Syllabus

(Session: 2023/2024; 2024/2025 and 2025/2026)

B.Sc. (Honors)

in

Information and Communication Technology (ICT)

Institute of Information Technology
Jahangirnagar University
Savar, Dhaka-1342.

About the Institute

Institute of Information Technology of Jahangirnagar University (IIT-JU) started its journey on October 2009 to create efficient Information & Communication Technology professionals. The erstwhile Computer and Information Technology Institute (CITI) previously (known as Computer Center) of JU has been taken as the backbone of the institute. IIT-JU currently offers Bachelor of Science in Information and Communication Technology (BICT), Master of Science in Information and Communication Technology (MICT), Master of Philosophy (MPhil) in Information and Communication Technology, Doctor of Philosophy (Ph.D.) in Information and Communication Technology, Professional Master in Information Technology (MIT) and Post Graduate Diploma in Information Technology (PGDIT). This institute also offers short certificate courses and all modules of CCNA. In addition, IIT is conducting state-of-the-art research works in collaboration of industries and foreign universities.

Vision

The vision of the IIT-JU is to enlighten the students through need-based academic innovation and research works and prepare them for the real-life challenges in the field of ICT.

Mission

M1: To inculcate teaching and learning process promoting state-of-the art IT industry practices in information and communication technology (ICT) to address global challenges.
M2: To integrate academics, research and entrepreneurship skills to address present and future challenges of the society and industry.
M3: To develop professionalism with strong foundations adapting to changing technology.

Program objectives

The Program Educational Objective (PEO) of IIT-JU are as follows:

PEO1: Provide students with a strong theoretical foundation as well as industry relevant skills in various technologies related to ICT to be able to adapt to the evolving technical challenges and changing career opportunities.

PEO2: Instill analytic and critical thinking skills in order to exhibit analytical decision-making and complex problem-solving abilities when dealing with real-time challenges.

PEO3: Indoctrinate professional and ethical aspects of modern computing technology so that students can apply their skills to design, create and use computing artifacts that are economically feasible and socially acceptable through their innovations.

PEO4: Providing an education that will prepare graduates to create, sustain and improve ICT infrastructure in organizations, as well as manage ICT resources to support a variety of organizational functions in order to confront contemporary issues in a broader social context.

Mapping PEO to Mission Statement:

Mission of the Program	PEO1	PEO2	PEO3	PEO4

M1: To inculcate teaching and learning process promoting state-of-the art IT industry practices in information and communication technology (ICT) to address global challenges.	√	√		√
M2: To integrate academics, research and entrepreneurship skills to address present and future challenges of the society and industry.	√		√	√
M3: To develop professionalism with strong foundations adapting to changing technology.		√	√	√

Program Learning Outcomes (PLO):
A graduate student of IIT-JU will have an ability to

PLO1: Engineering Knowledge – Apply Knowledge of mathematics, natural science, engineering and ICT fundamentals, engineering and ICT specialization to manage complex software and information management systems.

PLO2: Problem Analysis – Identify, formulate, study, and analyze complex Information and Communication Technology related problems using mathematical principles and natural sciences to draw demonstrable conclusions.

PLO3: Design/Development of Solutions – Design and develop software projects given their specifications considering performance and cost constraints by identifying, formulating and solving software engineering problems and understanding the software project management principles.

PLO4: Investigation – Conduct investigations into complex problems while demonstrating creativity and using evidence-based skills and research methods such as experiment design, data analysis and interpretation and information synthesis pertaining to Information and Communication Technology to draw relevant conclusions.

PLO5: Modern Tool Usage – Create, select and apply appropriate techniques, resources, modern tools, technologies and the fundamental principles that underlie the students within the context of ICT with an understanding of the limitations.

PLO6: The Engineer and Society – Apply reasoning based on contextual knowledge to become software engineers who are eager to work on projects that are both relevant and have a significant impact on people's lives concerning environmental, economic and social issues both in the local and global perspective.

PLO7: Environment and Sustainability – Examine the global and environmental impact of information and communication technology-based solutions and apply the learning for sustainable development.

PLO8: Ethics – Recognize professional obligations and use legal and ethical standards to make informed decisions in computing practice.

PLO9: Individual and Teamwork – Ability to function independently or as part of a team with responsibility for multidisciplinary settings.

PLO10: Communication – Extend entrepreneurship and leadership skills by communicating efficiently with the technical, management, user and academic audiences in oral, written and graphic form making effective presentations and give and receive clear instructions including documentation of hardware and software systems.

PLO11: Project Management and Finance – Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PLO12: Lifelong Learning– Recognize the need for adapting to emerging technology and continuously upgrading their abilities with a desire towards lifelong learning.

Mapping PEO vs. PLO:

Program Learning Outcomes (POs)	Program Educational Objectives			
	PEO1	PEO2	PEO3	PEO4
1. PLO1 Engineering Knowledge	√			√
2. PLO2 Problem Analysis		√		
3. PLO3 Design/Development of Solutions	√		√	
4. PLO4 Investigation	√	√		
5. PLO5 Modern Tool Usage			√	√
6. PLO6 The Engineer and Society		√	√	
7. PLO7 Environment and sustainability				√
8. PLO8 Ethics			√	
9. PLO9 Individual and Teamwork	√	√		√

10. PLO10 Communication		√	√		
11. PLO11 Project Management and Finance		√	√	√	
12. PLO12 Life-long Learning		√	√		

Mapping PEO vs. Types of Courses

First Year First Semester					
Course Code	Course Title	PEO1	PEO2	PEO3	PEO4
ICT 1101	Structured Programming Language	√	√		
ICT 1103	Electrical Circuits	√	√	√	
ICT 1105	Physics	√	√		√
ICT 1107	Engineering Mathematics-I	√	√		
ICT 1109	Communicative English	√	√		
ICT 1102	Structured Programming Language Lab	√		√	
ICT 1104	Electrical Circuits Lab	√	√		
ICT 1106	Soft Skill Development Lab		√	√	
ICT 1100	Course Viva	√	√	√	

First Year Second Semester					
Course Code	Course Title	PEO1	PEO2	PEO3	PEO4
ICT 1201	Electronic Devices and Circuits	√	√		√
ICT 1203	Object Oriented Programming	√	√	√	
ICT 1205	Engineering Mathematics-II	√	√		
ICT 1207	Discrete Mathematics	√	√		
ICT 1209	Bangladesh Studies	√			
ICT 1202	Electronic Devices and Circuits Lab		√	√	
ICT 1204	Object Oriented Programming Lab	√	√		
ICT 1200	Project Work - I and Course Viva	√	√	√	

Second Year First Semester					
Course Code	Course Title	PEO1	PEO2	PEO3	PEO4
ICT 2101	Data Structures	√	√		
ICT 2103	Digital Logic Design	√	√		√
ICT 2105	Data Communication and Computer Networks	√	√		
ICT 2107	Numerical Analysis for Engineers	√	√	√	
ICT 2109	Statistics and Probability for Engineers		√	√	
ICT 2102	Data Structures Lab	√	√		
ICT 2104	Digital Logic Design Lab	√	√	√	
ICT 2106	Data Communication and Computer Networks Lab	√	√		
ICT 2100	Course Viva	√	√	√	

Second Year Second Semester					
Course Code	Course Title	PEO1	PEO2	PEO3	PEO4
ICT 2201	Algorithm Analysis and Design	√	√		
ICT 2203	Analog and Digital Communication	√	√		
ICT 2205	Engineering Mathematics-III		√	√	
ICT 2207	Financial and Managerial Accounting	√	√		
ICT 2209	Innovation and Entrepreneurship	√	√	√	
ICT2202	Algorithm Analysis and Design Lab	√	√		
ICT 2204	Analog and Digital Communication Lab	√	√		
ICT 2200	Project Work - II and Course Viva		√	√	

Third Year First Semester					
Course Code	Course Title	PEO1	PEO2	PEO3	PEO4
ICT 3101	Operating Systems	√	√		√
ICT 3103	Database Management System	√	√	√	√
ICT 3105	Software Engineering Theories and Practices	√	√	√	
ICT 3107	ICT Business Analytics and Data Visualization	√	√	√	
ICT 3109	Principles of Economics	√		√	
ICT 3102	Operating Systems Lab	√	√	√	√
ICT 3104	Database Management System Lab	√	√		
ICT 3106	Software Engineering Theories and Practices Lab		√	√	√
ICT 3100	Course Viva				

Third Year Second Semester					
Course Code	Course Title	PEO1	PEO2	PEO3	PEO4
ICT 3201	Internet and Web Technology	√	√	√	√
ICT 3203	Artificial Intelligence and Neural Networks	√	√	√	
ICT 3205	Software Architecture and Design Pattern	√	√	√	√
ICT 3207	Information and Data Security		√	√	√
ICT 3209	Smart Sensors and Internet of Things	√	√		
ICT 3202	Internet and Web Technology Lab		√	√	
ICT 3204	Artificial Intelligence and Neural Networks Lab	√	√	√	√
ICT 3206	Software Architecture and Design Pattern Lab				
ICT 3200	Project Work – III and Course Viva				

Fourth Year First Semester					
Course Code	Course Title	PEO1	PEO2	PEO3	PEO4
ICT4100	Internship	√	√	√	√
Or					
ICT 41XX	From Option – I				
ICT 41XX	From Option – I Lab				
ICT 41XX	From Option – I				
ICT 41XX	From Option – I Lab				
ICT 41XX	From Option – I				
ICT 41XX	From Option – I Lab				
ICT 41XX	From Option – I				
ICT 41XX	From Option – I Lab				

Option I					
Course Code	Course Title	PEO1	PEO2	PEO3	PEO4
ICT 4101	Cloud Computing and web Services	√	√	√	
ICT 4102	Cloud Computing and web Services lab	√	√		
ICT 4103	Mobile Application Development			√	√
ICT 4104	Mobile Application Development Lab	√	√		
ICT 4105	Computer Vision and Robotics	√	√		√
ICT 4106	Computer Vision and Robotics Lab	√	√	√	
ICT 4107	Cyber Security and ICT Auditing	√	√		√
ICT 4108	Cyber Security and ICT Auditing Lab	√	√	√	
ICT 4109	Cryptography and Network Security	√		√	√
ICT 4110	Cryptography and Network Security Lab	√	√	√	
ICT 4111	Computer Network Service and Management	√	√		
ICT 4112	Computer Network Service and Management Lab			√	√
ICT 4113	Big Data Analytics and Application	√	√		
ICT 4114	Big Data Analytics and Application Lab	√	√		√
ICT 4115	Human Computer Interaction	√	√	√	

ICT 4116	Human Computer Interaction Lab	√	√		√
ICT 4117	Software Verification and Validation	√	√	√	
ICT 4118	Software Verification and Validation Lab	√		√	√
ICT 4119	Computer Architecture and Microprocessor	√		√	√
ICT 4120	Computer Architecture and Microprocessor Lab	√	√		√

Fourth Year Second Semester					
Course Code	Course Title	PEO1	PEO2	PEO3	PEO4
ICT 4201	Software Project Management	√	√	√	
ICT 4203	Machine Learning	√	√		√
ICT 4205	Software Documentation and Quality Assurance	√	√	√	√
ICT 42XX	From Option – II				
ICT 42XX	From Option – II				
ICT 4202	Software Project Management Lab	√	√		
ICT 4200	Research Project	√	√	√	

Option – II					
Course Code	Course Title	PEO1	PEO2	PEO3	PEO4
ICT 4207	Natural Language Processing	√	√		
ICT 4209	Parallel and Distributed System	√	√		
ICT 4211	Data Mining and Knowledge Discovery	√	√		
ICT 4213	Digital Image Processing	√	√	√	
ICT 4215	Digital Healthcare and Informatics	√	√		
ICT 4217	Simulation and Optimization Techniques	√	√	√	
ICT 4219	Wireless and Cellular Networks	√	√	√	√
ICT 4221	Embedded System Design	√		√	
ICT 4223	Research Methodology		√		√
ICT 4225	Digital Forensic	√		√	√
ICT 4227	Optical Fiber Communication	√	√	√	√
ICT 4229	Microwave Engineering and Satellite Communication	√		√	√
ICT 4231	Multimedia Communication	√	√		
ICT 4233	Introduction to 3D Modeling and Design	√	√	√	
ICT 4235	Enterprise Resource Planning and Systems	√	√	√	√
ICT 4237	Augmented Reality	√		√	
ICT 4239	Applied Data Science		√		√
ICT 4241	Human Centric Design Methods	√		√	√
ICT 4243	IT Professional and Ethics	√	√	√	√
ICT 4245	ICT Risk Management and Disaster Control	√		√	√
ICT 4247	Contemporary Course on Information and Communication Technology				

COURSE CURRICULUM FOR B. Sc. (Hons.) in ICT
Program Overview:
B. Sc. (Hons.) in Information and Communication Technology shall extend over a period of four academic years and will consist of eight semesters. The program hereinafter is called as Undergraduate Program. Each year will divide into two semesters. Each semester will have a duration of six months. Students shall be evaluated in each semester. A semester will be segmented into Class-weeks, Preparatory leave and Semester-end examination. The total time distribution for completing a semester will be as follows:

Sl.	Segment	Length
I.	Classes	14 Weeks
II.	Preparatory leave before semester-end examination	1 Weeks
III.	Semester-end examination	3 Weeks
IV.	Result Publishing & Semester Break	4 Weeks
	Total	22 Weeks

During class-weeks, if classes do not held in any particular week due to the reason beyond the control of the university, the week shall deem to be an effective class-week, if number of working days is equal to or more than three.

Admission:
Admission of students and examination of courses to the B.Sc. (Honors) program shall be guided by the Admission Ordinance and the Examination Ordinance of the University.

Eligibility:
Eligibility of students for taking part into the admission test shall be determined and guided as per rules of the University.

Admission Test:
Procedures for admission test shall be guided by the rules of the University. Along with that, a student will be considered eligible for admission if he/she obtains minimum 30% marks in Physics and minimum 40% marks in Mathematics in the admission test. Information relating to the detail syllabus, type and format of questions, date, time and place of the admission test will be found in the admission brochure, daily newspapers and on the web site, http://www.juniv.edu/iit/ or http://iit.juniv.edu.

Selection Procedure:
Selection procedure shall be guided as per rules of the University.

Rules for Admission:
Procedures for admission shall be guided as per rules of the University.

Tuition & Other Fees:
Tuition fees and the mode of payment of four years program shall be guided as per rules of the university.

Course Offering and Instruction:
The courses to be offered in a particular semester are announced and published in the Registration Package along with the tentative semester schedule before the end of the previous semester. The courses to be offered in any semester will be decided by the Committee of Courses for Undergraduate Program. Each course is conducted by a course teacher who is responsible for maintaining the expected standard of the course and for the assessment of students' performance. One of the course teachers or any other member of the teaching staff of the Institute will be designated as course coordinator for each semester. He/she has the full responsibility for coordinating the work of the other members of the Institute involving in that semester.

Course Pattern and Credit Structure:
The undergraduate program is covered by a set of theoretical courses along with a set of laboratory courses to support them.

Course Designation and Numbering System:
A course will be represented by course number, course title, credit hours and contact hours per week (Theory or Lab). Each course is designated by a three two letter code identifying the B. Sc. program offered followed by a four-digit number having the following interpretation: The first and second digits correspond to the year and the semester in which the course is normally taken by the students. The third digit is reserved for maintaining continuity. The last digit is an odd number for theoretical courses and an even number for laboratory courses. The following example illustrates a course representation system:

Course Code	Course Title	Credit Hrs.	Class Hrs./ Week
ICT 1101	Structured Programming Language	3.0	3 hrs.

Assignment of Credits:
The assignment of credits to a theoretical course follows a different rule from that of a practical or laboratory course. Courses of study for the B.Sc. (Hons.) in Information & Communication Technology are defined as per rules of the University.

Credit Hour Requirement:
The total contact hours for each 3 credits Theoretical course is 42 hours and for each 1.5 credits Lab oriented course is 42 hours. Marks allocated for each course either theoretical or practical is 100. The evaluation of a course will be carried by taking tutorial examination and a final examination.
A student for the B.Sc. (Hons.) in Information & Communication Technology will have to complete a total of 158 credit-hours during the four years' undergraduate program.

Industrial/Professional Training Requirements:
There shall be an Industrial/Professional training requirements at the end of the fourth semester. The objective of this training program is to enlighten the students with practical orientation and give them an opportunity to make use of their theoretical concepts and practical skills in real life situations. All students will be placed in public and private sectors, particularly those organizations that are engaged in activities having direct relevance to the Information & Communication Technology and likely to enhance the knowledge and skill of the students. The training program shall extend over a period of minimum three weeks. The outcome of this program will be an Industrial/Professional training report as prescribed in the syllabus. Training program shall be equivalent to a two credit hours laboratory course and be evaluated by this final report accordingly. The credit earned in this training program will not contribute in any GPA/CGPA calculation of the student's result but the student has to obtain a satisfactory (S) grade in this course to get promotion in the next semester.

Placement of Students for Industrial /Professional Training Requirement:
The academic committee of the Institute shall arrange for the placement of students and shall nominate internal and external supervisor(s) of the students going for Industrial Attachment. The Director of the Institute will send the names of the internal and external supervisors to the Director Controller of the Examination office for appointment.

Research Project:
Research Project work is required for the partial fulfillment of the completion of bachelor degree. A committee shall be formed for monitoring the project works for undergraduate students. This committee will finalize the placement of students for research project and shall nominate supervisor, internal and external members. The Director of the Institute will send the names of the internal and external members to the Controller of the Examination Office for appointment.

Assessment:

For the purpose of assessment, 100 marks shall be assigned to each three-credit hours' course. Assessment of a student in a course shall be based on marks obtained in the course-end examination (written) and class assessments/continuous assessment. Marks allotted for class assessment/continuous assessment shall be 40% of the total earned marks for each theoretical course and 60% for each practical course.

Assessment Criteria	Theoretical Course	Practical Courses
Class/Continuous Assessment	40%	60%
Final examination	60%	40%
Total	100%	100%

Class Assessment / Continuous Assessment and Submission of Assessment:

Class assessment/continuous assessment will consist of class attendance, written class tests, quizzes, presentation, project works, case studies, assignments, term papers and discussion sessions. For assessment of class test in theoretical courses there shall be a minimum of three tutorial tests (declared/undeclared) for each three-credit hours course. For assessment of class test in practical courses there shall be a minimum of three declared written tutorial tests for each three-credit hours' course. The distribution of marks for each theoretical course shall be as follows:

Theoretical Courses	Marks (%)
Class participation / Attendance	10%
Assignments	10%
Tutorial tests/Class tests	20%
Semester-end Examination	60%
Total	100%

The distribution of marks for each practical course will be as follows:

Practical Courses	Marks (%)
Class participation/Attendance	10%
Class test/Tutorial	20%
Experiment Evaluation	10%
Report	10%
Quiz/Viva	10%
Semester-end Examination	40%
Total	100%

The distribution of marks for internship will be as follows

Internship	Marks (%)
Midterm Presentation	10%
Final presentation	20%
Final Report	10%
Company Evaluation	60%
Total	100%

Examinations:

Final examination for each semester will be conducted as per Examination Ordinance for semester system in the university and controlled by Office of the Controller of Examination.

Grading System:

The Universal Grading System introduced by the University Grant Commission (UGC) of Bangladesh will be followed which is given below. The total numerical marks obtained by a student in each course will be converted into Letter Grade (LG) and Grade Point (GP). According to the Grade Point, the GPA (Grade Point Average) and CGPA (Cumulative Grade Point Average) will be calculated. The conversion of Letter Grade and Grade Point will be as follows:

Numerical Grade	Letter Grade	Grade Points
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%	D	2.00
Less than 40%	F	0.00
Incomplete	I	
Satisfactory or Unsatisfactory	S or U	Industrial/ Professional Tanning

Continuation	X	Industrial Attachment etc.

Earned Credits:
- The grades of the courses, in which a student has obtained minimum qualifying pass grade, shall only be counted as credits earned by him/her. Other grades shall not be counted for Grade Point Average (GPA) calculation.
- If a student obtains an F grade in any course in any semester, he/she will have to repeat the course(s), whenever offered within his/her total duration of academic years. In that case his/her earned credit shall not be more than B.
- If a student obtains I(incomplete) grade in one or more courses in any semester, he/she will have to repeat the course(s), whenever offered within his total duration of academic years.

Performance Evaluation:
The performance of a student will be evaluated in terms of two indices: (i) semester grade point average (GPA) and (ii) Cumulative Grade Point Average (CGPA) which is the grade point average for all the semester completed. Students will be considered to be making normal progress toward a degree if their Cumulative Grade Point Average (CGPA) for all work attempted is 2.00 or higher. Students who regularly maintain a GPA of 2.00 in each semester or better are making good progress toward the degrees and are in good standing with the University. Students who fail to maintain this minimum rate of progress will not be in good standing. This can happen when any one of the following conditions exists. The earned GPA in each semester falls below 2.00, or The Cumulative GPA falls below 2.00, or the earned number of credits falls below 15 times the number of semesters attended. All such students can make up their deficiencies in GPA and credit requirements by completing courses in the subsequent semester(s) and backlog courses, if there are any, with better grades. When the minimum GPA and credit requirements are achieved, the student is again returned to good standing.

Class Attendance:
To sit for the class assessment and course-end examination, a student must have to have minimum class attendance of 75% which will be guided by the rules of the university.

Qualifying Marks:
- The qualifying pass grade in a particular course will be determined by the rules of the University. If any student gets F grade in one or more courses, he/she has to cover it within the time limit which is mentioned in section 19 of this ordinance.
- If a candidate remains absent in a course-end Examination for a course for reasons like - serious illness, accident or any other valid reason, his/her course may be graded I (Incomplete). With subject to the approval of the concerned authority of the University, he/she may get a chance to recover it like section 19.

Promotion to next semester:
A student must secure the minimum qualifying grade in each of the courses in the semester-end examination in order to be considered "pass" in that semester. However, for promotion to the next semester, a candidate shall have to obtain a minimum GPA, which will be followed as per University rules.

Referred Examination:
Matters relating to referred examination shall be guided by the rules of the University.

Student Adviser:
One adviser is normally appointed for a group of students by the Director of the Institute. The adviser advises each student about the academic program of that particular semester. However, it is also the student's responsibility to keep regular contact with his/her adviser who will review and eventually approve the student's specific plan of study and monitor subsequent progress of the student. The adviser is also authorized to permit the student to drop one or more courses based on his/her previous academic performance and corresponding categorization.

Time Limit:
How long a student shall be permitted to continue as a Bachelor's Degree candidate will be decided by the rules of the University.

COURSE CURRICULUM

First Year First Semester				
Sl.	Course Code	Course Title	Credit Hrs.	Class Hrs./ Week
1	ICT 1101	Structured Programming Language	3.0	2 hrs.
2	ICT 1103	Electrical Circuits	3.0	3 hrs.
3	ICT 1105	Physics	3.0	3 hrs.
4	ICT 1107	Engineering Mathematics-I	3.0	2 hrs.
5	ICT 1109	Communicative English	3.0	3 hrs.
6	ICT 1102	Structured Programming Language Lab	3.0	2 hrs.
7	ICT 1104	Electrical Circuits Lab	1.5	3 hrs.
8	ICT 1106	Soft Skills Development Lab	1.5	3 hrs.
9	ICT 1100	Course Viva	0.5	
		Total Credit	20.0	

First Year Second Semester				
Sl.	Course Code	Course Title	Credit Hrs.	Class Hrs./ Week
1	ICT 1201	Electronic Devices and Circuits	3.0	3 hrs.
2	ICT 1203	Object Oriented Programming	3.0	3 hrs.

3	ICT 1205	Engineering Mathematics-II	3.0	3 hrs.
4	ICT 1207	Discrete Mathematics	3.0	3 hrs.
5	ICT 1209	Bangladesh Studies	3.0	2 hrs.
6	ICT 1202	Electronic Devices and Circuits Lab	1.5	3 hrs.
7	ICT 1204	Object Oriented Programming Lab	1.5	3 hrs.
8	ICT 1200	Project Work - I and Course Viva	1.0	
		Total Credit	19.0	

Second Year First Semester				
Sl.	Course Code	Course Title	Credit Hrs.	Class Hrs./ Week
1	ICT 2101	Data Structures	3.0	3 hrs.
2	ICT 2103	Digital Logic Design	3.0	3 hrs.
3	ICT 2105	Data Communication and Computer Networks	3.0	3 hrs.
4	ICT 2107	Numerical Analysis for Engineers	3.0	3 hrs.
5	ICT 2109	Statistics and Probability for Engineers	3.0	3 hrs.
6	ICT 2102	Data Structures Lab	1.5	3 hrs.
7	ICT 2104	Digital Logic Design Lab	1.5	3 hrs.
8	ICT 2106	Data Communication and Computer Networks Lab	1.5	3 hrs.
9	ICT 2100	Course Viva	0.5	
		Total Credit	20.0	

Second Year Second Semester				
Sl.	Course Code	Course Title	Credit Hrs.	Class Hrs./ Week
1	ICT 2201	Algorithm Analysis and Design	3.0	3 hrs.
2	ICT 2203	Analog and Digital Communication	3.0	3 hrs.
3	ICT 2205	Engineering Mathematics-III	3.0	3 hrs.
4	ICT 2207	Financial and Managerial Accounting	3.0	3 hrs.
5	ICT 2209	Innovation and Entrepreneurship	3.0	2 hrs.
6	ICT2202	Algorithm Analysis and Design Lab	1.5	3 hrs.
7	ICT 2204	Analog and Digital Communication Lab	1.5	3 hrs.
8	ICT 2200	Project Work - II and Course Viva	1.5	3 hrs.
		Total Credit	19.0	

Third Year First Semester				
Sl.	Course Code	Course Title	Credit Hrs.	Class Hrs./ Week
1	ICT 3101	Operating Systems	3.0	3 hrs.
2	ICT 3103	Database Management System	3.0	3 hrs.
3	ICT 3105	Software Engineering Theories and Practices	3.0	3 hrs.
4	ICT 3107	ICT Business Analytics and Data Visualization	3.0	3 hrs.
5	ICT 3109	Principles of Economics	3.0	3 hrs.
6	ICT 3102	Operating Systems Lab	1.5	3 hrs.
7	ICT 3104	Database Management System Lab	1.5	3 hrs.
8	ICT 3106	Software Engineering Theories and Practices Lab	1.0	3 hrs.
9	ICT 3100	Course Viva	0.5	
		Total Credit	20.0	

SI.	Course Code	Course Title	Credit Hrs.	Class Hrs./ Week
		Third Year Second Semester		
1	ICT 3201	Internet and Web Technology	3.0	3 hrs.
2	ICT 3203	Artificial Intelligence and Neural Networks	3.0	3 hrs.
3	ICT 3205	Software Architecture and Design Pattern	3.0	3 hrs.
4	ICT 3207	Information and Data Security	3.0	3 hrs.
5	ICT 3209	Smart Sensors and Internet of Things	3.0	3 hrs.
6	ICT 3202	Internet and Web Technology Lab	1.5	3 hrs.
7	ICT 3204	Artificial Intelligence and Neural Networks Lab	1.5	3 hrs.
8	ICT 3206	Software Architecture and Design Pattern Lab	1..5	3 hrs.
9	ICT 3200	Project Work – III and Course Viva	1.0	
		Total Credit	20.5	

SI.	Course Code	Course Title	Credit Hrs.	Class Hrs./ Week
		Fourth Year First Semester		
1	ICT4100	Internship	18.0	----
		Total Credit	18.0	
		Or		
1	ICT 41XX	From Option – I	3.0	3 hrs.
2	ICT 41XX	From Option – I Lab	1.5	3 hrs.
3	ICT 41XX	From Option – I	3.0	3 hrs.
4	ICT 41XX	From Option – I Lab	1.5	3 hrs.
5	ICT 41XX	From Option – I	3.0	3 hrs.
6	ICT 41XX	From Option – I Lab	3.0	3 hrs.
7	ICT 41XX	From Option – I	3.0	3 hrs.
8	ICT 41XX	From Option – I Lab	3.0	3 hrs.
		Total Credit	18.0	

SI.	Course Code	Course Title	Credit Hrs.	Class Hrs./ Week
		Option – I		
1	ICT 4101	Cloud Computing and Web Services	3.0	3 hrs.
2	ICT 4102	Cloud Computing and Web Services lab	1.5	3 hrs.
3	ICT 4103	Mobile Application Development	3.0	3 hrs.
4	ICT 4104	Mobile Application Development Lab	1.5	3 hrs.
5	ICT 4105	Computer Vision and Robotics	3.0	3 hrs.
6	ICT 4106	Computer Vision and Robotics Lab	1.5	3 hrs.
7	ICT 4107	Cyber Security and ICT Auditing	3.0	3 hrs.
8	ICT 4108	Cyber Security and ICT Auditing Lab	1.5	3 hrs.
9	ICT 4109	Cryptography and Network Security	3.0	3 hrs.
10	ICT 4110	Cryptography and Network Security Lab	1.5	3 hrs.
11	ICT 4111	Computer Network Service and Management	3.0	3 hrs.
12	ICT 4112	Computer Network Service and Management Lab	1.5	3 hrs.
13	ICT 4113	Big Data Analytics and Application	3.0	3 hrs.
14	ICT 4114	Big Data Analytics and Application Lab	1.5	3 hrs.
15	ICT 4115	Human Computer Interaction	3.0	3 hrs.
16	ICT 4116	Human Computer Interaction Lab	1.5	3 hrs.
17	ICT 4117	Software Verification and Validation	3.0	3 hrs.

18	ICT 4118	Software Verification and Validation Lab	1.5	3 hrs.
19	ICT 4119	Computer Architecture and Microprocessor	3.0	3 hrs.
20	ICT 4120	Computer Architecture and Microprocessor Lab	1.5	3 hrs.

Fourth Year Second Semester				
Sl.	Course Code	Course Title	Credit Hrs.	Class Hrs./ Week
1	ICT 4201	Software Project Management	3.0	3 hrs.
2	ICT 4203	Machine Learning	3.0	3 hrs.
3	ICT 4205	Software Documentation and Quality Assurance	3.0	3 hrs.
4	ICT 42XX	From Option – II	3.0	3 hrs.
5	ICT 42XX	From Option – II	3.0	3 hrs.
6	ICT 4202	Software Project Management Lab	1.5	3 hrs.
7	ICT 4200	Research Project	5.0	10 hrs.
		Total Credit	21.5	

Option – II				
Sl.	Course Code	Course Title	Credit Hrs.	Class Hrs./ Week
1	ICT 4207	Natural Language Processing	3.0	3 hrs.
2	ICT 4209	Parallel and Distributed System	3.0	3 hrs.
3	ICT 4211	Data Mining and Knowledge Discovery	3.0	3 hrs.
4	ICT 4213	Digital Image Processing	3.0	3 hrs.
5	ICT 4215	Digital Healthcare and Informatics	3.0	3 hrs.
6	ICT 4217	Simulation and Optimization Techniques	3.0	3 hrs.
7	ICT 4219	Wireless and Cellular Networks	3.0	3 hrs.
8	ICT 4221	Embedded System Design	3.0	3 hrs.
9	ICT 4223	Research Methodology	3.0	3 hrs.
10	ICT 4225	Digital Forensic	3.0	3 hrs.
11	ICT 4227	Optical Fiber Communication	3.0	3 hrs.
12	ICT 4229	Microwave Engineering and Satellite Communication	3.0	3 hrs.
13	ICT 4231	Multimedia Communication	3.0	3 hrs.
14	ICT 4233	Introduction to 3D Modeling and Design	3.0	3 hrs.
15	ICT 4235	Enterprise Resource Planning and Systems	3.0	3 hrs.
16	ICT 4237	Augmented Reality	3.0	3 hrs.
17	ICT 4239	Applied Data Science	3.0	3 hrs.
18	ICT 4241	Human Centered Design Method	3.0	3 hrs.
19	ICT 4243	IT Professional and Ethics	3.0	3 hrs.
20	ICT 4245	ICT Risk Management and Disaster Control	3.0	3 hrs.
21	ICT 4247	Contemporary Course on Information and	3.0	3 hrs.
22	ICT 4249	Contemporary Course on Information and Communication Technology	3.0	3 hrs.

1st Year 1st Semester

ICT 1101 Structured Programming Language

Course Summary:
In order to meet up the challenges of ICT, students need to learn about computer programming. This course introduces the fundamental concepts of structured programming. Topics include fundamentals of computers and number systems, algorithms & flowcharts, fundamental programming constructs: syntax and semantics of a higher-level language, variables, expressions, operators, simple I/O to console and files, conditional and iterative control structures, functions and parameter passing, dynamic memory allocation, file processing; fundamental data structures: arrays, structures, strings and string processing; and testing and debugging strategies.

Course Objectives:	The objective of this course is to - Introduce fundamental programming concepts by using various concepts and structures for writing programs. - Distinguish language definition from implementation, syntax and parsing from semantics and evaluation, understand how program state maps to memory (global/statics, locals/stack, heap/instances) and understand the implications of heap reachability for memory management. - Provide students with opportunities to develop, understand, test, and evolve substantial programs using a modern IDE and associated configuration tools with respect to program design and development.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand and apply** the flowchart construction, top-down design of programming, the basics of programming, and different types of selection structures and loop statements to write, compile, and execute a structured program.	**PLO1**
	CLO2- To **apply** one-dimensional and multidimensional arrays, strings, user defined functions, recursion to write a structured program.	**PLO1**
	CLO3- To **understand and use** of pointers, structure & union types, dynamic memory allocation and file management to solve different problems using structured programming.	**PLO1**
	CLO4- To **design and build** a realistic problem in complex applications by selecting appropriate language constructs and data structures. **(For Lab Course)**	**PLO3, PLO5**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CO1	Top-down Design of Programming, Flow chart constructions, Introduction to C Programming (input, output, variables, data type, operators, and expressions).	Lecture, Discussion, Problem Based Learning (PBL)	Essay Type Answer Exercise
CO1	Memory organization, memory access, precision of decimal, binary and floating point number, program execution in memory, memory addressing.	Lecture , Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CO1	Structured Program Development in C: Control Statements 1(if, if...else, top-down and stepwise refinement).	Lecture , Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CO1	Program Control: Control Statements 2 (for, while, do…while, switch, break and continue).	Lecture, Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CO2	Introduction to Arrays: Arrays, Declaring Arrays, Examples Using Arrays, arrays of strings).	Lecture , Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CO2	Introduction to Arrays: Searching Arrays, Sorting Arrays, Multidimensional Arrays.	Lecture , Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CO2	Introduction to Functions: Library Functions, Function Definitions, Function Prototypes and Argument, Header Files, Random Number Generation.	Lecture, Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CO2	Introduction to Functions: Passing Arguments to Functions, Call by Value, Call by References, Passing Arrays to Functions, Recursive Functions.	Lecture, Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise

CO2	Characters and Strings: String Conversion, String Manipulation,	Lecture, Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CO3	Structure and Union: Definition of structure, Union, Structure union applications, Self-referential structure, Structure and Union: Link List, Array of Structure.	Lecture, Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CO3	Pointers: Pointer Variable Declarations and Initialization, Pointer Operators, Passing Arguments to Functions by Reference with Pointers. Pointer Expressions and Pointer Arithmetic, arrays of pointers, and function pointers, dynamic memory allocation.	Lecture, Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CO3	File Processing: Files and Streams, Creating a Sequential File, Reading Data from Sequential File, Writing data to File, and Updating Sequential Files.	Lecture, Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CO4	Real Life Problem: Design a problem, choose appropriate language constructs and data structures, solve the real life problem	Lecture, Discussion, Report Writing, Coding and Running Program in Lab Classes	Exercise, Project Work Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1					√
CLO2					√
CLO3			√		√
CLO4			√	√	√

Suggested Texts:
- Problem Solving and Program Design in C, 7th Edition by J Hanly and E Koffman.
- C programming language, 2nd Edition by Kernigham & Ritchie.
- Teach Yourself C, 3rd Edition by Herbert Schildt.
- Programming in Ansi C, 8th Edition by Balagurushwami.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the fundamental programming constructs.
  - Understand and write searching and sorting techniques.
  - Understand a typical C-like program environment.
- Cognitive skills (thinking and analysis)
  - Be able to understand and analyze any problem and derive its solution.
  - Be able to develop and design algorithms.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - Be able to write C-like programs to build programming skills, designing skills and problem-solving skills

ICT 1103 Electrical Circuits

Course Objectives:	The objective of this course is to • Describe the concept of circuit elements lumped circuits, waveforms, circuit laws and network reduction. • Outline the electrical network using mesh and nodal analysis by applying network theorems. • Provide the concept of Energy storage elements. • Analyze the transient response of RC, LC and RLC circuits.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **learn** concepts of DC and AC circuit analysis.	PLO1
	CLO2- To **explain** laws and methods of circuit analysis.	PLO1, PLO2
	CLO3- To **apply** laws and theorems for solving electrical circuits.	PLO3, PLO6, PLO10

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Fundamental electrical concepts and measuring units. Active and passive components: Resistor, properties of resistors, types of resistors.	Lecture Assignment	Short Answer Exercise/

CLO2	Ohm's law, Power and Energy: Ohm's law, DC-circuits, conductance and resistance.	Lecture Assignment	Short Answer Exercise
CLO1, CLO2	Series and Parallel DC Circuit: Kirchoff's current law, current divider rule, open circuit, short circuit, etc. Analysis of series-parallel network. Methods of analysis for DC networks, current source, source conversion. branch-current analysis, mesh analysis, nodal analysis, bridge network, star delta, delta star.	Lecture Assignment Case Study Group Discussion	Short Answer Exercise MCQ
CLO2, CLO3	Network theorems (DC): superposition theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem. Millman's theorem, substitution theorem, reciprocity theorem. Sinusoidal alternating waveforms. Sine wave, general format for sinusoidal voltage or current. phase relations, etc. Response of basic R, L and C elements to a sinusoidal voltage or current, frequency response, rectangular and polar form, conversion between forms, phasors.	Lecture Assignment Problem Based Learning (PBL)	Short Answer Identification Group Exercise
CLO1, CLO2, CLO3	Analysis of series and parallel AC circuit: Impedance and phasor diagram, voltage divider rule, frequency response of the R-C circuit, admittance and susceptance. Current divider rule, frequency response of the parallel R-L network, etc. Analysis of series-parallel AC circuit. Methods of analysis for AC network, independent and dependent controlled source and source conversions, mesh analysis, nodal analysis, bridge network.	Lecture Assignment Case Study Group Discussion	Short Answer Discussion Exercise MCQ
CLO2	Introduction to transformers: Single phase and three phase transformers, Applications of transformer.	Lecture Assignment	Short Answer Discussion
CLO2, CLO3	Introduction to polyphase system: Three-phase generator, Y-connected generator, Phase Sequence.	Lecture Assignment	Short Answer Assignment MCQ

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√			√	√
CLO3	√	√			√

Suggested Texts:
- Introductory Circuit Analysis, 13th Edition by R. L. Boylestad.
- Basic Electric Circuit Analysis, 5th Edition by David E. Johnson, J.L. Hilborn & J.R. Johnson.
- Alternating Current Circuits, 4th Edition by R. M. Kerchner, G. F. Corcoran.
- Electric Machines, 5th Edition by J. Nagarath and D. P. Kothari.
- Lesson's in Electrical Circuit, 5th Edition by Tony R. Kuphaldt.
- Introductory Circuitry for Electrical and Computer Engineering, 1st Edition by Nilson.

Intended Learning Outcomes:
- Knowledge and understanding
  - Acknowledge the principles of operation and the main features of electric machines and their applications.
  - Understand the impact of engineering solutions in a global, economic, environmental and societal context.
- Cognitive skills (Thinking and analysis)
  - Be able to identify, formulate, and solve engineering problems.
  - Be able apply nodal analysis, mesh analysis, superposition and source transformation to solve DC circuits.
  - Be able to compute time response of current and voltage in second order RLC circuits.
  - Be able to analyze electric circuit using simulation software.
- Communication skills (Personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable skills)
  - Be able to apply electrical circuit analysis skill to build efficient and constructive devices.

ICT 1105 Physics

Course Objectives:	The objective of this course is to • Provide basis of heat and thermodynamics, wave and oscillation, optics. • Provide knowledge of basic theories of the optical fiber. • Describe physical behavior of matter and their characteristics.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able to:	CLO-PLO Mapping
	CLO1- To **explain** various concepts and principles in the field of physics.	PLO1
	CLO2- To **apply** experimental statistics to determine the precision of a series of measurements.	PLO1, PLO2
	CLO3- To **measure** properties of a variety of electrical and optical systems.	PLO2, PLO6
	CLO4- To **determine** critically and to **use** appropriate concepts to analyze qualitatively problems or situations involving the fundamental principles of physics.	PLO2, PLO4, PLO6

	CLO5- To **represent** these physics concepts and principles mathematically in those situations; to apply those concepts and principles in particular situations through the analysis and solution of practical physics problems.		**PLO6, PLO7**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Heat and Thermodynamics: Principle of temperature measurements: platinum resistance thermometer, thermoelectric thermometer, pyrometer; Kinetic theory of gases: Maxwell's distribution of molecular speeds, mean free path, equipartition of energy, Brownian motion, Van der Waal's equation of state, review of the First Law of thermodynamics and its application, reversible and irreversible processes, Second Law of thermodynamics, Carnot cycle; Efficiency of heat engines, Carnot's Theorem, entropy and disorder, thermodynamic functions, Maxwell relations, Clausius-Clapeyron Equation, Gibbs Phase Rule, Third Law of thermodynamics.	Lecture Assignment	Short Answer Exercise
CLO1, CLO2	Waves and Oscillations: Differential equation of a simple harmonic oscillator, total energy and average energy, combination of simple harmonic oscillations, Lissajous' figures, spring-mass system, calculation of time period of torsional pendulum, damped oscillation, determination of damping coefficient, forced oscillation, resonance, two-body oscillations, Reduced mass, differential equation of a progressive wave, power and intensity of wave motion, stationary wave, group velocity and phase velocity, architectural acoustics, reverberation and Sabine's formula.	Lecture Assignment	Short Answer Presentation
CLO3, CLO4, CLO5	Physical Optics: Interference of light, Young's double slit experiment; Displacements of fringes, Fresnel Bi-prism, interference at wedge shaped films, Newton's rings, interferometers; Diffraction of light: Fresnel and Fraunhoffer diffraction, diffraction by single slit, diffraction from a circular aperture, resolving power of optical instruments, diffraction at double slit & N-slits-diffraction grating; Polarization: production and analysis of polarized light, Brewster's law, Malus law, Polarization by double refraction, retardation plates, Nicol prism, optical activity, polarimeters, polaroid.	Lecture Assignment Problem Based Learning (PBL)	Short Answer Group Discussion Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√				√
CLO3	√				√
CLO4	√	√		√	√
CLO5	√	√			√

Suggested Texts:
- Physics Principles with Applications, 7th Edition by Douglas C. Giancoli, Publisher: Pearson and Prentice Hall.
- Fundamentals of Physics, 10th Edition by David Halliday, Jearl Walker, and Robert Resnick.
- The Physics of Vibrations and Waves, 6th Edition by H. J. Pain, Publisher:John Wiley and Sons, 2013.
- Principle of Optics, 6th Edition by M. Born and E. Wolf, Publisher: Pergamon Press, 1980.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand fundamental ideas of differential and integral calculus of functions of one and more variables.
  - ➢ Understand relation within Computer Science and Calculus.
- Cognitive skills (thinking and analysis)
  - ➢ Be able to solve first and second order linear homogeneous and non-homogeneous differential equations.
  - ➢ Be able to apply differential equations to problems in engineering, physics, biology and economics.
  - ➢ Be able to identify different types of series and determine whether a a particular series converges.
  - ➢ Be able to perform integration by using the appropriate method of integration.
- Communication skills (personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - ➢ Be able to use Differentiation and Integration concepts to comprehend and construct mathematical arguments.

ICT 1107 Engineering Mathematics-I

Course Objectives:	The objective of this course is to
	• Provide the basic concepts of limits, continuity, function of single variable and several variables, calculus and applications of calculus in engineering.

	• Understand the applications of calculus to science and real life are numerous.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** basic concept of functions, limits and continuity.	**PLO1**
	CLO2- To **learn** with differential calculus and expose the concepts of integral calculus.	**PLO1, PLO2**
	CLO3- To **apply** the applications of differential and integral calculus especially in science and engineering field.	**PLO3, PLO6**
	CLO4- To **analyze** the IT related and engineering applications and real-life problems.	**PLO2, PLO6**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2, CLO3	Differential Calculus: Functions, Limit, Continuity, Tangent and Normal, Subtangent and subnormal in Cartesian and polar co-ordinates, Derivative and technique of differentiation, Successive differentiations, Leibnitz's theorem; Roole's theorem, Mean value theorem in finite and infinite forms; Expansion of functions. Indeterminate forms, Maximum and minimum values of functions of single variable.	Lecture Assignment	Short Answer Exercise
CLO2, CLO3	Partial differentiations: Basic of Partial differentiations, Partial differentiations for a transformation of variables, Euler's rule on homogenous functions.	Lecture Assignment Discussion	Short Answer Identification Exercise
CLO2, CLO3	Integral Calculus: Techniques of integration, Integration by the method of substitutions; Integration by parts; Standard integrals; Integration by the method of successive reduction.	Lecture Assignment	Short Answer Discussion
CLO2, CLO4	Definite Integrals: Fundamental theorem of integral calculus, Properties of definite integral and its use in summing series, Walli's formula, Beta function and Gamma function, Numerical integration; Trapezoidal approximation, Simpson's rule, Improper integrals.	Lecture Assignment	Short Answer Presentation
CLO3, CLO4	Applications of Definite Integrals: Area under a curve, area between two curves, volumes, length of a plane curve, area of a surface of revolution in Cartesian and polar co-ordinates.	Lecture Assignment Demonstration	Short Answer Assignment MCQ

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√				√
CLO3		√			√
CLO4	√			√	√

Suggested Texts:
- Calculus, 10th Edition by Howard Anton, Irl C. Bivens, Stephen Davis.
- Calculus, 4th Edition by Robert T Smith and Roland Minton.
- Thomas' Calculus, 14th Edition by Joel R. Hass, Christopher E. Heil, Maurice D. Weir.
- Calculus (Single and Multivariable), 6th Edition by Deborah Hughes-Hallett, Andrew M. Gleason.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand the mathematical functions.
  - ➢ Understand the use of differential and integral calculus in Science and Engineering.
- Cognitive skills (thinking and analysis)
  - ➢ Be able to explain at high levels concepts and implement basic operations in Differential and Integral Calculus.
  - ➢ Be able to analyze the optimum value of a quantity using concept of Differential Calculus, able to analyze the area of a region or volume of solid using knowledge of Integral Calculus.
- Communication skills (personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - ➢ Be able to use the concepts of Differential and Integral Calculus to comprehend and construct mathematical arguments.

ICT 1109 Communicative English

Course Objectives:	The objective of this course is to	
	• Enhance student presentation skills and public speaking skills using various media - visuals, audio, PowerPoint presentations, short impromptu presentations, long planned presentations, educational or training sessions, lectures and simply giving a talk on a subject to a group on a voluntary basis. These are important in business, sales, training, teaching, lecturing, social situations and generally feeling comfortable speaking. • Focus on the technical communication and writing skills necessary for presenting information of a technical nature. There is intensive practice through students writing reports in engineering field.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** the right tone and best words for writing technical documents using nondiscriminatory language, active verbs, and methods for assessing validity of sources.	PLO1
	CLO2- To **Determine** how to achieve clarity in technical communication and identify patterns of organization used for clarity.	PLO1, PLO2
	CLO3- To **Distinguish** between formal and informal reports and compare different report types (e.g., progress reports, research and lab reports, incident reports, recommendation reports, feasibility reports, and evaluation reports).	PLO2
	CLO4- To **Analyze** the content and structure of proposals and interpretation of data.	PLO2, PLO4
	CLO5- To **Evaluate** types of resumes and the purposes for letters with technical instructions.	PLO4, PLO10
	CLO6- To **Present** varied kinds of reports graphic, oral, or written in a technically appropriate manner.	PLO7, PLO10

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO6	Language: Imperative verbs, Modal verbs, Tense, Tag questions, Transformation of Simple-Complex-Compound Sentences, Basic question forms and Short Answers, Reported speech - statements, commands and questions.	Lecture Exercise	Short Answer Assignment Quiz
CLO1, CLO3	Speaking: Commenting figures and graphs, speaking against listening, talking about preferences, discussion, debate, expressing opinion, talking about current news, expressing possibilities, seeking suggestion and advice, agreement, asking for clarification, probabilities, Prompt analysis from presentation or documentation.	Lecture Discussion Practice	Presentation Conversation
CLO4	Listening: listening exercise to enhance the ability to understand announcements, lectures and other interactive messages in audio format.	Lecture Audio Exercise	Short Answer
CLO5	Reading: Reading comprehension, reading articles, journals, newspapers –answering different types of questions based on comprehensions. Demonstrate critical thinking skills, analyze scientific data, find, evaluate and apply information to solve a problem.	Lecture Practice Exercise	Short Answer Presentation
CLO2	Writing: Compose an academic writing, proper development of theme, develop ideas in essay, Technical Resumes & Cover Letters, official email, Investigative research with academic integrity, originality, depth of thought, and mastery of an approved style of source documentation, Elements of Technical Document, formal Technical Reports.	Lecture Assignment Demonstration	Short and Broad Answer Assignment Quiz

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√			√
CLO3				√	
CLO4	√				√
CLO5				√	√
CLO6	√				√

Suggested Texts:
- Cliff's TOEFL (for practice of different skills), 5th Edition.
- Technical Writing Basics by Brian R. Holloway, Pearson New International Edition, 4th edition. Publisher: Pearson 2014
- Barman, Binoy. Basic Language Skills Practice, 1st Edition by M. Maniruzzaman. Publisher: Dhaka Friends' Book Corner, 2004.
- Technical Writing and Communication Skills for Professional Students Paperback – January 31, 2014
  by J. B. Rajesh. Publisher: Lambert Academic Publishing.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Gathering information and applying in writing skill.
  - ➢ Understanding the use of grammar in communication.
- Cognitive skills (thinking and analysis)
  - ➢ Thinking against listening.
  - ➢ Analyzing and speaking in the same time.
- Communication skills (personal and academic)
  - ➢ Speaking both formal and informal in personally and academically.
  - ➢ Group discussion - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - ➢ Be able to use the concepts of reading, speaking and writing in practical life.

ICT 1102 Structured Programming Lab

Course Summary:
In order to meet up the challenges of ICT, students need to learn about computer programming. This course introduces the fundamental concepts of structured programming. Topics include fundamentals of computers and number systems, algorithms & flowcharts, fundamental programming constructs: syntax and semantics of a higher-level language, variables, expressions, operators, simple I/O to console and files, conditional and iterative control structures, functions and parameter passing, dynamic memory allocation, file processing; fundamental data structures: arrays, structures, strings and string processing; and testing and debugging strategies.

Course Objectives:	The objective of this course is to • Provide students with the skills needed to effectively design develop, implement, debug, test, and maintain programs a more generally to solve problems using a computer • Solve various problems in C on a regular basis to increase the programming ability. • Prepare themselves for national and international competitions • Develop beginner level software.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **use** an integrated programming environment to write, compile, and execute a C program as well as **apply** debugging techniques to locate and resolve errors.	**PLO5**
	CLO2- To demonstrate skills to choose appropriate language constructs and data structures to design, build and test realistic, complex application	**PLO5**
	CLO3- To **design** and implement programs involving decision structures, loops, arrays, structures and unions.	**PLO3, PLO5**
	CLO4- To analysis a computer program for syntactic and semantic correctness	**PLO2**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction to C Programming (input, output, variables, data type, operators, and expressions)	Lecture Discussion Problem Based Learning	Exercise
CLO1	Memory organization, memory access, precision of decimal, binary and floating point number, program execution in memory, memory addressing	Lecture Discussion Problem Based Learning	Exercise
CLO1, CLO2	Structured Program Development in C: Control Statements 1(if, if...else, while, top-down and stepwise refinement)	Lecture Discussion Problem Based Learning	Exercise
CLO1, CLO2	Program Control: Control Statements 2 (for, do…while, switch, break and continue)	Lecture Discussion Problem Based Learning	Exercise
CLO2, CLO3	Introduction to Functions: Math Library Functions, Function Definitions, Function Prototypes and Argument, Header Files, Random Number Generation	Lecture Discussion Problem Based Learning	Exercise
CLO2, CLO3	Introduction to Functions: Recursive functions, References and Reference Parameters, passing arguments to functions and passing arguments by reference	Lecture Discussion Problem Based Learning	Exercise
CLO2, CLO3	Introduction to Arrays: Arrays, Declaring Arrays, Examples Using Arrays, Passing Arrays to Functions, arrays of strings)	Lecture Discussion Problem Based Learning	Exercise
CLO2, CLO3	Introduction to Arrays: Case study, Searching Arrays, Sorting Arrays, Multidimensional Arrays	Lecture Discussion Problem Based Learning	Exercise
CLO2, CLO3	Structure and Union: Definition of structure, Union, Structure union applications, Self-referential structure, Structure and Union: Link List, Array of Structure	Lecture Discussion Problem Based Learning	Exercise
CL02, CLO3, CLO4	Pointers: Pointer Variable Declarations and Initialization, Pointer Operators, Passing Arguments to Functions by Reference with Pointers. Pointer Expressions and Pointer Arithmetic, Arrays, Pointers, Function Pointers.	Lecture Discussion Problem Based Learning	Exercise
CLO2, CLO3, CLO4	Characters and Strings: String Conversion, String Manipulation, Comparison Functions, Search Functions, and Memory Functions	Lecture Discussion Problem Based Learning	Exercise
CLO2, CLO4	File Processing: Files and Streams, Creating a Sequential File, Reading Data from Sequential File, Writing data to File, and Updating Sequential Files.	Lecture Discussion Problem Based Learning	Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√		√		√
CLO2	√		√		√
CLO3	√	√			√
CLO4	√	√			√

Intended Learning Outcomes:

- Knowledge and understanding
  - Understand the fundamental programming constructs.
  - Understand and write searching and sorting techniques.
  - Understand a typical C-like program environment.
- Cognitive skills (thinking and analysis)
  - Be able to understand and analysis any problem and derive its solution.
  - Be able to develop and design algorithms.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - Be able to write C-like programs to build programming skills, designing skills, problem solving skills.

ICT 1104 Electrical Circuits Lab

Course Objectives:	The objective of this course is to	
	• Introduce with basic electrical components such as capacitor Introduce inductors and electronic devices.	
	• Demonstrate and understand different electrical circuits components.	
	• Design different electrical circuits.	
	• Apply different circuit network theorem.	
	• Construct real time embedded circuit.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **learn** concepts of DC and AC circuit analysis.	**PLO1**
	CLO2- To **explain** laws and methods of circuit analysis.	**PLO2**
	CLO3- To **apply** laws and theorems for solving electrical circuits.	**PLO3, PLO5**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Familiar with register color code.	Demonstration Case studies Lecture	Practical Exam Report Viva-Voce
CLO1	Series and parallel registers.	Inquiry Based Learning Lecture	Practical Exam Report Observation
CLO2, CLO3	Verification of Ohm's and Kirchhoff's Laws.	Demonstration Problem Based Learning	Practical Exam Viva-Voce Observation
CLO2, CLO3	Verification of Superposition, Thevenin's, Norton's and Maximum power transfer theorem.	Group assignment Lecture Problem Based Learning	Observation Report Viva-Voce
CLO2, CLO3	RC Circuit Analysis	Inquiry Based Learning Lecture Exercise	Practical Exam Viva-Voce

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				
CLO2	√				√
CLO3	√	√	√		√

*Intended Learning Outcomes***:**

- Knowledge and understanding
  - ➢ Acknowledge the principles of operation and the main features of electric machines and their applications.
  - ➢ Understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- Cognitive skills (Thinking and analysis)
  - ➢ Be able to identify, formulate, and solve engineering problems.
  - ➢ Be able apply nodal analysis, mesh analysis, superposition and source transformation to solve DC circuits.
  - ➢ Be able to compute time response of current and voltage in second order RLC circuits.
  - ➢ Be able to analyze electric circuit using simulation software.
- Communication skills (Personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable skills)
  - ➢ Be able to apply electrical circuit analysis skill to build efficient and constructive devices.

ICT 1106 Soft Skills Development Lab

Course Objectives:	The objective of this course is to	
	• Improve communication skills for better interaction. • Teach conflict resolution for harmonious relationships. • Enhance teamwork capabilities. • Boost productivity through effective time management. • Develop adaptability and resilience. • Cultivate networking and relationship-building skills.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **enhance** communication skills, including active listening and public speaking.	
	CLO2- To **promote** effective conflict resolution and positive interpersonal relationships.	
	CLO3- To **develop** strong teamwork and leadership abilities.	
	CLO4- To **improve** time management and productivity.	
	CLO5- To **enhance** adaptability, resilience, and problem-solving skills	

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	**Effective Communication Workshop:** Enhance communication skills through group discussions, active listening, and public speaking exercises, improving participants' confidence and articulation.	Group Discussions Peer Feedback Case studies	Group Project Presentation
CLO2	**Conflict Resolution Challenge:** Develop interpersonal skills and conflict resolution techniques through role-play scenarios and negotiation practice, fostering improved conflict resolution and positive relationships.	Group Discussions Peer Feedback Case studies	Group Project Presentation
CLO3	**Teamwork Simulation:** Gain practical insights into teamwork and leadership dynamics by completing complex tasks with role switching, enhancing participants' ability to collaborate effectively in teams.	Group Discussions Peer Feedback Case studies	Group Project Presentation
CLO4	**Time Management Challenge:** Improve time management and productivity skills by setting goals, using time management techniques, and tracking time usage, leading to increased productivity and task prioritization.	Group Discussions Case studies Simulation	Group Project Presentation
CLO5	**Adaptability and Resilience Exercise**: Develop adaptability and resilience through role-play scenarios and problem-solving exercises, preparing participants for change and unforeseen challenges.	Group Discussions Case studies Simulation	Group Project Presentation
CLO1, CLO3	**Networking and Relationship Building Challenge:** Enhance networking and relationship-building skills via speed networking, elevator pitch practice, and networking etiquette sessions, empowering participants to create strong professional connections.	Group Discussions Peer Feedback Case studies	Group Project Role-Playing

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				
CLO2	√				√
CLO3	√	√	√		√

Suggested Text:
- Adrian Furnham, "Personality and Intelligence at Work", Psychology Press, 2008.
- John Adair Kegan Page, "Leadership for Innovation", 1st edition, Kogan, 2007.
- M.Ashraf Rizvi, "Effective Technical Communication", 1st edition, Tata McGraw Hill, 2005.
- Krishna Mohan and NP Singh, "Speaking English Effectively", 1st edition, Macmillan, 2008.
- Soft Skills Material of Infosys Under the Academic Initiative of Campus Connect.

*Intended Learning Outcomes***:**
- Knowledge and understanding
  - ➢ Comprehensive understanding of key soft skills.
  - ➢ Knowledge of underlying principles and best practices.
- Cognitive Skills (Thinking and Analysis):
  - ➢ Improved critical thinking and problem-solving.
  - ➢ Enhanced decision-making with soft skills.
- Communication Skills (Personal and Academic):
  - ➢ Improved personal and academic communication.
  - ➢ Clear presentation of findings and insights.
- Practical and Subject Specific Skills (Transferable Skills):
  - ➢ Development of transferable skills like time management and teamwork.
  - ➢ Subject-specific skills for building valuable connections within the field.

ICT 1100: Course Viva
The content of the viva includes the syllabus of all major courses.

<u>1st Year 2nd Semester</u>

ICT-1201: Electronic Devices and Circuit

Course Objectives:	The objective of this course is to	
	• Understand the basic of Electronics on which analysis and design of electrical and electronic circuits and systems are based, including lumped circuit, digital and operational amplifier abstractions. • Enable students to use abstractions to analyze and design simple electronic circuits. • To understand how complex devices, such as semiconductor diodes and field-effect transistors works. • Understand how the models are used in the design and analysis of useful circuits. • Enable students to design and construct electronics circuits, take measurements of circuit behavior and performance.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** the operation of electronic circuit elements.	**PLO1**
	CLO2- To **analyze** responses of electronic circuits.	**PLO2, PLO3**
	CLO3- To **design** amplifier and instrumental circuits.	**PLO2, PLO3**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction: Introduction to semiconductors, p-type and n-type semiconductors. p-n junction diode characteristics.	Lecture Assignment	Short Answer Exercise Tutorial
CLO1, CLO2	Diode applications: half and full wave rectifiers with and without different filter, clipping and clamping circuits, regulated power supply using zener diode.	Lecture Assignment	Short Answer Assignment Exercise
CLO1, CLO2, CLO3	Bipolar Junction Transistor (BJT): principle of operation, I-V characteristics; Transistor circuit configurations (CE, CB, CC). BJT biasing, load lines; BJTs at low frequencies; Hybrid model, *h* parameters, simplified hybrid model; Small-signal analysis and multi-stage amplifiers, frequency response of BJT amplifier.	Lecture Assignment	Short Answer Presentation
CLO2, CLO3	Field Effect Transistors (FETs): Principle of operation of JFET and MOSFET; Depletion and enhancement type NMOS and PMOS; Biasing of FETs; Low and high frequency models of FETs, Switching circuits using FETs; Introduction to CMOS.	Lecture Assignment	Exercise Interview
CLO2, CLO3	Operational Amplifiers (OP-AMPs): Linear applications of OP-AMPs, gain, input and output impedances, active filters, frequency response and noise. Introduction to feedback, Oscillators, Silicon Controlled Rectifiers (SCR).	Lecture Assignment	Short Answer Assignment MCQ
CLO3	TRIAC, DIAC and UJT: Characteristics and applications; Introduction to IC fabrication processes.	Lecture Assignment	Exercise Interview

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√			√	√
CLO3	√	√	√		√

Suggested Texts:
- Electronic Devices and Circuit, 5th Edition by David. A. Bell.
- Integrated Electronics, 2nd Edition by Millman & Halkiasa.
- Basic Electronics, 1st Edition by Bagdi and Sing.
- Electronic Devices and Circuit Theory, 11th Edition by R. L. Boylestad, L. Nashelsky.
- Principle of Electronic Circuits, 1st Edition by R.K. Mozumder.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand about constant gain, summing and buffering amplifiers.
  - Understand conduction using electron and hole theory.
- Cognitive skills (thinking and analysis)
  - Be able to explain different types of controlled sources.
  - Be able to develop an understanding of what common mode operation is.

- ➢ Be able to acquaint with the frequency response of BJT and FET amplifier.
- ➢ Be able to calculate ac, dc and average ac resistance of a diode from the characteristics.
- Communication skills (personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
    - ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - ➢ Be able to use mathematical reasoning to comprehend and construct mathematical arguments.

ICT 1203: Object Oriented Programming

Course Objectives:	The objective of this course is to
	- Understand fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries, etc. - Be aware of the important topics and principles of software development. - Have the ability to write a computer program to solve specified problems. - Be able to use the Java SDK environment to create, debug and run simple Java programs. - To build themselves as a professional developer in Java.

Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **demonstrate** the important features of object oriented programming.	**PLO1, PLO2**
	CLO2- To **analyze** a real time problem and develop an object oriented program that solves it.	**PLO2, PLO3, PLO5**
	CLO3- To **understand** the basic principles of creating Java applications with graphical user interface (GUI).	**PLO1, PLO5**
	CLO4- To **understand** the basic approaches to the design of software applications.	**PLO1, PLO5**
	CLO5- To **test** a Java application of medium complexity, consisting of multiple classes.	**PLO2, PLO7**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2	Introducing C++: Definition of OOP, C++ Console I/O, Introduction to Classes, Basic concept of Object Oriented Programming, Difference between Structured Programming and Object Oriented Programming, Difference between C/C++, Introducing Function Overloading, Benefits of OOP, Characteristics of Procedure Oriented Programming, Characteristics of Object Oriented Programming and Application of Object Oriented Programming.	Lecture Group Assignment	Short Answer Report Exercise
CLO2, CLO3	Introducing Classes, Arrays, Pointers and References: Constructor and Destructor functions, Constructors with parameters, Introducing Inheritance, Object Pointers, Relation between Classes, Structures and unions, In-line functions, Automatic in-line functions, Assigning objects, Passing objects to functions, Returning objects from function, Defining member functions, Friend functions, Static member functions. Array of objects, Pointer to objects, the pointer, using new and delete, passing references, returning references independent references.	Lecture Group Assignment	Essay Type Answer Report Exercise
CLO3, CLO4	Function Overloading and Operator Overloading: Constructor Overloading, Copy constructor, Default arguments, Overloading ambiguity, Address of overloaded function. Binary operator overloading, Unary operator overloading, Relational and logical operator overloading, Operator overloading using friend functions, Limitations of operator overloading.	Lecture Demonstration Group Assignment	Short Answer Report Exercise
CLO3, CLO4	Inheritance: Defining derived classes, Single inheritance, multiple inheritance, multilevel inheritance, Hierarchical inheritance, Virtual base classes, Constructors in derived classes, nesting of classes.	Lecture Group Assignment	Exercise Report Presentation
CLO3, CLO4	C++ I/O System: Streams, Stream classes, Unformatted I/O, Binary I/O, formatted I/O, I/O manipulators, Inserters, Extractors, File I/O streams, Opening and closing files, Random access files, I/O status checking, Customized I/O and files.	Lecture Assignment Demonstration	Short Answer Report Exercise
CLO3, CLO4	Virtual Functions: Pointers to derived classes, Applying Polymorphism using virtual functions, Polymorphic class, Pure Virtual functions, Abstract classes, early binding, and late binding.	Lecture Group Assignment	Essay Type Answer Report Exercise Presentation
CLO4, CLO5	Template Exception Handling and Standard Template Library: Generic functions, Generic classes, Exception handling, Throwing mechanism, Catching mechanism, Rethrowing mechanism, Specifying exceptions Templates, Components of STL, Container, Algorithms.	Lecture Assignment	Essay Type Answer Exercise Report
CLO3	Introduction to Java: History of Java, Java Class Libraries, Introduction to Java Programming, A simple Program, Memory Concepts, Decision Making.	Lecture Demonstration	Short Answer Report Exercise
CLO3	Methods: Introduction to Program Module, Static Methods, Math Class Methods, Declaring Methods with multiple parameters, Java API Packages, Automatic Variables, Recursion, Method Overloading, Method of the Applet Class.	Lecture Group Assignment	Short Answer Exercise Report

CLO3, CLO4	Inheritance and Polymorphism: Introduction to Superclasses and Subclasses, Protected Members, Using Constructors and Finalizers in Subclasses, Composition vs. Inheritance, Introduction to polymorphism, Dynamic method building, Final Methods and Classes.	Lecture Demonstration Group Assignment	Essay Type Answer Short Answer Exercise Report Presentation
CLO3	GUI Components: Overview of Swing Components, Introduction to Event Handling with Nested Classes, Common GUI Event Types and Listener Interfaces, Mouse Event Handling,	Lecture Demonstration Group Assignment	Short Answer Exercise Presentation
CLO3, CLO4	Graphics and Java 2D: Graphics Contexts and Graphics Objects, Color Control, Font Control, Drawing different Objects-Lines, Rectangles, Polygons, 2D API.	Lecture Demonstration	Short Answer Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√			√	√
CLO3			√		√
CLO4	√		√		√
CLO5	√	√			√

Suggested Texts:
- The C++ Programming Language, 4th Edition by Bjarne Stroustrup.
- Object-Oriented Programming with C++, 4th Edition by Robert Lafore.
- C++: The Complete Reference, 4th Edition by H. Schildt.
- C++: How to program. 10th Edition by Deitel H M and Deital P J.
- Java The Complete Reference, 9th Edition by Herbert Schildt.
- The Java Programming Language, 4th Edition by Ken Arnold, James Gosling, David Holmes.
- JAVA How To Program, 10th Edition by Deitel and Deitel, Publisher: Prentice/Hall International.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the basic features of object oriented programming.
  - Understand the fundamental object oriented programming constructs.
  - Understand and write basic OOP based program in computer.
- Cognitive skills (thinking and analysis)
  - Be able to understand and analysis any problem and derive its solution.
  - Be able to develop and design algorithms.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - Be able to identify the real time problems to solve based on object oriented programming concepts.

ICT 1205: Engineering Mathematics-II

Course Objectives:	The objective of this course is to • Provide the knowledge of basic techniques of mathematics such as matrix algebra, Fourier analysis and so on. • Use of mathematical tools are of a variety of uses especially in the field of information and communication Engineering. • Unitize mathematics in analyzing engineering theories.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** fundamental properties of matrices including determinants, inverse matrices, eigenvalues and linear transformations	PLO1
	CLO2- To **solve** system of linear equations.	PLO1, PLO2
	CLO3- To **comprehend** vector spaces and subspaces.	PLO1
	CLO4- To **interpret** vectors in two and three-dimensional spaces both algebraically and geometrically.	PLO4
	CLO5- To **analyze** real life problems using coordinate axis.	PLO6

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy

CLO1, CLO2, CLO3	Theory of Matrices: Concepts of matrices, types of matrices, transposes, determinant, Sarrus' rule, Laplace expansion, inverse matrix, elementary row operations of matrices (echelon form and row reduced echelon form of matrices), LU-Decomposition and rank.systems of linear equations and it's solution by Cramer's Rule, Gaussian elimination method and inverse matrix method, Kronecker-Capelli theorem. Vector spaces: Definition and example, subspaces, linear combination, linear independence, basis and dimension. Linear transformations on, Linear transformation, the kernel and image of a linear transformation, rank and nullity of a linear transformation. Diagonalization of matrices: Introduction, eigenvalues and eigenvectors, diagonalization of matrices and the Cayley-Hamilton theorem.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO4, CLO5	Two-Dimensional Geometry: Change of axes, Transformation of co-ordinates, Pair of straight lines, Circles, System of circles, The general equation of second degree, Identification of curves.	Lecture, Discussion Group Assignment Demonstration	Report Exercise Presentation
CLO4, CLO5	Three-Dimensional Geometry: Co-ordinate system, Direction cosines and direction ratios, Plane, Straight line and Sphere.	Lecture Group Assignment Demonstration	Report Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1					√
CLO2	√	√			√
CLO3				√	√
CLO4	√				√
CLO5	√	√			√

Suggested Texts:
- Elementary Linear Algebra, 11th Edition by Howard Anton, Chris Rorres.
- Elementary Linear Algebra, 6th Edition by Ron Larson, David C. Falvo, Publisher: Houghton Mifflin Harcourt Publishing, Boston, New York.
- Linear Algebra and Its Applications, 5th Edition by David C. Lay.
- Analytical Geometry: 2D and 3D, 1st Edition by P. R. Vittal, Publisher: Pearson Education India, 2013.
- Introduction to Linear Algebra, 5th Edition by Gilbert Strang, Publisher: Wellesley-Cambridge Press.
- Linear Algebra, Concepts and Methods, 1st Edition by Martin Anthony and Michele Harvey.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the basic concepts of linear algebra and analytical geometry.
  - Understand relation within Computer Science and Coordinate geometry.
- Cognitive skills (thinking and analysis)
  - Be able to understand and analysis the different mathematical problems related to the matrix, vectors and transformations.
  - Be able to analyze Mathematical model using Coordinate geometry concepts.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - Be able to understand and analysis the important theorem and ideas of linear algebra and analytical geometry to solve the complex problems, particularly related to the computer science and engineering fields.

ICT 1207: Discrete Mathematics

Course Objectives:	The objective of this course is to • Apply formal mathematical, logical reasoning techniques and basic counting techniques to solve a variety of problems. • Apply algorithms to problems including searching algorithms, base conversion algorithms in the design and analysis of other algorithms, computability theory, software engineering, and computer systems. • To solve discrete probability problem sets in combinatorics and probability theory to media applications. • Apply Graph and Tree.
Course Learning Outcomes (CLOs):	On completion of the course students will be able:
	CLO1- To **understand** mathematical reasoning.
	CLO2- To **learn** theorem proving.
	CLO3- To **analyze** combinatorial algorithmic problems.
	CLO4- To **apply** discrete structures to model real life problems.

Course Learning Outcomes (CLOs):		CLO-PLO Mapping
		PLO1
		PLO1, PLO2
		PLO1, PLO2
		PLO3, PLO4

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy

CLO1, CLO2	Set theory, Propositional logic and Mathematical Induction: Set Theory, Mathematical reasoning and proof techniques, Prepositional calculus and predicate calculus.	Lecture Assignment	Short Answer Exercise Assignment
CLO1, CLO2	Relations: Relations and Their Properties, -binary Relations and Their Applications, Representing Relations, Closures of Relations, Equivalence Relations, Partial Orderings, Function and algebraic Structure	Lecture Assignment	Short Answer Assignment Exercise
CLO1, CLO2	Graph and Tree: Basic terminologies of graph and tree, Handshaking theorem, Bipartite graphs, Graph Isomorphism, Hamilton circuits and path, Euler circuit and path, Shortest path problem, Chromatic number, Properties of tree, Binary search tree, Tree traversal, BFS and DFS, Graph coloring, N-queens problem, Minimum Spanning Tree and Prim's and Kruskal's algorithm.	Lecture Assignment	Exercise Interview
CLO2, CLO3, CLO4	Number Theory: Divisibility, Primes, Prime Examples, Generating functions, Factorial factors, Relative Primality, 'mod': The Congruence Relation, Independent Residues, Binomial Coefficient, Special Numbers and Chinese remainder theorem,	Lecture Assignment	Exercise Interview Assignment
CLO3, CLO4	Discrete Probability and Algorithms: Definitions, Mean and Variances, Probability Generating Functions, Flipping Coins, Hashing. Growth of functions, complexity of algorithms.	Lecture Assignment	Short Answer Assignment MCQ
CLO3, CLO4	Graph and Tree: Basic terminologies of graph and tree, Handshaking theorem, Bipartite graphs, Graph Isomorphism, Hamilton circuits and path, Euler circuit and path, Shortest path problem, Chromatic number, Properties of tree, Binary search tree, Tree traversal, BFS and DFS, Graph coloring, N-queens problem, Minimum Spanning Tree and Prim's and Kruskal's algorithm.	Lecture Assignment	Exercise Interview
CLO2, CLO4, CLO4	Counting and Boolean Algebra: The Basics of Counting, The Pigeonhole Principle, Permutations and Combinations, Binomial Coefficients and Identities, Linear Recurrence Relations, Divide-and-Conquer Algorithms and Recurrence Relations, Generating Functions, Inclusion–Exclusion, Boolean Functions, Logic Gates, Minimization of Circuits	Lecture Assignment	Exercise Assignment Tutorial MCQ

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√				√
CLO3	√			√	√
CLO4		√			√

Suggested Texts:
- Discrete Mathematics and its Applications, 7th Edition by Rosen, K.H.
- Discrete Mathematics, 4th Edition by Olympid Nicodemi.
- Number Theory, 4th Edition by S.G. Telang.
- Elements of Discrete Mathematics, 3rd Edition by C. L. Liu.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the mathematical reasoning behind a program.
  - Understand relation within a common set of numbers.
- Cognitive skills (thinking and analysis)
  - Be able to explain at high levels concepts and implement basic operations in discrete mathematics.
  - Be able to perform combinatorial analysis to solve counting problems.
  - Be able to develop mathematical models through relations, combinatory, graphs, and trees.
  - Be able to apply graph theory and other mathematical methods to both data structures and analysis of algorithms, and some other problems in computer sciences.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - Be able to use mathematical reasoning to comprehend and construct mathematical arguments.

ICT 1209: Bangladesh Studies

Course Objectives:	The objective of this course is to
	- Equip students with knowledge of Bengali language development, linguistic structure, phonetics, and literature, fostering correct language usage, and facilitating practical discussions.
	- Foster students' factual knowledge and analytical skills, enabling them to engage and appreciate Bangladesh's history, politics, economy and socio-political developments since its emergence as an independent state.
	- Identify the major socio-economic, political, environmental and developmental issues that have arisen during this period, before assessing the progress over time.

Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** Bengali language development, linguistic structure, literature and culture to enhance their language proficiency.	PLO1, PLO2
	CLO2- To **identify** specific stages of Bangladesh's political history, through the ancient, medieval, colonial and post-colonial periods and critically analyses plurality of cultural identities of Bangladesh.	PLO4
	CLO3- To **explain** the economy and patterns of economic changes through qualitative and quantitative analysis. This will increase their awareness on global issues of development processes and the nature of environmental challenges including ways to address them effectively.	PLO7, PLO10

Course Contents:

CLO	Course Content	Teaching Learning Strategy	Assessment Strategy
CLO1	**Bengali Literature**: Bengali colloquial and dialect, literature exposing the popular work of major Bengali poets, novelists and essayists.	Class Lecture Open Discussion	Q/A Peer Assessment
CLO1	**Bangladesh Culture and Heritage:** Deals with the cultural and political heritage of Bangladesh from ancient times, ethnic origin of the people in Bangladesh, festivals, colonial legacy, baul culture, creativity in the arts and crafts.	Lecture Question-Answer,	Q/A Peer Assessment
CLO2	**Historical Studies of Bangladesh:** Ancient time, Muslim and British colonial rules, Pakistani movement and birth of Pakistan (1947), Language movement (1952), six-point movement (1966), Mass upsurge (1969) and Independence of Bangladesh	Lecture Story-Telling Sharing Audio-Video Pictures	Q/A Peer Assessment
CLO2	**Constitution of Bangladesh:** Preamble and Objectives, Fundamental Rights and Duties, Structure of Government, Separation of Powers, Fundamental Principles of State Policy, The President, The Parliament, The Judiciary, Local Government, Constitutional Amendments, Emergency Provisions, Special Provisions for Indigenous Communities.	Debate Case Studies Sharing audio-video Sharing Real Life Experience Assignment	Open Discussion Q/A Peer Assessment
CLO2	**Government of Bangladesh:** Structure of Government, Executive Branch, Legislature, Judiciary, Political Parties, Local Government, Administrative Divisions, Public Administration, Legal System, Election Process, Government Policies and Programs, Challenges, and Future Prospects.	Debate Case Studies Poster Presentation Sharing Audio-Video	Q/A Peer Assessment Assignment
CLO2, CLO3	**Economy of Bangladesh**: Historical Background, Nature, important economic sectors, significance of IT sector in Bangladesh economy, SDG, Vision 2021.	Debate Group Problem Solving	Open Discussions Q/A Peer Assessment
CLO3	**Urbanization & Climate Change:** Climate Change Impacts, Urbanization Trends, Infrastructure Development, Flooding and Drainage, Adaptation Strategies, Environmental Challenges, Population Growth, Urban Planning, Sustainable Development, Resilience Building, Policy and Governance.	Q/A Session Debate Brainstorming Topic Presentation	Open Discussion Q/A Presentation Assignment

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√	√		√
CLO3	√	√		√	√

Suggested Texts:
- Banglapedia: National Encyclopedia, Asiatic Society of Bangladesh, Dhaka, 2nd Edition by Islam, S., 2003.
- Bangladesh at the Crossroads. University Press Ltd, 1st Edition by Kibria, S. A., 1999.
- Bangladesh: A Political History since Independence. London: IB Taurus, 1st Edition by Riaz, A., 2016.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the historical, archeological and anthropological journey of Bengal people and their development and present status of the nation.
- Cognitive skills (thinking and analysis)
  - Critically analyze how different constitutional bodies and socio-political institutions operate and how their behavior impact on political governance.
  - Critically analyze and present cogent argument on why tensions and contestations between and among social groups may emerge within and among states both in written and oral form.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations, and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - The students attending this course are expected to be made aware of the past and present of Bangladesh for the enlargement of their knowledge to face 21st century.

ICT 1202: Electronic Devices and Circuits Lab

Course Objectives:	The objective of this course is to	
	• Understand Basic characteristic and operation of electronic devices.	
	• Design amplifier, oscillator, filter etc. and construct real time embedded circuit.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **verify** the working of different diodes, transistors, CRO probes and measuring instruments. Identifying the procedure of doing the experiment.	PLO1, PLO2
	CLO2- To **design** the circuits with basic semiconductor devices (active & passive elements), measuring instruments and power supplies that serves many practical purposes.	PLO3, PLO5
	CLO3- To **apply** measure and record the experimental data, analyze the results, and prepare a formal laboratory report.	PLO3, PLO4
	CLO4- To **design** structured program for complex computational applications.	PLO3, PLO6

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO3	Verification of P-N junction diode characteristics.	Demonstration Case studies Lecture	Practical Exam Report Viva-Voce
CLO1, CLO3	Verification of Zener diode characteristics.	Inquiry Based Learning (IBL) Lecture	Practical Exam Report Observation
CLO1, CLO3	Verification of Rectifiers (with and without c-filter).	Demonstration Problem Based Learning (PBL)	Practical Exam Viva-Voce Observation
CLO2, CLO3	Verification of BJT characteristics (CE configuration).	Group assignment Problem Based Learning (PBL)	Observation Report Viva-Voce
CLO2, CLO3	Verification of FET characteristics (CS configuration).	Inquiry Based Learning (IBL) Lecture Exercise	Practical Exam Viva-Voce Completion
CLO2, CLO3	Verification of SCR characteristics.	Demonstration Problem Based Learning (PBL)	Observation Report Viva-Voce
CLO2, CLO3	Verification of UJT characteristics.	Group assignment Problem Based Learning (PBL)	Practical Exam Viva-Voce Completion
CLO2, CLO3	Verification of CRO Operation and its Measurements.	Inquiry Based Learning (IBL) Lecture, Exercise	Observation Report Viva-Voce
CLO2, CLO3	Verification of BJT-CE Amplifier.	Demonstration Problem Based Learning (PBL)	Practical Exam Viva-Voce Completion
CLO2, CLO3, CLO4	Verification of FET-CE Amplifier.	Group assignment Problem Based Learning (PBL)	Practical Exam Report Observation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√				√
CLO3		√			
CLO4			√		√

Intended Learning Outcomes:

• Knowledge and understanding
  ➢ Understand about constant gain, summing and buffering amplifiers.
  ➢ Understand conduction using electron and hole theory.
• Cognitive skills (thinking and analysis)
  ➢ Be able to develop an understanding of what common mode operation is.
  ➢ Be able to acquaint with the frequency response of BJT and FET amplifier.

➢ Be able to calculate ac, dc and average ac resistance of a diode from the characteristics.
- Communication skills (personal and academic)
  ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations, and giving and receiving clear instructions.
  ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  ➢ Be able to use mathematical reasoning to comprehend and construct mathematical arguments.

ICT 1204: Object Oriented Programming Lab

Course Objectives:	The objective of this course is to • Provide understanding of programming language using C++ and Java. Its main objective is to teach the basic concepts and techniques which form the object oriented programming paradigm.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **analyze** the various important features of object oriented programing.	**PLO1, PLO5**
	CLO2- To **design** and **implement** the object oriented program for developing the industrial level applications.	**PLO3, PLO6**
	CLO3- To **apply** the knowledge to solve real time problem.	**PLO7, PLO11**
	CLO4- To **know** in preparing a professional looking package for each business project using javadoc**.**	**PLO11, PLO12**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction to Java: Basics of Java programming, Data types, Variables, Operators, Control structures including selection, Looping, Java methods, Overloading, Math class, Arrays in java.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1, CLO2	Objects and Classes: Basics of objects and classes in java, Constructors, Finalizer, Visibility modifiers, Methods and objects, Inbuilt classes like String, Character, String Buffer, File, this reference.	Problem Based Learning (PBL) Lecture Group Assignment	Practical Exam Exercise Report
CLO1, CLO2, CLO3	Inheritance and Polymorphism: Inheritance in java, Super and sub class, Overriding, Object class, Polymorphism, Dynamic binding, Generic programming, Casting objects, Instance of operator, Abstract class, Interface in java, Package in java, UTIL package.	Problem Based Learning (PBL) Lecture Group Assignment	Practical Exam Exercise Report
CLO2, CLO3, CLO4	Event and GUI programming: Event handling in java, Event types, Mouse and key events, GUI Basics, Panels, Frames, Layout Managers: Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons, Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box, Applet and its life cycle, Introduction to swing.	Lecture Demonstration	Exercise Presentation Report
CLO3, CLO4	I/O programming: Text and Binary I/O, Binary I/O classes, Object I/O, Random Access Files.	Lecture Demonstration Group Assignment	Short Answer Exercise Presentation Report
CLO2, CLO4	Multithreading in java: Thread life cycle and methods, Runnable interface, Thread synchronization, Exception handling with try-catch-finally, Collections in java, Introduction to JavaBeans and Network	Lecture Problem Based Learning (PBL) Project	Practical Exam Report Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√			√	√
CLO3		√			√
CLO4			√		√

Intended Learning Outcomes:
- Knowledge and understanding
  ➢ Understand the basic concepts of object oriented programming.
  ➢ Understand the fundamental object oriented programming constructs.
  ➢ Understand and write basic OOP program.

- Cognitive skills (thinking and analysis)
  - Be able to understand and analysis any problem and derive its solution.
  - Be able to develop and design algorithms.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations, and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - Be able to realize the real time problems and develop the solution with the principle of OOP.

ICT 1200: Project Work - I and Course Viva

The content of the viva includes the syllabus of all major courses. Each group of students must have to do a project work based on the courses taught in the 1st Year's 1st and 2nd Semester. A faculty member or representative from other dept./institute/industry will supervise the project.

2nd Year 1st Semester

ICT 2101: Data Structures

Course Objectives:	The objective of this course is to • Solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, binary search trees, graphs and writing programs for these solutions.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **describe** how arrays, records, linked structures, stacks, queues, trees, and graphs are represented in memory and used by algorithms to solve a problem.	PLO1
	CLO2- To **develop** algorithms for manipulating stacks, queues, linked lists, hash tables, trees, and graphs.	PLO2, PLO5
	CLO3- To **analyze** and **select** the most suitable and effective algorithm for solving problem and case study.	PLO2, PLO5
	CLO4- To **use** programming tools to write and debug codes for abstract data types.	PLO4, PLO5

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO4	Introduction to Data Structures & Algorithms: Types of Data Structure, Basic Concepts of Algorithm, Programming Principle, ADT and class.	Lecture Discussion	Essay Type Answer MCQ
CLO1, CLO3	Algorithm Efficiency: Analysis Order of magnitude, Asymptotic Notations.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer MCQ Exercise
CLO1, CLO3	Sorting: Selection Sort, Insertion Sort, Bubble Sort, Advanced Sorting - Quick Sort, Merge Sort.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Exercise
CLO1, CLO3	Searching: Sequential Search, Binary Search.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Exercise
CLO1, CLO2, CLO4	Linked Lists: Pointer, Introduction to Linked List, Types of Linked Lists, Linked List Operation, Create Linked List, Linked List Declaration, Add node, Delete Node, Find Node, and Circular Linked list.	Lecture Assignment Demonstration	Essay Type Answer Report Exercise Presentation
CLO1, CLO2, CLO4	Stack: Introduction to Stack, Stack Operations–pop and push, Stack Implementation, stack application.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation
CLO1, CLO2, CLO4	Queue: introduction, Queue Implementation (Array and link list), Queue operations, Circular queue.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation
CLO1, CLO3, CLO4	Tree: Introduction, Terms related to tree, Binary search tree, Tree Operation – create node, add node, delete node, print node, search node, Tree Traversal (pre-order, in-order and post-order).	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation

CLO1, CLO2	Heap: Introduction, Maintaining the heap property, Building a heap, The heap sort algorithm.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation
CLO2, CLO3	Graphs: Breadth first search (BFS), Depth first search Graphs (DFS), Minimum Spanning Tree, Dijkstra's Algorithm.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation
CLO2, CLO3	Hashing: Hash function, Need for a good hash function, Hash table, Collision resolution techniques, Linear probing, Implementation of hash table with linear probing, Quadratic Probing, Implementation of hash table with quadratic probing, Double hashing, Implementation of hash table with double hashing, Applications.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√		√	√
CLO3	√	√		√	√
CLO4	√	√			√

Suggested Texts:
- Data Structure and Algorithm, 7th Edition by Schaum's Outline Series.
- Data Structure, 1st Edition by Edward M. Reinggold.
- Fundamentals of Data Structures, 1st Edition by Horowitz E. and Sahni, S Galgotia.
- C++ Plus Data Structures, 5th Edition by Nell Dale.
- Data Structures Using C, 1st Edition by Aaron M. Tenenbaum.
- Introduction to Algorithms, 3rd Edition by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest.
- Data Structure and Program Design in C, 2nd Edition by Kruse, Tondo, Leung, Publisher: Prentice-Hall.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the basic concepts of data structures.
  - Understand the fundamental steps of designing algorithms.
- Cognitive skills (thinking and analysis)
  - Be able to understand and analysis any problem and derive its solution.
  - Be able to design and develop algorithms using various data structures.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - Be able to identify the complex and real life problems to solve using the effective understanding of data structure and algorithms.

ICT 2103: Digital Logic Design

Course Objectives:	The objective of this course is to • Introduce the concept of digital and binary systems. • Design and analyze combinational logic circuits. • Design and analyze sequential logic circuits. • Understand the basic software tools for the design and implementation of digital circuits and systems.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **introduce** the wave shaping circuits, Switching Characteristics of diode and transistor to the students.	**PLO1**
	CLO2- To **analyze** different types of Multi vibrators and their design procedures.	**PLO2**
	CLO3- To **understand** Sampling Gates and to **Design** NAND and NOR gates using various logic families.	**PLO3**
	CLO4- To **design** digital circuits using Boolean Algebraic and state transition techniques.	**PLO3, PLO5**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy

CLO3, CLO4	Number System: Review of number system, Binary, Octal, Hexadecimal, BCD, and ASCII. Boolean Algebra and Minimization: Introductory concept of number systems and codes. Boolean constants and variables, truth tables. Basic logic function. Boolean expressions, Implementing circuits from Boolean expressions, Boolean theorems, De Morgan's theorem. Sum-of-product and product -of-Sum forms. Simplifying logic circuits, algebraic simplification, the Karnaugh map method, Qnine McCluskey design method.	Lecture Assignment	MCQ Exercise
CLO3, CLO4	Logic Gates and Combination Circuits: Different types of logic gates. Circuit design using NAND or NOR gates only. Alternate logic-gate representations, Designing combinatorial logic circuits. Exclusive OR and NOR circuits. Logic circuits with multiple outputs designing without a truth table.	Lecture Assignment	Short Answer Discussion
CLO3, CLO4	Flip-flops: SR, JK, D and T flip flops. The D latch. Master slave FF. Flip flop application. FF synchronization. Data stores and transfer. Frequency division counting. One shot. Arithmetic circuits: Adder circuits. Carry propagation, carry look-ahead adder. IC parallel adder. The 2's complement addition and subtraction system. The BCD adder. Binary multiplier	Lecture Assignment	Short Answer Presentation
CLO3, CLO4	Counters and Register: Asynchronous Counter, Ripple counters, counters with mod numbers<2", IC asynchronous counters, asynchronous down counter, propagation delay and ripple counters, Synchronous down and up/down counters. Decoding a counter, Decoding glitches. Cascading BCD counters, Shift- register.	Lecture Assignment	Short Answer presentation
CLO3, CLO4	Counter Application: frequency counter, digital clock. IC register. MSI Logic Circuits: Decoders, BCD-to-decimal decoders, BCD-to-7-segment decoder/drivers. Encoders. Multiplexes applications. Demultiplexer, Encoders. Multiplexes applications. Demultiplexer.	Lecture Assignment	Short Answer Presentation
CLO3, CLO4	Integrated-Circuit Logic Families: Digital IC terminologies, TTL series characteristics, open-collector TTL, ECL family, MOS digital ICs, MOSFET, CMOS tristate logic, TTL-CMOS-TTL interfacing, Memory Devices: Memory terminology, general memory operation, semiconductor memory technologies, different types of ROMs, semiconductor RAMs, static and dynamic RAMs Magnetic bubble memory, CCD memory, VHDL & FPGA Concept.	Lecture Assignment	Short Answer Presentation
CLO2	Pulse Operations, Analysis and design of Bistable Multivibrator: Pulse transformers, pulse transmission, pulse generation; Analysis and Design of Fixed bias transistor binary, Commutating capacitors, Triggering circuits , Non saturating Binary, Schmitt trigger circuit and its Applications, Analysis and design of Monostable, Astable Multivibrator: Analysis and design of Monostable multivibrators (Collector-coupled and Emitter-coupled) using transistors and Analysis and design of Astable multivibrator (Collector coupled and Emitter-coupled) using transistors.	Lecture Assignment	Short Answer Presentation
CLO1	Interfacing with analog world. Digital-to-analog conversion (D/A converter circuitry, DAC application), analog-to-digital conversion (Successive approximation ADC, flash ADC, digital-ramp ADC), Sample-and-hold circuits.	Lecture Assignment	Short Answer Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√	√	√	√
CLO2	√	√	√	√	√
CLO3	√	√	√		√
CLO4	√	√	√		√

Suggested Texts:
- Digital Systems, Principles and Applications, 11th Edition by Ronald J Tocci.
- Digital Computer Electronics, 3rd Edition by A P Malvino.
- Pulse and Digital Circuits, 1st Edition by Venkata Rao K, Rama Sudha K, Manmadha rao G, Publisher: Pearson, 2010.
- Pulse, Switching and Digital Circuits, 5th Edition by David A. Bell, Publisher: OXFORD University Press.
- Digital Electronics, 1st Edition by Taub & Schilling.

Intended Learning Outcomes:
- Knowledge and understanding
  - Demonstrate practical skills in the programming and testing of digital systems on FPGA and microcontroller development boards.
  - Understand the time and frequency domain aspects.
  - Understand how to analyze, build and troubleshoot digital circuits.
- Cognitive skills (thinking and analysis)
  - Be able to identify, formulate, and solve engineering problems.
  - Be able to analyze and synthesize combinational logic circuits.
  - Be able to apply Boolean algebra to solve logic functions.
  - Be able to interpret schematics to determine principal circuit functions.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)

➢ Be able to apply digital electronic circuit analysis skill to build efficient and constructive devices.
➢ Be able to apply logic design circuits with Programmable Logic Devices.

ICT 2105: Data Communication and Computer Networks

Course Objectives:	The objective of this course is to	
	• Provide students with a solid foundation in principles and technologies of data communication and computer networks.	
	• Enable students to design, implement, and manage computer networks, including selecting appropriate hardware, protocols, and security measures.	
	• Teach students how to troubleshoot network issues and ensure the reliability and performance of network infrastructures.	
	• Equip students with the knowledge and skills needed to address network security concerns, including threat identification and implementing security measures.	
	• Foster effective communication and collaboration skills, enabling students to work in multidisciplinary teams and convey technical concepts to diverse audiences.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **Understand** and apply network security principles to protect data and resources, mitigating security threats and ensuring data confidentiality and integrity.	PL01
	CLO2- To **Demonstrate** a comprehensive understanding of data communication and computer network principles, equipping them with the knowledge and skills necessary to excel in the field.	PLO4, PLO5
	CLO3- To **Analyze** and troubleshoot network issues, demonstrating effective problem-solving skills in diagnosing and resolving connectivity and performance problems.	PLO2, PLO4
	CLO4- To **Design** and implement computer networks, considering factors such as transmission media, protocols, and security, to create efficient and secure network infrastructures.	PLO5

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	**Introduction to Data Communication and Networks:** Fundamentals of Data Communication, Types of Data Communication, Components of a Data, Communication System, Data Transmission and Reception.	Lecture Assignment	Short Answer Exercise
CLO1, CLO2	**Transmission Media and Signal Encoding:** Guided Media (Twisted Pair, Coaxial Cable, Optical Fiber), Wireless Media (Radio Waves, Microwaves, Infrared), Modulation and Demodulation, Signal Encoding Techniques, Line Coding Schemes.	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO2	**Data Link Layer and Network Layer:** Data Link Control (Error Detection, Flow Control), Data Link Layer Protocols, Network Layer Functions, Network Addressing, Routing Algorithms.	Lecture Assignment	Short Answer Discussion
CLO3, CLO4	**Routing and Switching**: Routing Tables, Switching Techniques, Virtual LANs (VLANs), Network Layer Protocols (IPv4 and IPv6).	Lecture Assignment	Short Answer Presentation
CLO1, CLO3	**Transport Layer and Application Layer:** Transport Layer Services, Multiplexing and Demultiplexing, Connection Establishment and Termination, Application Layer Protocols (HTTP, FTP, SMTP, DNS), Socket Programming.	Lecture Assignment	Short Answer Assignment MCQ
CLO3, CLO4	**Network Security and Management:** Security Threats and Measures, Cryptography and Encryption, Firewall and Intrusion Detection Systems, Wireless and Mobile Networks, Network Performance Monitoring and QoS.	Lecture Assignment Project	Short Answer Group Exercise MCQ

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√		√	√
CLO3	√	√	√	√	√
CLO4	√		√		√

Suggested Texts:
- Data Communications and networking, 5th Edition by Behrouz A. Forouzan.
- Data and Computer Communication, 10th Edition by William Stallings.
- Telecommunication System Engineering: Analog and Digital Network Design, 4th Edition by Roger L. Freeman.
- Communication Systems, 5th Edition by S. Haykin, M.Moher.
- Computer Networking: Principles, Protocols, and Practice by Olivier Bonaventure

Intended Learning Outcomes:
- Knowledge and understanding
  ➢ Understand the basic of data communications.
  ➢ Understand the reference models for data communications, their layers and corresponding functions, services and protocols.
  ➢ Understand the protocol techniques, local area networks and how Internet is built.
  ➢ Understanding error detection and correction techniques.
  ➢ Understanding different communication techniques.
- Cognitive skills (thinking and analysis)
  ➢ Be able to apply the skills within data communications and computer networks.

> ➤ Be able to apply data communication theory in practice.
> ➤ Be able to apply different coding techniques in practice.
- Communication skills (personal and academic)
  > ➤ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  > ➤ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.

ICT 2107: Numerical Analysis for Engineers

Course Objectives:	The objective of this course is to • Provide the student with numerical methods of solving the non-linear equations, interpolation and approximation, numerical differentiation and integration.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** the nature and operations of Numerical Analysis.	**PLO1**
	CLO2- To **formulate** the usage of numerical methods in modern scientific computing.	**PLO2, PLO3**
	CLO3- To **demonstrate** familiarity with theories and concepts used in Numerical Analysis and **identify** the steps required to carry out a piece of research on a topic in Numerical Analysis.	**PLO2, PLO7**
	CLO4- To **conduct** derivation of the Numerical Methods, studying their convergence rate and performance, applicability of the methods on different test examples.	**PLO4, PLO6**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO3	Numerical calculation: Introduction and fundamental concepts of numerical methods for linear equations. Approximation in numerical computation, Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors.	Lecture Discussion Assignment	Short Answer Exercise
CLO2	Roots of Nonlinear Equations using bracketing and open-ended methods: Bisection, False Position, Fixed Point, Newton-Raphson, Secant method. Nature of convergence of all methods should also be discussed.	Lecture Problem Based Learning (PBL) Assignment	Short Answer Exercise
CLO3, CLO4	Direct Solution of Linear Equations: Gaussian Elimination(Naïve Gaussian Elimination, Gaussian Elimination with pivoting,), Gauss-Jordan Method, LU Decomposition Iterative Solution of Linear Equations: Jacobi's Method, Gauss-Seidel Method.	Lecture Problem Based Learning (PBL) Assignment	Exercise
CLO3, CLO4	Curve Fitting- Interpolation and Approximation: Direct Method of Interpolation, Lagrange, Newton's Interpolation Polynomial, Interpolation with Equidistant Points, Spline Interpolation.	Lecture Group Assignment Demonstration	Exercise Practical Exam
CLO3, CLO4	Regression Analysis: Linear, Transcendental and Polynomial equation	Lecture Project Problem Based Learning (PBL) Demonstration	Report Exercise Presentation Practical Exam
CLO3, CLO4	Numerical Integration: Newton-Cotes Methods, Trapezoidal and Simpson rules (⅓ rule, ⅜ rule), Romberg Integration.	Lecture Project Problem Based Learning (PBL)	Report Exercise Presentation Practical Exam
CLO3, CLO4	Numerical Solution of Ordinary Differential Equation: Taylor series, Picard, Runge-Kutta, Heun's, Euler's method.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Report Exercise Presentation Practical Exam
CLO3, CLO4	Solution of partial Differential Equations: Determination of characteristics equation of a matrix using Faddeev-Leverrier method; Eigenvalue and Eigenvector and matrix inversion.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√		√	√
CLO3	√		√		√
CLO4	√		√	√	√

Suggested Texts:
- Numerical Methods, 1st Edition by E. Balagurusamy.
- Numerical Methods for Engineers, 7th Edition by Steven C. Chapra, Raymond P. Canale.
- Numerical Mathematics and Computing, 7th Edition by Cheny & Kinkaid.

- Numerical Method, 3rd Edition by Jain & Iyenger.
- Computer Oriented Numerical Methods, 4th Edition by Rajaraman, V.

Intended Learning Outcomes:

- Knowledge and understanding
  - ➢ Students will understand the basic numerical techniques with the underlying mathematical explanation to find out solutions to ordinary and partial differential equations, different linear and nonlinear equations etc.
  - ➢ Students will also gain the knowledge of how to interpolate or extrapolate with the data available.
- Cognitive skills (thinking and analysis)
  - ➢ Students will be able to analyze large systems of linear equations, problems of a matrix which can be obtained numerically where analytical methods fail to give solutions.
  - ➢ Most of the engineering problems are characterized in the form of either nonlinear ordinary differential equations or partial differential equations. Students will be able to perceive and analyze the problems to solve the given ODE numerically, useful in attempting any engineering problem.
- Communication skills (personal and academic)
  - ➢ Individual assignments at the end of every topic-based session will help students to select a numerical method taking into account accuracy and cost requirements, interpret and validate the computed results, which may lead to further refinement of the mathematical model.
  - ➢ Consecutively students will grow an ability to design and conduct experiments as well as to analyze and interpret data.

ICT 2109: Statistics and Probability for Engineers

Course Objectives:	The objective of this course is to - Provide the basic theorem of statistical and various statistical data representation methods. - Understand the concept of data collection methods, measure of location, dispersion, absolute and relative measures. - Provide tools for supporting decisional processes through the management of databases and the use of statistic and mathematic models. - Provide an introduction to probability theory, random variables, markov processes and queuing models. It is important because of its direct application in areas such as genetics, finance and telecommunications.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** different types of measures of location and dispersions.	**PLO1**
	CLO2- To **draw** different types of graphs and diagrams and their uses.	**PLO2, PLO4**
	CLO3- To **estimate** index and intensity of relationship among different phenomenon.	**PLO2, PLO5**
	CLO4- To **calculate** probability of occurrence of any event using different probability distribution formula.	**PLO4, PLO7**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2	Elements of Statistics: Nature and scope of statistics, Nature & representation of statistical data; Attributes and variables; population and sample, discrete and continuous variables.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CLO1, CLO2	Method of data collection: Interviews, Questionnaires and surveys, Observations, Documents and records, Focus groups, Oral histories.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer Home Exercise
CLO1, CLO2	Sampling procedure: Simple random, stratified, systematic and cluster sampling technique.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CLO1	Measures of location: Characteristics of an ideal measure; Arithmetic mean; Geometric mean; Harmonic mean; Median; Mode.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise
CLO1, CL02	Measure of dispersion: Characteristics of an ideal measure: Absolute & Relative measures; Range; Standard deviation; Mean deviation; Quartile deviation; Quartiles; Deciles; Percentiles; Coefficient of dispersion; Coefficient of variation; Skewness and kurtosis.	Lecture Group Assignment Problem Based Learning (PBL)	Essay Type Answer Report Exercise
CLO4	Elements of Probability: Meaning and definition of probability; A priori and a posteriori probability; Basic terminology of probability; Random variables; Probability function; Expectation of sum and products.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CLO4	Probability Distribution: Binomial, Poisson, Normal & Exponential distribution.	Lecture Problem Based Learning (PBL)	Essay Type Answer Home Exercise

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO3, CL02	Regression and correlation: Relationship between variables; Fitting of regression lines; Simple correlation; Rank correlation; Multiple correlation and regression.	Lecture Group Assignment Problem Based Learning (PBL)	Essay Type Answer Project Report Exercise Presentation
CLO3	Tests of Significance: Tests of means, Variance, Correlation coefficient, regression coefficient and associations, model validation.	Lecture Individual Assignment Problem Based Learning (PBL)	Essay Type Answer Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√			√

Suggested Texts:
- Fundamentals of Probability and Statistics for Engineers, 1st Edition by T.T. Soong.
- Fundamentals of Biostatistics, 7th Edition by Bernard Rosner.
- Probability & Statistics for Engineers, 9th Edition by Johnson R.A, Miller & Freud's.
- Biostatistics - A Foundation for Analysis in the Health Sciences, 11th Edition by Wayne W. Daniel, Chaad L. Cross.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the basic concepts of statistics, probability and causal relationships.
  - Understand how to collect sample from a population.
  - Understand the means of presentation of data and results.
- Cognitive skills (thinking and analysis)
  - Be able to understand and analyze any sample data.
  - Be able to understand cause and effect among various phenomena.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - Be able to identify the complex and real life data using the effective understanding of the statistical parameters and analysis of data.

ICT 2102: Data Structures Lab

Course Objectives:	The objective of this course is to	
	- Develop skills to design and analyze simple linear and nonlinear data structures. - Strengthen the ability to the students to identify and apply the suitable data structure for the given real-world problem.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **design** and **apply** appropriate data structures to solve real world problems.	**PLO2, PLO3**
	CLO2- To **use** programming tools to write and debug codes for abstract data types.	**PLO5, PLO6**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2	Introduction to Programming Principle, ADT and class.	Lecture Discussion	Short Answer Exercise
CLO1, CLO2	Lab practices on Selection Sort, Insertion Sort, Bubble Sort, Quick Sort, and Merge Sort.	Lecture Discussion Problem Based Learning (PBL)	Short Answer Exercise Practical Exam
CLO1, CLO2	Working with Sequential Search, Binary Search.	Lecture Problem Based Learning (PBL)	Exercise Practical Exam

CLO1, CLO2	Working with Pointer, Linked List, Create Linked List, Linked List Declaration, Add node, Delete Node, Find Node, and Circular Linked list.	Lecture Group Assignment Demonstration	Exercise Report Presentation
CLO1, CLO2	Lab practices on Stack, Stack Operations–pop and push, Stack applications.	Lecture Project Problem Based Learning (PBL) Demonstration	Report Exercise Presentation Practical Exam
CLO1, CLO2	Lab practices on Queue, Queue Implementation (Array and link list), Queue operations, and Circular queue.	Lecture, Project Problem Based Learning (PBL) Demonstration	Report, Exercise Presentation Practical Exam
CLO1, CLO2	Working with tree, Binary search tree, Tree Operation – create node, add node, delete node, print node, search node, Tree Traversal (pre-order, in-order and post-order).	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Report Exercise Presentation Practical Exam
CLO1, CLO2	Lab practice on creating heap, maintaining the heap property, Building a heap, and heap sort algorithm	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation
CLO1, CLO2	Working with Breadth first search (BFS), Depth first search Graphs (DFS), Minimum Spanning Tree, Dijkstra's Algorithm.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Report Exercise Presentation Practical Exam
CLO1, CLO2	Lab practices on Hash function, Hash table, Collision resolution techniques, Implementation of hash table with linear probing, Implementation of hash table with quadratic probing, Implementation of hash table with double hashing, Applications.	Lecture Project Problem Based Learning (PBL) Demonstration	Report Exercise Presentation Practical Exam

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√	√	√	√
CLO2	√	√	√	√	√

Intended Learning Outcomes:

- Knowledge and understanding
  - ➢ Understand the basic concepts of data structures and algorithms.
  - ➢ Understand the fundamental steps of designing algorithms.
- Cognitive skills (thinking and analysis)
  - ➢ Be able to understand and analysis any problem and derive its solution.
  - ➢ Be able to design and develop algorithms using various data structures.
- Communication skills (personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - ➢ Be able to identify the complex and real life problems to solve using the effective understanding of data structure and algorithms.

ICT 2104: Digital Logic Design Lab

Course Objectives:	The objective of this course is to • Get familiar with basic logic gates-AND, OR, NOT, XOR, XNOR. • Enable students to design combinational logic circuits. • Enable students to design sequential logic circuits. • Enable students to understand the operation of various digital circuits.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **introduce** the students the wave shaping circuits, Switching Characteristics of diode and transistor.	**PLO1**
	CLO2- To **analyze** different types of Multi vibrators and their design procedures.	**PLO2, PLO5**
	CLO3- To **understand** Sampling Gates and to Design NAND and NOR gates using various logic families.	**PLO1, PLO3**
	CLO4- To **design** digital circuits using Boolean Algebraic and state transition techniques.	**PLO3, PLO4**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO3, CLO4	Verify the truth table of basic logic gates: AND, OR, NOT, NAND, NOR. Also truth table of Ex-OR, Ex-NOR, truth table of OR, AND, NOT, realized using NAND & NOR gates, SOP and POS expression.	Lecture Assignment Hands on Experiments	Short Answer Exercise Experiment
CLO3, CLO4	Half adder / subtractor & Full adder / subtractor using NAND and NOR gates and to verify their truth tables, 4-bit ripple adder / subtractor using basic Half adder / subtractor and Full Adder / Subtractor.	Lecture Assignment	MCQ Presentation Experiment
CLO3, CLO4	Truth table of 4-to-1 multiplexer and 1-to-4 demultiplexer. Realize the multiplexer using basic gates only. Also, construct 8-to-1 multiplexer and 1-to-8 demultiplexer using blocks of 4-to-1 multiplexer and 1-to-4 demultiplexer.	Lecture Assignment	Short Answer Discussion
CLO3	Binary to gray and gray to binary converter. Also, verify the truth table for all possible combinations, R-S, J-K and D Flip-flops with and without clock signal and verify their truth table.	Lecture Assignment	Short Answer Presentation
CLO3	Divide by 2, 4 & 8 asynchronous counter. Construct a 4-bit binary and ring counter for a particular output pattern using D Flip-flop, parallel in/ parallel out and serial in/ serial out registers using clock.	Lecture Assignment	Short Answer Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√				√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Intended Learning Outcomes:

- Knowledge and understanding
  - Demonstrate practical skills in the programming and testing of digital systems on FPGA and microcontroller development boards.
  - Understand the time and frequency domain aspects.
  - Understand how to analyze, build and troubleshoot digital circuits.
- Cognitive skills (thinking and analysis)
  - Be able to identify, formulate, and solve engineering problems.
  - Be able analyze and synthesize combinational logic circuits.
  - Be able to apply Boolean algebra to solve logic functions.
  - Be able to interpret schematics to determine principal circuit functions.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - Be able to apply digital electronic circuit analysis skill to build efficient and constructive devices.
  - Be able to apply logic design circuits with Programmable Logic Devices.

ICT 2106: Data Communication and Computer Network Lab

Course Objectives:	The objective of this course is to • Provide information about computer network organization and implementation. • Gain practical experience in installation, monitoring, and troubleshooting of current LAN systems. • Describe various types of routing techniques, VLAN operation and its management.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **Understand** and implement physical network connectivity, including cabling and termination.	**PLO1**
	CLO2- To **Analyze** network traffic using tools like Wireshark, allowing for efficient network issue identification and resolution.	**PLO2, PLO4**
	CLO3- To **Configure** and manage computer networks, routing, switching, and addressing.	**PLO3**
	CLO4- To **Enhance** network security and **develop** troubleshooting skills, ensuring the effective management and security of network infrastructures.	**PLO3, PLO5**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy

CLO1	**Network Configuration Lab:** Setting up a basic network with routers, switches, and computers, and configuring IP addresses and network services.	Demonstration Case studies Lecture	Practical Exam Report Viva-Voce
CLO1, CLO2	**Packet Analysis with Wireshark:** Using Wireshark to capture and analyze network traffic, focusing on packet inspection and troubleshooting.	Demonstration	Practical Exam Report Viva-Voce
CLO1, CLO3	**Cabling and Termination:** Practical exercises in crimping Ethernet cables, connecting network devices, and understanding physical layer connectivity.	Problem Based Learning (PBL) Project	Practical Exam Viva-Voce
CLO3	**Router and Switch Configuration:** Configuring routers and switches, including IP routing, VLAN configuration, and network services setup.	Demonstration	Practical Exam Report Viva-Voce
CLO3, CLO4	**Firewall Configuration:** Setting up and configuring a network firewall to control traffic and enhance security, including access control rules.	Problem Based Learning (PBL) Project Lecture	Practical Exam Report Viva-Voce
CLO1, CLO3	**Wireless Network Setup:** Configuring and securing wireless networks, including Wi-Fi router setup and encryption methods.	Group assignment Lecture	Practical Exam, Report Viva-Voce
CLO3, CLO4	**Network Troubleshooting:** Real-world troubleshooting scenarios to diagnose and resolve network issues, covering connectivity problems and performance optimization.	Problem Based Learning (PBL) Projects	Practical Exam Report Viva-Voce

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1		√	√		√
CLO2	√	√			√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Intended Learning Outcomes:

- Knowledge and understanding
  - ➤ Understand the knowledge on designing and building a complete system.
  - ➤ Understand different layer of computer network.
- Cognitive skills (thinking and analysis)
  - ➤ Be able to analyze and capture network traffic.
  - ➤ Be able to analyze soundness or potential flaws in proposed protocols.
  - ➤ Be able to apply the theory of basic network performance analysis.
- Communication skills (personal and academic)
  - ➤ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - ➤ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - ➤ Be able to design logical sub-address blocks with a given address block.

ICT 2100: Course Viva
The content of the viva includes the syllabus of all major courses.

2nd Year 2nd Semester

ICT 2201: Algorithm Analysis and Design

Course Objectives:	The objective of this course is to • Analyze the asymptotic performance of algorithms. • Write rigorous correctness proofs for algorithms. • Demonstrate a familiarity with major algorithms and data structures. • Apply important algorithmic design paradigms and methods of analysis. • Synthesize efficient algorithms in common engineering design situations.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** the different types of computational complexities for optimizing the algorithms.	**PLO1**

CLO2- To **design** and **analyze** different types of algorithms for solving the various complex problems.	PLO2, PLO3
CLO3- To **analyze** and **select** the most suitable and effective algorithm for solving certain real life problem.	PLO4, PLO7

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO2	Introduction to Algorithm and Mathematical Induction: Introductory concepts and definitions related to algorithm formula, notation for describing algorithms, introduction to mathematical induction, examples, counting regions in the plane, simple coloring problem, simple inequality, Euler's formula, Finding edge-disjoint paths in a graph, Arithmetic versus geometric means, loop invariant etc.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CLO1, CLO3	Analysis of Algorithms Complexity and Design of Algorithm by Induction: The O notation, time and space complexity, recurrence relations: intelligent guesses divide and conquer relations, recurrence relation with full history, design by induction: evaluation polynomials, maximal induced subgraph. Finding one-to-one mappings, skyline problem, finding the maximum consecutive subsequence, strengthening the induction hypothesis, dynamic programming: Knapsack problem	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer MCQ Exercise
	Algorithms Involving Trees: Find the minimum and maximum value of a BST, Find successor and predecessor of a BST, Insert a data in a BST, Delete a data from a BST, Calculate the time complexity of various operation on a BST, Insert into and delete from AVL tree, Searching, insertion and deletion in a B-tree, Insertion and deletion in a red-black tree.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO2, CLO3	Algorithm Involving Sequences and Sets: Introduction, Binary search and variations, Interpolation search, sorting: Bucket sort, Radix sort, Insertion sort, Selection sort, Merge sort, Quick sort, Heap sort, order statistics, data compression, string matching, sequence comparisons, probabilistic algorithms, finding a majority, etc.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO2, CLO3	Methods for the design of efficient algorithms: Divide and conquer, greedy method, dynamic programming, back tracking, branch and bound;	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Report Exercise Presentation
CLO1, CLO2	Graph and Geometric Algorithms: Introduction, Eulerian graphs, graph traversals: Depth-first Search, Breadth-first Search, Topological Sorting, minimum-cost Spanning trees, network flows, Hamiltonian tours, decompositions of graphs, construction polynomials, convex hulls, closest pair, intersection of horizontal and vertical line segments, etc.	Lecture Discussion Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation
CLO2	Reductions and NP-Completeness: Introduction, examples of reductions, reductions involving linear programming reductions for lower bounds, polynomial time reductions, nondeterminism and Cook's Theorem, examples of NP-completeness Proofs, techniques for dealing with NP-complete problems, etc.	Lecture Group Assignment Demonstration	Essay Type Answer Report Presentation
CLO2, CLO3	Parallel Algorithms: Introduction, models of parallel computation, algorithms for shared-memory machines, algorithms for interconnected networks, systolic computation, etc.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√		√	√
CLO2	√	√		√	√
CLO3	√	√	√	√	√

Suggested Texts:
- Introduction to Algorithms, 3rd Edition by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest.
- Fundamentals of Computer Algorithms, 2nd Edition by Ellis Horowitz and Sartaj Sahni.
- Algorithms, 3rd Edition by Robert Sedgewick.
- Introduction to Algorithm, 1st Edition by Udi Manber.
- Introduction to the Design and Analysis of Algorithms, 3rd Edition by Anany V. Levitin.
- Algorithms + Data Structures= Programs, 1st Edition by Niklaus Wirth.
- Data Structures & Algorithms in C++, 4th Edition by Adam Drozdek.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand the basic concepts of algorithm analysis and design.
  - ➢ Understand the fundamental steps of designing and optimizing algorithms.
- Cognitive skills (thinking and analysis)

- ➢ Be able to understand and analysis any problem and derive its solution.
- ➢ Be able to design and optimize algorithms to solve particular complex problems effectively.
- Communication skills (personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - ➢ Be able to identify the complex and real life problems to solve using the effective understanding of the design and analysis of algorithms.

ICT 2203: Analog and Digital Communication

Course Objectives:	The objective of this course is to	
	- Introduce the concepts of analog communication systems and to equip students with various issues related to analog communication, such as radio wave propagation, modulation, demodulation, broadcasting transmitters & receivers. - Provide the fundamental knowledge about the building blocks of digital communication system. - Understanding and analyzing the signal flow in a digital communication system. - Analyze error performance of a digital communication system over various modulation techniques and waveform coding techniques in presence of noise and other interferences will also be covered to good extend.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **explain** various concepts and principles of radio wave propagation, (de)-modulation and (de/en) coding.	**PLO2, PLO6**
	CLO2- To **apply** statistical model in the analog and digital communication system.	**PLO1**
	CLO3- To **explain** the components of analog and digital communication system.	**PLO1**
	CLO4- To **determine** critically and to use modulation and line coding in various system.	**PLO2, PLO3**
	CLO5- To **evaluate** the performance of the communication systems.	**PLO3, PLO5**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Radio Wave Propagation: Surface and space wave propagation, Sky wave through Ionosphere. Pulse method for measuring height and electron concentration of Ionospheric region; Chapman theory of layer formation, Ionospheric storm.	Lecture Assignment	Short Answer Exercise
CLO1	Modulation and Demodulation: Linear modulation - AM, SSB, DSB, and SSB generation, PLL Circuit to generate linear modulated signals, low and high power modulators, Exponential modulation- FM and PM, demodulation of AM, FM. Broadcasting Transmitter: Transmitter classification, Elements of transmitter, AM and FM transmitters, SSB transmitter, stabilized master oscillator, Frequency multipliers, Mixer circuits, RF power amplifier, Pre-emphasis circuits, Transmitter performance-carrier frequency requirements, audio frequency response, distortion and signal to distortion ratio.	Lecture Assignment	Short Answer Exercise
CLO4	Radio Receiver: Receiver classification, Elements of receiver, AM and FM receivers, SSB receiver, Comparison of AM and FM receivers, Noise in receiver, AGC circuits, AFC circuits, Noise limiters, Receiver sensitivity, Cross modulation, Spurious responses.	Lecture Assignment	Short Answer Presentation
CLO2, CLO3, CLO5	Representation of Random Signals and Noise in Communication System: Signal Power and Spectral Representations, White noise, Thermal noise, PSDF of White Signals. Input and Output Relationship for Random Signals and Noise Passed Through a Linear Time Invariant System, Band Limited White Noise, ARC Filtering of White Noise. Noise performance of Analog Communication Systems: Signal-to-Noise Ratio in Linear Modulation, Synchronous Detection of DSB. Signal-to-Noise Ratio for AM and SSB, FM, Effect of Noise in Envelope and Square Law Detection of AM, Threshold Effects in Nonlinear Detectors.	Lecture Assignment	Short Answer Presentation
CLO2, CLO3, CLO5	Elements of Digital Communication Systems: Model of Digital Communication Systems, Digital Representation of Analog Signal, Certain issues in Digital Transmission, Advantages of Digital Communication Systems, Bandwidth-S/N tradeoff, Hartley Shannon Law.	Lecture Assignment	Short Answer Presentation
CLO2, CLO3, CLO5	Pulse Code Modulation: PCM Generation and Reconstruction, Quantization noise, Non uniform Quantization and Companding, DPCM, Adaptive DPCM, DM and Adaptive DM. Noise in PCM and DM. Line Coding: Techniques and Analysis	Lecture Assignment Problem Based Learning (PBL)	Short Answer Exercise

CLO2, CLO3, CLO5	Digital Modulation Techniques: Digital Modulation Techniques: Introduction, ASK, ASK Modulator, Coherent ASK Detector, Non-Coherent ASK Detector, FSK, Bandwidth and Frequency Spectrum of FSK. Non coherent FSK Detector, Coherent FSK Detector, FSK Detection Using PLL, BPSK, Coherent PSK Detection, QPSK, Differential PSK.	Lecture Assignment Problem Based Learning (PBL)	Short Answer Group Discussion Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√	√		√
CLO2	√	√	√		√
CLO3	√	√	√		√
CLO4	√	√	√		√
CLO5	√	√	√	√	√

Suggested Texts:

- Electronic communication systems, 4th Edition by George Kennedy, Barnard Davis.
- Principles of communication systems, 3rd Edition by Taub and Schilling.
- Analog and Digital Communication systems, 4th Edition by Martin S Roden.
- Analog & Digital Communication, 4th Edition by B P Lathi.
- Communication Systems Engineering, 2nd Edition by Proakis & Salehi.

Intended Learning Outcomes:

- Knowledge and understanding
  - Understand the fundamental concept of wave propagation, basic communication system and its various components.
  - Understand the performance metric of communication systems.
- Cognitive skills (thinking and analysis)
  - Be able to find the performance of various modulation schemes.
  - Be able to apply various modulation and encoding schemes in real-life applications.
  - Be able to identify different types of radio transmission, its techniques and applications.
  - Be able to formulate the power spectra, bandwidth efficiency, spread spectrum modulation.
  - Be able to design and develop digital communication system through simulation.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations, giving, and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - Be able to use incorporating digital modulation and coding schemes in communication systems.

ICT 2205: Engineering Mathematics-III

Course Objectives:	The objective of this course is to
	• Construct, or give examples of, mathematical expressions that involve vectors, matrices, and linear systems of linear equations.
	• Evaluate mathematical expressions to compute quantities that deal with linear systems and eigenvalue problems.
	• Analyze mathematical statements and expressions (for example, to assess whether a particular statement is accurate, or to describe solutions of systems in terms of existence and uniqueness).
	• Write logical progressions of precise mathematical statements to justify and communicate your reasoning.
	• Apply linear algebra concepts to model, solve, and analyze real-world situations.
	• Construct and interpret linear transformations in R^2 or R^3 (for example, interpret a linear transform as a projection or as a shear).

Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **identify** a system of linear equations (or linear system) and describe its solution set. Write down the coefficient matrix and augmented matrix of a linear system.	PLO1
	CLO2- To **use** elementary row operations to reduce matrices to echelon forms. Make use of echelon forms in finding the solution sets of linear systems. Perform standard operations with vectors in Euclidean space. Understand the meaning of linear independence/dependence and span. Interpret linear systems as vector equations.	PLO2, PLO3
	CLO3- To **define** matrix-vector product and be able to interpret linear systems as matrix equations.	PLO1, PLO3
	CLO4- To **determine** the parametric vector form of solutions of linear systems.	PLO3, PLO4
	CLO5- To **relate** the solution set of a consistent inhomogeneous linear system to the solution set of its associated homogeneous equation.	PLO6

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2, CLO3, CLO5	**Theory of Matrices:** Concepts of matrices, types of matrices, transposes, determinant, Sarrus' rule, Laplace expansion, inverse matrix, elementary row operations of matrices (echelon form and row reduced echelon form of matrices), LU-Decomposition and rank. Systems of linear equations and it's solution by Cramer's Rule, Gaussian elimination method and inverse matrix method, Kronecker-Capelli theorem.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO2, CLO3	**Diagonalization of matrices:** Introduction, eigenvalues and eigenvectors, diagonalization of matrices and the Cayley-Hamilton theorem, Vectors and Scalars, Algebra of vectors, Scalar triple product, Vector triple product, Vector differentiation and vector integration, Gradient, Divergence and Curl, Cartesian, Spherical, Polar and Cylindrical system.	Lecture Discussion Group Assignment Demonstration	Report Exercise Presentation
CLO1, CLO2, CLO3, CLO4, CLO5	**Laplace Transform:** Introduction, Laplace transform of elementary function, Properties of Laplace Transforms, Inverse Laplace transforms, and their properties, Convolution theorem, Heaviside's expansion formula and their Applications.	Lecture Discussion Group Assignment Demonstration	Report Exercise Presentation
CLO1, CLO2, CLO3, CLO4, CLO5	**Fourier analysis:** Real and complex form of Fourier series, Fourier Integral, Fourier transforms and their uses in solving boundary value problems.	Lecture Discussion Group Assignment Demonstration	Report Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	**Assignment**	**Project**	**Presentation**	
CLO1	√	√		√	√
CLO2	√	√		√	√
CLO3	√	√		√	√
CLO4	√	√		√	√
CLO5	√	√		√	√

Suggested Texts:
- Elementary Linear Algebra, Author: Howard Anton, Chris Rorres, 11th Edition by John Wiley & Sons, Inc.
- Elementary Linear Algebra. Author: Ron Larson, David C. Falvo, 6th Edition by Houghton Mifflin Harcourt Publishing Company, Boston, New York.
- Linear Algebra and Its Applications, 4th Edition by David C. Lay.
- Vector Analysis, 2nd Edition by Murray R Spiegel (Schaum's Outlines Series).
- A Text Book on Co-ordinate Geometry with Vector Analysis, 1st Edition by Rahman & Bhattacharjee.
- Fourier analysis with application to boundary value problems, 1st Edition by Murray R Spiegel (Schaum's Outlines Series).
- Laplace Transforms, 1st Edition by Murray R Spiegel (Schaum's Outlines Series).

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the basic concepts of matrices, vectors, Fourier analysis and Laplace transform.
  - Have preparation in successful continuation of their studies towards more advanced and specialized courses in their field.
- Cognitive skills (thinking and analysis)
  - Be able to understand and analysis the different mathematical problems related to the matrix and vectors.
  - Be able to solve the Initial and Boundary value problems that arise frequently in any field of Engineering.
  - Be able to decompose a function into its constituent frequencies.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations, giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - Be able to understand and analysis the important theorem and ideas of matrices, vectors, Fourier analysis and Laplace transform to solve the complex problems, particularly related to the computer science and engineering fields.

ICT 2207: Financial and Managerial Accounting

Course Objectives:	The objective of this course is to	
	• Prepare financial reports that provide information about a firm's performance to external parties such as investors, creditors and tax authorities. • Improve the effectiveness of both the management planning and control functions. • Provide the information that is needed for sound economic decision making in the perspective of accounting.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** the importance of accounting and accounting as an information systems.	PLO1
	CLO2- To **learn** how to prepare journal, ledger and trial balance.	PLO4
	CLO3- To **learn** preparation of basic financial statements considering adjusting and closing entries.	PLO4
	CLO4- To **apply** cost concepts and **apply** different costing techniques in decision making.	PLO6, PLO7
	CLO5- To **analyze** short term and long-term investment prospects and making relevant decisions.	PLO8, PLO11

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Financial Accounting: objectives and importance of accounting; Accounting as an information system; computerized system and applications in Accounting; role of accountancy profession.	Lecture Assignment	Short Answer Exercise MCQ
CLO2, CLO3	Recording System: double entry mechanism; accounts and their classification; Accounting equation; Accounting cycle: journal, ledger & trial balance.	Lecture Assignment	Short Answer Exercise
CLO4	Preparation of Financial Statements: importance and limitations of statement of Comprehensive Income; preparation of statement of Comprehensive Income; usefulness and limitations of statement of Financial Position; preparation of statement of Financial Position; importance of statement of change in Equity; preparation of statement of change in Equity.	Lecture Assignment	Short Answer Case Study Discussion
CLO4	Financial Statement Analysis and Interpretation: different techniques of financial statement analysis; ratio analysis & interpretation, sensitivity analysis; cash flow analysis.	Lecture Assignment Presentation	Exercise Case Study Discussion
CLO4	Management Accounting: definition; Management Accounting; scope and functions of Management Accounting; evolution of Management Accounting; Financial Accounting Vs. Management Accounting; Cost Accounting Vs. Management Accounting;standard of ethical conduct for Management Accountants.	Lecture Assignment	Short Answer Exercise MCQ
CLO4	Cost Classification and Cost Behavior Analysis: cost concepts and classification; methods of segregating costs into fixed and variable costs (High-Low Method; Inspection of Accounts/Accounts Classification Method; Engineering Method; Ordinary Least Square Method); overhead costs; meaning and classifications of overhead costs; overhead recovery method/rate; Job order costing: preparation of job cost sheet and quotation price.	Lecture Assignment	Short Answer Assignment
CLO4	Inventory Valuation: absorption costing and marginal/variable costing technique; Cost-Volume-Profit (CVP) analysis; usefulness and limitations of CVP analysis; breakeven analysis; computations of breakeven point and shutdown point.	Lecture Assignment	Short Answer Exercise Case Study
CLO5	Investment Decisions: the concept of relevant cost; using relevant cost information in decision making; limiting factor Analysis; addition or deletion of products or departments; special sales orders; sell or process further decision; capital budgeting; various techniques of evaluation of capital investments.	Lecture Assignment Presentation	Exercise Case Study Discussion

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√		√	√
CLO2	√	√		√	√
CLO3	√	√		√	√
CLO4	√	√		√	√
CLO5	√	√		√	√

Suggested Texts:
- Intermediate accounting. Hoboken, 3rd Edition by Kieso, D. E., Weygandt, J. J., & Warfield, T. D., Publisher: John Wiley & Sons.
- Introduction to Management Accounting, 13th Edition by C. T. Horngren, G. Sundem and W. O. Stratton.
- Financial Accounting study manual, Professional Stage- Knowledge level and Application level, Publisher: ICAB.
- Management Accounting: Information for Decision-Making and Strategy Execution, 6th Edition by Atkinson, A.A., Kaplan, R.S., Matsumura, E.M. and Young, S.M.

Intended Learning Outcomes:

- Knowledge and understanding
  - ➢ Understand the concept of Financial Accounting and Management Accounting.
  - ➢ Understand the use of financial statements for investment decisions.

Cognitive skills (thinking and analysis)
  - ➢ Be able to explain basic concepts of Financial Accounting and Management Accounting.
  - ➢ Be able to record economic transactions and prepare basic financial statements for the interested users.
  - ➢ Be able to use different financial statement analysis techniques and interpret the results.

- Communication skills (personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations, and giving and receiving clear instructions.
  - ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.

- Practical and subject specific skills (transferable skills)
  - ➢ Be able to use different financial statement analysis techniques to make proper short term and long-term investment decisions.

ICT 2209: Innovation and Entrepreneurship

Course Objectives:	The objective of this course is to	
	• Think critically and creatively about the nature of business opportunities, resources, and industries.	
	• Describe the processes by which innovation is fostered, managed, and commercialized.	
	• Spot new business opportunities in the environment, whether by recognition, development, or creation.	
	• Effectively and efficiently evaluate the potential of new business opportunities.	
	• Assess the market potential for a new venture, including customer need, competitors, and industry attractiveness.	
	• Develop a business model for a new venture, including revenue, margins, operations, working capital, and investment.	
	• Develop pro forma financial statements that reflect business model decisions and that can be used to determine future funding requirements.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** entrepreneurship, innovation, and the entrepreneurial mindset.	**PLO1**
	CLO2- To **learn** how to strategically manage innovation and identify its sources.	**PLO4**
	CLO3- To **analyze** state support, clusters, technology platforms, and intellectual property in fostering innovation and entrepreneurship.	**PLO2, PLO4**
	CLO4- To **create** effective innovation business plans, including financial forecasting and risk management.	**PLO6, PLO7**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	**Fundamentals of Entrepreneurship:** Introduction to Entrepreneurship, Definitions and Key Concepts, Entrepreneurial Process and Phases, The Entrepreneurial Mindset and Characteristics	Lecture Assignment	Short Answer Exercise MCQ
CLO2, CLO3	**Innovation and Management:** Characteristics of Innovation, Factors Initiating Innovations, Stages of the Innovation Process, Statistical Measurement of Innovation.	Lecture Assignment	Short Answer Exercise
CLO4	**Strategies for Innovation:** Configuration of Innovation in Enterprises, Open Innovation Models and Resources, Strategic Management of Innovation, Entrepreneurship as an Innovative Driver	Lecture Assignment	Short Answer Case Study Discussion
CLO4	**Sources and Transfer of Innovation**: Sources and Origins of Innovation, Technological Transfer and Innovation Diffusion, Technology Foresight and Innovation Forecasting, Entrepreneurship in High Technologies	Lecture Assignment Presentation	Exercise Case Study Discussion
CLO4	**Managing Innovation Projects:** Developing High-Tech Products and Prototypes, Crafting Comprehensive Innovation Business Plans, Financing Strategies and Risk Management in Venture Projects	Lecture Assignment	Short Answer Project MCQ
CLO4	**Supporting Innovation and National Systems:** State Initiatives and Policy Support for Innovation, Territorial Clusters and Regional Competitiveness, Technology Platforms and Intellectual Property Management	Lecture Assignment	Short Answer Assignment

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√		√	√
CLO2	√	√		√	√
CLO3	√	√		√	√
CLO4	√	√	√	√	√

Suggested Texts:
- Timmons, Jeffry A., Gillin, L. M., Burshtein, S., and Spinelli, Stephen Jr. (2011). New Venture Creation: Entrepreneurship for the 21st Century – A Pacific Rim Perspective, 1st Edition. McGraw-Hill Irwin.

- Bessant, J. (2003) High Involvement Innovation: Building and Sustaining Competitive Advantage Through Continuous Change. Chicester: John Wiley & Sons.
- Bygrave, W and Zackarakis, A (2013) Entrepreneurship, 3rd Edition, John Wiley and Co.
- Drucker, P. (1999) Innovation and Entrepreneurship, Butterworth Heinemann, Oxford.

Intended Learning Outcomes:

- Knowledge and understanding
  - ➢ Gain a solid foundation in the principles and concepts of entrepreneurship and innovation.
  - ➢ Develop a comprehensive understanding of the entrepreneurial process, the factors driving innovation, and their impact on businesses and economies.
  - ➢ Acquire knowledge about various innovation management strategies and their real-world applications.
  - ➢ Understand the significance of state support, clusters, and technology platforms in the context of fostering innovation.
- Cognitive skills (thinking and analysis)
  - ➢ Develop critical thinking and analytical skills to evaluate entrepreneurial opportunities and the potential for innovation.
  - ➢ Apply problem-solving skills to address challenges related to business innovation, risk management, and strategy.
  - ➢ Enhance the ability to analyze and assess the impact of innovation on industry and markets.
  - ➢ Foster creativity and innovative thinking, enabling students to identify and evaluate new opportunities.
- Communication skills (personal and academic)
  - ➢ Improve personal communication skills through collaborative group work and presentations.
  - ➢ Develop the ability to articulate and defend innovative ideas and strategies effectively.
  - ➢ Enhance academic communication skills through written reports, documentation, and formal presentations.
  - ➢ Strengthen interpersonal communication skills for team collaboration in the entrepreneurial and innovation contexts.
- Practical and subject specific skills (transferable skills)
  - ➢ Acquire practical skills in crafting innovation business plans, financial forecasting, and risk management.
  - ➢ Develop subject-specific skills in high-tech entrepreneurship, technology foresight, and intellectual property management.
  - ➢ Cultivate transferable skills such as problem-solving, time management, and project management, essential for various professional contexts.
  - ➢ Foster an entrepreneurial mindset, equipping students with skills to identify and pursue opportunities for innovation and entrepreneurship.

ICT 2202: Algorithm Analysis Design and Lab

Course Objectives:	The objective of this course is to • Learn how to analyze a problem & design the solution for the problem. In addition to that, solution must be optimum, i.e., time complexity & memory usage of the solution must be very low.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** the different types of computational complexities for optimizing the algorithms.	PLO1
	CLO2- To **design** and **analyze** different types of algorithms for solving the various complex problems.	PLO2, PLO3, PLO5
	CLO3- To **analyze** and **select** the most suitable and effective algorithm for solving certain real life problem.	PLO4, PLO11

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Working with time and space complexities.	Lecture Discussion Problem Based Learning Demonstration	Short Answer Exercise Practical Exam Presentation
CLO2	Lab practices on Selection Sort, Insertion Sort, Bubble Sort, Sequential Search, Binary Search.	Lecture Discussion Problem Based Learning	Short Answer Exercise Practical Exam
CLO1, CLO3	Working with Greedy algorithms: Activity Selection Problem, Job Sequencing Problem, Kruskal's and Prim's Minimum Spanning Tree, Dijkastra's Shortest Path Algorithm, Max Flow Problem, Fractional Knapsack Problem.	Lecture Group Assignment Problem Based Learning	Exercise Report Practical Exam
CLO2, CLO3	Lab Practices on Divide and Conquer Algorithms: Binary Search**,** Quicksort**,** Merge Sort**,** Strassen's Algorithm , Cooley–Tukey Fast Fourier Transform (FFT) algorithm.	Lecture Problem Based Learning Demonstration	Exercise Practical Exam Presentation
CLO2	Lab practice on building Binary Search Tree (BST), Find the minimum and maximum value of a BST, Find successor and predecessor of BST, Insert a data in BST, Delete data from a BST, Insert into and delete from AVL tree, Searching, insertion and deletion in a B-tree, Insertion, deletion in a red-black tree.	Lecture Problem Based Learning Demonstration	Exercise Practical Exam Presentation
CLO2, CLO3	Lab practices on Dynamic Programming: Longest Common Subsequence, Travelling Salesman Problem, Bellman–Ford Algorithm, Floyd Warshall Algorithm, Matrix Chain Multiplication.	Lecture Project Problem Based Learning Demonstration	Report Exercise Presentation Practical Exam

CLO2, CLO3	Working with Backtracking: 8 Queen Problem, Combinational Sum, Word Break Problem, m Coloring Problem.	Lecture Project Problem Based Learning Demonstration	Report Exercise Presentation Practical Exam
CLO2, CLO3	Working with Branch and Bound algorithms: Job Assignment Problem, 0/1 Knapsack, 8 puzzle Problem, N Queen Problem.	Lecture Group Assignment Problem Based Learning Demonstration	Report Exercise Presentation Practical Exam
CLO2, CLO3	Lab practices on NP-Complete and NP-Hard Problems: Hamilton Path, Hamilton Cycle, Graph homomorphism problem, Minimum k-cut, Bandwidth problem	Lecture Group Assignment Problem Based Learning Demonstration	Report Exercise Presentation Practical Exam

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√	√	√	√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√

Intended Learning Outcomes:

- Knowledge and understanding
  - Understand the basic concepts of the analysis and design of algorithms.
  - Understand the fundamental steps of designing and optimizing algorithms.
- Cognitive skills (thinking and analysis)
  - Be able to understand and analysis any problem and derive its solution.
  - Be able to design and optimize algorithms to solve complex and real life problems.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations, and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - Be able to identify the complex and real life problems to solve using effective understanding of the design and analysis of algorithms.

ICT 2204: Analog and Digital Communication Lab

Course Objectives:	The objective of this course is to • Implements different types of analog and digital communication technique with different types of communication kits. • Train the students to analyze the modulation and demodulation techniques such as amplitude modulation, frequency modulation and understand their performance using both trainer kit and circuit implementation.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **explain** various concepts and principles of radio wave propagation, (de)-modulation and (de/en)coding.	PLO2, PLO4
	CLO2- To **apply** statistical model in the analog and digital communication system.	PLO2, PLO5
	CLO3- To **explain** the components of analog and digital communication system.	PLO6, PLO9
	CLO4- To **formulate** the power spectra, bandwidth efficiency, spread spectrum modulation.	PLO3, PLO6
	CLO5- To **determine** critically and to use modulation and line coding in various system.	PLO3, PLO11

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2, CLO3, CLO5	Familiar with various analog and digital modulation scheme.	Demonstration Case studies Lecture	Practical Exam Report Viva-Voce
CLO1	BER analysis of the various modulation	Inquiry Based Learning (IBL) Lecture Exercise	Practical Exam Report Observation
CLO4	Design an optical fiber communication system	Demonstration Case studies Lecture	Practical Exam Viva-Voce Observation
CLO5	Effect of fading and noise on the signal	Group Assignment Lecture Problem Based Learning (PBL)	Observation Report Viva-Voce

CLO3	Performance of SISO, MISO and MIMO	Inquiry Based Learning (IBL) Lecture Exercise	Practical Exam Viva-Voce

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1					
CLO2	√	√			√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√
CLO5	√	√	√	√	√

Intended Learning Outcomes:

- Knowledge and understanding
  - ➢ Acknowledge the principles of operation and the main features of analog and digital transmission.
  - ➢ Understand the performance metric of communication systems.

- Cognitive skills (Thinking and analysis)
  - ➢ Be able to find the performance of various modulation schemes.
  - ➢ Be able to apply various modulation and encoding schemes in the real-life applications.
  - ➢ Be able to identify the different types of radio transmission, its techniques and applications.
  - ➢ Be able to formulate the power spectra, bandwidth efficiency, spread spectrum modulation.
- Communication skills (Personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - ➢ Be able to apply electrical circuit analysis skill to build efficient and constructive devices.

ICT 2200: Project Work II and Course Viva
The content of the viva includes the syllabus of all major courses. Each group of students must have to do a project work based on the courses taught in the 2nd Year's 1st and 2nd Semester. A faculty member or representative from other dept./institute/industry will supervise the project.

3rd Year 1st Semester

ICT 3101: Operating Systems

Course Objectives:	The objective of this course is to	
	- Understand the basic components of a computer operating system, and interactions among the various components. - Provide an introduction on the policies for scheduling. - Covers deadlocks, memory management, synchronization, system calls, and file systems. - Describe the knowledge of main memory and virtual memory.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** the history of modern computers.	PLO1
	CLO2- To **analyze** each of the major components of an operating system.	PLO2
	CLO3- To **explore** more advanced topics in the field, including memory management and file input/output.	PLO4

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Operating System: OS role in computer systems, Operating system concepts, Operating system structure.	Lecture Assignment	Short Answer Discussion
CLO1, CLO2	Process: Process model and implementation, Inter-Process Communication (IPC), classical IPC problems, process scheduling, multiprocessing and time-sharing, CPU management.	Lecture Assignment	Short Answer Discussion Assignment
CLO3	Memory management: Swapping, paging, segmentation, virtual memory.	Lecture Assignment	Short Answer Discussion
CLO3	Input/Output: Hardware, software, disk, terminals, clocks.	Lecture Assignment	Short Answer Discussion
CLO2, CLO3	Deadlock: Resource allocation and deadlock, deadlock detection, prevention and recovery.	Lecture Assignment	Assignment MCQ
CLO2, CLO3	File Systems: Files, directories, security, protection, and Case study of some operating systems.	Lecture Assignment	Short Answer Discussion

Assessment Pattern:

CLO	Continuous Assessment	Term Final

	Class Test	Assignment	Project	Presentation	
CLO1	√			√	√
CLO2	√				√
CLO3	√	√			√

Suggested Texts:
- Operating System Concepts. 10th Edition by Avi Silberschatz, Peter Baer Galvin and Greg Gagne.
- Operating System: Design and Implementation. 3rd Edition by Andrew S. Tanenbaum.
- Operating system Concepts. 9th Edition by Kernigham & Ritchie.
- Operating system Concept and Design. 2nd Edition by M. Milenkovic.
- Operating system, 1st Edition by Madnick & Donovan.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the goals of standardization of OS (and other) interfaces.
  - Understand the execution of a program as the trace of consecutive machine language instructions residing in the computer memory and how typical programming structures manifest themselves in machine language.
  - Understand the layered structure of input/output (I/O) software and give a broad overview of I/O interrupt handling.
- Cognitive skills (thinking and analysis)
  - Be able to understand the typical (physical) computer memory hierarchy and the compromises involved in using such a hierarchy.
  - Be able identify the most common data structures required in an OS implementation.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations, and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.

ICT 3103: Database Management Systems

Course Objectives:	The objective of this course is to
	• Understand the role of a database management system in an organization.
	• Understand basic database concepts, including the structure and operation of the relational data model.
	• Construct simple and moderately advanced database queries using Structured Query Language (SQL).
	• Understand and successfully apply logical database design principles, including E-R diagrams and database normalization.
	• Design and implement a small database project using Microsoft Access.
	• Understand the concept of a database transaction and related database facilities, including concurrency control, journaling, backup and recovery and data object locking and protocols.
	• Describe and discuss selected advanced database topics, such as distributed database systems and the data warehouse.
	• Understand the role of the database administrator.

Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **differentiate** database systems from file systems by enumerating the features provided by database systems and describe each in both function and benefit.	**PLO1, PLO2**
	CLO2- To **define** the terminology, features, classifications, and characteristics embodied in database systems.	**PLO1, PLO2**
	CLO3- To **analyze** an information storage problem and derive an information model expressed in the form of an entity relation diagram.	**PLO2, PLO4**
	CLO4- To **demonstrate** an understanding of the relational data model.	**PLO2, PLO5**
	CLO5- To **transform** an information model into a relational database schema and to **use** a data definition language and/or utilities to implement the schema using a DBMS.	**PLO2,**
	CLO6- To **formulate**, using relational algebra, solutions to a broad range of query problems.	**PLO3**
	CLO7- To **formulate**, using SQL, solutions to a broad range of query and data update problems.	**PLO3**
	CLO8- To **demonstrate** an understanding of normalization theory and apply such knowledge to the normalization of a database.	**PLO3, PLO4**

Course Contents:

CLO	**Course Contents**	**Teaching Learning Strategy**	**Assessment Strategy**

CLO1, CLO2, CLO4, CLO5	Introduction: Data, Information, File Processing Concept, fundamental concept of Database Management System (DBMS), purpose of DBMS, advantages and implications of DBMS, view of data. Relational Databases, Database Architecture, Transaction Management.	Lecture Discussion	Essay Type Answer MCQ
CLO4	Data Models: The evolution of data models, importance of data models, degrees of data abstraction, business rules.	Lecture Discussion	Essay Type Answer Exercise
CLO3, CLO4	Data modeling using Entity Relationship Model: Overview of database design and ER model, Entity Types, Entity Sets, Attributes, Keys, Relationships, relationship Types, Roles, Structural Constraints.	Lecture Discussion Assignment	Exercise Report
CLO4, CLO5	Data modeling using Entity Relationship Model: Direct ERD Issues, weak entity sets, Codd's rules, Relational Database design: features of good relational database design, refining the ER Design for different databases, Naming Conventions, Extended ER features: Aggregation, Specialization and Generalization.	Lecture Discussion	Essay Type Answer Exercise
CLO4, CLO5	Relational Model: Relational Model Concepts, Structure of relational database, Relational Database Design Using ER-to-Relational Mapping, Relational Constraints and Relational Database Schemas.	Lecture Assignment Demonstration	Exercise Report
CLO5, CLO8	Relational database model: Decomposition, Functional Dependency, Data Anomalies, Basics Concept of Normalization, Normalization (1NF, 2NF, 3NF, BCNF).	Lecture Problem Based Learning (PBL) Demonstration	Exercise Report
CLO6	Relational algebra and calculus: Basics relational algebra operations: introduction, Selection and projection, Set operations, Renaming, Joins, syntax, semantics, Operators, grouping and ungrouping, relational Comparison, Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Exercise Report
CLO7	Constraints, Views and SQL: What is constraints, types of constraints, Integrity constraints, Views: Introduction to views, data independence, security, updates on views, comparison between tables and views. SQL: Data manipulation languages, Null values and set operations, Aggregate functions, Nested sub queries, derived relations, SQL Joins, Views, Query optimization, Assertion and Trigger, Procedures and Functions.	Lecture Assignment Problem Based Learning (PBL) Demonstration	Exercise Report
CLO1, CLO3	File organization and data storage: Indexing: primary and secondary indexes, B+ trees, hash tables.	Lecture Demonstration Assignment	Essay Type Answer Report
CLO1	Transaction management and Concurrency control: ACID properties, serializability and concurrency control, Lock based concurrency control, Deadlock, Wait for Graph, Recovery, Access control and security.	Lecture Demonstration	Essay Type Answer Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√	√		√
CLO2	√	√	√		√
CLO3	√	√	√		√
CLO4	√	√	√		√
CLO5	√	√	√		√
CLO6	√	√	√		√
CLO7	√	√	√	√	√
CLO8	√	√	√		√

Suggested Texts:
- Database Systems Concepts, 7th Edition by A. Silberschatz, H. Korth and S. Sudarshan, Publisher: McGraw Hill.
- Fundamentals of Database Systems, 7th Edition by Ramez Elmasri.
- An Introduction to Database Systems, 7th Edition by C. J. Date.
- An Introduction to Database Systems, 3rd Edition by R. Ramakrishnan and J. Gehrke.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Students will have a broad understanding of database concepts and database management system.
  - ➢ Students will be able to model an application's data requirements using conceptual modeling tools like ER diagrams and design database schemas based on the conceptual model.
- Cognitive skills (thinking and analysis)
  - ➢ Students will be able to analyze problems, identify and define the computing requirements appropriate to its solution.
  - ➢ Students will be able to conceptualize data using different data models.
- Communication skills (personal and academic)
  - ➢ Through different individual and group assignments provided to the students, they would be able to understand the technical requirements of a particular informational problem.

- Practical and subject specific skills (transferable skills)
  - ➢ Be able to identify the simple and complex database related problems to solve using the effective understanding of the database management systems.

ICT 3105: Software Engineering Theories and Practices

Course Objectives:	The objective of this course is to	
	• Learn basic SW engineering methods and practices, selected models.	
	• Understand Role of project management, planning, scheduling, risk management, verification and validation techniques	
	• Analyze quality control that will enable the students to apply these in subsequent projects and work experiences.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** the current theories, models, techniques that provide a basis for software lifecycle	PLO1, PLO2
	CLO2- To **analyze** the software engineering lifecycle by demonstrating competence in communication, planning, analysis, design, construction, and deployment.	PLO2, PLO4
	CLO3- To **demonstrate** an ability to use the techniques and tools necessary for engineering practice.	PLO5, PLO6, PLO10, PLO12

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2	Software Engineering Paradigms: Definition of software engineering, The classical life cycle, prototyping fourth generation technique, The product and the process, measurement matrices.	Lecture Assignment	Short Answer Exercise
CLO1, CLO2	Software Project Planning: Planning objectives, S/W slope, Resources, Metrics for S/W productivity and quality, S/W project estimation, Decomposition techniques, Empirical Estimation Models, Automated Estimation tools, S/W project scheduling.	Lecture Assignment	Short Answer Identification Exercise
CLO2	Requirement Analysis Fundamentals: Analysis principle, Software Prototyping Specification, Requirement analysis Methodologies, Structured and Object oriented analysis, Data Flow-oriented Analysis methods.	Lecture Assignment	Short Answer Discussion
CLO2, CLO3	Software Design fundamentals: Design process, Design Fundamentals, S/W architecture, Program structure, Data structure, S/W procedure, Modularity, abstraction, Effective modular design, Procedural design, Data flow-oriented design, Top-down and bottom-up design, Design Process Considerations, Transform analysis, Transaction analysis, Data structure-oriented design, Logical construction of programs and systems, Data structured systems development, object-oriented design, Design concepts, methods & strategy. Real-time Design. Coding style, Code documentation, Data declaration, statement construction, Input/output. Software reliability and availability models: Software quality factors, software review, software quality metrics, Software reliability, Software quality assurance approach.	Lecture Assignment	Short Answer presentation
CLO2, CLO2	Software Testing Techniques: Testing fundamentals, White box testing, Basis path testing, Loop testing, Black Box testing.	Lecture Assignment	Short Answer Assignment
CLO2, CLO3	Software Testing Strategies: Verification and validation, Organization for software testing, Unit testing, Integration testing, Validation testing, System testing, The art of debugging.	Lecture Assignment	Short Answer Group Exercise
CLO2, CLO3	Software Maintenance and Configuration Management: Definition, Maintenance Characteristics, Maintainability, Maintenance tasks, Software configuration Management.	Lecture Assignment	Short Answer Group Exercise MCQ

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√			√	√
CLO2	√	√			√
CLO3	√		√		√

Suggested Texts:
- Software Engineering, 7th Edition by Ian Sommerville.
- Software Engineering: A Practitioners Approach, 7th Edition by R.S. Pressman.
- Software Architecture: Prospective on an Emerging Discipline, 1st Edition by Mary Shaw.
- Fundamentals of Software Engineering, 2nd Edition by Ghezzi, M. Jazayeri.
- Designing Object-oriented Software, 1st Edition by R. Wirfs-Brock, Brian Wilkerson, Lauren Wiener.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand the software engineering basics.
  - ➢ Understand the professional and ethical responsibility.
  - ➢ Understand the software development life cycle.
- Cognitive skills (thinking and analysis)

> ➤ Be able to design and conduct experiments, as well as to analyze and interpret data.
> ➤ Be able to identify, formulate, and solve engineering problems.
> ➤ Be able to use the techniques, skills, and modern engineering tools necessary for engineering practice.
> ➤ Be able to analyze, design, verify, validate, implement, apply, and maintain software systems.

- Communication skills (personal and academic)
  > ➤ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  > ➤ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.

ICT 3107: ICT Business Analytics and Data Visualization

Course Objectives:	The objective of this course is to • Introduce students to key information technology concepts that will allow them to understand how they provide the necessary data and information for business analytics. • Enable students to use tools for conducting data analysis, Predictive Analytics and data visualization to assist in the delivery of delivering real-time actionable intelligence. • Familiarize with the operational & technological best practices of business analytics.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **demonstrate** the strategic value of information, data management, and Business Analytics to ICT based organizational decision-making activities.	PLO10
	CLO2- To **analyze** various datasets using complementary data analytics/business analytics tools to generate insights and/or foresights to approach the organization's complex problems.	PLO2, PLO5, PLO7
	CLO3- To **analyze** and **review** in more depth the current algorithms, methodologies and modelling for ICT business analytics based on the outcome of the student group assignment deliverable.	PLO10, PLO11, PLO12

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2	Introduction: Overview of ICT business analytics, concept of business value from corporate data, the exploitation of information for advantage, types and sources of information value.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CLO1, CLO2	Business intelligence: Nature and value of business intelligence, business analytics, and how different types of analytics can add value to corporate ICT data sources, Enterprise data life cycle and data governance.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer MCQ Exercise
CLO2, CLO3	Combining and importing data: Knowledge discovery, data mining, data warehousing, data lake, ICT Business analytics, Online Analytical Processing (OLAP) analysis, metadata.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO2, CLO3	Data exploration and visualizing trends: Data preparation, Data visualization, visualization techniques, dashboard, uses of data visualization tools (R studio, Python, Tableau)	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO3	Data management: The relationship between corporate strategy and Information Systems (IS) strategy pertaining data management, Privacy, ethical, legal issues associated with organizational data, anomaly detection	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Report Exercise Presentation
CLO3	Cloud based data management and analytics: Building analytic models using cloud-based data management	Lecture Discussion Group Assignment	Essay Type Answer Report, Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√			√
CLO3	√			√	√

Suggested Texts:

- Business Analytics: Data Analysis & Decision Making, 5th Edition by S. Christian Albright, Wayne L. Winston.
- The Big Book of Dashboards: Visualizing Your Data Using Real-World Business Scenarios Paperback, 1st Edition by Steve Wexler, Jeffrey Shaffer, Andy Cotgreave.
- Good Charts: The HBR Guide to Making Smarter, More Persuasive Data Visualizations Paperback, 1st Edition by Scott Berinato.
- Essentials of Business Analytics, 2nd Edition by Camm, Cochran, Fry, Ohlmann, Anderson, Sweeney, Williams.

Intended Learning Outcomes:

- Knowledge and understanding
  - Enable all participants to recognize, understand and apply the language, theory and models of the field of business analytics.
  - Understand the core and necessary data mining techniques so that students understand how to work with large data sets and apply the appropriate data mining technique to answer business questions.
- Cognitive skills (thinking and analysis)
  - Foster an ability to critically analyze, synthesize and solve complex unstructured business problems.
  - Evaluate various ICT business analytic tools and techniques for the business interesting points finding from the student group work deliverable
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - Propose a business analytics report to solve practical problems identified in an ICT business project.

ICT 3109: Principles of Economics

Course Objectives:	The objective of this course is to	
	- Provide an introduction to a broad range of economic concepts, theories and analytical techniques. - Cover both microeconomics - the analysis of choices made by individual decision-making units (households and firms) - and macroeconomics - the analysis of the economy as a whole. - Discuss the analysis of market, supply and demand, model in which trade-offs and choices will be considered through comparison of costs and benefits of actions. - Analyzed production and market structure at the firm level. Macroeconomic issues regarding the interaction of goods and services markets, labor and money at an aggregate level will be modelled. - Examine microeconomic market failures and macroeconomic objectives.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** basic concept of scarcity, choice and opportunity cost.	PLO1
	CLO2- To **learn** demand, supply, market equilibrium and comparative static analysis.	PLO2, PLO3
	CLO3- To **examine** the economic agent behavior and **apply** the micro and macroeconomic policies in science and engineering field.	PLO4, PLO6
	CLO4- To **use** the economic tools in choosing techniques and analyze the IT related issues to address the real-life problems.	PLO11, PLO12

Course contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2	Fundamentals of Economics: Definition of economics and basic concepts of macroeconomics, Evolution of economic thought, Macroeconomic agents and their interactions, circular flow diagram, production possibility frontier, Law of demand, Determinants, demand curve, exception, Law of supply, Determinants, supply curve, exception, Intersection between demand and supply curve, Determination of equilibrium price and quantity, Changes of the market equilibrium.	Lecture Assignment	Short Answer Exercise Case Studies from the Real World Problems
CLO3, CLO4	Price Elasticity of Demand: Concepts, Calculations and interpretation, Determinants, Graphical Illustration, Income and cross elasticity of demand, Revenue implications of price elasticity of demand.	Lecture Assignment Discussion	Short Answer Identification of the Nature of the Commodities Exercise
CLO3	Utility and Consumer's Choice: Cardinal and ordinal approaches of utility, Law of diminishing marginal utility, Indifference curve, Budget line and Consumer's Utility maximization.	Lecture Assignment	Short Answer Discussion

CLO3	Production: Resources / Factors of production, Short run vs long run production behavior of a firm (special reference to IT firm), Cost structure of a firm and determination of profit maximizing output level.	Lecture Assignment	Short Answer Problem solving
CLO3, CLO4	Market and Government Policy: Types of market based on competition, Consumers and producer's reaction under different policy (Fiscal, monetary and growth policies) setting in different market. GNP, GDP and National income measurement.	Lecture Assignment Case studies	Short Answer Assignment Mathematical problems

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√				√
CLO3	√			√	√
CLO4		√			√

Suggested Texts:
- Economics, 11th Edition by Arnold, Roger, Publisher: South-Western, Cengage Learning - International Edition.
- Principles of Economics, 8th Edition by Mankiw, N. Gregory.
- Microeconomics, 11th Edition by Michel Parkin, Publisher: Addison Wesley Longman.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the basic concepts of scarcity, choice and opportunity cost.
  - Understand the use of economic tools to explain how unlimited wants are to be met with limited resources.
- Cognitive skills (thinking and analysis)
  - Be able to explain the real-life problems of demand, supply and market equilibrium and its change under different government's policy setting.
  - Be able to analyze how the economic agents are driven by their optimization goals and what is the time path to reach such optimum levels.
- Communication skills (personal and academic)
  - An individual assignment (mathematical depiction, graphical illustration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - Be able to use the concepts and analytical tools to comprehend and construct economic arguments.

ICT 3102: Operating System Lab

Course Objectives:	The objective of this course is to • Familiarize with basic Linux commands and executing those commands on OS files. • Learn and develop programs using Shell Scripting. • Implementing OOP in Linux environment.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** the history of modern computers.	PLO1
	CLO2- To **analyze** each of the major components of an operating system.	PLO2, PLO5
	CLO3- To **explore** more advanced topics in the field, including memory management and file input/output.	PLO4

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction to operating systems concepts, process management, memory management, file systems, virtualization, and distributed operating systems.	Demonstration	Practical Exam Viva-Voce
CLO2	Familiarization with UNIX system calls for process management and inter-process communication.	Demonstration Case studies, Lecture	Practical Exam Viva-Voce
CLO2	Experiments on process scheduling and other operating system tasks through simulation/implementation.	Demonstration	Practical Exam Viva-Voce
CLO2	Resource allocation and deadlock, deadlock detection, prevention and recovery.	Demonstration Assignment	Practical Exam Viva-Voce
CLO3	Files, directories, security, protection, and Case study of some operating systems.	Demonstration Assignment	Demonstration Assignment
CLO2, CLO3	Apply the operating system concepts by experimenting on either Unix operating systems.	Exercise	Completion

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1				√	√
CLO2	√	√			√
CLO3	√				√

Intended Learning Outcomes:

- Knowledge and understanding
  - Understand the goals of standardization of OS (and other) interfaces.
  - Understand the execution of a program as the trace of consecutive machine language instructions residing in the computer memory, and how typical programming structures manifest themselves in machine language.
  - Understand the layered structure of input/output (I/O) software and give a broad overview of I/O interrupt handling.
- Cognitive skills (thinking and analysis)
  - Be able to understand the typical (physical) computer memory hierarchy and the compromises involved in using such a hierarchy.
  - Be able identify the most common data structures required in an OS implementation.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations, and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - Be able to read and understand simple bash scripts, modify them in a controlled way, and produce simple scripts.
  - Possess the courage and basic skills to use a unix-like OS, e.g., Linux, by means of a command line shell and an SSH terminal connection.

ICT 3104: Database Management Systems Lab

Course Objectives:	The objective of this course is to • Provide a sound introduction to the discipline of database management as a subject in its own right, rather than as a compendium of techniques and product-specific tools. • Familiarize the participant with the nuances of database environments towards an information-oriented data-processing oriented framework. • Give a good formal foundation on the relational model of data. • Present SQL and procedural interfaces to SQL comprehensively. • Give an introduction to systematic database design approaches covering conceptual design, logical design and an overview of physical design. • Motivate the participants to relate all these to one or more commercial product environments as they relate to the developer tasks. • Present the concepts and techniques relating to query processing by SQL engines. • Present the concepts and techniques relating to ODBC and its implementations.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** the formal foundation of the relational model of data.	**PLO1**
	CLO2- To **execute** SQL and procedural interfaces to SQL comprehensively.	**PLO5**
	CLO3- To **formulate** systematic database design approaches covering conceptual design, logical design and an overview of physical design.	**PLO2, PLO5**
	CLO4- To **present** the concepts and techniques relating to query processing by SQL engines**.**	**PLO3**
	CLO5- To **apply** normalization techniques to normalize the database.	**PLO6**
	CLO6- To **apply** the concept of indexing, transaction and query processing to develop the database applications.	**PLO6, PLO10**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO2, CLO3, CLO5	Creation of a database and writing SQL queries to retrieve information from the database.	Lecture Discussion Problem Based Learning Assignment	Report Exercise Practical Exam
CLO1, CLO2	Apply the constraints like Primary Key, Foreign key, NOT NULL to the tables.	Lecture Discussion Problem Based Learning	Report Exercise Practical Exam
CLO2, CLO4	Performing Insertion, Deletion, Modifying, Altering, Updating and Viewing records based on conditions.	Lecture Discussion Problem Based Learning Assignment	Report Exercise Practical Exam

CLO2, CLO4	Nested queries, Sub queries.	Discussion Problem Based Learning Assignment	Report Exercise Practical Exam
CLO2, CLO4	Implementation of JOINS.	Discussion Problem Based Learning Assignment	Report Exercise Practical Exam
CLO4	Application of aggregate functions.	Discussion Problem Based Learning Assignment	Report Exercise Practical Exam
CLO4	Queries using Conversion functions, string functions, date functions.	Discussion Problem Based Learning Assignment	Report Exercise Practical Exam
CLO6	Views, Sequences, Synonyms	Discussion Problem Based Learning Assignment	Report Exercise Practical Exam
CLO1, CLO3, CLO5	Database Design using ER modeling, normalization and Implementation for any application	Discussion Problem Based Learning Group Assignment	Report Exercise Practical Exam
CLO1, CLO2, CLO3, CLO4, CLO5, CLO6	Case Study using real life database applications.	Project Problem Based Learning Demonstration	Report Exercise Practical Exam Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√
CLO5	√	√	√	√	√
CLO6	√	√	√	√	√

Intended Learning Outcomes:

- Knowledge and understanding
  - Understand, appreciate and effectively explain the underlying concepts of database technologies.
  - Design and implement a database schema for a given problem-domain.
- Cognitive skills (thinking and analysis)
  - Students will also be able to write and analyze SQL commands to create tables and indexes, insert/update/delete data and query data in a relational DBMS.
  - Examine techniques pertaining to Database design practices.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Students will also be assigned the task of implementing a database based project which would refine their idea of design issues preserving data security.
- Practical and subject specific skills (transferable skills)
  - Students will be able to install, configure and interact with MySQL Relational Database Management System.
  - Students will also grow the ability to describe, define and apply the major components of the relational database model to database design.

ICT 3106: Software Engineering Theories and Practices Lab

Course Objectives:	The objective of this course is to • Learn basic SW engineering methods and practices, selected models. • Identify role of project management including planning, scheduling and, risk management, verification and validation techniques and quality control that will enable the students to apply these in subsequent projects and work experiences.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** the history of Software Engineering.	**PLO1**
	CLO2- To **analyze** each of the major components of Software Engineering.	**PLO2, PLO5**
	CLO3- To **explore** more advanced topics in the field, including software requirements, design, implementation, testing, and maintenance.	**PLO3, PLO4 PLO10**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	Demonstration	Practical Exam Viva-Voce
CLO2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	Demonstration Case Studies Lecture	Practical Exam Viva-Voce
CLO2, CLO3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	Demonstration	Practical Exam Viva-Voce
CLO3	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions	Demonstration Assignment	Practical Exam Viva-Voce

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√			√	√
CLO3	√	√	√		√

Intended Learning Outcomes:

- Knowledge and understanding
  - Software Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals in the aspect of Software.
  - The ability to apply standard practices and strategies in software service management using open-ended programming environments with agility to deliver a quality service for business success.
- Cognitive skills (thinking and analysis)
  - Be able to understand the typical design of model and implementation for the product of Software.
  - Be able to identify the most critical reasoning of cost estimation of software Engineering.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations, and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
  - The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity.
- Practical and subject specific skills (Transferable Skills)
  - Be able to read and understand simple software design in the aspect of business enterprise.
  - Be able to design software requirement specifications in the aspect of business solution.
  .

ICT 3100: Course Viva
The content of the viva includes the syllabus of all major courses.

3rd Year 2nd Semester

ICT 3201: Internet and Web Technology

Course Objectives:	The objective of this course is to
	• Equip students with a solid understanding of internet and web technology fundamentals.
	• Develop practical skills in web development, covering front-end and back-end techniques.
	• Introduce students to server-side technologies and web frameworks for dynamic web application development.
	• Instill knowledge of essential web security and performance optimization practices.
	• Familiarize students with emerging trends and future directions in web technology, ensuring preparedness for industry.
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To understand and proficiently apply web development skills in creating responsive and interactive websites.	PLO1, PLO2
	CLO2- To demonstrate knowledge of server-side technologies, including database integration and dynamic content generation.	PLO3, PLO5, PLO6
	CLO3- To practice secure web development techniques and optimize website performance.	PLO4, PLO7
	CLO3- To design emerging web technology trends and apply them in real-world scenarios.	PLO4

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction to Internet and Web Technology: Understanding the Internet, Evolution of the World Wide Web, Basics of HTTP and HTTPS, Web Browsers and Their Role, Web Development Tools and Environments	Lecture Discussion Problem Based Learning	Q&A Exercise
CLO1	Web Development Fundamentals: Structure and Elements, CSS3: Styling and Layout, JavaScript: Introduction and Fundamentals, Client-Side vs. Server-Side Scripting, Responsive Web Design Principles	Lecture Problem Based Learning	Quiz Exercise
CLO2	Server-Side Technologies: Introduction to Server-Side Scripting, Common Server-Side Technologies (e.g., PHP, Python, Ruby), Web Servers and Hosting Environments, Database Integration and Management, Dynamic Web Content Generation	Lecture Problem Based Learning Home Work	Q&A Group Assignment Presentation
CLO2, CLO3	Web Development Frameworks: Introduction to Web Development Frameworks, Popular Web Frameworks, Framework-Based Web Application Development, Single-Page Applications (SPAs), RESTful API Design and Integration	Lecture Problem Based Learning Assignment	Q&A Individual Assignment Presentation
CLO2, CLO3	Web Security and Performance: Web Security Fundamentals, Secure Coding Practices, Authentication and Authorization, Web Performance Optimization, Caching and Content Delivery	Lecture Problem Based Learning	Quiz Individual Assignment
CLO2, CLO3	Emerging Trends and Future of Web Technology: Progressive Web Apps (PWAs), WebAssembly and WebVR, Internet of Things and Web Integration, Blockchain and Web Technology, Future Web Development Trends	Lecture Problem Based Learning	Short Answer Individual Assignment

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√

Suggested Texts:
- Berson: Client/Server Architecture, McGraw-Hill Series on Computer Communication, 2nd edition.
- Chris Bates: Web Programming. Building Internet Applications, John Wiley & Sons, Ltd., 2nd edition.
- Douglas E. Comer: Computer Networks and Internets with Internet Applications, Prentice Hall International, Inc., 2001, 3rd edition.

Intended Learning Outcomes:
- Knowledge and understanding
  - Gain knowledge and understanding of web technology fundamentals, including HTML, CSS, and JavaScript.
  - Comprehend server-side technologies and their role in web development, such as database integration and dynamic content generation.
  - Understand the principles of web security and performance optimization to create safe and efficient websites.
  - Familiarize with emerging web technology trends and their impact on the industry.
- Cognitive skills (thinking and analysis)
  - Apply analytical thinking to identify and address challenges in web design and implementation.
  - Use creative thinking to generate innovative solutions for web-related issues.
  - Evaluate and analyze the performance of web applications and make data-driven improvements.
- Communication skills (personal and academic)
  - Enhance personal communication skills for effectively articulating design ideas and findings.
  - Develop academic communication skills to present web projects and ideas persuasively.
  - Practice clear and concise communication in both written and verbal forms.
  - Collaborate and communicate effectively within a team environment, essential for web development projects.
- Practical and subject specific skills (transferable skills)
  - Acquire practical web development skills that can be applied to real-world projects and industries.
  - Gain hands-on experience in creating responsive and interactive websites.
  - Learn practical skills in web security, coding, and performance optimization.
  - Develop transferable skills, such as problem-solving, project management, and adaptability, valuable in various professional contexts.

ICT 3203: Artificial Intelligence and Neural Networks

Course Objectives:	The objective of this course is to • Present an overview of artificial intelligence (AI) principles and approaches. • Develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents: Search, Knowledge representation, inference, logic and learning.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **analyze** the various Knowledge organizations and management, Agent, rule base, inference engine, search methods, Matching Techniques.	PLO1, PLO2
	CLO2- To **identify** the difference between Natural Language processing, Pattern recognition, expert systems and neural network.	PLO1, PLO2

CLO3- To **analyze** the various algorithm related to NLP, pattern recognition, rule base, Genetic algorithm and ANN.		**PLO4, PLO5**
CLO4- To **apply** Fuzzy logic, Generic Algorithm and ANN in many real-life applications and also NLP, perceptron and Robotics in sensor data**.**		**PLO3, PLO6, PLO8**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Fundamentals of AI: What is AI? Its foundation and history Intelligent Agents: Agents and Environments, The Structure of Agents, Nature of the Environment, Solving Problems by Searching, Problem-Solving Agent, various types of searching technique.	Lecture Assignment	Short Answer Exercise
CLO1	Informed Search and Exploration: Informed (Heuristic) Search Strategies, Heuristic Functions, Local Search Algorithms and Optimization Problems, Local Search in Continuous Spaces, Online Search Agents and Unknown Environments. Constraint Satisfaction Problems: Constraint Satisfaction Problems, Backtracking Search for CSPs, Local Search for Constraint Satisfaction Problems. Adversarial Search: Optimal Decisions in Games, Alpha-Beta Pruning, Imperfect, Real-Time Decisions, Games That Include an Element of Chance.	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO1	Knowledge and Reasoning: Knowledge-Based Agents, The Wumpus World, Propositional Logic and Predicate Logic, Knowledge Representation.	Lecture Assignment Demonstrate	Short Answer Exercise
CLO1, CLO4	Planning: The Planning Problem, Planning with State-Space Search, Partial-Order Planning, Planning Graphs, Planning with Propositional Logic, Planning and Acting in the Real World.	Lecture Assignment	Short Answer Discussion
CLO1	Learning: Learning from Observations, Knowledge in Learning, Statistical Learning Methods, Reinforcement Learning.	Lecture Assignment	Short Answer Discussion
CLO3, CLO4	Fuzzy Logic Systems: Fuzzy Logic Systems Architecture, Example of a Fuzzy Logic System, Application Areas of Fuzzy Logic. Artificial Neural Network: Basic Structure of ANNs, Types of Artificial Neural Networks, Machine Learning in ANNs, Back Propagation Algorithm, Bayesian Networks (BN), Application.	Lecture Assignment Demonstrate	Short Answer Presentation
CLO2, CLO3, CLO4	Natural Language Processing: Components of NLP, Steps in NLP, Implementation Aspects of Syntactic Analysis. Perception: Image Formation, Early Image Processing Operations, Extracting Three-Dimensional Information, Object Recognition Robotics: Robotic Perception, Planning to Move, planning uncertain movements, Moving.	Lecture Assignment Demonstrate	Short Answer Discussion

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Suggested Texts:
- Artificial Intelligence: A Modern Approach, 3rd Edition by Stuart Russell, Peter Norvig.
- Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence, 1st Edition by Kosko Bart.
- Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, Eastern Economy Edition by G. A. Vijayalakshmi Pai and Sanguthevar Rajasekaran.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand solving problems by searching problem solving agent and various types of searching technique.
  - ➢ Learn knowledge-based system, FL and ANN.
  - ➢ Learn how to apply NLP and Perception in data.
- Cognitive skills (thinking and analysis)
  - ➢ Be able to apply inference engine, fuzzy-genetic algorithm and artificial neural network in designing in designing intelligent agent.
  - ➢ Be able implement simple searching method, NLP, rule base systems, genetic algorithm and artificial neural network for various real-life applications, such as robotic application, image analysis, character recognition, pattern analysis, etc. using MATLAB.
  - ➢ Be able to incorporate machine intelligence.
- Communication skills (personal and academic)
  - ➢ Individual assignments including demonstration and presentation involve receiving clear instructions, designing and making an effective presentation.
  - ➢ A term project (group work) - where students will be assessed in terms of their effectiveness as an individual or leader in the team.
- Practical and subject specific skills (transferable skills)
  - ➢ Be able to apply various methods for designing new digital signal processing systems and for continued learning.

ICT 3205: Software Architecture and Design Pattern

Course Objectives:	The objective of this course is to	
	• Provide insight into common software engineering processes and best practices. • Impart knowledge about the impact of requirement engineering and its proper implementation. • Teach fundamental design principles and their application for modular and scalable software. • Develop skills for constructing high-quality, reliable, and maintainable software while emphasizing software measurement, resource allocation, and modern testing practices.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1 - To understand the importance of requirement engineering and gather relevant software requirements effectively.	**PLO1, PLO2**
	CLO2 - To differentiate and apply various software architecture patterns based on project needs.	**PLO2, PLO6, PLO8**
	CLO3 - To gain a solid grasp of common software engineering processes and best practices.	**PLO3, PLO7**
	CLO4 - To utilize Software Engineering design principles for assessing project feasibility, costs, and risks.	**PLO6, PLO11, PLO12**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	**Introduction to Software Engineering:** Software Development Process, Various Life Cycle Models, Key Concepts and Terminology.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO1, CLO2	**Requirement Analysis:** Communication Techniques, Analysis Principles, Software Prototyping, Requirement Specification.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO2, CLO3	**Analysis Modeling:** Steps of System Analysis, Feasibility Study, Economic and Technical Analysis, System Specification, Elements of Analysis Model, Data Modeling, Functional Modeling and Information Flow, Behavioral Modeling, Mechanics of Structured Analysis, Data Dictionary	Lectures Independent Research Class Discussions	Exercise Report Presentation
CLO3, CLO4	**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	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO3, CLO4	**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 Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO1, CLO3	**Maintenance and Metrics**: Major Maintenance Activities, Estimating Maintenance Cost and Productivity, Technical Metrics for Software, Software Quality, Framework for Technical Metrics, Metrics for Analysis and Design Models, Metrics for Source Code, Metrics for Testing and Maintenance, Software Architecture, Software Project Management.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO3, CLO4	**Design Patterns and Formal Methods:** Introduction to design patterns. Different Patterns: Strategy, Observer, Factory, Singleton, Command, Adapter, Facade, Template Method, Iterator, Composite, State, Proxy, Compound Patterns, Formal Methods in Software Engineering: its need and application, Formal specifications, Formal Verifications, Introduction to Z Language, Formal methods and testing.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√			√
CLO3	√	√			√
CLO4	√	√			√

Suggested Texts:
• Software Engineering: A Practitioner's Approach- Roger S. Pressman.
• Patterns of Enterprise Application Architecture 1st Edition by Martin Fowler, Addison-Wesley Professional Publications.
• Head First Design Patterns, Eric & Elisabeth Freeman, O'REILLY.
• Software Architecture in Practice by Len Bass, Paul Clements, and Rick Kazman, Addison-Wesley Professional Publications.

Intended Learning Outcomes:
• Knowledge and understanding

- ➢ Demonstrate a deep understanding of software architecture principles and various architectural styles.
- ➢ Identify and explain key design patterns and their relevance in software development.
- Cognitive skills (thinking and analysis)
  - ➢ Apply critical thinking to analyze and select appropriate architectural choices and design patterns.
  - ➢ Develop problem-solving skills by implementing design patterns to address real-world software challenges.
- Communication skills (personal and academic)
  - ➢ Effectively convey complex architectural and design concepts through clear and concise communication.
  - ➢ Present and discuss software architecture and design principles in an academic context, fostering effective academic communication.
- Practical and subject specific skills (transferable skills)
  - ➢ Apply architectural and design patterns to create modular and maintainable software solutions.
  - ➢ Select and implement design patterns based on specific project requirements.
  - ➢ Conduct code reviews and provide constructive feedback to enhance software quality.
  - ➢ Analyze, compare, and adapt architectural patterns and design solutions in diverse software development scenarios, demonstrating subject-specific expertise.

ICT 3207: Information and Data Security

Course Objectives:	The objective of this course is to • Provide an understanding of principal concepts, major issues, technologies and basic approaches in information and data security. • Develop an understanding of security policies (such as authentication, and confidentiality). • Understand of database security model. • Understand of multilevel secure relational model and poly-instantiation integrity. • Analyze of various types of security incidents and attacks, and learn methods to prevent, detect and react incidents and attacks.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** the fundamentals of managing information and data security systems and personnel.	PLO1
	CLO2- To **learn** how security and management are interrelated.	PLO2, PLO4
	CLO3- To **analyze** common threats and **recognize** vulnerabilities of information systems.	PLO4, PLO7
	CLO4- To **understand** the laws and regulations surrounding information and data security.	PLO7, PLO8
	CLO5- To **learn** how to plan for disaster recovery.	PLO7
	CLO6- To **learn** how to conduct security audit.	PLO6, PLO11
	CLO7- To **understand** and **apply** security policies.	PLO3

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Defining Database and Information Security, Concept of Information Security, The three concepts of Information and data Security.	Lecture Assignment	Short Answer Exercise
CLO1, CLO2	Access Control in Current System, Multilevel Security, Different Techniques for Inference Control, Integrity Principle and Mechanism.	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO2	Three Components of Trust Management, Trust Management using PGP Certificates, Concept of Trust Negotiation.	Lecture Assignment	Short Answer Discussion
CLO2	Data As a Service (DAS) Model, Encrypted Data Management, Query processing architecture for DAS.	Lecture Assignment	Short Answer presentation
CLO2	Introduction to Geospatial Database, Geospatial Data Models, Security of Geospatial data Through Access Control Models.	Lecture Assignment	Short Answer MCQ
CLO2, CLO3	Introduction to Data Warehouses and OLAP Systems, Security Problem Description, Classify Security Threats & Identify Security Requirements, Three-tier Security Architecture	Lecture Assignment Project	Short Answer Group Exercise MCQ
CLO2, CLO3	Hadoop Distributed File System, (HDFS), Map Reduce Algorithm.	Lecture Assignment	Short Answer Group Exercise MCQ
CLO3, CLO4	Steganography versus Watermarking, Watermarking Solution for Relational data.	Lecture Assignment Project	Short Answer Group Exercise MCQ

CLO3, CLO4	What is statistical database? Understanding of Data Compromise, How to Protect Data from Snooper, Query set size control mechanism..	Lecture Assignment	Short Answer Assignment MCQ
CLO3, CLO5	Attacks to Server Systems, Denial of Service Attack, Attacks to Network Systems.	Lecture Assignment Project	Short Answer Group Exercise MCQ
CLO5, CLO6	What is Risk Management process, Identifying Information Assets, Identifying Security Risk and evaluation, Risk Treatment?	Lecture Assignment	Short Answer Group Exercise MCQ
CLO4, CLO7	Information Security Governance, Information Security Management System (ISMS), Information Security Policy, Standards and Procedures, Information Security Evaluation.	Lecture Assignment Project	Short Answer Group Exercise MCQ

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				
CLO2	√				√
CLO3		√			√
CLO4	√			√	√
CLO5	√				√
CLO6	√				√
CLO7				√	√

Suggested Texts:
- Database Security and Auditing: Protecting Data Integrity and Accessibility, 1st Edition by Hasan A. Afyouni.
- Database Security, 1st Edition by Silvano Castano, Maria Fugini, Giancarlo Martella, and Pierangela Samarati.
- Implementing Database Security and Auditing, 1st Edition by Ron Ben Ratan, Publisher: Elsevier Digital Press, 2005.
- Database Security, 1st Edition by Alfred Basta, Melissa Zgola.
- Principles of Information Security, 6th Edition by Michael E. Whitman and Herbert J. Mattord, Publisher: Cengage Learning.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the principal concepts, major issues, technologies and basic approaches in information and data security.
  - Gain the basic principles of security and to know how it affects our daily life.
  - Gain an understanding of terms and terminology commonly used in security management.
  - Know how vulnerabilities occur and how to limit them.
  - Gain a fundamental understanding of what an attack/threats is, and how to identify and prevent them from occurring.
  - Gain a fundamental knowledge of security audit and security policies.
- Cognitive skills (thinking and analysis)
  - Be able to implement security plan and monitor solutions.
  - Be able to monitor and evaluate audit logs and set administrator alerts.
  - Be able to respond to any breach of security and adjust organizational security plan accordingly.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - Be able to demonstrate and apply knowledge of current trends in ICT security, particularly those that relate to security threats, security policies, dissenter management and security audit.

ICT 3209: Smart Sensors and Internet of Things

Course Objectives:	The objective of this course is to - Understand of various physical phenomenon of different types of sensors and microsystems. - Design of sensors with appropriate electronic interface as a complete system. - Discuss about various types of sensors like magnetic, optical, bio, chemical, radiation, electrical and mechanical etc. - Emphasis on the integration of electronics with sensors to provide a smart transducer or a system on a chip with multiple integrated devices.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **select** the right sensor for a given application.	PLO1, PLO2
	CLO2- To **design** basic circuit building blocks.	PLO3
	CLO3- To **simulate, synthesize, and layout** a complete sensor or sensor system, MEMS device or Microsystems ready for fabrication tools.	PLO4, PLO5

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Sensors: Working Principles; Different types, Selection of Sensors for Practical Applications; Introduction of Different Types of Sensors such as Capacitive, Resistive, Surface Acoustic Wave for Temperature, Pressure, Humidity, Toxic Gas etc. Important Characteristics of Sensors: Determination of the Characteristics Impedance Spectroscopy: Equivalent circuit of Sensors and Modelling of Sensors.	Lecture Assignment	Short Answer Exercise
CLO1, CLO2	Importance and Adoption of Smart Sensors Architecture of Smart Sensors: Important components, their features; Interface Electronic Circuit for Smart Sensors and Challenges for Interfacing the Smart Sensor.	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO1, CLO2	Wireless sensor network (WSN): Introduction to Wireless Sensor Networks; Network Architecture; Hardware Platforms; Medium Access Control Protocol design; Routing protocols for WSN; 8 Energy Harvesting WSNs.	Lecture Assignment	Short Answer Discussion
CLO2, CLO3	Internet of Things (IoT): Introduction to IoT; Internet of Things Architecture; Vision and Challenges for realizing the Internet of Things.	Lecture Assignment	Short Answer Presentation
CLO2, CLO3	Internet of Things Application Domains: Design and Implementation of IoT for Environmental Condition Monitoring:Development of WSN Based Smart Bed for Health Care Application (Case study); Study of Smart City, smart village and their Design (Case study); Application of IoT in agriculture (Case study).	Lecture Assignment Case study Demonstrate	Short Answer Presentation
CLO2, CLO3	Design and development of Security and Privacy Technologies related to IoT.	Lecture Assignment	Short Answer Presentation
CLO2, CLO3	Relevance of smart sensors and IoT to Developing World and Research Scope for the Internet of things.	Lecture Assignment	Short Answer Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√			√	√
CLO3	√	√			√

Suggested Texts:
- Handbook of Modern Sensors, 2nd Edition by Jacob Fraden.
- Semiconductor Sensors, 1st Edition by S. M. Sze.
- Fundamentals of Wireless Sensor Networks: Theory and Practice, 1st Edition by Willy, Waltenegus Dargie and Christian Poellabauer.
- 6LoWPAN: The Wireless Embedded Internet, 1st Edition by Zach Shelby, Carsten Bormann, Publisher: Wiley.
- Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, 1st Edition by Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers.
- Interconnecting Smart Objects with IP: The Next Internet, 1st Edition by Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the general concepts of Smart Sensors and Internet of Things (IoT).
  - Recognize various devices, sensors and applications.
- Cognitive skills (thinking and analysis)
  - Identify and compare approaches to automatically monitoring the environmental data.
  - Analyze network problems to determine the root cause and relevant of internet of things network.
  - Describe how network problem regarding data decimation and data gathering can be discover and mitigate.
  - Identify and describe routing protocols for WSN and IoT.
  - Explore and analyze recent approaches to solving low energy consumption and quality of services related problem in WSN and IoT.
- Communication skills (personal and academic)
  - Develop research skills related to design an IoT network to address a daily life problem.
  - Write a review of current literature on an aspect of Internet of Things.
  - Select a technical paper and summarize it for the class in a brief presentation.
- Practical and subject specific skills (Transferable Skills)
  - Create IoT solutions using sensors, actuators and Devices.

ICT 3202: Internet and Web Technology Lab

Course Objectives:	The objective of this course is to • Develop an ability to design and implement static and dynamic website. • Acquire knowledge and skills for creation of web site considering both client and server side programming. • Explore different web extensions and web services standards.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** internetworking mechanism and web publishing.	PLO1
	CLO2- To **analyze** real time scenario to solve through web technology.	PLO2, PLO3
	CLO3- To **develop** website with web programming languages.	PLO5, PLO10
	CLO4- To **design** complex application.	PLO3, PLO6

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2	Introductions Syllabus Review Tools for developing client-side web applications Accessing Web Folders JavaScript – Introduction, Data Operations, Basic Input and Output, Document Objects, Browser Objects.	Problem Based Learning (PBL)	Exercise
CLO3	HTML basics	Problem Based Learning (PBL)	Exercise
CLO3	Style sheets	Problem Based Learning (PBL)	Exercise
CLO3	Dynamic page using DOM, CSS, and JS	Problem Based Learning (PBL)	Exercise
CLO3, CLO4	Form processing at the client side	Problem Based Learning (PBL)	Exercise
CLO3, CLO4	HTML and DHTML Common tags- Block Level and Inline Elements, Lists, Tables, Images, Forms, Frames; Cascading Style sheets, CSS Properties; Java Script: Introduction to Java Script, Objects in Java Script, Dynamic HTML with Java Script.	Problem Based Learning (PBL)	Exercise
CLO3, CLO4	JDBC: Data Base, Database Schema, A Brief Overview of The JDBC Process, JDBC Driver Types, JDBC Packages, Database Connection, Associating The JDBC-ODBC Bridge With Database, Creating, Inserting, Updating And Deleting Data In Database Tables, Result Set, Metadata.	Problem Based Learning (PBL)	Exercise
CLO3	Web server, server side processing, PHP basics.	Problem Based Learning (PBL)	Exercise
CLO3	Introduction to PHP: Basics of PHP, Functions, Error Handling, Interaction between PHP and MySQL, Database using Forms, Using PHP to manipulate and Retrieve Data in MySQL.	Problem Based Learning (PBL)	Exercise
CLO4	Web based real time Problem Solving project.		Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√				√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Intended Learning Outcomes:
1. Explain different components and technologies of World Wide Web as a platform.
2. Design and develop websites using fundamental web languages, technologies and tools.
3. Distinguish between server-side and client-side web technologies.
4. Describe various web technology and application development issues and trends.
5. Conduct independent research on a subject related to the course material.

ICT 3204: Artificial Intelligence and Neural Networks Lab

Course Objectives:	The objective of this course is to • Provide understanding of some fundamental issues and algorithms in artificial intelligence (AI). • Provide some fundamental tools and algorithms required to produce • Exhibit limited human-like abilities, particularly in the form of Problem Solving by search, representing and reasoning with knowledge, planning, and learning.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping

	CLO1- To **analyze** the various knowledge organizations and management, agent, rule base, inference engine, search methods and matching techniques.	**PLO2, PLO5**
	CLO2- To **identify** the difference between natural language processing, pattern recognition, expert systems and neural network.	**PLO2, PLO4**
	CLO3- To **analyze** the various algorithm related to NLP, pattern recognition, rule base, Genetic algorithm and ANN.	**PLO2, PLO4**
	CLO4- To **apply** Fuzzy logic, Generic Algorithm and ANN in many real-life applications and also Apply NLP, perceptron and Robotics in sensor data.	**PLO3, PLO6, PLO8**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Getting started with python and Create environment for AI and machine learning. Preprocessing and labeling data.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Understand supervised learning – Classification. Building classifier in Python using LR/DT/RF. Understand performance of the classifier.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Understand clustering. Algorithm for clustering the data. Measuring the clustering performance. Design KNN based classifier for a real time problem.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Extracting statistics from time series data. Analyzing sequence data by HMM. Analysis of stock market.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Concept of searching in AI. Understand various types of searching algorithm. Using searching algorithm design for games.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3	Reading, writing and displaying an image. Color space conversion. Edge, face and eye detection.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO4	Design and construct a FLC for solving real life problem. Design and construct a NF system for solving real life problem.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Build an ANN based classifier. Apply ANN classifier in designing logic gates.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Understand the difference between shallow and deep machine learning. Design and construct a CNN model in python and use it as image classifier.	Problem Based Learning (PBL) Lecture Group Assignment	Practical Exam Exercise Report

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand solving problems by Searching Problem-Solving Agent, various types of searching technique.
  - Learn knowledge-based system, FL and ANN.
  - Learn how to apply NLP and Perception in data.
- Cognitive skills (thinking and analysis)
  - Be able to apply inference engine, fuzzy-genetic algorithm and artificial neural network in designing in designing intelligent agent.
  - Be able implement simple searching method, NLP, rule base systems, genetic algorithm and artificial neural network for various real-life applications, such as robotic application, image analysis, character recognition, pattern analysis, etc. using MATLAB/Python.
  - Be able to incorporate machine intelligence.

- Communication skills (personal and academic)
  - ➢ Individual assignments after each lab work and group assignments including demonstration and presentation involve receiving clear instructions, designing and writing an effective report and making an effective presentation.
  - ➢ A term project (group work) - where students will be assessed in terms of their effectiveness as an individual or leader in the team.
- Practical and subject specific skills (transferable skills)
  - ➢ Be able to apply various methods for designing new digital signal processing systems and for continued learning.

ICT 3206: Software Architecture and Design Pattern Lab

Course Objectives:	The objective of this course is to • To give students a 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 Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1 - To **improve** software development skills, these experiments provide practical knowledge in various phases of software development, such as requirements analysis, design, and testing.	PLO1, PLO2
	CLO2 - To **develop** problem-solving abilities, students learn to dissect complex software challenges methodically, from eliciting requirements to debugging.	PLO2, PLO6, PLO8
	CLO3 - To **enhance** project management skills, individuals gain insights into estimating, scheduling, and monitoring software projects effectively, contributing to better project outcomes.	PLO3, PLO7
	CLO4 - To **prioritize** user satisfaction, design evaluation and testing help in understanding the importance of meeting user needs, resulting in more user-friendly software.	PLO6, PLO11, PLO12

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2	**Requirements Elicitation and Use Case Diagram:** Gather and document software requirements for a chosen company/client. Create a Use Case Diagram to depict interactions between users and the system.	Hands-On Project Group Collaboration Mentoring	Documentation Report Project
CLO2, CLO3	**Analysis Model to Architectural and Component Level Design:** Based on the requirements, design an Activity Diagram, Data Flow Diagram, Class Diagram, State Diagram, and Sequence Diagram to establish the system's architecture and component-level design.	Hands-On Project Group Collaboration Mentoring	Documentation Report Presentation Project
CLO2	**User Interface Design, Design Evaluation, Testing Strategies, and Tactics**: Design the user interface for a specific module using a swim lane diagram. Evaluate the design using usability heuristics and generate black-box and white-box test cases for thorough testing.	Hands-On Project Group Collaboration Mentoring	Documentation Report Presentation Project
CLO3, CLO4	**Software Testing and Debugging:** Implement and perform testing on the designed module. Execute black-box and white-box tests, identify defects, and use relevant tools for debugging.	Hands-On Project Group Collaboration Mentoring	Documentation Report Presentation Project
CLO3	**Managing Software Projects:** Analyze project estimation and scheduling, estimate time and resources, create a project schedule, allocate resources, and monitor project progress to ensure it stays on track.	Hands-On Project Group Collaboration Mentoring	Documentation Report Presentation Project
CLO1, CLO3	**Integration and System Testing:** Integrate previously developed modules to create a functional prototype. Conduct integration testing to ensure the modules work together, followed by system testing to assess overall system functionality.	Hands-On Project Group Collaboration Mentoring	Documentation Report Presentation Project
CLO3, CLO4	**Maintenance and Post-Deployment:** Address the maintenance phase of the software project, including fixing defects, making enhancements, and ensuring the software remains up-to-date and functional after deployment.	Hands-On Project Group Collaboration Mentoring	Documentation Report Presentation Project

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Gain an understanding of the software development lifecycle, from requirements elicitation to post-deployment maintenance.
  - ➢ Acquire knowledge of software design principles, design patterns, and architectural concepts.
  - ➢ Comprehend the importance of user-centric design and the impact of software on end-users.

- Cognitive skills (thinking and analysis)
  - Develop analytical skills to break down complex software problems into manageable components.
  - Apply critical thinking to evaluate the effectiveness of design choices and problem-solving strategies.
  - Enhance problem-solving abilities by identifying and addressing software defects during testing and debugging.
- Communication skills (personal and academic)
  - Improve personal communication skills through group collaboration, peer review, and project presentation.
  - Develop the ability to communicate technical information effectively in written reports and documentation.
  - Enhance academic communication skills by articulating and defending design decisions and project outcomes during presentations and peer assessments.
- Practical and subject specific skills (transferable skills)
  - Acquire practical software development skills, including requirements elicitation, architectural design, and testing techniques.
  - Cultivate subject-specific skills in software design, enabling the application of design patterns, architectural modeling, and project management.
  - Develop transferable skills such as problem-solving, time management, and project management, valuable in various professional contexts.

ICT3200: Project Work - III and Course Viva
The content of the viva includes the syllabus of all major courses. Each group of students must have to do a project work based on the courses taught in the 3rd Year's 1st and 2nd Semester. A faculty member or representative from other dept./institute/industry will supervise the project.

<u>4th Year 1st Semester</u>

ICT 4100: Internship
Outline: The student will work full-time as an intern to particular company for a period of six months. S/he will be evaluated based on the marks provided by the company along with the marks of at least two presentations given at IIT.

<u>Option - I</u>

ICT 4101: Cloud Computing and web Services

Course Objectives:	The objective of this course is to	
	- Develop a comprehensive understanding of cloud computing, including its origins, essential characteristics, and comparisons with traditional IT services. - Explore the architectural influences and scenarios that shape cloud computing, emphasizing its benefits, limitations, and regulatory considerations. - Delve into the layers and models of cloud architecture, including Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS), while addressing challenges and risks. - Familiarize students with cloud simulators and virtualization technologies like VMware, enabling hands-on experience in cloud-related tools and practices.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To demonstrate a deep understanding of cloud computing principles, including architecture, benefits, and challenges.	**PLO2**
	CLO2- To apply cloud simulators and virtualization tools effectively for practical cloud-based solutions.	**PLO1**
	CLO3- To evaluate and address security and regulatory issues in cloud computing and web services.	**PLO4, PLO5**
	CLO4- To develop the skills necessary to integrate web services with cloud technologies in real-world applications	**PLO3**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2, CLO3	Introduction to Cloud Computing: Origins of Cloud Computing, Cloud Components and Essential Characteristics, Comparing Cloud Providers with Traditional IT Service Providers, Roots of Cloud Computing	Lecture Assignment	Short Answer Exercise
CLO1, CLO4	Cloud Computing Insights: Architectural Influences: High-Performance Computing, Utility, and Enterprise Grid Computing, Cloud Scenarios and Benefits: Scalability, Simplicity, Vendors, Security, Limitations: Handling Sensitive Information, Application Development, Security Benefits, Regulatory Issues and Government Policies	Lecture Assignment Demonstrate	Short Answer Identification Exercise

CLO1, CLO3	Cloud Architecture Layers and Models: Layers in Cloud Architecture, Software as a Service (SaaS): Features and Benefits, Platform as a Service (PaaS): Features and Benefits, Infrastructure as a Service (IaaS): Features and Benefits, Service Providers, Challenges, and Risks in Cloud Adoption, Cloud Deployment Models: Public, Private, Community, Hybrid, Advantages of Cloud Computing	Lecture Assignment	Short Answer Discussion
CLO2, CLO4	Introduction to Cloud Simulators: CloudSim and GreenCloud, Understanding CloudSim Simulator, CloudSim Architecture (User Code, CloudSim, GridSim, SimJava), Working Platform for CloudSim, Introduction to GreenCloud	Lecture Assignment	Short Answer Presentation
CLO3	Introduction to VMWare Simulator: Basics of VMWare, Advantages of VMWare Virtualization, Using VMWare Workstation, Creating Virtual Machines and Understanding Their Functions, Cloning Virtual Machines, Virtualizing a Physical Machine, Starting and Stopping Virtual Machines	Lecture Assignment	Short Answer Exercise
CLO2, CLO4	Web Services in the Cloud: Overview of Web Services, Cloud-Based Web Services, Integration of Web Services with Cloud Computing, Benefits and Use Cases of Cloud-Based Web Services, Real-World Applications and Case Studies	Lecture Assignment Demonstrate	Short Answer Identification Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√			√
CLO3	√	√			√
CLO4	√	√			√

Suggested Texts:
- Cloud computing a practical approach - Anthony T.Velte , Toby J. Velte Robert Elsenpeter, TATA McGraw- Hill , New Delhi – 2010
- Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online - Michael Miller - Que 2008
- Cloud computing for dummies- Judith Hurwitz , Robin Bloor , Marcia Kaufman ,Fern Halper, Wiley Publishing, Inc, 2010
- Cloud Computing (Principles and Paradigms), Edited by Rajkumar Buyya, James Broberg, Andrzej Goscinski, John Wiley & Sons, Inc. 2011

Intended Learning Outcomes:
- Knowledge and understanding
  - ➤ Acquire a solid knowledge and understanding of cloud computing concepts, architectures, and deployment models.
  - ➤ Gain insights into the principles and characteristics of web services in cloud computing.
  - ➤ Comprehend the regulatory and security considerations associated with cloud technologies.
  - ➤ Develop a deep understanding of cloud simulators and virtualization tools.
- Cognitive skills (thinking and analysis)
  - ➤ Apply critical thinking and analysis to assess the suitability of cloud computing solutions for specific business needs.
  - ➤ Analyze complex cloud scenarios, benefits, limitations, and regulatory challenges.
  - ➤ Evaluate the performance and security aspects of cloud-based web services.
  - ➤ Synthesize information from cloud simulators to design practical solutions for cloud computing.
- Communication skills (personal and academic)
  - ➤ Enhance personal communication skills for articulating technical concepts and solutions.
  - ➤ Develop academic communication skills for presenting research findings and course-related work effectively.
  - ➤ Collaborate with peers to exchange ideas, share insights, and discuss academic topics.
  - ➤ Communicate cloud computing and web services concepts to a wider audience, ensuring clarity and understanding.
- Practical and subject specific skills (transferable skills)
  - ➤ Develop practical skills in using cloud simulators and VMware for virtualization.
  - ➤ Gain hands-on experience in creating cloud-based solutions and web services.
  - ➤ Cultivate problem-solving skills through real-world applications of cloud technologies.
  - ➤ Acquire transferable skills in project management, critical thinking, and adaptability, applicable in various professional contexts.

ICT 4102: Cloud Computing and web Services lab

Course Objectives:	The objective of this course is to	
	• Develop practical skills in cloud computing, virtualization, and web service deployment. • Gain hands-on experience in using cloud simulators and cloud-based platforms. • Enhance problem-solving abilities related to cloud computing and web services. • Foster a deeper understanding of cloud service management and resource optimization.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To understand the fundamentals of simulating cloud scenarios and running scheduling algorithms using CloudSim	PLO2, PLO5

CLO2- To acquire the knowledge and skills necessary for managing cloud resources, exploring service deployment, and understanding cloud service characteristics effectively.	**PLO2, PLO4**
CLO3- To gain practical experience in setting up virtual machines, installing software, and executing programs in a virtualized environment.	**PLO2, PLO4**
CLO4- To develop hands-on skills in deploying web applications using Google App Engine and other cloud-based platforms.	**PLO3, PLO6, PLO8**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Virtual Machine Setup: Install Virtualbox or VMware Workstation, Create virtual machines with different flavors of Linux or Windows OS, Set up virtual machines on a Windows 7 or 8 host	Demonstration Problem Based Learning Group Assignment	Practical Exam Report
CLO1	C Compiler Installation: Install a C compiler in a virtual machine created using VirtualBox, Execute simple C programs to test the compiler.	Demonstration Problem Based Learning Group Assignment	Project Practical Exam Report
CLO3, CLO4	Google App Engine Basics: Install Google App Engine, Create a "Hello World" app and other simple web applications using Python or Java, Use the Google App Engine (GAE) launcher to launch these web applications	Demonstration Problem Based Learning Group Assignment	Project Practical Exam Report
CLO1	Simulating Cloud Scenarios with CloudSim: Simulate a cloud scenario using CloudSim, Run a scheduling algorithm that is not present in CloudSim	Demonstration Problem Based Learning Group Assignment	Group Project Practical Exam Report
CLO1	File Transfer between Virtual Machines: Find a procedure to transfer files from one virtual machine to another virtual machine	Demonstration Problem Based Learning Group Assignment	Group Project Practical Exam Report
CLO3	Launching Virtual Machines with Trystack: Find a procedure to launch virtual machines using Trystack, an online OpenStack demo version	Demonstration Problem Based Learning Group Assignment	Presentation Practical Exam Report
CLO4	Hadoop Single Node Cluster Setup: Install a Hadoop single node cluster, Run simple applications like word count to test the Hadoop setup	Demonstration Problem Based Learning Group Assignment	Presentation Practical Exam Report
CLO3, CLO4	Service Deployment and Usage in Cloud: Study Hadoop MapReduce and HDFS, Deploy and use services over the cloud, Manage cloud computing resources effectively, Explore existing cloud characteristics and service models	Demonstration Problem Based Learning Group Assignment	Project Practical Exam Report

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Intended Learning Outcomes:

- Knowledge and understanding
  - Develop knowledge and understanding of cloud computing, virtualization, and web service deployment.
  - Acquire a deep understanding of cloud simulator tools, such as CloudSim.
  - Gain insights into practical application scenarios in cloud computing and web services.
  - Understand the principles of service deployment and resource management in the cloud.
- Cognitive skills (thinking and analysis)
  - Apply critical thinking and analysis to solve problems related to cloud computing, virtualization, and web services.
  - Analyze and evaluate cloud scenarios, scheduling algorithms, and cloud-based platforms.
  - Develop problem-solving skills for troubleshooting virtual machine and cloud-related issues.
  - Apply analytical thinking to optimize cloud resources and service deployment.
- Communication skills (personal and academic)
  - Enhance personal communication skills for effectively collaborating with peers in the lab.
  - Develop academic communication skills for presenting research findings and lab work.
  - Practice clear and concise communication of technical concepts in the context of cloud computing and web services.
  - Improve teamwork and interpersonal communication skills through lab activities.
- Practical and subject specific skills (transferable skills)
  - Develop practical skills in setting up virtual machines, installing software, and running programs in a virtualized environment.
  - Gain hands-on experience in deploying web applications using cloud platforms like Google App Engine.
  - Cultivate problem-solving skills and resource management abilities in a cloud computing

ICT 4103: Mobile Application Development

Course Objectives:	The objective of this course is to	
	• Know the components and structure of mobile application development frameworks for Android and windows OS based mobiles.	
	• Understand how to work with various mobile application development frameworks.	
	• Learn the basic and important design concepts and issues of development of mobile applications.	
	• Understand the capabilities and limitations of mobile devices.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **design** and **implement** various mobile applications using emulators.	**PLO3, PLO5**
	CLO2- To **deploy** applications to hand-held devices.	**PLO3, PLO10**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Android Basics: Introduction, Architecture, Environment Setup, Emulator or Create AVD, Hello World App, Application Components, Activity Lifecycle, Content Providers, Broadcast Receivers, Services, Fragments, App Folder	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO1	Intents and Service: Android Intents (Implicit, Explicit), Intent Filters, Implicit Intents Vs Explicit Intents	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO1	UI Layouts: View and ViewGroup, *UI Layouts, LinearLayout, RelativeLayout, TableLayout, FrameLayout, ListView, GridView, WebView*	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO1	UI Controls: TextView, EditText, AutoCompleteTextView, Button, ImageButton, Toggle Button, RadioButton, CheckBox, RadioGroup, ProgressBar, RatingBar, AlertDialog, Spinner, *DatePicker, TimePicker, TextClock*	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO1	Menus: Options Menu, Context Menu, Popup Menu.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO1	Notifications and Alarms: Toast, Custom Toast, Progress Notification, Push Notifications using Firebase Cloud Messaging.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO1	Animations: Rotate Animations, Slide Up Down Animations, Fade In Out Animations, Zoom In Out Animations.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO1	Connectivity: Bluetooth, Bluetooth Turn ON or OFF, Bluetooth Device Discoverable, Bluetooth List Paired Devices, WiFi.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO1	Multimedia: Camera App, Audio, Audio Recorder, Audio Manager, Video Player.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO1	Parsing: Android XML Parsing using DOM Parser, SAX Parser, XMLPullParser. JSON Parsing etc.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO1	Storage: Android Shared, Preferences, Session Management, Internal Storage, External Storage, Android SQLite Database, SQLite ListView.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO2	Events and Themes: Input Events, Styles and Themes, Custom Views, Drag and Drop, Google Maps API, Send Email, Send SMS, Phone Calls, Gestures, Sensors, Test App on Real Device, Publish App on Google Play Store.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO2	AdMob Ads: Integrate AdMob Ads, Banner Ads in App, Interstitial Ads in App, Rewarded Video Ads in App.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation

CLO2	Graphics: Android Clipboard, ImageSwitcher, Loading Spinner, Navigation Drawer Sliding Menu, Internet Connection, TextToSpeech, Login and Registration Screen Design, Tabs with Fragments and ViewPager, ScrollView, Facebook Integration, Firebase Cloud Messaging.	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√	√	√	√
CLO2	√	√	√	√	√

Suggested Texts:
- Head First Android Development: A Brain-Friendly Guide, 2nd Edition by Dawn Griffiths, David Griffiths.
- Android Programming, The Big Nerd Ranch Guide, 2nd Edition by Bill Phillips, Chris Stewart, Brian Hardy & Kristin Marsicano.
- Android Cookbook: Problems and Solutions for Android Developers, 2nd Edition by Ian F. Darwin.
- Android Programming for Beginners, 2nd Edition by John Horton.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the basic concepts of Mobile Application Development.
  - Understand the fundamental issues of Mobile Apps, software architecture, operating platforms, user interfaces and data storage.
- Cognitive skills (thinking and analysis)
  - Be able to understand and analysis the different Mobile Applications related to User Interface, Layout, Widgets, Fragment, Animation, Clipboard, Facebook, Cloud, etc.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - Be able to understand and analysis the important theorem and ideas of Mobile Application Development to solve the realistic problems, particularly related to the computer science and engineering fields.

ICT 4104: Mobile Application Development Lab

Course Objectives:	The objective of this course is to - To understand the components and structure of mobile application development frameworks for Android and windows OS based mobiles. - To understand how to work with various mobile application development frameworks. - To learn the basic and important design concepts and issues of development of mobile applications. - To understand the capabilities and limitations of mobile devices. - Construct real time embedded circuit.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **learn** and develop mobile applications using GUI and Layouts.	PLO-1
	CLO2- To **explain** mobile applications using Event Listener and Databases (SQLite).	PLO-2
	CLO3- To **apply** RSS Feed, Internal/External Storage, SMS, Multithreading, GPS and Analyze and discover own mobile app for simple needs.	PLO3, PLO5

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Familiar with an application that uses GUI components, Font and Colors.	Demonstration Case studies Lecture	Practical Exam Report Viva-Voce
CLO1	Application that uses Layout Managers and event listeners. Develop a native calculator application.	Inquiry Based Learning Lecture	Practical Exam Report Observation
CLO2, CLO3	Basic graphical primitives on the screen and Databases.	Demonstration Problem Based Learning	Practical Exam Viva-Voce Observation
CLO2, CLO3	Use of mobile applications using RSS Feed, Internal/External Storage, SMS, Multithreading and GPS.	Group assignment Lecture Problem Based Learning	Observation Report Viva-Voce
CLO2, CLO3	Data to the SD card, creates an alert upon receiving a message, creates alarm clock.	Inquiry Based Learning Lecture Exercise	Practical Exam Viva-Voce

Assessment Pattern:

CLO	Continuous Assessment	Term Final

	Class Test	Assignment	Project	Presentation	
CLO1	√				
CLO2	√	√		√	√
CLO3	√	√	√	√	√

*Intended Learning Outcomes***:**

- Knowledge and understanding
  - ➢ Identify the basic knowledge on mobile application environment and technology
  - ➢ Explain the concepts and processes of mobile application development
  - ➢ Discuss design and development issues specific to mobile applications
  - ➢ Design and develop mobile applications, using development tools and environments.
- Cognitive skills (Thinking and analysis)
  - ➢ Be able to identify, formulate, and solve engineering problems.
  - ➢ Be able to development of frameworks for Android and windows OS based mobiles.
  - ➢ Be able learn the basic and important design concepts and issues of development of mobile applications.
  - ➢ Be able to understand the capabilities and limitations of mobile devices.
  - ➢ Be able to analyze and discover own mobile app for simple needs.
- Communication skills (Personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable skills)
  - ➢ Be able to build and apply necessary aps to build real life program.
  - ➢ Be able to Cross-platform and networking events or websites development skills

ICT 4105: Computer Vision and Robotics

Course Objectives:	The objective of this course is to
	• Develop a solid understanding of computer vision principles and their relevance in robotics applications.
	• Enable students to apply image analysis techniques, recognize objects, and calibrate cameras effectively.
	• Familiarize students with the principles of single and multiple view geometry for precise robotic perception.
	• Introduce advanced concepts such as visual odometry, motion analysis, and machine learning for practical robotic navigation and object recognition.

Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** the fundamental concepts and techniques of computer vision and robotics, enabling them to apply these principles to real-world problems.	**PLO1, PLO2**
	CLO2- To **demonstrate** the ability to analyze and process images, including the extraction of features and the recognition of objects in images.	**PLO2, PLO5**
	CLO3- To **apply** knowledge of camera models, calibration, and geometry to accurately perceive and interpret the 3D world in a robotic context.	**PLO3, PLO5**
	CLO4- To **integrate** advanced topics, such as visual odometry, motion analysis, and machine learning, to develop practical solutions for robot pose estimation, navigation, and object recognition.	**PLO3, PLO5, PLO6**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Fundamentals of Computer Vision: Introduction to Computer Vision, Computer vision overview, Historical context and applications in robotics, Image Processing Fundamentals, Image sampling and quantization, Mathematical tools for image processing (array, matrix, operations), Arithmetic and geometric operations, Morphology and spatial operations. Frequency Analysis, Fourier transforms in image processing, Frequency domain operations	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1.CLO2	Image Formation and Geometry: Camera Models and Calibration, Camera models and their application in robotics, Calibration techniques for accurate imaging, Single and Multiple View Geometry, Single view geometry and perspective projection, Epipolar geometry for multiple views, Feature extraction for object tracking	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Robot Pose and Motion: Position and Orientation, Feature-based alignment and pose estimation, Time-varying pose and trajectories, Structure from motion and dense motion estimation, Visual Odometry and SLAM, Visual Odometry (Semi-direct VO, direct sparse odometry), Localization and Mapping (SLAM), Formulations, relocalization, and map optimization	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1,CLO3	Image Analysis and Recognition: Image Analysis and Features, Image pyramids and feature extraction, Edge and corner detection, Object Recognition and Interpretation, Object detection, Instance and category recognition, Context and scene understanding.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report

CLO3, CLO4	Advanced Topics in Computer Vision and Robotics: Stereo Vision and 3D Reconstruction, Point correspondences and epipolar geometry, 3D reconstruction and depth maps, Motion Analysis, Optical flow and affine motion models, Image stabilization techniques	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Machine Learning in Robotics and Vision: Feature-Based Object Recognition, Using statistical inference for object recognition, Appearance-Based Modeling, Eigenspace methods for object recognition, Sensor Fusion and Robot Kits, Integration of sensors (IMU, mono vs. stereo, RGB-Depth), Utilizing robot kits for practical applications	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Suggested Text:
- Russell & Norvig Chapters 24 & 25 in Artificial Intelligence: A modern approach, Prentice Hall, 1995, ISBN: 0130803022 - Highly Recommended
- Robin R. Murphy, Introduction to AI Robotics, MIT Press, 2000, ISBN: 0262133830, Recommended, supplementary for Robotics
- Solomon and Breckon, Fundamentals of Digital Image Processing, Wiley-Blackwell, 2010, ISBN 978-0470844731, Highly Recommended
- Ulrich Nehmzoe, Mobile Robotics: A Practical Introduction, 2nd Edition, Recommended
- RC Gonzalez, RE Woods, SL Eddins: Digital Image Processing Using MATLAB, 2nd Edition, Prentice Hall 2009, ISBN: 9780982085400, Excellent but expensive, covers a lot of IVR some of AV.

Intended Learning Outcomes:
- Knowledge and understanding
  - Gain a comprehensive understanding of the principles and concepts of computer vision and their application in robotics.
  - Acquire knowledge of various techniques related to image processing, camera models, and image analysis.
  - Develop an understanding of geometric concepts and their role in single and multiple view geometry for robotic perception.
- Cognitive skills (thinking and analysis)
  - Develop the ability to analyze and evaluate complex problems in computer vision and robotics.
  - Apply critical thinking to design and implement solutions for image analysis, object recognition, and camera calibration.
  - Engage in problem-solving by utilizing knowledge of geometry, image formation, and motion analysis for robotic applications.
  - Apply analytical skills to assess and improve the performance of robots in practical scenarios.
- Communication skills (personal and academic)
  - Effectively communicate complex technical concepts and ideas related to computer vision and robotics both verbally and in writing.
  - Engage in collaborative discussions and teamwork, presenting findings and insights to peers.
  - Develop the ability to write reports and research papers on topics related to computer vision and robotics.
  - Present and explain practical robotics solutions to a wider audience with clarity and precision.
- Practical and subject specific skills (transferable skills)
  - Demonstrate proficiency in using software and hardware tools for image processing, camera calibration, and object recognition.
  - Acquire hands-on experience in implementing and testing robotic systems that incorporate the principles of computer vision.
  - Cultivate problem-solving, adaptability, and innovation skills that are transferable to various fields beyond computer vision and robotics.

ICT 4106: Computer Vision and Robotics Lab

Course Objectives:	The objective of this course is to
	- Develop practical skills in image processing and camera calibration. - Gain hands-on experience in object recognition and motion analysis. - Enhance programming abilities for robot control and machine learning applications. - Explore and apply robotic simulation software for virtual experimentation and testing.

Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** the significance of camera calibration for accurate image analysis and to be proficient in the calibration process.	**PLO1, PLO2**
	CLO2- To **analyze** of fundamental image processing techniques, including grayscale conversion, thresholding, and filtering, and the ability to apply them to enhance images effectively.	**PLO2**
	CLO3- To **implement** basic object recognition through feature extraction and matching, enabling the identification of objects in images.	**PLO3, PLO4**
	CLO4- To **design** optical flow and motion detection, including calculating optical flow and detecting object motion in image sequences, which are crucial for motion analysis in robotics and computer vision applications	**PLO3, PLO5**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy

CLO		Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Camera Calibration: Teach the importance of camera calibration for accurate image analysis, and demonstrate the calibration process.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1, CLO2	Object Recognition: Implement basic object recognition using feature extraction and matching techniques.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO2, CLO3	Optical Flow and Motion Detection: Explore motion analysis by calculating optical flow and detecting object motion in image sequences.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3	Robot Control with Vision: Develop a simple robot control system that uses computer vision for tasks like following a path or avoiding obstacles.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Feature Tracking and Visual Odometry: Learn the basics of feature tracking and visual odometry for robot navigation and pose estimation.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3	Machine Learning for Object Detection: Introduce students to machine learning for object detection, allowing them to train a model for real-time object recognition.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Robotic Simulation Exercise: Provide hands-on experience with robotic simulation software to simulate robot movements and tasks in a virtual environment.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Demonstration of Robots with Different DOFs: Demonstrate and compare robots with varying degrees of freedom (2 DOF, 3 DOF, 4 DOF, etc.) to understand their capabilities.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO4	Programming the Robot for Applications: Further develop programming skills by working on a different robot application assignment.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Intended Learning Outcomes:

- Knowledge and understanding
  - Acquire a deep understanding of fundamental image processing techniques, camera calibration, and object recognition.
  - Develop knowledge of motion analysis and optical flow, including their applications in robotics and computer vision.
- Cognitive skills (thinking and analysis)
  - Apply critical thinking to solve practical problems in image processing and camera calibration.
  - Analyze and evaluate data related to object recognition and motion analysis, leading to informed decision-making.
- Communication skills (personal and academic)
  - Effectively communicate findings and insights gained from lab experiments to peers and instructors.
  - Collaborate with fellow students on assignments, fostering effective teamwork and communication skills.
- Practical and subject specific skills (transferable skills)
  - Cultivate hands-on skills in robot control, machine learning, and the use of robotic simulation software.
  - Develop transferable skills such as problem-solving, adaptability, and the ability to apply learned concepts to real-world scenarios, beyond the scope of the lab experiments.

ICT 4107: Cyber Security and ICT Auditing

Course Objectives:	The objective of this course is to - Define cybersecurity from an internal audit perspective. - Describe the scope, purpose, and limitations of cybersecurity. - Recognize how to measure effectiveness within the cybersecurity program. - Express the importance of information security governance with the cybersecurity program. - Explore basic auditing considerations for cybersecurity-related compliance. - Recognize typical cybersecurity-related preventive, directive, detective, mitigating, redundant, compensating, and corrective controls. - Identify simple audit activities to assess cyber resiliency within existing operational audit programs.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **demonstrate** a comprehensive understanding of cybersecurity principles and practices.	**PLO2, PLO5**
	CLO2- To effectively **apply** governance, risk management, and control measures in the context of cybersecurity.	**PLO2, PLO4**

	CLO3- To **perform** auditing and assessment of cybersecurity controls and frameworks.	**PLO2, PLO4**
	CLO4- To **apply** preventive, detective, and corrective controls for addressing cybersecurity threats and incidents	**PLO3, PLO6, PLO8**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Overview of Cybersecurity: What is cybersecurity?, Anatomy of a breach, Threat types, Risk categories, Controls by function, Defense in depth, layered security, and the OSI Model.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Information Security Governance, Risk, and Control: Cybersecurity governance, Cybersecurity risk management, Cybersecurity maturity models, Cybersecurity controls, Cybersecurity program development, Assurance: Governance, risk management, and control, Auditing cybersecurity.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Control Primer: Internal control, Control design and maintenance, Types of controls, Control levels, Control classifications, Controls by function, Asset and control inventory, Auditing controls.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Directive Controls: Directive controls, Threats to directive controls, Cybersecurity frameworks, standards, and guidelines, Cybersecurity training, Incentive programs, Incentive programs: Overall controls.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Preventive Controls: Preventive controls, Anatomy of a breach, Monitoring and alerting.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3	Detective Controls: Purpose of detective controls, The cybersecurity triad, Detecting cyber incidents, Detecting cyber incidents: Actions, Containing cyber incidents, Identifying data exposure, The breach, Audit logs, Considerations for detective controls, Security incident event monitoring, Data classification, and detective controls.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Suggested Texts:
- IT Auditing Using Controls to Protect Information Assets, Third Edition 3rd Edition by Mike Kegerreis. Publisher: McGraw Hill
- Computer Security Fundamentals (Pearson IT Cybersecurity Curriculum) 4th Edition by William (Chuck) Easttom II. Publisher: Pearson IT Certification.
- The Basics of IT Audit: Purposes, Processes, and Practical Information 1st Edition by Stephen D. Gantz. Publisher: Syngress
- IT Audit, Control, and Security 2nd Edition by Robert R. Moeller. Publisher: Wiley.

Intended Learning Outcomes:
- Knowledge and understanding
  - Develop a solid knowledge of cybersecurity concepts, principles, and best practices.
  - Understand the anatomy of security breaches, threat types, risk categories, and controls in cybersecurity.
  - Gain insight into the governance, risk management, and control frameworks applied in cybersecurity.
- Cognitive skills (thinking and analysis)
  - Apply critical thinking and analytical skills to assess cybersecurity risks and vulnerabilities.
  - Analyze and evaluate cybersecurity controls, measures, and auditing processes.
  - Develop problem-solving skills for addressing cybersecurity challenges effectively.
- Communication skills (personal and academic)
  - Enhance personal communication skills for effective collaboration in cybersecurity teams.
  - Develop academic communication skills for presenting research findings and cybersecurity reports.
  - Practice clear and concise communication of technical concepts in the field of cybersecurity.
- Practical and subject specific skills (transferable skills)
  - Acquire practical skills in implementing preventive, detective, and corrective cybersecurity controls.
  - Apply subject-specific skills in conducting cybersecurity assessments, audits, and assurance.
  - Cultivate transferable skills such as project management, risk analysis, and compliance in cybersecurity.

ICT 4108: Cyber Security and ICT Auditing Lab

Course Objectives:	The objective of this course is to
	• Develop a comprehensive understanding of cybersecurity principles and practices.
	• Equip students with knowledge and skills to assess and manage cybersecurity risks.
	• Enable effective audits of information security controls and frameworks.
	• Prepare for addressing cybersecurity threats and vulnerabilities through preventive, detective, and corrective measures.

Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** and apply various substitution and transposition techniques, including Caesar Cipher and Rail fence transformations.	**PLO1**
	CLO2- To **aquire** practical experience in network monitoring and data analysis, including the use of tools like Wireshark, tcpdump, and rootkits for security assessment	**PLO1, PLO4**
	CLO3- To **analyze** and counteract common cyber attacks, such as Dictionary Attacks and Brute Force Attacks.	**PLO2, PLO4**
	CLO4- To **implement** the Diffie-Hellman Key Exchange mechanism using HTML and JavaScript for secure communication.	**PLO3, PLO5, PLO8**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Implement the following Substitution & Transposition Techniques concepts: a) Caesar Cipherb) Rail fence row & Column Transformation.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Implement the Diffie-Hellman Key Exchange mechanism using HTML and JavaScript. Consider the end user as one of the parties (Alice) and the JavaScript application as other party (bob).	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Implement the following Attack: a) Dictionary Attack b) Brute Force Attack.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Installation of Wire shark, tcpdump, etc and observe data transferred in client server communication using UDP/TCP and identify the UDP/TCP datagram.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Installation of rootkits and study about the variety of options.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3	Perform an Experiment to Sniff Traffic using ARP Poisoning.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO4	Demonstrate intrusion detection system using any tool (snort or any other s/w).	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Demonstrate how to provide secure data storage, secure data transmission and for creating digital signatures.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Intended Learning Outcomes:
• Knowledge and understanding

- ➢ Demonstrate a deep understanding of various cybersecurity and ICT auditing concepts and techniques.
- ➢ Interpret and apply theoretical knowledge to practical situations, ensuring a strong foundation in the subject.
- Cognitive skills (thinking and analysis)
  - ➢ Develop critical thinking skills for analyzing and addressing cybersecurity and auditing challenges.
  - ➢ Apply analytical skills to assess and respond to cyber threats and vulnerabilities effectively.
- Communication skills (personal and academic)
  - ➢ Enhance personal communication skills for effective collaboration within cybersecurity teams.
  - ➢ Develop academic communication skills for presenting findings and reports on cybersecurity and ICT auditing topics.
- Practical and subject specific skills (transferable skills)
  - ➢ Acquire practical skills for implementing cybersecurity measures and conducting ICT audits.
  - ➢ Cultivate transferable skills such as problem-solving, risk management, and compliance in the field of cybersecurity and ICT auditing.
  - ➢ These ILOs encompass a holistic approach to knowledge, cognitive skills, communication skills, and practical abilities, providing students with a well-rounded education in the domain of cybersecurity and ICT auditing.

IT 4109: Cryptography and Network Security

Course Objectives:	The objective of this course is to • Acquire the fundamentals idea of Cryptography. • Acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity. • Understand the various key distribution and management schemes. • Understand how to deploy encryption techniques to secure data in transit across data networks. • Design security applications in the field of Information technology.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** the terms and terminology commonly used in Cryptography and Network Security and possess a fundamental knowledge of Network Security and know how to provide the security of a network.	**PLO1, PLO5, PLO7**
	CLO2- To **understand** what a threat, attack and vulnerability are and **know** how to identify and prevent them from occurring.	**PLO2, PLO3**
	CLO3- To **demonstrate** and **apply** knowledge of current trends in ICT security, particularly those that relate to security protocols and policy, cryptography, malware, digital forensics, and legal evidence.	**PLO3, PLO5, PLO10**
	CLO4- To **apply** skills in the identification of security threats, implementation of secure system properties, security testing, and incident response and investigate emerging security trends and their application to professional practice.	**PLO3, PLO4, PLO5, PLO7**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	1) Significance of Information and its Protection in Our Life 2) OSI Security Architecture 3) Security Services, Goals and Mechanisms 4) Attacks, Threats, Vulnerability, and Control	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO1	1) Why Mathematics is Necessary in Cryptography and Network Security? 2) Integer and Binary Operations 3) Modular Arithmetic 4) Additive Inverse, Multiplicative Inverse and Extended Euclidean Algorithm 5) Euler's Totient Function 6) Prime Factorization and Primality Testing 7) Matrix and its Multiplicative Inverse	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation

CLO1, CLO2	1) General Idea Behind Cryptography and Steganography
	2) Basic Terminologies Related to Them
	3) Various Cryptographic and Steganographic Techniques
	4) Symmetric-key Vs. Asymmetric-key Cryptography
	5) Traditional Vs. Modern Ciphers:
	  a) Additive, Multiplicative, Affine, Auto-key, Playfair, Vigenere, Key-less and Keyed-ciphers
	  b) DES, AES, RSA, Rabin, and Elliptic Curve Cryptosystems
	6) Three Pass Protocol
		Lecture
		Discussion
		Group Assignment
		Demonstration
			Exercise
			Report
			Presentation

CLO3	1) Hash Function and its Importance in Network Security 2) Popular Hash Functions and their Functions 3) Desirable Properties of Hash Function 4) Hash Function Vs. MAC 5) Digital Signature Vs. Conventional Signature Vs. Cryptosystem	Lectures Independent Research Class Discussions	Exercise Report Presentation

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
	6) Processes of Signing and Verification 7) Services Provided by Digital Signature		
CLO3, CLO4	1) Identification, Verification, Authentication, and Authorization 2) Message Authentication Vs. Entity Authentication 3) Authentication Factors 4) Providing Authentication by Hash and MAC 5) Various Schemes of Knowledge-based and Challenge-response Authentication 6) Biometric Authentication	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO2, CLO3	1) Challenges in Symmetric-key and Public-key Distribution 2) Need for KDC 3) Various Protocols for Creating Session Key 4) Kerberos as a KDC and an authentication protocol. 5) Symmetric-key agreement protocols 6) Need for digital certificates and certification authorities for public key distribution 7) Idea of a Public-Key Infrastructure (PKI)	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO2, CLO3	1) Need for Web Security 2) Available Tools to Achieve Website Security 3) Providing Web Security by SSL and SET Protocols 4) Creating Dual Signature 5) Virtual Private Network and Tunneling	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO3, CLO4	1) What does Access Control Mean? 2) Access Control Mechanisms: 3) Need for a Firewall, its Characteristics and Benefits, Firewall Techniques and Types, Implementing a Firewall 4) IDS Vs. IDPS, Requirement Fulfilled by an IDS, Architecture of an IDS	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation
CLO3, CLO4	1) General Structure of an E-mail Application Program 2) Providing E-mail Security by PGP 3) MIME and S/MMME and their Applications 4) Structure of Messages Exchanged in PGP and S/MIME 5) Architecture of IP Security and its Application	Lecture Discussion Group Assignment Demonstration	Exercise Report Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√			√	√
CLO3	√			√	√
CLO4	√	√			√

Suggested Texts:
- Cryptography and Network Security, 2nd Edition by Behrouz A Forouzan, Publisher: Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2007.
- Cryptography and Network Security, 4th Edition by William Stallings., Publisher: Prentice Hall, New Delhi, 2006.
- Cryptography and Network Security, 2nd Edition by Atul Kahate, Publisher: Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2009.
- Applied Cryptography, 2nd Edition by Bruce Schneier, Publisher: John Wiley & Sons, New York, 1996.
- Mastering Network Security, Bk & Cd-Rom Edition by Chris Brenton, Publisher: BPB Publication, New Delhi, 2002.
- Network Security, 2nd Edition by Steven L Shaffer, Alan R Simon, Publisher: AP Professional, New York, 2001.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand the principal concepts, major issues, technologies and basic approaches in cryptography and Network security.
  - ➢ Gain the basic principles of Network Security and know how it affects our daily life.
  - ➢ Gain an understanding of terms and terminology commonly used in Network Security.
  - ➢ Know how vulnerabilities occur and how to limit them.
  - ➢ Gain a fundamental understanding of what an attack / threat is, and how to identify and prevent them from occurring.
  - ➢ Evaluate tools and technologies for use in protecting the network and individual network systems
- Cognitive skills (thinking and analysis)
  - ➢ Be able to implement security plan and monitor solutions.
  - ➢ Be able to monitor and evaluate audit logs and set administrator alerts.
  - ➢ Be able to respond to any breach of security and adjust organizational security plan accordingly.
- Communication skills (personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations, and giving and receiving clear instructions.
  - ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)

> Be able to demonstrate and apply knowledge of current trends in ICT security, particularly those that relate to security protocols and policy, cryptography, malware, digital forensics, and legal evidence.

ICT 4110: Cryptography and Network Security Lab

Course Objectives:	The objective of this course is to	
	• Develop practical skills in implementing cryptographic techniques.	
	• Explore and assess the security of various cryptographic algorithms.	
	• Emphasize data integrity and authentication using message authentication codes and hash functions.	
	• Understand secure communication through key establishment and digital signatures.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To attain a deep **understanding** of cryptographic principles and their practical application.	**PLO1, PLO2**
	CLO2- To gain expertise in **assessing** the security of cryptographic algorithms.	**PLO2, PLO4**
	CLO3- To **demonstrate** proficiency in ensuring data integrity and authentication.	**PLO4, PLO5**
	CLO4- To **apply** secure communication techniques effectively, including key establishment and digital signatures.	**PLO3, PLO5, PLO8**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Shift Cipher and Mono-Alphabetic Cipher Encryption and Decryption: Explore the encryption and decryption processes of the Mono-Alphabetic Cipher.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Message Authentication Codes with MD5: Implement MD5-based Message Authentication Codes to ensure data integrity and authenticity.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Cryptographic Hash Function Analysis (SHA-256): Study the SHA-256 cryptographic hash function for secure data hashing.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Symmetric Encryption using DES Algorithm: Implement Data Encryption Standard (DES) for symmetric encryption and decryption.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Symmetric Encryption with AES (Advanced Encryption Standard): Explore AES for symmetric encryption, a modern standard in cryptography.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3	Diffie-Hellman Key Establishment Protocol: Implement the Diffie-Hellman protocol for secure key exchange in network communication.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO4	Public-Key Cryptosystems and RSA Encryption: Study RSA encryption as a public-key cryptosystem for secure communication.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Digital Signatures with DSA (Digital Signature Algorithm): Implement the Digital Signature Algorithm (DSA) for message authentication and non-repudiation.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Intended Learning Outcomes:

• Knowledge and understanding
  > Gain a solid knowledge and understanding of cryptographic techniques, algorithms, and their practical application.
  > Comprehend the principles of data integrity, authentication, and secure communication.
• Cognitive skills (thinking and analysis)
  > Develop critical thinking and analytical skills in assessing cryptographic algorithms and security measures.
  > Analyze and evaluate the effectiveness of cryptographic solutions in real-world scenarios.
• Communication skills (personal and academic)
  > Enhance personal and academic communication skills through effective collaboration with peers and instructors during lab activities and discussions.
  > Communicate complex cryptographic concepts and findings clearly and coherently.
• Practical and subject specific skills (transferable skills)
  > Cultivate practical skills in implementing cryptographic techniques and securing network communication.

> ➢ Develop transferable skills, including problem-solving, adaptability, and the ability to apply cryptographic knowledge to various domains beyond the lab environment.

ICT 4111: Computer Network Service and Management

Course Objectives:	The objective of this course is to	
	• Develop expertise in designing, implementing, and managing computer network services, ensuring optimal network performance and reliability. • Acquire knowledge and skills in network security, including threat detection, prevention, and response, to safeguard network infrastructure and data. • Learn to deploy and manage network services and protocols, such as DNS, DHCP, and VPN, to support diverse organizational needs and enhance network functionality. • Gain proficiency in network monitoring, troubleshooting, and performance optimization, enabling efficient network service delivery and maintenance.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** the process of monitor, troubleshoot, and optimize network services, facilitating smooth and efficient network operations.	**PLO1, PLO2**
	CLO2- To **identify** and address network security threats to protect network infrastructure and sensitive data.	**PLO2, PLO4**
	CLO3- To **deploy** and manage essential network services and protocols to support diverse organizational needs and optimize network functionality.	**PLO2, PLO3**
	CLO4- To **design**, implement, and manage computer network services to ensure reliable and efficient network performance.	**PLO3, PLO5, PLO8**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Evolution of the Network Architecture: Internet Design Principles, Key protocols and their evolution, Internet structure, Exchange Points, Economic relationships among stakeholders, Trends in the Evolution of the Network Architecture	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Routing and Inter-Networking: Addressing and Routing, Mobility, New Network Architectures, Routing Algorithms, Classless Inter-domain Routing, Inter-domain Routing, IDR, BGP, IBGP, BGP attributes, Scalability of BGP	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Transport Network (Backbone): Optical Transport Network, IP over SDH, IP over WDM/ASON, IP over WDM/GbEthernet, MPLS, From MPLS to GMPLS, SDN	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	New Network and Transport Protocols: IPv6, IPv4-IPv6 coexistence, Mobile IP, IP Multicast, Other IP protocols (HIP), Multipath TCP, Other Transport protocols (QUIC)	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Resource Management: Quality of Service principles, Quality of Service and Quality of Experience (QoS and QoE), Integrated Services Architecture, Differentiated Services Architecture	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3	5G Network Architecture: 5G Network Characteristics, Key Performance Indicators (KPI), Framework for 5G networks, Core, edge, and access networks, Virtualization technologies (NFV), Software Defined Networks (SDN), Orchestration and management, Slicing.	Lecture Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Suggested text:
- Computer networking: a top-down approach - Kurose, J.F.; Ross, K.W, Addison-Wesley, 2017. ISBN: 9781292153599
- Computer networks - Tanenbaum, A.S.; Feamster, N.; Wetherall, D.J, Pearson , 2021. ISBN: 9781292374062
- Engineering Internet QoS - Jha, S.; Hassan, M, Artech House, 2002. ISBN: 1580533418
- 5G system design: architectural and functional considerations and long term research - Marsch, P. [i 3 més] (eds.), John Wiley & Sons, Inc, 2018. ISBN: 9781119425120

Intended Learning Outcomes:

- Knowledge and understanding
  - Acquire in-depth knowledge and understanding of computer network service design, implementation, and management.
  - Understand the principles of network security and threat detection and prevention.
- Cognitive skills (thinking and analysis)
  - Develop critical thinking and analytical skills to evaluate and optimize network performance.
  - Analyze and assess network security threats and develop strategies for protection.
- Communication skills (personal and academic)
  - Enhance personal and academic communication skills through effective interaction with peers, instructors, and stakeholders regarding network service and security.
- Practical and subject specific skills (transferable skills)
  - Cultivate practical skills in network service deployment, monitoring, and troubleshooting.
  - Develop transferable skills such as problem-solving, adaptability, and the ability to manage network services in diverse organizational settings.

ICT 4112: Computer Network Service and Management Lab

Course Objectives:	The objective of this course is to • Develop practical networking skills in cable making, installation, and configuration. • Enhance proficiency in router, switch, and wireless router management. • Foster an understanding of routing protocols and dynamic routing. • Cultivate the ability to design networks, configure remote access, and implement security measures for effective network service management.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** routing protocols and their practical implementation in real-world network scenarios.	**PLO1, PLO2**
	CLO2- To **demonstrate** proficiency in practical networking skills, including cable making and device installation.	**PLO2**
	CLO3- To **apply** theoretical knowledge to configure and manage network devices such as routers, switches, and wireless routers effectively.	**PLO4, PLO5**
	CLO4- To **design,** configure, and secure network topologies, ensuring efficient network service management.	**PLO3, PLO5, PLO10**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Cable Making and Network Card Installation Learn to create straight-through and crossover cables and install network cards for connectivity.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	TCP/IP Configuration and Star Network Setup Configure TCP/IP protocols and set up a star network using network devices	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Router Configuration and Basic Routing Configure Router 2621 and implement static routing for network management.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Dynamic Routing Protocols Study dynamic routing protocols like RIP and IGRP and configure distance vector routing.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	Introduction to Switch and Administrative Configuration Familiarize with Cisco IOS, apply switch basics, and perform administrative configurations.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3	Wireless Router and MAC Filtering Study the TP-LINK Wireless Router and implement MAC filtering for security.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO4	Introduction to Network Devices and Routing in Packet Tracer/GNS3 Explore routing protocols, simulation tools like Packet Tracer and GNS3	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	Designing Network Topology and Remote Access Configuration Create network topologies and configure TELNET protocols for remote access.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√

CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Intended Learning Outcomes:

- Knowledge and understanding
  - ➢ Gain in-depth knowledge and understanding of network devices, routing protocols, and network configurations.
  - ➢ Comprehend the principles of network security and practical applications in securing network infrastructure.
- Cognitive skills (thinking and analysis)
  - ➢ Develop critical thinking and analytical skills to troubleshoot network issues and optimize network performance.
  - ➢ Analyze routing protocols and design network topologies that align with specific requirements.
- Communication skills (personal and academic)
  - ➢ Enhance personal and academic communication skills by effectively collaborating with peers and instructors during lab activities and discussions.
  - ➢ Communicate network configurations and solutions clearly and concisely.
- Practical and subject specific skills (transferable skills)
  - ➢ Cultivate practical skills in configuring, managing, and troubleshooting network devices, which can be applied in real-world networking roles.
  - ➢ Develop transferable skills such as problem-solving, adaptability, and network design that are relevant beyond the lab environment.

ICT 4113: Big Data Analytics and Application

Course Objectives:	The objective of this course is to • Understand the Big Data Platform and its Use cases. • Provide an overview of Apache Hadoop. • Provide HDFS Concepts and Interfacing with HDFS. • Understand Map Reduce Jobs. • Provide hands on Hadoop Eco System. • Apply analytics on Structured, Unstructured Data. • Exposure to Data Analytics with R.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **identify** Big Data and its Business Implications**.**	**PLO1**
	CLO2- To **list** the components of Hadoop and Hadoop Eco-System.	**PLO1, PLO2**
	CLO3- To **access** and **Process** Data on Distributed File System.	**PLO2, PLO5**
	CLO4- To **manage** Job Execution in Hadoop Environment**.**	**PLO4, PLO5**
	CLO5- To **develop** Big Data Solutions using Hadoop Eco System.	**PLO3**
	CLO6- To **analyze** Infosphere Big Insights Big Data Recommendations.	**PLO2**
	CLO7- To **apply** Machine Learning Techniques using R.	**PLO3, PLO5**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2, CLO4, CLO5	Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analyzing Data with Unix tools, Analyzing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere Big Insights and Big Sheets.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CLO2, CLO3, CLO4, CLO5	The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer MCQ Exercise
CLO2, CLO3, CLO4, CLO5	Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO5, CLO6	Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators.Hive: Hive S hell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase: HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. Big SQL : Introduction	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO7	Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.	Lecture Group Assignment Problem Based Learning (PBL)	Report Exercise Presentation

CLO7	Basic Neural Network and Tensor Flow. Neural Networks and Deep Learning are emerging as the highest precision tools for many large scale classification and pattern recognition problems. We will learn how to use Tensor Flow both on GPU and CPU machines.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√			√	√
CLO3	√			√	√
CLO4	√				√
CLO5	√	√		√	√
CLO6	√			√	√
CLO7	√	√			√

Suggested Texts:

- Big Data Analytics: Systems, Algorithms, Applications, 1st Edition by Prabhu, C.S.R., Sreevallabh Chivukula, A., Mogadala, A., Ghosh, R., Livingston, L.M.J.
- Big Data for Beginners: Understanding SMART Big Data, Data Mining & Data Analytics For improved Business Performance, Life Decisions & More!, 1st Edition by Vince Reynolds.
- A Hands-On Introduction to Data Science, 1st Edition by Chirag Shah.
- Guide to Big data Hadoop Distributed File System A book for beginners/intermediate, 1st Edition by Kartikeya Mishra.
- The Ultimate Guide to Data Analytics, Data Mining, Data Warehousing, Data Visualization, Regression Analysis, Database Querying, Big Data for Business and Machine Learning for Beginners, 1st Edition by Herbert Jones.

Intended Learning Outcomes:

- Knowledge and understanding
  - Understand the basic concepts of big data analysis and its Implications.
  - Identify the components of Hadoop and Hadoop Eco-System.
- Cognitive skills (thinking and analysis)
  - Be able to apply Machine Learning Techniques.
  - Be able to analyze Infosphere Big Insights Big Data Recommendations.
  - Be able to develop Big Data Solutions using Hadoop Eco System.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - Be able to identify the complex and real life problems to solve using the effective understanding of the design and analysis of algorithms
  .

ICT 4114: Big Data Analytics and Application Lab

Course Objectives:	The objective of this course is to
	- Get familiar with Hadoop distributions, configuring Hadoop and performing File management tasks. - Experiment MapReduce in Hadoop frameworks.. - Implement MapReduce programs in variety applications. - Explore MapReduce support for debugging - Understand different approaches for building Hadoop MapReduce programs for real-time applications.

Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **Describe** the key issues in Big Data Management and experiment with the Hadoop framework.	PLO1, PLO2
	CLO2- To **Explain** the structure and unstructured data by using NoSQL commands.	PLO1, PLO2
	CLO3- To **Apply** scientific computing algorithms for finding similar items and clustering.	PLO3, PLO5
	CLO4- To **Test** fundamental enabling techniques and scalable algorithms for data stream mining.	PLO4
	CLO5- To D**evelop** Big Data Solutions using Hadoop Eco System.	PLO3

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO3	Types of Digital Data, Introduction to Big Data, Big Data Analytics, Installation of Hadoop Framework, it's components and study the HADOOP ecosystem., Apache Hadoop, Analyzing Data with Unix tools, Analyzing Data with Hadoop, word count program using MapReduce	Lecture Discussion Problem Based Learning (PBL)	Exercise

CLO2	Install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL Commands	Lecture Discussion Problem Based Learning (PBL)	Exercise
CLO3, CLO4	Implementing simple algorithms in Map-Reduce: Matrix multiplication, DGIM algorithm using any Programming Language/ Implement Bloom Filter using any programming language	Lecture Discussion Problem Based Learning (PBL) Demonstration	Exercise Presentation
CLO4, CLO5	Streaming Data Analysis using flume for data apture, PYSpark / HIVE for data analysis of twitter data, chat data, weblog analysis etc. Clustering algorithm (K-Means/CURE) using Map-Reduce	Lecture Discussion Problem Based Learning (PBL) Demonstration	Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√	√		√
CLO3	√	√	√		√
CLO4	√		√	√	√
CLO5	√		√	√	√

Suggested Texts:
- Big Data Analytics: Systems, Algorithms, Applications, 1st Edition by Prabhu, C.S.R., Sreevallabh Chivukula, A., Mogadala, A., Ghosh, R., Livingston, L.M.J.
- Big Data for Beginners: Understanding SMART Big Data, Data Mining & Data Analytics For improved Business Performance, Life Decisions & More!, 1st Edition by Vince Reynolds.
- A Hands-On Introduction to Data Science, 1st Edition by Chirag Shah.
- Guide to Big data Hadoop Distributed File System A book for beginners/intermediate, 1st Edition by Kartikeya Mishra.
- The Ultimate Guide to Data Analytics, Data Mining, Data Warehousing, Data Visualization, Regression Analysis, Database Querying, Big Data for Business and Machine Learning for Beginners, 1st Edition by Herbert Jones.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the basic concepts of big data analysis and its Implications.
  - Identify the components of Hadoop and Hadoop Eco-System.
- Cognitive skills (thinking and analysis)
  - Be able to apply Machine Learning Techniques.
  - Be able to analyze Infosphere Big Insights Big Data Recommendations.
  - Be able to develop Big Data Solutions using Hadoop Eco System.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - Be able to identify the complex and real-life problems to solve using the effective understanding of the design and analysis of algorithms.

ICT 4115: Human Computer Interaction

Course Objectives:	The objective of this course is to - Develop proficiency in applying interaction design principles and practices. - Acquire skills in effective social interaction and collaboration within interactive systems. - Apply cognitive and affective factors to enhance user experience and product design. - Gain expertise in addressing technological constraints and opportunities in human-computer interaction.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** and apply interaction design principles effectively.	PLO1, PLO2
	CLO2- To **excel** in social interaction and collaboration within interactive systems.	PLO1, PLO10
	CLO3- To **apply** cognitive and affective factors to design user-friendly interactive products.	PLO4, PLO5
	CLO4- To **design** technology and device considerations in human-computer interaction.	PLO3, PLO5

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction to HCI and Interaction Design: Good vs. poor interaction design, Definition of interaction design, Components of interaction design, Forms of guidance in interaction design	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO1, CLO2	Social Interaction and Collaboration: Communication mechanisms in HCI, Collaboration in interactive systems, Types of social mechanisms for collaboration, Theories related to collaborative systems.	Lecture Assignment	Short Answer Discussion
CLO1, CLO2	Understanding Users and Cognitive Factors: Importance of cognition in interaction design, Role of affection in user experience, Application of cognition and affection in design, Examples of effective interactive product design, Mental models and conceptual frameworks	Lecture Assignment	Short Answer Presentation
CLO2, CLO3	Technology and Interaction Design: Various devices in HCI, Technological constraints and opportunities, Conceptualizing interaction, Interface metaphors in design	Lecture Assignment Demonstrate	Short Answer Presentation
CLO3	Web Interfaces and Interaction Design: Paradigms in web interfaces, Types of web interfaces, Design and research issues for web interfaces, Applications and development in interaction design	Lecture Assignment Demonstrate	Short Answer Presentation
CLO3, CLO4	User-Centered Design and Evaluation: Principles of a user-centered approach, Data gathering methods and requirements analysis, Tools for requirements gathering (interviews, predictive techniques), Advantages and disadvantages of analytical evaluation, Usability testing methods in HCI, Role of field studies in evaluation, Inspection methods, Heuristic evaluation for various interactive products, Walkthrough techniques and procedures	Lecture Assignment Demonstrate	Short Answer Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√		√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Suggested Texts:
- Dix A. et al., Human-Computer Interaction. Harlow, England: Prentice Hall, 2004, ISBN-10: 0130461091.
- Yvonne Rogers, Helen Sharp, Jenny Preece, Interaction Design: Beyond Human Computer Interaction, 3rd Edition, Wiley, 2011, ISBN-10: 0470665769.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand cognitive aspects of interaction design.
  - ➢ Understand the design–evaluation–redesign cycles involving users.
- Cognitive skills (thinking and analysis)
  - ➢ Differentiate between good and poor design.
  - ➢ Analyze a system's interface design, before writing any code.
  - ➢ Evaluate the lifecycle of a product using user support and understand it's importance.
- Communication skills (personal and academic)
  - ➢ Develop research skills related to finding and reading current literature on cognitive psychology / sciences, sociology, computing, mobility, etc.
  - ➢ Select a technical paper and summarize it for the class in a brief presentation
- Practical and subject specific skills (Transferable Skills)
  - ➢ Design interfaces for different environments, people, places, and activities.

ICT 4116: Human Computer Interaction Lab

Course Objectives:	The objective of this course is to
	• Foster practical skills in user-centered design and usability testing, equipping students with hands-on experience in enhancing software applications.
	• Cultivate the ability to apply user research to guide the design process effectively and create user-friendly software.
	• Instill knowledge and expertise in addressing accessibility concerns and ensuring software applications comply with web accessibility guidelines, promoting inclusive design.

- Develop proficiency in data-driven decision-making through A/B testing, enabling students to make informed design choices based on user feedback and analysis.

Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **create** and enhance software applications with a strong focus on user-centered design, improving overall user satisfaction.	**PLO3, PLO5**
	CLO2- To **conduct** usability testing and make informed decisions to refine software applications based on user feedback.	**PLO2, PLO4**
	CLO3- To **develop** user personas and intuitive information architectures that guide effective software design.	**PLO3, PLO6**
	CLO4- To **design** accessibility and compliance with web accessibility guidelines, making technology accessible to a wider audience.	**PLO3, PLO5, PLO6**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	UI Enhancement through Redesign Redesign a software application or website to improve user experience.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO2	Usability Testing for Software Conduct usability testing to gather user feedback on software applications.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO1	User Persona Creation for Design Develop user personas to guide effective software application design.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO2, CLO3	Information Architecture for User-Friendly Design Design an intuitive information structure for easy data access.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3	Mobile App Prototyping and Refinement Create and improve mobile app prototypes based on user feedback.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO2, CLO3	Accessibility Testing and Improvements Test for accessibility and propose enhancements for inclusive design.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO2	A/B Testing for Data-Driven Design Analyze user feedback and conduct A/B testing for informed design decisions.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report
CLO3, CLO4	User-Centered App Development Develop a user-friendly software application from scratch with user research and wireframing.	Problem Based Learning (PBL) Group Assignment	Short Answer Practical Exam Report

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Intended Learning Outcomes:

- Knowledge and understanding
  - Acquire a deep understanding of user-centered design principles and the importance of usability in software applications.
- Cognitive skills (thinking and analysis)
  - Develop critical thinking and analytical skills to evaluate software usability and make informed design decisions.
- Communication skills (personal and academic)
  - Enhance personal and academic communication skills through effective interaction with peers, instructors, and users during usability testing and design discussions.
- Practical and subject specific skills (transferable skills)
  - Cultivate practical skills in usability testing, user research, persona development, and accessibility compliance, which are transferable to real-world design and development projects.

ICT 4117: Software verification and Validation

Course Objectives:	The objective of this course is to	
	• Give students an insight about common software engineering processes and software testing practices.	
	• Teach students the impact of software testing requirement and the proper way to analyze from requirement specification.	
	• Facilitate necessary knowledge about basic testing principles to make modular and scalable programs.	
	• 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.	
	• Teach students software verification concepts and how to design testing document from requirements.	
	• Provide the knowledge about testing their software and modern software verification and validation practices	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** the process of software testing.	PLO1
	CLO2- To **differentiate** between the overall role of verification and validation and the specific role of software or system testing.	PLO1, PLO2
	CLO3- To **apply** rigorous software verification approach in SDLC.	PLO2, PLO4
	CLO4- To **analyze** the effectiveness of a V&V plan with respect to its objectives.	PLO3, PLO4
	CLO5- To **analyze** testing requirement from requirement specification.	PLO4, PLO5
	CLO6- To **design** a testing document according to software architecture.	PLO3

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2	Demonstrate the application of verification and validation tasks and their outcomes during the software life cycle.	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO3, CLO4	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.	Lecture Assignment	Short Answer Discussion
CLO5, CLO6	Appraise various research in software verification and validation and provide critical insight as to their content with the class.	Lecture Assignment	Short Answer presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√			√	√
CLO3	√	√			√
CLO4	√				√
CLO5	√	√			√
CLO6	√			√	√

Suggested Texts:
- Marcus S. Fisher, Software Verification and Validation An Engineering and Scientific Approach, 2007th Edition..
- Software Verification and Validation: A Practitioner's Guide, Steven R. Rakitin.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand cognitive aspects of software testing.
  - ➢ Understand the application of verification and validation tasks and their outcomes during the software life cycle.
- Cognitive skills (thinking and analysis)
  - ➢ Apply various verification and validation techniques based on various characteristics of the system/software.
  - ➢ Analyze the effectiveness of a V&V plan with respect to its objectives.
  - ➢ Analyze testing requirement from requirement specification.
- Communication skills (personal and academic)
  - ➢ Develop research skills related to finding and reading current literature on cognitive psychology / sciences, sociology, computing, mobility, etc.
  - ➢ Select a technical paper and summarize it for the class in a brief presentation
- Practical and subject specific skills (Transferable Skills)
  - ➢ Design interfaces for different environments, people, places, and activities.

ICT 4118: Software verification and Validation Lab

Course Objectives:	The objective of this course is to • Give students an insight about common software testing practices. • Facilitate the students with the knowledge about the software testing process that is developed from testing documents. • Teach students tools for software testing. • Help the students to develop a practical test case design and bug reporting environment.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **differentiate** between white box and black box testing of complex software systems.	PLO1, PLO2
	CLO2- To **use** software testing frameworks JUnit, Selenium to test complex Software Systems.	PLO2, PLO3
	CLO3- To **implement** White box and Black box testing.	PLO4, PLO5
	CLO4- To **analyze** the steps for bug reporting process.	PLO5, PLO6
	CLO5- To **design** and develop test cases of different features.	PLO3, PLO11

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2	Demonstrate the application of verification and validation tasks and their outcomes during the software life cycle.	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO3, CLO4	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.	Lecture Assignment	Short Answer Discussion
CLO5	Appraise various research in software verification and validation and provide critical insight as to their content with the class.	Lecture Assignment	Short Answer presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				
CLO2	√		√		√
CLO3	√				√
CLO4	√				√
CLO5	√				√
CLO6			√		√

Suggested Texts:
- Marcus S. Fisher, Software Verification and Validation An Engineering and Scientific Approach, 2007th Edition.
- Software Verification and Validation: A Practitioner's Guide, Steven R. Rakitin.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand cognitive aspects of software testing.
  - ➢ Understand the application of verification and validation tasks and their outcomes during the software life cycle.
- Cognitive skills (thinking and analysis)
  - ➢ Apply various verification and validation techniques based on various characteristics of the system/software.
  - ➢ Analyze the effectiveness of a V&V plan with respect to its objectives.
  - ➢ Analyze testing requirement from requirement specification.
- Communication skills (personal and academic)
  - ➢ Develop research skills related to finding and reading current literature on cognitive psychology / sciences, sociology, computing, mobility, etc.
  - ➢ Select a technical paper and summarize it for the class in a brief presentation
- Practical and subject specific skills (Transferable Skills)
  - ➢ Design interfaces for different environments, people, places, and activities

ICT-4119: Computer Architecture and Microprocessor

Course Objectives:	The objective of this course is to	
	• Gain the fundamental concepts of underlying modern computer organization and architecture. The student will familiarize about hardware design including logic design, basic structure and behavior of the various functional modules of the computer and how they interact to provide the processing needs of the user. The students will also become familiar with the architecture and the instruction set of an Intel microprocessor. Assembly language programming will be studied as well as the design of various types of digital and analog interfaces. Understand the architecture of 8085, 8086, 80286 and 80386.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **describe** the basic design of computer logic, through simple combinational and sequential logic circuits	**PLO1, PLO2**
	CLO2- To **understand** the architecture of widely used microprocessor model like 8086.	**PLO2**
	CLO3- To **analyze** the architecture and instruction set of 80286 and 80386 microcontrollers.	**PLO2, PLO5**
	CLO4- To **design** I/O circuits and memory interfacing circuits.	**PLO3, PLO6**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Design Methodology: Introduction, Combinational circuits, Sequential circuits, the register level, Register-level components, Design method, the processor-level, Processor-level components, Design techniques.	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO1	Arithmetic Logic Unit: Fixed-point arithmetic, Addition, Subtraction, Multiplication and division, Processor Organization, Arithmetic Logic Unit, Design of Arithmetic Circuit, Design of Logic Circuit, Design of Arithmetic Logic Unit.	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO1	Control Design: Basic concepts of control unit, Hardwired control, GCD processor control unit, Multiplier control unit, CPU control unit, Micro-programmed control; Microinstruction.	Lecture Assignment	Short Answer Discussion
CLO1	Memory Organization: Memory devices and characteristics, RAM organization, Serial access memory; Virtual memory, Main-memory allocation, Segments and pages, High speed memories, Cache memory.	Lecture Assignment	Short Answer Discussion
CLO1	Microprocessors: Concept of microprocessor, Evolution of microprocessors.	Lecture Assignment	Short Answer Discussion
CLO2	Internal architecture of Intel 8085,8086/8088 microprocessors: Instruction set and format, Programming in machine assembly language, Interrupt structure, DMA, I/O operation, Microprocessor interface ICs, peripheral interfacing, Microprocessor based system design, Coprocessor, Multiprocessor system.	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO3	Intel 80286, 80386 microprocessors: memory management scheme, Protection mechanism, 80386 modes; Pentium microprocessor; Advanced microprocessors.	Lecture Assignment	Short Answer Discussion
CLO4	Interfacing with analog world: A/D conversion, digital ramp ADC, successive approximation ADC, flush ADC, tristate ADC, D/A converter, DAC specifications, DAC applications, Data acquisition, sample-and hold circuits, multiplexing.	Lecture Assignment	Short Answer Discussion

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√				√
CLO3				√	√
CLO4	√	√			√

Suggested Texts:
- Computer Architecture and Organization, 5th Edition by John P. Hayes.
- Microprocessors and Microcomputer based system Design, 2nd Edition by Md. Rafiquzzaman.
- Microprocessors and System Design, 1st Edition by Gibson & Cheu.
- Microprocessors and Interfacing: Hardware and Software, 1st Edition by D. V. Hall.
- Language Programming Technique in IBM PC, 1st Edition by Alan R. Miller.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the architecture and operation of typical microprocessors and microcontrollers.
  - Understand the programming and interfacing of microprocessors and microcontrollers.

- Cognitive skills (thinking and analysis)
  - Be able to demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor and microcontroller.
  - Be able to compare accepted standards and guidelines to select appropriate Microprocessor (8085 & 8086) and Microcontroller to meet specified performance requirements.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.

ICT-4120: Computer Architecture and Microprocessor Lab

Course Objectives:	The objective of this course is to	
	- Provide understanding of microprocessor, interfaces, interrupts. - Understand details about microprocessor with memory and peripheral chips involving system design. - Describe the concept of 8259A Programmable Interrupt Controller (PIC) and DMA.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** the architecture of widely used microprocessor model like 8086.	PLO1
	CLO2- To **analyze** the architecture and instruction set of 80286 and 80386 microcontroller.	PLO2, PLO5
	CLO3- To **design** I/O circuits and memory interfacing circuits.	PLO3

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Code demonstrating on how 8, 16, 32 and 64-bit values can be used with software code	Demonstration Case studies Lecture	Practical Exam Viva-Voce
CLO2	Lab practice on the use of branching, flags, stacks, procedures, macros, and interrupts.	Problem Based Learning (PBL) Lecture	Practical Exam Viva-Voce
CLO2	Lab practice for the basic arithmetic and logic operations available in assembly language.	Problem Based Learning (PBL) Lecture	Practical Exam Viva-Voce
CLO3	Discuss string operations and demonstrating a variety of string operations including search and search & replace.	Demonstration Case studies Lecture	Practical Exam Viva-Voce
CLO3	Lab practice on using inline assembly language programming within a C++ program and with a standalone assembler, such as MASM or TASM.	Exercise	Completion

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√			√
CLO3	√		√		√

Intended Learning Outcomes:

- Knowledge and understanding
  - Understand the architecture and operation of typical microprocessors and microcontrollers.
  - Understand the programming and interfacing of microprocessors and microcontrollers.
- Cognitive skills (thinking and analysis)
  - Be able to demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor and microcontroller.
  - Be able to compare accepted standards and guidelines to select appropriate Microprocessor (8085 & 8086) and Microcontroller to meet specified performance requirements.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - Be able to analyze assembly language programs, select appropriate assemble into machine a cross assembler utility of a microprocessor and microcontroller.
  - Be able to design electrical circuitry to the Microprocessor I/O ports in order to interface the processor to external devices.

Be able to evaluate assembly language programs and download the machine code that will provide solutions real-world control problems

4th Year 2nd Semester

ICT 4201: Software Project Management

Course Objectives:	The objective of this course is to
	• 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 Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** the process of software testing.	PLO1,
	CLO2- To **identify** an efficient management strategy for a business scenario.	PLO1, PLO2
	CLO3- To **demonstrate** his/her ideas both formally and informally to a group of their peers and the management.	PLO2, PLO4
	CLO4- To **explain** the concepts of various software testing methods & be able to apply appropriate testing approaches for development of software.	PLO4, PLO5
	CLO5- To **implement** communication, modeling, construction & deployment practices in software development.	PLO2, PLO4
	CLO6- To **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.	PLO3, PLO11

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1-CLO6	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.	Lecture Assignment Demonstrate	Short Answer Identification Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√			√	√
CLO3	√			√	√
CLO4	√				√
CLO5	√	√			√
CLO6	√	√			√

Suggested Texts:
• Quality Software Project Management by Linda I. Safer, Donald F. Shafer, Robert T. Futrell.

Intended Learning Outcomes:
• Knowledge and understanding
  ➢ Understand the process of software testing.
  ➢ Understand an efficient management strategy for a business scenario.
• Cognitive skills (thinking and analysis)
  ➢ Implement communication, modeling, construction & deployment practices in software development.
  ➢ 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.
• Communication skills (personal and academic)
  ➢ Develop research skills related to finding and reading current literature on cognitive psychology / sciences, sociology, computing, mobility, etc.
  ➢ Demonstrate his/her ideas both formally and informally to a group of their peers and the management.
• Practical and subject specific skills (Transferable Skills)
  ➢ Design interfaces for different environments, people, places, and activities.

ICT 4202: Software Project Management Lab

Course Objectives:	The objective of this course is to	
	• 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 Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **explain** the quality management process & software metrics used in software development.	**PLO1, PLO2**
	CLO2- To **explain** the concepts of various software testing methods & be able to apply appropriate testing approaches for development of software.	**PLO1, PLO2**
	CLO3- To **implement** communication, modeling, construction & deployment practices in software development.	**PLO2, PLO3**
	CLO4- To **apply** SEI's Capability Maturity Model for project management & planning.	**PLO5, PLO6**
	CLO5- To **analyze & design** the software models using unified modeling language (UML).	**PLO3**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1-CLO5	Implementing the concepts of planning and managing of software development projects by getting involved in an actual project. Experimenting and implementing the different Software Process models, ISO 9000, SEI's Capability Maturity Model, continuous process improvement. Planning, scheduling, tracking, cost estimation, risk management, configuration management.	Lecture Assignment Demonstrate	Short Answer Identification Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√			√
CLO3	√		√		√
CLO4	√				√
CLO5	√		√		√
CLO6	√			√	√

Suggested Texts:
• Quality Software Project Management by Linda I. Safer, Donald F. Shafer, Robert T. Futrell.

Intended Learning Outcomes:
• Knowledge and understanding
  ➢ Understand the process of software testing.
  ➢ Understand an efficient management strategy for a business scenario.
• Cognitive skills (thinking and analysis)
  ➢ Implement communication, modeling, construction & deployment practices in software development.
  ➢ 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.
• Communication skills (personal and academic)
  ➢ Develop research skills related to finding and reading current literature on cognitive psychology / sciences, sociology, computing, mobility, etc.
  ➢ Demonstrate his/her ideas both formally and informally to a group of their peers and the management.
• Practical and subject specific skills (Transferable Skills)
  ➢ Design interfaces for different environments, people, places, and activities.

ICT 4203: Machine Learning

Course Objectives:	The objective of this course is to	
	• Learn supervised and unsupervised learning models.	
	• Learn various types of machine learning algorithm.	
	• Understand the tuning parameters of the algorithms.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **develop** an appreciation for what is involved in learning models from data.	**PLO3**
	CLO2- To **understand** a wide variety of learning algorithms.	**PLO1, PLO2**
	CLO3- To **understand** how to evaluate models generated from data.	**PLO4, PLO5**
	CLO4- To **apply** the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.	**PLO6, PLO9, PLO10**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO3	Introduction: Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation.	Lecture Discussion Problem Based Learning	Essay Type Answer Exercise
CLO1	Inductive Classification: The concept learning task. Concept learning as search through a hypothesis space. General-to-specific ordering of hypotheses. Finding maximally specific hypotheses. Version spaces and the candidate elimination algorithm. Learning conjunctive concepts. The importance of inductive bias.	Lecture Discussion Problem Based Learning	Essay Type Answer MCQ Exercise
CLO1	Decision Tree Learning: Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity. Occam's razor. Overfitting, noisy data, and pruning.	Lecture Discussion Problem Based Learning Demonstration	Essay Type Answer Exercise Presentation
CLO2, CLO4	Ensemble Learning: Using committees of multiple hypotheses. Bagging, boosting and Decorate. Active learning with ensembles. Experimental Evaluation of Learning Algorithms: Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO2, CLO3, CLO4	Computational Learning Theory: Models of learnability: learning in the limit; probably approximately correct (PAC) learning. Sample complexity: quantifying the number of examples needed to PAC learn. Rule Learning: Propositional and First-Order: Translating decision trees into rules. Heuristic rule induction using separate and conquer and information gain. First-order Horn-clause induction (Inductive Logic Programming) and Foil. Learning recursive rules. Inverse resolution, Golem, and Progol.	Lecture Group Assignment Problem Based Learning Demonstration	Report Exercise Presentation
CLO2, CLO4	Artificial Neural Networks: Neurons and biological motivation. Linear threshold units. Perceptron: representational limitation and gradient descent training. Multilayer networks, backpropagation. Hidden layers, constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks. Support Vector Machines: Maximum margin linear separators. Quadratic programming, finding maximum margin separators. Kernels for learning non-linear functions. Bayesian Learning: Probability theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logistic regression. Bayes and Markov nets for representing dependencies.	Lecture Discussion Group Assignment Problem Based Learning Demonstration	Essay Type Answer Report Exercise Presentation
CLO2, CLO4	Instance-Based Learning: Constructing explicit generalizations versus comparing to past specific examples. k-Nearest-neighbor algorithm. Case-based learning. Text Classification: Bag of words representation. Vector space model and cosine similarity. Relevance feedback and Rocchio algorithm. Versions of nearest neighbor and Naive Bayes for text. Clustering and Unsupervised Learning: Learning from unclassified data. Clustering. Hierarchical Agglomerative Clustering. k-means partitional clustering. Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabeled data.	Lecture Group Assignment Demonstration	Essay Type Answer Report Exercise Presentation
CLO2, CLO4	Language Learning: word-sense disambiguation, sequence labeling. Hidden Markov models (HMM's). Viterbi algorithm for determining most-probable state sequences. Forward-backward EM algorithm for training the parameters of HMM's. Use of HMM's for speech recognition, part-of-speech tagging, and information extraction. Conditional random fields (CRF's). Probabilistic context-free grammars (PCFG). Parsing and learning with PCFGs. Lexicalized PCFGs.	Lecture Group Assignment Problem Based Learning Demonstration	Essay Type Answer Report Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Suggested Texts:
- Neural Networks and Fuzzy Logic by Ling S, UTS.
- Introduction to Artificial Neural Systems, 1st Edition by Zurada J.M., Publisher: West Publishing Company.
- Neural Networks for Pattern Recognition, 1st Edition by Bishop C., Publisher: Oxford Univ. Press, 2004.
- Artificial Intelligence, 4th Edition by Stuart Russell, Peter Norvig.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the basic concepts of machine learning algorithm analysis and design.
  - Understand the fundamental steps of designing and optimizing machine learning algorithms.
- Cognitive skills (thinking and analysis)

➢ Be able to understand and analysis any problem and derive its solution.
➢ Be able to design and optimize machine learning algorithms to solve particular complex problems effectively.
- Communication skills (personal and academic)
  ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  ➢ Be able to identify the complex and real life problems to solve using effective understanding of design and analysis of machine learning algorithms.

ICT 4205: Software Documentation and Quality Assurance

Course Objectives:	The objective of this course is to	
	- Introduces major concepts of software documentation. - Give an overview of writing methods and practices that software engineers use to create software documentation. - Explain fundamental SQA considerations and understand the role of testing in SQA. - Gain a solid understanding of state of the art in software testing.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** different forms of software forms of documentation and procedures.	PLO1, PLO2
	CLO2- To **understand** writing methods and practices that software engineers use to create software documentation.	PLO1, PLO2
	CLO3- To **create** documentation such as screen, page design using a standard language.	PLO2, PLO4
	CLO4- To **use** an automated testing tool to write test cases and perform testing.	PLO5
	CLO5- To **perform** inspections, reviews, walkthroughs of code and design of a large software system.	PLO3, PLO4

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2, CLO3	Introduction to software documentation; Task-Orientation Strategies; Principles of Software Documentation; Forms of Software Documentation; Document Preparation/Creation; Designing Tutorials; Analysis Guidelines; Planning and Documentation Process; Documenting Software Architecture.	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO4, CLO5	Basic concepts in software quality assurance; Software testing as a quality assurance technique; Principles of testing, testing process activities, testing standards, and matrices; Functional testing; Model-based testing; Structure based testing; Automated unit testing and test driven development[Refactoring and Regression testing; Integration testing; Testing object oriented applications; Introduction to system testing; Introduction to testing distributed/web applications; Introduction to testing service oriented applications; Code inspection, review techniques, and walkthroughs; Alpha, Beta, and Validation testing.	Lecture Assignment Demonstrate	Short Answer Identification Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√			√	√
CLO3	√	√			√
CLO4	√	√			√
CLO5	√				√

Suggested Texts:
- Thomas T. Barker Writing a Software Documentation: a Task-oriented approach (Pearson Education: 2003).
- Software Testing: A Craftsman's Approach, Fourth Edition, Paul C. Jorgensen, Grand Valley State University, Allendale, Michigan, USA, 2013, ISBN: 978-1466560680, CRC press.

Intended Learning Outcomes:
- Knowledge and understanding
  ➢ Understand different forms of software forms of documentation such tutorials, procedures, and references.
  ➢ Understand fundamental SQA considerations and understand the role of testing in SQA.
- Cognitive skills (thinking and analysis)
  ➢ Design documentation such as screen, page design using a standard language.
  ➢ Perform inspections, reviews, and walkthroughs of code and design of a large software system.
- Communication skills (personal and academic)
  ➢ Develop research skills related to finding and reading current literature on cognitive psychology / sciences, sociology, computing, mobility, etc.
  ➢ Demonstrate his/her ideas both formally and informally to a group of their peers and the management.
- Practical and subject specific skills (Transferable Skills)
  ➢ Design interfaces for different environments, people, places, and activities.

Option – II

ICT 4207: Natural Language Processing

Course Objectives:	The objective of this course is to	
	• Introduce students to the fundamentals of Language Processing and Tokenization.	
	• Show students how to apply many of the basic predictive methods that are common in modern NLP.	
	• Make the students have a practical and hands-on experience with common NLP tools.	
	• Train the students in the basic theory and application of programs used for NLP tasks like NER, POS tagging etc..	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** basic concepts of NLP and its significance in Data analysis.	**PLO1**
	CLO2- To **use** ANN, RNN, CNN for different NLP problems.	**PLO1, PLO2**
	CLO3- To **explain** about the methods to process textual data like tokenization, stop word removal etc.	**PLO2, PLO4**
	CLO4- To **understand** the NLP topics like Document Categorization, Document Summarization.	**PLO4, PLO6**
	CLO5- To **use** word Embedding for document representations.	**PLO3, PLO4**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1-CLO6	**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.	Lecture Assignment Demonstrate	Short Answer Identification Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√			√
CLO3	√				√
CLO4	√	√			√
CLO5	√			√	√

Suggested Texts:
- J. H. Speech and Language Processing, Jurafsky, D. and Martin.
- Foundations of Statistical Natural Language Processing, Manning, C. D. and H. Schütze.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand different basic concepts of NLP.
  - ➢ Understand NLP significance in Data analysis.
- Cognitive skills (thinking and analysis)
  - ➢ Apply deep learning techniques to solve different NLP problems.
  - ➢ Use word Embedding for document representations.
- Communication skills (personal and academic)
  - ➢ Develop research skills related to finding and reading current literature on cognitive psychology / sciences, sociology, computing, mobility, etc.
  - ➢ Demonstrate his/her ideas both formally and informally to a group of their peers and the management.
- Practical and subject specific skills (Transferable Skills)
  - ➢ Design interfaces for different environments, people, places, and activities.

ICT 4209: Parallel and Distributed System

Course Objectives:	The objective of this course is to	
	• Provide an understanding of the principles of parallel and distributed system along with their applications in real world.	
	• Understand their architecture both in software and hardware platform.	
	• Learn challenges that the system faces while implementation.	
	• Learn security and failure handling and finally the importance of consistency and synchronization in distributed system.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**

CLO1- To **distinguish** the features of parallel and distributed system.	PLO1, PLO2
CLO2- To **demonstrate** knowledge of the core architectural aspects of distributed systems, detail learning of the main underlying components of distributed systems (such as RPC, RMC, DCE RMC file systems).	PLO4, PLO5
CLO3- To **use** and **apply** important methods in distributed systems to support scalability and fault tolerance.	PLO3, PLO7

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction: Why use parallel and distributed systems? Why not use them?, Speedup and Amdahl's Law.	Lecture Discussion Problem Based Learning	Essay Type Answer Exercise
CLO2	Hardware and Software architectures: multiprocessors (shared memory), networks of workstations (distributed memory), clusters, threads and shared memory, processes and message passing, distributed shared memory (DSM), distributed shared data (DSD).	Lecture Discussion Problem Based Learning	Essay Type Answer MCQ Exercise
CLO2	Parallel Algorithms: Concurrency and synchronization, Data and work partitioning, Common parallelization strategies, Granularity, Load balancing, Examples: parallel search, parallel sorting, etc.	Lecture Discussion Problem Based Learning Demonstration	Essay Type Answer Exercise Presentation
CLO2	Distributed Systems: System Architecture, Communication, Mid-session Recess, Replication & Consistency, Distributed Shared Memory, Synchronization & Coordination, Middleware, Fault Tolerance, Security, Naming, Distributed File Systems.	Lecture Discussion Problem Based Learning Demonstration	Essay Type Answer Exercise Presentation
CLO2, CLO3	Shared-Memory Programming: Threads, Pthreads, Locks and semaphores. Distributed-Memory Programming: Message Passing, MPI, PVM, Other Parallel Programming Systems: Trademarks: Distributed shared memory.	Lecture Discussion Problem Based Learning Demonstration	Essay Type Answer Exercise Presentation
CLO2, CLO3	System Configurations: Aurora: Scoped behavior and abstract data types, Enterprise: Process templates, Protocols for DSM systems, Impact of network protocols (TCP/IP, UDP/IP, bulk-data transfer, etc.), System area networks (SAN) (e.g., Myrinet).	Lecture Group Assignment Problem Based Learning Demonstration	Report Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√			√
CLO3	√	√			√

Suggested Texts:
- Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, 2nd Edition by B. Wilkinson and M. Allen, Publisher: Prentice Hall.
- Distributed Systems: Principles and Paradigms, 2nd Edition by Andrew S. Tanenbaum & Maarten van Steen, Publisher: Pearson Prentice Hall.
- Distributed Systems: Concepts and Design, 3rd Edition by George Coulouris, Jean Dollimore & Tim Kindberg, Publisher: Addison-Wesley.
- Distributed Operating Systems, Eastern Economy Edition by Pradeep K. Sinha, Publisher: IEEE Press.
- Introduction to Parallel Computing, 2nd Edition by Kumar, Grama, Gupta and Karypis, Publisher: Benjamin Cummings Publishing Co.
- Using MPI: Portable Parallel Programming with the Message-Passing Interface, 3rd Edition by William Gropp, Ewing Lusk, and Anthony Skjellum.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand the basic concepts of distributed and parallel systems.
  - ➢ Understand the fundamental steps of designing and optimizing system.
- Cognitive skills (thinking and analysis)
  - ➢ Be able to understand and analysis any problem and derive its solution.
  - ➢ Be able to design and optimize algorithms to solve particular complex problems effectively.
- Communication skills (personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - ➢ Be able to identify the complex and real life problems to solve using effective understanding of the design and analysis of algorithms.

ICT 4211: Data Mining and Knowledge Discovery

Course Objectives:	The objective of this course is to	
	• Understand about data mining and its importance as well as application of data mining in real life situation.	
	• Understand types of data mining techniques.	
	• How to apply the techniques of clustering, classification, association finding, feature selection and visualization on real world data.	
	• How to set up a data mining process for an application, including data preparation, modelling and evaluation.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **demonstrate** advanced knowledge of data mining concepts and techniques.	**PLO1, PLO2**
	CLO2- To **apply** the techniques of clustering, classification, association finding, feature selection and visualization on real world data and data mining software and toolkits in a range of applications**.**	**PLO3, PLO5**
	CLO3- To **determine** whether a real world problem has a data mining solution.	**PLO4, PLO6**
	CLO4- To **set** up a data mining process for an application, including data preparation, modelling and evaluation.	**PLO2, PLO3, PLO4**

Course Contents:

CLO	**Course Contents**	**Teaching Learning Strategy**	**Assessment Strategy**
CLO1, CLO3	Introduction: Definition of data mining, its application and challenges; Area and types of data mining.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CLO1	Related technologies - Machine Learning, DBMS, Statistics, Data Mining Goals, Stages of the Data Mining Process, Data Mining Techniques, Knowledge, and Representation Methods. Data Warehouse and OLAP: Data Warehouse and DBMS.	Lecture Problem Based Learning (PBL)	Essay Type Answer Exercise
CLO2, CLO4	Data preprocessing: Types of data and data set; Data cleaning, selection, Data transformation, Data reduction, Discretization and linearization.	Lecture Problem Based Learning (PBL) Home work	Report Group Assignment Presentation
CLO2, CLO3	Exploratory analysis: Descriptive statistics; Visualization using Plots and diagrams and OLAP.	Lecture Problem Based Learning (PBL) Assignment	Report Individual Assignment Presentation
CLO2, CLO4	Classification: Types of classification, Hunts algorithms for Decision trees classification. Validating a model.	Lecture Problem Based Learning (PBL)	Report Individual Assignment
CLO2	Clustering: K-means, hierarchical and density-based clustering and pitfalls of these clustering.	Lecture Problem Based Learning (PBL)	Essay Type Answer Individual Assignment
CLO2	Text mining: extracting attributes (keywords), structural approaches (parsing, soft parsing), Bayesian approach in classifying text.	Lecture Problem Based Learning (PBL)	Essay Type Answer
CLO2, CLO3, CLO4	Web mining: classifying web pages, extracting knowledge from the web, Data Mining software and applications.	Lecture Problem Based Learning (PBL)	Essay Type Answer

Assessment Pattern:

CLO	**Continuous Assessment**				**Term Final**
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√

Suggested Texts:
- Introduction to Data Mining, 2nd Edition by Vipin KumarIan H. Witten and Eibe Frank,
- Data Mining: Practical Machine Learning Tools and Techniques, 2nd Edition by Morgan Kaufmann, 2005.
- Data Mining and Data Warehousing, 2nd Edition by Bharat Bhushan Agarwal, Sumit Prakash Tayal, Publisher: Mcgraw Hilll.
- Data Warehousing, Data Mining and OLAP, 1st Edition by Alex Berson and Stephen J. Smith, Publisher: Mcgraw Hill.

Intended Learning Outcomes:

- Knowledge and understanding
  - Understand the data mining and different types of data mining along with their application.
  - Gain knowledge on data processing techniques.
  - Gain clear knowledge on how to validate any mining model.
- Cognitive skills (thinking and analysis)
  - Be able to understand processing and selection of data for any other task.
  - Be able to understand hidden information that exists beneath the descriptive output of data.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - Be able to identify the complex and real life data using effective understanding of the data mining.

ICT 4213: Digital Image Processing

Course Objectives:	The objective of this course is to
	- Study the image fundamentals and mathematical transforms necessary for image processing. - Study the image enhancement techniques. - Study image restoration procedures. - Study the image segmentation and compression procedures. - Gain understanding of algorithm, analytical tools and practical implementations of various digital image applications.

Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **analyze** images in the frequency domain using various transforms and review the fundamental concepts of a digital image processing system.	PLO1, PLO2
	CLO2- To **evaluate** the techniques for image enhancement and image restoration and categorize various compression techniques.	PLO4, PLO5
	CLO3- To **interpret** image compression standards with image segmentation and representation techniques.	PLO4, PLO5

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction: Elements of digital image processing systems, Elements of visual perception, brightness, contrast, hue, saturation, Color image fundamentals - RGB, HSI models, Image sampling, Quantization, dither, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT, KLT, SVD.	Lecture Discussion	Essay Type Answer Exercise
CLO2	Digitization of images and its properties: Sampling, quantization, metric properties, topological properties, histogram, noise.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer MCQ Exercise
CLO2, CLO3	Data structures for image analysis and Image processing: Computer program = data + algorithm, Levels of Image Data Representation, Relational models, Traditional Image Data Structures, Topological Data Structures, Relational Structures, Hierarchical Data Structures, Pyramids.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO3	Segmentation: detection of discontinuities, edge linking and boundary detection, thresholding, region-oriented segmentation, use of motion in segmentation.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO2, CLO3	Image transforms: Z-transform, 2D Fourier transform, discrete cosine transform, Hadamard transform, Walsh transform, Slant transform.	Lecture Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO2	Image compression: run-length coding, transform coding, standards.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√	√	√	√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√

Suggested Texts:

- Digital Image Processing and Analysis: Application with MATLAB and CVIP tools, 3rd Edition by SE Umbaugh, Taylor & Francis, Publisher: CRC Press, 2018.
- Digital Image Processing, 4th Edition by Rafael C. Gonzalez.
- Principles of Digital Image Processing: Advanced Methods, 2013th Edition by Wilhelm Burger, Mark J. Burge.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the basic concepts of image analysis.
  - Students will learn basic image processing theories and their real-world applications.
- Cognitive skills (thinking and analysis)
  - Be able to understand and analysis any image.
  - Be able to design and conduct digital imaging experiments.
  - Be able to analyze and interpret image and video data.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - Be able to identify the complex image patterns to be used for machine learning.

ICT 4215: Digital Healthcare and Informatics

Course Objectives:	The objective of this course is to	
	- Introduce students to the problems and challenges that health informatics addresses. - Introduce students to the research and practices of health Informatics. - Provide all students with basic skills and knowledge in health Informatics to apply in their future health related careers. - Lead students in discussion around ethical and Diversity issues in health Informatics.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** problems and challenges that health informatics addresses.	**PLO1, PLO2**
	CLO2- To **identify** current health informatics application challenges and opportunities and determine possible solutions.	**PLO3, PLO4**
	CLO3- To **evaluate** the issues of privacy and security in terms of social, ethical and policy decisions in health informatics practice.	**PLO6, PLO8**
	CLO4- To **apply** basic knowledge to the research and practice of health informatics.	**PLO3, PLO11**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1-CLO4	Overview of Health Informatics; Electronic Health Records; Standards and Interoperability; Health Information Exchange; Healthcare Analytics; Clinical Decision Support and Consumer Health Informatics; Bioinformatics; Privacy, Security, and Ethics	Lecture Assignment Demonstrate	Short Answer Identification Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√			√
CLO3	√	√			√
CLO4	√			√	√

Suggested Texts:
- Hersh, W., & Hoyt, R. (2018). Health informatics: A practical guide (7th ed.). Lulu Press.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand problems and challenges that health informatics addresses.
  - Explores issues in health care informatics.
- Cognitive skills (thinking and analysis)
  - Evaluate the privacy and security issues of health informatics.
  - Use knowledge to the practice of health informatics.
- Communication skills (personal and academic)
  - Develop research skills related to finding and reading current literature on cognitive psychology / sciences, sociology, computing, mobility, etc.
  - Demonstrate his/her ideas both formally and informally to a group of their peers and the management.
- Practical and subject specific skills (Transferable Skills)
  - Design interfaces for different environments, people, places, and activities.

ICT 4217: Simulation and Optimization Technique

Course Objectives:	The objective of this course is to
	• Understand the role of a database management system in an organization.
	• Understand basic database concepts, including the structure and operation of the relational data model.
	• Construct simple and moderately advanced database queries using Structured Query Language (SQL).
	• Understand and successfully apply logical database design principles, including E-R diagrams and database normalization.
	• Design and implement a small database project using Microsoft Access.
	• Understand the concept of a database transaction and related database facilities, including concurrency control, journaling, backup and recovery and data object locking and protocols.
	• Describe and discuss selected advanced database topics, such as distributed database systems and the data warehouse.
	• Understand the role of the database administrator.

Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **differentiate** database systems from file systems by enumerating the features provided by database systems and describe each in both function and benefit.	**PLO1, PLO2**
	CLO2- To **define** the terminology, features, classifications, and characteristics embodied in database systems.	**PLO1, PLO2**
	CLO3- To **analyze** an information storage problem and derive an information model expressed in the form of an entity relation diagram.	**PLO2, PLO4**
	CLO4- To **demonstrate** an understanding of the relational data model.	**PLO2, PLO5**
	CLO5- To **transform** an information model into a relational database schema and to **use** a data definition language and/or utilities to implement the schema using a DBMS.	**PLO2,**
	CLO6- To **formulate**, using relational algebra, solutions to a broad range of query problems.	**PLO3**
	CLO7- To **formulate**, using SQL, solutions to a broad range of query and data update problems.	**PLO3**
	CLO8- To **demonstrate** an understanding of normalization theory and apply such knowledge to the normalization of a database.	**PLO3, PLO4**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2, CLO4, CLO5	**Linear Resistive Circuit Analysis:** Nodal Analysis, Automatic Equation Formulation, Modified Nodal Analysis, Solution of a System of Linear Algebraic Equations, Sparsity and the Optimal Ordering of Circuit Equations	Lecture Discussion	Essay Type Answer MCQ
CLO4	Analysis Using Transforms: The Laplace Transform and Its Applications	Lecture Discussion	Essay Type Answer Exercise
CLO3, CLO4	**The Method of Moments:** The Monte Carlo Method, Tolerance Design	Lecture Discussion Assignment	Exercise Report
CLO4, CLO5	**Electronic Circuit Optimization**: Basic Terms and Definitions, Newton's Method, Application of Newton's Method, DC Operating Point Design	Lecture Discussion	Essay Type Answer Exercise
CLO4, CLO5	**Nonlinear DC Analysis**: Two-Terminal Companion Model, Equation Formulation, Nonlinear Circuit Analysis Algorithm, Other Nonlinear Elements, Convergence Aspects of Nonlinear DC Analysis, DC Analysis of Electronic Circuits	Lecture Assignment Demonstration	Exercise Report
CLO5, CLO8	**Transient Analysis of Electronic Circuits:** Statement of the Problem, The Backward Euler Formula and Its Application, Application of the Backward Euler Formula, Analysis of Nonlinear Dynamic Circuits, Accuracy, Stability, and Stiffness, Multistep Integration Formulae, Implementation Considerations, Some Specific Applications, Device Modeling	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Exercise Report

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√	√		√
CLO2	√	√	√		√
CLO3	√	√	√		√
CLO4	√	√	√		√
CLO5	√	√	√		√
CLO6	√	√	√		√
CLO7	√	√	√	√	√
CLO8	√	√	√		√

Suggested Texts:
• Database Systems Concepts, 7th Edition by A. Silberschatz, H. Korth and S. Sudarshan, Publisher: McGraw Hill.

- Fundamentals of Database Systems, 7th Edition by Ramez Elmasri.
- An Introduction to Database Systems, 7th Edition by C. J. Date.
- An Introduction to Database Systems, 3rd Edition by R. Ramakrishnan and J. Gehrke.

Intended Learning Outcomes:
- Knowledge and understanding
  - Students will have a broad understanding of database concepts and database management system.
  - Students will be able to model an application's data requirements using conceptual modeling tools like ER diagrams and design database schemas based on the conceptual model.
- Cognitive skills (thinking and analysis)
  - Students will be able to analyze problems, identify and define the computing requirements appropriate to its solution.
  - Students will be able to conceptualize data using different data models.
- Communication skills (personal and academic)
  - Through different individual and group assignments provided to the students, they would be able to understand the technical requirements of a particular informational problem.
- Practical and subject specific skills (transferable skills)
  - Be able to identify the simple and complex database related problems to solve using the effective understanding of the database management systems.

ICT 4219: Wireless and Cellular Networks

Course Objectives:	The objective of this course is to • Build an understanding of the fundamental concepts of cellular network. • Familiarize the student with the basic taxonomy and terminology of the wireless networking. • Introduce the student to advanced networking concepts, preparing the student for entry Advanced courses in computer networking. • Gain expertise in some specific areas of networking such as the design and maintenance of individual networks.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **design** and **analyze** WLAN, home RF and WSN for an educational/research institute or office.	**PLO2, PLO3**
	CLO2- To **implement** MANET or WSN in any emergency situation (lack of infrastructure) and learn features of 5G mobile communications.	**PLO3, PLO9**
	CLO3- To **understand** protocol and access technique 4G network and able to analyze the built in functions of MATLAB-18 for LTE to simulate, such network to measure the performance under fading channel.	**PLO4, PLO5, PLO6**
	CLO4- To **understand** designing and optimization of cellular network.	**PLO7, PLO9**

Course Contents:

CLO	*Course Contents*	Teaching Learning Strategy	Assessment Strategy
CLO1	Classification of wireless network: Home RF and Bluetooth, IEEE 802.11 family, protocol stack of IEEE 802.11, frame format of Wi-Fi, CSMA/CA of MAC sublayer, binary exponential backoff algorithm and flow chart	Lecture Assignment	Short Answer Exercise
CLO1, CLO2	Mobile ad-hoc network (MANET): Destination-Sequenced Distance Vector (DSDV) protocol, Cluster-Head Gateway Switch Routing Protocol, Wireless Sensor Network (WSN), Sensor Node Structure, LEACH and DEEP Clustering Protocol	Lecture Assignment Demonstrate	Essay Type Answer Short Answer Identification Exercise
CLO1	Wide Area Network: concept of cell and cell cluster, co-site, adjacent channel and co-channel interferences of WAN, handover and roaming, channel allocation scheme	Lecture Assignment	Essay Type Answer Short Answer Discussion
CLO4	Advanced Mobile Communication: Vision of IMT 2000, principle of CDMA/WCDMA, architecture of 3G mobile (UMTS) communication, satellite based mobile communications	Lecture Assignment	Essay Type Answer Short Answer Report Presentation
CLO1, CLO4	WiMAX: Development of IEEE 802.16, adaptive modulation and channel coding of WiMAX, BW allocation algorithms, Wi-Fi and WiMAX integrated network, 802.16 Protocol Stack, a security sublayer, MAC common part sublayer and Service Specific Convergence Sub-layer, TDD and FDD operation	Lecture Assignment	Essay Type Answer Short Answer Exercise Report Presentation
CLO3, CLO4	4G Technology: Development of 4G long-term evolution (LTE), femtocell deployment , OFDMA-based physical layer access and MIMO of LTE, architecture of LTE, LTE frame structure and RB	Lecture Assignment	Essay Type Answer Short Answer Exercise Report Presentation

| CLO1, CLO4 | 5G Wireless Systems:
Cognitive radio network, cooperative spectrum sensing, objectives of 5G mobile communication, activities of METIS, 5G Challenges,Massive MIMO, D2D and M2M communications, Moving Networks and Ultra-dense Networks of 5G. | Lecture
Assignment | Short Answer
Exercise
Report
Presentation |

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√			√
CLO3	√	√			√
CLO4	√	√			√

Suggested Texts:
- Wireless communication, 2nd Edition by Rappaport.
- Wireless & Mobile Network Architectures, 1st Edition by Yi bing Lin.
- An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications, 2nd Edition by Christopher Cox.
- Computer and Communication Networks, 2nd Edition by Nader F. Mir.
- 5G Wireless Systems: Simulation and Evaluation Techniques (Wireless Networks), 1st Edition by Yang Yang, Jing Xu, Guang Shi, Cheng-Xiang Wang.
- Cognitive Radio Communications and Networks, 1st Edition by Alexander M. Wyglinski, Maziar Nekovee, Y. Thomas Hou.
- Wireless Communications, 1st Edition by Andrea Goldsmith
- Wireless and Mobile Network Architecture, Wiley Student Edition by Yi-Bing Lin and Imrich chlamtac.
- Wireless Communication and Networks, 2nd Edition by William Stallings.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand and apply knowledge of mathematics, science and engineering.
  - Understand and design a system, component or process to meet desired needs within realistic constraints.
- Cognitive skills (thinking and analysis)
  - Keep himself updated on latest wireless technologies and trends in the communication field.
  - Be able to describe and explain radio standards and communication protocols on the link and networking layers for wireless personal area networks and inter-working with wireless local area networks and cellular networks.
  - Understand the transmission of voice and data through various networks.
  - Be familiar with architectures, functions and performance of wireless sensor networks systems and platforms.
- Communication skills (personal and academic)

  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.

ICT 4221: Embedded System Design

Course Objectives:	The objective of this course is to • Discuss the major components that constitute an embedded system. • Implement small programs to solve well-defined problems on an embedded platform. • Develop familiarity with tools used to develop in an embedded environment.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** what is a microcontroller, microcomputer and embedded system.	PLO1
	CLO2- To **understand** different components of a micro-controller and their interactions.	PLO1, PLO5
	CLO3- To **become** familiar with programming environment used to develop embedded systems.	PLO3, PLO5
	CLO4- To **understand** key concepts of embedded systems, like IO, timers, interrupts, interaction with peripheral devices.	PLO1, PLO5
	CLO5- To **learn** debugging techniques for an embedded system.	PLO4, PLO7

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO3, CLO5	Introduction: Embedded Systems Overview, Design Challenge, Processor Technology, IC Technology, Design Technology, Trade-Offs.	Lecture Assignment	Short Answer Exercise

CLO2	Custom Single Purpose Processors: Combinational Logic; Sequential Logic; Custom Single Purpose Processor Design; Rt-Level Custom Single Purpose Processor Design; Optimizing Custom Single Purpose Processors.	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO1, CLO2	General Purpose Processors: Basic Architecture; Operation; Programmer's View; Development Environment; ASIPs; Selecting a Microprocessor; General Purpose Processor Design.	Lecture Assignment	Short Answer Discussion
CLO1, CLO2	Standard Single-Purpose Processors: Timers, counters And Watchdog Timer; UART; Pulse Width Modulators; LCD Controllers; Keypad Controllers; Stepper Motor Controllers; Analog to Digital Converters; Real Time Clock.	Lecture Assignment	Short Answer Presentation
CLO2, CLO3, CLO4	Memory: Memory Write Ability and Storage Permanence; Common Memory Types; Composing Memory; Memory Hierarchy and Cache; Advanced RAM.	Lecture Assignment	Short Answer Presentation
CLO2, CLO3, CLO4	Interfacing: Communication Basics; Microprocessor Interfacing: I/O Addressing; Microprocessor Interfacing: Interrupts; Microprocessor Interfacing: Direct Memory Access; Arbitration; Multilevel Bus Architecture; Advance Communication Principles; Serial Protocols; Parallel Protocols; Wireless Protocols.	Lecture Assignment	Short Answer Presentation
CLO2, CLO3, CLO4	Introduction To Real Time Operating Systems: Tasks and Task States; Tasks and Data; Semaphores and Shared Data.	Lecture Assignment	Short Answer Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√	√	√	√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√
CLO4	√	√	√	√	√
CLO5	√	√	√	√	√

Suggested Texts:
- Embedded Systems: A Contemporary Design Tool, 2nd Edition by Peckol, James, Publisher: John Wiley and Sons, 2008.
- Analog Interfacing to Embedded Microprocessor Systems, 2nd Edition by Ball, Stuart, Newnes, 2004.
- Embedded System Design, A Unified Hardware/Software Introduction, Student Edition by Frank Vahid, Tony Givargis, Publisher: John Wiley, 2006 reprint.
- An Embedded Software Primer, 1st Edition by David .E. Simon, Fourth Impression 2007, Publisher: Pearson Education.
- Computers as Components: Principles of Embedded Computing System Design, 3rd Edition by Morgan Kaufmann, Marilyn Wolf, 2012.

Intended Learning Outcomes:
- *Knowledge and understanding*
  - Understand fundamental of a microcontroller, microcomputer and embedded system.
  - Become familiar with different components of a micro-controller and their interactions.
  - Become familiar with programming environment used to develop embedded systems.
  - Learn how to design an embedded system using microelectronics devices.
  - Learn the debugging techniques for an embedded system.
  - Understand key concepts of embedded systems like IO, timers, interrupts, interaction with peripheral devices.
- *Cognitive skills (thinking and analysis)*
  - Be able to understand importance of embedded systems, differences between microcontrollers and microprocessor, hardware platforms and peripherals.
  - Students will be able to use different software for embedded system design.
  - Students will be able to explain the architecture of various controllers, the pin diagram and internal structure of input/output devices, RAM organization and working registers.
  - Students will be able to complete small project on embedded system.
- Communication skills (personal and academic)
  - Individual assignments including demonstration and presentation involve receiving clear instructions, designing and making an effective presentation.
  - A term project (group work) - where students will be assessed in terms of their effectiveness as an individual or leader in the team.
- Practical and subject specific skills (transferable skills)
  - Be able to apply various methods for designing new digital signal processing systems and for continued learning.

ICT 4223: Research Methodology

Course Objectives:	The objective of this course is to • Understand research terminology. • Be aware of the ethical principles of research, ethical challenges and approval processes. • Describe quantitative, qualitative and mixed methods approaches to research. • Identify the components of a literature review process. • Critically analyze published research.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** a general definition of research design.	PLO1
	CLO2- To **know** why educational research is undertaken and the audiences that profit from research studies.	PLO2, PLO9
	CLO3- To **identify** the overall process of designing a research study from its inception to its report.	PLO10, PLO11
	CLO4- To **get** familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research and know the primary characteristics of quantitative research and qualitative research and more.	PLO8, PLO11

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1, CLO2, CLO3	Study design: cross-sectional, case-control, cohort, and intervention studies. Measures of disease frequency and risk and alternative sources of epidemiological data. Interpretation of epidemiological and statistical concepts as causality, random errors, bias, confounding.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation
CLO1, CLO2, CLO3	Describing univariate and bivariate data: tables and graphs; proportions; measures of central tendency (mean, median) and variability (range, standard deviation, percentiles); correlation coefficients, differences and ratios.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration Demonstrate	Essay Type Answer Report Exercise Presentation
CLO1, CLO2, CLO3	Statistical inference: confidence intervals and p-values, hypotheses tests. Simple and multiple linear and logistic regression analysis. Statistical analyses using software SPSS.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation
CLO4	Qualitative research methods: observational method, interviews, focus group discussions, participatory methods. Measures of illness perceptions and experiences; participant accounts of everyday life. Describing the data collection process; sampling principles; the role of gatekeepers; the interactions between researcher and researched; the links between theory and method Qualitative data analysis, validity and triangulation in qualitative research.	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√		√	√
CLO2	√	√		√	√
CLO3	√	√		√	√
CLO4	√	√		√	√

Suggested Texts:
- Basic epidemiology, 2nd Edition by Bonita, Ruth; Beaglehole, Robert, Kjellström, Tord, Geneva, WHO.
- Health research methodology: a guide for training in research methods, 2nd Edition by Manila, WHO.
- Principles of biostatistics, 2nd Edition by Pagano, Marcello, Gauvreau, Kimberlee, Pacific Grove.
- Qualitative methods for health research, 2nd Edition by Judith M. Green and Nicki Thorogoo.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand a general definition of research design.
  - Familiarize with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.
  - Learn the primary characteristics of quantitative research and qualitative research.
  - Familiarize with how to write a good introduction to an educational research study and the components that comprise such an introduction.
  - Define the meaning of a variable and be able to identify independent, dependent and mediating variables.
  - Define theory use in quantitative research.
  - Define a central phenomenon in qualitative research.
  - Learn the steps in the process of quantitative data collection.
  - Learn the various types of quantitative sampling and find which one presents the most rigorous approach to use.

- ➢ Learn the types of descriptive statistics typically reported in educational research studies.
- ➢ Learn how to conduct a statistical test of a hypothesis and which criteria for selecting appropriate statistical test.
- ➢ Learn the various types of validity strategies typically used in good qualitative research.
- ➢ Learn the conventions with good APA style for scholarly writing.
- Cognitive skills (thinking and analysis)
  - ➢ Understand why educational research is undertaken and find the audiences that profit from research studies.
  - ➢ Identify the overall process of designing a research study from its inception to its report.
  - ➢ Identify a research problem stated in a study.
  - ➢ Learn about conducting a literature review for a scholarly educational study.
  - ➢ Distinguish a purpose statement, a research question or hypothesis and a research objective.
  - ➢ Distinguish between categorical and continuous measures.
  - ➢ Distinguish between a population and a sample.
  - ➢ Know various types of quantitative sampling and find which one presents the most rigorous approach to use.
  - ➢ Understand the link between quantitative research questions and data collection and how research questions are operationalized in educational practice.
  - ➢ Distinguish between the writing structure used for a quantitative study and for a qualitative study.
  - ➢ Learn how to evaluate a quantitative study and a qualitative study.
    .
- Communication skills (personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective research reports using proper writing structure and making effective presentations.
- Practical and subject specific skills (transferable skills)
  - ➢ Design a good quantitative purpose statement and good quantitative research questions and hypotheses.
  - ➢ Design a good qualitative purpose statement and a good central question in qualitative research.
  - ➢ Write scholarly report using proper writing convention.

ICT 4225: Digital Forensic

Course Objectives:	The objective of this course is to	
	- Emphasize the importance of digital forensics. - Prepare students to conduct a digital investigation in an organized and systematic way. - Provide theoretical and practical knowledge as well as current research on Digital Forensics.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **Describe** digital forensics and **relate** it to an investigative process.	**PLO1, PLO4**
	CLO2- To **Explain** the legal issues of preparing for and performing digital forensic analysis based on the investigator's position and duty.	**PLO8**
	CLO3- To **Demonstrate** use of digital forensics tools and perform basic digital forensics.	**PLO2, PLO3**
	CLO4- To **Guide** a digital forensics exercise and **recognize** the state of the practice and the gaps in technology, policy, and legal issues.	**PLO3, PLO5, PLO8**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction to Computer Forensics: Understanding the need for computer forensics, Defining computer forensic.	Lecture, Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CLO1, CLO4	Computer Hardware: Understanding computer components, Digital Media, Hard disk basics Files and File Systems: Windows file systems, - FAT32 - NTFS - Forensic file images	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer MCQ Exercise
CLO2, CLO4	Forensic Tools: Forensic hardware, Hardware write/blockers, Hard drive acquisitions, Processing the scene. Forensic Software: Overview of different software packages, EnCase Introduction.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO2, CLO3	Bookmarking and Searching: Creating basic search queries, Hex, Decimal, and Binary - ASCII - Unicode GREP: Understanding GREP, Building Regular Expressions, Creating GREP keywords, Viewing and managing keywords and cases	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO2, CLO3, CLO4	Forensic Reports: Creating a forensic report, Proper report writing, and Explaining forensics to the uneducated. Email Analysis: Viewing e-mail, Webmail, POP, IMAP.	Lecture Group Assignment Problem Based Learning (PBL)	Report Exercise Presentation

	File Signature Analysis: File signatures, File extensions, Differences between, Identifying differences. Hash Analysis: Understanding hash algorithms, Hashing files, Hash libraries.	Demonstration	
CLO4	Other Windows Artifacts: Common windows artifacts, recycle bin, My Documents, Recent files, Installed programs, Windows XP vs. Windows 7.	Lecture Discussion Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1		√			√
CLO2	√				√
CLO3	√				√
CLO4	√			√	√

Suggested Texts:
- Practical Mobile Forensics, 4th Edition by Rohit Tamma, Oleg Skulkin, Heather Mahalik, Satish Bommisetty, 2020.
- Digital Forensics and Incident Response, 2nd Edition by Gerard Johansen, 2020.
- Cyber Security, 1st Edition by Jocelyn O. Padallan, 2019.
- File System Forensic Analysis, 1st Edition by Brian Carrier.
- Handbook of Digital Forensics and Investigation, 1st Edition by Eoghan Casey.

Intended Learning Outcomes:
- Knowledge and understanding
  - Digital Forensics methodology with a solid understanding of requirements for handling digital evidence.
  - Requirements and impact on maintaining evidence integrity and chain of custody.
  - Principles, procedures, and the basic concepts of forensic standards and best practices, e.g. forensic tool testing.
  - The overall process for establishment and maintenance of a digital forensic lab environment.
  - The role of expert witnesses and digital evidence in the context of legal proceedings.
  - The role of policies, standards and guidelines for controls and is capable of applying his/her knowledge in case studies.
- Cognitive skills (personal and academic)
  - Forensic acquisition of digital evidence from computer and network media.
  - Live system forensics and evaluation of order of volatility.
  - Evidence analysis with timeline analysis and forensic reconstruction.
  - Scientific documentation of forensic acquisition and analysis.
  - Applying forensic principles on practical case-studies.
  - Performing stakeholder analysis, risk assessment and forensic triage on limited case-studies.
  - Evaluating the applicability of forensic methods and tools for various controls given a certain scope and policy for the control.
- Communication skills (personal and academic)
  - Capability of analyzing business, legal, ethical and case-specific requirements for planning and conducting a digital forensics investigation.
  - Understanding of forensic analysis and incident response processes.
  - Working independently and familiarity with digital forensics terminology.
  - Capability of discussing professional problems such as documentation, decision making processes, implementation plans, operations, reviews and corrective actions, with forensic experts, IT specialists and general managers.
  - Learning skills to continue acquiring new knowledge and skills in a largely self-directed manner.
  - Ability to contribute to innovative thinking and innovation processes.

ICT 4227: Optical Fiber Communication

Course Objectives:	The objective of this course is to • Analyze the operation of LEDs, laser diodes, and PIN photo detectors (spectral properties, bandwidth, and circuits) and apply in optical systems. • Explain the principles of compare and contrast single- and multi-mode optical fiber characteristics. • Analyze and design optical communication and fiber optic sensor systems. • Locate, read and discuss current technical literature dealing with optical fiber systems.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** the components of fiber optic communication.	**PLO1**
	CLO2- To **analyze** signal degradation and loss measurement.	**PLO2, PLO4**
	CLO3- To **evaluate** the performance of optical network.	**PLO4, PLO5**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction to Optical Fibers: Evolution of fiber optic system, Element of an Optical Fiber Transmission link, Total internal reflection, Acceptance angle, Numerical aperture, Skew rays, Ray Optics, Optical Fiber Modes and Configurations , Mode theory of Circular Wave guides, Overview of Modes-Key Modal concepts, Linearly Polarized Modes, Single Mode Fibers-Graded Index fiber structure.	Lecture Assignment	Short Answer Exercise
CLO2	Signal Degradation of Optical Fibers: Attenuation – Absorption losses, Scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in Optical Wave guides-Information Capacity determination -Group Delay-Material Dispersion, Wave guide Dispersion, Signal distortion in SM fibers-Polarization, Mode dispersion, Intermodal dispersion, Pulse Broadening in GI fibers-Mode Coupling -Design Optimization of SM fibers-RI profile and cut-off wavelength.	Lecture Assignment Demonstrate	Short Answer Problem Solving Exercise
CLO1, CLO3	Fiber Optical Sources and Coupling: Direct and indirect Band gap materials-LED structures -Light source materials - Quantum efficiency and LED power, Modulation of a LED, lasers Diodes-Modes and Threshold condition -Rate equations -External Quantum efficiency -Resonant frequencies -Laser Diodes, Temperature effects, Introduction to Quantum laser, Fiber amplifiers- Power Launching and coupling, Lencing schemes, Fiber -to- Fiber joints, Fiber splicing-Signal to Noise ratio , Detector response time.	Lecture Assignment	Short Answer Case study Discussion
CLO1	Principles of Fiber Optics Communications Analog & Digital Transmission, Digital Coding, Electrical & Optical Bandwidth, Dispersion Effects , Bandwidth and Data Rate Dynamic Range , Noise and Bit Error Rate, optical modulation	Lecture Assignment	Short Answer Presentation
CLO1, CLO3	Fiber Optic Receiver and Measurement: Fundamental receiver operation, Pre amplifiers, Error source, Receiver Configuration, Probability of Error, Quantum limit. Fiber Attenuation measurements Dispersion measurements, Fiber Refractive index profile measurements, Fiber cut-off Wave length Measurements, Fiber Numerical Aperture Measurements, Fiber diameter measurements.	Lecture Assignment	Short Answer Assignment MCQ
CLO1, CLO3	Optical Networks and System Transmission Basic Networks – SONET / SDH – Broadcast and select WDM Networks, Wavelength Routed Networks, Nonlinear effects on Network performance, Link Power budget, Rise time budget, Noise Effects on System Performance-Operational Principles of WDM Performance of WDM and EDFA, system Solutions, Optical CDMA, Ultra High Capacity Networks.	Lecture Assignment Project	Short Answer Group Exercise MCQ

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√			√
CLO2	√	√	√	√	√
CLO3	√	√	√	√	√

Suggested Texts:
- Understanding Fiber Optics, 4th Edition by Jeff Hecht, Publisher: Prentice Hall, 2003.
- Introduction to Optical Fiber Communication Systems, 1st Edition by William B. Jones. Jr., Holt, Publisher: Rinheart and Winston, Inc. 1988.
- Optical Fiber Communication, 2nd Edition by Gerd Keiser, Publisher: McGraw Hill, 1991.
- Optical Fiber Communications – Principles and Practice, 2nd Edition by John M. Senior, Publisher: Prentice Hall, 1992.
- Fiber Optic Communication, 4th Edition by Palaise.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand the basic of optical communications.
  - ➢ Understand signal degradation, optical fiber modes, receiver operation and measurement.
  - ➢ Understand the protocol techniques and operation principle of optical network.
- Cognitive skills (thinking and analysis)
  - ➢ Be able to apply the skills within fiber optic communications and optical networks.
  - ➢ Be able to apply network algorithm in practice.
- Communication skills (personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.

ICT 4229: Microwave Engineering and Satellite Communication

Course Objectives:	The objective of this course is to
	• Introduce about RF/microwave research and construction techniques.
	• Use passive device, active device, and two-port network signal transmission in microwave subsystems.
	• Design protocols as well as strategies for evaluating system results.
	• Explain the link design and link carrier-to-noise ratio performance factor.
	• Discuss about basic satellite terminology, provide students with a solid foundation in orbital dynamics and/satellite launches, enlighten students on various access networks and earth station developments,
	• Introduce students to global positioning system and data packets.

Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **State** the basic concept of microwaves, microwave measurements, Microwave link, Microwave antenna, Radar.	**PLO2**
	CLO2- To **Describe** the construction, working principle, applications of basic microwave components and devices, and Time Domain Reflectrometry (TDR) Systems.	**PLO2, PLO3**
	CLO3- To **Explain** the working principle and applications of microwave tubes amplifier and oscillators.	**PLO2, PLO5**
	CLO4- To Analyze and **deign** basic microwave amplifiers, RF filters, RF oscillator, and mixer models.	**PLO2, PLO3**
	CLO5- To **Understand** satellite terminology, provide foundation in orbital dynamics and/satellite launches, enlighten students on various access networks and earth station developments.	**PLO4, PLO12**
	CLO6- To **evaluate** the link design and performance of the microwave/satellite communication systems.	**PLO11**

Course Contents:

CLO	**Course Contents**	**Teaching Learning Strategy**	**Assessment Strategy**
CLO1	An introduction to microwave engineering, Transmission lines as circuit elements, Smith chart analysis methods.	Lecture Assignment	Short Answer Exercise
CLO2	Impedance transforming and matching circuits, Line and waveguide structures and associated components, Power waves and the network scattering matrix	Lecture Assignment	Short Answer Exercise
CLO3, CLO4	Passive devices, Two-port network signal transmission Active devices, Communication link design	Lecture Assignment Case Study Group Discussion	Short Answer Exercise MCQ
CLO5	Communication Satellite: Orbit and Description: A Brief history of satellite Communication, Satellite Frequency Bands, Satellite Systems, Applications, Orbital Period and Velocity, effects of Orbital Inclination, Azimuth and Elevation, Coverage angle and slant Range, Eclipse, Orbital Perturbations, Placement of a Satellite in a Geo-Stationary orbit.	Lecture Assignment Problem Based Learning (PBL)	Short Answer Identification Group Exercise
CLO5, CLO6	Satellite Sub-Systems: Attitude and Orbit Control system, I I &C subsystem, Attitude Control subsystem, Power systems, Communication subsystems, Satellite Antenna Equipment. Satellite Link: Basic Transmission Theory, System Noise Temperature and G/T ratio, Basic Link Analysis, Interference Analysis, Design of satellite Links for a specified C/N, (With and without frequency Re-use), Link Budget.	Lecture Assignment Case Study Group Discussion	Short Answer Discussion Exercise MCQ
CLO5	Propagation effects: Introduction, Atmospheric Absorption, Cloud Attenuation, Tropospheric and Ionospeheric Scintillation and Low angle fading, Rain induced attenuation, rain induced cross polarization interference. Multiple Access.	Lecture Assignment	Short Answer Discussion
CLO5, CLO6	Earth Station Technology: Transmitters, Receivers, Antennas, Tracking Systems, Terrestrial Interface, Power Test Methods, Lower Orbit Considerations. Satellite Navigation and GPS Systems: Radio and Satellite Navigation, GPS Position Location Principles, GPS Receivers, GPS C/A Code Accuracy, Differential GPS.	Lecture Assignment	Short Answer Assignment MCQ

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2				√	√
CLO3	√			√	√
CLO4		√			√
CLO5	√				√
CLO6		√			√

Suggested Texts:
- Microwave Engineering, 4th Edition by David M. Pozar, Publisher: John Wiley & Sons, 2011.
- Microwave Engineering, 1st Edition by Sanjeeva Gupta.
- Satellite Communications, 2nd Edition by Timothy Pratt, Charles Bostian, Jeremy Allnutt, Publisher: John Wiley & Sons, 2013.
- Principle of Carriers Communication, 1st Edition by N. Biswas.

- Satellite Communications Engineering, 2nd Edition by Wilbur, L. Pritchand, Robert A. Nelson and Heuri G. Suyderhoud, Publisher: Pearson.
- Principles of Communication Engineering, 2006 Edition by A.K. Chhabra.
- Microwave communication system, 1st Edition by V.K. Mourya.

Intended Learning Outcomes:

- Knowledge and understanding
  - ➢ Acknowledge the principles of operation and the main features of microwave engineering & satellite communications and their applications.
  - ➢ Understand the impact of engineering solutions in a global, economic, environmental and societal context.
- Cognitive skills (Thinking and analysis)
  - ➢ Be able to identify, formulate, and solve engineering problems.
  - ➢ Be able to understand Impedance transforming and matching circuits, line and waveguide structures and its associated components, power waves and the network scattering matrix.
  - ➢ Be able understand operation of satellite subsystems.
  - ➢ Be able to compute various types of losses in microwave and satellite systems.
  - ➢ Be able to analyze Active and Passive devices Two-port network signal transmission of microwave systems and effects of propagation in satellite communication.
- Communication skills (Personal and academic)
  - ➢ An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - ➢ Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable skills)
  - ➢ Be able to apply design microwave and satellite communication link.

ICT 4231: Multimedia Communication

Course Objectives:	The objective of this course is to - Understanding the multimedia communications systems, application and basic principles. - Analysis of the multimedia streaming. - Performing and establishing multimedia communication terminals. - Presentation of multimedia communications.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **describe** technical characteristics and performance of multimedia system and terminals.	PLO1, PLO2
	CLO2- To **design** creative approach in application of multimedia devices, equipment and systems.	PLO3
	CLO3- To **carry** out experiments and measurements on the multimedia systems in laboratory conditions on real components and equipment.	PLO4, PLO11
	CLO4- To **interpret** and **analyze** measurement results obtained on the multimedia system and components.	PLO4, PLO5
	CLO5- To **describe** the development process and applications of the multimedia systems.	PLO9, PLO11
	CLO6- To **test** multimedia communication systems and equipment in real conditions.	PLO6, PLO7

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction to Multimedia Communication, Information Theory: Info theoretical foundation for lossless coding: entropy, conditional entropy, relative entropy, mutual information, prefix coding, kraft-McMillan inequality. Entropy Coding: Shannon-Fano and Huffman	Lecture Assignment	Short Answer Exercise
CLO1	Variable Length Coding in JPEG and H.264 and JPEG/MPEG	Lecture Assignment	Short Answer Exercise
CLO1, CLO2	Arithmetic Coding, Transforms: KL transform (de-correlation interpretation), PCA (geometry interpretation), SVD, DCT, and Graph Fourier Transform (GFT)	Lecture Assignment	Short Answer presentation
CLO3, CLO4	Scalar and Vector Quantization schemes in image coding. CABAC in HEVC.	Lecture Assignment	Short Answer presentation
CLO2, CLO3, CLO5	Video Signal Processing: YCbCr color space sampling, block based motion model, sub-pixel resolution motion estimation, fast algorithms in motion estimation; MV Prediction, Intra Prediction, Deblocking, SAO and Scalability.	Lecture Assignment	Short Answer presentation
CLO2, CLO3, CLO4	Video Coding Standard and Systems: HEVC. Rate-Distortion Optimization: Lagrangian Method; Video Coding Mode Decision and Rate Control	Lecture Assignment Problem Based Learning (PBL)	Short Answer Exercise

CLO3, CLO4, CLO6	Rate Control in HEVC; Deep Learning in Compression, Quality of Experiences (QoE), MPEG System I: ISOBMFF and DASH; Media Transport I: Congestion Control; Media Transport II: Error Control	Lecture Assignment Problem Based Learning (PBL)	Short Answer Group Discussion Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√				√
CLO3		√			√
CLO4	√	√			√
CLO5	√			√	√
CLO6	√			√	√

Suggested Texts:
- Introduction to Multimedia Communications: Applications, Middleware, Networking, 1st Edition by Kamisetty Rao, Zoran Bojkovic, Dragorad Milovanovic, 2006.
- Multimedia Communication Systems—Techniques, Standards And Networks, 1st Edition by Dragorad A. Milovanovic, 2012.
- Multimedia, 1st Edition by Robert Burnett, Anna Brunstrom, Publisher: Wiley.
- Wireless Multimedia Communication System, 1st Edition by K.R. Rao, Publisher: CRC Press, 2014.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the fundamental concept of multimedia communication and entropy theory.
  - Understand the coding and performance metric of multimedia communication systems.
- Cognitive skills (thinking and analysis)
  - Be able to explain entropy coding and arithmetic coding.
  - Be able to apply entropy transformation and apply quantization schemes in image coding.
  - Be able to investigate video signal processing and video coding scheme.
  - Be able to apply deep learning in image/video compression.
  - Be able to design and develop congestion and error control
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations, and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (Transferable Skills)
  - Be able to use incorporating digital modulation and coding schemes in communication systems.

ICT 4233: Introduction to 3D Modelling and Design

Course Objectives:	The objective of this course is to • Gain basic concepts and understanding of tools related to 3D production. • Become comfortable with basics of modeling, lighting, texturing and rendering. • Understand the fundamentals of strong 3D design.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **identify** key developments in the history of animation and 3D modeling.	PLO1
	CLO2- To **explain** the role technology played in enhancing 3D modeling techniques.	PLO1, PLO2
	CLO3- To **describe** two current or future applications of 3D modeling.	PLO3, PLO4
	CLO4- To **articulate** social change corresponding with technological developments in 3D modeling.	PLO6

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1-CLO4	Introduction to 3D Modeling; History of 3D Modeling; Tools of the Trade; Creating 3D Environments; Visual Elements; Power of Light and Shade; 3D Geometrics; Texturing; Rendering;	Lecture Assignment Demonstrate	Short Answer Identification Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√

CLO2	√	√				√
CLO3	√					√
CLO4	√	√				√

Suggested Texts:
- Introducing Maya 2013 by Dariush Derakhshani Publisher: Sybex.
- The Art of 3D Computer Animation and Effects, Fourth Edition by Isaac Kerlow, Publisher: John Wiley & Sons; 2009.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand different basic concepts.
  - ➢ Understand the role technology played in enhancing 3D modeling techniques.
- Cognitive skills (thinking and analysis)
  - ➢ Apply knowledge to develop applications of 3D modeling.
- Communication skills (personal and academic)
  - ➢ Develop research skills related to finding and reading current literature on cognitive psychology / sciences, sociology, computing, mobility, etc.
  - ➢ Demonstrate his/her ideas both formally and informally to a group of their peers and the management.
- Practical and subject specific skills (Transferable Skills)
  - ➢ Design interfaces for different environments, people, places, and activities.

ICT 4235: Enterprise Resource Planning and Systems

Course Objectives:	The objective of this course is to • Introduce students to enterprise systems and show how organizations use enterprise systems to run their operations more efficiently and effectively. • Inform about the critical success factors and implementation strategies that lead to enterprise system success, and about the informational, knowledge, and decision-making opportunities afforded by enterprise systems. • Examine typical Enterprise Systems modules.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To demonstrate a good understanding of basic issues in Enterprise Systems.	**PLO1, PLO2**
	CLO2- To explain the challenges associated with implementing enterprise systems and their impacts on organizations.	**PLO2, PLO4**
	CLO3- To describe the selection, acquisition and implementation of enterprise systems.	**PLO4**
	CLO4- To communicate and assess an organization's readiness for enterprise system implementation with a professional approach in written form.	**PLO6, PLO10**
	CLO5- To demonstrate an ability to work independently and in a group.	**PLO9, PLO11**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1-CLO5	Introduction to Enterprise Systems for Management; Systems Integration; Enterprise Systems Architecture; Development Life Cycle Implementation Strategies; Software and Vendor Selection; Operations and Postimplementation; Program and Project Management; Organizational Change and Business Process Reengineering; Organizational Change and Business Process Reengineering; Supply Chain Management; Customer Relationship Management;	Lecture Assignment Demonstrate	Short Answer Identification Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√			√
CLO3	√	√			√
CLO4	√			√	√
CLO5	√				√

Suggested Texts:
- Enterprise Systems for Management, Luvai F. Motiwalla and Jeff Thompson, second edition, Published by PEARSON: ISBN-13: 978-0-13-214576-3.
- Enterprise Resource Planning – Alexis Leon – Second Edition – TMH.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand the role of enterprise software in integrating business functions.
  - ➢ Understand NLP significance in Data analysis.

- Cognitive skills (thinking and analysis)
  - ➢ Analyze the strategic options for ERP identification and adoption.
  - ➢ Design the ERP implementation strategies.
- Communication skills (personal and academic)
  - ➢ Develop research skills related to finding and reading current literature on cognitive psychology / sciences, sociology, computing, mobility, etc.
  - ➢ Demonstrate his/her ideas both formally and informally to a group of their peers and the management.
- Practical and subject specific skills (Transferable Skills)
  - ➢ Create reengineered business processes for successful ERP implementation.

ICT 4237: Augmented Reality

Course Objectives:	The objective of this course is to • Introduces students to augmented reality (AR) technologies and their use. • Describe the history and recent developments of AR. • Discuss the revolution and impact of AR. • Incorporate spatial computing into software.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** the importance of augmented reality with real-time examples.	**PLO1**
	CLO2- To **explore** different technologies, concepts, and development environments that can be used for these types of content delivery.	**PLO1, PLO2**
	CLO3- To **apply** these principles to design different prototypes using the available equipment.	**PLO2, PLO4**
	CLO4- To **design,** develop, and test software for AR devices.	**PLO3, PLO6**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1-CLO6	**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.	Lecture Assignment Demonstrate	Short Answer Identification Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√			√
CLO3	√	√			√
CLO4	√			√	√

Suggested Texts:
- JKaliraj P, Devi T, (2021). Innovating with Augmented Reality: Applications in Education and Industry (P. Kaliraj, Ed.) (1st ed.). Auerbach Publications. https://doi.org/10.1201/9781003175896.
- Creating Augmented and Virtual Realities: Theory and Practice for Next-Generation Spatial Computing 1st Edition, Erin Pangilinan, Steve Lukas, Vasanth Mohan, O'Reilly Media; 1 edition (2019).

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand different basic augmented reality.
  - ➢ Understand the importance of augmented reality with real-time examples.
- Cognitive skills (thinking and analysis)
  - ➢ Apply different principles of AR to design different prototypes using the available equipment.
  - ➢ Develop and test software for AR devices.
- Communication skills (personal and academic)
  - ➢ Develop research skills related to finding and reading current literature on cognitive psychology / sciences, sociology, computing, mobility, etc.
  - ➢ Demonstrate his/her ideas both formally and informally to a group of their peers and the management.

- Practical and subject specific skills (Transferable Skills)
  - ➢ Design interfaces for different environments, people, places, and activities.

ICT 4239: Applied Data Science

Course Objectives:	The objective of this course is to	
	• Introduce the fundamentals of data analytics and data science.	
	• Facilitate knowledge about data visualizations and appropriate analysis.	
	• Acquaint students with the methods to store and access data from a variety of sources.	
	• Familiarize with techniques and tools for transformation of Data.	
	• Help to accumulate basic ideas about statistical methods, regression techniques, and machine learning algorithms to make sense out of data sets both large and small.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **explain** Data Science and Big Data and their impact on real life situations.	**PLO1**
	CLO2- To **outline** procedures for collecting, cleaning and preparing data from necessary domain.	**PLO1, PLO2**
	CLO3- To **apply** different methods to summarize and analyze data.	**PLO2, PLO4**
	CLO4- To **create** visual representation of data, that has been abstracted in some schematic form, including attributes or variables for the units of information.	**PLO4, PLO6**
	CLO5- To **design** models to solve data dependent real-life problems.	**PLO3, PLO5**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction to Data Science, The scope of Data Science, Descriptive Statistics and Exploratory Data Analysis.	Lecture Demonstrate	Short Answer Identification Exercise
CLO2, CLO3, CLO4	Data Scraping, Cleaning and Summarization. Statistical Significance and P-values. Principles of Visualizing Data.	Lecture Assignment Demonstrate	Short Answer Exercise
CLO5	Building Models and Validating Models. Linear Algebra Review. Linear Regression and Logistic Regression. Large-scale Clustering. Mining Massive Datasets. Crowdsourcing and Ensemble Learning.	Lecture Demonstrate	Short Answer Identification Exercise

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√			√
CLO3	√	√			√
CLO4	√			√	√
CLO5	√			√	√

Suggested Texts:
- The Signal and the Noise: Why so many predictions fail but some don't, by Nate Silver, Penguin Press.
- The Art of Data Science, by Roger D. Peng and Elizabeth Matsui.

Intended Learning Outcomes:
- Knowledge and understanding
  - ➢ Understand Data Science with its impact on real life situations.
  - ➢ Understand procedures for data pre-processing.
- Cognitive skills (thinking and analysis)
  - ➢ Analyze and organize relevant data through appropriate data visualizations.
  - ➢ Create and present a data analytics predictive model, software system, or visualization.
- Communication skills (personal and academic)
  - ➢ Develop research skills related to finding and reading current literature on cognitive psychology / sciences, sociology, computing, mobility, etc.
  - ➢ Demonstrate his/her ideas both formally and informally to a group of their peers and the management.
- Practical and subject specific skills (Transferable Skills)
  - ➢ Design interfaces for different environments, people, places, and activities.

ICT-4241: Human Centered Design Methods

Course Objectives:	The objective of this course is to • Develop hands-on experience in creating customer-driven products, services, or systems with a focus on innovation and practicality. • Introduce and apply design methods and tools to enhance students' design capabilities. • Execute a capstone design project or its equivalent to consolidate learning. • Emphasize the consideration of social, economic, and environmental impacts in the design process. • Engage with industry professionals to gain insights and coaching for professional design practice.

Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **understand** design strategy and sustainability, making informed design decisions that align with organizational goals and consider environmental impact.	**PLO1, PLO2**
	CLO2- To **cultivate** strong research and observational skills, enabling the effective identification of user needs and their translation into design solutions.	**PLO2, CLO4**
	CLO3- To **analyze** concept generation and prototyping, using creative brainstorming and structured methods to bring user-centered design concepts to life.	**PLO3, PLO4**
	CLO4- To **develop** proficiency in human-centered design principles and techniques, fostering a user-centric design approach.	**PLO3, PLO5**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction to Human-Centered Design: Course Introduction, What is Human-Centered Design, Foundations of HCD, Creating an Interview Guide, Individual	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO1, CLO2	Foundations of Human-Centered Design (HCD): Selection 01 from Design for the Real World, Selection 02 from Design for the Real World, Creating an Agenda for an HCD Workshop	Lecture Assignment Demonstrate	Short Answer Identification Exercise
CLO3	Observing and Identifying Needs: Looking for Connection, How to Talk to Strangers, Designing an Activity, Selection from The Design of Everyday Things	Lecture Assignment	Short Answer Discussion
CLO2, CLO3	User-Centered Research: Engage and Relate, Critical Interpretation and Philosophy, Selection from The Design of Everyday Things, Fresh Eyes, How to Listen to Strangers	Lecture Assignment	Short Answer Discussion
CLO4	Design Strategy and Sustainability: Design Context and Strategy, Sustainable Design Strategies, Customer and User Needs Assessment, Research Methods on Translating Customer Interviews and Card Sorting, Frameworks for Understanding Customer Needs, Translating the Voice of the Customer	Lecture Assignment	Short Answer Discussion
CLO3, CLO4	Concept Generation and Prototyping: Concept Generation: Creativity & Brainstorming, Concept Generation: Structured Methods, Design for the Environment and Whole Systems Design, Concept Selection and Testing, Low-Fidelity Prototyping Workshop, Moving from Low to Medium and High Fidelity Prototyping, Communicating Actionable Design Research, Visualization and UX Design	Lecture Assignment	Short Answer Discussion Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√				√
CLO2	√	√			√
CLO3	√	√		√	√
CLO4	√	√			√

Suggested Texts:
- Boehner, K., Vertesi, J., Sengers, P., & Dourish, P. (2007). How HCI interprets the probes. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: CHI'07, ACM.
- Braun & Clarke. (2012). Thematic analysis. APA Handbook of Research Methods in Psychology: Vol. 2. Research Designs.
- Golsteijn, C., van den Hoven, E., Frohlich, D., and Sellen, A. (2012). Towards a more cherishable digital object. In Proceedings of the Designing Interactive Systems Conference (DIS '12). ACM Press, pp. 655-664.
- Petrelli, D., Bowen, S., & Whittaker, S. (2013). Photo Mementos: Designing Digital Media to Represent Ourselves At Home. International Journal of Human-Computer Studies, 72, 320–336.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand design methods and tools for creating customer-driven products.
  - Gain knowledge of professional design practice and its principles.
  - Recognize the social, economic, and environmental impacts of design.
- Cognitive skills (thinking and analysis)
  - Develop analytical skills for research and problem-solving in design.
  - Enhance creative thinking and concept generation abilities.
  - Apply critical thinking to address complex design challenges.
- Communication skills (personal and academic)

➢ Improve personal and academic communication, including clear articulation of design ideas.
➢ Develop effective visualization and presentation skills.
➢ Enhance professional interaction through engagement with industry experts.

ICT 4243: IT Professional and Ethics

Course Objectives:	The objective of this course is to • Provide necessary theoretical knowledge and skills to critically analyze ethical dilemmas, evaluate alternatives and communicate to all stakeholders with the decision taken in a convincing manner. • Understand ethical issues as the students pertain to professional and personal identity. • Learn to consider thyself and the world around from these basic ethical positions.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	**CLO-PLO Mapping**
	CLO1- To **demonstrate** an understanding of codes of ethics in Information and Communication Technology.	**PLO8**
	CLO2- To **identify** social responsibilities of computer professionals and information technologists.	**PLO6**
	CLO3- To **evaluate** solutions to ethical problems and make a recommendation for the best course of action.	**PLO4, PLO7, PLO8**
	CLO4- To **design** structured program for complex computational applications	**PLO3, PLO11**

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Introduction: Understanding how computers impact on society, professional ethics in ICT, and practical codes of conduct as an expression of these professional ethics.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer Exercise
CLO2	Professionalism in computing: Professional bodies in IT and related fields, Professional bodies trade unions, and other organizations, characteristics and functions of a professional body, social responsibilities of IT professionals to the public at large, fellow members, clients; Trust, honesty and integrity.	Lecture Discussion Problem Based Learning (PBL)	Essay Type Answer MCQ Exercise
CLO1, CLO3	Ethics in computing: Philosophy, ethics, and applied ethics, Factors affecting in making ethical decisions, Theories in ethics, Common computer ethics fallacies such as Computer game fallacy, law-abiding citizen fallacy, shatterproof fallacy, candy-from-a –baby fallacy, hacker's fallacy, free information fallacy, Code of conducts in IT professional bodies	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO1, CLO3, CLO4	Legal issues in ethical Analysis of Information Systems: Intellectual property, Software licensing issues, Computer evidence, Online transactions, Electronic signatures, Online communities, Computer misuse and frauds.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO1, CLO3, CLO4	Social issues of privacy: Personal information, Data protection principles, Knowledge and consent in the Internet, Privacy enhancing and invasive tools/methods	Lecture Group Assignment Problem Based Learning (PBL) Demonstration	Report Exercise Presentation
CLO1, CLO3, CLO4	Conflicts of Interest: Contracts (MOU, NDA, User agreements), Liabilities, Warranty and maintenance, Offline dispute resolution methods, Issues in resolving dispute relating online transactions.	Lecture Discussion Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√		√	√
CLO2	√	√		√	√
CLO3	√	√		√	√
CLO4	√	√		√	√

Suggested Texts:
- George Reynolds, Ethics in Information Technology, 6th Edition by Thomson Course Technology.
- Ethics for the Professions, 1st Edition by John Rowan & Samuel Zinaich, Jnr. Wadsworth.
- A Modern Legal Ethics: Adversary Advocacy in a Democratic Age, 1st Edition by Daniel Markovits.

Intended Learning Outcomes:

- Knowledge and understanding
  - Understand, identify and apply different ethical philosophies, frameworks, and methodologies for professionals
  - Analyze the local and global impact of computing on individuals, organizations and society.
- Cognitive skills (thinking and analysis)
  - Be able to identify and relate appropriate privacy measures and their management for the computing environment.
  - Be able to reflect a professional behavior particularly in the fields of IS and software development.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - An awareness of ethical, social and cultural issues within a global context and their importance in the exercise of professional skills.

ICT 4245: IT Risk and Service Management

Course Objectives:	The objective of this course is to • Understand the concepts of Project Management for planning in execution of projects. • Understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation. • Analyze, apply and appreciate contemporary project management tools and methodologies. • Understand the service management processes. • Apply service management frameworks for enhancing service firms' competitiveness.	
Course Learning Outcomes (CLOs):	On completion of the course students will be able:	CLO-PLO Mapping
	CLO1- To **understand** project characteristics and various stages of a project**.**	PLO1
	CLO2- To **analyze** the learning and **understand** techniques for Project planning, scheduling and execution Control.	PLO2, PLO6
	CLO3- To **apply** the risk management plan and analyze the role of stakeholders.	PLO4, PLO10
	CLO4- To **analyze** and **select** the most suitable methods and framework for project and service management respectively.	PLO11, PLO12

Course Contents:

CLO	Course Contents	Teaching Learning Strategy	Assessment Strategy
CLO1	Stages of a project: Feasibility studies and the establishment of a business case for a project, Requirements elicitation, analysis and verification: purpose and methods, establishing project objectives, goals and measures of success, Stages of a development project. Adapting the development life cycle to projects where off-the-shelf packages to be installed.	Lecture Discussion	Short Questions
CLO2	Project planning and estimating: Use of product and work breakdown structures (PBS and WBS), Use of (activity on node) precedence plans and network analysis; Critical path analysis, Gantt charts, resource allocation, including the identification of resource types and the resolution of resource clashes, Agile approaches to planning: the use of time-boxing; product and sprint backlogs; prioritization of increments (e.g. using MoSCoW rules), methods, advantages and disadvantages and relative accuracy of different estimating techniques.	Lecture Discussion Case Study	Essay Type Answer MCQ Exercise
CLO2	Progress monitoring, project control, and reporting: What to monitor and why: key project metrics related to time/progress (e.g. planned and actual activity duration) costs (e.g. planned and actual effort and other costs) scope/size of functionality and quality (e.g. Earned value analysis: planned and earned value, actual costs; cost and schedule performance indicators, including their graphical representation, Assessment of implications and impact on the project of deviations and changes to project plan.	Lecture Discussion Case Study	Essay Type Answer Exercise Presentation
CLO3	Risk management: Risk identification: types of risk, risk checklists, Risk prioritization: assessment of likelihood and impact of risk; qualitative and quantitative methods of assessing risk exposure, Risk management tactics, including risk avoidance, risk transfer, risk reduction, risk mitigation and contingency planning, Cost benefit analysis of planned risk reduction actions, risk reduction leverage, Risk registers.	Lecture Discussion Problem Based Learning (PBL) Demonstration	Essay Type Answer Exercise Presentation
CLO4.	Service management concepts and frameworks: Services and service management. Customer-facing services. Resource-facing services. Identifying IT services. Service quality SERVQUAL model The service lifecycle. Processes. Functions. Roles Service strategy. Service portfolio. Service catalog management. Service level agreements. Introduction to ITIL v3, ISO 20000 and FitSM.	Lecture Discussion	Short Questions

CLO		Teaching Method	Assessment Strategy
CLO4	Specification of services and business models: Business models with a CANVAS template. Market understanding. The empathy map. Service definition and service portfolio specification. Understanding the organization of the entity that will deliver the services.	Lecture Discussion Group Assignment Problem Based Learning (PBL) Demonstration	Essay Type Answer Report Exercise Presentation
CLO2	Planning and delivery processes: Service portfolio management, Service level management, Service reporting, Service availability and continuity management, Capacity management, Information security management, Customer relationship management and Supplier relationship management.	Lecture Group Assignment Demonstration	Essay Type Answer Report Project Presentation
CLO4	Service management tools: Tool assessment framework, analysis of specific ITSM tools Selection of the tool that best fits a given SMS.	Demonstration	Project Presentation

Assessment Pattern:

CLO	Continuous Assessment				Term Final
	Class Test	Assignment	Project	Presentation	
CLO1	√	√		√	√
CLO2	√	√		√	√
CLO3	√	√		√	√
CLO4	√	√		√	√

Suggested Texts:
- Software Project Management, 5th Edition by Bob Hughes and Mike Cotterell.
- The Practical Guide to World-Class IT Service Management, 1st Edition by Kevin J Smith.
- Project Management for IT-related Projects, 3rd Edition by Bob Hughes.
- Effective Project Management: Traditional, Agile, Extreme, 7th Edition by Robert K. Wysocki.
- Service Management: Operations, Strategy, and Information, 7th Edition by James A Fitzsimmons and Mona J. Fitzsimmons.

Intended Learning Outcomes:
- Knowledge and understanding
  - Understand the basic concepts of project management.
  - Understand the fundamental steps of IT service management.
- Cognitive skills (thinking and analysis)
  - Be able to understand and analyze various stages of a project.
  - Be able to identify IT services as a means to provide functionality and value to customers in the context of specific case studies.
- Communication skills (personal and academic)
  - An individual assignment (demonstration and presentation) involves writing effective reports and designing documentation, making effective presentations and giving and receiving clear instructions.
  - Group assignment (to be done in a group) - where students will be assessed in terms of their effectiveness as individual or leader in a team.
- Practical and subject specific skills (transferable skills)
  - Be able to apply techniques for Project planning, scheduling and execution control.
  - Be able to select the appropriate tools to support a given designed service management solution.

ICT 4247: Contemporary Course on Information and Communication Technology
The content and detail of this course will be designed by the course teacher.