and the Final Examination = 60%.
The coursework consists of at least two tests with a combined weight of 20% of the final mark, 10% as a part of continuous assessment like the class test, quiz, problem-solving, short assignment and 10% of the final mark is reserved for class attendance as per rule of the university. Assignment submission date will be fixed by the Course Instructor.
Mid Semester Test Date: The mid-semester test is scheduled after the mid-semester break, and it covers topics in weeks 1-6. More details will be provided at lectures.
Final Exam Test Date: Final Exam Test schedule will be declared by the department before the preparatory leave. The final exam covers all the topics. Students must be able to show an understanding of the course material.

Assessment of Course Learning Outcome
<table>
<tr><th>CLO</th><th>Test</th><th>Assignment</th><th>Final Examination</th></tr>
<tr><td>1</td><td>x</td><td>x</td><td>x</td></tr>
<tr><td>2</td><td>x</td><td>x</td><td>x</td></tr>
<tr><td>3</td><td>x</td><td>x</td><td>x</td></tr>
<tr><td>4</td><td>x</td><td></td><td>x</td></tr>
<tr><td>5</td><td>x</td><td>x</td><td>x</td></tr>
</table>
Grading System
The grading system has been detailed in Section 7 “Grading System” in Semester Ordinance</td></tr>
<tr><td>Course Outline</td><td>3.1 Course Outline
<table>
<tr><th>Course Content</th><th>Teaching Strategy</th></tr>
</table></td></tr>
</table>

		1. Description of the land and its people b. Impacts of geographical features c. Ethnic composition of Bengal d. Development of Bengali language and its significance e. Cultural syncretism and religious tolerance f. Distinctive identity of Bangalis in the context of undivided Bengal	Lecture, tutorial and exercise	
		2. Proposal for United Independent Bengal State, Pakistan movement and foreshadowing of Bangladesh, the 1947 partition of the subcontinent a. Rise of communalism under the British colonial rule b. The 1940 Lahore Resolution c. Suhrawardy's move for undivided independent Bengal d. The establishment of Pakistan, 1947 e. Foundation of the Awami Muslim League (1949) and the struggle for emancipation of the Bangalis	Lecture, discussion and assignment	
		3. Pakistan: Structure of the state and disparity a. Central and provincial structures b. Influence of military and civil bureaucracies c. socio-economic, political and cultural disparities	Lecture, discussion and assignment	
		4. Language movement and quest for Bengali identity a. Misrule by Muslim League and struggle for democratic politics b. The Language movement: context, phases and international recognition of 21 February as Mother Language Day c. United Front elections of 1954 : Results and consequences	Lecture, tutorial and exercise	
		5. Military rule: the regimes of Ayub Khan (1958-1969) and Yahia Khan (1969-1971) a. Military rule and its characteristics b. Ayub Khan's rise to power and characteristics of his rule (political repression, Basic democracy, Islamisation) c. Fall of Ayub regime and Pakistan under Yahya military junta	Lecture, tutorial and exercise	
		6. Rise of Bangali nationalism and the movement for the right to self-determination a. Resistance against Pakistani cultural aggression and resurgence of Bengali nationalism	Lecture, tutorial and exercise	

		b. Bangabandhu Sheikh Mujibur Rahman's 6-points programme (1966) : Its significance and reaction of the regime c. The Agartala Conspiracy Case, 1968		
		7. The mass- upsurge of 1969 and its consequences a. Background b. Movement based on 6-points and 11-points programmes **c.** Fall of the Ayub regime **d.** Emergence of Bangabandhu as an undisputed leader	Lecture, tutorial and exercise	
		8. Election of 1970 and its significance a. Legal Framework Order (LFO) of general Yahya Khan b. Programmes of different political parties c. Election results d. Pakistani military junta's conspiracy to thwart the results	Lecture, tutorial and exercise	
		9. Non-cooperation movement and 7th March address of Bangabandhu a. The non-cooperation movement against Pakistani rule and its salient features b. 7th March address of Bangabandhu : Background c Significance of 7th March address d. International recognition of 7th March address as world heritage by UNESCO (2017)	Lecture, discussion	
		10. Declaration of Independence of Bangladesh a. Operation Searchlight (25 March 1971) b. Declaration of Independence of Bangladesh by Bangabandhu c. Beginning of the Liberation War of Bangladesh	and assignment	
		11. The War of Liberation, 1971 a. Genocide, repression of women, Bangali refugees in India b. Formation of Bangladesh government and Constitutional proclamation of Independence c. The spontaneous early resistance and subsequent organized resistance by Mukti Fouz, Mukti Bahini, Guerrillas and the frontal war in December 1971 d. Campaign in favor of the War of Liberation (Shadhin Bangla Betar Kendra, campaigns in abroad and formation of international public opinion) e. Contribution of students, women, the mass people and different political parties in the War of Liberation f. The role of great powers and the United Nations in the Liberation War g. The contribution of India in the Liberation War	Lecture, discussion	

	h. The anti-liberation activities of the Peace Committee, Al-Badar, Al-Shams, Rajakars, pro-Pakistani political parties and other Pakistani collaborators , killing of the Bengali intellectuals at the end of the war i. Arrest and Trial of Bangabandhu in Pakistani custody and reaction of the World community j. Formation of joint command of Mukti Bahini and Indian allied forces and Victory in the war k. Evaluation of Bangabandhu's contributions in the Independence of Bangladesh	
	12. The Bangabandhu government, 1972-1975 a. Homecoming of Bangabandhu and his address at Race Course on 10 January 1972 b. Making of the Bangladesh Constitution, 1972 c. Reconstruction of the war-ravaged country by Bangabandhu government d. Foreign policy of Bangabandhu; his first address at the United Nations in 1974 e. Bangabandhu's 'Second Revolution' or System change, 1975 f. The assassination of Bangabandhu and his family members and the ideological turn-around	Lecture, tutorial and exercise

Alignment of topics of the courses with CLOs

	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
Content 1	**x**	**x**			
Content 2	**x**	**x**	**x**		**x**
Content 3	**x**	**x**	**x**		**x**
Content 4	**x**		**x**	**x**	
Content 5	**x**			**x**	**x**
Content 6				**x**	**x**
Content 7				**x**	**x**
Content 8			**x**	**x**	**x**
Content 9				**x**	**x**
Content 10				**x**	**x**
Content 11				**x**	**x**
Content 12					

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	**PLO1**	**PL02**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**

	CLO 1	**2**								**2**			
	CLO 2	**2**			**2**		**2**				**1**		**1**
	CLO 3	**1**		**1**					**2**			**1**	
	CLO 4	**1**	**1**			**1**		**1**					
	CLO 5	**2**											

Recommended Readings

1. Ahmed, Salahuddin and Bazlul Mobin Chowdhury (eds.), *Bangladesh: National Culture and Heritage: An Introductory Reader* (Dhaka: Independent University Bangladesh, 2004)
2. Harun-or-Roshid, *The Foreshadowing of Bangladesh: Bengal Muslim League and Muslim Politics, 1906-1947* (Dhaka : The University Press Limited, 2012)
3. Harun-or-Rashid, *The Foreshadowing of Bangladesh: Bengal Muslim League and Muslim politics, 1906-1947. (*Dhaka: The University Press Limited 2003)
4. Harun-or-Rashid, *From 1947 Partition to Bangladesh: BANGABANDHU and State Formation in Perspective*. (Dhaka: The University Press Limited 2021)
5. Jahan Rounaq, *Pakistan: Failure in National Integration,(Dhaka :* The University Press Limited, 1977)
6. Jahan Rounaq, *Political Parties in Bangladesh*, (Dhaka: Prothoma Prokashan 2015)
7. Talukder Maniruzzaman, *Radical Politics and the Emergence of Bangladesh, (Dhaka :* Mowla,Brothers, 2003)
8. Talukdar Maniruzzaman , *The Bangladesh Revolution and Its Aftermath,* (Dhaka: UPL 2003)
9. Nurul Islam, *Making of a Nation : Bangladesh- An Economist Tale, (*Dhaka: UPL 2013)
10. শেখ মুজিবুর রহমান : অসমাপ্ত আত্মজীবনী, (ঢাকা : দি ইউনিভার্সিটি (প্রেসলিমিটেড, ২০১২)
11. নীহার রঞ্জন রায় : বাঙালীর ইতিহাস, (কলকাতা : দে' জ পাবলিশিং, ১৪০২ সাল) ১১. সালাহ্ উদ্দিন আহমেদ ও অন্যান্য (সম্পাদিত), বাংলাদেশের মুক্তি সংগ্রামের ইতিহাস ১৯৪৭-১৯৭১, (ঢাকা) আগামী প্রকাশনী, ২০০২)
12. আবুল মাল আবদুল মুহিত : বাংলাদেশ: জাতি রাষ্ট্রের উদ্ভব, (ঢাকা : সাহিত্য প্রকাশ, ২০০০)
13. সিরাজুল ইসলাম (সম্পাদিত), বাংলাদেশের ইতিহাস ১৭০৪-১৯৭১, ৩ খন্ড, (ঢাকা: এশিয়াটিক সোসাইটি অব বাংলাদেশ, ১৯৯২)
14. হারুন-অর-রশিদ : বঙ্গীয় মুসলিম লীগ পাকিান আন্দোলন বাঙালির রাষ্ট্রভাবনা ও বঙ্গবন্ধু, (ঢাকা : অন্য প্রকাশন, ২০১৮) ১৫. হাসান হাফিজুর রহমান :বাংলাদেশের স্বাধীনতাযুদ্ধ দলিলপত্র, (সম্পাদিত), (ঢাকা-গণপ্রজাতন্ত্রী বাংলাদেশ সরকার, ১৯৮৫)
15. হাসান হাফিজুর রহমান :বাংলাদেশের স্বাধীনতাযুদ্ধ দলিলপত্র, (সম্পাদিত), (ঢাকা-গণপ্রজাতন্ত্রী বাংলাদেশ সরকার, ১৯৮৫)
16. সৈয়দ আনোয়ার হোসেন : বাংলাদেশের স্বাধীনতাযুদ্ধে পরাশক্তির ভূমিকা, (ঢাকা :ডানা প্রকাশনী, ১৯৮২)
17. মুনতাসীর মামুন ও অন্যান্য, স্বাধীন বাংলাদেশের অভ্যুদয়ের ইতিহাস, (ঢাকা: সুবর্ণ, ২০১৭)
18. আবু মো দেলোয়ার হোসেন, স্বাধীন বাংলাদেশের অভ্যুদয়ের ইতিহাস, (ঢাকা : বিশ্ববিদ্যালয় প্রকাশনী, ২০১৪)
19. আশফাক হোসেন, স্বাধীন বাংলাদেশের অভ্যুদয়ের ইতিহাস, (ঢাকা: প্রতিশৃণ্য প্রকাশন, ২০১৯)
20. আবু মো দেলোয়ার হোসেন, বাংলাদেশের ইতিহাস, ১৯০৫-১৯৭১
21. আশফাক হোসেন : বাংলাদেশের মুক্তিযুদ্ধ ও জাতিসংঘ, (ঢাকা: বাংলা একাডেমি, ২০০৩)
22. আবু মো. দেলোয়ার হোসেন, ড. মোহাম্মদ সেলিম (সম্পাদনা) : বাংলাদেশ ও বহির্বিশ্বে ইতিহাস সমিতি, (২০১৫) ২৩, আশফাক হোসেন, বাংলাদেশের মুক্তিযুদ্ধ ও ইন্দ্রিরা গান্ধী (ঢাকা : সুবর্ণ প্রকাশনী, ২০১৭)

First Year Second Semester

Course Title:	Introduction to Software Engineering
Credits:	3.0
Course No.:	SWE 0613-1225
Credit Hours:	3 hours/week
Rationale:	This course will help to prepare students for initiating knowledge and education in software engineering at an elementary level and experiential learning opportunities to apply that knowledge to solve real-world problems.
Objectives:	● To help the students to be successful professionals in the field with elementary knowledge of software engineering ● To facilitate the students to utilize and exhibit strong communication and interpersonal skills ● Accumulate basic ideas about professional and ethical principles when functioning as members and leaders of multi-disciplinary teams ● To develop the skills required to apply their foundations in software engineering to adapt to readily changing environments using the appropriate theory, principles and processes
Course Contents:	**Introduction:** Overview of Software Industry, Introduction to Software Engineering, Software Development Process and Various Life Cycle Models. **Requirement Analysis:** Communication Techniques, Analysis Principles, Software Prototyping, Requirement Specification. **Group Dynamics:** Working in Teams, Characteristics of Successful Team, Understanding Group Dynamics, Team Roles and Temperament, Democratic Team and Chief Programmer Team Approach. **Introduction to Extreme Programming**, **Analysis Modeling:** Steps of system analysis, Feasibility study, Economic and technical analysis, System specification, the elements of analysis model, Data modeling, Functional modeling and information flow, Behavioral modeling, Mechanics of structured analysis, Data Dictionary. **Software Design:** Design principles, Design Concepts, effective modular design, design heuristics, Data Design, Architectural Design process, Transformation mapping, Transaction mapping, interface design, human-computer interface design, procedural design. **Software Testing:** Testing fundamentals, test case design, white-box testing, black-box testing, testing GUIs, Unit testing, Integration testing, validation testing, system testing, debugging. **Maintenance:** Major maintenance activities, estimating maintenance cost and productivity. **Technical Metrics for Software:** Software quality, Framework for technical metrics, metrics for analysis and design models, source code, testing and maintenance. **Software Architecture:** Pipe and Filter, Object Oriented, Event Based, Layered System, Data-centered repository, Process Control Architectures, **Object Oriented Software Engineering**: O-O concepts, O-O analysis, Domain analysis, O-O analysis process, Object relational model. O-O design: system design process, object design process, O-O programming.

O-O Testing: Testing strategies, test case design.

Service Oriented Software Engineering: Introduction to SOA, SOAP, Analysis, design, validation, verification, implementation and maintenance of service oriented software; ESB, Messaging Architecture, Software Tools for SOA.

Software Project Management: Cost estimation, risk analysis, project scheduling.

Introduction to CASE Tools: What is CASE, taxonomy of CASE tools, iCASE environment, CASE repository, Example CASE tools.

Intellectual Properties: Trade Marks, CopyRights, Trade Secrets, Patents.

Introduction to UML.

Course Learning Outcomes (CLOs):

CLO 1	Analyze and design software solutions using various software development processes and life cycle models.
CLO 2	Collaborate effectively in a team environment and understand group dynamics to develop successful software projects.
CLO 3	Apply software design principles to create effective and efficient software solutions.
CLO 4	Implement software testing and maintenance techniques to ensure software quality and improve software productivity.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	**PLO1**	**PL02**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO 12**
CLO 1	**2**	**3**										**1**
CLO 2	**2**	**2**			**1**			**1**				**2**
CLO 3	**2**	**2**	**1**			**1**	**1**			**1**		**1**
CLO 4	**2**	**1**	**1**									**1**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	CL, T, OR, GD	A, P
CLO2	CL, T, OR, GD, PrbL, PjrL	A, P
CLO3	CL, T, OR, PrbL, PjrL	A, P
CLO4	GD, PrbL, PrjL, BL	V, P, RW

	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)
Course Plan	

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Overview of Software Industry and Introduction to Software Engineering	Lecture, Class Discussion	Quiz	CLO1
2	Software Development Process and Life Cycle Models	Lecture, Group Discussion	Group Presentation	CLO1
3	Requirement Analysis: Communication Techniques, Analysis Principles, Software Prototyping, Requirement Specification	Lecture, Case Study Analysis	Case Study, Report Writing	CLO1
4	Group Dynamics: Working in Teams, Characteristics of Successful Team, Understanding Group Dynamics, Team Roles and Temperament, Democratic Team and Chief Programmer Team Approach	Lecture, Group Activities	Group Presentation, Peer Evaluation	CLO2
5	Extreme Programming and Analysis Modeling: Introduction to Extreme Programming, Steps of System Analysis, Feasibility Study, Economic and Technical Analysis, System Specification, The Elements of Analysis Model, Data Modeling, Functional Modeling and Information Flow, Behavioral Modeling, Mechanics of Structured Analysis, Data Dictionary	Lecture, Group Activities	Group Presentation, Quiz	CLO1

		6	Software Design Principles and Concepts	Lecture, Design Activity	Design Report, Quiz	CLO3
		7	Software Testing: Testing Fundamentals, Test Case Design, White-Box Testing, Black-Box Testing, Testing GUIs, Unit Testing, Integration Testing, Validation Testing, System Testing, Debugging	Lecture, Case Study Analysis	Report, Quiz	CLO4
		8	Maintenance and Technical Metrics for Software	Lecture, Case Study Analysis	Case Study Report, Quiz	CLO4
		9	Software Architecture: Pipe and Filter, Object Oriented, Event Based, Layered System, Data-centered Repository, Process Control Architectures	Lecture, Group Activity	Group Presentation, Quiz	CLO3
		10	Object Oriented Software Engineering	Lecture, Case Study Analysis	Report Writing, Quiz	CLO3, CLO4
		11	O-O Testing and Service Oriented Software Engineering	Lecture, Group Activity	Group Presentation, Quiz	CLO4
		12	Software Project Management	Lecture, Group Activity	Group Presentation, Quiz	CLO3, CLO4
		13-14	Intellectual Properties and UML	Lecture, Group Activity	Group Presentation, Quiz	CLO4
Text Books	**Text:** 1. Beginning Software Engineering– Rod Stephens **Reference:** 1.Software engineering–Ian Sommerville 2. Software Engineering: An Engineering Approach–Peters					

Course Title	Data Structure

<table>
<tr><td>Credits</td><td>3.0</td></tr>
<tr><td>Course No</td><td>SWE 0613-1127</td></tr>
<tr><td>Contact hours</td><td>3 hours/week</td></tr>
<tr><td>Rationale</td><td>To provide the students with solid foundations in the basic concepts of programming, that is, in data structures and related algorithms. To teach the students how to select and design data structures and algorithms that are appropriate for problems that they might encounter in future and how to study their computational complexities.</td></tr>
<tr><td>Objective</td><td>● To explain the purpose and the mathematical background of algorithm analysis
● To facilitate necessary knowledge about the abstract data types, such as, stacks, queues and deques
● To familiarize with variety of ways that linearly and weakly ordered data can be stored, accessed, and manipulated
● To facilitate necessary knowledge about the characteristics and optimal behavior of hash tables for access and retrieval
● To provide the knowledge of various sorting algorithms and the run-time analysis required to determine their efficiencies
● To help them understand various tree traversal techniques and graph algorithms</td></tr>
<tr><td>Course Content</td><td>Internal Data Representation: Specification, representation, Asymptotic analysis: Recurrences, Substitution method and manipulation of basic data structures: arrays, records and pointers, linked lists, stacks, queues, recursion, trees, optimal search trees, heaps, disjoint sets. Recursion: permutation, combination. Sorting: merge sort, quick sort (randomized quick sort), distribution sort (counting sort, radix sort, bucket sort), lower bounds for sorting, external sort. Binary Tree: Binary tree representation using array and pointers, traversal of Binary Tree (in-order, pre-order and post-order). Ternary tree, Binary Search Tree: BST representation, basic operations on BST (creation, insertion, deletion, querying and traversing), application- searching, sets. Ternary search tree, Binary Index tree, Segment tree, RMQ (Range Minimum Query). Searching: Application of Binary Search- finding element in a sorted array, finding nth root of a real number, solving equations. Heap: Min-heap, max-heap, Fibonacci-heap, applications-priority queue, heap sort. Set Operations& Disjoint Set: Set representation using bitmask, set/clear bit, querying the status of a bit, toggling bit values, LSB, application of set operations, union find, path compression. Huffman Coding Graph: Graph representation (adjacency matrix/adjacency list), basic operations on graph (node/edge insertion and deletion), Traversing a graph:Review of Breadth first search (BFS), Depth first search (DFS), Topological Sort, Strongly Connected Components, Euler Path, Articulation Point, Bridge, Bi-connected Components, graph-bicoloring, Floodfill, Dijkstra’s Shortest Path Algorithm, Bellman –Ford algorithm and negative cycle detection, Floyd-Warshall all pair shortest path algorithm, Johnson’s algorithm, shortest path in Directed Acyclic Graph. Minimum spanning tree: Prim’s algorithm and Kruskal’s algorithm. Self-Balancing Binary Search Tree: AVL tree (rotation, insertion). String ADT: The concatenation of two strings, the extraction of substrings, searching a string for a matching substring, parsing, Suffix tree, Suffix array.</td></tr>
<tr><td>Course Learning Outcome</td><td>Course Learning Outcomes: After the successful completion of the course, the student will be able to-
<table>
<tr><td>CO 1</td><td>Define and explain the fundamental data structures such as lists, queues, trees, etc.</td><td>Understand</td></tr>
<tr><td>CO 2</td><td>Illustrate the concept of algorithm complexity analysis</td><td>Understand</td></tr>
<tr><td>CO 3</td><td>Compare tradeoffs in the design and implementations of the data structures</td><td>Analyze</td></tr>
<tr><td>CO 4</td><td>Select appropriate algorithms to use in specific applications and apply</td><td>Apply</td></tr>
<tr><td>CO 5</td><td>Design data structures to store and manipulate data while solving real life problems.</td><td>Evaluate</td></tr>
</table></td></tr>
</table>

Mapping of Course Learning Outcomes to Program Learning Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	**3**											
CO 2		**3**										
CO 3			**3**									
CO 4				**3**								
CO 5				**3**								**1**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CO	Teaching Learning Strategy	Assessment Strategy
CO 1	Interactive Lectures, problem solving	Class Test, Quiz, Final Exam
CO 2	Interactive Lectures, problem solving	Class Test, Quiz, Final Exam
CO 3	Interactive Lectures, problem solving	Class Test, Quiz, Final Exam
CO 4	Interactive Lectures, Case studies	Class Test, Quiz, Final Exam
CO 5	Interactive Lectures, Case studies	Class Test, Quiz, Final Exam

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CO
01	Internal Data Representation	Lectures, Tutorial class	Class Test, Quiz, FinalExam, Assignment	CO 2
02	Recursion	Lectures, Tutorial class	Class Test, Quiz, FinalExam, Assignment	CO 4
03	Sorting	Lectures, Tutorial class	Class Test, Quiz, FinalExam, Assignment	CO 1, 3, 4, 5
04	Sorting	Lectures, Tutorial class	Class Test, Quiz, FinalExam, Assignment	CO 1, 3, 4, 5
05	Binary Tree	Lectures, Tutorial class	Class Test, Quiz, FinalExam, Assignment	CO 1, 3, 4, 5
06	Ternary tree, Binary Search Tree	Lectures, Tutorial class	Class Test, Quiz, FinalExam, Assignment	CO 1, 3, 4, 5
07	Searching	Lectures, Tutorial class	Class Test, Quiz, FinalExam, Assignment	CO 1, 3, 4, 5
08	Set Operations & Disjoint Set	Lectures, Tutorial class	Class Test, Quiz, FinalExam, Assignment	CO 1, 3, 4, 5
09	Huffman Coding	Lectures, Tutorial class	Class Test, Quiz, FinalExam, Assignment	CO 1, 3, 4, 5
10	Graph	Lectures, Tutorial class	Class Test, Quiz, FinalExam, Assignment	CO 1, 3, 4, 5
11	Graph	Lectures, Tutorial class	Class Test, Quiz, FinalExam, Assignment	CO 1, 3, 4, 5
12	Minimum spanning tree	Lectures, Tutorial class	Class Test, Quiz, FinalExam, Assignment	CO 1, 3, 4, 5

	<table><tr><td>13</td><td>Self-Balancing Binary Search Tree</td><td>Lectures, Tutorial class</td><td>Class Test, Quiz, FinalExam, Assignment</td><td>CO 1, 3, 4, 5</td></tr><tr><td>14</td><td>String ADT</td><td>Lectures, Tutorial class</td><td>Class Test, Quiz, FinalExam, Assignment</td><td>CO 1, 3, 4, 5</td></tr></table>
Text Books	1. Advanced Data Structures - Peter Brass 2. Data Structures – Seymour Lipschutz, Schaum's Outlines Series. 3. Introduction to Algorithms - Thomas H. Cormen , Charles E. Leiserson

Course Title	Data Structure Lab
Credits	1.5
Course No	SWE 0613-1128
Contact hours	3 hours/week
Rationale	To provide the students with solid foundations for implementation of various linear and non-linear data structures. To teach the students how to select, design and develop data structures and algorithms that are appropriate for problems that they might encounter.
Objective	● To facilitate necessary hands-on knowledge to implement and manipulate various linear and non-linear data structures ● To facilitate necessary hands-on knowledge to implement various searching and sorting algorithms ● To facilitate necessary hands-on knowledge to design and develop real-world applications using suitable data structure.
Course Content	This course is based on the theory course CSE 0612-1237. This course has been design to facilitate students with hands-on experience to implement various types of linear and non-linear data structures and related algorithms to manipulate those data structures. Besides, students will implement various sorting and searching algorithms also. At the end of the course the students should be able to design and develop data structures and sorting and searching algorithms that are used in various real-world applications. Here are the data structures and algorithms that will be implemented by the students. ● Binary and linear searching using arrays; representing stack and queue using arrays ● Different types of linked lists; representing stacks and queues using linked list ● Converting infix expression to postfix and evaluating postfix expressions ● Implementing few algorithms using recursion ● Implementing various sorting algorithms ● Creating, manipulating and traversing Binary and Ternary trees ● Creating, manipulating, traversing and searching BSTs ● Creating and manipulating max/min heaps and implementing merge sort ● Implementing Kruskal's minimum spanning tree algorithm using disjoint sets ● Implementing compression algorithm using Huffman Coding graph ● Creating, manipulating, traversing and searching various types of graphs ● Implementing few well-known graph based algorithms ● Implementing, Prim's algorithm for finding minimum spanning tree

	● Creating, manipulating, traversing AVL trees; solving few string based problems using string operations.
Course Learning Outcome	**Course Learning Outcomes:** After the successful completion of the course, the student will be able to-

CO 1	Understand various data representation techniques in the real world.	Understand
CO 2	Implement linear and non-linear data structures.	Apply
CO 3	Analyze various algorithms based on their time and space complexity	Analyze
CO 4	Design and develop real-world applications using suitable data structure.	Design
CO 5	Identify suitable data structure to solve various computing problems	Evaluate

Mapping of Course Learning Outcomes to Program Learning Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	**3**											
CO 2		**3**										
CO 3			**3**									
CO 4				**3**								
CO 5				**3**								**1**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CO	Teaching Learning Strategy	Assessment Strategy
CO 1	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam
CO 2	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam
CO 3	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam
CO 4	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam
CO 5	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CO
01	Binary and linear searching using arrays; representing stack and queue using arrays	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam	CO 1, 2, 3, 4, 5
02	Different types of linked lists; representing stacks and queues using linked list	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam	CO 1, 2, 4, 5
03	Converting infix expression to postfix and evaluating postfix expressions	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam	CO 3, 4, 5
04	Implementing few algorithms using recursion	Hands-on demonstration,	Viva, Assignment,	CO 2, 3, 4

		problem solving	Lab Exam	
05	Implementing various sorting algorithms	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam	CO 3, 4, 5
06	Creating, manipulating and traversing Binary and Ternary trees	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam	CO 1, 2, 3
07	Creating, manipulating, traversing and searching BSTs	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam	CO 1, 2, 3, 4, 5
08	Creating and manipulating max/min heaps and implementing merge sort	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam	CO 1, 2, 3, 4, 5
09	Implementing Kruskal's minimum spanning tree algorithm using disjoint sets	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam	CO 3, 4, 5
10	Implementing compression algorithm using Huffman Coding graph	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam	CO 3, 4, 5
11	Creating, manipulating, traversing and searching various types of graphs	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam	CO 1, 2, 3, 4
12	Implementing few well-known graph based algorithms	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam	CO 3, 4, 5
13	Implementing, Prim's algorithm for finding minimum spanning tree	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam	CO 3, 4, 5
14	Creating, manipulating, traversing AVL trees; Solving few string based problems using string operations.	Hands-on demonstration, problem solving	Viva, Assignment, Lab Exam	CO 1, 3, 4, 5

Text Books

1. Advanced Data Structures - Peter Brass
2. Data Structures – Seymour Lipschutz, Schaum's Outlines Series.
3. Introduction to Algorithms - Thomas H. Cormen , Charles E. Leiserson

Course Title:	Mechanics, Wave, Heat and Thermodynamics
Credits:	3.0
Course No.:	PHY 0533-1203W
Credit Hours:	3 hours/week
Objectives:	● To provide students with a basic understanding of Newtonian mechanics ● To prepare students to explore the nature of vibrating systems and wave motion ● To orient students with classical theories of thermodynamics for the application to simple macroscopic systems ● To introduce the microscopic ideal-gas model.
Course Contents:	**Mechanics:** Kinematics in one and two dimensions, projectile motion, circular motion; Newton's laws of motion; work, conservative force, potential energy, conservation of

mechanical energy; dynamics of systems of particles, conservation of linear momentum, collisions; rotational dynamics of rigid bodies, conservation of angular momentum; central forces and gravitation, Kepler's laws.

Waves: Simple harmonic motion, damped and forced vibrations; waves in elastic media; sound waves, Doppler effect; Fourier's theorem and its applications.

Heat and thermodynamics: Zeroth law of thermodynamics, principles of thermometry, constant volume gas thermometer; first and second laws of thermodynamics, entropy; thermal radiation: Stefan-Boltzmann laws, Wein's laws, Rayleigh-Jeans law, Planck's law; kinetic theory of ideal gasses, equipartition of energy.

Course Learning Outcomes (CLOs):

CLO 1	Understand the basic concepts and principles of classical mechanics.
CLO 2	Develop skills for solving problems involving reference frames, Newton's laws, momentum, force, work, impulse, torque, and angular momentum, and recognizing the importance of conservation theorems.
CLO 3	Analyze quantitatively the behavior of oscillatory systems and wave motion.
CLO 4	Describe the Doppler effect for sound and the Fourier representation of periodic functions.
CLO5	Explain the ideal-gas model, the concepts and laws of classical thermodynamics of blackbody radiation. and macroscopic quantities like pressure, temperature, and internal energy of a system.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping Course Learning Outcomes (COs) with the POs

Course Learning Outcomes (CO)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12
CO 1	3											
CO 2	3	3		2								
CO 3	3	3		2								
CO 4	3											
CO 5	3	3		2								

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

Mapping Course Learning Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning	Assessment Strategy
CO1	TL01, TL05	CA01, CA03/CA04
CO2	TL01, TL05	CA01, CA03/CA04
CO3	TL01, TL05	CA01, CA03/CA04

	CO4	TL01, TL05	CA02, CA03/CA04
	CO5	TL01, TL05	CA02, CA03/CA04
Text Books	1. Halliday, D. and Resnick, R.: Physics (Vol. I and Vol II) 2. Sears, Zemansky and Young: University Physics 3. Puri, S. P.: Fundamentals of Vibrations and Waves 4. Saha and Srivastava: A Treatise of Heat		

Course Title:	Linear and Abstract Algebra
Credits:	3.0
Course No.:	MAT 0541-1207W
Credit Hours:	3 hours/week
Rationale:	This course will cover the fundamental properties of linear and abstract algebraic structures such as the properties of the algebra of real numbers and matrices, vector spaces, groups, rings, and fields.
Objectives:	● To provide expertise on common matrix operations including cofactor expansions and row reductions, and applying these tools in computing determinant, rank, inverse, and echelon forms of a matrix. ● To make students able to investigate the consistency of a system of linear equations and to choose an appropriate method to find the solution of a given system of linear equations. ● Acquaint students with the fundamental properties of vector spaces and subspaces including null space and column space, and their bases and dimensions. ● To facilitate students understand the properties of linear transformations, transformation matrices and their changes for a given basis with respect to the standard basis of a vector space. ● To make students able to find the characteristic polynomial, eigenvalues, associated eigenvectors, and the diagonalized matrix of a transformation matrix. ● To facilitate students to distinguish the similarities and differences among various types of groups, rings, ideals, and fields. ● Help the students to conceptualize common theories in linear and abstract algebras, and their applications to linear and algebraic error-control codes.
Course Contents:	**Matrix**: Introduction to matrices, addition and multiplication of matrices, determinant, Cramer's rule, adjoint and inverse of a matrix, elementary row operations and echelon forms of matrix, rank, row rank, column rank of a matrix and their equivalence, matrix methods for solving system of linear equations. **Vector space**: Vector space and subspace over real numbers, direct sum, linear combination, linear dependence and independence of vectors, basis and dimension of vector space, quotient space and isomorphism theorems, inner product space, orthogonal and orthonormal bases. **Linear transformation**: Kernel, rank and nullity, matrix representation, change of basis, eigenvalues and eigenvectors, characteristic equations and Cayley-Hamilton theorem,

diagonalization of matrices, canonical forms, and applications of linear algebra to linear error-control codes.

Groups: Groups and subgroups, cyclic group, multiplication of subgroups, normal subgroups, quotient (factor) groups, centre of a group, permutation groups, homomorphism, isomorphism and automorphism of groups with related theorems and problems, Cayley's theorem, generalized isomorphism theorem, centralizer, and normalizer of an element/subset in a group.

Rings: Rings and subrings,ideals,prime, maximal and minimal ideals, principal ideals with related theorems, sum and direct sum of ideals, factor rings, integral domain and field with related theorems and problems, and applications of abstract algebra to algebraic error-control codes.

Course Learning Outcomes (CLOs):

After the successful completion of the course, the student will be able to

CLO 1	compute the determinant, inverse, echelon form, and rank of a given matrix by cofactor expansion method and/or row reduction method.
CLO 2	determine the existence and uniqueness of the solution of a system of linear equations and find its solution by choosing an appropriate method.
CLO 3	test the independence of vectors and find the dimension and basis of a given vector space and its various subspaces.
CLO 4	write down the matrix representing a linear transformation under a given basis and observe how the matrix changes if the basis is changed.
CLO 5	determine the eigenvalues, associated eigenvectors, diagonalization, and different factorizations of a transformation matrix.
CLO 6	understand mathematical concepts studied in abstract mathematics such as permutation groups, factor groups, abelian groups, rings, ideals, and fields.
CLO 7	understand different types of subgroups such as normal subgroups, cyclic subgroups and identify the structure and characteristics of these subgroups.
CLO 8	apply the techniques of linear and abstract algebras in solving problems related to algebraic error-control codes.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	**PLO1**	**PL02**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**
CLO 1	**X**											
CLO 2	**X**	**X**		**X**								
CLO 3	**X**											
CLO 4	**X**			**X**								
CLO 5	**X**											
CLO 6	**X**	**X**										
CLO 7	**X**											

	CLO 8	**X**	**X**		**X**	**X**	**X**	**X**					
Text Books	1. Ayers, F.: Matrices 2. Artin, M.: Algebra 3. Lipschutz, S.: Linear Algebra 4. **Van Lint, J. H.:** Introduction to Coding Theory 5. Paley, H. and Weicheel, P. M.: A First Course in Abstract Algebra												

Course Title:	Basic Statistics and Probability
Credits:	03
Course No.:	STA 0542 1201W
Credit Hours:	3 hours/week
Rationale:	Software engineers apply their statistical expertise by gathering data to analyze the needs of users before managing development and testing. This course is assigned to acquire knowledge for analyzing the data.
Objectives:	● Provide the basic knowledge of statistical tools. ● Equip the students for analyzing the data in descriptive way as well as provide the basic concepts of probability distributions and stochastic processes
Course Contents:	**Frequency distribution of data:** Population and sample. Collection and representation of statistical data. Tabulation of data. Class intervals. Frequency distribution, discrete, continuous and cumulative distributions. Histograms and frequency polygons. Graphical representation of data. **Statistical measures:** Measures of central tendency - arithmetic mean, median, mode, geometric mean, weighted average, harmonic mean. Measures of dispersion - range, standard deviation, variance, coefficient of variation, moments, skewness, kurtosis. Correlation theory: linear correlation. Measures of correlation and its significance. **Regression and curve fitting:** Linear and non-linear regression. Methods of least squares. Curve fitting. Probability: definition of probability and related concepts. Laws of probability. Discrete and continuous random variables. Mathematical expectations. Conditional probability. **Probability distributions:** Binomial, Poisson and normal distributions and their properties. **Stochastic process:** Markov chain (discrete and continuous). Queuing theory – birth and death process in queuing. Examples from computer science. Queuing models – elementary concepts.
Course Learning Outcomes (CLOs):	**CLO1** understand the basic statistical tools **CLO2** apply the descriptive statistical tools for their collected data. **CLO3** analyze cause-effect related data as well

	CLO4 understand the basic concepts of probability, probability distribution and stochastic processes.
Mapping of CLOs with Program Learning Outcomes (PLOs):	**Mapping of Course Learning Outcomes to Program Learning Outcomes**

CLO /PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	2	2	2								1	1
CLO 2	3	3	3								1	1
CLO 3	2	2	2								1	1
CLO 4	2	2	2								1	1

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Lecture using board	Quiz/ assignment, semester end examination
CLO 2	Lecture using board, assignment	Presentation (individual/group), mid-term examination 1
CLO 3	Lecture using board, assignment	Assignment, Presentation (individual/group), mid-term examination 2
CLO 4	Lecture using board	semester end examination

Course Plan

Course plan specifying content, CLOs, co-curricular activities (if any), teaching learning and assessment strategy mapped with CLOs.

Week	Topic	Teaching-Learning Strategy	Assessment Strategy	CLOs
1	Frequency distribution of data: population and sample. Collection and representation of statistical data.	Lecture using board	Quiz/ assignment Semester-end examination	1,2
2	Tabulation of data. Class intervals. Frequency distribution, discrete, continuous and cumulative distributions. Histograms, Box plot and frequency polygons. Graphical representation of data.	Lecture using board	Quiz/ assignment Semester-end examination	1,2

		3	measures of central tendency - arithmetic mean, median, mode,	Lecture using board	Quiz/ assignment Semester-end examination	1,2	
		4	geometric mean, weighted average, harmonic mean.	Lecture using board	Quiz/ assignment Semester-end examination	1,2	
		5	Measures of dispersion - range, standard deviation, variance, coefficient of variation, moments, skewness, kurtosis	Lecture using board	Quiz/ assignment Semester-end examination	1,2	
		6	Probability: definition of probability and related concepts. Laws of probability.	Lecture using board	Quiz/ assignment Semester-end examination	4	
		7	Revision	Lecture using board	**Mid-term examination-1**	1,2,4	
		8	Discrete and continuous random variables. Mathematical expectations.	Lecture using board	Quiz/ assignment Semester-end examination	4	
		9	Conditional probability. Probability distributions: binomial,	Lecture using board	Quiz/ assignment Semester-end examination	4	
		10	Poisson and normal distributions and their properties.	Lecture using board	Quiz/ assignment Semester-end examination	4	
		11	Correlation theory: linear correlation. Measures of correlation and its significance.	Lecture using board	Quiz/ assignment Semester-end examination	3	
		12	Regression and curve fitting: linear and non-linear regression. Methods of least squares. Curve fitting.	Lecture using board	Quiz/ assignment Semester-end examination	3	
		13	Stochastic process. Markov chain (discrete and continuous). Queuing theory – birth and death process in queuing. Examples	Lecture using board	Quiz/ assignment Semester-end examination	4	

	from computer science. Queuing models – elementary concepts.				
14	Revision	Lecture using board	**Mid-term examination-2**, Presentation, Semester-end examination	3,4	

Learning Materials	1) Recommended Readings ● Montgomery, D C and Runger, G C. Applied Statistics and Probability for Engineers, 3rd Ed, John Wily and Sons, 2003. ● Shill R.N. &DebnathS.C. : An introduction to the theory of Statistics, Dhaka, 2001 2) Supplementary Readings ● Ross S M, Stochastic Processes, 2nd Ed, Jhon Wiley & Sons, NY ● Mostafa, M G, Methods of Statistics, Karim press and publication, Dhaka Bangladesh. 1989 ● Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical Statistics, 10th ed, Sultan chand and sons, 2000 ● Hogg R V & Craig A T, Introduction to Mathematical Statistics, 5th Ed, Macmillan, London, 1995

Course Title:	Sociology for Engineers
Credits:	3.0
Course No.:	SOC 0314-1203W
Credit Hours:	3 hours/week
Rationale:	The course is organized to provide SWE students with the fundamentals of sociological knowledge. It intends to teach students core but basic topics of sociology including theories and methods, culture, society, social organization, social stratification, and social change. Above all, it provides students with the skills to understand society's basic ideas and concepts from sociological points of view.
Objectives:	**The objectives of the course are to:** 1. Teach students basic sociological concepts including society, community, social process, culture, and social structure.

	2. Provide students with knowledge of the major theoretical approaches and methods in sociology. 3. Help students gain knowledge on social institutions of human society including the family, marriage, kinship, and religion. 4. Help students develop insight to address crime, deviance, and social control. 5. Provide students with basic knowledge on global environmental issues and population
Course Contents:	**Introduction to Sociology:** Definition, Nature, Scope, Origin & Development of Sociology. **Doing Sociology:** Scientific Method & techniques for Sociological Investigation. **Basic Concepts and Social Processes:** Society, Community, Association, Institution, Group, Cooperation, Conformity, Competition, Conflict, Assimilation, and Accommodation. **Culture:** Development of culture, components of culture, Cultural integration, Cultural variation, Culture, and sociological perspectives. **Types of Society:** From Hunting Gathering to Industrialization. **Social Institutions**: Family, Religion, Perspectives. **Social Stratification**: Systems & Perspectives, Social Mobility, Class Structure. **Social Change:** Factors & Theories. **Collective Movement**: Group, Crowd & Mob. **Population & Environment:** Population Growth, Ecology, Ecosystem, Threats to Global Environment.
Course Learning Outcomes (CLOs):	**Course Learning Outcomes (COs):** **Upon completion of the course, students will be able to:** **CO1** Demonstrate an understanding of key sociological concepts and theories of reality; **CO2** Explain primary ideas and methods of sociological research; **CO3** Analyze social stratification, systems, and different forms of social inequality; **CO4** Draw connections between society and different environmental issues; and **CO5** Apply sociological concepts and theories in analyzing real social lives.
Mapping of CLOs with Program Learning Outcomes (PLOs):	**Mapping of Course Learning Outcomes to Program Learning Outcomes**

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO 12
CLO 1	2	2	2								1	1
CLO 2	3	3	3								1	1
CLO 3	2	2	1								1	1
CLO 4	2	2	2								1	1
CLO 5	1	1	2								1	1

<table>
<tr><td>Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:</td><td>
<table>
<tr><th>COs</th><th>Teaching-Learning Strategy</th><th>Assessment Strategy</th></tr>
<tr><td>CO1</td><td>Lecture and Visual Presentation</td><td>Class Participation</td></tr>
<tr><td>CO2</td><td>Lecture and Class Discussion</td><td>Class Participation & Midterm 1</td></tr>
<tr><td>CO3</td><td>Lecture, Visual Presentation, and Class Discussion</td><td>Class participation</td></tr>
<tr><td>CO4</td><td>Lecture, Visual Presentation, and Group Discussion</td><td>Class Participation & Midterm 2,</td></tr>
<tr><td>CO5</td><td>Lecture, Visual Presentation, and Class Presentation.</td><td>Assessment, & Final exam</td></tr>
</table>
</td></tr>
<tr><td>Text Books</td><td>

Bottomore, T. B. (1964). Sociology: A Guide to Problems and Literature. London: George Allen & Unwin, Ltd.
Henslin, J. M. (2004). Sociology: a down-to-earth approach (3rd ed.). NSW: Pearson Australia.
Giddens, A. (2009). Sociology (6th ed.). Cambridge: Polity Press.
Inkles, A. (1964). What Is Sociology? An Introduction to the Discipline and Profession (7th ed.). Denvor: Prentice Hall.
MacIver, R. M., & Page, C. H. (1965) Society. London: Macmillan and Company, London
Robertson, I. (1997). Sociology: A Brief Introduction. New York: Worth Publishers, Inc.
Schaefer, R. T., & R.P. Lamm, R. P. (1997). Sociology: A Brief Introduction (2nd ed). New York: McGraw Hill.
Zanden, J. W. V. (1995). Sociology: The Core (4th ed). New York. NY: McGraw-Hill College.

</td></tr>
</table>

Course Title:	PROJECT WORK I
Credits:	3.0
Course No.:	SWE 0610-1250
Credit Hours:	3 hours/week
Rationale:	This is a project which enables the freshmen to apply their novel acquired knowledge to some of the basic real world problem solving. This course enables the students to apply their analytical and programming capability in the design and development of their developed projects and solutions.
Objectives:	● To facilitate necessary knowledge about solving real world problems. ● To help the students to develop Problem solving related to constructing and designing software systems. ● To provide the students with the knowledge of software design and testing.
Course Contents:	Any project based on C language including implementation of Data Structure is acceptable. Gaming project using graphics.h library in C is preferable. Teachers must have to ensure every project is unique. Innovative project ideas should get extra weight to prevent imitating old projects.
Course Learning	**CLO 1** Develop the ability to apply C programming concepts to solve practical problems through project-based learning.

Outcomes (CLOs):

CLO 2	Acquire proficiency in implementing data structures and algorithms in C language for project development.
CLO 3	Develop creativity and innovation skills through the development of unique and innovative project ideas.
CLO 4	Demonstrate effective collaboration and communication skills in project planning, execution, and presentation.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	2										1	1
CLO 2	3				3				2	2	1	1
CLO 3	2		1				3		2			1
CLO 4	3											1

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to the Course and Project Selection	Lecture and discussion	Project proposal submission and presentation.	CLO1
2-3	Literature Review and Planning	Lecture and discussion	Literature review submission	CLO2

				and project plan submission.	
	4-6	Implementation and Testing	Lecture and discussion	Code submission, testing report submission, and presentation.	CLO3
	7-8	Integration and Deployment	Lecture and discussion	Integrated project submission, deployment report submission, and presentation.	CLO4
	9-10	Project Demonstration	Lecture and discussion	Project demonstration and presentation.	CLO1, CLO2, CLO3, CLO4
	11-12	Peer Review and Evaluation	Lecture and discussion	Peer evaluation report submission.	CLO1, CLO2, CLO3, CLO4
	13-14	Final Project Submission and Evaluation	Lecture and discussion	Final project submission and evaluation report submission.	CLO1 ,CLO2, CLO3, CLO4

Second Year

Second Year First Semester

Course Title:	Introduction to Competitive Programming
Credits:	2

<table>
<tr><td>Course No.:</td><td>SWE 0613-2122</td></tr>
<tr><td>Credit Hours:</td><td>4 hours/week</td></tr>
<tr><td>Rationale:</td><td>This course is designed to help both beginners and intermediate programmers alike to dominate the algorithms and data structures necessary to do well in programming contests and to gain a competitive edge over candidates in software interviews. Techniques and applications that are useful for the field, focusing on real problems and how they are solved are expected to be covered in this course</td></tr>
<tr><td>Objectives:</td><td>● To facilitate the necessary knowledge about advanced data structures and algorithms
● To enhance the skill of problem-solving
● To get trained with sprint and marathon contests
● To help to improve thinking capability and solution formulation</td></tr>
<tr><td>Course Contents:</td><td>Data Structure: Trie Tree, BIT, Segment Tree, Splay Tree, MO’s Algorithm, Square Root Decomposition, Heavy Light Decomposition, Persistent Data Structure (Segment Tree, Trie), DSU on Tree, Treap, K-D Tree, KNN Tree, Sparse Table.
String Processing: KMP, Suffix Array, Suffix Automata, Suffix Tree, Palindromic Tree, Aho-Corasick, Manacher Algorithm, Extended KMP, Hashing (Rolling Hash).
Game Theory: Nim Game, Sprague-Grundy Value, Green Hackenbush, Blue Red Hackenbush, Blue Red Green Hackenbush, Colon Principle, Fusion Principle.
Combinatorics & Probability: Burnside Lemma, Inclusion Exclusion, Combination, Permutation, Catalan Number, Stirling Number, Probability, Expected Value.
Number Theory: Chinese Remainder Theorem, Euler Phi, Extended Euclid, Prime Factorization, Mobius Function, Primitive Prime, Huge Mod.
Basic Math: FFT, DFT, NTT, Gaussian Elimination, Matrix Exponentiation.
Basic Geometry: Fundamental Concepts of Geometry, Closest Pair of Point, Convex Hull, Rectangle Union, Circle Union, Polygon Clipping, Line Sweep, Line Intersection.
Dynamic Programming: Coin change variations, knapsack, LIS, LCS, Edit Distance, etc.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>
<table>
<tr><td>CLO1</td><td>Apply the data structures and algorithms to design solutions to critical programming problems</td></tr>
<tr><td>CLO2</td><td>Avoid doing plagiarism in the contest time regarding it as a crime</td></tr>
<tr><td>CLO3</td><td>Explain the idea, used algorithm and data structure behind to solve a critical problem with others</td></tr>
<tr><td>CLO4</td><td>Prepare themselves to deal with competitive environments by attending frequent problem solving contests</td></tr>
</table>
</td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td>Mapping of Course Learning Outcomes to Program Learning Outcomes
<table>
<tr><th>CLO /PLO</th><th>PLO1</th><th>PL02</th><th>PLO3</th><th>PLO4</th><th>PLO5</th><th>PLO6</th><th>PLO7</th><th>PLO8</th><th>PLO9</th><th>PLO10</th><th>PLO11</th><th>PLO 12</th></tr>
<tr><td>CLO 1</td><td></td><td>X</td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CLO 2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
</table>

	CLO 3												
	CLO 4												**X**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lectures, Online Contests	Online Contests, Final Contests
CLO2	Lectures, Online Contests	All contests
CLO3	Flip Classroom	Editorial Presentation
CLO4	Online and Onsite Contests	All contests

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Plagiarism and Data Structures**	Lectures, Online Contest	Online and Onsite contests, Editorial presentation	CLO 01, CLO2, CLO4
2	**Data Structures**	Lectures, Flip Classroom		CLO 03
3	**String Processing**	Lectures, Online Contests		CLO 01, CLO2, CLO4
4	**String Processing**	Lectures, Flip Classroom		CLO 03
5	**Number Theory**	Lectures, Online Contests	Online and Onsite Contests, Editorial Presentation	CLO 01, CLO2, CLO4
6	**Number Theory**	Lectures, Flip Classroom		CLO 03
7	**Basic Math**	Lectures, Online Contests		CLO 01, CLO2, CLO4
8	**Combinatorics and Probability**	Lectures, Online Contests	Class Test, FInal Exam	CLO 01, CLO2, CLO4
9	**Basic Geometry**	Lectures, Online Contests		CLO 01, CLO2, CLO4
10	**Basic Geometry**	Lectures, Flip Classroom		CLO 03
11	**Dynamic Programming**	Lectures, Online Contests		CLO 01, CLO2, CLO4

	12	**Dynamic Programming**	Lectures, Online Contests, Flip Classroom		CLO 01, CLO2, CLO3, CLO4
	13	**Dynamic Programming**	Lectures,Online Contests, Flip Classroom		CLO 01, CLO2, CLO3, CLO4
	14	**Game Theory**	Lectures, Online Contests		CLO 01, CLO2, CLO4
Text Books	1. Competitive Programming 3: Steven and Felix Halim 2. Competitive Programming 4: Steven and Felix Halim 3. Data Structure and Algorithm: Mahbubul Hasan Shanto				

Course Title	Object Oriented Programming Language
Credits	3.0
Course No	SWE 0613-2123
Contact hours	3 hours/week
Rationale	Students wishing to build up their career in CSE need to develop software to solve problems and this course will help them learn the basics of OOP and OOP programming using JAVA.
Objective	● To help students conceptualize basic theories and principles of object-oriented programming; ● Helping the students to develop the ability in applying the concepts of data encapsulation, inheritance, and polymorphism to large-scale software ● To facilitate necessary knowledge about good programming practices and how to write modular codes with the help of OOP concepts. ● To provide knowledge of packages, and how to work with them. Also, give students training to code reusable programs with JAVA. ● To make students understand how to work with JAVA generic templates to design Classes and data structures that can work with different data types.

<table>
<tr><td>Course Content</td><td>Introduction to Java: History of Java, Java Class Libraries, Introduction to Java Programming, A simple Program, The Bytecode. Data Types, Variables, and Arrays: Strongly Typed Language, The Primitive Types, Literals, Variables, Type Conversion and Casting, Arrays, Strings. Operators: Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, The Assignment & ? Operator, Operator Precedence. Control Statements: Java’s Selection Statements: if & switch, Iteration Statements: while, do-while, for, for-each & nested loops, Jump Statements: break, continue, return. Introducing Classes: Class Fundamentals, Declaring Objects, Assigning Object Reference Variables, Introducing Methods, Constructors, The this Keyword, Garbage Collection. A Closer Look at Methods and Classes: Overloading Methods, Using Objects as Parameters, Argument Passing, Returning Objects, Recursion, Access Control, Understanding static, final, Nested and Inner Classes, Command-Line Arguments & Variable-Length Arguments. Inheritance: Inheritance Basics, Using super, Creating a Multilevel Hierarchy, Method Overriding, Dynamic Method Dispatch, Abstract Classes, final with Inheritance, Local Variable Type Inference and Inheritance, The Object Class. Packages and Interfaces: Packages and Member Access, Importing Packages, Interfaces, Default Interface Methods, Use static Methods in an Interface, Private Interface Methods. Exception Handling: Exception-Handling Fundamentals, Exception Types, Uncaught Exceptions, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws & finally, Java’s Built-in Exceptions, Creating Your Own Exception Subclasses, Chained Exceptions. Multithreaded Programming: The Java Thread Model, The Main Thread, Creating a Thread, Creating Multiple Threads, Using isAlive and join, Thread Priorities, Synchronization, Interthread Communication, Suspending, Resuming, and Stopping Threads, Obtaining a Thread’s State, Using Multithreading. Enumerations, I/O, Generics: Enumeration Fundamentals, Type Wrappers, I/O Basics, Console Input/Output, The I/O Classes and Interfaces, I/O Exceptions, Stream Classes, Serialization, A Simple Generics Example, The General Form of a Generic Class, Bounded Types, Wildcard Arguments, Generic Interfaces, Generic Class Hierarchies. Lambda Expressions, Modules, Records: Introducing Lambda Expressions, Block Lambda Expressions, Passing Lambda Expressions as Arguments, Module Basics, Legacy Code and the Unnamed Module, Exporting to a Specific Module, Module Graphs, Record Basics, Text Blocks, Sealed Classes & Interfaces. String Handling, Collections Framework, Utility Classes: The String Constructors, String Operations, String Methods, StringBuffer, StringBuilder, Collection Interfaces, Collection Classes, Spliterators, Working with Maps, The Collection Algorithms, StringTokenizer, Date, Formatter, Scanner. Event Handling, AWT, Swing: Event Handling Mechanisms, Delegation Event Model, Event Classes, Event Listener Interfaces, Adapter Classes, AWT Classes, Window Fundamentals, AWT Control Fundamentals, The Origins of Swing, Swing Features, Components and Containers, Swing Packages, Painting in Swing, Swing Menus.</td></tr>
<tr><td>Course Learning Outcome</td><td>After the successful completion of the course, the student will be able to-<table><tr><td>CLO 1</td><td>Recognize the basic syntax, compilation, and execution order and process of Java programming language.</td></tr></table></td></tr>
</table>

CLO 2	Describe key concepts of the object-oriented programming paradigm.
CLO 3	Interpret real-world problems in terms of objects rather than procedures.
CLO 4	Apply object-oriented programming principles to implement small and medium-scale Java programs with simple graphical user interfaces.
CLO 5	Design Java programs for complex problems, making good use of the features of the language such as classes, inheritance, polymorphism, abstraction, package, and interface.

Mapping of Course Learning Outcomes to Program Learning Outcomes

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO 1	3											
CLO 2	3											
CLO 3				3								3
CLO 4		3										
CLO 5			3									

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures	Quiz, Class Test, Final Exam
CLO 2	Lectures	Quiz, Class Test, Final Exam
CLO 3	Lectures	Class Test, Final Exam
CLO 4	Lectures	Class Test, Final Exam
CLO 5	Lectures	Class Test, Final Exam

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLO
01	Introduction to Java	Lectures	Quiz, Class Test, Final Exam	CLO 1
02	Data Types, Variables, and Arrays			
03	Operators			
04	Control Statements		Class Test, Final Exam	
05	Introducing Classes			CLO 2,3,4,5
06	A Closer Look at Methods and Classes			
07	Inheritance			
08	Packages and Interfaces		Quiz, Class Test, Final Exam	
09	Exception Handling		Class Test, Final Exam	CLO 1,4
10	Multithreaded Programming			
11	Enumerations, I/O, Generics			
12	Lambda Expressions, Modules, Records			
13	String Handling, Collections Framework, Utility Classes			
14	Event Handling, AWT, Swing			

Textbook

1. Java: The Complete Reference by Herbert Schildt.
2. Introduction to Programming in Java, Robert Sedgewick & Kevin Wayne.
3. An Introduction to Object-Oriented Programming, Timothy Budd.
4. Java-How to Program by Deitel & Deitel.

Course Title	Object Oriented Programming Language Lab
Credits	3.0

Course No	SWE 0613-2124
Contact hours	6 hours/week
Rationale	Students wishing to build up their career in CSE need to develop software to solve problems and this course will help them learn how to design and implement small to medium-scale Java programs with simple graphical user interfaces applying Object Oriented Programming principles.
Objective	● To help students develop the ability to write programs using Java programming language ● To help students develop the ability to design and develop software using theories and principles of object-oriented programming ● To help students develop the ability to interpret real-world problems in terms of objects rather than procedures. ● To help students achieve the ability to develop software as a team member and effectively communicate between team members. ● To make students able to lead and manage a software development project
Course Content	**Introduction to Java:** Introducing Java development environment setup, Compiling and Executing A simple Program**. Data Types, Variables, and Arrays:** Strongly Typed Language, The Primitive Types, Literals, Variables, Type Conversion and Casting, Arrays, Strings. **Operators:** Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, The Assignment & ? Operator, Operator Precedence. **Control Statements:** Java's Selection Statements: if & switch, Iteration Statements: while, do-while, for, for-each & nested loops, Jump Statements: break, continue, return**. Introducing Classes:** Class Fundamentals, Declaring Objects, Assigning Object Reference Variables, Introducing Methods, Constructors, The this Keyword, Garbage Collection. **A Closer Look at Methods and Classes:** Overloading Methods, Using Objects as Parameters, Argument Passing, Returning Objects, Recursion, Access Control, Understanding static, final, Nested and Inner Classes, Command-Line Arguments & Variable-Length Arguments. **Inheritance:** Inheritance Basics, Using super, Creating a Multilevel Hierarchy, Method Overriding, Dynamic Method Dispatch, Abstract Classes, final with Inheritance, Local Variable Type Inference and Inheritance, The Object Class**. Packages and Interfaces:** Packages and Member Access, Importing Packages, Interfaces, Default Interface Methods, Use static Methods in an Interface, Private Interface Methods. **Exception Handling:** Exception-Handling Fundamentals, Exception Types, Uncaught Exceptions, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws & finally, Java's Built-in Exceptions, Creating Your Own Exception Subclasses, Chained Exceptions. **Multithreaded Programming:** The Java Thread Model, The Main Thread, Creating a Thread, Creating Multiple Threads, Using isAlive and join, Thread Priorities, Synchronization, Interthread Communication, Suspending, Resuming, and Stopping Threads, Obtaining a Thread's State, Using Multithreading. **Enumerations, I/O, Generics:** Enumeration Fundamentals, Type Wrappers, I/O Basics, Console Input/Output, The I/O Classes and Interfaces, I/O Exceptions, Stream Classes, Serialization, A Simple Generics Example, The General Form of a Generic Class, Bounded Types, Wildcard Arguments, Generic Interfaces, Generic Class Hierarchies. **Lambda Expressions, Modules, Records:** Introducing Lambda Expressions, Block Lambda Expressions, Passing Lambda Expressions as Arguments, Module Basics, Legacy Code and the Unnamed Module, Exporting to a Specific Module, Module Graphs, Record Basics, Text Blocks, Sealed Classes & Interfaces. **String Handling, Collections Framework, Utility**

<table>
<tr><td></td><td>Classes: The String Constructors, String Operations, String Methods, StringBuffer, StringBuilder, Collection Interfaces, Collection Classes, Spliterators, Working with Maps, The Collection Algorithms, StringTokenizer, Date, Formatter, Scanner. Event Handling, AWT, Swing: Event Handling Mechanisms, Delegation Event Model, Event Classes, Event Listener Interfaces, Adapter Classes, AWT Classes, Window Fundamentals, AWT Control Fundamentals, The Origins of Swing, Swing Features, Components and Containers, Swing Packages, Painting in Swing, Swing Menus.</td></tr>
<tr><td>Course Learning Outcome</td><td>After the successful completion of the course, the student will be able to-
<table><tr><td>CLO 1</td><td>Write and execute a basic java program using proper syntax, compilation, and execution procedure of Java.</td></tr><tr><td>CLO 2</td><td>Model classes from real-world problems in terms of objects rather than procedures.</td></tr><tr><td>CLO 3</td><td>Apply object-oriented programming principles to implement small and medium-scale Java programs with simple graphical user interfaces.</td></tr><tr><td>CLO 4</td><td>Design Java programs for complex problems, making good use of the features of the language such as classes, inheritance, polymorphism, abstraction, package, and interface.</td></tr><tr><td>CLO 5</td><td>Develop software as a team member and effectively communicate between team members.</td></tr><tr><td>CLO 6</td><td>Exercise project management through the development of a small Java software development project.</td></tr></table></td></tr>
<tr><td>Mapping of Course Learning Outcomes to Program Learning Outcomes</td><td><table><tr><td></td><td>PLO 1</td><td>PLO 2</td><td>PLO 3</td><td>PLO 4</td><td>PLO 5</td><td>PLO 6</td><td>PLO 7</td><td>PLO 8</td><td>PLO 9</td><td>PLO 10</td><td>PLO 11</td><td>PLO 12</td></tr><tr><td>CLO 1</td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CLO 2</td><td></td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CLO 3</td><td></td><td></td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr><tr><td>CLO 4</td><td></td><td></td><td></td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table></td></tr>
</table>

CLO 5									X	X		
CLO 6											X	

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures	Practical Test, Final Exam
CLO 2	Lectures	Practical Test, Final Exam
CLO 3	Lectures, Demonstration	Presentation, Viva
CLO 4	Lectures	Practical Test, Final Exam
CLO 5	Lectures, Demonstration	Presentation, Viva
CLO 6	Lectures, Demonstration	Presentation, Viva

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLO
01	Introduction to Java	Lectures, Demonstration	Practical Test, Final Exam	CLO 1
02	Data Types, Variables, and Arrays			
03	Operators			
04	Control Statements			
05	Introducing Classes		Practical Test, Final Exam	CLO 2,3,4
06	A Closer Look at Methods and Classes			
07	Inheritance			
08	Packages and Interfaces			
09	Exception Handling		Presentation, Viva	CLO 5,6
10	Multithreaded Programming			
11	Enumerations, I/O, Generics			

	12	Lambda Expressions, Modules, Records			
	13	String Handling, Collections Framework, Utility Classes			
	14	Event Handling, AWT, Swing			
Textbook	1. Java: The Complete Reference by Herbert Schildt. 2. Introduction to Programming in Java, Robert Sedgewick & Kevin Wayne. 3. An Introduction to Object-Oriented Programming, Timothy Budd. 4. Java-How to Program by Deitel & Deitel.				

Course Title:	Software Requirement Engineering
Credits:	2.0
Course No.:	SWE 0612-2125
Credit Hours:	2 hours/week
0Rationale:	This course provides the students with the necessary knowledge to understand, apply and analyze requirements engineering process and use it for elicitation, specification, modeling and analysis of software and system requirements. This course helps the students to understand the prerequisites for developing a solid software system by analyzing and evaluating the proper requirements of a software solution.
Objectives:	● Help the students to develop effective functional and non-functional requirements that are complete, concise, correct, consistent, testable and unambiguous. ● Provide the students with necessary knowledge about appropriate requirements elicitation techniques to identify requirements. ● Accumulate basic ideas about designing a set of software models to be used to flesh out hidden requirements and drive clarity into the system functional requirements ● Foster the ability of the students to effectively analyze requirements and prioritize accordingly. ● Help them to perform requirements engineering in the context of the most common software development life cycles and processes. ● Help the students to create a requirements specification to communicate requirements to a broad set of stakeholders. ● Facilitate the students to learn various requirements validation techniques to critically evaluate their requirements to identify defects ● Acquaint students with the basic tools to manage change to requirements
Course Contents:	**Introduction :** The Business Case for Requirements Analysis, Requirements Analysis through Software Life Cycles, Requirements Analysis, based on the Nature of Software Development, Requirement Specification, Quality Assurance Methods, The Nature of Meetings,

<table>
<tr><td></td><td>Understanding Requirements, System Planning Approaches, Requirements Validation and Testing, Requirements Analysis in Detail : System Scope Models, Universal Modeling Language (UML) ,The Requirements Document, The Specifications Document, Software Tools Assisting Development of Requirements and Specifications. Advanced Topics in Requirements Analysis: User Interface Design, Data Flow Modeling, Viewpoint Oriented Requirements Methods, Non Functional Requirements (Performance, Safety Critical Systems) Formal Methods : Introduction to Formal Methods, Formal Methods in Industrial Applications, Underpinnings of Formal Methods, Z and B for producing specifications.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>On successful completion of this course, students will be able to:
<table>
<tr><td>CLO 1</td><td>Implement different requirement elicitation techniques and tools.</td></tr>
<tr><td>CLO 2</td><td>Write clear, concise, and unambiguous software requirements specification.</td></tr>
<tr><td>CLO 3</td><td>Apply software requirement engineering concepts to real-world projects.</td></tr>
</table></td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td>
<table>
<tr><th>Course Learning Outcomes (CLO)</th><th>PLO 1</th><th>PLO 2</th><th>PLO 3</th><th>PLO 4</th><th>PLO 5</th><th>PLO 6</th><th>PLO 7</th><th>PLO 8</th><th>PLO 9</th><th>PLO 10</th><th>PLO 11</th><th>PLO 12</th></tr>
<tr><td>CLO1</td><td></td><td></td><td>1</td><td>3</td><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CLO2</td><td></td><td>1</td><td></td><td></td><td>3</td><td></td><td></td><td></td><td></td><td>3</td><td></td><td></td></tr>
<tr><td>CLO3</td><td></td><td></td><td>2</td><td>1</td><td></td><td></td><td>2</td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:</td><td>
<table>
<tr><th>CLOs</th><th>Teaching-Learning Strategy</th><th>Assessment Strategy</th></tr>
<tr><td>CLO1</td><td>CL, T</td><td>CT, Q, V, MS</td></tr>
<tr><td>CLO2</td><td>CL, T, OR, PrbL</td><td>CT, A, MS, SF</td></tr>
<tr><td>CLO3</td><td>CL, T, OR, PrbL</td><td>CT, A, MS, SF</td></tr>
</table>
(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)</td></tr>
</table>

<table>
<tr><td>Course Plan</td><td>
<table>
<tr><th>Week</th><th>Topic</th><th>Teaching Learning Strategy</th><th>Assessment Strategy</th><th>CLOs</th></tr>
<tr><td>1</td><td>The Business Case for Requirements Analysis</td><td>CL, T PrbL</td><td>CT, Q, V, MS</td><td>CLO1</td></tr>
<tr><td>2-3</td><td>Requirements Analysis based on the Nature of Software Development</td><td>CL, T, OR, PrbL</td><td>CT, A, MS, SF</td><td>CLO1</td></tr>
<tr><td>4-5</td><td>Requirements Analysis in Detail</td><td>CL, T, OR, PrbL</td><td>CT, A, MS, SF</td><td>CLO1, CLO1</td></tr>
<tr><td>6-7</td><td>Software Tools Assisting Development of Requirements and Specifications.</td><td>CL, T, OR, PrbL</td><td>CT, A, MS, SF</td><td>CLO1, CLO2</td></tr>
<tr><td>8-9</td><td>User Interface Design</td><td>CL, T, OR, PrbL</td><td>CT, A, MS, SF</td><td>CLO2, CLO3</td></tr>
<tr><td>10-11</td><td>Data Flow Modeling</td><td>CL, T, OR, PrbL</td><td>CT, A, MS, SF</td><td>CLO2, CLO3</td></tr>
<tr><td>12-13</td><td>Non-Functional Requirements</td><td>CL, T, OR, PrbL</td><td>CT, A, MS, SF</td><td>CLO2, CLO3</td></tr>
<tr><td>14</td><td>Formal Methods</td><td>CL, T, OR, PrbL</td><td>CT, A, MS, SF</td><td>CLO2, CLO3</td></tr>
</table>
(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)
</td></tr>
<tr><td>Text books</td><td>1. Software Requirements Analysis and Specifications – Jag Sodhi
2. Software Requirements Engineering–Richard H. Thayer, Merlin Dorfman, Sidney C. Bailin
3. Innovations for Requirement Analysis–Barbara Paech, Craig Martell</td></tr>
</table>

Course Title:	Software Requirement Engineering Lab
Credits:	1.5
Course No.:	SWE 0613-2126
Credit Hours:	3 hours/week

<table>
<tr><td>Rationale:</td><td>This course helps the students to use their knowledge in Software Requirement analysis to prepare and evaluate the proper requirements of a software solution for developing a user-friendly and scalable software system.</td></tr>
<tr><td>Objectives:</td><td>

Train students to select the appropriate requirements elicitation techniques to identify requirements.
Facilitate the students in designing a set of software models to be used to flesh out hidden requirements and drive clarity into the system functional requirements
Acquaint the students with the basic tools to effectively analyze requirements and prioritize accordingly.
Help the students to conceptualize basic theories to perform requirements engineering in the context of the most common software development life cycles and processes.
Make the students understand requirements specifications to communicate requirements to a broad set of stakeholders.
To facilitate necessary knowledge to Implement and utilize various requirements validation techniques to critically evaluate their requirements to identify defects
Help the students to get an idea about managing change to requirements

</td></tr>
<tr><td>Course Contents:</td><td>Requirements elicitation and analysis: techniques such as interviews, surveys, observation, and prototyping
Requirements Analysis in Detail: Requirements specification: writing clear and concise requirements, use cases, and user stories.
Requirements validation and verification: ensuring requirements are complete, consistent, and unambiguous.
Requirements management: tracking, tracing, and controlling requirements throughout the software development life cycle.
Requirements modeling: using diagrams, such as use case diagrams, class diagrams, and state transition diagrams, to visualize requirements.
Requirements engineering tools and methodologies: using tools like JIRA, Confluence, and UML for requirements management and modeling.
Agile requirements engineering: using Agile methodologies, such as Scrum and Kanban, for requirements management and delivery.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>On successful completion of this course, students will be able to:
<table>
<tr><td>CLO1</td><td>Plan effectively, manage, and deliver software requirements for a variety of software development projects.</td></tr>
<tr><td>CLO2</td><td>Proficient in using different modeling techniques such as use case diagrams, class diagrams, activity diagrams, and state diagrams to represent and communicate requirements.</td></tr>
<tr><td>CLO3</td><td>Perform teamwork to solve complex real-world problems and communicate their findings on a written report and/or by oral presentations</td></tr>
</table>
</td></tr>
<tr><td>Mapping of CLOs with Program Learning</td><td>
<table>
<tr><th>Course Learning Outcomes (CLO)</th><th>PLO 1</th><th>PLO 2</th><th>PLO 3</th><th>PLO 4</th><th>PLO 5</th><th>PLO 6</th><th>PLO 7</th><th>PLO 8</th><th>PLO 9</th><th>PLO 10</th><th>PLO 11</th><th>PLO 12</th></tr>
</table>
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Outcomes (PLOs):

CLO1		2										
CLO2			3		2							
CLO3									3	2		

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrbL	A, LE, PP
CLO2	CL, T, OR, GD, PrbL	A, LE, PP
CLO3	CL, T, OR, PrbL	A, PP

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Requirements elicitation and analysis**	CL, T PrbL	CT, Q, V, MS	CLO1
2-3	**Requirements Analysis in Detail**	CL, T, OR, PrbL	CT, A, MS, SF	CLO1
4-5	**Requirements validation and verification**	CL, T, OR, PrbL	CT, A, MS, SF	CLO1, CLO1
6-7	**Requirements management**	CL, T, OR, PrbL	CT, A, MS, SF	CLO1, CLO2
8-9	**Requirements modeling**	CL, T, OR, PrbL	CT, A, MS, SF	CLO2, CLO3
10-11	**Requirements engineering tools and methodologies**	CL, T, OR, PrbL	CT, A, MS, SF	CLO2, CLO3
12-13	**Agile requirements engineering**	CL, T, OR, PrbL	CT, A, MS, SF	CLO2, CLO3

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

	(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)
Text books	1. Software Requirements Analysis and Specifications – Jag Sodhi 2. Software Requirements Engineering–Richard H. Thayer, Merlin Dorfman, Sidney C. Bailin 3. Innovations for Requirement Analysis–Barbara Paech, Craig Martell

Course Title	Computer Architecture
Credits	3.0
Course No.	CSE 0613-2119W
Contact hours	3 hours/week
Rationale	This course is designed to provide a strong foundation for students to understand the modern areas of computer architecture. It will describe a broad range of architectural designs highlighting the design decisions and how these design decisions impact on system performance. The students will be able to apply these insights and principles to future computer designs.
Objective	●To make the students recognize the fundamental technologies and performance evaluation of different computer systems. ●To help them to know the instruction set architecture of a system and variations of ISA in different systems. ●To describe how a computer performs arithmetic operations. ●To provide ideas about internal architecture of a processor along with parallel computing. ●To identify the underlying technologies on different levels of memory hierarchy and their management in a system. ●To accumulate basic ideas about fundamental technologies on multicore and multiprocessing system and their application.
Course Content	**Introduction to Computer Architecture:** Overview and history; Cost factor; Performance metrics, Fundamental blocks of computer. **Instruction set architecture: C**lassifying instruction set architectures, Registers, Addressing Modes, RISC versus CISC, x86 Architecture, ARM Architecture. **Memory Hierarchy:**Hierarchical Organization, Cache memory; Basic cache structure and design; Fully associative, direct, and set associative mapping; Analyzing cache effectiveness; Replacement policies; Writing to a cache; Multiple caches; Upgrading a cache; Main Memory; Virtual memory and machine, Paging, Replacement strategies. **Data Representation:** Data type representation, signed number, fixed point, floating point, character. **Processor and Pipelining:**Datapath, pipelined Datapath,Pipelining basics, types, stalling and forwarding, Throughput and Speedup of Pipelining, Pipelining hazards. **Parallelism:** Instruction level parallelism, introduction, challenges and limitations, Scalar and superscalar pipelining, branch prediction, increase uniprocessor throughput.**Multiprocessors and Multi-core Computers:** SISD, SIMD, and MIMD architectures; Centralized and distributed shared memory- architectures; Multi-core Processor architecture. **Input/output Devices:** Performance measure, Types of I/O device, Buses and interface to CPU, RAID.
Course Learning Outcomes	After the successful completion of the course, the student will be able to **CO 1** Identify the fundamental technologies incorporated in computer architectures. **CO 2** Elevate the memory management technologies. **CO 3** Implement pipelining mechanism and parallel computing in to the processor. **CO 4** Improve I/O performance.

Mapping of Course Learning Outcomes to Program Learning Outcomes

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		x										
CO2			x	x					x			
CO3			x						x			
CO4					x				x			

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CO	Teaching Learning Strategy	Assessment Strategy
CO1	Lectures	Quiz, Class Test, Final Exam
CO2	Lectures, Demonstration	Class Test, Assignment, Final Exam
CO3	Lectures, Demonstration	Viva, Class Test, Final Exam
CO4	Lectures, Demonstration	Class Test, Viva, Final Exam

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CO
01	Introductory concepts about Computer Architecture.	Lectures	Class Test, Assignment, Final Exam	CO1
02	Basic Instruction set architecture	Lectures		CO1
03	Study the Instruction set architecture of different machines	Lectures		CO1
04	Memory Hierarchy Design	Lectures		CO2
05	Basic cache structure and design	Lectures		CO2
06	Main Memory, Virtual memory and machine	Lectures,		CO2
07	Data Representation	Lectures		CO2
08	Insights of Processor	Lectures		CO3
09	Pipelining Technology	Lectures,		CO3
10	Pipelining hazards	Lectures		CO3
11	Parallelism	Lectures		CO3
12	Multiprocessors and Multi-core Computers	Lectures,		CO3
13	Input/output Devices	Lectures,		CO4
14	Hands-on Practices	Demonstration	Practical Test, Viva.	CO2, CO3,CO4

Textbook

1. Computer Architecture and Organization by John P.Hayes.

	2. Computer Organization and Design: The hardware / software interface by David A.Patterson and John L.Hennessy.

Course Title:	Cost and Management Accounting
Credits:	03
Course No.:	BUS 0411-2101W
Credit Hours:	3 hours/week
Rationale:	This course will enable the students to acquire a conceptual knowledge on cost accounting and management accounting
Objectives:	This course aims to: I. describe the cost concepts, cost behavior, and cost accounting techniques that are applied to manufacturing and service businesses. II. interpret cost accounting statements III. provide the students with the capability to apply theoretical knowledge in decision making. IV. analyze and evaluate information for cost ascertainment, planning, control of business operations V. discuss the various techniques available to measure managerial performance and to motivate employees towards organizational goals.

Course Learning Outcomes (CLOs):

CLO1	understand the theories and concepts of costing needed to cope up with future business challenges.
CLO2	make technically of the analyzing of different costing method which is preferable for every stakeholder.
CLO3	analyze of both qualitative and quantitative data to formulate best costing methods
CLO4	identify and analyze both qualitative and quantitative standards to formulate best control methods
CLO5	able to interpret the techniques and methods used cost control and help to managers in decision making.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	**PLO1**	**PL02**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO 12**
CLO 1	**3**	**1**							**2**			
CLO 2			**3**									
CLO 3	**3**			**1**	**1**	**2**						

	CLO 4	**2**	**3**			**3**		**3**	**2**	**2**			
	CLO 5	**2**			**2**						**3**		

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

Teaching Learning Strategies:

Teaching Strategies	Code
Lecture	01
Case Study	02
Problem Solving	03
Group Discussion	04
Audio Visual Presentation	05

Assessment Methods:

Type of Assessment	Assessment Code
Quiz Test	01
Written Test	02
Problem solving	03
Presentation	04
Assignment	05

Course Plan:

Week	Course Contents	Teaching Learning Strategy	Assessment Strategy	CLO
	Cost Accounting 50%			
1	**Introduction to Cost Accounting:** Definition of Cost Accounting, Comparison of Cost Accounting and Financial Accounting; The role of Cost Accounting; Methods and Techniques of Cost Accounting; Characteristics of an Ideal Cost Accounting System	01	01,02	1
2	**Cost Concepts, Classifications and Statements:** Cost Object; Expenditures, Cost, Expense and Loss; Cost Classifications; Cost Data and Uses; The Chart of Accounts; Statement of Cost of Goods Manufactured and Sold; Cost Statement or Cost Sheet	01	01,02	2
3	**Costing and Control of Materials:** Classification of Materials; Accounting for Materials; Store ledger(FIFO & WAM) method; Inventory Planning; Ordering Cost, Holding Cost and EOQ; Effect of Quantity Discounts on EOQ; Safety Stock and Reorder Point; Material Control Methods; Materials	02	02,04	2

		Requirement Planning System. Practical problem.			
	4	**Costing and Control of Labour**: Productivity and Labour Costs; Costs included in Labour; Accounting for Labour; Time Keeping, Computation of total payroll and Allocation of Payroll costs; Different incentive plan; Labour cost Control, Labour Turnover and Control of Labour Turnover; Learning Curve Theory. Practical problem & solution	01, 02	01, 02	3,4
	5	**Costing and Control of Manufacturing Overhead**: Manufacturing Overhead Costs; Actual Vs. Normal Costing of Manufacturing Overhead; Production Capacity, Predetermined Overhead Rates; Departmental vs. Plantwide Overhead Rates; Separating Mixed Costs. Scatter-graph; High-low Method and Regression Analysis; Accounting for Manufacturing Overhead; Analysis and Disposition of Under-applied-and Over-applied Overhead	04, 05	02,05	3,4
	6	**Contract Costing**: Determination of profit of completed and incomplete contracts.	03, 04	02,05	4, 5
		Assessment			
		Management Accounting 50%			
	7	**Introduction of Management Accounting** :Definition-process of Management Accounting, characteristics of Management Accounting, scope of Management Accounting, purpose and objectives of Management Accounting, Comparison of Management Accounting and Financial Accounting	04, 05	01, 05	2,4
	8	**Cost Terms, Concepts and Classifications:** Cost Behaviour (Analysis and Use): General cost classifications- product costs versus period costs- cost classifications on Financial Statements. Types of cost behaviour patterns- the Analysis of Mixed Costs, High-low method	03,04	02,04	1,4
	9	**Cost-Volume-Profit Relationships:** The basics of CVP analysis- Break -even analysis- Break-even chart- Sales Mix. Business application and	03, 04	02,04	1,4

		mathematical problem of CVP analysis			
	10	**Budget:** Define Budget, Types of Budget, Cash budget, purchase budget, sales budget, flexible budget and Related problems	03, 05	01,05	2,3,4
	11	**Standard Costing:** Meaning and Objectives- Types of ratios. Standard Costing and its uses for making business decision. Variance calculation, Decision making process from these calculations.	04,05	01,04	5
	12	**Assessment**			
	13	**Standard Costing:** Variance calculation, Decision making process from these calculations..	01	01	5
	14	**Assessment and Review**			

Text Books & References	**Text Book:** 1.Cost Accounting –Volume-1 by Basu and Das; 2. Managerial Accounting by Ray H. Garrison, Eric W. Noreen **Reference Books:** 1. : Cost Accounting by Mutz Uzry et al.
SEE-Semester End Examination (60)	

Bloom's Category	**Test**
Remember	**10**
Understand	**15**
Apply	**10**
Analyze	**10**
Evaluate	**10**
Create	**05**

Course Title:	Principles of Economics
Credits:	3.0
Course No.:	ECO 0311-2105W
Credit Hours:	3 hours/week
Course Description and Objectives:	This course provides an introduction to the main ideas and concepts involved in modern economics and attempts to provide students with an understanding of how the economy works, what type of problems economists attempt to solve, and how they set about trying to solve them. The course is primarily concerned with the analysis of individual decision-making agents, the behavior of firms and industries in the economy (microeconomics), on the economy as a whole (macroeconomics) and the inherent problems facing underdeveloped and developing countries (economic development). The Microeconomics part provides a brief and simple introduction to the subject matter and scope of Economics. This section aims to provide an introduction to microeconomic analysis.

	It outlines the theory of markets with relevant applications to business, social and individual issues. The course covers the principles and consequences of "rational" choice by individual economic agents in markets . The course also provides an introductory analysis of the role of governments in seeking to ensure the efficient operation of markets. Macroeconomics section provides a brief and simple introduction to the subject matter and scope of Macroeconomics. It also aims to provide an introduction to macroeconomic analysis outlining how the national income is measured and determined. It also provides a framework in which the interaction of money and goods and services markets can be developed, allowing students to understand the process by which the levels of economic activity, employment are determined. Economic development section provides students with an understanding of economic theories and analysis in the field of development economics. The section is designed to deal with a selection of issues and problems facing the developing economies.
Prerequisites:	Basic arithmetic and an ability to learn, to understand, and manipulate simple graphs are required, but it would be difficult to do any job in the private or public sector without these skills.
Course Learning Outcomes (CLOs):	Successful completion of this course should enable students to: CLO 1. Understand the analysis of individual decision-making agents, the behavior of firms and industries in the economy CLO 2. Understand the concept of elasticity quantitatively and qualitatively in economic analysis and know differences between different types of markets ; CLO 3. Explain macroeconomic concepts and use simple economic models to interpret the behaviour of key macroeconomic variables; CLO 4. Understand monetary and fiscal policy and Government budget; CLO 5. Understand the main issues confronting underdeveloped and developing countries.
Mapping of CLOs with Program Learning Outcomes (PLOs):	**Mapping of Course Learning Outcomes to Program Learning Outcomes** **CLO /PLO** | **PLO1** | **PL02** | **PLO3** | **PLO4** | **PLO5** | **PLO6** | **PLO7** | **PLO8** | **PLO9** | **PLO10** | **PLO11** | **PLO12** **CLO 1** | **CLO 2** | **CLO 3** | **CLO 4** | **CLO 5** |
Mapping Course Learning Outcomes (CLOs) with the	**Teaching Strategies** The course materials are delivered through certain teaching-learning activities such as lectures, reading, assignments, exercise and workshop papers. **Assessment Strategies** **No.** | **Description** | **Mark**

Teaching-Learning and Assessment Strategy:

1	Class attendance	10
2	Midterm test	20
3	Assignments	10
4	Final Exam	60

Coursework = 40% of the overall mark, and the Final Examination = 60%.

The coursework consists of at least two tests (one can be substituted by assignment) with a combined weight of 20% of the final mark, 10% as a part of continuous assessment like the class test, quiz, problem-solving, short assignment and 10% of the final mark is reserved for class attendance as per rule of the university. Assignment submission date will be fixed by the course convener.

Mid Semester Test Date: The mid-semester test is scheduled after the mid-semester break, and it covers topics in weeks 1-6. More details will be provided at lectures.

Final Exam Test Date: Final Exam Test schedule will be declared by the department before the preparatory leave. The final exam covers all the topics. Students must be able to show an understanding of the course material.

Assessment of Course Learning Outcome

Outcome	Test	Assignment	Final Examination
1	X	X	X
2	X	X	X
3	X	X	X
4	X	X	X
5	X		X

Grading System

The grading system has been detailed in Section 7 "Grading System" in Semester Ordinance

Course Content

Course Outline

Course Content	Teaching Strategy
1. Introduction to Microeconomics: Definition and scope; basic concepts and tools—PPF and circular flow model; fundamental economic problems and solution systems; Concepts of demand, supply and equilibrium; Concepts of elasticity, different types of elasticities, their applications; Concepts of total and marginal utility; Concepts of production, cost and profit, characteristics of different types of markets.	Lecture, tutorial and exercise
2. Introduction to Macroeconomics: Key macroeconomic indicators and their performance measurement - GNP, GDP, inflation, unemployment; money, functions of money, function of commercial and central bank, monetary policy; fiscal policy and structure of govt. budget.	Lecture, tutorial and assignment
3. Development and related issues: Growth and development; concept of poverty and poverty measures; HDI; key human-socio-economic development indicators of Bangladesh, Sustainable Development Goals (SDG).	Lecture and discussion

3.1 Alignment of topics of the courses with CLOs

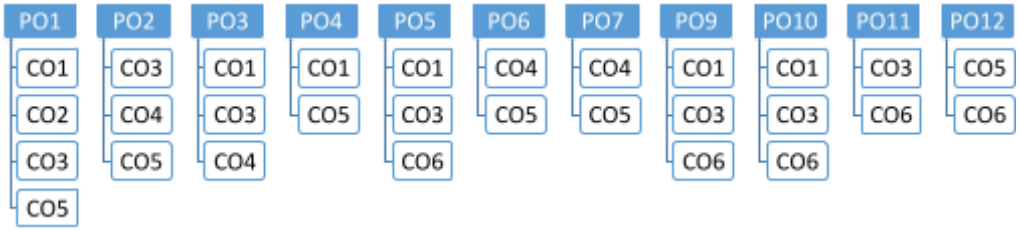
	CLO 1	CLO 2	CLO 3	CLO 4
Content 1	X	X		
Content 2			X	X
Content 3				

Text Books	1. Arnold, R. A. (2014): Economics, South Western Publishing Company, Eleventh Edition 2. Bangladesh Economic Review relevant issues. 3. Mankiw, N. G. (2012): Principles of Economics, Thomson South Western Publishing, Sixth Edition 4. Samuelson, P. A. and Nordhaus,W. D. (2009): Economics, McGraw-Hill USA, Nineteenth Edition. 5. Todaro, M. P. and Smith,S. C. (2012): Economics of Development in the Third World, Longman, Eleventh Edition

Second Year Second Semester

Course Title:	Theory of Computation
Credits:	02
Course No.:	SWE 0613-2227
Credit Hours:	2 hours/week
Rationale:	This course will cover the fundamental limits on what can be efficiently computed in our universe and other possible universes. These limits reveal deep and mysterious properties about information, knowledge, and processing, as well as practical issues about what can and cannot be computed.
Objectives:	● The essence of the theory of computation gives students to help develop mathematical and logical models that run efficiently and to the point of halting. ● Since all machines that implement TOC logically, studying TOC gives students an insight into computer hardware and software limitations ● This course will introduce students about three foundational areas of computer science namely the basic mathematical models of computation, problems that can be solved by computers and problems that are computationally hard.
Course Learning Outcomes (CLOs):	After the successful completion of the course, the student will be able to-

CO1	Show a competent understanding of the basic concepts of complexity theory.
CO2	Defines machine models formally.
CO3	Demonstrate advanced knowledge of formal computation and its relationship to languages
CO4	Recognize and comprehend formal reasoning about languages
CO5	Distinguish different computing languages and classify their respective types.

	CO6 | Proves the undecidability or complexity of a variety of problems
Mapping of CLOs with Program Learning Outcomes (PLOs):	Mapping of Course Learning Outcomes to Program Learning Outcomes 
Course Plan:	

Week	Course Contents	Topic	CLO
1-2	Know the background of the subject.	Introduction To Automata	CO1, CO2, CO3, CO5
	Interpret the different computation Theories.	Computability Theory, Automata Theory	CO1, CO2, CO3, CO5
	Sketch some of the mathematical concepts.	Mathematical Notions - Sets Function and Relations graphs - Strings and languages	CO1, CO3, CO4, CO5
	Familiarize some mathematical terms commonly used in solving problems.		CO1, CO2, CO3, CO5
	Illustrate few mathematical proofs that often occur in the theory of computation.	Summary of mathematical terms Definitions, Theorems	CO1, CO3, CO4, CO5, CO6
	Rewrite mathematical words or statements that will justify the mathematical proof.	Proofs - Finding proofs Types of Proof - Proof by construction - Proof by contradiction	CO1, CO3, CO4, CO5, CO6

	3-7	Explain the finite automata and the use of this kind of model.	Finite Automata - Formal definition of a finite automaton - Examples of finite automata - Formal definition of computation - Designing finite automata - The regular operations	CO1, CO2, CO3, CO5, CO4, CL06	
		Cite some examples of finite automaton that can be seen everywhere.	Nondeterminism - Formal definition of a nondeterministic finite automaton - Equivalence of NFAs and DFAs - COsure under the regular operations	CO5, CO6, CO1, CO3	
		Create a particular approach that will help in designing various types of automata.	Regular Expressions - Formal definition of a regular expression - Equivalence with finite automata	CO1, CO2, CO3, CO5, CO4, CO6	
	8-10	Define context free grammars and the properties of context free languages.	Context-Free Languages	CO1, CO2, CO3, CO5	
		Use of correct grammar to describe a language by generating	Context-Free Grammars	CO1, CO3, CO6	

			each string of that language in a following manner.	- Formal definition of a context-free grammar - Examples of context-free grammars - Designing context-free grammars - Ambiguity - Chomsky normal form		
			Design and Construct a context-free grammars.	Pushdown Automata - Formal definition of a pushdown automaton - Examples of pushdown automata - Equivalence with context-free grammars	CO1, CO2, CO3, CO5	
			Understand the basic knowledge about much more powerful model in computing devices.	Non-Context -Free Languages - The pumping lemma for context-free languages	CO1, CO2, CO3, CO5	
			Know the difference between finite automata and Turing machines.	Deterministic Context-Free Languages - Properties of DCFLs - Deterministic context-free grammars Context-Free Languages	CO1, CO3, CO6	
			Enumerate some of variants of Turing machines and the proofs of	Context-Free Grammars	CO1, CO3, CO6	

			equivalence in power of each variants.	- Formal definition of a context-free grammar - Examples of context-free grammars - Designing context-free grammars - Ambiguity - Chomsky normal form		
		11-13	Understand the basic knowledge about much more powerful model in computing devices.	COMPUTABILITY THEORY) THE CHURCH–TURING THESIS	CO1, CO2, CO3, CO5	
			Know the difference between finite automata and Turing machines.	Turing Machines - Formal definition of a Turing machine - Examples of Turing machines	CO1, CO2, CO3, CO5	
			Enumerate some of variants of Turing machines and the proofs of equivalence in power of each variants.	Variants of Turing Machines - Multitape Turing machines - Nondeterministic Turing machines	CO1, CO2, CO3, CO5, CO4	
			Describe what algorithm is and how it is connected to Turning machines.	The Church–Turing Thesis	CO1, CO2, CO3, CO5, CO4	
			Explore the limits of algorithmic solvability.	The Church–Turing	CO1, CO2, CO3,	

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<tr><td></td><td></td><td>Thesis</td><td>CO5, CO4, CO6</td></tr>
<tr><td>14</td><td>Assessment and Review</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Text Books & References</td><td>Recommended Resources: Linz, Peter. An Introduction to Formal Languages and Automata. Sixth Edition
Required Resources: Sipser, Michael. Introduction to the Theory of Computation
& E. Hopcroft, John. Introduction to Automata Theory ,Language and Computation</td></tr>
<tr><td>SEE-Semester End Examination (60)</td><td>
<table>
<tr><th>Bloom’s Category</th><th>Test</th></tr>
<tr><td>Remember</td><td>10</td></tr>
<tr><td>Understand</td><td>15</td></tr>
<tr><td>Apply</td><td>10</td></tr>
<tr><td>Analyze</td><td>10</td></tr>
<tr><td>Evaluate</td><td>10</td></tr>
<tr><td>Create</td><td>05</td></tr>
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Course Title:	Algorithm Design and Analysis
Credits:	3.0
Course No.:	SWE 0613-2229
Credit Hours:	3 hours/week
Rationale:	This course provides the students with solid foundations in the basic concepts of programming: data structures and algorithms. Also, this course explains the selection and designing criteria of data structures and algorithms that are appropriate for problems that may be encountered. This course also describes correctness of algorithms in terms of mathematical induction and presents their computational complexities.
Objectives:	● To familiarize the students with the asymptotic performance of algorithms. ● To facilitate necessary knowledge about rigorous correctness and proofs for algorithms. ● To demonstrate a familiarity with major algorithms and data structures. ● To teach important algorithmic design paradigms and methods of analysis. ● Accumulate basic ideas about synthesizing efficient algorithms in common engineering design situations.
Course Contents:	**Analysis of Algorithm:** Asymptotic analysis: Recurrences, Substitution method, Recurrence tree method, Master method. **Hash Table:** Hash tables, hash function, open addressing, perfect hashing, single and multi probehasing. **Greedy Algorithms:** Elements and properties of Greedy algorithms, fractional knapsack, job scheduling with deadline.

Dynamic Programming: Elements of DP (Optimal substructure, Overlapping sub problem), Coin change related problem, 0-1 knapsack, Longest Common Subsequence finding problem, LCS and LIS/LDS variations, Matrix Chain Multiplication.

Red black Tree and Binomial Heaps, Stassen's algorithm

Network Flow: Flow Networks, Max-Flow Min-cut theorem, Ford Fulkerson method and its limitation, Edmonds Karp algorithm, Maximum bipartite matching, minimum path cover, edge cover.

Backtracking/Branch-and-Bound: Permutation, Combination, 8-queen problem, 15-puzzle problem, Graph Coloring, N-queen problem, Hamiltonian cycle, Branch and Bound in backtracking. For example in traveling salesman problem.

Geometric algorithm: Segment-segment intersection, Convex-hull, Closest pair problem.

Number Theory: Chinese Remainder Theorem, Euler phi, extended Euclid, application of prime factorization application of phi. **RSA public key generation,** NP Completeness, NP hard and NPcomplete problems.

String Matching Algorithms: Naïve string matching algorithm, Rabin Karp algorithm, String matching with finite automata, Knuth Morris Pratt (KMP) algorithm, Trie, Suffix tree and Suffix Array. Basic combinatorics, Probability and Game theory. Least Common Ancestor, Range Minimum Query, Polynomials, DFT and FFT.

Course Learning Outcomes (CLOs):

CLO 1	Develop an innovative project idea using object-oriented programming approach and a standard algorithm that addresses a real-world problem in the IT field.
CLO 2	Apply project management principles, tools, and techniques to plan, execute, monitor, and control project activities, resources, and deliverables.
CLO 3	Evaluate the effectiveness and efficiency of the project solution in terms of meeting the project goals, user requirements, and technical specifications.
CLO 4	Demonstrate effective communication, collaboration, and teamwork skills in presenting project progress, outcomes, and recommendations to stakeholders.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3	2										2
CLO 2	2	2							1	1	2	
CLO 3	3		3	3	3	2					2	
CLO 4	3						3	3				2

Mapping Course

Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, P
CLO2	CL, T, OR, GD, PrbL, PjrL	A, P
CLO3	CL, T, OR, PrbL, PjrL	A, Pj
CLO4	GD, PrbL, PrjL, BL	V, P

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to Algorithm Analysis and Asymptotic Analysis	Lecture, in-class exercises	Quiz	CLO1, CLO2
2-3	Divide and Conquer Algorithms and Recurrence Relations	Lecture, in-class exercises, problem-solving sessions	Quiz, Assignments	CLO1, CLO2, CLO3
4-5	Greedy Algorithms	Lecture, in-class exercises, problem-solving sessions	Quiz, Assignments	CLO1, CLO2, CLO3, CLO4
6-7	Dynamic Programming	Lecture, in-class exercises, problem-solving sessions	Quiz, Assignments	CLO1, CLO3, CLO4
8	Hash Tables	Lecture, in-class exercises	Quiz, Assignments	CLO1, CLO2, CLO4
9-10	Network Flow and Bipartite Matching	Lecture, in-class exercises, problem-solving sessions	Quiz, Assignments	CLO1, CLO2, CLO3, CLO4
11-12	Backtracking/Branch-and-Bound and Geometric Algorithms	Lecture, in-class exercises, problem-solving sessions	Quiz, Assignments	CLO2, CLO3, CLO4
13-14	String Matching Algorithms, Number Theory, and NP Completeness	Lecture, in-class exercises, problem-solving sessions	Quiz, Assignments	CLO1, CLO2, CLO3, CLO4

Text Books	1. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson. 2. Algorithms by Robert Sedgewick and Kevin Wayne.

Course Title:	Algorithm Analysis and Design Lab
Credits:	1.5
Course No.:	SWE 0613-2230
Credit Hours:	3 hours/week
Rationale:	This course provides the students with solid foundations in the basic concepts of programming: data structures and algorithms. Also, this course helps in the implementation of data structures and algorithms that are appropriate for problems that may be encountered. This course also enables the students to evaluate the correctness of algorithms in terms of mathematical induction and analyze their computational complexities.
Objectives:	● To facilitate necessary knowledge about the asymptotic performance of algorithms. ● Acquaint students with the basic tools for rigorous correctness and proofs for algorithms. ● Help the students to conceptualize basic theories in major algorithms and data structures. ● To provide the knowledge of algorithmic design paradigms and methods of analysis. ● Foster the analytical and critical ability of the students to apply efficient algorithms in common engineering design situations.
Course Contents:	**Hash Table:** Hash tables, hash function, open addressing, perfect hashing, single and multi-probe hashing. **Greedy Algorithms:** Elements and properties of Greedy algorithms, fractional knapsack, job scheduling with deadline. **Dynamic Programming:** Elements of DP (Optimal substructure, Over-lapping sub problem), Coin change related problem, 0-1 knapsack, Longest Common Subsequence finding problem, LCS and LIS/LDS variations, Matrix Chain Multiplication. **Red black Tree and Binomial Heaps, Stassen's algorithm** **Network Flow:** Flow Networks, Max-Flow Min-cut theorem, Ford Fulkerson method and its limitation, Edmonds Karp algorithm, Maximum bipartite matching, minimum path cover, edge cover. **Backtracking/Branch-and-Bound:** Permutation, Combination, 8-queen problem, 15-puzzle problem, Graph Coloring, N-queen problem, Hamiltonian cycle, Branch and Bound in backtracking. For example, in the traveling salesman problem. **Geometric algorithm:** Segment-segment intersection, Convex-hull, Closest pair problem. **Number Theory:** Chinese Remainder Theorem, Euler phi, extended Euclid, application of prime factorization application of phi. **RSA public key generation,** NP Completeness, NP hard and NP complete problems. **String Matching Algorithms:** Naïve string matching algorithm, Rabin Karp algorithm, String matching with finite automata, Knuth Morris Pratt (KMP) algorithm, Trie, Suffix tree and

	Suffix Array, Basic combinatorics, Probability and Game theory. Least Common Ancestor, Range Minimum Query, Polynomials, DFT and FFT.
Course Learning Outcomes (CLOs):	

CLO 1	Design and implement efficient algorithms to solve a variety of computational problems using a range of algorithmic techniques, such as dynamic programming, greedy algorithms, backtracking, and network flow.
CLO 2	Analyze the time and space complexity of algorithms and evaluate their performance empirically through the implementation of experiments and measurements.
CLO 3	Demonstrate proficiency in implementing various data structures, such as hash tables, red-black trees, and binomial heaps, and use them to solve algorithmic problems.
CLO 4	Develop skills in problem-solving, critical thinking, and teamwork through working on algorithmic problems and completing lab assignments.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3		3		2							2
CLO 2	2	2		2		2		1	1		1	
CLO 3	3	2		3		1	1			1		
CLO 4	3		3		2						1	2

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs

		1	Introduction to Algorithm Design and Analysis Lab	Lecture	Lab attendance and participation .	CLO1
		2	Implementation of Basic Algorithms	Lecture and Hand-on Coding Demonstration	Assignment, Presentation	CLO1
		3	Analysis of Algorithms	Lecture and Hand-on Coding Demonstration	Assignment, Presentation	CLO1
		4	Hash Tables	Lecture and Hand-on Coding Demonstration	Assignment, Presentation	CLO1
		5	Greedy Algorithms	Lecture and Hand-on Coding Demonstration	Assignment, Presentation	CLO1, CLO2
		6	Dynamic Programming	Lecture and Hand-on Coding Demonstration	Assignment, Presentation	CLO1, CLO2
		7	Red-Black Trees and Binomial Heaps	Lecture and Hand-on Coding Demonstration	Assignment, Presentation	CLO1 , CLO2
		8	Network Flow	Lecture and Hand-on Coding Demonstration	Assignment, Presentation	CLO1 , CLO2, CLO3, CLO4
		9	Backtracking/Branch-and-Bound	Lecture and Hand-on Coding Demonstration	Assignment, Presentation	CLO1 , CLO2, CLO3, CLO4
		10	Geometric Algorithms	Lecture and Hand-on Coding Demonstration	Assignment, Presentation	CLO1 , CLO2, CLO3, CLO4
		11	Number Theory	Lecture and Hand-on Coding Demonstration	Assignment, Presentation	CLO1 , CLO2, CLO3, CLO4
		12	String Matching Algorithms	Lecture and Hand-on Coding Demonstration	Assignment, Presentation	CLO1 , CLO2, CLO3, CLO4
		13	Basic Combinatorics, Probability and Game Theory	Lecture and Hand-on Coding Demonstration	Assignment, Presentation	CLO1 , CLO2, CLO3, CLO4

	14	Range Minimum Query, Polynomials, DFT and FFT	Lecture and Hand-on Coding Demonstration	Assignment, Presentation	CLO1 , CLO2, CLO3, CLO4
Text Books	1. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson. 2. Algorithms by Robert Sedgewick and Kevin Wayne.				

Course Title:	Numerical Analysis
Credits:	2.0
Course No.:	SWE 0541-2231
Credit Hours:	2 hours/week
Rationale:	There are many interesting or economically pressing problems that do not have the "closed form algebraic solutions". Numerical methods are the answer to that. Numerical analysis is the story of how functions, derivatives, integrals, and differential equations are handled as strings of numbers in the computer. Many of these problems are too large or too difficult to solve in a conventional manner, for which we resort to using the computer to do the hard work for us. It is intended to introduce the student to the algorithms and techniques an engineer might employ in solving these difficult problems. This course helps us to know how fast errors cause problems and to find better algorithms that cause less error. Therefore, this course is indispensable for all students in almost all disciplines.
Objectives:	● To facilitate necessary knowledge about deriving appropriate numerical methods to solve algebraic and transcendental equations ● Acquaint students with the basic tools to develop appropriate numerical methods to approximate a function, solve a differential equation ● Help them conceptualize basic theories to derive appropriate numerical methods to evaluate a derivative at a value ● Helping the students to develop ability in deriving appropriate numerical methods to solve a linear system of equations ● Make the students understand error analysis mechanism for various numerical methods ● To accumulate basic ideas about various numerical root finding methods ● Foster the analytical and critical ability of the students to derive appropriate numerical methods to calculate a definite integral ● To make them understand various numerical methods in a modern computer language like Matlab, Python
Course Contents:	**Approximation and round off error:** Errors in numerical calculations. Error: Definitions, sources, examples. Propagation of Error. A general error formula. Taylor series and reminders. **Root finding:** The bisection method and the iteration method, the method of false position. Newton-raphson method. Roots of polynomials. **Solution of systems of Linear equations:** Gaussian elimination. The pivoting strategy, Iteration method solution of tridiagonal systems. LU decomposition, matrix inverse. **Numerical solution of ordinary differential equations:** Euler's method (including modified form), Runge-Kutta method. **Numerical Integration:** Trapezoidal method. Simpson's method. Weddle's method; Eigen value problems for matrices, Use of computer to implement projects in numerical methods.

Methods of approximation theory: Polynomial interpolation: Lagrange form, divided formula for interpolation.
Regression: Background, linear regression, non-linear regression.
Optimization: optimization in one dimension; unconstrained optimization; nonlinear least squares; constrained optimization; iterative linear solvers – gradient descent, conjugate gradient.

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO 1	Analyze the sources of errors in mathematical operations on the computer and their effects on using numerical algorithms
CLO 2	Perform numerical analysis to obtain approximate solutions for various mathematical operations and tasks, such as finding the solution of linear and nonlinear equations, root finding, optimization, interpolation, integration, and the solution of ordinary differential equations
CLO 3	Analyze the behavior of various numerical methods and to be able to discuss their stability, their order of convergence and their conditions of application

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	X			X								
CLO2	X	X	X	X								
CLO3	X	X		X								

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T	CT, Q, V, MS
CLO2	CL, T, OR, PrbL	CT, A, MS, SF
CLO3	CL, T, OR, PrbL	CT, A, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Approximation and round-off errors**	CL, T PrbL	CT, Q, V, MS	CLO 1

		2-3	**Root finding**	CL, T, OR, PrbL	CT, A, MS, SF	CLO 2, CLO 3	
		4-5	**Solution of system of linear equations (SLEs)**	CL, T, OR, PrbL	CT, A, MS, SF	CLO 2, CLO 3	
		6-7	**Ordinary differential equations (ODE)**	CL, T, OR, PrbL	CT, A, MS, SF	CLO 2, CLO 3	
		8-9	**Numerical Integration**	CL, T, OR, PrbL	CT, A, MS, SF	CLO 2, CLO 3	
		10-11	**Interpolation**	CL, T, OR, PrbL	CT, A, MS, SF	CLO 2, CLO 3	
		12-13	**Regression**	CL, T, OR, PrbL	CT, A, MS, SF	CLO 2, CLO 3	
		14	**Optimization**	CL, T, OR, PrbL	CT, A, MS, SF	CLO 2, CLO 3	
	(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning) (CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)						
Text books	1. Numerical Methods for Engineers – Steven C. Chapra, Raymond P. Canale 2. Numerical Analysis – R.L. Burden, J.D. Faires 3. Scientific Computing: An introductory survey – Michael T. Heath						

Course Title:	Numerical Analysis Lab
Credits:	1.5
Course No.:	SWE 0541-2232
Credit Hours:	3 hours/week
Rationale:	This course introduces students to numerical methods for the solution of basic mathematical problems that cannot be solved by hand. The course aims to introduce students to the toolbox of widely-used numerical methods in computational science. Students will be able to apply these methods to problems in a variety of sciences. It is designed for practical implementations

<table>
<tr><td></td><td>of common algorithms taught in the corresponding theory course – SWE 0541-2231. Students will design and implement algorithms directly from pseudo codes, as well as from problem statements new to them.</td></tr>
<tr><td>Objectives:</td><td>● To familiarize with the numerical methods used in computational science
● To help to develop skills to apply numerical methods to problems in practice.
● To familiarize with, use, and understand software which uses numerical methods
● To facilitate with the knowledge about the role of numerical methods in science
● To provide basic knowledge of coding various numerical methods in a modern computer language like Matlab, Python</td></tr>
<tr><td>Course Contents:</td><td>Approximation and round off error: Measuring error, relative approximate error, relative true error
Root finding: Bisection method, false position methods, Newton-raphson method
Solution of systems of Linear equations: Naïve Gaussian elimination. Gaussian elimination with partial pivoting, The pivoting strategy, Iteration method solution of tridiagonal systems. LU decomposition, matrix inverse.
Numerical solution of ordinary differential equations: Euler's method (including modified form), Runge-Kutta method.
Numerical Integration: Trapezoidal method. Simpson's method. Weddle's method; Eigen value problems for matrices, Use of computer to implement projects in numerical methods.
Methods of approximation theory: Polynomial interpolation: Lagrange form, Newton’s divided difference formula for interpolation.
Regression: Background, linear regression, non-linear regression.
Optimization: optimization in one dimension; unconstrained optimization; nonlinear least squares; constrained optimization; iterative linear solvers – gradient descent, conjugate gradient.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>On successful completion of this course, students will be able to:
<table>
<tr><td>CLO 1</td><td>Implement algorithms from a known/given pseudocode for solving numerical analysis problem</td></tr>
<tr><td>CLO 2</td><td>Design and/or implement algorithms directly from a given problem statement (without needing any pseudocode)</td></tr>
<tr><td>CLO 3</td><td>Implement bug-free and efficient codes against all algorithms</td></tr>
<tr><td>CLO 4</td><td>Perform teamwork to solve complex real-world problems and communicate their findings on a written report and/or by oral presentations</td></tr>
</table></td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td>
<table>
<tr><th>Course Learning Outcomes (CLO)</th><th>PLO 1</th><th>PLO 2</th><th>PLO 3</th><th>PLO 4</th><th>PLO 5</th><th>PLO 6</th><th>PLO 7</th><th>PLO 8</th><th>PLO 9</th><th>PLO 10</th><th>PLO 11</th><th>PLO 12</th></tr>
<tr><td>CLO1</td><td>X</td><td>X</td><td>X</td><td></td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CLO2</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CLO3</td><td>X</td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</table>

	CLO4								X	X	X		

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrbL	A, LE, PP
CLO2	CL, T, OR, GD, PrbL	A, LE, PP
CLO3	CL, T, OR, PrbL	A, PP
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Approximation and round-off errors**	CL, T, OR, GD, PrbL	A, LE, PP	CLO1, CLO2, CLO3, CLO4
2-3	**Root finding**	CL, T, OR, GD, PrbL	A, LE, PP	CLO1, CLO2, CLO3, CLO4
4-5	**Solution of system of linear equations (SLEs)**	CL, T, OR, GD, PrbL	A, LE, PP	CLO1, CLO2, CLO3, CLO4
6-7	**Ordinary differential equations (ODE)**	CL, T, OR, PrbL	A, PP	CLO1, CLO2, CLO3, CLO4
8-9	**Numerical Integration**	CL, T, OR, PrbL	A, PP	CLO1, CLO2, CLO3, CLO4
10-11	**Interpolation**	GD, PrbL, PrjL, BL	V, P, RW, Prj	CLO1, CLO2, CLO3, CLO4

		12-13	**Regression**	GD, PrbL, PrjL, BL	V, P, RW, Prj	CLO1, CLO2, CLO3, CLO4
		14	**Optimization**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	V, P, RW, Prj	CLO1, CLO2, CLO3, CLO4
	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)					
Text books	1. Numerical Methods for Engineers – Steven C. Chapra, Raymond P. Canale 2. Numerical Analysis – R.L. Burden, J.D. Faires 3. Scientific Computing: An introductory survey – Michael T. Heath					

Course Title:	Operating System and System Programming
Credits:	3.0
Course No.:	SWE 0613-2233
Credit Hours:	3 hours/week
Rationale:	This course presents fundamental concepts related to the design and implementation of operating systems. Topics include basic operating system structure, process scheduling, process and thread synchronization and concurrency, memory management, file systems.
Objectives:	The objective of the course is ● To acquaint students with the role of the operating system as a high level interface to the hardware. ● To facilitate necessary knowledge about the low level implementation of CPU dispatch. ● Help them conceptualize basic theories in low level implementation of memory management. ● Make the students understand the basic idea about the performance trade-offs inherent in OS implementation
Course Contents:	**Introduction:** Operating Systems Concept, Computer System Structures, Operating System Structures, Operating System operations, Protection and Security, Special-Purpose Systems. **Fundamentals of OS:** OS services and components, multitasking, multiprogramming, time sharing, buffering, spooling **Process Management:** Process Concept, Process Scheduling, Process State, Process Management, Inter process Communication, interaction between processes and OS,

Communication in Client-Server Systems, Threading, Multithreading, Process Synchronization.

Concurrency control: Concurrency and race conditions, mutual exclusion requirements, semaphores, monitors, classical IPC problem and solutions, Dead locks - characterization, detection, recovery, avoidance and prevention.

Memory Management: Memory partitioning, Swapping, Paging, Segmentation, Virtual memory - Concepts, Overlays, Demand Paging, Performance of demand paging, Page replacement algorithm, Allocation algorithms.

Storage Management: Principles of I/O hardware, Principles of I/O software, Secondary storage structure, Disk structure, Disk scheduling, Disk Management, Swap-space Management, Disk reliability, Stable storage implementation.

File Concept: File support, Access methods, Allocation methods, Directory systems, File Protection, Free Space management.

Protection & Security*:* Goals of protection, Domain of protection, Access matrix, Implementation of access matrix, Revocation of access rights, The security problem, Authentication, One-time passwords, Program threats, System threats, Threat monitoring, Encryption, Computer-security classification.

Distributed Systems: Types of Distributed Operating System, Communication Protocols, Distributed File Systems, Naming and Transparency, Remote File Access, State full Versus Stateless Service, File Replication.

Case Studies: Study of a representative Operating Systems.

System Programming: Introduction to System Programming and Linux / Unix, Shell Programming, C Language for System Programming, Make and Make files, Process and Signals, Threads, Inter process Communications, X- Window Programming, Principle of single and multi user operating systems.

Course Learning Outcomes (CLOs):

CLO 1	Analyze and design solutions to common operating system problems using appropriate techniques and tools.
CLO 2	Apply knowledge of process and memory management to optimize system performance and ensure efficient resource allocation.
CLO 3	Evaluate security risks and implement appropriate protection mechanisms in an operating system environment.
CLO 4	Develop system-level software using programming languages and tools commonly used in system programming.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	**PLO1**	**PL02**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**
CLO 1	**3**											**1**
CLO 2	**3**				**2**				**3**		**1**	

CLO 3	**3**			**2**			**2**				**1**	**1**
CLO 4	**3**								**3**			

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, P
CLO2	CL, T, OR, GD, PrbL, PjrL	A, P
CLO3	CL, T, OR, PrbL, PjrL	A, P
CLO4	GD, PrbL, PrjL, BL	V, Pj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to Operating Systems	Lecture and discussion	Quiz	CLO1
2	Fundamentals of OS	Lecture and group activity	Group presentation	CLO1
3	Process Management	Lecture and hands-on exercises	Programming assignment	CLO1, CLO2
4	Concurrency Control	Lecture and case study	Report Writing	CLO2
5	Memory Management	Lecture and simulation	Report Writing	CLO2
6	Storage Management	Lecture and group discussion	Assignment	CLO2
7	File Concept	Lecture and group discussion	Group presentation	CLO2
8	Protection & Security	Lecture and case study	Report Writing	CLO3
9	Distributed Systems	Lecture and group activity	Group project	CLO1, CLO4

	10	Case Studies	Lecture and group discussion	Group presentation	CLO1, CLO4
	11	Introduction to Linux/Unix	Lecture and hands-on exercises	Programming assignment	CLO1, CLO4
	12	System Programming - Shell Programming	Lecture	Programming assignment	CLO4
	13	System Programming - C Language for System Programming	Lecture and hands-on exercises	Programming assignment	CLO4
	14	System Programming - Process and Signals, Threads, Interprocess Communications, X-Window Programming, and Principles of Single and Multi-User Operating Systems	Lecture and hands-on exercises	Presentation and Assignment	CLO3, CLO4
Text Books	1. Operating System Concepts by Silberschatz & Galvin Wiley 2000 (7th Edition) 2. Operating Systems by Achyut S. Godbole Tata Mc Graw Hill (2nd Edition)				

Course Title:	Operating System and System Programming Lab
Credits:	1.5
Course No.:	SWE 0613-2234
Credit Hours:	3 hours/week
Rationale:	The goal of this course is to have students understand and appreciate the principles in the design and implementation of some of the features on operating systems software.
Objectives:	The objective of this course is, ● Acquaint students with UNIX system calls for process management ● To facilitate necessary knowledge about inter-process communication; ● Help them conceptualize basic theories in CPU scheduling for processes. ● Make the students understand Process Synchronization techniques using Critical section. ● Help the students to apply the knowledge of Multi -Threading and Thread Synchronization. ● Acquaint students with the knowledge of network operating system tasks through simulation/implementation. ● Foster the analytical and critical capability of the students by experimenting on different operating systems.
Course Contents:	**Thread programming:** Creating thread and thread synchronization.

	Process Programming: The Process ID, running a New Process, terminating a Process, Waiting for Terminated Child Processes, Users and Groups, Sessions and Process Groups. **Concurrent Programming:** Using fork, exec for multi-task programs. **File Operations:** File sharing across processes, System lock table, Permission and file locking, Mapping Files into Memory, Synchronized, Synchronous, and Asynchronous Operations, I/O Schedulers and I/O Performance. **Communicating across processes:** Using different signals, Pipes, Message queue, Semaphore, Semaphore arithmetic and Shared memory.
Course Learning Outcomes (CLOs):	

CLO 1	Apply the concepts and techniques of operating system management through hands-on lab exercises.
CLO 2	Develop skills in programming and system administration tools used for operating system management.
CLO 3	Analyze and troubleshoot common problems and issues that arise in operating system management.
CLO 4	Demonstrate proficiency in using system programming and Linux/Unix tools to manage operating systems

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3										1	2
CLO 2	3	3		3				1			2	2
CLO 3	3	3		2		1			2		2	1
CLO 4	3										1	1

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

	(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)
Course Plan	

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to the lab environment and Linux/Unix basics	Hands-on lab exercises and demonstrations	Lab exercise submission and grading	CLO1
2	Process management in Linux/Unix	Hands-on lab exercises and programming assignments	Programming assignments and lab exercise submission	CLO2, CLO3, CLO4
3	Process scheduling and synchronization	Hands-on lab exercises and programming assignments	Programming assignments and lab exercise submission	CLO1, CLO2, CLO3, CLO4
4	Memory management and virtual memory	Hands-on lab exercises and programming assignments	Programming assignments and lab exercise submission	CLO2, CLO3, CLO4
5	File systems and storage management	Hands-on lab exercises and programming assignments	Programming assignments and lab exercise submission	CLO2, CLO3, CLO4
6	Input/output management and device drivers	Hands-on lab exercises and programming assignments	Programming assignments and lab exercise submission	CLO2, CLO3, CLO4
7	Introduction to shell scripting and system administration	Hands-on lab exercises and programming assignments	Programming assignments and lab exercise submission	CLO2, CLO3, CLO4

		8	Networking and network programming in Linux/Unix	Hands-on lab exercises and programming assignments	Programming assignments and lab exercise submission	CLO2, CLO3, CLO4
		9	Distributed systems and remote access	Hands-on lab exercises and programming assignments	Programming assignments and lab exercise submission	CLO2, CLO3, CLO4
		10	Security and user management in Linux/Unix	Hands-on lab exercises and programming assignments	Programming assignments and lab exercise submission	CLO2, CLO3, CLO4
		11	Linux/Unix system calls and libraries	Hands-on lab exercises and programming assignments	Programming assignments and lab exercise submission	CLO2, CLO3, CLO4
		12	Advanced system programming and scripting	Hands-on lab exercises and programming assignments	Programming assignments and lab exercise submission	CLO2, CLO3, CLO4
		13	Introduction to X-Window programming	Hands-on lab exercises and programming assignments	Programming assignments and lab exercise submission	CLO2, CLO3, CLO4
		14	Final project and review	Independent lab work and project presentations	Project submission and presentation grading	CLO1, CLO2, CLO3, CLO4
Text Books	1. The 'C' Odyssey UNIX-The Open, Boundless C by Meeta Gandhi, Tilak Shetty, Rajiv Shah. 2. Beginning Linux Programming by Neil Matthew and Richard Stones 3. Linux System Programming by Robert Love					

Course Title:	Ethics and cyber law
Credits:	2.0
Course No.:	SWE 0488-2235
Credit Hours:	2 hours/week
Rationale:	This course consists of a sustained study of ethical and legal issues that arise in relation to employment in the public and private sectors, including allocation of resources, corporate and social responsibility, relationships, and discrimination. A main focus of this course will be on the ethical and legal standards governing information technology. New technology creates ethical challenges for individuals around the globe, and applies to most persons regardless of whether they are employed in the information technology field or a more traditional occupation. The study of Cyber Ethics provides a framework for making ethical decisions that professionals are likely to encounter in the workplace. This course will not only focus on ethics but on the legal, economic, social, cultural and global impacts of decisions that are made in the context of professional occupations.
Objectives:	● To facilitate necessary knowledge about ethics and boundaries of morality and technology. ● Helping the students to conceptualize basic theories about different rules for legal bindings. ● Acquaint students with the basic tools to understand, explore, and acquire a critical understanding of cyber law. ● To Accumulate basic ideas about developing ability for dealing with frauds and deceptions (confidence tricks, scams)
Course Contents:	Ethics: Introduction. Meta Ethics: Objectivism and Relativism, Non-naturalism, Cognitivism and Non-Cognitivism, The epistemic problem for cognitivism, Moral relativism., Cross-cultural differences and similarities, Different Psychological Issues in Meta ethics: Egoism and Altruism, Emotion and Reason, Male and Female morality. Normative Ethics: Goodness, Rightness, Consequentialism, Utilitarianism. Applied Ethics: Business Ethics, Environmental Ethics and Social Ethics, Computer and Information Ethics. Developing ethical analysis skills and professional values. Cyber Law: Module I: Introduction: Computers, Internet and their Impacts in Society; Need for Cyber Law in Social and International Perspectives; Overview of Cyber Law, Cyberspace Building blocks of CyberSpace; Cyber Jurisprudence at International and National Level Jurisdictional Aspects in Cyber Law. Module II: Cyber Crimes & Legal Framework: Cyber Crimes against Individuals, Institution and State; Hacking; Digital Forgery; Cyber Stalking/Harassment; Cyber Pornography; Identity Theft & Fraud; Cyber terrorism; Cyber Defamation; Different offenses under ICT Act, 2006. Module III: Intellectual Property Issues in CyberSpace: Interface with Copyright Law; Interface with Patent Law; Trademarks & Domain Names Related issues.

	Module IV: E Commerce: Concept; E-commerce-Salient Features; Online approaches like B2B, B2C & C2C; Online contracts; Click Wrap Contracts; Applicability of Contract Act, 1872. Module V: Cyber Tribunal: Establishment of Cyber Tribunal, Trial Procedure of Cyber Tribunal, Bail Rules, Time Limit, Power of Investigation etc.; Cyber Appellate Tribunal: Establishment of Cyber Appellate Tribunal, Procedure and Power Cyber Appellate Tribunal, Appeal Procedure in case of not establishing Cyber Appellate Tribunal.
Course Learning Outcomes (CLOs):	

CLO 1	Evaluate ethical issues related to computer technology and information systems.
CLO 2	Analyze the legal framework for cyber crimes and intellectual property issues in cyberspace.
CLO 3	Apply ethical and legal principles to real-world situations in the use of computer technology and information systems.
CLO 4	Develop critical thinking skills to address ethical dilemmas and legal issues related to cyberspace.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	2								1			
CLO 2	2	1				1		1			1	
CLO 3	1	1	1	1			1					1
CLO 4	1											1

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, P
CLO2	CL, T, OR, GD, PrbL, PjrL	A, P
CLO3	CL, T, OR, PrbL, PjrL	A, P, Prj
CLO4	GD, PrbL, PrjL, BL	V, P

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to the course and the field of ethics; Meta ethics: Objectivism and Relativism	Lecture, Group Discussion	Written Assignment	CLO1
2	Non-naturalism, Cognitivism and Non-Cognitivism, The epistemic problem for cognitivism	Lecture, Group Discussion	Quiz	CLO1
3	Moral relativism, Cross-cultural differences and similarities	Lecture, Group Discussion	Written Assignment	CLO1
4	Different Psychological Issues in Meta ethics: Egoism and Altruism, Emotion and Reason, Male and Female morality	Lecture, Group Discussion	Quiz	CLO1
5	Normative Ethics: Goodness, Rightness, Consequentialism, Utilitarianism	Lecture, Group Discussion	Written Assignment	CLO1
6	Applied Ethics: Business Ethics	Lecture, Case Study Analysis	Group Presentation	CLO3
7	Applied Ethics: Environmental Ethics and Social Ethics	Lecture, Case Study Analysis	Group Presentation	CLO3
8	Applied Ethics: Computer and Information Ethics	Lecture, Case Study Analysis	Written Assignment	CLO3
9	Cyber Law: Introduction: Computers, Internet and their Impacts in Society; Need for Cyber Law in Social and International Perspectives; Overview of Cyber Law, Cyberspace Building blocks of CyberSpace; Cyber Jurisprudence at	Lecture, Group Discussion	Quiz	CLO2, CLO3, CLO4

	International and National Level			
10	Jurisdictional Aspects in Cyber Law	Lecture, Group Discussion	Written Assignment	CLO2
11	Cyber Crimes & Legal Framework: Cyber Crimes against Individuals, Institution and State; Hacking; Digital Forgery; Cyber Stalking/Harassment; Cyber Pornography; Identity Theft & Fraud; Cyber terrorism; Cyber Defamation; Different offenses under ICT Act, 2006.	Lecture, Case Study Analysis	Group Presentation	CLO2
12	Intellectual Property Issues in CyberSpace: Interface with Copyright Law; Interface with Patent Law; Trademarks & Domain Names Related issues.	Lecture, Group Discussion	Written Assignment	CLO2
13	E Commerce: Concept; E-commerce-Salient Features; Online approaches like B2B, B2C & C2C; Online contracts; Click Wrap Contracts; Applicability of Contract Act, 1872.	Lecture, Case Study Analysis	Group Presentation	CLO2, CLO3, CLO4
14	Cyber Tribunal: Establishment of Cyber Tribunal, Trial Procedure of Cyber Tribunal, Bail Rules, Time Limit, Power of Investigation etc.; Cyber Appellate Tribunal: Establishment of Cyber Appellate Tribunal, Procedure and Power Cyber Appellate Tribunal.	Lecture, Case Study Analysis	Group Presentation	CLO2, CLO3, CLO4

Course Title:	MANAGEMENT INFORMATION SYSTEMS
Credits:	2.0
Course No.:	SWE 0688-2237
Credit Hours:	2 hours/week
Rationale:	Students need to have the idea about how information can be used to make business value and how to use information to run business successfully. This course will help the students with this.
Objectives:	● To help students understand information system concept ● Familiarize students with the approaches of MIS development. ● Develop ability to use information tools to produce business value.
Course Contents:	Introduction to MIS: Management Information System Concept. Definitions, Role of MIS, Approaches of MIS development. MIS and Computer: Computer Hardware for Information System, Computer Software for Information System, Data Communication System, Database Management Technology, Client-Server Technology. Decision-Support System: Introduction, Evolution of DSS, Future development of DSS. Application of MIS: Applications in manufacturing Sector, Applications in service sector, Case Studies.
Course Learning Outcomes (CLOs):	**CLO 1** Apply MIS concepts and approaches to real-world business problems. **CLO 2** Analyze the role of computer hardware and software in an MIS. **CLO 3** Evaluate the potential benefits and limitations of decision-support systems. **CLO 4** Assess the use of MIS in different sectors, including manufacturing and service industries.
Mapping of CLOs with Program Learning Outcomes (PLOs):	**Mapping of Course Learning Outcomes to Program Learning Outcomes**

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	2				1				1			
CLO 2	2			2				1				1
CLO 3	1		2			1	1			1	1	
CLO 4	1	1										

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and	

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, P
CLO2	CL, T, OR, GD, PrbL, PjrL	A, P

Assessment Strategy:

CLO3	CL, T, OR, PrbL, PjrL	A, P
CLO4	GD, PrbL, PrjL, BL	V, P

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to MIS and its Role	Lecture, Class Discussion, Case studies	Quiz and Group Discussion	CLO1
2	Approaches of MIS Development	Lecture, Class Discussion, Case studies	Quiz and Group Discussion	CLO1
3	MIS and Computer	Lecture, Class Discussion, Case studies	Quiz and Presentation	CLO1
4	Data Communication System and Database Management Technology	Lecture, Class Discussion, Case studies	Quiz and Presentation	CLO2
5	Client-Server Technology	Lecture, Class Discussion, Case studies	Quiz and Presentation	CLO1, CLO2
6	Introduction to Decision-Support System (DSS)	Lecture, Class Discussion, Case studies	Quiz and Presentation	CLO1
7	Evolution of DSS	Lecture, Class Discussion, Case studies	Quiz and Presentation	CLO2
8	Future Development of DSS	Lecture, Class Discussion, Case studies	Quiz and Presentation	CLO1
9	Applications of MIS in Manufacturing Sector	Lecture, Class Discussion, Case studies	Quiz and Presentation	CLO2, CLO3
10	Applications of MIS in Service Sector	Lecture, Class Discussion, Case studies	Quiz and Presentation	CLO2

	11	Case Studies on MIS	Lecture, Class Discussion, Case studies	Quiz and Presentation	CLO2
	12	Challenges of MIS Implementation	Lecture, Class Discussion, Case studies	Quiz and Presentation	CLO2
	13	MIS Implementation Strategies	Lecture, Class Discussion, Case studies	Quiz and Presentation	CLO2
	14	Review and Final Exam	Lecture, Class Discussion, Case studies	Final Exam	CLO1, CLO2, CLO3, CLO4
Text Books	Management Information Systems by Kenneth C. Laudon, Carol Guercio Traver				

Course Title:	PROJECT WORK II
Credits:	2.0
Course No.:	SWE 0610-2250
Credit Hours:	4 hours/week
Rationale:	Students need to develop the intuition of using the knowledge that they are learning in theoretical courses to solve real life complex problems. This course offers the students the opportunity to develop their skill to use the knowledge of the previous learned core courses like Structured Programming Language, Data Structures.
Objectives:	● Help the students to apply their knowledge in solving real life projects ● Facilitate the students to enhance their problem solving capability. ● Help the students to learn team building capabilities ● Acquaint students with the basic web and mobile application development tools and technologies to enhance their development capabilities.
Course Contents:	Project focusing on an Object oriented programming approach and using a standard algorithm is preferable. Every project should maintain a goal so that it can be used as a useful tool in the IT fields. Also innovative project ideas that require different types of scripting/programming languages or programming tools can be accepted with respect to the consent of the corresponding project supervisor.
Course Learning Outcomes (CLOs):	**CLO 1** | Develop an innovative project idea using object-oriented programming approach and a standard algorithm that addresses a real-world problem in the IT field.

CLO 2	Apply project management principles, tools, and techniques to plan, execute, monitor, and control project activities, resources, and deliverables.
CLO 3	Evaluate the effectiveness and efficiency of the project solution in terms of meeting the project goals, user requirements, and technical specifications.
CLO 4	Demonstrate effective communication, collaboration, and teamwork skills in presenting project progress, outcomes, and recommendations to stakeholders.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3	3	2	2							2	
CLO 2	3	2	2	2	2					1		2
CLO 3	3					2	1			1		2
CLO 4	3							1	1		2	

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Course Introduction, Object Oriented Programming (OOP) Concepts, and Standard Algorithm	Lecture, Discussion, and Demonstration	Quiz and Class Participation	CLO1
2	Project Selection, Requirements	Lecture, Discussion, and	Project Proposal and Presentation	CLO1, CLO2

	Gathering, and Analysis	Case Study Analysis		
3	Project Planning and Design	Lecture, Discussion, and Demonstration	Project Plan and Design Document	CLO2, CLO3
4	Project Implementation: Coding and Debugging	Lecture, Discussion, and Hands-on Programming	Code Review and Testing	CLO2, CLO3
5	Testing and Integration	Lecture, Discussion, and Hands-on Programming	Testing and Integration	CLO1, CLO2, CLO4
6	Documentation and Maintenance	Lecture, Discussion, and Hands-on Programming	Documentation and Maintenance Plan	CLO1, CLO2, CLO3
7	Project Presentation and Demonstration	Presentation and Demonstration	Presentation and Demonstration	CLO2, CLO3, CLO4
8-14	Project Refinement and Enhancement	Lecture, Discussion, and Hands-on Programming	Code Review and Testing	CLO1, CLO2, CLO3, CLO4

Third Year

Third Year First Semester

Course Title:	Software Architecture and Design Patterns
Credits:	3
Course No.:	SWE 0613-3121
Credit Hours:	3 hours/week
Rationale:	Software Engineering is about the discipline needed to develop high quality software that can be understood, maintained and adapted over long periods of time by many different people. 'Quality' is a key word here. An understanding of what software quality really means is central to understanding what software engineering is all about. The course attempts to foster an understanding of software quality: what it is, and how to achieve it. This can be done through the use of a team project running throughout the course, in which teams trade software modules with one another. By attempting to understand, assess, and modify one another's programs, students will gain insight into the nature of software quality, and why an ability to program is not sufficient for the construction of high quality software.
Objectives:	**Objectives:** ● To give students an insight about common software engineering processes and well-known practices. ● To teach students the impact of requirement engineering and the proper way to do that. ● To provide students with knowledge about basic design principles and how those principles can be utilized to make more modular and scalable programs. ● To help students develop skills that will enable them to construct software of high quality – software that is reliable, and that is reasonably easy to understand, modify and maintain. ● To teach students basic software measurement concepts and how to allocate resources from the perspective of a software manager or team lead. ● Help them conceptualize basic theories in Software Testing to properly test their software and modern software verification and validation practices.
Course Contents:	**Introduction:** Introduction to Software Engineering, Software Development Process and Various Life Cycle Models. **Requirement Analysis:** Communication Techniques, Analysis Principles, Software Prototyping, Requirement Specification. **Analysis Modeling:** Steps of system analysis, Feasibility study, Economic and technical analysis, System specification, the elements of analysis model, Data modeling, Functional modeling and information flow, Behavioral modeling, Mechanics of structured analysis, Data Dictionary. **Software Design:** Design principles, Design Concepts, effective modular design, design heuristics, Data Design, Architectural Design process, Transformation mapping, Transaction mapping, interface design, human-computer interface design, procedural design. **Software Testing:** Testing fundamentals, test case design, white-box testing, black-box testing, testing GUIs, Unit testing, Integration testing, validation testing, system testing, debugging.

Maintenance: Major maintenance activities, estimating maintenance cost and productivity.

Technical Metrics for Software: Software quality, Framework for technical metrics, metrics for analysis and design models, source code, testing and maintenance.

Software Architecture: Pipe and Filter, Object Oriented, Event Based, Layered System, Data-centered repository, Process Control Architectures.

Software Project Management: Cost estimation, risk analysis, project scheduling.

Design Patterns: Introduction to design patterns. Different Patterns: Strategy, Observer, Factory, Singleton, Command, Adapter, Facade, Template Method, Iterator, Composite, State, Proxy, Compound Patterns.

Formal Methods: Formal Methods in Software Engineering: its need and application, Formal specifications, Formal Verifications, Introduction to Z Language, Formal methods and testing.

Course Learning Outcomes (CLOs):

After the successful completion of the course, the student will be able to-

CLO 1	Ability to implement design patterns: Students will be able to implement design patterns in a programming language, such as Java or any other oop language, and understand the benefits of using these patterns.
CLO 2	Ability to implement software architecture: Students will be able to implement software architecture using design patterns and understand the importance of keeping the architecture flexible, maintainable, and scalable.
CLO 3	Knowledge of best practices in software design and architecture: Students will gain an understanding of the best practices in software design and architecture, including the importance of software documentation and testing.
CLO 4	Ability to apply concepts in real-world scenarios: Students will be able to apply the concepts learned in the course to real-world software development projects and reflect on the strengths and weaknesses of their implementation.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3		3		2							
CLO 2	3	3	3									
CLO 3	3										2	
CLO 4	3	3	3	3		3	1	1	1	1		3

Mapping Course Learning Outcomes (CLOs) with

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrjL	A, LE

the Teaching-Learning and Assessment Strategy:	

CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Software Engineering and Software Development Process.** **Topics covered: Overview of software engineering, software development life cycle models.**	CL, T, OR, GD, PrbL	A, LE, PP	CLO1, CLO2, CLO3, CLO4
2	**Communication Techniques and Requirement Analysis Principles.** **Topics covered: Communication techniques, requirement analysis principles, software prototyping.**	CL, T, OR, GD, PrbL	A, LE, PP	CLO1, CLO2, CLO3, CLO4
3-4	**System Analysis and Feasibility Study.** **Topics covered: System analysis, feasibility study, economic and technical analysis, system specification.**	CL, T, OR, GD, PrbL	A, LE, PP	CLO1, CLO2, CLO3, CLO4
5-6	**Data Modeling and Functional Modeling** **Topics covered: Data modeling, functional modeling and information flow,**	CL, T, OR, PrbL, PjrL	A, PP, P	CLO1, CLO3, CLO4

		behavioral modeling, structured analysis.			
	7-8	**Software Design.** **Topics covered: Design principles, design concepts, effective modular design, design heuristics, data design.**	CL, T, OR, PrbL	A, PP	CLO1, CLO2, CLO4
	9-10	**Software Testing.** **Topics covered: Testing fundamentals, test case design, white-box testing, black-box testing, GUI testing**	GD, PrbL, PrjL, BL	A, V, P, RW, Prj	CLO1, CLO2, CLO3, CLO4
	11-12	**Maintenance and Technical Metrics for Software.** **Topics covered: Major maintenance activities, estimating maintenance cost and productivity, technical metrics for software quality.**	GD, PrbL, PrjL, BL	A, V, P, RW, Prj	CLO3, CLO4
	13-14	**Software Architecture and Design Patterns.** **Topics covered: Software architecture, design patterns, including strategy, observer, factory, singleton, and command.**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	A, V, P, RW, Prj	CLO2, CLO3, CLO4
	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)				
Text books	1. Software Engineering: A Practitioner's Approach- Roger S. Pressman. 2. Head First Design Patterns, Eric & Elisabeth Freeman, O'REILLY. 3.				

Course Title:	Software Architecture and Design Patterns Lab
Credits:	1.5
Course No.:	SWE 0613-3122
Credit Hours:	3 hours/week
Rationale:	Software Engineering is about the discipline needed to develop high quality software that can be understood, maintained and adapted over long periods of time by many different people. 'Quality' is a key word here. An understanding of what software quality really means is central to understanding what software engineering is all about. The course attempts to foster an understanding of software quality: what it is, and how to achieve it. This can be done through the use of a team project running throughout the course, in which teams trade software modules with one another. By attempting to understand, assess, and modify one another's programs, students will gain insight into the nature of software quality, and why an ability to program is not sufficient for the construction of high quality software.
Objectives:	● To give students hands-on training on basic design principles and how those principles can be utilized to make more modular and scalable programs. ● To familiarize students with basic software engineering diagrams like (class diagram, state diagram, use-case diagrams, etc.) and how these diagrams can be used to describe a software from different viewpoints. ● To help students develop the ability of significant teamwork and project based experience ● To develop skills that will enable the students to construct software of high quality – software that is reliable, and that is reasonably easy to understand, modify and maintain
Course Contents:	Software Engineering lab work is solely designed to attain hands-on experience of architectural design, documentation and testing of software so that students can develop the software following the documents only. Also this lab includes Introduction to UML, Introduction to CASE Tools and Introduction to MVC Pattern. **Step1 (Requirement Engineering)**: Choose a company/institute/client for which software will be developed (make sure that they will provide required information whenever necessary). Follow the steps for eliciting requirements and generate use-case diagrams. Also analyze the sufficiency of the requirement engineering outcome for steps to follow. **Step 2 (Analysis model to Architectural and Component level design)**: Generate Activity diagram, Data flow diagram(DFD), Class diagram, State diagram, Sequence diagram and follow other relevant steps for creating complete architectural and component level design of the target software. **Step 3 (User Interface design, Design evaluation, Testing strategies and Testing Tactics)**: Perform the user interface design with the help of a swim lane diagram. Carry out the design evaluation steps. Generate all test cases for complete checking of the software using black box, white box testing concept. **Step 4 Software testing and debugging** **Step 5 (Managing Software Projects)**: Analyze the estimation and project schedule.

Course Learning Outcomes (CLOs):

After the successful completion of the course, the student will be able to-

CLO 1	Hands-on experience with design patterns: Students will gain hands-on experience implementing design patterns in a programming language, such as Java or Python, and understand the benefits of using these patterns.
CLO 2	Ability to implement software architecture: Students will be able to implement software architecture using design patterns and understand the importance of keeping the architecture flexible, maintainable, and scalable.
CLO 3	Ability to apply concepts in real-world scenarios: Students will be able to apply the concepts learned in the course to real-world software development projects and reflect on the strengths and weaknesses of their implementation.
CLO 4	Collaboration and teamwork skills: Students will have the opportunity to work in teams to complete lab assignments, providing them with the opportunity to develop collaboration and teamwork skills

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	**PLO1**	**PL02**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO 12**
CLO 1	**3**	**3**	**3**		**3**			**1**		**2**		
CLO 2	**3**	**3**	**3**					**1**				
CLO 3	**3**	**3**	**3**	**3**	**3**	**2**		**1**				
CLO 4	**3**	**3**	**3**	**3**		**2**	**3**	**2**	**3**	**3**	**2**	**3**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	CL, T, OR, GD	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	**Topic**	**Teaching Learning Strategy**	**Assessment Strategy**	**CLOs**

		1-2	**Overview of software engineering, requirement analysis principles, software prototyping.** **Lab activities: Installing software development tools, requirements gathering and analysis for a sample project.**	CL, T, OR, GD, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4	
		3-4	**System analysis, feasibility study, economic and technical analysis, system specification, data modeling, functional modeling and information flow.** **Lab activities: Implementing data and functional modeling using a modeling tool, applying structured analysis techniques.**	CL, T, OR, GD, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4	
		5-6	**Design principles, design concepts, effective modular design, design heuristics, data design.** **Lab activities: Designing software architecture, implementing the design in a programming language.**	CL, T, OR, GD, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4	
		7-8	**Testing fundamentals, test case design, white-box testing, black-box testing, GUI testing.** **Lab activities: Writing test cases, implementing and executing tests, debugging.**	CL, T, OR, PrbL, PjrL	Lab Report, Hands-on exercises	CLO1, CLO3, CLO4	

	9-10	**Major maintenance activities, estimating maintenance cost and productivity, technical metrics for software quality** **Lab activities: Maintenance and refactoring of a sample software project, applying technical metrics.**	CL, T, OR, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO4
	11-12	**Software architecture, design patterns, including strategy, observer, factory, singleton, and command.** **Lab activities: Implementing design patterns in a programming language, applying software architecture principles.**	GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
	13-14	**Final Project: Integrating the concepts and techniques learned throughout the course.** **Developing a software project, applying all the techniques learned in the course.**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	Final Project Report, Presentation	CLO2, CLO3, CLO4
	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)				
Text Books	1. Software Engineering: A Practitioner's Approach- Roger S. Pressman. 2. Head First Design Patterns, Eric & Elisabeth Freeman, O'REILLY.				

Course Title:	Artificial Intelligence
Credits:	3.0
Course No.:	SWE 0619-3123
Credit Hours:	3 hours/week
Rationale:	Web search, speech recognition, face recognition, machine translation, autonomous driving, and automatic scheduling; these are all complex real-world problems, and the goal of artificial intelligence (AI) is to tackle these with rigorous tools. This course will help students to learn the foundational principles that drive these applications and practice implementing these systems. The main goal of the course is to equip students with the tools to tackle new AI problems they might encounter in life. This course will make students able to build applied systems and to account for intelligence from a computational point of view by introducing representations, techniques, and architectures used.
Objectives:	● To provide the most fundamental knowledge to the students so that they can understand what AI is. ● To teach theoretic proofs and formal notations of AI. ● To introduces students to the basic knowledge representation, problem solving, and learning methods of artificial intelligence ● To facilitate the students in developing intelligent systems by assembling solutions to concrete computational problems. ● To make the students understand the role of knowledge representation, problem solving, and learning in intelligent-system engineering, and appreciate the role of problem solving. ● To help the students to explore applications of rule chaining, heuristic search, logic, constraint propagation, constrained search, and other problem-solving paradigms.
Course Contents:	**What is Artificial Intelligence:** The AI problems, The underlying assumption, What is an AI technique. **Problems, Problem spaces and Search:** Defining the problem as a state space search, Production system, Problem characteristics. **Heuristics Search Techniques:** Generate and Test, Hill climbing, Best First Search, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis. **Knowledge Representation Issues:** Representation and Mappings, Approaches to knowledge Representation, Issues in Knowledge representation. **Using Predicate logic:** Representing simple facts in logic, Representing Instance and Isa relationships, Computable functions and Predicates, Resolution. **Representing Knowledge using Rules:** Procedural versus Declarative Knowledge, Logic Programming, Forward versus Backward Reasoning, Matching. **Game playing:** Overview, The Mimimax Search Procedure, Adding Alpha-Beta cutoffs, Additional refinements, iterative Deepening. **Planning:** Overview, An example Domain: The Blocks World, Components of a planning system, Goal stack planning. **Understanding:** What is Understanding, What makes Understanding hard, Understanding as constraint satisfaction.

	N**atural Language Processing:** Introduction, Syntactic Processing, Semantic Analysis, Discourse and Pragmatic Processing. **Expert systems:** representing and using domain knowledge, Expert system shells explanation, Knowledge Acquisition.
Course Learning Outcomes (CLOs):	

CLO 1	Apply AI techniques to solve real-world problems.
CLO 2	Analyze and compare different search algorithms for various AI problems.
CLO 3	Evaluate the suitability of different knowledge representation techniques for different problem domains.
CLO 4	Critically assess the challenges and limitations of natural language processing and expert systems.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	**PLO1**	**PL02**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**
CLO 1	**2**			**2**			**2**					**1**
CLO 2	**3**	**2**							**2**	**1**	**1**	
CLO 3	**2**		**1**		**2**	**2**					**1**	
CLO 4	**2**							**2**				**1**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	CL, T, OR, GD	A, P
CLO2	CL, T, OR, GD, PrbL, PjrL	A, P
CLO3	CL, T, OR, PrbL, PjrL	A, P
CLO4	GD, PrbL, PrjL, BL	A, V, P

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	**Topic**	**Teaching Learning Strategy**	**Assessment Strategy**	**CLOs**

		1	Introduction to Artificial Intelligence and AI Problems	Lecture, Presentation, Discussion	Quiz	CLO1
		2	Search Algorithms	Lecture, Presentation, Hands-on Practice	Assignment	CLO1,2
		3	Knowledge Representation	Lecture, Presentation, Discussion	Quiz	CLO1
		4	Predicate Logic	Lecture, Presentation, Hands-on Practice	Assignment	CLO1,2
		5	Representing Knowledge using Rules	Lecture, Presentation, Hands-on Practice	Quiz	CLO1, CLO2, CLO4
		6	Game Playing	Lecture, Presentation, Hands-on Practice	Assignment	CLO1, CLO2
		7	Planning	Lecture, Presentation, Hands-on Practice	Quiz	CLO2, CLO3, CLO4
		8	Understanding	Lecture, Presentation, Discussion	Assignment	CLO2, CLO3, CLO4
		9	Natural Language Processing	Lecture, Presentation, Hands-on Practice	Quiz	CLO2, CLO3, CLO4
		10	Expert Systems	Lecture, Presentation, Hands-on Practice	Assignment	CLO2, CLO3, CLO4
		11	Machine Learning Basics	Lecture, Presentation, Hands-on Practice	Quiz	CLO1, CLO2
		12	Supervised Learning Algorithms	Lecture, Presentation, Hands-on Practice	Assignment	CLO1, CLO2, CLO3, CLO4

	13	Unsupervised Learning Algorithms	Lecture, Presentation, Hands-on Practice	Assignment	CLO1, CLO2, CLO3, CLO4
	14	Deep Learning	Lecture, Presentation, Hands-on Practice	Assignment	CLO1, CLO2, CLO3, CLO4
Text Books	1. Artificial Intelligence : A Modern Approach by Stuart Russel. 2. The Cambridge Handbook of Artificial Intelligence by Keith Frankish, William M. Ramsey.				

Course Title:	Artificial Intelligence Lab
Credits:	1.5
Course No.:	SWE 0619-3124
Credit Hours:	3 hours/week
Rationale:	This course will help students to learn the foundational principles that drive the applications related to Artificial Intelligence and practice implementing these systems. Also this course aims to equip students with the tools to tackle new AI problems they might encounter in real-life so that they can build intelligent agent systems from a computational point of view.
Objectives:	● To help the students to understand the functionality of intelligent agents. ● To facilitate the students' knowledge of intelligent agents to solve different real-world problems. ● To provide the students with knowledge of different AI problems. ● To help the students in the development of intelligent systems by assembling different solution techniques. ● To Foster the analytical and critical ability of the students to design an expert system.
Course Contents:	Students will have to understand the functionalities of intelligent agents and how the agents will solve general problems. Students have to use a high-level language (Python, Prolog, LISP) to solve the following problems: **Backtracking:** State space, Constraint satisfaction, Branch and bound. Example: 8-queen, 8-puzzle, Crypt-arithmetic. **BFS and production:** Water jugs problem, The missionaries and cannibal problem. **Heuristic and recursion:** Tic-tac-toe, Simple block world, Goal stack planning, The tower of Hanoi. **Question answering:** The monkey and bananas problem. **Machine Learning and Deep Learning Basics**.
Course Learning Outcomes (CLOs):	**CLO 1** Develop an understanding of practical applications of artificial intelligence techniques. **CLO 2** Acquire proficiency in programming AI algorithms and tools.

CLO 3	Demonstrate the ability to implement and evaluate AI models.
CLO 4	Gain experience in solving real-world problems using AI techniques.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO 12
CLO 1	2			2			2					2
CLO 2	3	2							2	2	1	
CLO 3	2		1		2	2					2	
CLO 4	2							2				2

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, PP
CLO2	CL, T, OR, GD, PrbL, PjrL	A, PP, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, RW
CLO4	GD, PrbL, PrjL, BL	A, V, Prj, PP

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to Python programming language and AI libraries.	Lecture, Discussion, and Demonstration	Quiz and Class Participation	CLO1,2
2	Search algorithms implementation in AI.	Hands-on programming exercises	Programming assignment.	CLO2,3,4
3	Implementing heuristic search algorithms.	Hands-on programming exercises	Programming assignment.	CLO2,3,4

	4	Knowledge representation and reasoning.	Hands-on programming exercises	Programming assignment.	CLO1,2,3,4
	5	Natural Language Processing.	Hands-on programming exercises	Programming assignment.	CLO1, CLO2, CLO4
	6	Expert Systems.	Hands-on programming exercises	Programming assignment.	CLO1, CLO2
	7	Machine Learning Fundamentals.	Hands-on programming exercises	Programming assignment.	CLO2, CLO3, CLO4
	8	Supervised Learning.	Hands-on programming exercises	Programming assignment.	CLO2, CLO3, CLO4
	9	Unsupervised Learning.	Hands-on programming exercises	Programming assignment.	CLO2, CLO3, CLO4
	10	Reinforcement Learning.	Lecture, Discussion, and Case Study Analysis	Programming assignment.	CLO2, CLO3, CLO4
	11	Natural Language Processing using Deep Learning.	Lecture, Discussion, and Case Study Analysis	Programming assignment.	CLO1, CLO2
	12	Computer Vision using Deep Learning.	Lecture, Discussion, and Case Study Analysis	Programming assignment.	CLO1, CLO2, CLO3, CLO4
	13	Ethics in AI.	Lecture, Discussion, and Case Study Analysis	Programming assignment.	CLO1, CLO2, CLO3, CLO4
	14	Project work	Lecture, Discussion, and Case Study Analysis	Project report and demonstration.	CLO1, CLO2, CLO3, CLO4
Text Books	**1.** Artificial Intelligence; Elaine Rich and Kevin Knight **2.** Artificial Intelligence; Winston, Patrick Henry.				

Course Title:	Database Management System
Credits:	3.0
Course No.:	SWE 0612-3127
Credit Hours:	3 hours/week
Rationale:	The Database System course will concentrate on the principles, design, implementation and applications of database management systems. This course also helps the students to get familiarized with the existing technologies related to the database management system to develop real life products using the knowledge of SQL, PL SQL queries and functionalities.
Objectives:	● To teach the different issues involved in the design and implementation of a database system. ● To facilitate necessary knowledge about the physical and logical database designs, database modeling, relational, hierarchical and network models ● Make students understand the data manipulation language to query, update, and manage a database ● Acquaint students with the basic tool to develop an understanding of essential DBMS concepts such as: database security, integrity, concurrency, distributed database, Client/Server (Database Server), Data Warehousing. ● Help the students to design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing and implementing a DBMS.
Course Contents:	**Introduction:** Purpose of Database Systems, Data Abstraction, Data Models, Instances and Schemes, Data Independence, Data Definition Language, Data Manipulation Language, Database Manager, Database administrator, Database Users, Overall System Structure, Advantages and Disadvantage of a Database Systems. Data Mining and analysis, Database Architecture, History of Database Systems. **Relationship Entity-Model:** Entities and Entity Sets, Relationships and Relationship Sets, Attributes, Composite and Multivalued Attributes, Mapping Constraints, Keys, Entity-Relationship Diagram, Reducing of E-R Diagram to Tables, Specialization, Generalization, Attribute Inheritance, Aggregation, Alternative E-R Notations, Design of an E-R Database Scheme. **Relational Model:** Structure of Relational Database, Fundamental Relational Algebra Operations, the Tuple Relational Calculus, the Domain Relational Calculus, Modifying the Database. **Relational Commercial Language:** SQL, Basic structure of SQL Queries, Query-by-Example, Nested Sub queries, Complex queries, Integrity Constraints, Authorization, Dynamic SQL, Recursive Queries. **Relational Database Design:** Pitfalls in Relational Database Design, Functional Dependency Theory, Normalization using Functional Dependencies, Normalization using Multivalued Dependencies, Normalization using join Dependencies, Database Design Process. **File and System Structure:** Overall System Structure, Physical Storage Media, File Organization, RAID, Organization of Records into Blocks, Sequential Files, Mapping Relational Data to Files, Data Dictionary Storage, Buffer Management.

	Indexing and Hashing: Basic Concepts, Ordered Indices, B+ -Tree Index Files, B-Tree Index Files, Static and Dynamic Hash Function, Comparison of Indexing and Hashing, Index Definition in SQL, Multiple Key Access. **Concurrency Control:** Schedules, Testing for Serialize-ability, Lock-Based Protocols, Timestamp-Based Protocols, Validation Techniques, Multiple Granularity, Multi-version Schemes, Insert and Delete Operations, Deadlock Handling **Distributed Database:** Structure of Distributed Databases, Trade-off in Distributing the Database, Design of Distributed Database, Transparency and Autonomy, Distributed Query Processing, Recovery in Distributed Systems, Commit Protocols, Concurrency Control.
Course Learning Outcomes (CLOs):	**CLO 1** — Analyze the principles and techniques of database systems to design and implement efficient and reliable databases. **CLO 2** — Evaluate and compare the advantages and disadvantages of different data models and relational database design approaches. **CLO 3** — Apply normalization techniques to create well-structured databases that minimize redundancy and anomalies. **CLO 4** — Design and implement efficient indexing and hashing techniques to optimize database performance and access.
Mapping of CLOs with Program Learning Outcomes (PLOs):	**Mapping of Course Learning Outcomes to Program Learning Outcomes**

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	2			2			2					1
CLO 2	3	2							2	1	1	
CLO 3	2		1		2	2					1	
CLO 4	2							2				1

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, P
CLO2	CL, T, OR, GD, PrbL, PjrL	A, P
CLO3	CL, T, OR, PrbL, PjrL	A, P
CLO4	GD, PrbL, PrjL, BL	A, V, P

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

	(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)
Course Plan	

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to DBMS	Lecture, class discussion	Quiz, class participation	CLO1
2	Relationship Entity-Model	Lecture, case studies	Homework, class participation	CLO1,2
3	Relational Model	Lecture, problem-solving	Quiz, homework	CLO1
4	Relational Commercial Language	Lecture, hands-on practice	Quiz, class participation	CLO1,2
5	Relational Database Design	Lecture, case studies	Homework, class participation	CLO1, CLO2, CLO4
6	File and System Structure	Lecture, problem-solving	Quiz, homework	CLO1, CLO2
7	Indexing and Hashing	Lecture, hands-on practice	Quiz, class participation	CLO2, CLO3, CLO4
8	Concurrency Control	Lecture, case studies	Homework, class participation	CLO2, CLO3, CLO4
9	Distributed Database	Lecture, problem-solving	Quiz, homework	CLO2, CLO3, CLO4
10	Data Mining and Analysis	Lecture, hands-on practice	Quiz, class participation	CLO2, CLO3, CLO4
11	Database Architecture	Lecture, case studies	Homework, class participation	CLO1, CLO2
12	Relational Algebra Operations	Lecture, problem-solving	Quiz, homework	CLO1, CLO2, CLO3, CLO4
13	Authorization and Recovery	Lecture, hands-on practice	Quiz, class participation	CLO1, CLO2, CLO3, CLO4
14	Database Design Process	Lecture, case studies	Homework, class participation	CLO1, CLO2, CLO3, CLO4

Text Books	1. Database System Concepts – Abraham Silberschratz, Henry K. Korth, S. Sudarshan (5th edition)

	2. Fundamentals of Database Systems - Benjamin/Cummings, 1994 3. Database Principles, Programming, Performance - Morgan Kaufmann 1994 4. A First Course in Database Systems - Prentice Hall, 1997 5. Database Management Systems, McGraw Hill, 1996

Course Title:	Database Management System Lab
Credits:	2.0
Course No.:	SWE 0612-3128
Credit Hours:	4 hours/week
Rationale:	Database System LAB course will concentrate on the design and implementation of a database system and applying SQL query. It will also facilitate the students to create, maintain, design and develop complex database schema and queries for developing real life projects.
Objectives:	● To help the students understand the different issues involved in the design and implementation of a database system. ● To teach the physical and logical database designs, database modeling, relational, hierarchical and network models. ● To facilitate necessary knowledge about data manipulation language to query, update, and manage a database ● To Foster the analytical and critical skill of the students to design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing and implementing a DBMS.
Course Contents:	**Introduction:** MySQL, Oracle, SQL, Data Types, SQL / PLSQL, Oracle Software Installation, User Type, Creating User , Granting. **Basic Parts of Speech in SQL:** Creating Newspaper Table, Select Command (Where, order by), Creating View, Getting Text Information & Changing it, Concatenation, Cut & paste string (RPAD, LPAD, TRIM, LTRIM, RTRIM, LOWER, UPPER, INIT, LENGTH, SUBSTR, INSTR, SOUNDEX). **Playing The Numbers:** Addition, Subtraction, Multiplication, Division, NVL, ABS, Floor, MOD, Power, SQRT, EXR, LN, LOG, ROUND, AVG, MAX, MIN, COUNT, SUM, Distinct, SUBQUERY FOR MAX,MIN. **Grouping things together:** Group By, Having, Order By, Views Renaming Columns with Aliases. **When one query depends upon another:** Union, Intersect, Minus, Not in, Not Exists. **Changing Data:** INSERT, UPDATE, MERGE, DELETE, ROLLBACK, AUTOCOMMIT, COMMIT, SAVEPOINTS,MULTI TABLE INSERT, DELETE, UPDATE, MERGE. **Creating And Altering tables & views:** Altering table, Dropping table, Creating view, Creating a table from a table. **By What Authority:** Creating User, Granting User, Password Management.

An Introduction to PL/SQL: Implement a few problems using PL/SQL (eg Prime Number, Factorial, Calculating Area of Circle, etc).

An Introduction to Trigger and Procedure: Implement few problems using Trigger and Procedures

An Introduction to Indexing: Implement indexing using a large database and observe the difference between Indexed and Non-Indexed databases.

Course Learning Outcomes (CLOs):

CLO 1	Students will be able to design and implement a database schema using SQL.
CLO 2	Students will be able to write SQL queries to retrieve data from a database.
CLO 3	Students will be able to use normalization techniques to optimize database design.
CLO 4	Students will be able to implement concurrency control and recovery mechanisms in a distributed database system.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	**PLO1**	**PL02**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**
CLO 1	**2**			**2**			**2**					**1**
CLO 2	**3**	**2**							**2**	**1**	**1**	
CLO 3	**2**		**1**		**2**	**2**					**1**	
CLO 4	**2**							**2**				**1**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	CL, T, OR, GD	A, PP
CLO2	CL, T, OR, GD, PrbL, PjrL	A, PP
CLO3	CL, T, OR, PrbL, PjrL	A, P, PP
CLO4	GD, PrbL, PrjL, BL	A, V, Prj

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Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to DBMS	Lectures, discussion, and real-world examples	Quiz	CLO1
2	Entity-Relationship Model	Lectures, group activities, and case studies	Assignment	CLO1,2
3	Relational Model and Algebra	Lectures, hands-on exercises, and problem-solving sessions	Quiz	CLO1
4	Relational Database Design	Lectures, group activities, and case studies	Assignment	CLO1,2
5	SQL	Lectures, hands-on exercises, and problem-solving sessions	Quiz	CLO1, CLO2, CLO4
6	File and System Structure	Lectures, group activities, and case studies	Assignment	CLO1, CLO2
7	Indexing and Hashing	Lectures, hands-on exercises, and problem-solving sessions	Quiz	CLO2, CLO3, CLO4
8	Concurrency Control	Lectures, group activities, and case studies	Assignment	CLO2, CLO3, CLO4
9	Distributed Database Systems	Lectures, hands-on exercises, and problem-solving sessions	Quiz	CLO2, CLO3, CLO4
10	Distributed Query Processing	Lectures, group activities, and case studies	Assignment	CLO2, CLO3, CLO4
11	Recovery and Commit Protocols	Lectures, hands-on exercises, and problem-solving sessions	Quiz	CLO1, CLO2

	12	Authorization and Security	Lectures, group activities, and case studies	Assignment	CLO1, CLO2, CLO3, CLO4
	13	Advanced Topics in DBMS	Lectures, hands-on exercises, and problem-solving sessions	Quiz	CLO1, CLO2, CLO3, CLO4
	14	Review and Exam	Review sessions and practice exams	Final Exam	CLO1, CLO2, CLO3, CLO4
Text Books	1 Database System Concepts – Abraham Silberschratz, Henry K. Korth, S. Sudarshan (5th edition) 2 Fundamentals of Database Systems - Benjamin/Cummings, 1994 3 Database Principles, Programming, Performance - Morgan Kaufmann 1994 4 A First Course in Database Systems - Prentice Hall, 1997 5 Database Management Systems, McGraw Hill, 1996				

Course Title:	Web Technologies
Credits:	2.0
Course No.:	SWE 0612-3130
Credit Hours:	4 hours/week
Rationale:	Students need to know how web applications differ from traditional software and formal methodologies to build robust web applications. This course provides the students with the knowledge necessary to build large scale web projects by ensuring all industry qualities and standards. The students will get the opportunity to use their knowledge in different web technologies and frameworks to develop web portals.
Objectives:	● To help understand the characteristics and basic concepts of web applications; ● To teach students modern technologies and concepts of web development; ● To teach students MVC design patterns and how to use modern frameworks to develop high quality web applications; ● To teach students different security risks of a Web application and how to handle them; ● To teach students how to collect requirements from clients and develop a working web application.
Course Contents:	Concepts of Web Engineering, Requirements Engineering and Modeling Web Applications, Web Application Architectures, Technologies and Tools for Web Applications, Testing and Maintenance of Web Applications, Usability and Performance of Web Applications, Security of Web Applications, The Semantic Web, design methods and technologies, interface design, usability of web applications, accessibility, testing, metrics, operation and maintenance of Web applications, security, and project management, client-side (XHTML, JavaScript, and CSS) and

server-side (Perl and PHP) architecture, Web engineering concepts behind the frameworks of Joomla, Drupal, Wordpress.

Server-side technology: LAMP, Web application frameworks (example: Silverlight, Adobe Flex), Web 2.0 and Web APIs.

Front-end technology: HTML, XHTML, XML. CSS styling, layout, selector, Document object model and JavaScript.

Client-Programming: Web APIs with JavaScript (example: Google Ajax API).

MVC: Understanding Model, view and controller Model.

Understanding Web APIs: REST, XML, JSON, RSS Parsing.

JavaScript Exercise: The goal of this assignment is to allow you to explore and use as many of JavaScript's objects, methods, and properties as possible in a small assignment. Some functions must be written from scratch. Other functions, appropriately attributed, may be downloaded from the web and used as a part of the system or as the basis for your own functions.

PHP Exercise: Build a set of PHP scripts that perform some dynamic server side functionality.

Understanding plug-ins: Develop a Firefox extension.

Course Learning Outcomes (CLOs):

CLO 1	Apply web engineering concepts and technologies to design and develop web applications.
CLO 2	Demonstrate proficiency in client-side and server-side technologies used in web development.
CLO 3	Evaluate and select appropriate web application architectures, technologies, and tools for specific project requirements.
CLO 4	Analyze and solve problems related to web application usability, performance, and security.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	2			2			2					2
CLO 2	3	2							2	3	3	2
CLO 3	2		1		2	2					3	2
CLO 4	2							2				1

Mapping Course Learning

CLOs	Teaching-Learning Strategy	Assessment Strategy

Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO1	CL, T, OR, GD	A, PP
CLO2	CL, T, OR, GD, PrbL, PjrL	A, PP
CLO3	CL, T, OR, PrbL, PjrL	A, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to Web Engineering and Web Application Architectures	Lecture and discussion	Quiz	CLO1
2	Client-Side Technologies	Lecture and practical session	Practical Test	CLO1,2
3	Server-Side Technologies	Lecture and practical session	Practical Test	CLO1
4	Web APIs and REST	Lecture and practical session	Quiz	CLO1,2
5	Web Application Frameworks	Lecture and practical session	Practical Test	CLO1, CLO2, CLO4
6	MVC Architecture	Lecture and practical session	Quiz	CLO1, CLO2
7	JavaScript Exercise	Lecture and practical session	Practical Test	CLO2, CLO3, CLO4
8	PHP Exercise	Lecture and practical session	Practical Test	CLO2, CLO3, CLO4
9	Firefox Extension Development	Lecture and practical session	Practical Test	CLO2, CLO3, CLO4
10	Testing and Maintenance of Web Applications	Lecture and discussion	Quiz	CLO2, CLO3, CLO4
11	Usability and Performance of Web Applications	Lecture and practical session	Quiz	CLO1, CLO2

	12	Security of Web Applications	Lecture and practical session	Quiz	CLO1, CLO2, CLO3, CLO4
	13	The Semantic Web	Lecture and practical session	Quiz	CLO1, CLO2, CLO3, CLO4
	14	Recap and Revision	Lecture and practical session	Final Project	CLO1, CLO2, CLO3, CLO4
Text Books	1. Web Engineering, GertiKappel, Birgit Pröll, Siegfried Reich, Werner Retschitzegger 2. Web Engineering: A Practioner's Approach, Roger Pressman, David Lowe 3. Web Engineering Advancements and Trends, Alkhatib, Ghazi I				

Course Title:	Computer Networking
Credits:	03
Course No.:	CSE 0612 – 3113W
Credit Hours:	3 hours / week
Rationale:	The aim of this course is to introduce key concepts and principles of computer networks to provide a solid understanding of the technologies that support modern networked computer systems. The course will use a top-down approach to study the Internet and its protocol stack. Instances of architecture, protocol, application - examples will include email, web and media-streaming. It will cover communications services (e.g., TCP/IP) required to support such network applications. The implementation and deployment of communications services in wired and wireless LAN environments will be followed by a discussion of issues of network-security and network-management. Throughout the course, the Internet's architecture and protocols will be used as the primary examples to illustrate the fundamental principles of computer networking.
Objectives:	● To provide basic knowledge about various network technologies and techniques ● To facilitate idea about the importance of layering, and the OSI reference model ● To provide knowledge of understanding of the design and operation of an IP network, such as the Internet, and explain the purpose and function of its various components ● To make them understand the general principles behind addressing, routing, reliable transmission and other stateful protocols as well as specific examples of each ● To make them be able to describe the issues in connecting heterogeneous networks
Course Contents:	**Introduction:** Introduction to Computer Networks, Network Goals, Applications of Networks, Network Structure, Network Architectures, The OSI Reference Model, Data Transmission in the OSI Model, OSI Terminology, The ARPANET. **Local Area Network:** LAN Technology - Architecture, Topology. **Wired LANs:** Ethernet and Fast-Ethernet, Token Ring, FDDI. **Wireless LANs:** IEEE 802.11, Bluetooth. Backbone Networks, Virtual LANs. **Wide Area Network:** SONET, Virtual Circuit Networks - Frame Relay, ATM and ATM LANs. **Network Layer:** Logical Addressing.**Internet Protocol:** Internetworking, Routing Protocol, IPv4 and IPv6. **Address Mapping, Error Reporting and Multicasting:** ICMP, IGMP, ICMv6. Delivery, Forwarding and Routing. **Transport Layer:** Process-to-Process delivery, Transport Services, Protocol mechanisms, TCP, UDP, SCTP, Congestion and QoS. **Application Layer:**

	Domain Name System, Abstract Syntax Notation One (ASN.1), Network Management - SNMPv2, Electronic mail - SMTP and MIME, Uniform Resource Locator (URL) and Universal Resource Identifier (URI), Hypertext Transfer Protocol (HTTP). **Wireless and Mobile Networking**: Wireless Networking: Issues and Trends, Wireless Physical Layer Concepts, Wireless Cellular Networks, Mobile IP - IPv4, IPv6, TCP over Wireless, Ad Hoc Networks: Issues and Routing, Wireless Sensor Networks, Wireless Mesh and Multi-Hop Relay Networks, Wireless Network Security, Energy Management in Ad Hoc Wireless Networks.
Course Learning Outcomes (CLOs):	After the successful completion of the course, the student will be able to-

CO 1	**Explain The** architecture of a computer network and **describe** how each device in a network communicates with each other
CO 2	**Identify The** basic network protocols in each layer of a TCP/IP stack and **compare** with its counterpart OSI layer
CO 3	**Compare** different LAN technologies and their basic principles
CO 4	**Explain** the use of subnetting and use the technique to divide a large network into smaller logical subnetworks
CO 5	**Analyze** routing protocols and algorithms
CO 6	**Investigate** transport layer services, multiplexing/demultiplexing and congestion control
CO 7	**Identify** and **analyze** different types of application layer protocols such as HTTP, FTP, POP3, SMTP and DNS.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	X											
CLO 2		X										
CLO 3												X
CLO 4			X			X						
CLO 5					X							
CLO 6				X								
CLO 7				X	X							X

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and

CO	Teaching Learning Strategy	Assessment Strategy
CO 1	Lectures	Class Test, Quiz, Final Exam
CO 2	Lectures, Demonstration	Class Test, Quiz, Final Exam
CO 3	Lectures, Demonstration	Class Test, Final Exam
CO 4	Lectures, Demonstration	Class Test, Assignment, Final Exam
CO 5	Lectures	Class Test, Final Exam
CO 6	Lectures, Demonstration	Class Test, Final Exam

Assessment Strategy:	
Course Plan	

Week	Topic	Teaching-Learning Strategy	Assessment Strategy	CO
1	Introduction to Computer Networks	Lecture	Quiz, Class Test, Final Exam	**CO1**
2	Network Model: TCP/IP and OSI	Lecture	Quiz, Class Test, Final Exam	**CO2**
3	LAN Technology	Lecture	Class Test, Final Exam	**CO3**
4	Network Layer: IP Addressing	Lecture	Class Test, Final Exam	**CO4**
5	Network Layer: Subnetting	Lecture	Class Test, Final Exam	
6	Internet Protocol: Routing Protocol, IPv4 and IPv6.	Lecture	Class Test, Final Exam	**CO5**
7	Network Layer: NAT	Lecture	Class Test, Final Exam	
8	Transport Layer: Multiplexing-Demultiplexing	Lecture	Class Test, Final Exam	**CO6**
9	Transport Layer: UDP	Lecture	Class Test, Final Exam	
10	Transport Layer: TCP	Lecture	Class Test, Final Exam	
11	Application Layer: the Web and HTTP, FTP	Lecture	Class Test, Final Exam	**CO7**
12	Application Layer: Email, SMTP, DNS, Socket Programming.	Lecture	Class Test, Final Exam	
13	Wireless and Mobile Networking	Lecture	Class Test, Final Exam	
14	Review class			

Text Books	1. Data Communications and Networking – Behrouz A. Forouzan 2. Computer networks – A. S. Tanenbaum, Addison-Wesley. 3. Computer Networking: a Top-down Approach – James F. Kurose, Keith W. Ross 4. Computer Networks: A Systems Approach – Peterson and Davie.

Course Title:	Computer Networking Lab
Credits:	1.5
Course No.:	CSE 0612 – 3114W

<table>
<tr><td>Credit Hours:</td><td>3 hours/week</td></tr>
<tr><td>Rationale:</td><td>The aim of this lab course is to provide practical knowledge in computer networks. Students will learn subnetting and will design a network using Packet Tracer and analyze the behavior of TCP/IP layers. The students will gain practical knowledge of configuring Switch, Router, DHCP, FTP servers.</td></tr>
<tr><td>Objectives:</td><td>● To help students designing and implementing VLSM addressing schemes in a heterogeneous computer network using Packet Tracer
● To make them capable to configure Switch, Router and other end devices
● To make them capable to configure DHCP, SMTP and FTP servers
● To make them capable to design and implement a system using socket programming</td></tr>
<tr><td>Course Contents:</td><td>Subnetting and designing a network using Packet Tracer. Analysis of the TCP/IP behavior. Exploring several aspects of different Application layer protocols such as HTTP and DNS. Packet analysis. Server configuration: DHCP, SMTP, FTP, Web Switch and Router Configuration. Socket Programming.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>After the successful completion of the course, the student will be able to-
<table><tr><td>CO 1</td><td>Design and implement a heterogeneous computer network</td></tr><tr><td>CO 2</td><td>Analyze the behavior of different Application and Transport layer protocols</td></tr><tr><td>CO 3</td><td>Configure switch, router and end devices in a network and test connectivity</td></tr><tr><td>CO 4</td><td>Analyze and implement IP addressing and subnetting of IP networks</td></tr><tr><td>CO 5</td><td>Design a system using socket programming</td></tr></table></td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td>Mapping of Course Learning Outcomes to Program Learning Outcomes
<table><tr><th>CLO /PLO</th><th>PLO1</th><th>PL02</th><th>PLO3</th><th>PLO4</th><th>PLO5</th><th>PLO6</th><th>PLO7</th><th>PLO8</th><th>PLO9</th><th>PLO10</th><th>PLO11</th><th>PLO12</th></tr><tr><td>CLO 1</td><td></td><td></td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CLO 2</td><td></td><td>X</td><td></td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CLO 3</td><td></td><td></td><td></td><td></td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CLO 4</td><td></td><td></td><td>X</td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CLO 5</td><td></td><td></td><td>X</td><td></td><td></td><td></td><td></td><td></td><td>X</td><td>X</td><td></td><td></td></tr></table></td></tr>
<tr><td>Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and</td><td><table><tr><th>CO</th><th>Teaching Learning Strategy</th><th>Assessment Strategy</th></tr><tr><td>CO 1</td><td>Practical Session</td><td>Laboratory Report, Viva</td></tr><tr><td>CO 2</td><td>Practical Session</td><td>Laboratory Report, Viva, Quiz</td></tr><tr><td>CO 3</td><td>Practical Session</td><td>Laboratory Report, Viva, Final Exam</td></tr><tr><td>CO 4</td><td>Practical Session</td><td>Laboratory Report, Viva, Final Exam</td></tr><tr><td>CO 5</td><td>Practical Session</td><td>Project Report, Presentation, Viva</td></tr></table></td></tr>
</table>

Assessment Strategy:	
Course Plan	

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CO
1	Creating a heterogeneous network	Practical Session	Laboratory Report, Viva	**CO1**
2	Introduction to Wireshark	Practical Session	Laboratory Report, Viva, Quiz	**CO2**
3	Application Layer: Exploring several aspects of HTTP using Wireshark	Practical Session	Laboratory Report, Viva, Quiz	
4	Application Layer: Exploring several aspects of DNS using Wireshark	Practical Session	Laboratory Report, Viva, Quiz	
5	Transport Layer: Exploring several aspects of UDP using Wireshark	Practical Session	Laboratory Report, Viva, Quiz	
6	Packet Tracer - Implement Basic Connectivity, Basic Switch and End Device Configuration	Practical Session	Laboratory Report, Viva, Final Exam	**CO3**
7	Packet Tracer - Configure Initial Router Settings	Practical Session	Laboratory Report, Viva, Final Exam	
8	Packet Tracer - Basic Device Configuration	Practical Session	Laboratory Report, Viva, Final Exam	
9	Packet Tracer - Subnet an IPv4 Network	Practical Session	Laboratory Report, Viva, Final Exam	**CO4**
10	Packet Tracer - Subnetting Scenario	Practical Session	Laboratory Report, Viva, Final Exam	
11	Packet Tracer - VLSM Design and Implementation Practice Topology	Practical Session	Laboratory Report, Viva, Final Exam	
12	Packet Tracer - Design and Implement a VLSM Addressing Scheme	Practical Session	Laboratory Report, Viva, Final Exam	
13	Designing a system using Socket Programming	Practical Session	Project demonstration, viva, presentation	**CO5**
14	Review Class			

Text Books	1. Data Communications and Networking – Behrouz A. Forouzan 2. Computer networks – A. S. Tanenbaum, Addison-Wesley. 3. Computer Networking: a Top-down Approach – James F. Kurose, Keith W. Ross

	4. Computer Networks: A Systems Approach – Peterson and Davie.

Third Year Second Semester

Course Title:	Distributed Systems
Credits:	2
Course No.:	SWE 0612-3225
Credit Hours:	2 hours/week
Rationale:	Distributed systems help programmers aggregate the resources of many networked computers to construct highly available and scalable services. This class teaches the abstractions, design and implementation techniques that enable the building of fast, scalable, fault-tolerant distributed systems. Topics include multithreading, network programming, consistency, fault tolerance, consensus, security, and several case studies of distributed systems.
Objectives:	**Objectives:** ● To facilitate necessary knowledge about the principles, architectures, algorithms and programming models used in distributed systems. ● Acquaint students with the basic tools to analyze state-of-the-art distributed systems, such as Google File System, Hadoop, Map-reduce. ● Help them conceptualize basic theories in designing and implementing distributed systems ● Accumulate basic ideas about abstractions, design and implementation techniques that enable understanding the characteristics of Highly Scalable, Fault Tolerant distributed systems.
Course Contents:	Distributed System Models, System Architectures & Client-Server Models, Programming Systems and Models, Processes and threads, Remote Procedure Call, High-Performance Computing, MapReduce, Many-Task Computing, Workflow Systems, Grid Computing, Cloud Computing, Virtualization, IaaS Clouds, Filesystems, Networked Filesystems, Parallel Filesystems, Distributed Filesystems, Data-Intensive Computing, Distributed Hash Tables, Consistency Models, Fault Tolerance, Many-core Computing.
Course Learning Outcomes (CLOs):	After the successful completion of the course, the student will be able to- CLO 1: Analyze the strengths and weaknesses of different distributed system architectures and identify appropriate use cases for each. CLO 2: Evaluate the performance of distributed systems and propose strategies for optimizing resource usage and minimizing latency. CLO 3: Design fault-tolerant distributed systems that can handle failures in hardware, software, and network components. CLO 4: Develop scalable and efficient algorithms for distributed computing tasks, such as MapReduce, Many-Task Computing, and Distributed Hash Tables.

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	2				3	1		3	2		1	
CLO 2	2	1		3		2				1	2	
CLO 3	2		1	1			3		2			
CLO 4	2					1		1				3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Quiz, Coding Assignment, Report Writing, Final Exam
CLO 2	Lectures, Tutorial class	Quiz, Group Discussion, Report Writing, Final Exam
CLO 3	Lectures, Tutorial class	Quiz, Coding Assignment, Report Writing, Final Exam
CLO 4	Lectures, Tutorial class	Quiz, Group Discussion, Report Writing, Final Exam

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to Distributed Systems Lecture-based introduction to the course content	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO1
2	Distributed System Models and Architecture Group discussion and analysis of distributed	Lectures, Tutorial class	Written report on an assigned distributed system model or architecture	CLO2, 3

			system models and architectures				
		3	Processes, Threads, and Remote Procedure Call Hands-on lab exercises on programming with processes, threads, and RPC	Lectures, Tutorial class	Coding assignment to develop a distributed system using RPC	CLO2	
		4	High-Performance Computing and Many-Task Computing Lecture on HPC and Many-Task Computing	Lectures, Tutorial class	Group project to design and implement an HPC or Many-Task Computing system	CLO 1, CLO2	
		5	Workflow Systems and Grid Computing Case study analysis of workflow systems and grid computing	Lectures, Tutorial class	Written analysis of a real-world workflow or grid computing system	CLO3, 1	
		6	Cloud Computing and Virtualization Lecture and lab exercises on cloud computing and virtualization	Lectures, Tutorial class	Cloud computing project to develop and deploy a scalable application	CLO1, 2, 3	
		7	IaaS Clouds and Filesystems Lecture on IaaS clouds and networked filesystems	Lectures, Tutorial class	Written report on the design and implementation of an IaaS cloud and networked filesystem	CLO4, 2	
		8	Parallel Filesystems and Distributed Filesystems Lecture on parallel and distributed filesystems	Lectures, Tutorial class	Coding assignment to implement a parallel or distributed filesystem	CLO4	

		9	Data-Intensive Computing and Distributed Hash Tables Lecture and group discussion on data-intensive computing and DHTs	Lectures, Tutorial class	Group project to design and implement a DHT-based distributed system for data-intensive computing	CLO1, 2	
		10	Consistency Models and Fault Tolerance Case study analysis of consistency models and fault tolerance	Lectures, Tutorial class	Written analysis of a real-world distributed system with fault tolerance mechanisms	CLO2, 3	
		11	Many-Core Computing and MapReduce Lecture on many-core computing and MapReduce	Lectures, Tutorial class	Coding assignment to implement a MapReduce algorithm on a many-core system	CLO1,CLO2, CLO3, CLO4	
		12	Scalable Algorithms for Distributed Computing Lecture and lab exercises on scalable algorithms for distributed computing	Lectures, Tutorial class	Coding assignment to develop a scalable algorithm for a distributed computing task	CLO4, CLO1, CLO2	
		13	Security and Privacy in Distributed Systems Lecture and group discussion on security and privacy in distributed systems	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO1,2,3,4	
		14	Review and Synthesis Review of course content and synthesis of key concepts		Final exam covering all course content	CLO2, CLO3, CLO4, CLO1	

Text books	1. Distributed Systems: Principles and Paradigms. Andrew S. Tanenbaum and Maarten Van Steen 2. Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet (DCC) by Kai Hwang, Jack Dongarra& Geoffrey C. Fox

Course Title:	Distributed Systems Lab
Credits:	1.5
Course No.:	SWE 0612-3226
Credit Hours:	3 hours/week
Rationale:	Distributed systems help programmers aggregate the resources of many networked computers to construct highly available and scalable services. This class teaches the abstractions, design and implementation techniques that enable the building of fast, scalable, fault-tolerant distributed systems. Topics include multithreading, network programming, consistency, fault tolerance, consensus, security, and several case studies of distributed systems.
Objectives:	**Objectives:** ● To facilitate necessary knowledge about the principles, architectures, algorithms and programming models used in distributed systems. ● Acquaint students with the basic tools to analyze state-of-the-art distributed systems, such as Google File System, Hadoop, Map-reduce. ● Help them conceptualize basic theories in designing and implementing distributed systems ● Accumulate basic ideas about abstractions, design and implementation techniques that enable understanding the characteristics of Highly Scalable, Fault Tolerant distributed systems.
Course Contents:	Distributed System Models, System Architectures & Client-Server Models, Programming Systems and Models, Processes and threads, Remote Procedure Call, High-Performance Computing, MapReduce, Many-Task Computing, Workflow Systems, Grid Computing, Cloud Computing, Virtualization, IaaS Clouds, Filesystems, Networked Filesystems, Parallel Filesystems, Distributed Filesystems, Data-Intensive Computing, Distributed Hash Tables, Consistency Models, Fault Tolerance, Many-core Computing.
Course Learning Outcomes (CLOs):	After the successful completion of the course, the student will be able to-

CLO 1	Analyze the strengths and weaknesses of different distributed system architectures and identify appropriate use cases for each.
CLO 2	Evaluate the performance of distributed systems and propose strategies for optimizing resource usage and minimizing latency.
CLO 3	Design fault-tolerant distributed systems that can handle failures in hardware, software, and network components.
CLO 4	Develop scalable and efficient algorithms for distributed computing tasks, such as MapReduce, Many-Task Computing, and Distributed Hash Tables.

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3				1	1		3	2		1	2
CLO 2	3	1		2		3				1	2	1
CLO 3	3		2	1			3		2			3
CLO 4						1		1				3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class, Hands on exercise	Quiz, Coding Assignment, Report Writing, Final Project
CLO 2	Lectures, Tutorial class, Hands on exercise	Quiz, Group Discussion, Report Writing, Final Project
CLO 3	Lectures, Tutorial class, Hands on exercise	Quiz, Coding Assignment, Report Writing, Final Project
CLO 4	Lectures, Tutorial class, Hands on exercise	Quiz, Group Discussion, Report Writing, Final Project

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to Distributed Systems Lab Hands-on lab exercises to set up the lab environment and introduction to lab equipment	Lectures, Tutorial class	Quiz	CLO1
2	Network Programming with Sockets	Lectures, Tutorial class	Coding assignment	CLO2, 3

			Lab exercises on network programming using sockets				
		3	Concurrent Programming with Processes and Threads Hands-on lab exercises on concurrent programming with processes and threads	Lectures, Tutorial class	Coding assignment to develop a concurrent system using processes and threads	CLO2	
		4	Remote Procedure Call Lab Hands-on lab exercises on RPC programming	Lectures, Tutorial class	Coding assignment to develop a distributed system using RPC	CLO 1, CLO2	
		5	MapReduce Lab Hands-on lab exercises on MapReduce programming	Lectures, Tutorial class	Coding assignment to implement a MapReduce algorithm on a many-core system	CLO3, 1	
		6	Grid Computing Lab Lab exercises to set up a grid computing environment	Lectures, Tutorial class	Group project to design and implement a grid computing system	CLO1, 2, 3	
		7	Cloud Computing Lab Lab exercises to set up a cloud computing environment	Lectures, Tutorial class	Cloud computing project to develop and deploy a scalable application	CLO4, 2	
		8	Distributed Filesystems Lab Hands-on lab exercises on distributed filesystem programming	Lectures, Tutorial class	Coding assignment to implement a distributed filesystem	CLO4	

		9	Data-Intensive Computing Lab Lab exercises to set up a DHT environment	Lectures, Tutorial class	Group project to design and implement a DHT-based distributed system for data-intensive computing	CLO1, 2	
		10	Fault Tolerance Lab Hands-on lab exercises on fault tolerance programming	Lectures, Tutorial class	Coding assignment to develop a fault-tolerant distributed system	CLO2, 3	
		11	Many-Task Computing Lab Hands-on lab exercises on many-task computing programming	Lectures, Tutorial class	Coding assignment to develop a many-task computing system	CLO1,CLO2, CLO3, CLO4	
		12	Security and Privacy in Distributed Systems Lab Lab exercises on security and privacy in distributed systems	Lectures, Tutorial class	Coding assignment to develop security and privacy mechanisms for a distributed system	CLO4, CLO1, CLO2	
		13	Final Project Lab Group project to design and implement a distributed system that utilizes the concepts covered in the lab course	Lectures, Tutorial class	Final project presentation and report	CLO1,2,3,4	
		14	Review and Synthesis Review of lab course content and synthesis of key concepts		Final exam covering all course content	CLO2, CLO3, CLO4, CLO1	
Text books	1. Distributed Systems: Principles and Paradigms. Andrew S. Tanenbaum and Maarten Van Steen 2. Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet (DCC) by						

	Kai Hwang, Jack Dongarra& Geoffrey C. Fox

Course Title:	Software Usability and Metrics
Credits:	2
Course No.:	SWE 0613-3231
Credit Hours:	2 hours / week
Rationale:	Students of Software Engineering apart from developing a complex system need to be able to measure the complexity of the software systems. This course will help the students to develop the knowledge required to estimate the complexity of software systems. This course will also help them to develop understanding about the estimated developing time of a complex software system.
Objectives:	● To provide students with the theoretical knowledge of mathematics and statistics that are required to apply the different metrics used to measure a software. ● To help the students to understand the process of measuring software. ● To help the students to gain enough knowledge about the different metrics that are used to measure a software so that they can apply their knowledge to implement. ● Foster the analytical and critical capability of the students to use different estimation and risk analysis techniques to evaluate risks involved in software development.
Course Contents:	Overview of Software Metrics, The basics of Measurement, Goal based framework for software measurement, Empirical Investigation, Measuring Internal Attributes : Size, Measuring Internal Attributes : Structure, Measuring Cost and Effort, Measuring External product attributes :Quality, Measuring Software Reliability, Object Oriented Metrics, For hands-on experiences: Students will implement different software metrics calculation related algorithms, utilize existing industry related tools for measuring software metrics and compare it with their implementations to gain concrete idea.
Course Learning Outcomes (CLOs):	After the successful completion of the course, the student will be able to- **CLO 1** Knowledge of software usability concepts and principles. **CLO 2** Familiarity with software metrics and measurement techniques. **CLO 3** Knowledge of the impact of cultural and individual differences on software usability. **CLO 4** Capability to use software metrics to reform design decisions.
Mapping of CLOs with Program Learning Outcomes (PLOs):	**Mapping of Course Learning Outcomes to Program Learning Outcomes**

CLO /PLO	**PLO1**	**PL02**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO 12**
CLO 1	**3**							**1**				

CLO 2	**3**						**1**					
CLO 3	**3**		**3**	**2**	**3**	**3**		**1**	**2**			
CLO 4	**3**	**3**	**3**	**2**	**3**			**2**	**2**	**1**	**1**	**2**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, RW
CLO2	CL, T, OR, GD, PrbL	A, RW
CLO3	CL, T, OR, PrbL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL, GD	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1-2	**Overview of Software Metrics and the basics of Measurement.**	CL, T, OR	A, P	CLO1, CLO2
3-4	**Goal based framework for software measurement and Empirical Investigation.**	CL, T, OR, GD	A, P	CLO1, CLO2
5-6	**Measuring Internal Attributes - Size**	CL, T, OR, GD, PjrL	A, Prj	CLO1, CLO2, CLO3, CLO4
7-8	**Measuring Internal Attributes - Structure**	CL, T, OR, PrbL, PjrL	A, Prj	CLO1, CLO2, CLO3, CLO4
9-10	**Measuring Cost and Effort**	CL, T, OR, PrbL	A, P, Prj	CLO1, CLO2, CLO3, CLO4
11-12	**Measuring External Product Attributes - Quality**	CL,GD, PrjL, BL	A, P, Prj	CLO1, CLO2, CLO3, CLO4
13-14	**Measuring Software Reliability and Object-Oriented Metrics**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	A, P, Prj, BL	CLO2, CLO3, CLO4

	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)
Text Books	1. Software metrics- A Rigorous and Practical Approach, (3rd Edition) Norman Fenton, and Jones Bieman. 2. Software Measurement and Estimation: A practical Approach (1st Edition) Linda M. Laird, and M. Carol Brennan.

Course Title:	Software verification and Validation
Credits:	2
Course No.:	SWE 0613-3233
Credit Hours:	2 hours/week
Rationale:	Software Engineering is aiming to develop high quality software that can be understood, maintained and adapted over long periods of time by many different people. In the software development process Verification and Validation (V&V) obtain a significant part in SDLC. The goal of V&V is to provide an assessment of the ability of the software both to meet its requirements and to satisfy the needs of the user. The V&V process encompasses assessment, analysis, evaluation, review, inspection, and testing. The course attempts to foster an understanding of software testing and quality assurance: what it is, and how to achieve it. This can be done through the use of hands on practice of different techniques throughout the course. By demonstrating different software testing and quality assurance methodology, one can get the overall industry level idea about software verification and validation process.
Objectives:	● To give students an insight about common software engineering processes and software testing practices. ● To teach students the impact of software testing requirements and the proper way to analyze from requirement specification. ● To facilitate necessary knowledge about basic testing principles and the use of those principles can be to make modular and scalable programs. ● To help students develop skills that will enable them to construct software of high quality – software that is reliable, and that is reasonably easy to understand, modify and maintain. ● To teach students software verification concepts and how to design testing documents from requirements. ● To provide the knowledge about testing their software and modern software verification and validation practices.
Course Contents:	Demonstrate the application of verification and validation tasks and their outcomes during the software life cycle. Apply various verification and validation techniques based on various characteristics of the system/software (safety, security, risk, etc). Differentiate between the overall role of verification and validation and the specific role of software/system testing. Compare and Contrast the theoretical and practical limitations to software verification and

	validation analysis. Apply appropriate planning and scoping to a verification and validation effort based on the needs of the software system being developed. Develop a software verification and validation plan that reflects an understanding of verification and validation objectives, and appropriate problem/risk identification and tracking. Analyze the effectiveness of a V&V plan with respect to its objectives. Appraise various research in software verification and validation and provide critical insight as to their content with the class.
Course Learning Outcomes (CLOs):	

CLO 1	Knowledge of software testing methodologies: Students will gain an understanding of software testing methodologies, including black box testing, white box testing, and gray box testing, and the trade-offs between different testing methodologies.
CLO 2	Ability to use software testing tools: Students will be able to use software testing tools, such as JUnit or PyTest, and understand the benefits of using these tools in software testing.
CLO 3	Knowledge of software quality assurance: Students will gain an understanding of software quality assurance and the importance of software quality in the software development process.
CLO 4	Ability to apply concepts in real-world scenarios: Students will be able to apply the concepts learned in the course to real-world software development projects and reflect on the strengths and weaknesses of their implementation.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3	3	2		2					2		3
CLO 2	2	1	1			1						3
CLO 3	3	2	2	2	2							3
CLO 4	3	3	3	2	2		1	1	2	1	1	3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

	(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)
Course Plan	

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to software verification and validation concepts and their importance in the software development life cycle.**	CL, T, OR, GD	A, P	CLO1, CLO2
2-3	**Overview of various verification and validation techniques, such as inspection, walkthrough, formal verification, and testing.**	CL, T, OR, GD, PrbL	A, P	CLO1, CLO2
4	**Hands-on demonstration of the application of verification and validation techniques and their outcomes during the software life cycle.**	CL, T, OR, GD	A, P	CLO1, CLO2, CLO3
5-6	**Study of various characteristics of the system/software (safety, security, risk, etc) and how they affect the choice of verification and validation techniques**	CL, T, OR, PrbL	A, P	CLO1, CLO3, CLO4
7-8	**Differences between overall role of verification and validation and specific role of software/system testing, and how they complement each other.**	CL, T, OR, PrbL	A, P	CLO1, CLO2, CLO4
9-10	**Theoretical and practical limitations to software verification and validation analysis, and their**	CL, GD, PrbL, PrjL, BL	A, P, RW	CLO1, CLO2, CLO3, CLO4

		impact on the development process.			
	11	**Planning and scoping for a verification and validation effort, including problem/risk identification and tracking.**	CL, T, OR, GD, PrbL, PrjL	A, P	CLO2, CLO3, CLO4
	12-13	**Development of a software verification and validation plan, incorporating objectives, risk identification, and tracking.**	CL, T, OR, GD, PrbL, PrjL	A, P, RW	CLO1, CLO2, CLO3, CLO4
	14	**Analysis of the effectiveness of a V&V plan, and discussion of various research in software verification and validation, providing critical insight and feedback.**	CL, T, OR, GD, PrbL, PrjL	A, RW, V	CLO1, CLO2, CLO3, CLO4
	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)				
Text Books	1. SOFTWARE TESTING Principles and Practices. Naresh Chauhan				

Course Title:	Software verification and Validation Lab
Credits:	1.5
Course No.:	SWE 0613-3234
Credit Hours:	3 hours/week

<table>
<tr><td>Rationale:</td><td>Software Engineering is aiming to develop high quality software that can be understood, maintained and adapted over long periods of time by many different people. In the software development process Verification and Validation (V&V) obtain a significant part in SDLC. The goal of V&V is to provide an assessment of the ability of the software both to meet its requirements and to satisfy the needs of the user.

The V&V process encompasses assessment, analysis, evaluation, review, inspection, and testing. The course attempts to address the students to learn about software testing tools, processes. This encompasses the learners to update themselves about different states of software testing and various tools to achieve it. It will also allow them to design requirement documents for software products from customers to ensure quality software.</td></tr>
<tr><td>Objectives:</td><td>● To give students an insight about common software testing practices.
● To facilitate the students with the knowledge about the software testing process that is developed from testing documents.
● To teach students tools for software testing.
● To help the students to develop a practical test case design and bug reporting environment</td></tr>
<tr><td>Course Contents:</td><td>Demonstrate the application of verification and validation tasks and their outcomes during the software life cycle. Apply various verification and validation techniques based on various characteristics of the system/software (safety, security, risk, etc). Differentiate between the overall role of verification and validation and the specific role of software/system testing. Compare and Contrast the theoretical and practical limitations to software verification and validation analysis. Apply appropriate planning and scoping to a verification and validation effort based on the needs of the software system being developed. Develop a software verification and validation plan that reflects an understanding of verification and validation objectives, and appropriate problem/risk identification and tracking. Analyze the effectiveness of a V&V plan with respect to its objectives. Appraise various research in software verification and validation and provide critical insight as to their content with the class.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>
<table>
<tr><td>CLO 1</td><td>Hands-on experience with software testing: Students will gain hands-on experience in planning and executing software tests, including unit tests, integration tests, and system tests, and understand the importance of testing in software development.</td></tr>
<tr><td>CLO 2</td><td>Ability to use software testing tools: Students will be able to use software testing tools, such as JUnit or PyTest, and understand the benefits of using these tools in software testing.</td></tr>
<tr><td>CLO 3</td><td>Collaboration and teamwork skills: Students will have the opportunity to work in teams to complete lab assignments, providing them with the opportunity to develop collaboration and teamwork skills.</td></tr>
<tr><td>CLO 4</td><td>Ability to apply concepts in real-world scenarios: Students will be able to apply the concepts learned in the course to real-world software development projects and reflect on the strengths and weaknesses of their implementation.</td></tr>
</table>
</td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td>Mapping of Course Learning Outcomes to Program Learning Outcomes
<table>
<tr><th>CLO /PLO</th><th>PLO1</th><th>PL02</th><th>PLO3</th><th>PLO4</th><th>PLO5</th><th>PLO6</th><th>PLO7</th><th>PLO8</th><th>PLO9</th><th>PLO10</th><th>PLO11</th><th>PLO12</th></tr>
<tr><td>CLO 1</td><td>3</td><td>3</td><td>2</td><td></td><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td><td>3</td></tr>
</table>
</td></tr>
</table>

CLO 2	**2**	**1**	**1**		**3**							**3**
CLO 3	**3**	**3**	**2**	**3**		**2**			**3**	**3**		**3**
CLO 4	**3**	**3**	**3**	**3**		**2**	**1**	**1**	**2**	**1**	**1**	**3**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to software verification and validation concepts and hands-on demonstration of inspection techniques.**	CL, T, OR, GD, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
2-3	**Hands-on demonstration of walkthrough techniques and formal verification techniques.**	CL, T, OR, GD, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
4-5	**Hands-on demonstration of software testing techniques and their integration into the software development life cycle.**	CL, T, OR, GD, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
6	**Study of various characteristics of the system/software (safety, security, risk,**	CL, T, OR, PrbL, PjrL	Lab Report, Hands-on exercises	CLO1, CLO3, CLO4

			etc) and how they affect the choice of verification and validation techniques			
		7	**Hands-on demonstration of the application of verification and validation techniques and their outcomes during the software life cycle.**	CL, T, OR, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO4
		8	**Differences between overall role of verification and validation and specific role of software/system testing, and how they complement each other.**	GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
		9-10	**Hands-on demonstration of problem/risk identification and tracking techniques, and their integration into the verification and validation process.**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises	CLO2, CLO3, CLO4
		11	**Group project to develop a verification and validation plan and scope for a real-world software system.**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
		12-13	**Group project to analyze the effectiveness of a verification and validation plan, and hands-on demonstration of various research in software verification and validation.**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises, Final Project	CLO1, CLO2, CLO3, CLO4
		14	**Summary of the course and final hands-on project.**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises, Final Project	CLO1, CLO2, CLO3, CLO4

	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)
Text Books	1. SOFTWARE TESTING Principles and Practices. Naresh Chauhan

Course Title:	Technical Writing and Presentation
Credits:	02
Course No.:	SWE 0611-3242
Credit Hours:	4 hours / week
Rationale:	In this course students will be facilitated with knowledge on interpretation of their technical knowledge through writing. They will learn how to write in a specific format using the latest technologies, draw their diagrams and also present their work in front of the audience.
Objectives:	● To facilitate necessary knowledge about methods for technical writing ● To acquaint students with basic tools for writing, presentations and drawings ● To help them enhance the skills on presentation and communication
Course Contents:	Issues of technical writing and effective oral presentation in Computer Science and Engineering; Writing styles of definitions, propositions, theorems and proofs; Research Methodologies; Preparation of reports, research papers, theses and books: abstract, preface, contents, bibliography and index; Writing of book reviews and referee reports; Writing tools: LATEX; Diagram drawing software; presentation tools.
Course Learning Outcomes (CLOs):	After the successful completion of the course, the student will be able to-

CO 1	Apply skills on technical writing for writing technical and academic reports
CO 2	Use latest technologies for writing and drawing
CO 3	Apply skills on designing graphical representations
CO 4	Develop academic and industrial level of presentation skills

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1												X
CLO 2					X							
CLO 3			X							X		
CLO 4										X		

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CO	Teaching Learning Strategy	Assessment Strategy
CO 1	Demonstration, Lecture	Report, Assignment
CO 2	Practical Session	Report, Assignment, Viva, Quiz
CO 3	Practical Session	Report, Presentation
CO 4	Demonstration, Lecture	Presentation

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CO
1	Issues of technical writing and oral presentation	Demonstration, Lecture	Assignment	**CO1**
2	Research Methodologies	Demonstration, Lecture	Assignment	**CO1**
3	Research Methodologies	Demonstration, Lecture	Assignment	**CO1**
4	Writing styles	Demonstration, Lecture	Assignment	**CO2**
5	Preparation of reports, research papers, theses and books	Demonstration, Lecture	Assignment	**CO2**
6	Writing reviews	Demonstration, Lecture	Assignment	**CO2**
7	LATEX	Practical Session	Report, Viva, Quiz	**CO2, CO3**
8	LATEX	Practical Session	Report, Viva, Quiz	**CO2, CO3**
9	LATEX	Practical Session	Report, Viva, Quiz	**CO2, CO3**
10	LATEX	Practical Session	Report, Viva, Quiz	**CO2, CO3**
11	LATEX	Practical Session	Report, Viva, Quiz	**CO2, CO3**
12	How to Present?	Demonstration, Lecture	Presentation	**CO4**
13	How to Present?	Demonstration, Lecture	Presentation	**CO4**
14	How to Present?	Demonstration, Lecture	Presentation	**CO4**

Text Books

1. Engineers' guide to technical writing - Kenneth G. Budinski
2. Writing for Computer Science - Justin Zobel

Course Title:	Machine Learning

<table>
<tr><td>Credits:</td><td>3.0</td></tr>
<tr><td>Course No.:</td><td>SWE 0619-3243</td></tr>
<tr><td>Credit Hours:</td><td>3 hours/week</td></tr>
<tr><td>Rationale:</td><td>This course will help the students to use Machine Learning concepts and topics to solve complex problems. They will develop the ability to understand and evaluate the different aspects of the machine learning models. Also this course aims to help the students to gain an insight about how actually learning occurs in real life. This course offers a detailed analysis of the different state-of-the-art machine learning models and their appropriateness in solving a problem.</td></tr>
<tr><td>Objectives:</td><td>Upon completion of this course, students will be able to do the following:
To facilitate the students with necessary knowledge about machine learning problems which corresponds to different applications.
Acquaint students with the basic tools to understand a range of machine learning algorithms along with their strengths and weaknesses.
Help the students to understand the basic theory underlying machine learning.
Make the students understand the machine learning algorithms to solve problems of moderate complexity.
To foster the analytical and critical ability of the students to evaluate current research areas in machine learning and understand the issues raised by current research.</td></tr>
<tr><td>Course Contents:</td><td>Introduction to Machine Learning Concepts: Concepts of ML. Types of Machine Learning, Some ML applications and examples. The main components of a ML system. Requirements to design a ML system. Testing ML algorithms, Linear Regression, Logistic Regression, Regularization, Decision Tree, Learning a concept and hypothesis, Naïve Bayes Classifier, Artificial Neural Network, Linear Discriminants, Perceptron Learning, Delta Rule, Multi-layer Neural Network, Back-propagation Algorithm, Unsupervised Learning, Clustering Technique, K-means Clustering, Clique Graph, Hierarchical Clustering, Anomaly Detection, Dimensionality Reduction, N-gram Model, Hidden Markov Model, Support Vector Machine, Genetic Algorithm, Reinforcement Learning, Information Retrieval, Natural Language Processing: Introduction, Syntactic Processing, Semantic Analysis, Discourse and Pragmatic Processing. Recommender System. Deep Learning.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td><table>
<tr><td>CLO 1</td><td>Analyze and evaluate the performance of different machine learning algorithms in real-world applications.</td></tr>
<tr><td>CLO2</td><td>Apply machine learning algorithms to solve complex problems and make data-driven decisions.</td></tr>
<tr><td>CLO3</td><td>Critically evaluate the strengths and weaknesses of different machine learning techniques and their applicability in various domains.</td></tr>
<tr><td>CLO4</td><td>Develop and implement machine learning models using various programming languages and frameworks.</td></tr>
</table></td></tr>
<tr><td>Mapping of CLOs with Program</td><td>Mapping of Course Learning Outcomes to Program Learning Outcomes</td></tr>
</table>

Learning Outcomes (PLOs):

CLO/ PLO	PLO 1	PL 02	PLO 3	PLO 4	PLO 5	PLO 6	PL O7	PL O8	PLO 9	PLO 10	PLO 11	PL O 12
CLO1	2			2			2					1
CLO2	3	2							2	1	1	
CLO3	2		1		2	2					1	
CLO4	2							2				1

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, P
CLO2	CL, T, OR, GD, PrbL, PjrL	A, P
CLO3	CL, T, OR, PrbL, PjrL	A, P
CLO4	GD, PrbL, PrjL, BL	A, V, P

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to Machine Learning Concepts	Lecture and discussion	Quiz	CLO1,2
2-3	Linear Regression, Logistic Regression, and Regularization	Lecture, numerical examples, and group discussions	Assignment, Quiz	CLO2,3,4
4-5	Decision Trees, Naïve Bayes Classifier, and Artificial Neural Network	Lecture, numerical examples, and group discussions	Assignment, Quiz	CLO2,3,4
6-7	Unsupervised Learning and Clustering Techniques	Lecture, numerical examples, and group discussions	Assignment, Quiz	CLO2,3,4
8-9	Anomaly Detection and Dimensionality Reduction	Lecture, numerical examples, and group discussions	Assignment, Quiz	CLO2,3,4

	10-11	Hidden Markov Model and Support Vector Machine	Lecture, numerical examples, and group discussions	Assignment, Quiz	CLO2,3,4
	12-13	Genetic Algorithm and Reinforcement Learning	Lecture, numerical examples, and group discussions	Assignment, Quiz	CLO2,3,4
	14	Natural Language Processing and Deep Learning	Lecture, numerical examples, and group discussions	Final exam	CLO1,2,3,4
Text Books	1. Machine Learning, An Algorithmic Perspective(2nd Edition), Stephen Marsland 2. Introduction to machine learning (2nd edition), Alpaydin, Ethem. 3. The Art and Science of Algorithms that Make Sense of Data Machine Learning, Peter Flach. 4. Machine Learning, Tom Mitchell, McGraw Hill.				

Course Title:	Machine Learning Lab
Credits:	1.5
Course No.:	SWE 0619-3244
Credit Hours:	3 hours/week
Rationale:	This course will help the students to implement Machine Learning concepts and topics to solve complex problems. They will develop the ability to analyze and evaluate the different aspects of the machine learning models. This course offers a detailed analysis of the different state-of-the-art machine learning models and their appropriateness in solving a problem. Also this course helps the students to get familiarized with the different open source tools and technologies that are available in the field of Machine Learning.
Objectives:	Upon completion of this course, students will be able to do the following: ● To facilitate the students with necessary knowledge about machine learning problems corresponding to different applications. ● Help the students to understand a range of machine learning algorithms along with their strengths and weaknesses. ● Make the students understand the basic theory underlying machine learning. ● Accumulate basic ideas about machine learning algorithms to solve problems of moderate complexity.
Course Contents:	Laboratory works based on ID3 Algorithm for Decision Tree, Regression using LSE and estimating MSE, kNN Algorithm as Nearest Neighbor Classifier, Apply NB Classifier for a Classification Task, Application of the MLP-BP ANN algorithm, Application of GA for

	solving a problem, Application of SVM, Application of HMM, Exclusive clustering: K- means algorithm, Agglomerative clustering: Hierarchical algorithm.

Course Learning Outcomes (CLOs):

CLO 1	Develop and implement machine learning algorithms to solve real-world problems.
CLO 2	Apply various machine learning techniques and algorithms for classification, regression, clustering, and anomaly detection.
CLO 3	Analyze the performance of machine learning models using evaluation metrics and apply techniques to improve their accuracy.
CLO 4	Design and develop end-to-end machine learning pipelines that include data preprocessing, model selection, hyperparameter tuning, and deployment.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	**PLO1**	**PL02**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**
CLO 1	**2**			**2**			**2**					**1**
CLO 2	**3**	**2**							**2**	**1**	**1**	
CLO 3	**2**		**1**		**2**	**2**					**1**	
CLO 4	**2**							**2**				**1**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	CL, T, OR, GD	A, PP
CLO2	CL, T, OR, GD, PrbL, PjrL	A, PP
CLO3	CL, T, OR, PrbL, PjrL	A, Prj
CLO4	GD, PrbL, PrjL, BL	A, V, PP, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	**Topic**	**Teaching Learning Strategy**	**Assessment Strategy**	**CLOs**

		1	Course Introduction, Overview of ML Concepts, Types of Machine Learning, and Applications.	Lecture, Discussion, and Case Study.	Assignment	CLO1,2
		2	Supervised Learning Algorithms: Linear Regression, Logistic Regression, and Regularization.	Lecture and Practical Session.	Practical Exam.	CLO1,2
		3	Supervised Learning Algorithms: Decision Tree, Naive Bayes Classifier, Artificial Neural Network, and Support Vector Machine.	Lecture and Practical Session.	Practical Exam.	CLO1
		4	Unsupervised Learning Algorithms: Clustering Technique, K-means Clustering, Clique Graph, Hierarchical Clustering, and Anomaly Detection.	Lecture and Practical Session.	Practical Exam.	CLO1,2
		5	Dimensionality Reduction Techniques: N-gram Model and Hidden Markov Model.	Lecture and Practical Session.	Quiz, Assignment	CLO1, CLO2, CLO4
		6	Introduction to Deep Learning: Neural Network Basics, Multi-layer Neural Network, and Back-propagation Algorithm.	Lecture and Practical Session.	Quiz, Assignment	CLO1, CLO2
		7	Deep Learning: Convolutional Neural Network, Recurrent Neural Network, and Generative Adversarial Network.	Lecture and Practical Session.	Quiz, Assignment	CLO2, CLO3, CLO4
		8	Reinforcement Learning: Markov Decision Process, Q-Learning, and Temporal Difference Learning.	Lecture and Practical Session.	Quiz, Assignment	CLO2, CLO3, CLO4
		9	Information Retrieval: Vector Space Model,	Lecture and Practical Session.	Quiz, Assignment	CLO2, CLO3, CLO4

		Probabilistic Model, and Evaluation Metrics.			
	10	Natural Language Processing: Introduction, Syntactic Processing, and Semantic Analysis.	Lecture and Practical Session.	Quiz, Assignment	CLO2, CLO3, CLO4
	11	Natural Language Processing: Discourse and Pragmatic Processing.	Lecture and Practical Session.	Quiz, Assignment	CLO1, CLO2
	12	Recommender System: Collaborative Filtering, Content-based Filtering, and Hybrid Recommender Systems.	Lecture and Practical Session.	Quiz, Assignment	CLO1, CLO2, CLO3, CLO4
	13	Hands-on Project.	Lecture and Practical Session.	Quiz, Assignment	CLO1, CLO2, CLO3, CLO4
	14	Revision and Recapitulation.	Lecture, Discussion, and Case Study.	Assignment	CLO1, CLO2, CLO3, CLO4
Text Books	● Machine Learning, An Algorithmic Perspective (2nd Edition), Stephen Marsland ● Introduction to machine learning (2nd edition), Alpaydin, Ethem. ● The Art and Science of Algorithms that Make Sense of Data Machine Learning, Peter Flach. ● Machine Learning, Tom Mitchell, McGraw Hill.				

Course Title:	Entrepreneurship Development
Credits:	02
Course No.:	BUS 0414-3201W
Credit Hours:	2 hours/week
Rationale:	This course will enable the students to acquire the basic knowledge of business and its implications in starting a new venture.
Objectives:	This course aimed to: I. provide an understanding of the different forms of business, industry and services II. develop and strengthen entrepreneurial quality, i.e., motivation or need for achievement III. to analyze environmental set up relating to small industry and promoting it; understand the process and procedure involved in setting up small units. IV. know the sources of help and support available for starting a small-scale industry

	V. acquire necessary managerial skills required to run the industrial unit. Know the pros and cons of being an entrepreneur.
Course Learning Outcomes (CLOs):	

CLO1	Understand the entrepreneurship skills as it relates to real life;
CLO2	Understand needs for making a plan for starting a business ;
CLO3	Explore the entrepreneurial environment;
CLO4	Know about the business system of home and abroad;
CLO5	Analyze individual and group dynamics for effective team building.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO 12
CLO 1	3	1							2			
CLO 2			3									
CLO 3	3			1	1	2						
CLO 4	2	3			3		3	2				
CLO 5	2			2					2	3		

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

Teaching Learning Strategies:

Teaching Strategies	Code
Lecture	01
Case Study	02
Problem Solving	03
Group Discussion	04
Audio Visual Presentation	05

Assessment Methods:

Type of Assessment	Assessment Code
Quiz Test	01
Written Test	02
Problem solving	03
Presentation	04
Assignment	05

Course Plan

Week	Course Contents	Teaching Learning Strategy	Assessment Strategy	CLO
1	**Introduction entrepreneurship:** Concept of entrepreneurship, why become an entrepreneur, characteristics of successful entrepreneurs, economic impact of entrepreneurial firms, entrepreneurial firms' impact on society, entrepreneurial firms' impact on larger firms, decision to become an entrepreneur.	01	01,02	1
2	**Recognizing opportunities and generating ideas:** Identifying and recognizing opportunities, finding gaps in the market place, techniques for generating ideas, encouraging and protecting new ideas.	01	01,02	2
3	**Feasibility Analysis:** Product/service feasibility analysis, industry/target market feasibility analysis, organizational feasibility analysis and financial feasibility analysis.	02	02,04	2
4	**Writing a business plan:** Concept of a business plan, reasons for writing a business plan, who reads the business plan and what are they looking for, guidelines for writing a business plan, Outline of the business plan, presenting the business plan to investors.	01, 02	01, 02	3,4
5	**Industry and competitive analysis:** Industry analysis-studding industry trends, five forces model, value of the five forces model, industry types and opportunities, competitor analysis-identifying competitors, sources of competitive intelligence, completing a competitive analysis grid.	04, 05	02,05	3,4

	6	**Developing an effective Business Model:** Importance and diversity of business models.	03, 04	02,05	4, 5
		Assessment			
	7	How business models emerge, potential flaws of business models, components of an effective business model.	04, 05	01, 05	2,4
	8	**Preparing the proper ethical and legal foundation:** Establishing a strong ethical culture for a firm, obtaining business licenses and permits, choosing a form of business organization.	03,04	02,04	1,4
	9	**Assessing the new venture's financial strength and viability:** Financial objectives of a firm, Process of financial management	03, 04	02,04	1,4
	10	Pro Forma financial statements-pro forma income statement, pro forma balance sheet, pro forma statement of cash flow.	03, 05	01,05	2,3,4
	11	**Building a new venture team:** Creating a venture team, rounding out the team: the role of professional advisers.	04,05	01,04	5
	12	Assessment			
	13	**Getting financing or funding:** Importance of getting financing or funding, sources of equity funding, sources of debt financing, creating sources of financing and funding.	01	01	5
	14	**Assessment and Review**			
Text Books & References	**Text Book:** 1. Entrepreneurship: Successfully launching new ventures by Bruce R. Barringer and R Duane Ireland (4th edition / Latest edition.) 2. Entrepreneurial Development: S. S. Khanka, S. Chand Publisher, India **Reference Books:** 1. Essentials of entrepreneurship and small business management by Norman M Scarborough, Jeffrey R. Cornwall. (9th edition)				
SEE-Semester End	**SEE- Semester End Examination (60)**				

Examination (60)	Bloom's Category	Test
	Remember	**10**
	Understand	**15**
	Apply	**10**
	Analyze	**10**
	Evaluate	**10**
	Create	**05**

Course Title:	Project Work III
Credits:	2
Course No.:	SWE 0610–3250
Credit Hours:	4 hours/week
Rationale:	Software industry need expert manpower who are capable of solving real life problems using cutting edge technologies. This course will provide the students the necessary training required to solve such problems using cutting edge technologies. This course will also help the students to grow as a team member to solve problems as a team.
Objectives:	**Objectives:** ● To facilitate the students with necessary knowledge about developing industry level projects. ● To provide the students with the knowledge of cutting edge software development technologies. ● Help the students in applying Software Principles in real life projects. ● Provide sufficient help to the students to grow as a team member to solve complex problems.
Course Contents:	Projects must possess innovative ideas which reflect contemporary IT trends. Supervisor have to ensure that every accepted project contain basic level of research work. Projects that meet the software/hardware requirements of SUST or any other IT organization are highly preferable. Students have to give a presentation on their project works. Departments should take appropriate steps to archive all the projects and keep tracks to maintain the genuineness of the projects.
Course Learning Outcomes (CLOs):	**CLO 1**: Develop an innovative project idea using object-oriented programming approach and a standard algorithm that addresses a real-world problem in the IT field. **CLO 2**: Apply project management principles, tools, and techniques to plan, execute, monitor, and control project activities, resources, and deliverables. **CLO 3**: Evaluate the effectiveness and efficiency of the project solution in terms of meeting the project goals, user requirements, and technical specifications. **CLO 4**: Demonstrate effective communication, collaboration, and teamwork skills in presenting project progress, outcomes, and recommendations to stakeholders.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	3	2	2							2	3
CLO2	3	2	2	2	2					1		1
CLO3	3					2	1			1		2
CLO4	3							1	1		2	3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Course Introduction, HTML, CSS, JavaScript, and Font-end, Backend	Lecture, Discussion, and Demonstration	Quiz and Class Participation	CLO1
2	Project Selection, Requirements Gathering, and Analysis	Lecture, Discussion, and Case Study Analysis	Project Proposal and Presentation	CLO1, CLO2

		3	Project Planning and Design	Lecture, Discussion, and Demonstration	Project Plan and Design Document	CLO2, CLO3	
		4	Project Implementation: Coding and Debugging	Lecture, Discussion, and Hands-on Programming	Code Review and Testing	CLO2, CLO3	
		5	Testing and Integration	Lecture, Discussion, and Hands-on Programming	Testing and Integration	CLO1, CLO2, CLO4	
		6	Documentation and Maintenance	Lecture, Discussion, and Hands-on Programming	Documentation and Maintenance Plan	CLO1, CLO2, CLO3	
		7	Project Presentation and Demonstration	Presentation and Demonstration	Presentation and Demonstration	CLO2, CLO3, CLO4	
		8-14	Project Refinement and Enhancement	Lecture, Discussion, and Hands-on Programming	Code Review and Testing	CLO1, CLO2, CLO3, CLO4	
Text books							

Fourth Year

Fourth Year First Semester

Course Title:	Software Project Management
Credits:	2
Course No.:	SWE 0613-4125
Credit Hours:	2 hours/week
Rationale:	This course is aimed at introducing the primary important concepts of project management related to managing software development projects. The students will also get familiar with the different activities involved in Software Project Management. Further, they will also come to know how to successfully plan and implement a software project management activity, and to complete a specific project in time with the available budget.
Objectives:	**Objectives:** ● Help the students to identify the different project contexts and suggest an appropriate management strategy. ● Facilitate practicing of the role of professional ethics in successful software development. ● Providing assistance in identifying and describing the key phases of project management. ● Providing assistance in determining an appropriate project management approach through an evaluation of the business context and scope of the project.
Course Contents:	**Planning and managing of software development projects.** **Software process models.** **ISO 9000, SEI's Capability Maturity Model, continuous process improvement.** **Planning, scheduling, tracking, cost estimation, risk management, configuration management.** **Case Studies**

Course Learning Outcomes (CLOs):

After the successful completion of the course, the student will be able to-

CLO 1	Identify an efficient management strategy for a business scenario
CLO 2	Demonstrate his/her ideas both formally and informally to a group of their peers and the management
CLO 3	Implement communication, modeling, construction & deployment practices in software development
CLO 4	Apply knowledge of the key project management skills, such as product and work break-down structure, schedule, governance including progress reporting, risk and quality management in real life projects

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	2				3	1		3	2		1	3
CLO 2	2	1		3		2				2	1	3
CLO 3	2		1	1			3		2			3
CLO 4	2											3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 2	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 3	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 4	Lectures, Tutorial class	Quiz, Assignment, Final Exam

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1-2	**Introduction and overview of Software Project Management**	Lectures, Tutorial class	Quiz, Assignment, Final	CLO1

			Define project management and its importance Describe project management processes, knowledge areas, and project life cycles		Exam		
		3	**Software Process Models** Introduce the different software process models, including Waterfall, Agile, and Iterative models Discuss the strengths and weaknesses of each model	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1	
		4	**ISO 9000, SEI's Capability Maturity Model, and Continuous Process Improvement** Discuss the importance of quality management in software development Introduce ISO 9000, SEI's Capability Maturity Model, and Continuous Process Improvement frameworks	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4	
		5	**Project Initiation** Define project initiation and its importance Discuss the key activities involved in project initiation, including project charter, stakeholder identification, and project scope	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO 1, CLO4	
		6	**Project Planning**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4, 1	

			Introduce project planning and its importance Discuss the key activities involved in project planning, including project schedule, resource allocation, and risk management				
		7	**Project Execution and Control** Discuss the key activities involved in project execution and control, including project monitoring and controlling, change management, and quality assurance	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1, 4	
		8	**Software Configuration Management** Define software configuration management and its importance Discuss the key activities involved in software configuration management, including version control, change control, and configuration auditing	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4	
		9	**Software Estimation** Introduce software estimation and its importance Discuss the key techniques used in software estimation, including expert judgment, analogy, and parametric models	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2, 3	
		10	**Risk Management**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO 2	

			Define risk management and its importance Discuss the key activities involved in risk management, including risk identification, risk assessment, and risk response planning				
		11	**Project Monitoring and Controlling** Introduce project monitoring and controlling and its importance Discuss the key metrics used in project monitoring and controlling, including earned value analysis, schedule performance index, and cost performance index	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO 3	
		12	**Project Closure** Define project closure and its importance Discuss the key activities involved in project closure, including project evaluation, lessons learned, and project archive	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1,CLO2, CLO3, CLO4	
		13-14	**Case Studies** Present case studies that demonstrate the application of project management concepts and techniques Discuss the key lessons learned from each case study	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4, CLO1, CLO2, CLO3	
Text books	1. Quality Software Project Management by Linda I. Safer, Donald F. Shafer, Robert T. Futrell						

<table>
<tr><td>Course Title:</td><td>Software Project Management Lab</td></tr>
<tr><td>Credits:</td><td>1</td></tr>
<tr><td>Course No.:</td><td>SWE 0613-4126</td></tr>
<tr><td>Credit Hours:</td><td>2 hours/week</td></tr>
<tr><td>Rationale:</td><td>This course is aimed at implementing the primary important concepts of project management related to managing software development projects. The students will have the opportunity to experiment with the different activities involved in Software Project Management. Further, they will also get involved in successfully planning and implementing a software project management activity, and to complete a specific project in time with the available budget.</td></tr>
<tr><td>Objectives:</td><td>Objectives:
Help the students in experimenting with the different project contexts and applying different management strategy.
Facilitate the students in identifying the role of professional ethics in successful software development.
Providing students with the assistance required in identifying and describing the key phases of project management by engaging them in an actual project.
Providing assistance in determining an appropriate project management approach through an evaluation of the business context and scope of the project by engaging the students in a real-life project to solve a real-life problem.</td></tr>
<tr><td>Course Contents:</td><td>Planning and managing of software development projects.
Software process models.
ISO 9000, SEI’s Capability Maturity Model, continuous process improvement.
Planning, scheduling, tracking, cost estimation, risk management, configuration management.
Case Studies</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>After the successful completion of the course, the student will be able to-<table><tr><td>CLO 1</td><td>Implement communication, modeling, construction & deployment practices in software development</td></tr><tr><td>CLO 2</td><td>Apply SEI’s Capability Maturity Model for project management & planning.</td></tr><tr><td>CLO 3</td><td>Analyze & design the software models using unified modeling language (UML)</td></tr><tr><td>CLO 4</td><td>Use the concepts of various software testing methods & be able to apply appropriate testing approaches for development of software</td></tr></table></td></tr>
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Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	2				3	1		3	2		1	3
CLO 2	2	1		3		2				2	1	3
CLO 3	2		1	1			3		2			3
CLO 4	2											3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class, Hands on with Real Project	Presentation, Group Discussion, Project
CLO 2	Lectures, Tutorial class, Hands on with Real Project	Presentation, Group Discussion, Project
CLO 3	Lectures, Tutorial class, Hands on with Real Project	Presentation, Group Discussion, Project
CLO 4	Lectures, Tutorial class, Hands on with Real Project	Presentation, Group Discussion, Project

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to Software Project Management Familiarize students with project management tools and software, such as Microsoft Project and JIRA	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO1
2	Project Initiation Lab Define project initiation and its importance	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO2, 3

			Guide students to develop a project charter, identify stakeholders, and define project scope using project management software				
		3	Software design Project Planning Lab Introduce project planning and its importance Guide students to develop a project schedule, allocate resources, and identify risks using project management software	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO2	
		4	Project Execution and Control Lab Guide students to monitor project progress, manage changes, and ensure quality using project management software	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO 1, CLO2	
		5	Software Configuration Management Lab Guide students to use version control, change control, and configuration auditing tools to manage software configurations	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO3, 1	
		6	Software Estimation Lab Guide students to use software estimation tools and techniques, such as expert judgment, analogy, and parametric models	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO1, 2, 3	

		7	Risk Management Lab Guide students to use risk identification, assessment, and response planning tools and techniques	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO4, 2	
		8	Earned Value Analysis Lab Guide students to use earned value analysis tools to monitor project performance	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO4	
		9	Project Closure Lab Guide students to evaluate project success, identify lessons learned, and archive project artifacts using project management software	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO1, 2	
		10	Agile Project Management Lab Introduce Agile project management principles and practices Guide students to use Agile project management software, such as Trello and Scrumwise	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO2, 3	
		11	Project Portfolio Management Lab Introduce project portfolio management concepts and tools Guide students to use project portfolio management software, such as Microsoft	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO1,CLO2, CLO3, CLO4	

			Project Portfolio Management			
		12	Case Study Lab Present case studies that demonstrate the application of project management concepts and techniques Guide students to analyze and discuss the key lessons learned from each case study	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO4, CLO1, CLO2
		13-14	Team Project Lab Assign students to teams to work on a real-world software project Guide students to apply project management concepts and techniques learned in the lab course to plan, execute, and control the team project	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO1,2,3,4
Text books	1. Quality Software Project Management by Linda I. Safer, Donald F. Shafer, Robert T. Futrell					

Course Title:	Information and Network Security
Credits:	2
Course No.:	SWE 0612-4129
Credit Hours:	2 hours/week
Rationale:	This is an introductory course on computer security. The main objective of this course is to introduce the basic concepts of cryptography and computer security covering physical security, operating system security as well as network and web security.
Objectives:	● To facilitate the basic knowledge of classic crypto systems and basic crypto primitives. ● To assist students in developing introductory knowledge about block cipher and their different modes. ● To help students conceptualize basic theories of different cryptographic mechanism such as symmetric and public key encryption, digital signature and hash function.

<table>
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To assist students in developing basic knowledge about different security aspects covering multiple domains such as physical security, OS security, network security and web security.
To facilitate the basic knowledge of blockchain systems.

</td></tr>
<tr><td>Course Contents:</td><td>
Basic terminology and security concepts: Fundamental concepts, Access control models, Cryptographic concepts, Security principles

Classic Crypto Systems: Substitution cipher, Vigenère cipher, Hill Cipher, One-time pads

Symmetric Encryption: Advanced Encryption Standard (AES)

Public Key Encryption: RSA and El Gamal cryptosystems

Other crypto mechanisms: Hash Function, Digital Signature

Physical security: Authentication technologies, Direct attacks, Physical Intrusion Detection

Operating Systems Security: Process, security, Memory and file system security, Application program security

Malware and forensic analysis: Insider & Malware attacks, Computer viruses, Privacy-invasive software, Countermeasures, Malware forensic

Network Security: Network security concepts, Vulnerabilities in Link, Network, Transport and Application layers, Firewall, Tunneling and Intrusion detection, Denial of Service attacks, Countermeasures

Web security: Attacks on clients, Attacks on servers, Countermeasures

Blockchain and Bitcoin: History of money, The need of decentralization, State machine replication, Concepts of transaction, block, blockchain and distributed consensus of Blockchain security, Blockchain applications
</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>
<table>
<tr><td>CLO 1</td><td>Knowledge of information and network security concepts and techniques.</td></tr>
<tr><td>CLO 2</td><td>Understanding of security threats and vulnerabilities.</td></tr>
<tr><td>CLO 3</td><td>Ability to implement security measures, such as encryption and firewalls.</td></tr>
<tr><td>CLO 4</td><td>Understanding of the importance of security awareness and training.</td></tr>
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</td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td>
Mapping of Course Learning Outcomes to Program Learning Outcomes
<table>
<tr><th>CLO /PLO</th><th>PLO1</th><th>PL02</th><th>PLO3</th><th>PLO4</th><th>PLO5</th><th>PLO6</th><th>PLO7</th><th>PLO8</th><th>PLO9</th><th>PLO10</th><th>PLO11</th><th>PLO12</th></tr>
<tr><td>CLO 1</td><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td><td>1</td><td></td><td></td><td></td><td></td></tr>
<tr><td>CLO 2</td><td>3</td><td>3</td><td></td><td>3</td><td></td><td>2</td><td></td><td>2</td><td></td><td></td><td>2</td><td></td></tr>
<tr><td>CLO 3</td><td>3</td><td>3</td><td>3</td><td></td><td>3</td><td></td><td>3</td><td></td><td>1</td><td>3</td><td>1</td><td></td></tr>
<tr><td>CLO 4</td><td>3</td><td></td><td></td><td>2</td><td></td><td>3</td><td></td><td>3</td><td></td><td>2</td><td></td><td>3</td></tr>
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Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, P
CLO2	CL, T, OR, GD, PrbL, PjrL	A, P, RW
CLO3	CL, T, OR, PrbL, PjrL	A, P, RW
CLO4	GD, PrbL, PrjL, BL	V, A, P, RW

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Information and Network Security**	CL, T, OR,	A, P	CLO1, CLO2
2-3	**Classic Crypto Systems** **Substitution cipher** **Vigenère cipher** **Hill Cipher** **One-time pads**	CL, T, OR, GD	A, P, RW	CLO1, CLO2, CLO3
4-5	**Symmetric Encryption**	CL, T, OR, GD	A, P, RW	CLO1, CLO2, CLO3, CLO4
6-7	**Public Key Encryption**	CL, T, OR, PrbL, PjrL	A, P, RW	CLO1, CLO3, CLO4
8	**Other Crypto Mechanisms**	CL, T, OR, PrbL, PjrL	A, P, RW	CLO1, CLO2, CLO4
9-10	**Physical security**	GD, PrbL, PrjL, BL	A, P	CLO1, CLO2, CLO3, CLO4
11-12	**Operating Systems Security**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	A, P	CLO2, CLO3, CLO4
13-14	**Network and Web Security**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	A, P, RW	CLO1, CLO2, CLO3, CLO4

	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)
Text Books	1. Introduction to Computer Security by MichaelT. Goodrich and Roberto Tamassia 2. Introduction to Computer Security by Matt Bishop

Course Title:	Information and Network Security Lab
Credits:	1.5
Course No.:	SWE 0612-4130
Credit Hours:	3 hours/week
Rationale:	In this course, these students will carry out a number of hands -on lab works based on concepts gained in its counterpart theory course, SWE 429. The main motivation of this course is to provide hands-on experiences of working with different encryption algorithms, attacking systems exploiting different vulnerabilities and adopting security measures to counteract these vulnerabilities.
Objectives:	● To assist students in developing practical knowledge about different cryptographic algorithms ● To help students to identify different vulnerabilities within a system and to assess its security. ● To assist students in developing secure systems using different cryptographic libraries. ● To facilitate the knowledge of exploiting network vulnerabilities, attacking as well as defending a web application.
Course Contents:	Attacking classic cipher systems, Programming different cryptographic algorithms, Developing secure systems utilizing different cryptographic libraries, Exploiting network vulnerabilities, attacking and defending web applications and Malware analysis.
Course Learning Outcomes (CLOs):	**CLO 1** Hands-on experience with information and network security concepts and techniques. **CLO 2** Practice identifying and mitigating security threats and vulnerabilities. **CLO 3** Hands-on experience developing and implementing a security policy.
Mapping of CLOs with Program Learning Outcomes (PLOs):	**Mapping of Course Learning Outcomes to Program Learning Outcomes**

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO 12
CLO 1	3			2					2			
CLO 2	3	3	3		3	2	2	3		2	1	3

CLO 3	**3**		**3**	**3**	**3**	**2**			**3**	**1**		**2**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1-2	**Classic Crypto Systems**	CL, T, OR, GD, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
3-4	**Symmetric Encryption**	CL, T, OR, GD, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
5-6	**Public Key Encryption**	CL, T, OR, GD, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
7-8	**Other Crypto Mechanisms**	CL, T, OR, PrbL, PjrL	Lab Report, Hands-on exercises	CLO1, CLO3, CLO4
9-10	**Physical Security**	CL, T, OR, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO4
11-12	**Operating Systems Security**	GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
13-14	**Network and Web Security**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	Hands-on exercises ,Final Project Report, Presentation	CLO2, CLO3, CLO4

	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)
Text Books	1. Introduction to Computer Security by MichaelT. Goodrich and Roberto Tamassia 2. Computer Security: Principles and Practice by William Stallings Lawrie Brown, 4th Edition 3. Introduction to Computer Security by Matt Bishop

Course Title:	Human Computer Interaction
Credits:	3
Course No.:	SWE 0688-4131
Credit Hours:	3 hours/week
Rationale:	This course teaches students to design user interfaces based on the capabilities of computer technology and the needs of human factors. Students design a user interface for a system and implement a prototype from a list of informal requirements. The project is developed over three assignments by a design process based on current human–computer interaction principles.
Objectives:	**Objectives:** ● Provide an overview of the concepts relating to the design of human-computer interfaces in ways making computer-based systems comprehensive, friendly and usable. ● Help the students to understand the theoretical dimensions of human factors involved in the acceptance of computer interfaces. ● Understand the important aspects of implementation of human-computer interfaces. ● To foster the analytical and critical capability of the students to apply the knowledge of various design principles to design complex User Interfaces.
Course Contents:	**Foundations of Human–Computer Interaction:** Human Capabilities, The Computer, The Interaction, Paradigms **The Design Process:** Interaction Design Basics, HCI in the Software Process, Design Rules, Universal Design **Implementation Support: (**Implementation Tools **Evaluation and User Support:** Evaluation, User Support **Users Models:** Cognitive Models, Socio-organizational Issues and Stakeholder Requirements **Task Models and Dialogs:** Analyzing Tasks, Dialog Notations and Design **Groupware, Ubiquitous Computing, Virtual and Augmented Reality, Hypertext and Multimedia:** Groupware and Computer-supported Collaborative Work, Ubiquitous

	Computing, Virtual Reality and Augmented Reality, Hypertext, Multimedia and the World Wide Web
Course Learning Outcomes (CLOs):	After the successful completion of the course, the student will be able to-

CLO 1	Ability to analyze and evaluate existing user interfaces in terms of usability, accessibility, and user satisfaction..
CLO 2	Ability to design user interfaces for computer-based systems that are comprehensive, friendly, and usable, based on current human-computer interaction principles.
CLO 3	Knowledge of using appropriate cognitive and socio-organizational models to design effective user interfaces for different user groups.
CLO 4	Develop critical thinking and analytical skills necessary to identify social and ethical issues in HCI and design interfaces that consider these issues.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO 12
CLO 1	3		3		2							
CLO 2	3	3	3									
CLO 3	3										2	
CLO 4	3	3	3	3		3	1	1	1	1		3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrjL	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs

		1	**Introduction to Human-Computer Interaction** **Topics covered: Overview of HCI and its importance in computer-based systems.** **Foundations of HCI: human capabilities, the computer, and the interaction** **Paradigms of HCI**	CL, T, OR, GD, PrbL	A, LE, PP	CLO1, CLO2, CLO3, CLO4	
		2	**Design Process in HCI** **Topics covered: Interaction design basics** **HCI in the software process** **Design rules and principles** **Universal design**	CL, T, OR, GD, PrbL	A, LE, PP	CLO1, CLO2, CLO3, CLO4	
		3	**Implementation Support in HCI** **Topics covered: Implementation tools and technologies** **Prototyping techniques**	CL, T, OR, GD, PrbL	A, LE, PP	CLO1, CLO2, CLO3, CLO4	
		4	**Evaluation and User Support in HCI** **Topics covered: Methods for evaluating user interfaces** **User support and feedback mechanisms**	CL, T, OR, PrbL, PjrL	A, PP, P	CLO1, CLO3, CLO4	
		5	**User Models in HCI** **Topics covered: Design principles, design concepts, effective modular design, design**	CL, T, OR, PrbL	A, PP	CLO1, CLO2, CLO4	

			heuristics, data design.			
		6	**Task Models and Dialogs in HCI** **Topics covered: Analyzing user tasks and requirements** **Dialog notation and design principles** **Dialog management and control**	GD, PrbL, PrjL, BL	A, V, P, RW, Prj	CLO1, CLO2, CLO3, CLO4
		7	**Groupware and Computer-Supported Collaborative Work** **Topics covered: Introduction to groupware and its role in collaborative work** **Designing groupware applications for effective collaboration**	GD, PrbL, PrjL, BL	A, V, P, RW, Prj	CLO3, CLO4
		8	**Ubiquitous Computing** **Topics covered: Understanding the concept of ubiquitous computing** **Designing interfaces for ubiquitous computing environments**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	A, V, P, RW, Prj	CLO2, CLO3, CLO4
		9	**Virtual and Augmented Reality** **Topics Covered:** **ntroduction to virtual and augmented reality** **Designing interfaces for virtual and augmented reality applications**	CL, T, OR, GD, PrbL	A, LE, PP	CLO1, CLO2, CLO3, CLO4
		10	**Hypertext and Multimedia** **Topics Covered:**	CL, T, OR, PrbL, PjrL	A, PP, P	CLO1, CLO3, CLO4

		Understanding hypertext and multimedia **Designing interfaces for hypertext and multimedia applications**			
	11	**HCI in the Mobile and Wearable Computing Era** **Topics Covered:** **Introduction to mobile and wearable computing** **Designing interfaces for mobile and wearable computing devices**	CL, T, OR, PrbL	A, PP	CLO1, CLO2, CLO4
	12	**Social and Ethical Issues in HCI** **Topics Covered:** **Understanding the social and ethical implications of HCI** **Designing interfaces that consider social and ethical issues**	GD, PrbL, PrjL, BL	A, V, P, RW, Prj	CLO1, CLO2, CLO3, CLO4
	13-14	**Emerging Trends in HCI** **Topics Covered:** **Introduction to emerging trends in HCI** **Designing interfaces for emerging HCI technologies**	CL, T, OR, GD, PrbL	A, LE, PP	CLO1, CLO2, CLO3, CLO4
	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)				
Text books	1. Dix A. et al., Human-Computer Interaction. Harlow, England: Prentice Hall, 2004, ISBN-10: 0130461091				

	2. Yvonne Rogers, Helen Sharp, Jenny Preece, Interaction Design: Beyond Human Computer Interaction, 3rd Edition, Wiley, 2011, ISBN-10: 0470665769 1.

Course Title:	Human Computer Interaction Lab
Credits:	1.5
Course No.:	SWE 0688-4132
Credit Hours:	3 hours/week
Rationale:	This course teaches students to design user interfaces based on the capabilities of computer technology and the needs of human factors. Students design a user interface for a system and implement a prototype from a list of informal requirements. The project is developed over three assignments by a design process based on current human–computer interaction principles.
Objectives:	**Objectives:** ● Help the students to experiment with the design of human-computer interfaces in ways making computer-based systems comprehensive, friendly and usable. ● To accumulate basic ideas about exploring the theoretical dimensions of human factors involved in the acceptance of computer interfaces. ● Acquaint students with the basic tools and techniques for interface analysis, design, and evaluation. ● Make the students understand and identify the impact of usable interfaces in the acceptance and performance utilization of information systems. ● Help the students to identify the importtance of working in teams and the role of each member within an interface development phase
Course Contents:	**Foundations of Human–Computer Interaction:** Human Capabilities, The Computer, The Interaction, Paradigms **The Design Process:** Interaction Design Basics, HCI in the Software Process, Design Rules, Universal Design **Implementation Support: (**Implementation Tools **Evaluation and User Support:** Evaluation, User Support **Users Models:** Cognitive Models, Socio-organizational Issues and Stakeholder Requirements **Task Models and Dialogs:** Analyzing Tasks, Dialog Notations and Design **Groupware, Ubiquitous Computing, Virtual and Augmented Reality, Hypertext and Multimedia:** Groupware and Computer-supported Collaborative Work, Ubiquitous Computing, Virtual Reality and Augmented Reality, Hypertext, Multimedia and the World Wide Web
Course Learning	After the successful completion of the course, the student will be able to-

Outcomes (CLOs):

CLO 1	Ability to analyze and evaluate existing user interfaces in terms of usability, accessibility, and user satisfaction..
CLO 2	Ability to design user interfaces for computer-based systems that are comprehensive, friendly, and usable, based on current human-computer interaction principles.
CLO 3	Knowledge of using appropriate cognitive and socio-organizational models to design effective user interfaces for different user groups.
CLO 4	Develop critical thinking and analytical skills necessary to identify social and ethical issues in HCI and design interfaces that consider these issues.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Mapping of Course Learning Outcomes to Program Learning Outcomes

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3	3	3		3			1		2		
CLO 2	3	3	3					1				
CLO 3	3	3	3	3	3	2		1				
CLO 4	3	3	3	3		2	3	2	3	3	2	3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrjL	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Human-Computer Interaction** **Topics covered: Familiarization with**	CL, T, OR, GD, PrbL	P, LE	CLO1, CLO2, CLO3, CLO4

			the lab environment and equipment **Introduction to HCI concepts and principles**				
		2	**Interaction Design Basics** **Topics covered: Introduction to design process and principles** **Developing low-fidelity prototypes**	CL, T, OR, GD, PrbL	V, P	CLO1, CLO2, CLO3, CLO4	
		3	**HCI in the Software Process** **Topics covered: Understanding software development life cycle** **Designing user interfaces for different stages of software development**	CL, T, OR, GD, PrbL	A, LE, PP	CLO1, CLO2, CLO3, CLO4	
		4	**Universal Design** **Topics covered: Understanding accessibility in HCI** **Designing accessible user interfaces**	CL, T, OR, PrbL, PjrL	A, PP, P	CLO1, CLO3, CLO4	
		5	**Implementation Tools and Technologies** **Topics covered: Introduction to implementation tools and technologies** **Hands-on experience with implementation tools and technologies**	CL, T, OR, PrbL	A, PP	CLO1, CLO2, CLO4	
		6	**Evaluation Methods** **Topics covered: Introduction to evaluation methods** **Hands-on experience with evaluation methods**	GD, PrbL, PrjL, BL	A, V, P, RW, Prj	CLO1, CLO2, CLO3, CLO4	

		7	**User Models in HCI** **Topics covered: Introduction to cognitive and socio-organizational models of user behavior** **Developing user models for designing effective user interfaces**	GD, PrbL, PrjL, BL	A, V, P, RW, Prj	CLO3, CLO4	
		8	**Dialog Notation and Design** **Topics covered: Introduction to dialog notation and design principles** **Developing effective dialog designs**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	A, V, P, RW, Prj	CLO2, CLO3, CLO4	
		9	**Groupware and Computer-Supported Collaborative Work** **Topics Covered:** **Introduction to groupware and its role in collaborative work** **Designing groupware applications for effective collaboration**	CL, T, OR, GD, PrbL	A, LE, PP	CLO1, CLO2, CLO3, CLO4	
		10	**Ubiquitous Computing** **Topics Covered:** **Understanding the concept of ubiquitous computing** **Designing interfaces for ubiquitous computing environments**	CL, T, OR, PrbL, PjrL	A, PP, P	CLO1, CLO3, CLO4	
		11	**Virtual and Augmented Reality** **Topics Covered:** **Introduction to virtual and augmented reality**	CL, T, OR, PrbL	A, PP	CLO1, CLO2, CLO4	

		Designing interfaces for virtual and augmented reality applications			
	12	**Hypertext and Multimedia** **Topics Covered:** **Understanding hypertext and multimedia** **Designing interfaces for hypertext and multimedia applications**	GD, PrbL, PrjL, BL	A, V, P, RW, Prj	CLO1, CLO2, CLO3, CLO4
	13-14	**Final Project Presentation and Review** **Topics Covered:** **Students present their final project designs and receive feedback and review from the instructor and peers.**	GD, PrjL, BL	A, LE, PP	CLO1, CLO2, CLO3, CLO4
	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)				
Text books	1. Dix A. et al., Human-Computer Interaction. Harlow, England: Prentice Hall, 2004, ISBN-10: 0130461091 2. Yvonne Rogers, Helen Sharp, Jenny Preece, Interaction Design: Beyond Human Computer Interaction, 3rd Edition, Wiley, 2011, ISBN-10: 0470665769				

Course Title:	Thesis/Project
Credits:	04
Course No.:	SWE 0610-4150
Credit Hours:	8 hours / week

<table>
<tr><td>Rationale:</td><td>This course is intended to provide students hands-on experience in identifying a real-life computing problem on contemporary topics related to their field of interest and finding a solution through design, development and validation.</td></tr>
<tr><td>Objectives:</td><td>● To facilitate students apply theoretical concepts in practical settings.
● To help students develop problem-solving skills.
● To help students develop communication and teamwork skills.
● To help students develop project management skills.
● To help students promote an understanding of professional and ethical responsibilities.</td></tr>
<tr><td>Course Contents:</td><td>Research work based on the core courses studied in the previous semesters.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>After the successful completion of the course, the student will be able to-

<table>
<tr><td>CLO 1</td><td>Identify a real-life problem that can be translated to an engineering and/or computing solution through design, development and validation.</td></tr>
<tr><td>CLO 2</td><td>Identify outcomes and functional requirements of the proposed solution considering software and/or hardware specification and standards</td></tr>
<tr><td>CLO 3</td><td>Identify sub-components of a complex problem, prepare timeline and appropriate budget using the project management skill</td></tr>
<tr><td>CLO 4</td><td>Analyze, design, build, and evaluate engineering/computing system/subsystem with given specifications and requirements</td></tr>
<tr><td>CLO 5</td><td>Identify and validate the impact of environmental considerations and the sustainability of a system/subsystem of a complete project</td></tr>
<tr><td>CLO 6</td><td>Assess professional, ethical, and social impacts and responsibilities of the design project.</td></tr>
<tr><td>CLO 7</td><td>Function effectively in a multi-disciplinary team</td></tr>
<tr><td>CLO 8</td><td>Use modern analysis and design tools in the process of designing and validating of a system and subsystem</td></tr>
<tr><td>CLO 9</td><td>Present design project results through written technical documents and oral presentations</td></tr>
</table></td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td>Mapping of Course Learning Outcomes to Program Learning Outcomes

<table>
<tr><th></th><th>PLO 1</th><th>PLO 2</th><th>PLO 3</th><th>PLO 4</th><th>PLO 5</th><th>PLO 6</th><th>PLO 7</th><th>PLO 8</th><th>PLO 9</th><th>PLO 10</th><th>PLO 11</th><th>PLO 12</th></tr>
<tr><td>CLO 1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>3</td></tr>
</table></td></tr>
</table>

CLO 2		**3**	**2**									
CLO 3											**3**	
CLO 4			**3**	**3**								
CLO 5							**3**					
CLO 6						**3**		**3**				
CLO 7									**3**			
CLO 8					**3**							
CLO 9										**3**		

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Discussion	Report
CLO 2	Discussion	Report
CLO 3	Discussion	Report
CLO 4	Discussion	Report, Project Demo
CLO 5	Discussion	Report
CLO 6	Discussion	Report
CLO 7	Discussion	Peer-evaluation
CLO 8	Discussion	Project-demo, Presentation
CLO 9	Discussion	Report, Presentation

Fourth Year Second Semester

<table>
<tr><td>Course Title:</td><td>Internship</td></tr>
<tr><td>Credits:</td><td>18</td></tr>
<tr><td>Course No.:</td><td>SWE 0612-4220</td></tr>
<tr><td>Credit Hours:</td><td>36 hours/week</td></tr>
<tr><td>Rationale:</td><td>This course is specially designed to help the students to gain some extensive industry experience before graduating from the university. Software Engineering students need to be extremely skilled at using the latest technologies and to be able to work within a team. This course will help the students to understand how the job is actually done in an industry. They will be able to have the experience to work within a team to achieve a common goal. Also this course will help them to contribute to a real life project as they will work closely with a company for six months.</td></tr>
<tr><td>Objectives:</td><td>Objectives:
To help the students get exposed to real work within an actual company rather than a mere demo project.
Allowing the students to understand the work ethics of a company.
Facilitate the students in building up their teamwork so that they can work efficiently within a team to achieve a common goal.
Allowing the students to understand the skills that are demanded or required by the industry.
To let the students have work experience even before graduation.</td></tr>
<tr><td>Course Contents:</td><td>Semester long real world software development experience. Reporting and presentation after the internship.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td><table><tr><td>CLO 1</td><td>Apply software engineering principles and best practices in a real-world work environment.</td></tr><tr><td>CLO 2</td><td>Communicate effectively with team members and stakeholders in a professional setting.</td></tr><tr><td>CLO 3</td><td>Analyze and solve complex problems using critical thinking and technical skills.</td></tr><tr><td>CLO 4</td><td>Demonstrate professionalism, ethical behavior, and responsibility in the workplace.</td></tr></table></td></tr>
<tr><td>Mapping of CLOs with Program Learning</td><td>Mapping of Course Learning Outcomes to Program Learning Outcomes</td></tr>
</table>

Outcomes (PLOs):

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	3	2	2		1		2			2	3
CLO2	3	2	2	2	2				3	1		3
CLO3	3					2	1			2		3
CLO4	3		1					1	1		2	3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1-4	Allocation & Training		Midway Presentation	CLO1
5-14	Work in a Real Life Project		Presentation,Report Submission, Company Evaluation	CLO1, CLO2,CLO3, CLO4

Course Title:	Comprehensive Viva Voce
Credits:	1
Course No.:	SWE 0612-4220

<table>
<tr><td>Rationale:</td><td>Software Engineering students need to develop the skills necessary to do good at job interviews. This course will allow students to develop the communication skills that are necessary for the students to do well in the job viva. This course will test the overall Software Engineering knowledge base of the students that they gained in the four years.</td></tr>
<tr><td>Objectives:</td><td>Objectives:
To help the students to getting familiarize with the viva process
To accumulate basic ideas about having an overall grasp of the core subjects of Software Engineering
To facilitate the students to develop their communication skills required for job interviews.</td></tr>
<tr><td>Course Contents:</td><td>Viva based on studied major courses of Software Engineering.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>
<table>
<tr><td>CLO 1</td><td>Apply skills necessary to do well in job interviews</td></tr>
<tr><td>CLO 2</td><td>Outline the procedures for appearing in an interview</td></tr>
<tr><td>CLO 3</td><td>Demonstrate the core software engineering course knowledge</td></tr>
<tr><td>CLO 4</td><td>Demonstrate professionalism, ethical behavior, and responsibility in the workplace.</td></tr>
</table>
</td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td>Mapping of Course Learning Outcomes to Program Learning Outcomes
<table>
<tr><th>CLO/PLO</th><th>PLO1</th><th>PLO2</th><th>PLO3</th><th>PLO4</th><th>PLO5</th><th>PLO6</th><th>PLO7</th><th>PLO8</th><th>PLO9</th><th>PLO10</th><th>PLO11</th><th>PLO12</th></tr>
<tr><td>CLO1</td><td>3</td><td>3</td><td>2</td><td>2</td><td></td><td>1</td><td></td><td>2</td><td></td><td></td><td>2</td><td></td></tr>
<tr><td>CLO2</td><td>3</td><td>2</td><td>2</td><td>2</td><td>2</td><td></td><td></td><td></td><td>3</td><td>1</td><td></td><td></td></tr>
<tr><td>CLO3</td><td>3</td><td></td><td></td><td></td><td></td><td>2</td><td>1</td><td></td><td></td><td>2</td><td></td><td>1</td></tr>
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<tr><td>CLO2</td><td>OR, GD, PrbL, PjrL</td><td>A, LE, RW</td></tr>
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<tr><td>CLO4</td><td>GD, PrbL, PrjL, BL</td><td>V, P, RW, Prj</td></tr>
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	(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Optional Courses

Course Title:	Computer Graphics and Image Processing
Credits:	3.0
Course No.:	SWE 0613-4123
Credit Hours:	3 hours/week
Rationale:	In many engineering applications (e.g. automotive, aerospace, medical), the ability to quickly visualize newly designed shapes is indispensable. Using computer graphics, designers can interactively view and modify models of their shapes using a computer. Therefore, a student who is willing to build his/her career in modeling and visualizing the data from imaging this course will help them to learn the fundamentals and tools used to create and manipulate digital graphics.
Objectives:	● To provide knowledge on the basic elements and skills involved in the creation of computer graphics ● To help them to learn how to apply computer graphics skills and capacities to enhance published content ● To facilitate knowledge about how to model and visualize different products, buildings and cars etc. and visualize data from medical imaging such as CT scans ● To help them learn about the connection between computer graphics capacities and skills and workplace career and professional opportunities
Course Contents:	Computer Graphics Programming: OpenGL. **Raster Graphics**: Line Drawing, Anti-aliasing, Polygon Filling Algorithms. **Camera Analogy**: Viewing, Windowing, Clipping. **Projective Transformation (Ray-tracing):** Orthogonal Projection, Perspective Projection. **Vector:** Normal Vector, View Vector. **Matrix**: 2D and 3D Rotation and Translation Matrix. **Hidden Surface Removal**: z-buffering. **Lighting and Surface Property:** Diffused Light, Ambient Light, Specular Light, Lighting Models for reflection. **Shading**: Flat Shading, Lambert Shading, Phong Shading. **Texture Mapping**: Texture Fundamentals. **Animation:** Real time animation

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO1	Select and analyze fundamentals such as digital image representation, color perception, image formation, and image processing
CLO2	Apply algorithms related to hidden surface removal that includes but are not limited to the Z-buffer algorithm and the Painter's algorithm
CLO3	Elaborate the algorithmic and mathematical tools that are used to create a variety of digital images and effects
CLO4	Demonstrate three main subjects within computer graphics, modeling, rendering, and animation

Mapping of CLOs with Program Learning Outcomes (PLOs)

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	X	X	X									
CLO2	X	X	X									
CLO3	X	X	X	X	X							
CLO4	X	X	X	X	X							

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL, BL	CT, Q, A, MS, SF
CLO2	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF
CLO3	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF
CLO4	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1-2	**Raster Graphics:** Line Drawing, Anti-aliasing, Polygon Filling Algorithms.	CL, T, OR, PrbL, BL	CT, Q, A, MS, SF	1
3-4	**Matrix:** 2D and 3D Rotation and Translation Matrix.	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF	4
5-6	**Camera Analogy:** Viewing, Windowing, Clipping.	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF	3, 4
7-8	**Hidden Surface Removal:** z-buffering.	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF	2
9	**Projective Transformation (Ray-tracing):** Orthogonal Projection, Perspective Projection.	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF	4
10	**Vector:** Normal Vector, View Vector.	CL, T, OR, PrbL, BL	CT, Q, A, MS, SF	1

	11	**Lighting and Surface Property:** Diffused Light, Ambient Light, Specular Light, Lighting Models for reflection.	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF	3, 4
	12	**Shading:** Flat Shading, Lambert Shading, Phong Shading.	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF	3, 4
	13	**Texture Mapping:** Texture Fundamentals.	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF	3, 4
	14	**Animation:** Real-time animation.	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF	4
	(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning) (CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)				
Text books	1. Theory and Problems of Computer Graphics (3rd Edition) – Zhigang Xiang, Roy A. Plastock; McGraw Hill (2000). 2. Computer Graphics C Version (3rd Edition) – Donald Hearn, M. Pauline Baker; Pearson Prentice Hall (2004). 3. Computer Graphics Principle and Practice (3rd Edition) – Donald Hearn, M. Pauline Baker; Addison-Wesley Professional (2013).				

Course Title:	Computer Graphics and Image Processing Lab
Credits:	1.5
Course No.:	SWE 0613-4124
Credit Hours:	3 hours/week
Rationale:	This course motivates to develop and modify 2D and 3D visualization and transformation of any geometric object by using graphics library as well as working with texturing, lighting and coloring of such objects to develop different types of digital images with various effects.
Objectives:	● To learn basic concepts of 2D, 3D and animation graphics project using OpenGL graphics library ● To understand graphics programming and familiar with image manipulation, enhancement. ● To familiarize with 3D graphical scenes using open graphics library suits and learn to create animations and multimedia presentation/Game/Project. ● To develop 3D games and animation using different software like blender, unity etc.
Course Contents:	**Computer Graphics Programming:** OpenGL **Scan Conversion:** Implementation of Algorithms for drawing 2D Primitives – Line (DDA, Bresenham), Circle (Bresenham ,Midpoint) **Region Filling**: Scan line algorithm **Transformation:** 2D Geometric transformations – Translation, Rotation, Scaling, Reflection, Shear Window-Viewport, Composite 2D Transformations, 3D Transformations - Translation, Rotation, Scaling. **Clipping**: Line Clipping, polygon clipping **Projections**: 3D Projections – Parallel, Perspective.

	Animation: 2D Animation, Interactive animation using any authoring tool
Course Learning Outcomes (CLOs):	On successful completion of this course, students will be able to: CLO 1 — Learn and apply the graphics library OpenGL CLO 2 — Draw basic geometric shapes (Points, Lines, Circles) using drawing algorithms. CLO 3 — Apply geometrical transformations on graphical problem solving. CLO 4 — Develop skill to generate computer graphics animation software. CLO 5 — Demonstrate 2D and 3D graphics processing techniques. (transformation, viewing, clipping)
Mapping of CLOs with Program Learning Outcomes (PLOs):	

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1					X		X					
CLO2						X						
CLO3						X						
CLO4								X				
CLO5									X	X		

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:	

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrjL, BL	A, LE, PP, Prj
CLO2	CL, T, OR, PrjL, BL	A, LE, PP, Prj
CLO3	CL, T, OR, GD, PrjL, BL	A, LE, PP, Prj
CLO4	CL, T, OR, PrjL, BL	A, LE, PP, Prj
CLO5	CL, T, OR, PrjL, BL	A, LE, PP, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1-2	**Computer Graphics Programming**	CL, T, OR, PrjL, BL	A, LE, PP, Prj	CLO1

		3-6	**Scan Conversion**	CL, T, OR, PrjL, BL	A, LE, PP, Prj	CLO2
		7-8	**Region Filling**	CL, T, OR, PrjL, BL	A, LE, PP, Prj	CLO2
		9-10	**Transformation**	CL, T, OR, GD, PrjL, BL	A, LE, PP, Prj	CLO3
		11-12	**Clipping**	CL, T, OR, GD, PrjL, BL	A, LE, PP, Prj	CLO1, CLO2, CLO3
		13-14	**Animation**	CL, T, OR, PrjL, BL	A, LE, PP, Prj	CLO4, CLO5
	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)					
Text books	1. OpenGL Programming Guide: The Official Guide to Learning OpenGL (8th Edition)- Dave Shreiner, Graham Sellers, John Kessenich and Bill Licea-Kane; Addison Wesley Professional (2013) 2. Theory and Problems of Computer Graphics (3rd Edition) – Zhigang Xiang, Roy A. Plastock; McGraw Hill (2000). 3. Computer Graphics C Version (3rd Edition) – Donald Hearn, M. Pauline Baker; Pearson Prentice Hall (2004). 4. Computer Graphics Principle and Practice (3rd Edition) – Donald Hearn, M. Pauline Baker; Addison-Wesley Professional (2013).					

1.

Course Title:	Advanced Data Structure And Algorithm
Credits:	3
Course No.:	SWE 0613-4133
Credit Hours:	3 hours/week
Rationale:	Students need to have the ability to not only implement the algorithms but also they need to have sound understandings about why the algorithms works. This course will help them to prove the correctness of algorithms.
Objectives:	**Objectives:** ● To provide knowledge on the basic elements and skills involved in the creation of advanced algorithms ● To help them to learn how to apply advanced algorithms s skills and capacities to enhance published content

<table>
<tr><td></td><td>

To facilitate knowledge about how to model and visualize different real life problems and reduce them to one of the known problems that can be solved
To help them learn about the connection between advanced algorithms' capacities and skills and workplace career and professional opportunities.

</td></tr>
<tr><td>Course Contents:</td><td>
Introduction to Data Structures and Algorithms

Importance of Data Structures and Algorithms in Computing

Complexity Analysis and Asymptotic Notations

Analysis of Algorithms

Recurrence Relations and their Solutions

Sorting Algorithms: Bubble Sort, Insertion Sort, Selection Sort, Divide and Conquer Strategy and Merge Sort

Divide and Conquer Algorithms: Quick Sort, Binary Search and its Applications, Closest Pair of Points Problem

Greedy Algorithms: Activity Selection Problem,Huffman Coding

Dynamic Programming: Optimal Substructure and Overlapping Subproblems, Memoization and Tabulation, Rod Cutting Problem and Knapsack Problem

Graph Algorithms: Graph Representation and Traversal, Breadth-First Search and Depth-First Search

Shortest Path Algorithms: Dijkstra's Algorithm and Bellman-Ford Algorithm

Minimum Spanning Trees: Kruskal's Algorithm,Prim's Algorithm

String Algorithms: Pattern matching algorithms, tries, and suffix trees.

Advanced Dynamic Programming: Dynamic programming in graph algorithms, optimal substructure, and overlapping subproblems.

Advanced Divide and Conquer Algorithms: Binary search, closest pair, convex hull, and applications of divide and conquer algorithms.

Advanced Greedy Algorithms: Minimum spanning tree algorithms, shortest path algorithms, and Knapsack problem.

Advanced Backtracking Algorithms: N-Queens problem, subset sum problem, and graph coloring problem.

Advanced Computational Geometry Algorithms: Convex hull, Voronoi diagrams, and nearest neighbor search.

Advanced Approximation Algorithms: Vertex cover, set cover problems, Knapsack problem, and scheduling problems.
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<tr><td>Course Learning Outcomes (CLOs):</td><td>
After the successful completion of the course, the student will be able to-
<table>
<tr><td>CLO 1</td><td>Students will be able to analyze and evaluate the time and space complexity of advanced algorithms and data structures.</td></tr>
<tr><td>CLO 2</td><td>Students will be able to design and implement advanced algorithms and data structures to solve complex problems in computer science.</td></tr>
</table>
</td></tr>
</table>

CLO 3	Students will be able to apply various algorithmic design techniques, such as dynamic programming, greedy algorithms, and randomized algorithms, to solve real-world problems.
CLO 4	Students will be able to select and justify appropriate data structures and algorithms to solve a given problem based on their knowledge of their characteristics and trade-offs.

Mapping of CLOs with Program Learning Outcomes (PLOs):

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3											
CO 2		3										
CO 3			3									
CO 4				3								
CO 5				3								1

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures	Quiz, Problem Solving Contest
CLO 2	Lectures, Group Discussion, TPS **(Think-Pair-Share)**	Assignment, Quiz, Problem Solving Contest
CLO 3	Lectures, Demonstrations, Problem Solving Tasks, Complexity Analysis Comparison, TPS	Assignment,Quiz, Problem Solving Contest
CLO 4	Brainstorming, Decision Making Tasks	Quiz, Problem Solving Contest

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Data Structures and Algorithms** **Topics covered: Course Introduction and Overview**	Lectures, discussions, and examples to introduce the course content and motivate the	Quiz on asymptotic notations and complexity analysis	CLO1, CLO2, CLO3, CLO4

			Importance of Data Structures and Algorithms in Computing **Complexity Analysis and Asymptotic Notations**	importance of data structures and algorithms.			
		2	**Analysis of Algorithms** **Topics covered: Recurrence Relations and their Solutions** **Sorting Algorithms: Bubble Sort, Insertion Sort, Selection Sort** **Divide and Conquer Strategy and Merge Sort**	Lectures, in-class exercises, and coding assignments to illustrate the concepts and algorithms covered in the week.	Coding assignment on implementing merge sort algorithm and a quiz on sorting algorithms	CLO1, CLO2, CLO4	
		3	**Divide and Conquer Algorithms** **Topics covered: Quick Sort** **Binary Search and its Applications** **Closest Pair of Points Problem**	Lectures, in-class exercises, and coding assignments to illustrate the divide and conquer strategy and the applications covered in the week.	Coding assignment on implementing quick sort algorithm and a quiz on binary search and closest pair of points problem.	CLO1, CLO3, CLO4	
		4	**Greedy Algorithms** **Topics covered: Activity Selection Problem** **Huffman Coding**	Lectures, in-class exercises, and coding assignments to illustrate the greedy approach and the applications covered in the week.	Coding assignment on implementing Huffman coding and a quiz on the activity selection problem.	CLO1, CLO3, CLO4	
		5	**Dynamic Programming** **Topics covered: Optimal Substructure and Overlapping Subproblems**	Lectures, in-class exercises, and coding assignments to illustrate the dynamic programming	Coding assignment on implementing dynamic programming solutions for rod	CLO1, CLO2, CLO3, CLO4	

			Memoization and Tabulation **Rod Cutting Problem and Knapsack Problem**	approach and the applications	cutting problem and knapsack problem and a quiz.		
		6	**Graph Algorithms** **Topics covered:** **Graph Representation and Traversal** **Breadth-First Search and Depth-First Search** **Shortest Path Algorithms: Dijkstra's Algorithm and Bellman-Ford Algorithm**	Lectures, in-class exercises, and coding assignments to illustrate the graph algorithms and the applications	Coding assignment on implementing Dijkstra's Algorithm and a quiz on graph representation, traversal, and shortest path algorithms.	CLO1, CLO2, CLO3, CLO4	
		7	**Minimum Spanning Trees** **Topics covered: Kruskal's Algorithm** **Prim's Algorithm**	Lectures, in-class exercises, and coding assignments to illustrate the graph algorithms and the applications	Problem Solving Contest	CLO3, CLO4	
		8	**String Algorithms** **Topics covered:** **Pattern matching algorithms, tries, and suffix trees.**	Lectures, in-class exercises, and coding	Programming assignment to evaluate students' ability to implement and analyze string algorithms.	CLO2, CLO3, CLO4	
		9	**Advanced Dynamic Programming** **Topics Covered:** **Dynamic programming in graph algorithms, optimal substructure, and overlapping subproblems.**	Lecture, discussion, and implementation exercises to explain	Programming assignment to evaluate students' ability to implement and analyze dynamic programming algorithms.	CLO1, CLO2, CLO3, CLO4	
		10	**Advanced Divide and Conquer Algorithms**	Lecture, discussion, and coding exercises	Programming assignment to evaluate	CLO1, CLO3, CLO4	

			Topics Covered: **Binary search, closest pair, convex hull, and applications of divide and conquer algorithms.**		students' ability to implement and analyze divide and conquer algorithms.	
		11	**Advanced Greedy Algorithms** **Topics Covered:** **Minimum spanning tree algorithms, shortest path algorithms, and Knapsack problem.**	Lecture, discussion, and implementation exercises	Problem Solving Contest	CLO1, CLO2, CLO4
		12	**Advanced Backtracking Algorithms** **Topics Covered:** **N-Queens problem, subset sum problem, and graph coloring problem.**	Lecture, discussion, and implementation exercises	Programming assignment to evaluate students' ability to implement and analyze backtracking algorithms.	CLO1, CLO2, CLO3, CLO4
		13	**Advanced Computational Geometry Algorithms** **Topics Covered:** **Convex hull, Voronoi diagrams, and nearest neighbor search.**	Lecture, discussion, and implementation exercises	Problem Solving Contest	CLO1, CLO2, CLO3, CLO4
		14	**Advanced Approximation Algorithms** **Vertex cover, set cover problems, Knapsack problem, and scheduling problems.**	Lecture, discussion, and implementation exercises	Problem Solving Contest	CLO1, CLO2, CLO3, CLO4
Text books	1. Advanced Data Structures - Peter Brass 2. Data Structures – Seymour Lipschutz, Schaum's Outlines Series. 3. Introduction to Algorithms - Thomas H. Cormen , Charles E. Leiserson 1.					

Course Title:	Advanced Data Structure And Algorithm Lab
Credits:	1.5
Course No.:	SWE 0613-4134
Credit Hours:	3 hours/week
Rationale:	Students need to have the ability to not only implement the algorithms but also they need to have sound understandings about why the algorithms works. This course will help them to prove the correctness of algorithms.
Objectives:	**Objectives:** ● To provide knowledge on the basic elements and skills involved in the creation of advanced algorithms ● To help them to learn how to apply advanced algorithms s skills and capacities to enhance published content ● To facilitate knowledge about how to model and visualize different real life problems and reduce them to one of the known problems that can be solved ● To help them learn about the connection between advanced algorithms' capacities and skills and workplace career and professional opportunities.
Course Contents:	**Introduction to Data Structures and Algorithms** **Importance of Data Structures and Algorithms in Computing** **Complexity Analysis and Asymptotic Notations** **Analysis of Algorithms** **Recurrence Relations and their Solutions** **Sorting Algorithms:** Bubble Sort, Insertion Sort, Selection Sort, Divide and Conquer Strategy and Merge Sort **Divide and Conquer Algorithms:** Quick Sort, Binary Search and its Applications, Closest Pair of Points Problem **Greedy Algorithms:** Activity Selection Problem,Huffman Coding **Dynamic Programming:** Optimal Substructure and Overlapping Subproblems, Memoization and Tabulation, Rod Cutting Problem and Knapsack Problem **Graph Algorithms:** Graph Representation and Traversal, Breadth-First Search and Depth-First Search **Shortest Path Algorithms:** Dijkstra's Algorithm and Bellman-Ford Algorithm **Minimum Spanning Trees:** Kruskal's Algorithm,Prim's Algorithm **String Algorithms:** Pattern matching algorithms, tries, and suffix trees. **Advanced Dynamic Programming:** Dynamic programming in graph algorithms, optimal substructure, and overlapping subproblems. **Advanced Divide and Conquer Algorithms:** Binary search, closest pair, convex hull, and applications of divide and conquer algorithms.

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Advanced Backtracking Algorithms: N-Queens problem, subset sum problem, and graph coloring problem.

Advanced Computational Geometry Algorithms: Convex hull, Voronoi diagrams, and nearest neighbor search.

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<tr><td>CO 5</td><td></td><td></td><td></td><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1</td></tr>
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<tr><td>CLO 2</td><td>Lectures, Group Discussion, TPS (Think-Pair-Share)</td><td>Assignment, Quiz, Problem Solving Contest</td></tr>
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</table></td></tr>
</table>

CLO 4	Brainstorming, Decision Making Tasks	Quiz, Problem Solving Contest	

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Data Structures and Algorithms** **Topics covered: Course Introduction and Overview** **Importance of Data Structures and Algorithms in Computing** **Complexity Analysis and Asymptotic Notations**	Lectures, Tutorial class	Quiz on asymptotic notations and complexity analysis	CLO1, CLO2, CLO3, CLO4
2	**Analysis of Algorithms** **Topics covered: Recurrence Relations and their Solutions** **Sorting Algorithms: Bubble Sort, Insertion Sort, Selection Sort** **Divide and Conquer Strategy and Merge Sort**	Lectures, Tutorial class	Coding assignment on implementing merge sort algorithm and a quiz on sorting algorithms	CLO1, CLO2, CLO4
3	**Divide and Conquer Algorithms** **Topics covered: Quick Sort** **Binary Search and its Applications** **Closest Pair of Points Problem**	Lectures, Tutorial class	Coding assignment on implementing quick sort algorithm and a quiz on binary search and closest pair of points problem.	CLO1, CLO3, CLO4

		4	**Greedy Algorithms** **Topics covered: Activity Selection Problem** **Huffman Coding**	Lectures, Tutorial class	Coding assignment on implementing Huffman coding and a quiz on the activity selection problem.	CLO1, CLO3, CLO4	
		5	**Dynamic Programming** **Topics covered: Optimal Substructure and Overlapping Subproblems** **Memoization and Tabulation** **Rod Cutting Problem and Knapsack Problem**	Lectures, Tutorial class	Coding assignment on implementing dynamic programming solutions for rod cutting problem and knapsack problem and a quiz.	CLO1, CLO2, CLO3, CLO4	
		6	**Graph Algorithms** **Topics covered:** **Graph Representation and Traversal** **Breadth-First Search and Depth-First Search** **Shortest Path Algorithms: Dijkstra's Algorithm and Bellman-Ford Algorithm**	Lectures, Tutorial class	Coding assignment on implementing Dijkstra's Algorithm and a quiz on graph representation, traversal, and shortest path algorithms.	CLO1, CLO2, CLO3, CLO4	
		7	**Minimum Spanning Trees** **Topics covered: Kruskal's Algorithm** **Prim's Algorithm**	Lectures, Tutorial class	Problem Solving Contest	CLO3, CLO4	
		8	**String Algorithms** **Topics covered:** **Pattern matching algorithms, tries, and suffix trees.**	Lectures, Tutorial class	Programming assignment to evaluate students' ability to implement and analyze	CLO2, CLO3, CLO4	

					string algorithms.		
		9	**Advanced Dynamic Programming** **Topics Covered:** **Dynamic programming in graph algorithms, optimal substructure, and overlapping subproblems.**	Lectures, Tutorial class	Programming assignment to evaluate students' ability to implement and analyze dynamic programming algorithms.	CLO1, CLO2, CLO3, CLO4	
		10	**Advanced Divide and Conquer Algorithms** **Topics Covered:** **Binary search, closest pair, convex hull, and applications of divide and conquer algorithms.**	Lectures, Tutorial class	Programming assignment to evaluate students' ability to implement and analyze divide and conquer algorithms.	CLO1, CLO3, CLO4	
		11	**Advanced Greedy Algorithms** **Topics Covered:** **Minimum spanning tree algorithms, shortest path algorithms, and Knapsack problem.**	Lectures, Tutorial class	Problem Solving Contest	CLO1, CLO2, CLO4	
		12	**Advanced Backtracking Algorithms** **Topics Covered:** **N-Queens problem, subset sum problem, and graph coloring problem.**	Lectures, Tutorial class	Programming assignment to evaluate students' ability to implement and analyze backtracking algorithms.	CLO1, CLO2, CLO3, CLO4	
		13	**Advanced Computational Geometry Algorithms** **Topics Covered:** **Convex hull, Voronoi diagrams, and nearest neighbor search.**	Lectures, Tutorial class	Problem Solving Contest	CLO1, CLO2, CLO3, CLO4	

		14	**Advanced Approximation Algorithms** **Vertex cover, set cover problems, Knapsack problem, and scheduling problems.**	Lectures, Tutorial class	Problem Solving Contest	CLO1, CLO2, CLO3, CLO4
Text books	1. Advanced Data Structures - Peter Brass 2. Data Structures – Seymour Lipschutz, Schaum's Outlines Series. 3. Introduction to Algorithms - Thomas H. Cormen , Charles E. Leiserson					

Course Title:	Neural Network and Deep Learning
Credits:	3
Course No.:	SWE 0619-4135
Credit Hours:	3 hours/week
Rationale:	Students need to have the ability to implement Neural Network based models in their research methodologies. This course will help them to achieve this.
Objectives:	**Objectives:** ● To provide knowledge on the basic elements and skills involved in the creation of Neural Network based models. ● To help them to learn how to apply advanced neural network-based algorithms' skills and capacities to enhance published content ● To facilitate knowledge about how to model and visualize different real-life problems and apply neural network based models to solve them ● To help them learn about the connection between advanced deep learning algorithms' capacities and skills and workplace career and professional opportunities.
Course Contents:	Basic artificial neural networks, Recurrent Neural Network, Convulational Neural Network, LSTM, GRU, BIGRU, C-GRU, Word Embeddings, Graph neural networks, Few shot earning models, Reinforcement learning algorithms.
Course Learning Outcomes (CLOs):	After the successful completion of the course, the student will be able to- **CLO 1**: Understand the basic concepts of artificial neural networks and their applications in solving real-world problems. **CLO 2**: Develop skills in creating and implementing advanced neural network-based algorithms to enhance published content. **CLO 3**: Apply neural network-based models to solve different real-life problems and visualize the results using appropriate tools and techniques. **CLO 4**: Analyze the connection between deep learning algorithms' capabilities and skills and career opportunities in the workplace.

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3		3		2							
CLO 2	3	3	3									
CLO 3	3										2	
CLO 4	3	3	3	3		3	1	1	1	1		3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Quiz
CLO 2	Lectures, Tutorial class	Assignment, Quiz, Problem Solving Contest
CLO 3	Lectures, Tutorial class	Assignment,Quiz, Problem Solving Contest
CLO 4	Lectures, Tutorial class	Quiz, Problem Solving Contest

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Neural Networks** **Topics covered:** **The basics of artificial neural networks** **The architecture of a basic neural network** **Activation functions and their importance**	Lectures, Tutorial class	Quiz, Assignment, Presentation, Final Exam	CLO1, CLO2, CLO3, CLO4
2	**Recurrent Neural Networks (RNNs)**	Lectures, Tutorial class	Quiz, Assignment,	CLO1, CLO2, CLO4

			Topics covered: **The architecture of RNNs** **Exploring how RNNs work for sequence-based data** **Types of RNNs** **Backpropagation Through Time (BPTT)**		Presentation, Final Exam		
		3	**Convolutional Neural Networks (CNNs)** **Topics covered: Understanding the architecture of CNNs** **Exploring how CNNs work for image-based data** **Types of CNNs** **Backpropagation and Gradient Descent**	Lectures, Tutorial class	Quiz, Assignment, Presentation, Final Exam	CLO1, CLO3, CLO4	
		4	**Long Short-Term Memory (LSTM) Networks** **Topics covered: Understanding the architecture of LSTM networks** **Exploring how LSTMs work for sequence-based data** **Types of LSTMs** **Backpropagation Through Time (BPTT)**	Lectures, Tutorial class	Quiz, Assignment, Presentation, Final Exam	CLO1, CLO3, CLO4	
		5	**Gated Recurrent Unit (GRU) Networks** **Topics covered: Understanding the architecture of GRU networks**	Lectures, Tutorial class	Quiz, Assignment, Presentation, Final Exam	CLO1, CLO2, CLO3, CLO4	

			Exploring how GRUs work for sequence-based data **Types of GRUs** **Backpropagation Through Time (BPTT)**				
		6	**Bidirectional GRU (BIGRU) Networks** **Topics covered:** **Understanding the architecture of BIGRU networks** **Exploring how BIGRUs work for sequence-based data** **Types of BIGRUs** **Backpropagation Through Time (BPTT)**	Lectures, Tutorial class	Quiz, Assignment, Presentation, Final Exam	CLO1, CLO2, CLO3, CLO4	
		7	**Conditional GRU (C-GRU) Networks** **Understanding the architecture of C-GRU networks** **Exploring how C-GRUs work for sequence-based data** **Types of C-GRUs**	Lectures, Tutorial class	Quiz, Assignment, Presentation, Final Exam	CLO3, CLO4	
		8	**Word Embeddings** **Topics covered:** **Understanding the concept of word embeddings** **Applications of word embeddings** **Word2Vec and GloVe algorithms** **Visualizing word embeddings**	Lectures, Tutorial class	Quiz, Assignment, Presentation, Final Exam	CLO2, CLO3, CLO4	
		9	**Graph Neural Networks**	Lectures, Tutorial class	Quiz, Assignment,	CLO1, CLO2, CLO3, CLO4	

			Topics Covered: **Understanding the architecture of Graph Neural Networks** **Exploring how GNNs work for graph-based data** **Types of GNNs** **Backpropagation Through Graphs**		Presentation, Final Exam	
		10	**Few Shot Learning Models** **Topics Covered:** **Understanding the concept of Few Shot Learning** **Types of Few Shot Learning models** **Learning from small datasets** **Meta-learning algorithms**	Lectures, Tutorial class	Quiz, Assignment, Presentation, Final Exam.	CLO1, CLO3, CLO4
		11-14	**Reinforcement Learning Algorithms**	Lectures, Tutorial class	Quiz, Assignment, Presentation, Final Exam	CLO1, CLO2, CLO3, CLO4
Text books	1. Deep Learning by Ian Goodfellow and Y. Bengio. 1.					

Course Title:	Neural Network and Deep Learning Lab
Credits:	1.5
Course No.:	SWE 0619-4136
Credit Hours:	3 hours/week
Rationale:	Students need to have the ability to implement Neural Network based models in their research methodologies. This course will help them to achieve this.

<table>
<tr><td>Objectives:</td><td>Objectives:
To apply knowledge of the creation of Neural Network based models.
Apply advanced neural network-based algorithms' skills and capacities to enhance published content
Model and visualize different real-life problems and apply neural network-based models to solve them</td></tr>
<tr><td>Course Contents:</td><td>Basic artificial neural networks, Recurrent Neural Network, Convulational Neural Network, LSTM, GRU, BIGRU, C-GRU, Word Embeddings, Graph neural networks, Few shot earning models, Reinforcement learning algorithms.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>After the successful completion of the course, the student will be able to-<table><tr><td>CLO 1</td><td>Apply ANN in classification and Predictive models</td></tr><tr><td>CLO 2</td><td>Apply RNN for sequence prediction problems</td></tr><tr><td>CLO 3</td><td>Apply CNN for image classification problems</td></tr><tr><td>CLO 4</td><td>Demonstrate the ability the develop ML integrated applications using Tensorflow, PyTorch, Sklearn.</td></tr></table></td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td><table><tr><th>CLO /PLO</th><th>PLO1</th><th>PL 02</th><th>PLO3</th><th>PLO4</th><th>PLO5</th><th>PLO6</th><th>PLO7</th><th>PLO8</th><th>PLO9</th><th>PLO10</th><th>PLO11</th><th>PLO 12</th></tr><tr><td>CLO 1</td><td>3</td><td></td><td></td><td></td><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CLO 2</td><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CLO 3</td><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>2</td><td></td></tr><tr><td>CLO 4</td><td>3</td><td>1</td><td>2</td><td>1</td><td></td><td>3</td><td>1</td><td>1</td><td>1</td><td>1</td><td></td><td>3</td></tr></table></td></tr>
<tr><td>Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:</td><td><table><tr><th>CLO</th><th>Teaching Learning Strategy</th><th>Assessment Strategy</th></tr><tr><td>CLO 1</td><td>Lectures, Tutorial class</td><td>Quiz, Assignment, Presentation</td></tr><tr><td>CLO 2</td><td>Lectures, Tutorial class</td><td>Quiz, Assignment, Presentation</td></tr><tr><td>CLO 3</td><td>Lectures, Tutorial class</td><td>Quiz, Assignment, Presentation</td></tr><tr><td>CLO 4</td><td>Lectures, Tutorial class</td><td>Quiz, Assignment, Group Project, Lab Report</td></tr></table></td></tr>
</table>

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1-2	**Introduction to Neural Networks and their Applications** **Topics covered:** **Basic concepts of Neural Networks** **Understanding Feedforward Networks** **Implementing Neural Network for Classification using Sklearn**	Lectures, Tutorial class	Quiz, Assignment	CLO1
3-4	**Recurrent Neural Networks (RNNs)** **Topics covered:** **Introduction to RNN** **Understanding sequence prediction problems** **Implementing RNN for sequence prediction using Sklearn**	Lectures, Tutorial class	Quiz, Assignment	CLO2
5-6	**Convolutional Neural Networks (CNNs)** **Topics covered: ntroduction to CNN** **Understanding image classification problems** **Implementing CNN for image classification using Sklearn**	Lectures, Tutorial class	Quiz, Assignment, Presentation	CLO3
7-8	**Understanding the difference among ANN, RNN, and CNN** **Topics Covered:**	Lectures, Tutorial class	Quiz, Assignment, Group Project	CLO1, CLO2, CLO3

			Comparison of different types of Neural Networks **Understanding the strengths and weaknesses of each network**				
		9-10	**Word Embeddings and Graph Neural Networks** **Topics covered: Understanding Word Embeddings** **Implementing Word Embeddings for Natural Language Processing (NLP)**	Lectures, Tutorial class	Quiz, Assignment, Presentation	CLO1, CLO2, CLO3	
		11-12	**Few Shot Learning and Reinforcement Learning** **Topics covered:** **Understanding Few Shot Learning Models** **Implementing Few Shot Learning using Sklearn** **Understanding Reinforcement Learning Algorithms** **Implementing Reinforcement Learning using PyTorch**	Lectures, Tutorial class	Quiz, Assignment, Presentation, Group Project	CLO1, CLO2, CLO3, CLO4	
		13-14	**Building ML Integrated Applications using Tensorflow and PyTorch**	Lectures, Tutorial class	Quiz, Assignment, Presentation, Group Project	CLO1, CLO2, CLO3, CLO4	
Text books	1. Deep Learning by Ian Goodfellow and Y. Bengio. 1.						

<table>
<tr><td>Course Title:</td><td>Advanced Database System</td></tr>
<tr><td>Credits:</td><td>3</td></tr>
<tr><td>Course No.:</td><td>SWE 0612-4136</td></tr>
<tr><td>Credit Hours:</td><td>3 hours/week</td></tr>
<tr><td>Rationale:</td><td>The course explores advanced database systems, their management and their corporate role. At the heart of information systems lie database management systems, transactional database systems, data warehouses and databases for storing complex data. This course looks at the technologies, data models and policies that such systems require.</td></tr>
<tr><td>Objectives:</td><td>Objectives:
To facilitate in depth information about query process and optimization.
To make students understand and apply transaction and concurrency control.
To provide the knowledge of non-relational and spatial databases.
To help to develop an understanding of essential data mining concepts.
To facilitate the basic concepts and algorithms of data warehousing.</td></tr>
<tr><td>Course Contents:</td><td>Query Processing and Optimization: Query Interpretation, Equivalence of Expressions, Estimation of Query-ProcessingCost, Estimation of Costs of Access Using Indices, Join Strategies, Join Strategies for parallel Processing, Structure of the query Optimizer, Transformation of Relational Expression, Rewrite parse Tree

Transactions and Concurrency Control: Schedules, Testing for Serializability, Lock-Based Protocols, Timestamp-BasedProtocols, Validation Techniques, Multiple Granularity, Multiversion Schemes, Insert and Delete Operations, Deadlock Handling.

NoSQL: Scalability, CAP Theorem, BASE System, ACID vs BASE.

Spatial Database: Object Relational Model, Spatial data, Geometry types, Data Model – (Element, Geometry, Layer), Coordinate System, Tolerance, R-Tree etc.

Data Mining: Type of Data, Type of Interestingness, Data Mining vs Statistical Interference, Data Preprocessing, Types ofAttributes.

Data mining Concepts: Association Rule Mining (Apriori Algorithm), Classification (Decision Tree, Support Vector Machine, Naïve Bayes Classifier), Clustering – (K-means with variations, KNN, Genetic Algorithm) etc.

Data Warehousing: Basic concepts and algorithms.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>After the successful completion of the course, the student will be able to-<table><tr><td>CLO 1</td><td>Process and optimize queries.</td></tr><tr><td>CLO 2</td><td>Design systems that control concurrent schedules..</td></tr><tr><td>CLO 3</td><td>Differentiate between relational and non-relational databases and decide when to use what.</td></tr><tr><td>CLO 4</td><td>Explain the concepts of data warehousing.</td></tr></table></td></tr>
</table>

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3				2							
CLO 2	3			1			2					
CLO 3	3		1		2				2		2	
CLO 4	3	1	2	1		3	1	1	1	1		1

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 2	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 3	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 4	Lectures, Tutorial class	Quiz, Assignment, Final Exam

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Advanced Database System** **Topics covered:** **Introduction to Database System, Types of Database System, Characteristics of Database System, Advantages and Disadvantages of Database System.**	Lectures, Tutorial class	Quiz	CLO1
2	**Query Interpretation and Expression Equivalence** **Topics covered:**	Lectures, Tutorial class	Quiz	CLO1, CLO2

			Introduction to Query Processing, Query Interpretation, Expression Equivalence, Types of Expression Equivalence.				
		3	**Estimation of Query-Processing Cost** **Topics covered: Introduction to Cost Estimation, Cost Model, Factors Affecting Cost, Estimation of Cost.**	Lectures, Tutorial class	Quiz, Assignment	CLO2, CLO3	
		4	**Cost of Access Using Indices, Join Strategies** **Topics Covered:** **Types of Indices, Selection Strategy, Join Strategies.**	Lectures, Tutorial class	Quiz, Assignment	CLO1, CLO2, CLO3	
		5	**Query Optimization Strategies** **Topics covered: Cost-Based Optimization, Enumeration-Based Optimization, Memoization-Based Optimization.**	Lectures, Tutorial class	Quiz, Assignment	CLO1, CLO2	
		6	**Transaction and Concurrency Control** **Topics Covered:** **Introduction to Transactions, ACID Properties, Serializability, Lock-Based Protocols, Timestamp-Based Protocols, Validation Techniques, Multiple Granularity, Multiversion Schemes, Insert and Delete Operations, Deadlock Handling.**	Lectures, Tutorial class	Quiz, Assignment	CLO1, CLO2, CLO3	

		7	**NoSQL Databases** **Topics Covered:** **Overview of NoSQL, Advantages and Disadvantages, Types of NoSQL, CAP Theorem, BASE System.**	Lectures, Tutorial class	Quiz	CLO1, CLO2, CLO3	
		8	**Spatial Database** **Topics Covered:** **Introduction to Spatial Database, Spatial Data Types, Spatial Query Types, Object-Relational Model, R-Tree.**	Lectures, Tutorial class	Quiz, Final Exam	CLO3, CLO4	
		9	**Data Preprocessing** **Topics Covered:** **Data Preprocessing Techniques, Data Cleaning, Data Transformation, Data Reduction.**	Lectures, Tutorial class	Quiz, Final Exam	CLO1, CLO4	
		10	**Association Rule Mining** **Topics Covered:** **Basic Concepts of Association Rule Mining, Apriori Algorithm, Example of Association Rule Mining.**	Lectures, Tutorial class	Quiz, Final Exam	CLO3, CLO4	
		11	**Classification** **Topics Covered:** **Decision Tree, Support Vector Machine, Naïve Bayes Classifier, Example of Classification.**	Lectures, Tutorial class	Quiz, Final Exam	CLO3, CLO2	
		12	**Clustering** **Topics Covered:** **K-means with Variations, KNN, Genetic Algorithm,**	Lectures, Tutorial class	Quiz, Final Exam	CLO1, CLO3	

			Example of Clustering.			
		13-14	**Data Warehousing** **Topics Covered:** **Introduction to Data Warehousing, Basic Concepts of Data Warehousing, Architecture of Data Warehousing, Multidimensional Data Model, OLAP Operations.**	Lectures, Tutorial class	Quiz, Final Exam	CLO 4
Text books	1. Introduction to Data Mining – Pang-Ning Tan, Michael Steinbach, Vipin Kumar. 2. Advanced Database Systems – Carlo Zaniolo et al (The Morgan Kaufmann Series). 3. Oracle Advanced PL/SQL Programming with CD-ROM- ScottUrman.					

Course Title:	Advanced Database System Lab
Credits:	1.5
Course No.:	SWE 0612-4138
Credit Hours:	3 hours/week
Rationale:	The lab course aims to provide students with hands-on experience in implementing advanced database systems, their management and their corporate role. At the heart of information systems lie database management systems, transactional database systems, data warehouses and databases for storing complex data. This lab course looks at the technologies, data models and policies that such systems require.
Objectives:	**Objectives:** ● To help students understand the different issues involved in the design and implementation of non-relational and spatial databases. ● To help them implement NoSQL and Spatial databases. ● To help them write optimized queries. ● To help them implement data mining and data warehousing algorithms.
Course Contents:	**Query Processing and Optimization:** Query Interpretation, Equivalence of Expressions, Estimation of Query-ProcessingCost, Estimation of Costs of Access Using Indices, Join Strategies, Join Strategies for parallel Processing, Structure of the query Optimizer, Transformation of Relational Expression, Rewrite parse Tree **Transactions and Concurrency Control:** Schedules, Testing for Serializability, Lock-Based Protocols, Timestamp-BasedProtocols, Validation Techniques, Multiple Granularity, Multiversion Schemes, Insert and Delete Operations, Deadlock Handling.

NoSQL: Scalability, CAP Theorem, BASE System, ACID vs BASE.

Spatial Database: Object Relational Model, Spatial data, Geometry types, Data Model – (Element, Geometry, Layer), Coordinate System, Tolerance, R-Tree etc.

Data Mining: Type of Data, Type of Interestingness, Data Mining vs Statistical Interference, Data Preprocessing, Types ofAttributes.

Data mining Concepts: Association Rule Mining (Apriori Algorithm), Classification (Decision Tree, Support Vector Machine, Naïve Bayes Classifier), Clustering – (K-means with variations, KNN, Genetic Algorithm) etc.

Data Warehousing: Basic concepts and algorithms.

Course Learning Outcomes (CLOs):

After the successful completion of the course, the student will be able to-

CLO 1	Design and implement NoSQL and Spatial databases.
CLO 2	Write optimized queries.
CLO 3	Implement data mining algorithms.
CLO 4	Implement basic algorithms of data warehousing.

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**
CLO 1	**1**				**2**							
CLO 2	**3**	**2**		**1**		**1**	**2**			**2**		
CLO 3	**3**		**1**		**2**				**2**		**2**	
CLO 4	**3**	**1**	**2**	**1**			**1**	**1**	**1**	**1**		**1**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	**Teaching Learning Strategy**	**Assessment Strategy**
CLO 1	Lectures, Tutorial class	Quiz, Assignment, Project
CLO 2	Lectures, Tutorial class	Quiz, Assignment, Project
CLO 3	Lectures, Tutorial class	Quiz, Assignment, Project
CLO 4	Lectures, Tutorial class	Quiz, Assignment, Project

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Database Management System**	Lectures, Tutorial class	Quiz	CLO1
2	**SQL query execution, optimization and interpretation.**	Lectures, Tutorial class	Quiz	CLO1, CLO2
3	**Query processing and indexing**	Lectures, Tutorial class	Quiz, Assignment	CLO2, CLO3
4	**Transaction and concurrency control implementation**	Lectures, Tutorial class	Quiz, Assignment	CLO1, CLO2, CLO3
5	**Lock-based and timestamp-based concurrency control implementation.**	Lectures, Tutorial class	Quiz, Assignment	CLO1, CLO2
6	**Multiversion concurrency control implementation**	Lectures, Tutorial class	Quiz, Assignment	CLO1, CLO2, CLO3
7	**NoSQL database implementation**	Lectures, Tutorial class	Quiz	CLO1, CLO2, CLO3
8	**Spatial database implementation using PostGIS**	Lectures, Tutorial class	Quiz, Final Exam	CLO2, CLO4
9	**Data preprocessing for data mining**	Lectures, Tutorial class	Quiz, Final Exam	CLO1, CLO4
10	**Association rule mining implementation**	Lectures, Tutorial class	Quiz, Final Exam	CLO3, CLO1
11	**Decision tree and support vector machine implementation**	Lectures, Tutorial class	Quiz, Final Exam	CLO1, CLO2
12	**K-means clustering implementation**	Lectures, Tutorial class	Quiz, Final Exam	CLO2, CLO4
13	**Implementation of data warehousing concepts**	Lectures, Tutorial class	Quiz, Final Exam	CLO 3
14	**Final project implementation using any of the technologies learned in the lab**		Project	CLO1, CLO2, CLO3, CLO4

Text books	1. Introduction to Data Mining – Pang-Ning Tan, Michael Steinbach, Vipin Kumar. 2. Advanced Database Systems – Carlo Zaniolo et al (The Morgan Kaufmann Series). 3. Oracle Advanced PL/SQL Programming with CD-ROM- ScottUrman.

Course Title:	Bioinformatics
Credits:	3
Course No.:	SWE 0688-4139
Credit Hours:	3 hours/week
Rationale:	In this course, students will learn fundamental concepts and methods in bioinformatics. This course will provide a certain level of understanding of molecular biology and a working knowledge of bioinformatics applications and databases covering the topics sequence similarity and alignments, evolutionary processes, protein structure, genome characteristics and gene expression.
Objectives:	**Objectives:** ● To introduce students to the fundamentals of evolution, molecular biology and molecular evolution. ● To show students how to apply many of the basic predictive methods that are common in modern bioinformatics. ● To make the students have a practical and hands-on experience with common bioinformatics tools and databases. ● To train the students in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, prediction of protein function, and building phylogenetic trees.
Course Contents:	**Cell concept:** Cell to Chromosome, **Cell division. Nucleic acids:** Structure and properties of different forms of DNA and RNA; DNA replication. **Proteins:** Structure and classification, Central dogma of molecular biology. **Genetic code:** A brief account. **Genetics:** Mendel's laws of inheritance, Organization of genetic material of prokaryotes and eukaryotes, repetitive DNA, chromosome organization and banding patterns, structure of gene - intron, exon and their relationships, overlapping gene, regulatory sequence, Molecular mechanism of general recombination, gene conversion, Evolution and types of mutation, molecular mechanisms of mutation. **Introduction to Bioinformatics:** Definition and History of Bioinformatics, Bioinformatics Tools and Databases, Applications of Bioinformatics. **Sequence alignment:** Dynamic programming. Global, local, semiglobal. Scoring matrices. The Blast family of programs. Significance of alignments, Aligning more than two sequences. Patterns, Profiles and Multiple Alignments, Genomes alignment. Structure-based alignment.

Hidden Markov Models in Bioinformatics: Definition and applications in Bioinformatics. Examples of the Viterbi, the Forward and the Backward algorithms. Parameter estimation for HMMs.

Trees: The Phylogeny problem. Distance methods, parsimony, bootstrap. Stationary Markov processes. Rate matrices. Maximum likelihood. Felsenstein's post-order traversal.

Finding regulatory elements, Gibbs sampling.

Gene Detection and Genome Annotation,

Gene Expression Analysis.

Course Learning Outcomes (CLOs):

After the successful completion of the course, the student will be able to-

CLO 1	Analyze the fundamental concepts of molecular biology and molecular evolution to interpret the genetic information and its organization in prokaryotes and eukaryotes.
CLO 2	Apply basic predictive methods and bioinformatics tools to analyze nucleic acids, proteins, and genomes for sequence similarity and alignments, prediction of protein function, and building phylogenetic trees.
CLO 3	Utilize common bioinformatics tools and databases to acquire practical experience in analyzing and interpreting molecular data for gene detection, genome annotation, and gene expression analysis.
CLO 4	Evaluate the hidden Markov models and tree-building methods to compare and contrast the evolutionary relationships between different species and gain insight into the significance of alignments and patterns in molecular data.

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	1				2							
CLO 2	3	2		1		1	2			2		
CLO 3	3		1		2				2		2	
CLO 4	3	1	2	1								3

Mapping Course Learning Outcomes (CLOs) with the

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Quiz, Assignment, Final Exam

Teaching-Learning and Assessment Strategy:	**CLO 2**	Lectures, Tutorial class	Quiz, Assignment, Final Exam
	CLO 3	Lectures, Tutorial class	Quiz, Assignment, Final Exam
	CLO 4	Lectures, Tutorial class	Quiz, Assignment, Final Exam

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Bioinformatics and molecular biology** **Topics Covered:** **Overview of Bioinformatics and its applications** **Cell concept, DNA and RNA structure and properties**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1
2-3	**Genetic code, Mendel's laws, and genetic material organization** **Topics Covered:** **Central dogma of molecular biology** **Mendel's laws of inheritance, repetitive DNA** **Organization of genetic material of prokaryotes and eukaryotes**	Lectures, Tutorial class	Quiz, Assignment	CLO1
4-5	**DNA replication, transcription, and translation** **Topics Covered:** **DNA replication** **Transcription and translation**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1

		6-7	**Sequence alignment and scoring matrices** **Topics Covered:** **ntroduction to sequence alignment** **Dynamic programming** **Scoring matrices** **The Blast family of programs**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2	
		8-9	**Hidden Markov Models in Bioinformatics** **Topics Covered:** **Definition and applications in Bioinformatics** **Examples of the Viterbi, the Forward and the Backward algorithms** **Parameter estimation for HMMs**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2	
		10-11	**Phylogenetic trees and multiple sequence alignment** **Topics Covered:** **Phylogenetic trees and distance methods** **Parsimony and bootstrap** **Multiple sequence alignment**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2	
		12-14	**Gene detection, genome annotation, and gene expression analysis** **Topics Covered:** **Gene detection and genome annotation** **Gene expression analysis**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4, CLO3	

Text books	1. An Introduction to Bioinformatics Algorithms by Neil C. Jones and Pavel A. Pevzner. 2. Understanding Bioinformatics by Market Zvelebil, Jeremy O. Baum 3. Biological Sequence Analysis 4. Bioinformatics for Biologists by Pavel Pevzner and Ron Shamir.

Course Title:	Bioinformatics Lab
Credits:	1.5
Course No.:	SWE 0688-4140
Credit Hours:	3 hours/week
Rationale:	In this course, students will learn fundamental concepts and methods in bioinformatics. This course will provide certain level of understanding of molecular biology and a working knowledge of bioinformatics applications and databases covering the topics sequence similarity and alignments, evolutionary processes, protein structure, genome characteristics and gene expression.
Objectives:	**Objectives:** ● To introduce students to the fundamentals of evolution, molecular biology and molecular evolution. ● To show students how to apply many of the basic predictive methods that are common in modern bioinformatics. ● To make the students have a practical and hands-on experience with common bioinformatics tools and databases. ● To train the students in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, prediction of protein function, and building phylogenetic trees.
Course Contents:	**Cell concept:** Cell to Chromosome, **Cell division. Nucleic acids:** Structure and properties of different forms of DNA and RNA; DNA replication. **Proteins:** Structure and classification, Central dogma of molecular biology. **Genetic code:** A brief account. **Genetics:** Mendel's laws of inheritance, Organization of genetic material of prokaryotes and eukaryotes, repetitive DNA, chromosome organization and banding patterns, structure of gene - intron, exon and their relationships, overlapping gene, regulatory sequence, Molecular mechanism of general recombination, gene conversion, Evolution and types of mutation, molecular mechanisms of mutation. **Introduction to Bioinformatics:** Definition and History of Bioinformatics, Bioinformatics Tools and Databases, Applications of Bioinformatics.

Sequence alignment: Dynamic programming. Global, local, semiglobal. Scoring matrices. The Blast family of programs. Significance of alignments, Aligning more than two sequences. Patterns, Profiles and Multiple Alignments, Genomes alignment. Structure-based alignment.

Hidden Markov Models in Bioinformatics: Definition and applications in Bioinformatics. Examples of the Viterbi, the Forward and the Backward algorithms. Parameter estimation for HMMs.

Trees: The Phylogeny problem. Distance methods, parsimony, bootstrap. Stationary Markov processes. Rate matrices. Maximum likelihood. Felsenstein's post-order traversal.

Finding regulatory elements, Gibbs sampling.

Gene Detection and Genome Annotation,

Gene Expression Analysis.

Course Learning Outcomes (CLOs):

After the successful completion of the course, the student will be able to-

CLO 1	Apply bioinformatics techniques and tools for analyzing DNA, RNA and protein sequences
CLO 2	Develop an understanding of bioinformatics databases and their use in analyzing biological data
CLO 3	Demonstrate the ability to interpret and analyze experimental data in bioinformatics
CLO 4	Communicate scientific findings using appropriate tools and methods in bioinformatics

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PL 02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO 12
CLO 1	1			1	2				1			3
CLO 2	2			1		1		2		2		3
CLO 3	2		1		2	3			2		3	3
CLO 4	2	1					1					3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Lea

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Viva, Assignment, Group Project
CLO 2	Lectures, Tutorial class	Viva, Assignment, Group Project

rning and Assessment Strategy:	

CLO 3	Lectures, Tutorial class	Viva, Assignment, Group Project
CLO 4	Lectures, Tutorial class	Viva, Assignment, Group Project, Report Writing

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Bioinformatics databases and their use in analyzing biological data**	Lectures, Tutorial class	Viva, Assignment, Group Project	CLO2
2	**Sequence alignment and BLAST search**	Lectures, Tutorial class	Viva, Assignment, Group Project	CLO1
3	**Pairwise alignment and Scoring matrices**	Lectures, Tutorial class	Viva, Assignment, Group Project	CLO1
4	**Multiple sequence alignment and Phylogenetic analysis**	Lectures, Tutorial class	Viva, Assignment, Group Project	CLO1, CLO4
5	**Hidden Markov Models (HMM) and their applications in Bioinformatics**	Lectures, Tutorial class	Viva, Assignment, Group Project	CLO1
6	**Introduction to Gene expression analysis**	Lectures, Tutorial class	Viva, Assignment, Group Project	CLO3
7	**Microarray data analysis**	Lectures, Tutorial class	Viva, Assignment, Group Project	CLO3
8	**RNA-seq data analysis**	Lectures, Tutorial class	Viva, Assignment, Group Project	CLO3
9	**DNA sequence analysis using bioinformatics tools**	Lectures, Tutorial class	Viva, Assignment,	CLO1

					Group Project	
		10	**Protein structure prediction**	Lectures, Tutorial class	Viva, Assignment, Group Project	CLO1
		11	**Drug discovery using Bioinformatics tools**	Lectures, Tutorial class	Viva, Assignment, Group Project	CLO1, CLO2
		12	**Machine learning in Bioinformatics**	Lectures, Tutorial class	Viva, Assignment, Group Project	CLO1, CLO3
		13	**Analysis of next-generation sequencing data**	Lectures, Tutorial class	Viva, Assignment, Group Project	CLO 3
		14	**Project presentation and report writing**		Project, Report Writing	CLO4
Text books	1. An Introduction to Bioinformatics Algorithms by Neil C. Jones and Pavel A. Pevzner. 2. Understanding Bioinformatics by Market Zvelebil, Jeremy O. Baum 3. Biological Sequence Analysis 4. Bioinformatics for Biologists by Pavel Pevzner and Ron Shamir.					

Course Title:	Natural Language Processing
Credits:	3
Course No.:	SWE 0613-4141
Credit Hours:	3 hours/week
Rationale:	In this course, students will learn fundamental concepts and methods in NLP. This course will provide certain level of understanding of Language Processing and a working knowledge of NLP applications.

<table>
<tr><td>Objectives:</td><td>Objectives:

● To introduce students to the fundamentals of Language Processing and Tokenization.
● To show students how to apply many of the basic predictive methods that are common in modern NLP.
● To make the students have a practical and hands-on experience with common NLP tools.
● To train the students in the basic theory and application of programs used for NLP tasks like NER, POS tagging etc.</td></tr>
<tr><td>Course Contents:</td><td>Introduction. Words: Regular Expressions and Automata, Words and Transducers, N-Grams, Parts-of-Speech Tagging, Hidden Markov and Maximum Entropy Models,

Syntax: Formal Grammars, Syntactic Parsing, Statistical Parsing, Features and Unification, Language and Complexity.

Semantics and Pragmatics: The Representation of Meaning, Computational Semantics, Lexical Semantics, Computational Lexical Semantics, Computational Discourse.

Applications: Information Extraction, Question Answering and Summarization, Dialogue and Conversational Agents, Machine Translation.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>After the successful completion of the course, the student will be able to-

<table><tr><td>CLO 1</td><td>Analyze and explain fundamental concepts and methods in natural language processing.</td></tr><tr><td>CLO 2</td><td>Apply basic predictive methods and tools in modern NLP for tasks such as tokenization, named entity recognition, and part-of-speech tagging.</td></tr><tr><td>CLO 3</td><td>Evaluate and compare different approaches and models in NLP, including hidden Markov models and maximum entropy models.</td></tr><tr><td>CLO 4</td><td>Design and implement NLP systems for various applications, such as information extraction, question answering, and summarization.</td></tr></table></td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td><table><tr><th>CLO /PLO</th><th>PLO1</th><th>PL02</th><th>PLO3</th><th>PLO4</th><th>PLO5</th><th>PLO6</th><th>PLO7</th><th>PLO8</th><th>PLO9</th><th>PLO10</th><th>PLO11</th><th>PLO12</th></tr><tr><td>CLO 1</td><td>3</td><td>2</td><td></td><td>1</td><td>2</td><td></td><td>2</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CLO 2</td><td>3</td><td>2</td><td></td><td>1</td><td></td><td>1</td><td></td><td>2</td><td></td><td>2</td><td></td><td></td></tr><tr><td>CLO 3</td><td>3</td><td></td><td>1</td><td></td><td>1</td><td>3</td><td></td><td></td><td>2</td><td></td><td>3</td><td></td></tr><tr><td>CLO 4</td><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1</td><td></td><td>3</td><td>3</td></tr></table></td></tr>
</table>

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 2	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 3	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 4	Lectures, Tutorial class	Quiz, Assignment, Final Exam

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1-2	**Introduction to NLP and Language Processing** **Topics Covered:** **Overview of the field of NLP** **Language models and processing** **Tokenization and text normalization** **Regular expressions and finite-state automata**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1, CLO2
3-5	**Parts-of-Speech Tagging and Hidden Markov Models** **Topics Covered:** **Parts-of-speech tagging and its applications** **Hidden Markov Models and their use in NLP** **Viterbi algorithm for decoding HMMs**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1, CLO3
6-8	**Maximum Entropy Models and Information Extraction**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1, CLO3

			Topics Covered: **Maximum entropy models and their use in NLP** **Information extraction and its applications** **Named entity recognition and relation extraction**				
		8-10	**Syntax and Parsing** **Topics Covered:** **Formal grammars and their role in NLP** **Syntactic parsing techniques and algorithms** **Statistical parsing techniques and algorithms**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1, CLO4	
		11-12	**Semantics and Pragmatics** **Topics Covered:** **The representation of meaning in NLP** **Computational semantics and lexical semantics** **Computational discourse and pragmatics**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4	
		13-14	**Machine Translation and Dialogue Systems** **Topics Covered:** **Machine translation and its challenges** **Dialogue systems and conversational agents** **Question answering and summarization**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4	

Text books	1. J. H. Speech and Language Processing, Jurafsky, D. and Martin. 2. Foundations of Statistical Natural Language Processing, Manning, C. D. and H. Schütze.

Course Title:	Natural Language Processing Lab
Credits:	1.5
Course No.:	SWE 0613-4142
Credit Hours:	3 hours/week
Rationale:	The Natural Language Processing Lab Course is designed to provide students with a practical, hands-on experience with common NLP tools and techniques. The course aims to provide a deeper understanding of the concepts and methods covered in the Natural Language Processing theory course, and enable students to apply this knowledge in real-world scenarios.
Objectives:	**Objectives:** ● To give students a practical understanding of Natural Language Processing concepts and techniques. ● To provide hands-on experience with NLP tools and technologies commonly used in the industry. ● To train students in developing NLP applications using open-source NLP libraries such as NLTK and spaCy. ● To enable students to develop an understanding of the current trends and future directions of Natural Language Processing research.
Course Contents:	**Introduction. Words:** Regular Expressions and Automata, Words and Transducers, N-Grams, Parts-of-Speech Tagging, Hidden Markov and Maximum Entropy Models, **Syntax:** Formal Grammars, Syntactic Parsing, Statistical Parsing, Features and Unification, Language and Complexity. **Semantics and Pragmatics:** The Representation of Meaning, Computational Semantics, Lexical Semantics, Computational Lexical Semantics, Computational Discourse. **Applications:** Information Extraction, Question Answering and Summarization, Dialogue and Conversational Agents, Machine Translation.
Course Learning Outcomes (CLOs):	After the successful completion of the course, the student will be able to-

CLO 1	Develop the best practice of fundamental concepts and techniques in natural language processing
CLO 2	Gain practical experience in using tools and software for natural language processing tasks
CLO 3	Apply natural language processing techniques to real-world data sets
CLO 4	Evaluate and compare different approaches to natural language processing tasks.

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PL 02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO 12
CLO 1	2	2		1	1		2					3
CLO 2	2			2		1		2		2		3
CLO 3	1	1			2				2		3	3
CLO 4			2				1		1		3	3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Viva, Presentation, Group Project
CLO 2	Lectures, Tutorial class	Viva, Presentation, Group Project
CLO 3	Lectures, Tutorial class	Viva, Presentation, Group Project
CLO 4	Lectures, Tutorial class	Viva, Presentation, Group Project

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Natural Language Processing** **Tokenization** **Hands-on practice with tokenization using NLTK library**	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO1, CLO2, CLO3
2	**Regular expressions and Automata** **Hands-on practice with regular expressions using Python's re module**	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO3
3	**N-Grams**	Lectures, Tutorial class	Viva, Presentatio	CLO2, CLO3

			Parts-of-speech Tagging **Hands-on practice with N-grams and POS tagging using NLTK library**		n, Group Project		
		4	**Hidden Markov and Maximum Entropy Models** **Hands-on practice with HMMs and Maximum Entropy Models using NLTK library**	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO3	
		5	**Formal Grammars** **Syntactic Parsing** **Hands-on practice with syntactic parsing using NLTK library**	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO3	
		6	**Statistical Parsing** **Hands-on practice with statistical parsing using Stanford Parser**	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO3	
		7	**Features and Unification** **Hands-on practice with feature structures and unification**	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO3	
		8	**Representation of Meaning** **Computational Semantics** **Hands-on practice with semantic representation and computation**	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO3, CLO2	
		9	**Lexical Semantics** **Computational Lexical Semantics** **Hands-on practice with lexical semantics using WordNet**	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO3	

		10	**Computational Discourse** **Hands-on practice with computational discourse**	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO3
		11	**Information Extraction** **Hands-on practice with information extraction**	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO3
		12	**Question Answering and Summarization** **Hands-on practice with question answering and summarization**	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO3
		13	**Dialogue and Conversational Agents** **Hands-on practice with dialogue and conversational agents using NLTK library**	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO3
		14	**Machine Translation** **Hands-on practice with machine translation using Google Translate API**	Lecture	Viva, Presentation, Group Project	CLO2, CLO3, CLO4
Text books	1. J. H. Speech and Language Processing, Jurafsky, D. and Martin. 2. Foundations of Statistical Natural Language Processing, Manning, C. D. and H. Schütze.					

Course Title:	Cloud Computing
Credits:	3
Course No.:	SWE 0612-4143
Credit Hours:	3 hours/week
Rationale:	Students need to have understanding about the underlying technologies that are used to run cloud infrastructure, This course will help the students to have a better understanding about the cloud infrastructure.
Objectives:	**Objectives:**

<table>
<tr><td></td><td>

To introduce students to the different types of computing technologies and their characteristics.
To provide an overview of the architecture and deployment models of cloud computing.
To help students understand the foundational elements of cloud computing, including virtualization and cloud operating systems.
To introduce students to the various cloud service models, including SaaS, IaaS, and PaaS, and their advantages and limitations.
To help students understand the cloud bus and how it facilitates communication between cloud services.
To provide an understanding of the economics and risks associated with cloud computing.
To help students critically evaluate the current challenges facing cloud computing and analyze case studies to make informed decisions regarding cloud infrastructure.

</td></tr>
<tr><td>Course Contents:</td><td>
Introduction to different types of computing: Edge computing, Grid computing, Distributed Computing, Cluster-computing, Utility computing, Cloud computing.

Cloud computing architecture: Architectural framework; Cloud deployment models; Virtualization in cloud computing; Parallelization in cloud computing; Green cloud. Cloud Bus;

Cloud service models: Software as a Service (SaaS); Infrastructure as a Service (IaaS); Platform as a Service (PaaS).

Foundational elements of cloud computing: Virtualization; Cloud computing operating System; Browser as a platform; Advanced web technologies (Web 2.0, AJAX and Mashup); Introduction to autonomic systems; Service Level Agreements (SLA); Security/Privacy; Cloud economics; Risks assessment; Current challenges facing cloud computing.

Case studies.
</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>
After the successful completion of the course, the student will be able to-
<table>
<tr><td>CLO 1</td><td>Identify and describe the different types of cloud computing architectures and deployment models.</td></tr>
<tr><td>CLO 2</td><td>Analyze the foundational elements of cloud computing, such as virtualization, SLAs, cloud economics, and security/privacy.</td></tr>
<tr><td>CLO 3</td><td>Evaluate the different cloud service models and their application in real-world scenarios.</td></tr>
<tr><td>CLO 4</td><td>Assess the current challenges facing cloud computing and propose potential solutions.</td></tr>
</table>
</td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td>
<table>
<tr><th>CLO /PLO</th><th>PLO1</th><th>PL02</th><th>PLO3</th><th>PLO4</th><th>PLO5</th><th>PLO6</th><th>PLO7</th><th>PLO8</th><th>PLO9</th><th>PLO10</th><th>PLO11</th><th>PLO12</th></tr>
<tr><td>CLO 1</td><td>3</td><td></td><td>1</td><td></td><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CLO 2</td><td>2</td><td>1</td><td></td><td>2</td><td></td><td>1</td><td></td><td></td><td>3</td><td></td><td>1</td><td>1</td></tr>
<tr><td>CLO 3</td><td>2</td><td></td><td></td><td>1</td><td>1</td><td></td><td>1</td><td></td><td></td><td>2</td><td></td><td></td></tr>
</table>
</td></tr>
</table>

CLO 4	**3**		**1**		**3**	**2**		**1**			**1**	**1**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 2	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 3	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 4	Lectures, Tutorial class	Quiz, Assignment, Final Exam

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Computing Technologies** Edge computing Grid computing Distributed Computing Cluster-computing Utility computing Cloud computing	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1, CLO2
2	**Cloud Computing Architecture** Architectural framework Cloud deployment models Virtualization in cloud computing	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2, CLO1
3	**Parallelization in Cloud Computing** Green cloud Parallelization in cloud computing Cloud Bus	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2

		4	**Cloud Service Models** Software as a Service (SaaS) Infrastructure as a Service (IaaS) Platform as a Service (PaaS)	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1	
		5	**Foundational Elements of Cloud Computing** Virtualization Cloud computing operating System Browser as a platform	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2, CLO3	
		6	**Advanced Web Technologies** Web 2.0 AJAX and Mashup Introduction to autonomic systems	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2, CLO3	
		7	**Service Level Agreements (SLA)** Security/Privacy Cloud economics	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2, CLO3	
		8	**Risks Assessment in Cloud Computing** Cloud economics Risks assessment Current challenges facing cloud computing	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO3, CLO4	
		9-14	**Case Studies** Different case study	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4	
Text books	1. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things- Kai Hwang, Jack Dongarra, Geoffrey C. Fox. 2. Cloud Computing, Principles , System and Applications- Antonopoulos, Nikos, Gillam, Lee. 3. Cloud Computing: From Parallel Processing to the Internet of Things- Kai Hwang, Jack Dongarra, Geoffrey C. Fox.						

	4. Cloud Computing, Principles , System and Applications- Antonopoulos, Nikos, Gillam, Lee.

Course Title:	Cloud Computing Lab
Credits:	1.5
Course No.:	SWE 0612-4144
Credit Hours:	3 hours/week
Rationale:	Students need to have an understanding about the underlying technologies that are used to run cloud infrastructure. This course will help the students to have a better understanding about the cloud infrastructure..
Objectives:	**Objectives:** ● To introduce students to the different types of computing technologies and their characteristics. ● To provide an overview of the architecture and deployment models of cloud computing. ● To help students understand the foundational elements of cloud computing, including virtualization and cloud operating systems. ● To introduce students to the various cloud service models, including SaaS, IaaS, and PaaS, and their advantages and limitations. ● To help students understand the cloud bus and how it facilitates communication between cloud services. ● To provide an understanding of the economics and risks associated with cloud computing. ● To help students critically evaluate the current challenges facing cloud computing and analyze case studies to make informed decisions regarding cloud infrastructure.
Course Contents:	**Introduction to different types of computing**: Edge computing, Grid computing, Distributed Computing, Cluster-computing, Utility computing, Cloud computing. **Cloud computing architecture:** Architectural framework; Cloud deployment models; Virtualization in cloud computing; Parallelization in cloud computing; Green cloud. Cloud Bus; **Cloud service models**: Software as a Service (SaaS); Infrastructure as a Service (IaaS); Platform as a Service (PaaS). **Foundational elements of cloud computing**: Virtualization; Cloud computing operating System; Browser as a platform; Advanced web technologies (Web 2.0, AJAX and Mashup); Introduction to autonomic systems; Service Level Agreements (SLA); Security/Privacy; Cloud economics; Risks assessment; Current challenges facing cloud computing. **Case studies.** **Creating Windows servers on the cloud; Creating Linux servers on the cloud; Deploying applications on the cloud; Major cloud solutions and troubleshooting.**
Course Learning	After the successful completion of the course, the student will be able to-

Outcomes (CLOs):

CLO 1	Hands-on experience in creating and managing Windows and Linux servers on the cloud.
CLO 2	practical experience in deploying applications on the cloud.
CLO 3	major cloud solutions and provide troubleshooting experience.
CLO 4	Assess the economics and risks associated with cloud computing.

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PL 02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO 12
CLO 1	3		1		1						1	2
CLO 2	2	1		1	2		1			2		
CLO 3	2			2		1			3		1	
CLO 4	1		2		3	2		1				

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Viva, Presentation, Group Project
CLO 2	Lectures, Tutorial class	Viva, Presentation, Group Project
CLO 3	Lectures, Tutorial class	Viva, Presentation, Group Project
CLO 4	Lectures, Tutorial class	Viva, Presentation, Group Project

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1-2	**Introduction to Computing Technologies** Overview of cloud computing and virtualization	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO1, CLO2

			Creating a Windows server instance on the cloud Configuring Windows server instance for web hosting Creating a Linux server instance on the cloud Configuring Linux server instance for web hosting Deploying a PHP application on the Linux server				
		3-4	**Cloud Solutions and Deployment Models** Introduction to cloud deployment models Setting up a private cloud using OpenStack Configuring virtual machines and networks in OpenStack Deploying applications on OpenStack Understanding hybrid cloud solutions	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO4	
		5-6	**Cloud Service Models** Introduction to cloud service models Creating an infrastructure as a service (IaaS) solution using Amazon Web Services (AWS) Configuring virtual machines and storage in AWS Creating a platform as a service (PaaS) solution using Google Cloud Platform (GCP) Deploying a sample application on GCP	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO3	

		7-8	**Cloud Architecture and Virtualization** Understanding cloud architecture and design principles Setting up a cloud environment using Docker containers Creating and deploying Docker containers on the cloud Configuring load balancing and auto-scaling in a cloud environment Understanding the benefits and drawbacks of virtualization	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO4	
		9-10	**Cloud Security and Risk Assessment** Introduction to cloud security and risk assessment Understanding security threats in cloud computing Configuring security groups and network ACLs in AWS Implementing data encryption in cloud applications Conducting a risk assessment for a cloud-based solution	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO3	
		11-12	**Cloud Economics and Green Cloud** Introduction to cloud economics and cost optimization Understanding the factors that impact cloud costs	Lectures, Tutorial class	Viva, Presentation, Group Project	CLO2, CLO3, CLO4	

			Analyzing cloud billing and cost reports Understanding the concept of green cloud computing Implementing energy-efficient practices in cloud solutions				
		13-14	**Cloud Case Studies and Final Project** Review of cloud case studies and success stories Introduction to the final project Choosing a cloud solution for the final project Working on the final project Submission and presentation of the final project	Lectures, Tutorial class	Presentation, Group Project	CLO1, CLO2, CLO3, CLO4	
Text books	1. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things- Kai Hwang, Jack Dongarra, Geoffrey C. Fox. 2. Cloud Computing, Principles , System and Applications- Antonopoulos, Nikos, Gillam, Lee. 3. Cloud Computing: From Parallel Processing to the Internet of Things- Kai Hwang, Jack Dongarra, Geoffrey C. Fox. 4. Cloud Computing, Principles , System and Applications- Antonopoulos, Nikos, Gillam, Lee.						

Course Title:	Introduction to Dev-ops
Credits:	3

<table>
<tr><td>Course No.:</td><td>SWE 0613-4151</td></tr>
<tr><td>Credit Hours:</td><td>3 hours/week</td></tr>
<tr><td>Rationale:</td><td>To maintain servers the students need to have the knowledge regarding how servers are managed and how requests can be served in an efficient manner. This course will help them to have that knowledge.</td></tr>
<tr><td>Objectives:</td><td>● To provide students hands-on training on basic dev-ops tasks and how those techniques can be utilized to make more modular and scalable programs.
● To familiarize students with basic dev-ops tools like Jenkins, docker etc.
● To help students develop the ability to work in the Agile or Waterfall process of Software Development.
● To help develop skills that will enable the students to use basic Linux commands and shell scripting.</td></tr>
<tr><td>Course Contents:</td><td>Introduction to Devops, What Is Devops, History of Devops, Devops definition, DevOps Main Objectives, DevOps and Software Development Life Cycle, Waterfall Model, Agile Model, Continuous Integration & Deployment, Jenkins • Containers and Virtual Development, Docker, Vagrant, Configuration Management Tools, Ansible, Puppet, Chef, LINUX Basic and Admin, Linux OS Introduction, Importance of Linux in DevOps, Linux Basic Command Utilities.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>
<table>
<tr><td>CLO 1</td><td>Knowledge of DevOps principles and practices.</td></tr>
<tr><td>CLO 2</td><td>Understanding of the role of automation in DevOps.</td></tr>
<tr><td>CLO 3</td><td>Ability to apply continuous integration and delivery concepts.</td></tr>
<tr><td>CLO 4</td><td>Understanding of the importance of collaboration and communication in DevOps teams.</td></tr>
</table>
</td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td>
Mapping of Course Learning Outcomes to Program Learning Outcomes
<table>
<tr><th>CLO /PLO</th><th>PLO1</th><th>PL02</th><th>PLO3</th><th>PLO4</th><th>PLO5</th><th>PLO6</th><th>PLO7</th><th>PLO8</th><th>PLO9</th><th>PLO10</th><th>PLO11</th><th>PLO12</th></tr>
<tr><td>CLO 1</td><td>3</td><td></td><td></td><td></td><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td><td>3</td></tr>
<tr><td>CLO 2</td><td>2</td><td></td><td>1</td><td>1</td><td>2</td><td></td><td></td><td></td><td></td><td>3</td><td></td><td></td></tr>
<tr><td>CLO 3</td><td>2</td><td>3</td><td>3</td><td>2</td><td>3</td><td></td><td>2</td><td>3</td><td></td><td></td><td>2</td><td></td></tr>
<tr><td>CLO 4</td><td>3</td><td></td><td></td><td></td><td></td><td>3</td><td></td><td>3</td><td>3</td><td>3</td><td>2</td><td></td></tr>
</table>
</td></tr>
<tr><td>Mapping Course Learning Outcomes (CLOs) with the</td><td>
<table>
<tr><th>CLOs</th><th>Teaching-Learning Strategy</th><th>Assessment Strategy</th></tr>
<tr><td>CLO1</td><td>CL, T, OR, GD</td><td>A, P</td></tr>
</table>
</td></tr>
</table>

Teaching-Learning and Assessment Strategy:

CLO2	CL, T, OR, GD, PrbL, PjrL	A, P
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to DevOps**	CL, T, OR, GD, PrbL	A, P	CLO1, CLO2
2	**DevOps Definition**	CL, T, OR, GD, PrbL	A, P	CLO1, CLO2
3	**DevOps Main Objectives**	CL, T, OR, GD	A, P	CLO1, CLO2
4	**DevOps and Software Development Life Cycle**	CL, T, OR, GD	A, P	CLO1, CLO2, CLO3
5	**Waterfall Model**	CL, T, OR	A, P	CLO1, CLO2
6	**Agile Model**	CL, T, OR	A, P	CLO1, CLO2
7	**Continuous Integration & Deployment**	CL, T, OR, GD	A, P	CLO1, CLO2
8	**Jenkins**	CL, T, OR, GD, PrbL, PjrL	A, P, RW	CLO1, CLO2, CLO3, CLO4
9	**Containers and Virtual Development**	CL, T, OR, GD, PrbL, PjrL	A, P, RW	CLO1, CLO2, CLO3, CLO4
10	**Configuration Management Tools**	CL, T, OR, GD, PrbL, PjrL	A, P, RW	CLO1, CLO2, CLO3, CLO4
11	**LINUX Basic and Admin**	CL, T, OR, GD, PrbL, PjrL	A, P, RW	CLO1, CLO2, CLO3, CLO4
12-13	**Hands-On Labs**	CL, T, OR, GD, PrbL, PjrL	A, P, RW	CLO1, CLO2, CLO3, CLO4
14	**Final Project/Exam**	CL, T, OR, GD, PrbL, PjrL	A, P, RW	CLO1, CLO2, CLO3, CLO4

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

	(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)
Text Books	1. The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations

Course Title:	Introduction to Dev-ops Lab
Credits:	1.5
Course No.:	SWE 0613-4152
Credit Hours:	3 hours/week
Rationale:	To maintain servers the students need to have the knowledge regarding how servers are managed and how requests can be served in an efficient manner. This course will help them to have that knowledge and apply this knowledge practically.
Objectives:	● Utilize Dev-ops tools to make more modular and scalable programs. ● Use dev-ops tools like Jenkins, docker etc. in projects ● To help students develop the ability to work in the Agile or Waterfall process of Software Development. ● Use Linux commands and shell scripting for automating tasks.
Course Contents:	Introduction to Devops, What Is Devops, History of Devops, Devops definition, DevOps Main Objectives, DevOps and Software Development Life Cycle, Waterfall Model, Agile Model, Continuous Integration & Deployment, Jenkins • Containers and Virtual Development, Docker, Vagrant, Configuration Management Tools, Ansible, Puppet, Chef, LINUX Basic and Admin, Linux OS Introduction, Importance of Linux in DevOps, Linux Basic Command Utilities.
Course Learning Outcomes (CLOs):	**CLO 1** Hands-on experience with DevOps tools and practices. **CLO 2** Practice with automating software development processes. **CLO 3** Ability to implement continuous integration and delivery concepts. **CLO 4** Practical experience with infrastructure as code practices.
Mapping of CLOs with Program Learning Outcomes (PLOs):	**Mapping of Course Learning Outcomes to Program Learning Outcomes**

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3		1	2	3	1		1	1			3
CLO 2	3	3	3	2		2	2	1				2
CLO 3	3	3				2					1	2

	CLO 4	**3**		**3**	**2**	**3**	**3**	**2**		**3**	**3**	**1**	**3**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	A, LE
CLO2	CL, T, OR, GD, PrbL, PjrL	A, LE, RW
CLO3	CL, T, OR, PrbL, PjrL	A, PP, Prj
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to DevOps Lab**	CL, T, OR, GD, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2
2	**DevOps Definition Lab**	CL, T, OR, GD, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2
3	**DevOps Main Objectives Lab**	CL, T, OR, GD, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2
4	**DevOps and Software Development Life Cycle Lab**	CL, T, OR, PrbL, PjrL	Lab Report, Hands-on exercises	CLO1, CLO3, CLO4
5	**Waterfall Model Lab**	CL, T, OR, PrbL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO4
6	**Agile Model Lab**	GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
7	**Continuous Integration & Deployment Lab**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises	CLO2, CLO3, CLO4
8	**Jenkins Lab**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4

	9	**Containers and Virtual Development Lab**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises	CLO3, CLO4
	10	**Configuration Management Tools Lab**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
	11	**LINUX Basic and Admin Lab**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
	12-13	**Project Lab**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	Lab Report, Hands-on exercises	CLO1, CLO2, CLO3, CLO4
	14	**Final Project/Exam Lab**	CL, T, OR, PrbL GD, PrbL, PrjL, BL	Final Project, Report Submission	CLO1, CLO2, CLO3, CLO4
	(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning) (A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)				
Text Books	1. The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations				

Course Title:	Introduction To Cryptography
Credits:	3
Course No.:	SWE 0612-4153
Credit Hours:	3 hours/week
Rationale:	This is an introductory course on computer security. The main objective of this course is to introduce the basic concepts of cryptography and computer security covering physical security, operating system security as well as network and web security.
Objectives:	**Objectives:** ● To facilitate the basic knowledge of classic crypto systems and basic crypto primitives ● To assist students in developing introductory knowledge about block cipher and their different modes ● To help students conceptualize basic theories of different cryptographic mechanism such as symmetric and public key encryption, digital signature and hash function ● To assist students in developing basic knowledge about different security aspects covering multiple domains such as physical security, OS security, network security and web security ● To facilitate the basic knowledge of blockchain systems

<table>
<tr><td>Course Contents:</td><td>Basic terminology and security concepts: Fundamental concepts, Access control models, Cryptographic concepts, Security principles

Classic Crypto Systems: Substitution cipher, Vigenère cipher, Hill Cipher, One-time pads Symmetric Encryption: Advanced Encryption Standard (AES)

Public Key Encryption: RSA and ElGamal crypto systems

Other crypto mechanisms: Hash Function, Digital Signature

Physical security: Authentication technologies, Direct attacks, Physical Intrusion Detection

Operating Systems Security: Process, security, Memory and file system security, Application program security

Malware and forensic analysis: Insider & Malware attacks, Computer viruses, Privacy-invasive software, Countermeasures, Malware forensic

Network Security: Network security concepts, Vulnerabilities in Link, Network, Transport and Application layers, Firewall, Tunnelling and Intrusion detection, Denial of Service attacks, Countermeasures

Web security: Attacks on clients, Attacks on servers, Countermeasures

Blockchain and Bitcoin: History of money, The need of decentralization, State machine replication, Concepts of transaction, block, blockchain and distributed consensus of Blockchain security, Blockchain applications</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>After the successful completion of the course, the student will be able to-

<table>
<tr><td>CLO 1</td><td>Students will be able to define and apply basic terminology and security concepts in cryptography and computer security.</td></tr>
<tr><td>CLO 2</td><td>Students will be able to define the principles and use of classic crypto systems and basic crypto primitives.</td></tr>
<tr><td>CLO 3</td><td>Students will be able to differentiate between different cryptographic mechanisms, such as symmetric and public key encryption, digital signature, and hash functions, and their use cases.</td></tr>
<tr><td>CLO 4</td><td>Students will be able to evaluate security aspects covering multiple domains, including physical security, OS security, network security, and web security.</td></tr>
</table></td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td>
<table>
<tr><th>CLO /PLO</th><th>PLO1</th><th>PL02</th><th>PLO3</th><th>PLO4</th><th>PLO5</th><th>PLO6</th><th>PLO7</th><th>PLO8</th><th>PLO9</th><th>PLO10</th><th>PLO11</th><th>PLO12</th></tr>
<tr><td>CLO 1</td><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td><td>1</td><td></td><td></td><td></td><td></td></tr>
<tr><td>CLO 2</td><td>3</td><td>3</td><td></td><td>3</td><td></td><td>2</td><td></td><td>2</td><td></td><td></td><td>2</td><td></td></tr>
</table></td></tr>
</table>

CLO 3	**3**	**3**	**3**		**3**		**3**		**1**	**3**	**1**	
CLO 4	**3**			**2**		**3**		**3**		**2**		**3**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 2	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 3	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 4	Lectures, Tutorial class	Quiz, Assignment, Final Exam

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Cryptography and Computer Security** Overview of the course content and objectives Basic terminology and security concepts Access control models Cryptographic concepts Security principles	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1
2	**Classic Crypto Systems** Substitution cipher Vigenère cipher Hill Cipher One-time pads	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1, CLO2
3	**Symmetric Encryption** Advanced Encryption Standard (AES)	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2
4	**Public Key Encryption**	Lectures, Tutorial class	Quiz, Assignment, Final	CLO3

			RSA and ElGamal crypto systems		Exam		
		5	**Hash Function and Digital Signature** Basic theories and use cases	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO3	
		6	**Physical Security** Authentication technologies Direct attacks Physical Intrusion Detection	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4	
		7	**Operating Systems Security** Process security Memory and file system security Application program security	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4	
		8	**Malware and Forensic Analysis** Insider & Malware attacks Computer viruses Privacy-invasive software Countermeasures Malware forensic	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4	
		9	**Network Security** Network security concepts Vulnerabilities in Link, Network, Transport, and Application layers Firewall, Tunnelling and Intrusion detection Denial of Service attacks Countermeasures	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4	

		10	**Web Security** Attacks on clients Attacks on servers Countermeasures	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4
		11	**Blockchain and Bitcoin** History of money The need for decentralization State machine replication Concepts of transaction, block, blockchain, and distributed consensus of Blockchain security Blockchain applications	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4, CLO3
		12	**Blockchain and Bitcoin (contd.)** Concepts of transaction, block, blockchain, and distributed consensus of Blockchain security Blockchain applications	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4
		13-14	**Current Trends and Research in Cryptography and Computer Security** Recent developments and trends in cryptography and computer security Research areas and directions	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1,2,3,4
Text books	1. Introduction to Computer Security by Michael T. Goodrich and Roberto Tamassia 2. Introduction to Computer Security by Matt Bishop					

<table>
<tr><td>Course Title:</td><td>Introduction To Cryptography Lab</td></tr>
<tr><td>Credits:</td><td>1.5</td></tr>
<tr><td>Course No.:</td><td>SWE 0612-4154</td></tr>
<tr><td>Credit Hours:</td><td>3 hours/week</td></tr>
<tr><td>Rationale:</td><td>In this course, these students will carry out a number of hands-on lab works based on concepts gained in its counterpart theory course, SWE 454. The main motivation of this course is to provide hands-on experiences of working with different encryption algorithms, attacking systems exploiting different vulnerabilities and adopting security measures to counteract these vulnerabilities.</td></tr>
<tr><td>Objectives:</td><td>Objectives:
Develop practical skills in implementing cryptographic algorithms and protocols
Gain hands-on experience in exploiting network and web application vulnerabilities
Develop skills in analyzing and defending against malware attacks
Learn to develop secure systems using different cryptographic libraries</td></tr>
<tr><td>Course Contents:</td><td>Basic terminology and security concepts: Fundamental concepts, Access control models, Cryptographic concepts, Security principles

Classic Crypto Systems: Substitution cipher, Vigenère cipher, Hill Cipher, One-time pads Symmetric Encryption: Advanced Encryption Standard (AES)

Public Key Encryption: RSA and ElGamal crypto systems

Other crypto mechanisms: Hash Function, Digital Signature

Physical security: Authentication technologies, Direct attacks, Physical Intrusion Detection

Operating Systems Security: Process, security, Memory and file system security, Application program security

Malware and forensic analysis: Insider & Malware attacks, Computer viruses, Privacy-invasive software, Countermeasures, Malware forensic

Network Security: Network security concepts, Vulnerabilities in Link, Network, Transport and Application layers, Firewall, Tunnelling and Intrusion detection, Denial of Service attacks, Countermeasures

Web security: Attacks on clients, Attacks on servers, Countermeasures

Blockchain and Bitcoin: History of money, The need of decentralization, State machine replication, Concepts of transaction, block, blockchain and distributed consensus of Blockchain security, Blockchain applications

Attacking classic cipher systems, Programming different cryptographic algorithms, Developing secure systems utilizing different cryptographic libraries, Exploiting network vulnerabilities, attacking and defending web applications and Malware analysis.</td></tr>
<tr><td>Course Learning</td><td>After the successful completion of the course, the student will be able to-<table><tr><td>CLO 1</td><td>Develop practical skills in implementing cryptographic algorithms and protocols</td></tr></table></td></tr>
</table>

Outcomes (CLOs):

CLO 2	Gain hands-on experience in exploiting network and web application vulnerabilities.
CLO 3	Develop skills in analyzing and defending against malware attacks
CLO 4	Develop secure systems using different cryptographic libraries

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3							1				
CLO 2	3	3		3		2		2			2	
CLO 3	3	3	3		3		3		1	3	1	
CLO 4	3			2		3		3		2		3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Quiz, Presentation, Project
CLO 2	Lectures, Tutorial class	Quiz, Presentation, Project
CLO 3	Lectures, Tutorial class	Quiz, Presentation, Project
CLO 4	Lectures, Tutorial class	Quiz, Presentation, Project

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1-2	**Introduction to Cryptography and Computer Security** Introduction to cryptography and computer security concepts Basic Cryptography Tools: GPG, OpenSSL, Wireshark	Lectures, Tutorial class	Quiz, Presentation, Project	CLO1

		3-4	**Classic Cryptography Attacks** Substitution Cipher attacks Vigenère Cipher attacks Hill Cipher attacks	Lectures, Tutorial class	Quiz, Presentation, Project	CLO1	
		5-6	**Programming Cryptographic Algorithms** Implementing symmetric encryption algorithms (AES) Implementing public key encryption algorithms (RSA, ElGamal)	Lectures, Tutorial class	Quiz, Presentation, Project	CLO2	
		7-8	**Network Vulnerabilities and Exploitation** Network sniffing and spoofing Exploiting network vulnerabilities Firewall configuration and evasion	Lectures, Tutorial class	Quiz, Presentation, Project	CLO2	
		9-10	**Web Application Security** Web application vulnerabilities and attacks Cross-Site Scripting (XSS) attacks SQL Injection attacks	Lectures, Tutorial class	Quiz, Presentation, Project	CLO3	
		11-12	**Malware Analysis and Defense** Types of malware and their behavior Malware analysis tools and techniques Malware defense and countermeasures	Lectures, Tutorial class	Quiz, Presentation, Project	CLO3	

		13-14	**Final Project** Developing a secure system utilizing different cryptographic libraries Demonstration of the project in the lab	Lectures, Tutorial class	Quiz, Presentation, Project	CLO4
Text books	1. Introduction to Computer Security by Michael T. Goodrich and Roberto Tamassia 2. Introduction to Computer Security by Matt Bishop					

Course Title:	Applied Data Science
Credits:	3
Course No.:	SWE 0688-4155
Credit Hours:	3 hours/week
Rationale:	Data Science is a rapidly evolving field that studies how to analyze and organize relevant data through appropriate data visualizations. The technical foundation of Data science arises from Mathematics, Statistics and Computer Science. Those with a technical background related to data science need an understanding of the data relevant to the particular problem application area. Those with expertise in the application area must acquire the relevant technical knowledge in order to effectively and accurately make use of data science tools and methodologies. This course will build the technical and analytical skills required to collect, clean, and model data and show a path to bring all of these skills together in the creation and presentation of a data analytics predictive model, software system, or visualization.
Objectives:	**Objectives:** ● To introduce the fundamentals of data analytics and data science. ● To facilitate knowledge about data visualizations and appropriate analysis. ● To acquaint students with the methods to store and access data from a variety of sources. ● To familiarize with techniques and tools for transformation of Data. ● To help accumulate basic ideas about statistical methods, regression techniques, and machine learning algorithms to make sense out of data sets both large and small.
Course Contents:	Introduction to Data Science, The scope of Data Science, Descriptive Statistics and Exploratory Data Analysis. Data Scraping, Cleaning and Summarization. Statistical Significance and P-values. Principles of Visualizing Data. Building Models and Validating Models. Linear Algebra Review. Linear Regression and Logistic Regression. Large-scale Clustering. Mining Massive Datasets. Crowdsourcing and Ensemble Learning.

Course Learning Outcomes (CLOs):

After the successful completion of the course, the student will be able to-

CLO 1	develop the skills required for collecting, cleaning, and modeling data
CLO 2	Construct plans to solve nontrivial problems by combining different search and decomposition techniques
CLO 3	Design models to solve data dependent real life problems
CLO 4	apply data visualization techniques to effectively communicate findings

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	2					1		3			1	1
CLO 2	3	1			3				2	2	1	1
CLO 3	2		1				3		2			1
CLO 4	3			2								1

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 2	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 3	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 4	Lectures, Tutorial class	Quiz, Assignment, Final Exam

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Data Science**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1, 2

			Introduction to data science and its relevance Overview of data science tools and techniques Introduction to Python and R programming languages				
		2	**Data Scraping, Cleaning and Summarization** Techniques for scraping data from various sources Data cleaning techniques Summarizing data using descriptive statistics	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2, 3	
		3	**Statistical Significance and P-values** Understanding statistical significance Hypothesis testing P-values and confidence intervals	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2	
		4	**Principles of Visualizing Data** Introduction to data visualization Types of visualizations and when to use them Visualization tools and libraries	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO 1, CLO2	
		5	**Building and Validating Models** Introduction to machine learning algorithms	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO3, 1	

			Model selection and evaluation techniques Cross-validation and regularization				
		6	**Linear Algebra Review** Linear algebra basics Matrices and vectors Eigenvalues and eigenvectors	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1, 2, 3	
		7	**Linear Regression and Logistic Regression** Simple and multiple linear regression Logistic regression Model interpretation and evaluation	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4, 2	
		8	**Large-scale Clustering** Introduction to clustering K-means clustering Hierarchical clustering	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4	
		9	**Mining Massive Datasets** Introduction to big data Distributed computing and MapReduce Spark and Hadoop	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1, 2	
		10	**Crowdsourcing and Ensemble Learning** Introduction to crowdsourcing Ensemble learning techniques Applications of ensemble learning	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2, 3	
		11-12	**Case Studies**	Lectures, Tutorial class	Quiz, Assignment, Final	CLO1,CLO2, CLO3, CLO4	

			Analyzing real-world datasets Developing data science projects Presenting data analysis results		Exam	
		13-14	**Advanced Topics in Data Science** Deep learning and neural networks Natural language processing Time series analysis	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4, CLO1, CLO2
		13-14	**Current Trends and Research in Cryptography and Computer Security** Recent developments and trends in cryptography and computer security Research areas and directions	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1,2,3,4
		14	**Machine Translation** **Hands-on practice with machine translation using Google Translate API**		Quiz, Assignment, Final Exam	CLO2, CLO3, CLO4
Text books	1. The Signal and the Noise: Why so many predictions fail but some don't, by Nate Silver, Penguin Press. 2. The Art of Data Science, by Roger D. Peng and Elizabeth Matsui.					

Course Title:	Applied Data Science Lab
Credits:	3
Course No.:	SWE 0688-4156

<table>
<tr><td>Credit Hours:</td><td>3 hours/week</td></tr>
<tr><td>Rationale:</td><td>Data Science is a rapidly evolving field that studies how to analyze and organize relevant data through appropriate data visualizations. The technical foundation of Data science arises from Mathematics, Statistics and Computer Science. Those with a technical background related to data science need an understanding of the data relevant to the particular problem application area. Those with expertise in the application area must acquire the relevant technical knowledge in order to effectively and accurately make use of data science tools and methodologies. This course will build the technical and analytical skills required to collect, clean, and model data and show a path to bring all of these skills together in the creation and presentation of a data analytics predictive model, software system, or visualization.</td></tr>
<tr><td>Objectives:</td><td>Objectives:
To facilitate necessary knowledge about functionality of Data Science
To demonstrate how Data Science solves different real-world problems
To help solve different Data Science problems using appropriate Data visualization, organization and presentation
To help to develop systems by assembling different solution techniques</td></tr>
<tr><td>Course Contents:</td><td>Introduction to Data Science, The scope of Data Science, Descriptive Statistics and Exploratory Data Analysis. Data Scraping, Cleaning and Summarization. Statistical Significance and P-values. Principles of Visualizing Data. Building Models and Validating Models. Linear Algebra Review. Linear Regression and Logistic Regression. Large-scale Clustering. Mining Massive Datasets. Crowdsourcing and Ensemble Learning.

Python for data analysis. Data Wrangling with Python, including tools/libraries as Pandas, NumPy, and IPython. Machine Learning using Python.</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>After the successful completion of the course, the student will be able to-<table><tr><td>CLO 1</td><td>hands-on experience with various data science tools and techniques</td></tr><tr><td>CLO 2</td><td>develop skills in data cleaning, transformation, and modeling</td></tr><tr><td>CLO 3</td><td>Design models to solve data dependent real life problems</td></tr><tr><td>CLO 4</td><td>apply statistical methods, regression techniques, and machine learning algorithms to analyze data</td></tr></table></td></tr>
<tr><td>Mapping of CLOs with Program Learning Outcomes (PLOs):</td><td><table><tr><th>CLO /PLO</th><th>PLO1</th><th>PL02</th><th>PLO3</th><th>PLO4</th><th>PLO5</th><th>PLO6</th><th>PLO7</th><th>PLO8</th><th>PLO9</th><th>PLO10</th><th>PLO11</th><th>PLO12</th></tr><tr><td>CLO 1</td><td>2</td><td></td><td></td><td></td><td></td><td>1</td><td></td><td></td><td></td><td>3</td><td>1</td><td></td></tr><tr><td>CLO 2</td><td>3</td><td>1</td><td></td><td></td><td>2</td><td></td><td></td><td></td><td>1</td><td>1</td><td>1</td><td></td></tr><tr><td>CLO 3</td><td>2</td><td></td><td>1</td><td></td><td></td><td></td><td>2</td><td></td><td>1</td><td></td><td></td><td></td></tr></table></td></tr>
</table>

CLO 4	**3**			**2**				**1**				**3**

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Viva, Presentation, Project
CLO 2	Lectures, Tutorial class	Viva, Presentation, Project
CLO 3	Lectures, Tutorial class	Viva, Presentation, Project
CLO 4	Lectures, Tutorial class	Viva, Presentation, Project

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1-2	Introduction to lab course and setting up the environment Basic data cleaning and transformation using Python libraries (Pandas, NumPy) Hands-on exercise on data cleaning and transformation	Lectures, Tutorial class	Viva, Presentation, Project	CLO2,3
3-4	Introduction to data visualization using Matplotlib and Seaborn Hands-on exercise on data visualization Statistical methods and significance testing	Lectures, Tutorial class	Viva, Presentation, Project	CLO2, 3, 1
5-6	Introduction to regression analysis Linear regression using scikit-learn Hands-on exercise on linear regression	Lectures, Tutorial class	Viva, Presentation, Project	CLO2,1,3

		7-8	Introduction to logistic regression Logistic regression using scikit-learn Hands-on exercise on logistic regression	Lectures, Tutorial class	Viva, Presentation, Project	CLO 1, CLO2	
		9-10	Introduction to clustering Clustering techniques using scikit-learn Hands-on exercise on clustering	Lectures, Tutorial class	Viva, Presentation, Project	CLO3, 1	
		11-12	Introduction to ensemble learning Ensemble learning techniques using scikit-learn Hands-on exercise on ensemble learning	Lectures, Tutorial class	Viva, Presentation, Project	CLO1, 2, 3	
		13-14	Data analytics project development and presentation Final project presentation and evaluation	Lectures, Tutorial class	Viva, Presentation, Project	CLO4, 2, 3, 1	
Text books	1. The Signal and the Noise: Why so many predictions fail but some don't, by Nate Silver, Penguin Press. 2. The Art of Data Science, by Roger D. Peng and Elizabeth Matsui.						

Course Title:	Contemporary course on Software Engineering
Credits:	3
Course No.:	SWE 0613-4157
Credit Hours:	3 hours/week
Rationale:	Software Engineering is about the discipline needed to develop high quality software that can be understood, maintained and adapted over long periods of time by many different people. The course

	attempts to foster an understanding of software quality: what it is, and how to achieve it. This can be done through the use of a team project running throughout the course, in which teams trade software modules with one another. By attempting to understand, assess, and modify one another's programs, students will gain insight into the nature of software quality, and why an ability to program is not sufficient for the construction of high quality software.
Objectives:	**Objectives:** ● To give students an insight about common software engineering processes and well-known practices. ● To make students understand the impact of requirement engineering and the proper way to do that. ● To make students understand basic design principles and how those principles can be utilized to make more modular and scalable programs. ● To help students develop skills that will enable them to construct software of high quality – software that is reliable, and that is reasonably easy to understand, modify and maintain. ● To provide knowledge of basic software measurement concepts and how to allocate resources from the perspective of a software manager or team lead. ● To facilitate students with the knowledge how to properly test their software and modern software verification and validation practices.
Course Contents:	**Introduction:** Introduction to Software Engineering, Software Development Process and Various Life Cycle Models. **Requirement Analysis:** Communication Techniques, Analysis Principles, Software Prototyping, Requirement Specification. **Analysis Modeling:** Steps of system analysis, Feasibility study, Economic and technical analysis, System specification, the elements of analysis model, Data modeling, Functional modeling and information flow, Behavioral modeling, Mechanics of structured analysis, Data Dictionary. **Software Design:** Design principles, Design Concepts, effective modular design, design heuristics, Data Design, Architectural Design process, Transformation mapping, Transaction mapping, interface design, human-computer interface design, procedural design. **Software Testing:** Testing fundamentals, test case design, white-box testing, black-box testing, testing GUIs, Unit testing, Integration testing, validation testing, system testing, debugging. **Maintenance:** Major maintenance activities, estimating maintenance cost and productivity. **Technical Metrics for Software:** Software quality, Framework for technical metrics, metrics for analysis and design models, source code, testing and maintenance. **Software Architecture:** Pipe and Filter, Object Oriented, Event Based, Layered System, Data-centered repository, Process Control Architectures. **Software Project Management:** Cost estimation, risk analysis, project scheduling. **Design Patterns:** Introduction to design patterns. Different Patterns: Strategy, Observer, Factory, Singleton, Command, Adapter, Facade, Template Method, Iterator, Composite, State, Proxy, Compound Patterns. **Formal Methods:** Formal Methods in Software Engineering: its need and application, Formal specifications, Formal Verifications, Introduction to Z Language, Formal methods and testing.
Course Learning	After the successful completion of the course, the student will be able to-

Outcomes (CLOs):

CLO 1	Develop skills that will enable students to construct software of high quality
CLO 2	Requirement analysis and management
CLO 3	Analysis modeling and software design
CLO 4	Formal methods and future trends in software engineering

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	2					1		3			1	1
CLO 2	3	1			3				2	2	1	1
CLO 3	2		1				3		2			1
CLO 4	3			2								1

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 2	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 3	Lectures, Tutorial class	Quiz, Assignment, Final Exam
CLO 4	Lectures, Tutorial class	Quiz, Assignment, Final Exam

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	**Introduction to Software Engineering and Software Development Process**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1, 2

			Overview of software engineering Characteristics of high-quality software Introduction to software development process Software development life cycle models				
		2-3	**Requirement Analysis** Communication techniques in requirement engineering Analysis principles and software prototyping Requirement specification and management Techniques for eliciting, analyzing, and validating requirements	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2, 3	
		4-5	**Analysis Modeling** Steps of system analysis Feasibility study and economic analysis System specification Data modeling and functional modeling Behavioral modeling and mechanics of structured analysis Data dictionary and process modeling	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO2	
		6-7	**Software Design** Design principles and concepts Effective modular design and design heuristics	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO 1, CLO2	

			Data design and architectural design process Transformation and transaction mapping Interface and human-computer interface design Procedural design and software architecture				
		8-9	**Software Testing** Fundamentals of software testing Test case design and test levels White-box testing and black-box testing GUI testing and unit testing Integration testing and validation testing System testing and debugging techniques	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO3, 1	
		10-11	**Maintenance and Technical Metrics for Software** Major maintenance activities and estimating maintenance cost Software quality and framework for technical metrics Metrics for analysis and design models, source code, testing, and maintenance Software evolution and reengineering	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO1, 2, 3	
		12-13	**Software Project Management and Design Pattern**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4, 2	

			Cost estimation and risk analysis Project scheduling and software configuration management Introduction to design patterns and its types Strategy, observer, factory, singleton, command, adapter, facade, template method, iterator, composite, state, proxy, and compound patterns			
		14	**Formal Methods and Future Trends**	Lectures, Tutorial class	Quiz, Assignment, Final Exam	CLO4
Text books	1. Software Engineering: A Practitioner's Approach- Roger S. Pressman. 2. Head First Design Patterns, Eric & Elisabeth Freeman, O'REILLY.					

Course Title:	Contemporary course on Software Engineering Lab
Credits:	1.5
Course No.:	SWE 0613-4158
Credit Hours:	3 hours/week
Rationale:	Software Engineering is about the discipline needed to develop high quality software that can be understood, maintained and adapted over long periods of time by many different people. The course attempts to foster an understanding of software quality: what it is, and how to achieve it. This can be done through the use of a team project running throughout the course, in which teams trade software modules with one another. By attempting to understand, assess, and modify one another's programs, students will gain insight into the nature of software quality, and why an ability to program is not sufficient for the construction of high quality software.
Objectives:	**Objectives:** ● To give students an insight about common software engineering processes and well-known practices. ● To make students understand the impact of requirement engineering and the proper way to do that. ● To make students understand basic design principles and how those principles can be utilized to make more modular and scalable programs. ● To help students develop skills that will enable them to construct software of high quality – software that is reliable, and that is reasonably easy to understand, modify and maintain.

<table>
<tr><td></td><td>

To provide knowledge of basic software measurement concepts and how to allocate resources from the perspective of a software manager or team lead.
To facilitate students with the knowledge how to properly test their software and modern software verification and validation practices.

</td></tr>
<tr><td>Course Contents:</td><td>
Introduction: Introduction to Software Engineering, Software Development Process and Various Life Cycle Models.

Requirement Analysis: Communication Techniques, Analysis Principles, Software Prototyping, Requirement Specification.

Analysis Modeling: Steps of system analysis, Feasibility study, Economic and technical analysis, System specification, the elements of analysis model, Data modeling, Functional modeling and information flow, Behavioral modeling, Mechanics of structured analysis, Data Dictionary.

Software Design: Design principles, Design Concepts, effective modular design, design heuristics, Data Design, Architectural Design process, Transformation mapping, Transaction mapping, interface design, human-computer interface design, procedural design.

Software Testing: Testing fundamentals, test case design, white-box testing, black-box testing, testing GUIs, Unit testing, Integration testing, validation testing, system testing, debugging.

Maintenance: Major maintenance activities, estimating maintenance cost and productivity.

Technical Metrics for Software: Software quality, Framework for technical metrics, metrics for analysis and design models, source code, testing and maintenance.

Software Architecture: Pipe and Filter, Object Oriented, Event Based, Layered System, Data-centered repository, Process Control Architectures.

Software Project Management: Cost estimation, risk analysis, project scheduling.

Design Patterns: Introduction to design patterns. Different Patterns: Strategy, Observer, Factory, Singleton, Command, Adapter, Facade, Template Method, Iterator, Composite, State, Proxy, Compound Patterns.
Formal Methods: Formal Methods in Software Engineering: its need and application, Formal specifications, Formal Verifications, Introduction to Z Language, Formal methods and testing.

Case Studies
</td></tr>
<tr><td>Course Learning Outcomes (CLOs):</td><td>
After the successful completion of the course, the student will be able to-
<table>
<tr><td>CLO 1</td><td>Develop software using common software engineering processes and practices: Students will be able to apply software engineering principles, such as requirement engineering, design principles, and testing practices, to develop software that is reliable, scalable, and maintainable.</td></tr>
<tr><td>CLO 2</td><td>Test and verify software to ensure high quality: Students will learn modern software testing and verification practices, including white-box and black-box testing, unit testing, integration testing, and system testing. They will also learn how to use testing frameworks and tools to automate testing processes and ensure the quality of their software.</td></tr>
<tr><td>CLO 3</td><td>Apply software development tools to improve productivity: Students will learn how to use software development tools, such as IDEs, version control systems, and testing</td></tr>
</table>
</td></tr>
</table>

		frameworks, to improve their productivity and collaborate effectively with team members.
	CLO 4	Analyze and evaluate software for quality assurance: Students will learn how to analyze and evaluate software for quality assurance, including identifying and fixing software defects, measuring software performance, and optimizing software for scalability and maintainability.

Mapping of CLOs with Program Learning Outcomes (PLOs):

CLO /PLO	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO 12
CLO 1	2				3	1		3	2		1	3
CLO 2	2	1		3		2				2	1	3
CLO 3	2		1	1			3		2			3
CLO 4	2											3

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO	Teaching Learning Strategy	Assessment Strategy
CLO 1	Lectures, Tutorial class, Hands on with Real Project	Presentation, Group Discussion, Project
CLO 2	Lectures, Tutorial class, Hands on with Real Project	Presentation, Group Discussion, Project
CLO 3	Lectures, Tutorial class, Hands on with Real Project	Presentation, Group Discussion, Project
CLO 4	Lectures, Tutorial class, Hands on with Real Project	Presentation, Group Discussion, Project

Course Plan

Week	Topic	Teaching Learning Strategy	Assessment Strategy	CLOs
1	Introduction to software development tools: Introduction to IDEs, version control	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real	CLO1, 2

			systems, and testing frameworks.		Project		
		2	Requirements engineering: Requirements analysis, specification, and prototyping.	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO2, 3	
		3	Software design principles: Design concepts, modular design, and design heuristics.	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO2	
		4	Software testing fundamentals: Testing types, test case design, and test planning.	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO 1, CLO2	
		5	White-box testing: Statement coverage, branch coverage, and condition coverage.	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO3, 1	
		6	Black-box testing: Equivalence partitioning, boundary value analysis, and decision table testing.	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO1, 2, 3	
		7	Unit testing: Test-driven development and testing frameworks.	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO4, 2	
		8	**I**ntegration testing: Top-down and bottom-up integration testing.	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO4	
		9	Validation testing: Acceptance testing and usability testing.	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real	CLO1, 2	

					Project	
		10	System testing: Functional testing and performance testing.	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO2, 3
		11	Software maintenance: Maintenance activities and estimation	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO1,CLO2, CLO3, CLO4
		12	Technical metrics for software: Software quality metrics and measurement.	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO4, CLO1, CLO2
		13	Software project management: Cost estimation, risk analysis, and project scheduling.	Lectures, Tutorial class	Lectures, Tutorial class, Hands on with Real Project	CLO1,2,3,4
		14	Review and project presentation: Review of the course content and presentation of the final project.		Lectures, Tutorial class, Hands on with Real Project	CLO2, CLO3, CLO4
Text books	1. Software Engineering: A Practitioner's Approach- Roger S. Pressman. 2. Head First Design Patterns, Eric & Elisabeth Freeman, O'REILLY.					