**Curriculum**

**of**

**Bachelor of Science**

**in**

**Cyber Security**

**BS (CySec)**

**Revised: Spring 2023**



Department of Informatics and Systems,

School of Systems and Technology

University of Management and Technology,

Lahore, Pakistan

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# Curriculum Review Committee

Following are the members of the curriculum review committee who were involved in the revision of the BS-CySec program.

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# Preface

The BS (CySec) program intends to produce skilled professionals to understand the processes that impact information security, safeguarding information assets, collection and preservation of digital evidences, analysis of data, and identification and fixing of security vulnerabilities. The program will equip students with the fundamental knowledge of computer science that forms the technical foundation of the field, with an essential focus on experiential learning through laboratory exercises in the security courses. This degree is a state-of-the-art course with a perfect blend of Cyber Security that is designed to set the graduates up for immediate industry success by combining and leveraging today’s cutting-edge technology with real-world scenarios.

The curriculum conforms to the guidelines by National Computing Education Accreditation Council (NCEAC) and Higher Education Commission (HEC) of Pakistan.

# Acknowledgements

We are thankful to Allah Almighty for all his blessings, and enabling us completes this important task. We acknowledge and admire Dr. Asif Raza, the honorable rector of UMT, for his vision, motivation and support, moral as well as logistic, to make our academic programs up-to-date by including state-of-the-art courses, materials and practices. We also acknowledge the support of our faculty members for sharing their invaluable experiences and pieces of advice to improve the curriculum.

# UMT Vision & Mission

## Vision (Learning…)

It defines our existence, inspires all stakeholders associated with us, creates a powerful momentum inside, and responds to the challenges outside. It continues to evolve as the present captures new realities and foresight unfolds new possibilities. All in an incessant attempt to help individuals and organizations discover their God-given potentials to achieve Ultimate Success actualizing the highest standards of **efficiency**, **effectiveness**, **excellence**, **equity**, **trusteeship** and **sustainable development** of global human society.

## Mission (Leading …)

We aspire to become a **learn**ing institution and evolve as the **lead**ing community for the purpose of integrated **development of the society** by actualizing strategic partnership with stakeholders, harnessing **leadership**, generating useful **knowledge,** fostering enduring values, and projecting sustainable **technologies** and practices.

# SST Vision & Mission

## Vision

The School of Systems and Technology (SST) endeavours to emerge as an inclusive school responsive to **learn**ing technological changes, devoted to distinction and committed to the educational and research desires of the nation. The school will continue to win a belief of eminent teaching, research and service through emergent undergraduate, postgraduate and doctoral level programs of study in a variety of disciplines in collaboration with distinguished institutions inside the country and overseas. The School aspires for the **lead**ership role in quest of brilliance in Computing, Informatics, Systems and Technology.

Besides established fields of Computer Science and Information Technology, the School envisions exploring and initiating the emerging disciplines. The School is delegated with the responsibility of producing culturally progressive, technologically educated, academically competent and research-oriented graduates who are prepared to **lead**, **motivate** and maintain our enormous traditions.

## Mission

Build up the school to offer an outstanding teaching, **learn**ing and research atmosphere to the students who are **lead**ersand distinguish themselves by their professional competence, innovation, integrity, problem solving, and technical skills while responding to the global emerging challenges for the betterment of the society.

# Department of Informatics and Systems Vision & Mission

## Vision

The department of Informatics and Systems envisions to prepare well rounded, technically competent and skilled IT professionals to meet the challenges of the modern computing industry.

## Mission

The department’s programs will prepare students to **function** effectively in a dynamic technological era; **enable** them to have sound knowledge of the theory behind the core IT subjects. Thereby, enabling IT graduates to **analyze** and **identify** requirements for rapidly changing **computing problems** and information system environments.

# BS Cyber Security Vision & Mission

## Program Vision

To be a trailblazing program that produces adept and ethically-driven cyber security professionals equipped to safeguard digital ecosystems and counter emerging cyber threats in an evolving technological landscape.

## Program Mission

The BS Cyber Security program is committed to cultivating proficient cyber security experts with a comprehensive **understand**ing of information security principles, ethical practices, and innovative strategies. Through a rigorous curriculum, the program aims to impart specialized knowledge, **critical thinking** skills, and **hands-on experience** in cyber defense, threat **analysis**, and risk mitigation. Graduates will be prepared to address the complex challenges posed by cyber threats and contribute significantly to the security and resilience of digital infrastructures.

# Program Objective

The Bachelor of Science in Cyber Security program aims to equip students with a deep understanding of cyber security principles, methodologies, and practices essential for safeguarding digital assets against evolving cyber threats. Through a diverse curriculum encompassing various facets of cyber defense, risk management, and ethical hacking, the program endeavors to nurture skilled professionals capable of analyzing, mitigating, and preventing cyber-attacks across multiple domains. Throughout the program, students will:

* **Recall and explain** foundational concepts in Information Security and Cryptography, comprehending their significance in securing digital data.
* **Understand** the principles and theories behind Network Security and Operating Systems Security to establish secure computing environments.
* **Apply** encryption algorithms and techniques in Cryptography to secure communications and data transmission.
* **Analyze** network vulnerabilities, conduct penetration testing, and **propose** effective countermeasures in Ethical Hacking and Security Assessment courses.
* **Evaluate** the effectiveness of security measures and risk management strategies in real-world scenarios.
* **Assess** the impact of cyber threats on organizations' infrastructures and **formulate** risk mitigation strategies in Risk Management and Cyber Threat Intelligence subjects.
* **Design** and **implement** robust security architectures and protocols in Secure Software Development and Digital Forensics.
* **Develop** comprehensive incident response plans and execute them to handle cyber security breaches effectively.

These objectives, aligned with Bloom's Taxonomy, guide the program's curriculum to ensure students acquire a deep understanding of Cyber Security concepts, cultivate critical thinking skills, and apply knowledge effectively in various technological domains.

# Program Educational Objectives

|  |  |  |
| --- | --- | --- |
| Program Educational Objectives (PEOs) | |  |
| PEO No | **Description** | **Domain** |
| PEO-1 | Cyber Security Graduates will be able to **understand**, **design**, **develop** and **deploy** smart and intelligent cybersecurity solutions to **detect**, **analyze** and **prevent** the security threats to the cyber-physical systems (CPS) by **identify**ing the vulnerabilities and counter the emerging security threats to the information and communication technologies (ICT) and infrastructures. | Cognitive |
| PEO-2 | Cyber Security Graduates will be able to **apply** the hands-on skills needed to **plan** and **manage** the required cybersecurity resources through effective **communication**, professional **lead**ership, team management and decision-making skills. | Cognitive+ Psychomotor |
| PEO-3 | Cyber Security Graduates will be able to **pursue** lifelong learning goals to **analyze** the local and global impact of cyber security paradigms and practices by **exhibit**ing professionalism keeping in view the ethical, legal and social issues and **provide** robust solutions as cybersecurity professionals. | Affective |

**Mapping of PEOs with UMT Vision and Mission**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| UMT’s Vision and Mission Keywords | |  | PEOs keywords |  |
|  | | **PEO 1** | **PEO 2** | PEO 3 |
| Vision | Unfold New Possibilities  Sustainable Development  Achieve Ultimate Success | Smart and Intelligent Cybersecurity Solutions  Identify Vulnerabilities | Plan and manage the required cybersecurity resources | Provide robust solutions as cybersecurity professionals. |
| Mission | Integrated Development  Harness Leadership  Generate Useful Knowledge  Project Sustainable Technologies and Practices. | Prevent the security threats to the cyber-physical systems | Cybersecurity Resources  Professional Leadership  Decision-making Skills | Ethical, Legal, and Social Issues  Provide Robust Solutions |

**Mapping of PEOs with SST’s Vision and Mission**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SST’s Vision and Mission Keywords | | PEOs Keywords | | |
| **PEO 1** | **PEO 2** | PEO 3 |
| Vision | Eminent Teaching,  Research and Service  Leadership  Academic Competence | Smart and Intelligent Cybersecurity Solutions  Identify Vulnerabilities | Plan and manage the required cybersecurity resources | Provide robust solutions as cybersecurity professionals. |
| Mission | Outstanding Teaching, Learning and Research  Professional Competence  Problem Solving  Technical Skills Development  Respond to Global and Emerging Challenges | Prevent the security threats to the cyber-physical systems | Cybersecurity Resources  Professional Leadership  Decision-making Skills | Ethical, Legal, and Social Issues  Provide Robust Solutions |

# Program Learning Outcomes

The following are the Program Learning Outcomes according to the Seoul accord.

|  |  |  |
| --- | --- | --- |
| PLO No | PLO Title | PLO Description |
| PLO-1 | Academic Education | To prepare graduates as computing professionals |
| PLO-2 | Knowledge for Solving Computing Problems | Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements. |
| PLO-3 | Problem analysis | Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines. |
| PLO-4 | Design/  Development of Solutions | Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. |
| PLO-5 | Modern tool usage | Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations. |
| PLO-6 | Individual and Team Work | Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings. |
| PLO-7 | Communication | Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions. |
| PLO-8 | Computing Professionalism and Society | Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice |
| PLO-9 | Ethics | Understand and commit to professional ethics, responsibilities, and norms of professional computing practice |
| PLO-10 | Life-long learning | Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional |

PLO to PEO mapping for BS cyber Security program is as follows.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mapping of PLOs to PEOs | | | | |
| PLO No | **PLO Title** | **PEOs** | | |
| **PEO-1** | **PEO-2** | **PEO-3** |
| PLO-1 | Academic Education | ✔ |  |  |
| PLO-2 | Knowledge for Solving Computing Problems | ✔ |  |  |
| PLO-3 | Problem analysis | ✔ |  |  |
| PLO-4 | Design/ Development of Solutions | ✔ |  |  |
| PLO-5 | Modern tool usage | ✔ |  |  |
| PLO-6 | Individual and Team Work |  | ✔ |  |
| PLO-7 | Communication |  | ✔ |  |
| PLO-8 | Computing Professionalism and Society |  |  | ✔ |
| PLO-9 | Ethics |  |  | ✔ |
| PLO-10 | Life-long learning |  |  | ✔ |

# BS Computing Curriculum Model

The combined structure of BS Degree Programs in Computing is proposed to meet the needs of students through theory and practical computing experience. The students are expected to learn theoretical and practical understanding of the respective field of Computing. The proposed structure is dynamic and provides basis for various options including Breadth-Based, Depth-Based, and Integrated Breadth & Depth- Based specializations. Students may choose a particular option, which is most appropriate to their planned future career.

The General structure of the BS degree in any discipline of Computing is given in the table below. The whole degree program structure is divided into different categories/areas. Some of the categories are common and shall be covered by all degree programs of the computing discipline, for example Computing Core, General Education, etc. The domain elective provides high degree of flexibility to the program to excel in one or two areas. For example, any program would like to make specialty in the area of database or computer architecture where 7 courses (see category no. 5) can be offered to do so.

## Various Categories/Areas under Computing Discipline

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S#** | **Course Group** | **Credit Hours** | **Courses** | **Remarks** |
| 1 | Computing Core | 47 | 14 | Common to all computing programs |
| 2 | Domain Core | 18 | 6 | Related to the domain and must be different from one computing degree program to another. |
| 3 | Domain Elective (i.e. Technical Electives) | 21 | 7 | These courses are electives and would be very useful to provide in depth special knowledge under a specific domain. For example – under the Computer Science – one can take 7 courses from database or Artificial intelligence, etc. |
| 4 | Mathematics & Supporting Courses | 12 | 4 | Common to all computing degree programs. |
| 5 | General Education Requirement | 35 | 12 | Common to all computing degree program and to be offered as per the HEC Guidelines, details can be found at HEC website. [www.hec.gov.pk](http://www.hec.gov.pk/) |
| 6 | Elective Supporting Courses | 3 | 1 | Common to all computing degree  Programs. |
|  | **Total** | **136** | **44** |  |

## Essential Requirements for the Computing Degree

The following are the fundamental requirements to get admission and complete Computing degrees in universities/DAIs of Pakistan.

### Eligibility Criteria, Duration of the Program and Award of Degree

* Minimum 50% marks in Intermediate/12 years schooling/A- Level (HSSC) or Equivalent with Mathematics are required for admission in all BS Computing Programs other than BS Computing Engineering.

\**Equivalency certificate by IBCC will be required in case of education from some other country or system.*

* Minimum 60% marks in Intermediate/12 years schooling/A- Level (HSSC) or Equivalent with Mathematics are required for admission in BS Computer Engineering Program.
* The students who have not studied Mathematics at intermediate level have to pass deficiency courses of Mathematics (06 credits) in first two semesters.
* At minimum 136 credit hours are required for award of BS degrees in any computing discipline mentioned in this document.
* The minimum duration for completion of BS Computing degrees is four years. The HEC allows maximum period of seven years to complete BS degree requirements.
* A minimum 2.0 CGPA (Cumulative Grade Point Average) on a scale of 4.0 is required for award of BS Computing Degree.
* The students after successful completion of 04 semesters in BS Computing Programs may exit with Associate Degree in Computing subject to completion of all requirements for the award of associate degree, i.e., Credit Hours, CGPA, and compulsory courses.

## General Layout and Courses

In order to facilitate universities/DAIs who offer computing degree programs, this section present the general layout and courses details under various categories as mentioned above. There are ten different degree programs which can be offered under the computing discipline (see section 1). In order to make it flexible and easy for institutes to execute Computing degree program with desired quality, a common layout has been designed to make a similar layout and plan for each degree offered under the computing domain. The table below shows courses under different categories. Some of the categories are shown with generic course title such as Domain Core 1, 2 and so on. Actual titles and other details are given in the later sections of this document. This section also provides guidelines about the code scheme of courses.

## Guidelines for Coding Scheme of Courses

Following Guidelines are provided by NCEAC for coding scheme:

* Coding Scheme is based on the following principles:
  + Letter Code consists of two to four characters (three is preferred) to represents the title of the degree
    - Such as CSC for Computer Science, SE for Software Engineering, DSC, Data Sciences
    - MTH – Mathematics, PHY – Physics, etc.
  + Numerical code consists of three digits
    - 1st digit represents the level of difficulty
    - 2nd digit represents the area/specialization
    - 3rd and 4th digit represent the sequence in the area/specialization
    - For example: 1001 (1 - difficult level, Next 0 normally fundamental area, and in last 01 represents sequence number of course in the area)

Other examples

* For example - a course code CSC332
  + Level of Difficulty – 3 (could be offered in year 3), 3 – the course belongs to Databases, and 2 - this is 2nd course in the area of databases.
* For example, a course code CSC212
  + Level of Difficulty – 2 (could be offered in year 2), 1 – the course belongs to Programming, and 2 - this is 2nd course in the area of programming.

However, it is up to the university where they can use different type and style.

## Suggested Semester/Study Plan

Sem 1 + Sem 3 + Sem 5 + Sem 7 = **Theory 54 hours + Lab 42 hours**

Sem 2 + Sem 4 + Sem 6 + Sem 8 = **Theory 46 hours + Lab 36 hours + Project Lab 12 hours**

# Bachelor of Science in Cyber Security – BS CySec

Advancements in the information and communication technologies have led us to this era of information age. Abundance of data and information sharing put a growing demand of expertise in the area of Cyber Security. The importance of having a strong foundation of the core principles of Cyber Security is quite obvious. There is a dire need of building the core competency in the area like foundations of Cyber Security, the hardware and software security platforms, secure programming practices, and the ways of secure human-computer interaction. The program of Bachelor of Science in Cyber Security (BS-CySec) is aimed to fulfil all of these needs. BS-CySec program is expected to produce the trained and skillful Cyber Security experts who would have developed core computing foundation according to international standards and would be able to analyze security, ethical, & privacy issues, to devise the solutions. Upon completion, students will be able to evaluate security trends, recognize best practices, and understand IT security products and threats.

## Curriculum Model for BS CySec

The generic structure for computing degree program given before is mapped with the BS CySec program in the following tables.

## Mapping of BS CySec Program on the Generic Structure

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

## 

## Suggested Semester/Study Plan for BS CySec

**Semester-wise Roadmap BS (Cyber Security)**

|  |  |  |  |
| --- | --- | --- | --- |
| **1st** **Semester** | | | |
| **Course**  **Code** | **Course Title** | **Credit Hours** | **Pre-Requisite** |
| CC120 | Application of Information & Communication Technologies | 2 | – |
| CC120L | Application of Information & Communication Technologies Lab | 1 | – |
| CC111 | Programming Fundamentals | 3 | – |
| CC111L | Programming Fundamentals Lab | 1 | – |
| MA107 | Calculus and Analytical Geometry | 3 | – |
|  | Functional English | 3 | – |
| ISL101 | Islamic Studies | 3 | – |
|  | Ideology and Constitution of Pakistan | 3 | – |
| **Semester Credit Hours** | | **19** |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **2nd Semester** | | | |
| **Course**  **Code** | **Course Title** | **Credit Hours** | **Pre-Requisite** |
| NS125 | Applied Physics | 2 | – |
| NS125L | Applied Physics Lab | 1 | – |
| CC112 | Object Oriented Programming | 3 | CC111, CC111L |
| CC112L | Object Oriented Programming Lab | 1 | CC111, CC111L |
| MA102 | Multivariable Calculus | 3 | MA107 |
|  | Expository Writing | 3 | FE |
| MA150 | Probability and Statistics | 3 | – |
| CC141 | Quantitative Reasoning – 1 (Discrete Structures) | 3 | – |
| **Semester Credit Hours** | | **19** |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **3rd Semester** | | | |
| **Course**  **Code** | **Course Title** | **Credit Hours** | **Pre-Requisite** |
| CC213 | Data Structures | 3 | CC112, CC112L |
| CC213L | Data Structures Lab | 1 | CC112, CC112L |
| CC121 | Digital Logic Design | 2 | – |
| CC121L | Digital Logic Design Lab | 1 | – |
| CC281 | Software Engineering | 3 | – |
| GE293 | Civics and Community Engagement | 2 | – |
| CC361 | Information Security | 3 | – |
| MA210 | Linear Algebra | 3 | MA107 |
| **Semester Credit Hours** | | **18** |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **4th Semester** | | | | |
| **Course**  **Code** | **Course Title** | **Credit Hours** | **Pre-Requisite** |
| CC230 | Database Systems | 3 | – |
| CC230L | Database Systems Lab | 1 | – |
| CC222 | Computer Organization and Assembly Language | 2 | CC121, CC121L |
| CC222L | Computer Organization and Assembly Language Lab | 1 | CC121, CC121L |
|  | Technical Elective 1 (Open-Source Software Development) | 3 | – |
| HU201 | Professional Practices | 3 | – |
| CY261 | Information Assurance | 2 | – |
| CY261L | Information Assurance Lab | 1 | – |
| CC251 | Computer Networks | 2 | – |
| CC251L | Computer Networks Lab | 1 | – |
| **Semester Credit Hours** | | **19** |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **5th Semester** | | | |
| **Course**  **Code** | **Course Title** | **Credit Hours** | **Pre-Requisite** |
| CY361 | Cyber Security | 2 | CC361 |
| CY361L | Cyber Security Lab | 1 | CC361 |
| CC323 | Operating Systems | 3 | – |
| CC323L | Operating Systems Lab | 1 | – |
| CC371 | Artificial Intelligence | 3 | CC213, CC213L |
|  | Technical Elective 2 | 3 | – |
| EN220 | Technical & Business Writing | 3 | EW |
| MG450 | Innovation and entrepreneurship | 3 | – |
| SD100 | English Immersion | 0 | – |
| **Semester Credit Hours** | | **19** |  |

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| **6th Semester** | | | |
| **Course**  **Code** | **Course Title** | **Credit Hours** | **Pre-Requisite** |
| CY391 | Secure Software Design and Development | 2 | CY361, CY361L |
| CY391L | Secure Software Design and Development Lab | 1 | CY361, CY361L |
| CY351 | Network Security | 3 | CY361, CY361L |
| CC342 | Analysis of Algorithms | 3 | CC213, CC213L |
|  | University Elective 1 | 3 | – |
|  | Technical Elective 3 | 3 | – |
|  | Technical Elective 4 | 3 | – |
| SD101 | 21st Century Skills | 0 | – |
| **Semester Credit Hours** | | **18** |  |

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| **7th Semester** | | | |
| **Course**  **Code** | **Course Title** | **Credit Hours** | **Pre-Requisite** |
| CY461 | Digital Forensics | 3 | CY361, CY361L |
| CC425 | Parallel & Distributed Computing | 3 | CC323, CC323L |
|  | Technical Elective 5 | 3 | – |
|  | Technical Elective 6 | 3 | – |
| CC491 | Final Year Project – I | 2 | – |
| **Semester Credit Hours** | | **14\*** |  |

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| **8th Semester** | | | |
| **Course**  **Code** | **Course Title** | **Credit Hours** | **Pre-Requisite** |
|  | University Elective 2 | 3 | – |
|  | Technical Elective 7 | 3 | – |
| CC492 | Final Year Project – II | 4 | CC491 |
| **Semester Credit Hours** | | **10\*** |  |

**Total Courses: 44 Total Credit Hours: 136\*\*\***

\* Students who opt for the COOP Program will get 16 (14 + 2) credit hours in the 7th semester.

\*\*Students who opt for the COOP Program will get 14 (10 + 4) credit hours in the 8th semester.

\*\*\*Students who opt for the COOP Program in 7th and 8th semesters will get 142 (136 + 6) credit hours in the BS (Cyber Security) degree program.

# Course outlines of all courses

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| Application of Information and Communication Technologies | | | | | | |
| Course Code: | | CC120 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Apply** various information and communication technologies to solve real-world problems in different sectors. | | | | 2 | C-3 |
| CLO-2 | **Demonstrate** proficiency in using productivity tools and software applications for efficient information processing. | | | | 3 | C-2 |
| CLO-3 | **Evaluate** the ethical and social implications of information and communication technologies and make informed decisions. | | | | 5 | C-2 |
| Course Contents: | | | | | | |
| The course content of the course "Application of Information and Communication Technologies" focuses on exploring the practical applications and utilization of various technologies in different sectors. The course covers topics such as computer hardware and software components, networking fundamentals, database management systems, web development, multimedia technologies, and emerging trends in information and communication technologies. Students learn how to effectively use productivity tools such as word processors, spreadsheets, and presentation software. The course also addresses the ethical and social implications of technology use, including privacy, security, and digital citizenship. Practical hands-on exercises, projects, and case studies are incorporated to provide students with real-world applications and enhance their skills in utilizing information and communication technologies for problem-solving and decision-making. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Modern Oracle Database Programming 1st Edition by Alex Nuijten, Patrick Barel, ISBN-101484291654, ISBN-13978-1484291658, 2023. 2. Build 1st Edition by Tony Fadell, ISBN-100063046067, ISBN-13978-0063046061, 2022. 3. Improving Performance through Learning 1st Edition by Robert O. Brinkerhoff, Anne M. Apking, Edward W. Boon, ISBN-10179422419X, ISBN-13978-1794224193, 2019. | | | | | | |

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| Programming Fundamentals | | | | | | |
| Course Code: | | CC1101 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+1 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Understand** basic problem-solving steps and logic constructs. | | | | 1 | C-1 |
| CLO-2 | **Apply** basic programming concepts | | | | 2 | C-2 |
| CLO-3 | **Design and implement** algorithms to solve real-world problems. | | | | 4 | C-4 |
| Course Contents: | | | | | | |
| Introduction to problem solving, a brief review of Von-Neumann architecture, Introduction to programming, role of compiler and linker, introduction to algorithms, basic data types and variables, input/output constructs, arithmetic, comparison and logical operators, conditional statements and execution flow for conditional statements, repetitive statements and execution flow for repetitive statements, lists and their memory organization, multi-dimensional lists, introduction to modular programming, function definition and calling, stack rolling and unrolling, string and string operations, pointers/references, static and dynamic memory allocation, File I/O operations. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Practical labs, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. C++ How to Program, 10th Edition, Paul Deitel, Harvey Deitel, ISBN-10 9780134448237, ISBN-13 978-0134448237, 2016. 2. "STARTING OUT WITH C++", 9th Edition, Tony Gaddis, ISBN-10 9780134498379, ISBN-13 978-0134498379, 2017. 3. "Problem Solving with C++" 10th Edition, Walter Savitch, ISBN-10 0134448286, ISBN-13 978-0134498379, 2017. | | | | | | |

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| Natural Sciences (Example: Applied Physics) | | | | | | |
| Course Code: | | GE2609 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Comprehend** the working knowledge of fundamental laws of physics. | | | | 1 | C-2 |
| CLO-2 | **Apply** the knowledge of fundamental laws to solve various real-world problems. | | | | 1 | C-3 |
| CLO-3 | **Analyze** different physical problems using the knowledge gained from different areas like electromagnetism, optics etc. | | | | 3 | C-4 |
| Course Contents: | | | | | | |
| Electric force and its applications and related problems, conservation of charge, charge quantization, Electric fields due to point charge and lines of force. Ring of charge, Disk of charge, A point charge in an electric field, Dipole in a n electric field, The flux of vector field, The flux of electric field, Gauss’ Law, Application of Gauss’ Law, Spherically symmetric charge distribution, A charge isolated conductor, Electric potential energy, Electric potentials, Calculating the potential from the field and related problem Potential due to point and continuous charge distribution, Potential due to dipole, equipotential surfaces, Calculating the field from the potential , Electric current, Current density, Resistance, Resistivity and conductivity, Ohm’s law and its applications, The Hall effect, The magnetic force on a current, The Biot- Savart law, Line of B, Two parallel conductors, Amperes’ s Law, Solenoid, Toroids, Faraday’s experiments, Faraday’s Law of Induction, Lenz’s law, Motional emf, Induced electric field, Induced electric fields, The basic equation of electromagnetism, Induced Magnetic field, The displacement current, Reflection and Refraction of light waves, Total internal reflection, Two source interference, Double Slit interference, related problems, Interference from thin films, Diffraction and the wave theory, related problems, Single-Slit Diffraction, related problems, Polarization of electromagnetic waves, Polarizing sheets, related problems. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Building Electro-Optical Systems: Making It All Work Wiley Series in Pure and Applied Optics 3rd Edition by Philip C. D. Hobbs, ISBN-10 1119438977, ISBN-13 978-1119438977, 2022. 2. University Physics 15th Edition by Hugh Young, Roger Freedman, ISBN-10 0135216117, ISBN-13 978-0135216118, 2019. 3. Fundamentals of Physics 12th Edition by Robert Resnick, Jearl Walker, David Halliday, ISBN-10 1119801141, and ISBN-13 978-1119801146, 2021. | | | | | | |

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| Object Oriented Programming | | | | | | |
| Course Code: | | CC1102 | **Pre-requisite:** | Programming Fundamentals | | |
| Credit Hours: | | 3+1 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | Understandprinciples of object-oriented paradigm. | | | | 2 | C-2 |
| CLO-2 | Identify the objects & their relationships to build object-oriented solution. | | | | 3 | C-3 |
| CLO-3 | Model a solution for a given problem using object-oriented principles. | | | | 5 | C-3 |
| CLO-4 | Examine an object-oriented solution. | | | | 3 | C-4 |
| Course Contents: | | | | | | |
| Introduction to object oriented design, history and advantages of object oriented design, introduction to object oriented programming concepts, classes, objects, data encapsulation, constructors, destructors, access modifiers, const vs non-const functions, static data members & functions, function overloading, operator overloading, identification of classes and their relationships, composition, aggregation, inheritance, multiple inheritance, polymorphism, abstract classes and interfaces, generic programming concepts, function & class templates, standard template library, object streams, data and object serialization using object streams, exception handling. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Practical labs, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Object-Oriented Programming Exercises with Java, Latest Edition, Haris Tsetsekas, ISBN-13 979-8387780431, March 21, 2023. 2. Blueprints Visual Scripting for Unreal Engine 5, 3rd Edition, Marcos Romero, Brenden Sewell, ISBN-10 180181158X, ISBN-13 978-1801811583, 2022. 3. Protocol-Oriented Programming in Swift 5, Kindle Edition, Karoly Nyisztor, ISBN-10 ‎1785882945, 2021. | | | | | | |

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| Database Systems | | | | | | |
| Course Code: | | CC1103 | **Pre-requisite:** | Data Structures and Algorithm | | |
| Credit Hours: | | 3+1 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Describe** the fundamental database concepts, DBMS three Schema Architecture and SQL (DDL and DML) commands. | | | | 3 | C-2 |
| CLO-2 | **Illustrate** the conceptual Data Model (ER/EER Schema) and Implementation data model (Relational Database Schema) **Demonstrate** the integrity constraints and ER-Relational database mapping algorithms. | | | | 4 | C-2 |
| CLO-3 | **Contrast** good database design principles with bad database design using Functional Dependencies (FDs), Inference Rules of FDs, six normalization forms and joining algorithms. | | | | 4 | C-4 |
| CLO-4 | **Analyze** concurrency control algorithms to avoid deadlock in transactions. | | | | 4 | C-4 |
| CLO-5 | **Design and implement** a web-based database application that to solve a mini-world problem. | | | | 4 | C-4 |
| Course Contents: | | | | | | |
| Basic database concepts, Database approach vs file based system, database architecture, three level schema architecture, data independence, relational data model, attributes, schemas, tuples, domains, relation instances, keys of relations, integrity constraints, relational algebra, selection, projection, Cartesian product, types of joins, normalization, functional dependencies, normal forms, entity relationship model, entity sets, attributes, relationship, entity-relationship diagrams, Structured Query Language (SQL), Joins and sub-queries in SQL, Grouping and aggregation in SQL, concurrency control, database backup and recovery, indexes, NoSQL systems. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Practical labs, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Fundamentals of Database Systems, 7th edition, Kindle Edition, Ramez Elmasri, Shamkant Navathe, ISBN-13: 978-0133970777, ISBN-10: 0133970779, Feb3, 2022. 2. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg, ISBN-10 0132943263, ISBN-13 978-0132943260, 2014. 3. Database Systems: Design, Implementation, & Management, 13th Edition, Carlos Coronel, Steven Morris, ISBN-10 1337627909, ISBN-13 978-1337627900, 2018. | | | | | | |

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| Digital Logic Design | | | | | | |
| Course Code: | | CC1104 | **Pre-requisite:** | Applied Physics | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Understanding** of the Boolean Algebra, Boolean Functions, Combinational and Sequential Logic and PLDs | | | | 1 | C-2 |
| CLO-2 | **Demonstrate** the skills to design and analyze both  combinational and sequential circuits using a variety of  techniques | | | | 2 | C-3 |
| CLO-3 | **Understand** the relationship between abstract logic characterizations and practical electrical implementations. | | | | 3 | C-2 |
| Course Contents: | | | | | | |
| Number Systems, Logic Gates, Boolean Algebra, Combination logic circuits and designs, Simplification Methods (K-Map, Quinn Mc-Cluskey method), Flip Flops and Latches, Asynchronous and Synchronous circuits, Counters, Shift Registers, Counters, Triggered devices & its types. Mealy machines and Moore machines. Binary Arithmetic and Arithmetic Circuits, Memory Elements, State Machines. Introduction Programmable Logic Devices (CPLD, FPGA) Lab Assignments using tools such as Verilog HDL/VHDL, MultiSim. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Practical labs, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Digital Systems Design, Volume I: Numbering Systems and Logical Operations, Kindle Edition, Larry Massengale, ISBN-13 978-1949449112, 2019. 2. Digital Fundamentals by Thomas L. Floyd, 11th edition, ISBN-10 9780132737968, ISBN-13 978-0132737968, 2014. 3. Introduction to Logic Circuits & Logic Design with Verilog, 2nd Edition, Brock J. LaMeres, ISBN-10 3030136078, ISBN-13 978-3030136079, 2019. | | | | | | |

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| Data Structures | | | | | | |
| Course Code: | | CC2105 | **Pre-requisite:** | Object Oriented Programming | | |
| Credit Hours: | | 3+1 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Analyze** simple algorithms and determine their complexities. | | | | 3 | C-4 |
| CLO-2 | **Apply** the knowledge of data structures to other application domains. | | | | 3 | C-3 |
| CLO-3 | **Implement** various data structures and their algorithms, and apply them in implementing simple applications | | | | 4 | C-3 |
| Course Contents: | | | | | | |
| Abstract data types, complexity analysis, Big Oh notation, Stacks (linked lists and array implementations), Recursion and analyzing recursive algorithms, divide and conquer algorithms, Sorting algorithms (selection, insertion, merge, quick, bubble, heap, shell, radix, bucket), queue, de-queue, priority queues (linked and array implementations of queues), linked list & its various types, sorted linked list, searching an unsorted array, binary search for sorted arrays, hashing and indexing, open addressing and chaining, trees and tree traversals, binary search trees, heaps, M-way tress, balanced trees, graphs, breadth-first and depth-first traversal, topological order, shortest path, adjacency matrix and adjacency list implementations, memory management and garbage collection. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Practical labs, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Learning JavaScript Data Structures and Algorithms, 3rd Edition, Loiane Groner, ISBN-10 1788623878, ISBN-13 978-1788623872, 2018. 2. Hands-On Data Structures and Algorithms with Python, 3rd Edition, Dr. Basant Agarwal, Benjamin Baka, ISBN-13 978-1788995573, 2018. 3. Introduction to Algorithms, 4th Edition, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, ISBN-10 026204630X, ISBN-13 978-0262046305, 2022. | | | | | | |

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| Information Security | | | | | | |
| Course Code: | | CC2106 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Explain** key concepts of information security such as design principles, cryptography, risk management, and ethics | | | | 3 | C-2 |
| CLO-2 | **Discuss** legal, ethical, and professional issues in information security. | | | | 2 | A-2 |
| CLO-3 | **Apply** various security and risk management tools for achieving information security and privacy. | | | | 5 | C-3 |
| CLO-4 | **Identify** appropriate techniques to tackle and solve problems in the discipline of information security. | | | | 3 | C-4 |
| Course Contents: | | | | | | |
| Information security foundations, security design principles; security mechanisms, symmetric and asymmetric cryptography, encryption, hash functions, digital signatures, key management, authentication and access control; software security, vulnerabilities and protections, malware, database security; network security, firewalls, intrusion detection; security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics in information security, privacy and anonymity of data. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. ISO 27001 Handbook, Latest Edition, Cees van der Wens, ISBN-10 1098547683, ISBN-13 978-1098547684, 2019. 2. Computer Security: Principles and Practice, 3rd edition by William Stallings and Lawrie Brown, ISBN-10 9780134794105, ISBN-13 978-0134794105, 2017. 3. Principles of Information Security, 6th edition by M. Whitman and H. Mattord, ISBN-10 9781337102063, ISBN-13 978-1337102063, 2017. | | | | | | |

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| Artificial Intelligence | | | | | | |
| Course Code: | | CC2107 | **Pre-requisite:** | Discrete Structures | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Understand** key components of artificial intelligence. | | | | 1 | C-2 |
| CLO-2 | **Implement** classical artificial intelligence techniques for problem solving. | | | | 2 | C-2 |
| CLO-3 | **Appraise** real world problems for machine learning based solutions | | | | 3 | C-4 |
| CLO-4 | **Apply** knowledge representation and inference techniques for practical problem solving. | | | | 4 | C-3 |
| Course Contents: | | | | | | |
| An Introduction to Artificial Intelligence and its applications towards Knowledge Based Systems; Introduction to Reasoning and Knowledge Representation, Problem Solving by Searching (Informed searching, Uninformed searching, Heuristics, Local searching, Min- max algorithm, Alpha beta pruning, Game-playing); Case Studies: General Problem Solver, Eliza, Student, Macsyma; Learning from examples; ANN and Natural Language Processing; Recent trends in AI and applications of AI algorithms. Python programming language will be used to explore and illustrate various issues and techniques in Artificial Intelligence. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Practical labs, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. “Artificial Intelligence. A Modern Approach”, 4th ed, Russell, S. and Norvig, P., Prentice Hall, Inc., ISBN-10 0134610997, ISBN-13 978-0134610993, 2020. 2. Artificial Intelligence Basics, 1st Edition, Tom Taulli, ISBN-10 1484250273, ISBN-13 978-1484250273, 2019. 3. Age of Invisible Machines, 1st Edition, Robb Wilson, ISBN-13 978-1119899921, 2022. | | | | | | |

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| Computer Networks | | | | | | |
| Course Code: | | CC2108 | **Pre-requisite:** |  | | |
| Credit Hours: | | 3+1 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Describe** the key terminologies and technologies of computer networks | | | | 2 | C-2 |
| CLO-2 | **Explain** the services and functions provided by each layer in the Internet protocol stack. | | | | 2 | C-2 |
| CLO-3 | **Identify** various internetworking devices and protocols, and their functions in a network | | | | 2 | C-4 |
| CLO-4 | **Analyze** working and performance of key technologies, algorithms, and protocols. | | | | 3 | C-4 |
| Course Contents: | | | | | | |
| Introduction and protocols architecture, basic concepts of networking, network topologies, layered architecture, physical layer functionality, data link layer functionality, multiple access techniques, circuit switching and packet switching, LAN technologies, wireless networks, MAC addressing, networking devices, network layer protocols, IPv4 and IPv6, IP addressing, sub netting, CIDR, routing protocols, transport layer protocols, ports and sockets, connection establishment, flow and congestion control, application layer protocols, latest trends in computer networks. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Practical labs, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Computer Networking: A Top-Down Approach, 8th Edition, James Kurose, ISBN-10 0136681557, ISBN-13 978-0136681557, 2020. 2. Computer Networks, 6th Edition, Larry L. Peterson, Bruce S. Davie, ISBN-10 0128182008, ISBN-13 978-0128182000, 2021. 3. Data and Computer Communications, 10th Edition by William Stallings, ISBN-10 1292014385, ISBN-13 978-1292014388, 2021. | | | | | | |

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| Software Engineering | | | | | | |
| Course Code: | | CC2109 | **Pre-requisite:** | Object Oriented Programming | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Identify** a problem to be solved. | | | | 3 | C-1 |
| CLO-2 | **Propose** software solution for identified problem | | | | 3 | C-2 |
| CLO-3 | **Design**solution system using UML design tool | | | | 5 | C-4 |
| CLO-4 | **Construct** software prototype for proposed system. | | | | 4 | C-4 |
| Course Contents: | | | | | | |
| Nature of Software, Overview of Software Engineering, Professional software development, Software engineering practice, Software process structure, Software process models, Agile software Development, Agile process models, Agile development techniques, Requirements engineering process, Functional and non-functional requirements, Context models, Interaction models, Structural models, behavioral models, model driven engineering, Architectural design, Design and implementation, UML diagrams, Design patterns, Software testing and quality assurance, Software evolution, Project management and project planning, configuration management, Software Process improvement. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Software Engineering for Absolute Beginners, 1st Edition by Nico Loubser, ISBN-10 1484266218, ISBN-13 978-1484266212, 2021. 2. Modern Software Engineering, 1st Edition by David Farley, ISBN-10 0137314914, ISBN-13 978-0137314911, 2021. 3. Become an Effective Software Engineer, 1st Edition by Dr.James Stanier, ISBN-10 1680507249, ISBN-13 978-1680507249, 2020. | | | | | | |

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| Computer Organization & Assembly Language | | | | | | |
| Course Code: | | CC2110 | **Pre-requisite:** | Digital Logic Design | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Identify** the major components of computer architecture, and explain their purposes and interactions | | | | 1 | C-2 |
| CLO-2 | **Simulate** the internal representation of data, and show how data is stored and accessed in, I/O modules, and the interconnecting components of the computer systems | | | | 2 | C-3 |
| CLO-3 | **Analyze** the relationships between hardware architecture and its instruction set. | | | | 3 | C-4 |
| Course Contents: | | | | | | |
| Introduction to computer systems: compilation systems work, processors read and interpret instructions stored in memory, caches matter, storage devices form a hierarchy, the operating system manages the hardware, systems communicate with other systems using networks; Representing and manipulating information: information storage, integer representations, integer arithmetic, floating point; Machine-level representation of programs: a historical perspective, program encodings, data formats, accessing information, arithmetic and logical operations, control, procedures, array allocation and access, heterogeneous data structures, putting it together: understanding pointers, life in the real world: using the gdb debugger, out of-bounds memory references and buffer overflow, x86-64: extending ia32 to 64 bits, machine-level representations of floating-point programs; Processor architecture: the Y86 instruction set architecture, logic design and the Hardware Control Language (HCL), sequential Y86 implementations, general principles of pipelining, pipelined Y86 implementations. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Computer Organization and Assembly Language Programming, Kindle Edition by James L Peterson, ISBN-10 1792884966, and ISBN-13 978-1792884962, 2019. 2. Introduction to Computer Organization, Latest Edition by Robert Plantz, ISBN-10 1718500092, ISBN-13 978-1718500099, 2022. 3. Modern Computer Architecture and Organization, 2nd Edition, Jim Ladin, David Farley, ISBN-10 1803234512, ISBN-13 978-1803234519, 2022. | | | | | | |

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| Operating Systems | | | | | | |
| Course Code: | | CC3111 | **Pre-requisite:** | Data Structures and Algorithm | | |
| Credit Hours: | | 3+1 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Explain** the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems. | | | | 1 | C-2 |
| CLO-2 | **Analyze** the algorithms of the core functions of the Operating Systems and explain the major performance issues with regard to the core functions. | | | | 1 | C-3 |
| CLO-3 | **Differentiate** the knowledge in applying system software and tools available in modern operating systems. | | | | 2 | C-3 |
| Course Contents: | | | | | | |
| Operating systems basics, system calls, process concept and scheduling, inter-process communication, multithreaded programming, multithreading models, threading issues, process scheduling algorithms, thread scheduling, multiple-processor scheduling, synchronization, critical section, synchronization hardware, synchronization problems, deadlocks, detecting and recovering from deadlocks, memory management, swapping, contiguous memory allocation, segmentation & paging, virtual memory management, demand paging, thrashing, memory-mapped files, file systems, file concept, directory and disk structure, directory implementation, free space management, disk structure and scheduling, swap space management, system protection, virtual machines, operating system security. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Practical labs, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Operating Systems Concepts, 10th edition by Abraham Silberschatz, Greg Gagne, Peter B. Galvin, ISBN-10 1119800366, and ISBN-13 978-1119800361, 2021. 2. Operating Systems and Server Administration, Latest Edition by Tom Lesley, ISBN-13 979-8393140175, 2023. 3. The Human Operating Systems, Kindle Edition, Rob Murray, Jack Nicholson, Jerome Daley, ISBN-10 1735935212, ISBN-13 978-1735935218, 2021. | | | | | | |

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| Analysis of Algorithm | | | | | | |
| Course Code: | | CC4112 | **Pre-requisite:** | Data Structures and Algorithms | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Demonstrate** an understanding of algorithm design process and different problem-solving techniques. | | | | 2 | C-2 |
| CLO-2 | **Analyze** the time and space complexity of different algorithms. | | | | 3 | C-4 |
| CLO-3 | **Design** algorithms to solve simple computational problems and compare the implementations empirically. | | | | 4 | C-6 |
| Course Contents: | | | | | | |
| Introduction; role of algorithms in computing, Analysis on nature of input and size of input Asymptotic notations; Big-O, Big Ω, Big Θ, little-o, little-ω, Sorting Algorithm analysis, loop invariants, Recursion and recurrence relations; Algorithm Design Techniques, Brute Force Approach, Divide-and-conquer approach; Merge, Quick Sort, Greedy approach; Dynamic programming; Elements of Dynamic Programming, Search trees; Heaps; Hashing; Graph algorithms, shortest paths, sparse graphs, String matching; Introduction to complexity classes. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Beyond the Worst-Case Analysis of Algorithms 1st Edition by Tim Roughgarden, ISBN-10 1108494315, ISBN-13 978-1108494311, 2021. 2. CPS 230 DESIGN AND ANALYSIS OF ALGORITHMS, Kindle Edition by ceng yong, yong, ISBN-13 978-1108494311, 2023. 3. A Guide to Design and Analysis of Algorithms, Latest edition by Sandip Dutta Soubhik Chakraborty, Prashant Pranav, Naghma Khatoon, ISBN-13 979-8886973860, 2022. | | | | | | |

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| Machine Learning | | | | | | |
| Course Code: | | AC2202 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Illustrate** various concept learning algorithms with suitable examples. | | | | 1 | C-4 |
| CLO-2 | **Apply** supervised learning techniques to solve classification problems. | | | | 2 | C-3 |
| CLO-3 | **Apply** unsupervised learning techniques to solve clustering problems. | | | | 2 | C-3 |
| CLO-4 | **Apply** deep learning and reinforcement learning algorithms to environments with complex dynamics. | | | | 2 | C-3 |
| Course Contents: | | | | | | |
| Introduction to machine learning; concept learning: General-to-specific ordering of hypotheses, Version spaces Algorithm, Candidate elimination algorithm; Supervised Learning: decision trees, Naive Bayes, Artificial Neural Networks, Support Vector Machines, Overfitting, noisy data, and pruning, Measuring Classifier Accuracy; Linear and Logistic regression; Unsupervised Learning: Hierarchical Aglomerative Clustering. k-means partitional clustering; Self-Organizing Maps (SOM) k-Nearest-neighbor algorithm; Semi- supervised learning with EM using labeled and unlabled data; Reinforcement Learning: Hidden Markov models, Monte Carlo inference Exploration vs. Exploitation Trade-off, Markov Decision Processes; Ensemble Learning: Using committees of multiple hypotheses. Bagging, boosting. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Functional Programming on Go, 1st Edtion by Dylan Meeus, ISBN-10 1801811164, ISBN-13 978-1801811163, 2023. 2. Hands on Machine Learning with Scikit-Learn and TensorFlow, 3rd Edition by Aurelien Geron, ISBN-10 1098125975, ISBN-13 978-1098125974, 2022. 3. Deep Learning with PyTorch Latest Edition by Kunal Sawarkar, ISBN-10 180056161X, ISBN-13 978-1800561618, 2022. | | | | | | |

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| Artificial Neural Network & Deep Learning | | | | | | |
| Course Code: | | AC3203 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Describe** fundamentals of neural networks & deep learning. | | | | 1 | C-1 |
| CLO-2 | **Implement** appropriate Neural Networks to solve practical problems. | | | | 2 | C-3 |
| CLO-3 | **Apply** deep learning techniques for classification and recognition problems. | | | | 2 | C-3 |
| Course Contents: | | | | | | |
| Introduction and history of neural networks, Basic architecture of neural networks, Perceptron and Adaline (Minimum Error Learning) for classification. Basics of deep learning, learning networks, Shallow vs. Deep learning etc.; Machine learning theory – training and test sets, evaluation, etc. Selected topics from: Gradient descent (Delta) rule, Hebbian, Neo-Hebbian and Differential Hebbian Learning, Drive Reinforcement Theory, Kohonen Self Organizing Maps, Associative memory, Bi-directional associative memory (BAM), Energy surfaces, The Boltzmann machines, Backpropagation Networks, Feedforward Networks; Theory of Generalization; Multi-layer perceptrons, error back- propagation; Deep convolutional networks, Computational complexity of feed forward and deep convolutional neural networks; Unsupervised deep learning including auto-encoders; Deep belief networks; Restricted Boltzman Machines; Deep Recurrent Neural Networks (BPTT, LSTM, etc.); GPU programming for deep learning CuDNN; Generative adversarial networks (GANs); Sparse coding and auto-encoders; Data augmentation, elastic distortions, data normalization; Mitigating overfitting with dropout, batch normalization, dropconnect; Novel architectures, ResNet, GoogleNet, etc. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Deep Learning with JavaScript First Edition by Shanqing Cai, Stan Bileschi, Eric Nielsen, ISBN-10 1617296171, ISBN-13 978-1617296178, 2020. 2. Deep Learning with PyTorch 1st Edition by Eli Stevens , Luca Antiga, Thomas Viehmann, ISBN-10 1617295264, ISBN-13 978-1617295263, 2020. 3. Principles of Artificial Neural Networks 4th Edition by Daniel Graupe, ISBN-10 9811201226, ISBN-13 978-9811201226, 2019. | | | | | | |

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| Computer Vision | | | | | | |
| Course Code: | | AC3205 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Identify** basic concepts, terminology, theories, models and methods in the field of computer vision. Identify basic concepts, terminology, theories, models and methods in the field of computer vision. | | | | 1 | C-1 |
| CLO-2 | **Apply** computer vision techniques for solving practical problems. | | | | 2 | C-3 |
| CLO-3 | **Develop** computer vision applications using deep neural networks. | | | | 4 | C-6 |
| Course Contents: | | | | | | |
| Introduction to Computer Vision (Problems faced, History and Modern Advancements). Image Processing, Image filtering, Image pyramids and Fourier transform, Hough transform. Camera models, Setting up a camera model from parameters, Camera looking at a plane, Relationship of plane and horizon line, Rotation about camera center. Concatenation, Decomposition and Estimation of transformation from point correspondences, Points and planes in 2D/3D, Transformations in 2D/3D, Rotations in 2D/3D. Edge detection, corner detection. Feature descriptors and matching (HoG features, SIFT, SURF). Applications of Computer Vision Traditional Methods: Image Stitching: Making a bigger picture from smaller pictures Single View Geometry: Converting a single image into a 3D model. Applications of CV using Deep Learning: Image Detection (Localization, Historical Techniques, RCNN, FRCNN, YOLO, Retina), Image Segmentation (UNet, SegNet, MaskRCNN), Image Generation (GANN). | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. "Computer Vision: Algorithms and Applications" 2nd Edition by Richard Szeliski, ISBN-10 3030343715, ISBN-13 978-3030343712, 2022. 2. "Learning OpenCV 4: Computer Vision with Python 3" 3rd Edition by Joseph Howse and Prateek Joshi, ISBN-10 1789531616, ISBN-13 978-1789531619, 2020. 3. Hands-On Computer Vision with Detectron2 1st Edition by Van Vung Pham, Tommy Dang, ISBN-10 1800561628, ISBN-13 978-1800561625, 2023. | | | | | | |

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| Parallel & Distributed Computing | | | | | | |
| Course Code: | | AC3206 | **Pre-requisite:** | Operating Systems | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Demonstrate** an understanding of parallel and distributed computers. | | | | 1 | C-2 |
| CLO-2 | **Write** portable programs for parallel or distributed architectures using Message-Passing Interface (MPI) library. | | | | 4 | C-3 |
| CLO-3 | **Analyze** complex problems with shared memory programming with OpenMP. | | | | 3 | C-4 |
| Course Contents: | | | | | | |
| Asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, synchronization, and tools (Cuda, Swift, Globus, Condor, Amazon AWS, OpenStack, Cilk, gdb, threads, MPICH, OpenMP, Hadoop, FUSE). | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Parallel and Distributed Computing 1st Edition by Ajit Singh, ISBN-13 979-8464177437, 2021. 2. Scientific Parallel Computing Kindle Edition by Larkin Ridgway Scott, Terry Clark, Babak Bagheri, ISBN-13 978-0691119359, 2021. | | | | | | |

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| Natural Language Processing | | | | | | |
| Course Code: | | AE3301 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Review** the fundamental concepts of natural language processing. | | | | 1 | C-1 |
| CLO-2 | **Analyze** various approaches for language modelling. | | | | 3 | C-4 |
| CLO-3 | **Apply** NLP techniques to solve a given problem. | | | | 2 | C-3 |
| Course Contents: | | | | | | |
| Introduction & History of NLP, Parsing algorithms, Basic Text Processing, Minimum Edit Distance, Language Modeling, Spelling Correction, Text Classification, Deterministic and stochastic grammars, CFGs, Representing meaning /Semantics, Semantic roles, Semantics and Vector models, Sentiment Analysis, Temporal representations, Corpus-based methods, N-grams and HMMs, Smoothing and backoff, POS tagging and morphology, Information retrieval, Vector space model, Precision and recall, Information extraction, Relation Extraction (dependency, constituency grammar), Language translation, Text classification, categorization, Bag of words model, Question and Answering, Text Summarization. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Natural Language Processing in Action First Edition by Hobson Lane, Hannes Hapke, Cole Howard, ISBN-10 1617294632, ISBN-13 978-1617294631, 2019. 2. Natural Language Processing with Transformers, Revised Edition 1st Edition by Lewis Tunstall, Leandro von Werra, Thomas Wolf, ISBN-10 1098136799, ISBN-13 978-1098136796, 2022. 3. Practical Natural Language Processing 1st Edition by Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, ISBN-10 1492054054, ISBN-13 978-1492054054, 2020. | | | | | | |

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| Speech Processing | | | | | | |
| Course Code: | | AE3302 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Understand** the fundamental concepts and techniques used in speech processing, including speech analysis, synthesis, and recognition. | | | | 1 | C-1 |
| CLO-2 | **Implement** and evaluate algorithms for speech processing tasks, such as speech enhancement, speaker recognition, and emotion detection. | | | | 2 | C-3 |
| CLO-3 | Critically **evaluate** the strengths and limitations of current speech processing systems, and identify research directions for improving their performance and usability. | | | | 3 | C-3 |
| Course Contents: | | | | | | |
| Introduction and oOverview of speech processing tasks and applications, Historical development and key research issues, Acoustic properties of speech and human auditory system, Speech Analysis and Synthesis, Speech production and articulation models, Speech analysis techniques, such as short-time Fourier transform and linear prediction analysis, Speech synthesis techniques, such as formant synthesis and concatenative synthesis, Speech Enhancement and Recognition, Noise reduction and speech enhancement techniques, Hidden Markov models and Gaussian mixture models for speech recognition, Deep learning approaches for speech enhancement and recognition, Speaker Verification and Diarization, Text-independent and text-dependent speaker verification, Speaker diarization and clustering, Deep learning approaches for speaker verification and diarization, Multimodal Speech Processing, Audio-visual speech processing and fusion, Speech emotion recognition and sentiment analysis, Multilingual and cross-lingual speech processing, Applications of Speech Processing, Speech-to-text and text-to-speech systems, Voice assistants and chatbots, Speech analytics and voice biometrics | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Audio and Speech Processing with MATLAB 1st Edition by Paul Hill, ISBN-10 0367656310, ISBN-13 978-0367656317, 2020. 2. Multirate Signal Processing for Communication Systems 2nd Edition by Fredric J. Harris, ISBN-10 877022210X, ISBN-13 978-8770222105, 2021. 3. Deep Reinforcement Learning Hands-On 2nd Edition by Maxim Lapan, ISBN-10 1838826998, ISBN-13 978-1838826994, 2020. | | | | | | |

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| Data Mining | | | | | | |
| Course Code: | | AE3303 | **Pre-requisite:** | Linear Algebra | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Recognize** the fundamental concepts of data mining. | | | | 1 | C-1 |
| CLO-2 | **Apply** preprocessing and classification techniques to solve classification problems of moderate complexity. | | | | 2 | C-3 |
| CLO-3 | **Apply** Association rule mining techniques to extract patterns from a given problem. | | | | 2 | C-3 |
| Course Contents: | | | | | | |
| Introduction to Data Mining, Overview of data mining tasks and applications, Historical development and key research issues, Ethical and legal considerations in data mining, Data Preprocessing and Feature Selection, Data cleaning, transformation, and reduction techniques, Feature selection and dimensionality reduction methods, Missing data imputation and outlier detection, Classification and Regression, Decision tree induction and pruning algorithms, Bayesian classifiers and naive Bayes algorithm, Logistic regression and support vector machines, Clustering and Association Rule Mining, K-means and hierarchical clustering algorithms, Apriority algorithm for frequent itemset mining, Collaborative filtering and recommendation systems, Time Series Analysis and Text Mining, Autoregressive and moving average models for time series forecasting, Text preprocessing and sentiment analysis techniques, Topic modeling and information retrieval, Applications of Data Mining, Business intelligence and customer relationship management, Healthcare analytics and predictive modeling, Social network analysis and web mining. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Introduction to Data Mining and Analytics, 1st Edition by Kris Jamsa, ISBN-10 1284180905, ISBN-13 978-1284180909, 2020. 2. Data Mining 4th Edition by Jiawei Han, Jian Pei, Hanghang Tong, ISBN-10 0128117605, ISBN-13 978-0128117606, 2022. | | | | | | |

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| Advanced Statistics | | | | | | |
| Course Code: | | AE3304 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Analyze** complex data using advanced statistical techniques. | | | | 3 | C-4 |
| CLO-2 | **Develop** and apply advanced statistical models for real-world problems. | | | | 4 | C-5 |
| CLO-3 | **Evaluate** and interpret the results of advanced statistical analyses. | | | | 6 | C-5 |
| Course Contents: | | | | | | |
| Review of statistical inference and hypothesis testing. Linear models: multiple regression, ANOVA, and ANCOVA. Generalized linear models: logistic regression, Poisson regression, and survival analysis. Nonparametric methods: bootstrap, permutation tests, and rank-based tests. Multivariate methods: principal component analysis, factor analysis, and cluster analysis. Bayesian methods: Bayesian inference, hierarchical models, and Markov Chain Monte Carlo (MCMC) methods. Time series analysis: ARMA models, ARIMA models, and state-space models. Spatial statistics: spatial autocorrelation, geostatistics, and spatial regression. Machine learning: decision trees, random forests, and support vector machines. Applications in various fields, such as ecology, epidemiology, finance, and engineering. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Advanced Problems in Introductory Mechanics 2020 Edition by Soumendra Mandal, ISBN-13 979-8638555993, 2020. 2. Introduction to Statistics 1st Edition by Jim Frost, ISBN-10 1735431109, ISBN-13 978-1735431109, 2020. | | | | | | |

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| Reinforcement Learning | | | | | | |
| Course Code: | | AE3305 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Design** and implement reinforcement learning algorithms for sequential decision making. | | | | 4 | C-5 |
| CLO-2 | **Analyze** and evaluate the performance of reinforcement learning algorithms in complex environments. | | | | 6 | C-6 |
| CLO-3 | **Apply** reinforcement learning techniques to real-world problems in various fields, such as robotics, gaming, and finance. | | | | 7 | C-6 |
| Course Contents: | | | | | | |
| Introduction to reinforcement learning: definition, elements of an RL problem, Markov decision processes, and Bellman equation. Dynamic programming: value iteration, policy iteration, and model-based RL algorithms. Monte Carlo methods: Monte Carlo prediction, Monte Carlo control, and exploring starts. Temporal-difference methods: SARSA, Q-learning, and eligibility traces. Function approximation: linear methods, deep neural networks, and value-based and policy-based methods. Actor-critic methods: advantage actor-critic (A2C), asynchronous advantage actor-critic (A3C), and trust region policy optimization (TRPO). Exploration and exploitation: epsilon-greedy, UCB, and Thompson sampling. Multi-armed bandits: contextual bandits, linear bandits, and non-stationary bandits. Applications of RL: robotics, gaming, control systems, and recommendation systems. Advanced topics: deep reinforcement learning, meta-reinforcement learning, and multi-agent reinforcement learning. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. "Reinforcement Learning: An Introduction" 2nd Edition by Richard S. Sutton and Andrew G. Barto, ISBN-10 0262039249, ISBN-13 978-0262039246, 2018. 2. Deep Reinforcement Learning Hands On 2nd Edition by Maxim Lapan, ISBN-10 1838826998, and ISBN-13 978-1838826994, 2020. 3. Reinforcement Learning 1st Edition by Phil Winder Ph.D., ISBN-10 1098114833, ISBN-13 978-1098114831, 2020. | | | | | | |

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| Theory of Automata | | | | | | |
| Course Code: | | AE3306 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Explain** the different concepts in automata theory and formal languages. | | | | 2 | C-2 |
| CLO-2 | **Analyze** properties of languages, grammars, and automata with formal methods. | | | | 3 | C-4 |
| CLO-3 | **Design** grammars and models for different languages | | | | 4 | C-5 |
| Course Contents: | | | | | | |
| Finite State Models: Language definitions preliminaries, Regular expressions/Regular languages, Finite automata (FAs), Transition graphs (TGs), NFAs, Kleene’s theorem, Transducers (automata with output), Pumping lemma and non-regular language Grammars and PDA: CFGs, Derivations, derivation trees and ambiguity, Simplifying CFLs, Normal form grammars and parsing, Decidability, Context sensitive languages, grammars and linear bounded automata (LBA), Chomsky’s hierarchy of grammars Turing Machines Theory: Turing machines, Post machine, Variations on TM, TM encoding, Universal Turing Machine, Defining Computers by TMs. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Automata Theory: An Algorithmic Approach 1st Edition by Javier Esparza and Michael Blondin, ISBN-10 0262048639, ISBN-13 978-0262048637, 2023. 2. Automata Theory with Modern Applications Kindle Edition by James A. Anderson, ISBN-10 0521848873, ISBN-13 978-0521848879, 2022. 3. Automata Theory and Formal Languages: Fundamental Notions, Theorems, and Techniques 1st Edition by Alberto Pettorossi, ISBN-10 3031119649, ISBN-13 978-3031119644, 2022. | | | | | | |

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| HCI & Computer Graphics | | | | | | |
| Course Code: | | AE4307 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Design** user interfaces that conform to human factors principles. | | | | 3 | C-6 |
| CLO-2 | **Analyze** and evaluate the usability of a user interface. | | | | 3 | C-4 |
| CLO-3 | **Develop** computer graphics applications using modern graphics APIs. | | | | 4 | C-5 |
| Course Contents: | | | | | | |
| Introduction to HCI: definition, history, and principles. Human factors and user-centered design: ergonomics, cognitive psychology, and user testing. User interface design: design principles, affordances, and feedback. Interaction techniques: direct manipulation, menus, forms, and widgets. Graphical user interfaces: widgets, layouts, and windowing systems. Information visualization: data types, visual variables, and chart types. Virtual and augmented reality: immersion, presence, and interaction metaphors. Introduction to computer graphics: graphics systems, raster graphics, and vector graphics. 2D graphics: geometric transformations, color models, and image processing. 3D graphics: geometric modeling, rendering, and shading. Animation: principles of animation, keyframing, and motion capture. Advanced topics: HCI in mobile devices, ubiquitous computing, and tangible user interfaces. Final project: students will design, implement, and evaluate a user interface or a computer graphics application. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. HCI and Design in the Context of Dementia 1st Edition by Rens Brankaert, Gail Kenning, ISBN-10 3030328376, ISBN-13 978-3030328375, 2021. 2. HCI in Games 1st Edition by Xiaowen Fang, ISBN-10 3030226018, ISBN-13 978-3030226015, 2019. 3. HCI International 2019 – Poster 1st Edition by Constantine Stephanidis, ISBN-13 978-3030235277, 2019. | | | | | | |

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| Fuzzy Systems | | | | | | |
| Course Code: | |  | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Apply** fuzzy logic to design efficient rule-based systems. | | | | 3 | C-2 |
| CLO-2 | **Develop** algorithms for fuzzy clustering and classification of complex data. | | | | 3 | C-2 |
| CLO-3 | **Design** and evaluate fuzzy control systems for real-world applications. | | | | 4 | C-3 |
| Course Contents: | | | | | | |
| Introduction to fuzzy sets: definition, operations, and properties. Fuzzy logic: propositional and predicate logic, inference, and rule-based systems. Fuzzy clustering: c-means algorithm, fuzzy c-means algorithm, and validity indices. Fuzzy classification: nearest-neighbor classifiers, fuzzy decision trees, and fuzzy support vector machines. Fuzzy control: fuzzy inference systems, Mamdani and Sugeno models, and defuzzification methods. Fuzzy optimization: single-objective and multi-objective optimization using fuzzy logic. Fuzzy databases: fuzzy querying, fuzzy data mining, and fuzzy association rules. Applications of fuzzy systems: engineering, robotics, finance, and medicine. Advanced topics: type-2 fuzzy sets, granular computing, and fuzzy cognitive maps. Final project: students will design, implement, and evaluate a fuzzy system for a real-world problem. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Deep Neuro-Fuzzy Systems with Python 1st Edition by Himanshu Singh and Yunis Ahmad Lone, ISBN-10 1484253620, ISBN-13 978-1484253625, 2019. 2. The Application of Fuzzy Logic for Managerial Decision Making Processes 1st Edition by Andreas Meier, Edy Portmann, ISBN-10 331985304X, ISBN-13 978-3319853048, 2017. 3. Introduction to Fuzzy Logic 1st Edition by James K. Peckol, ISBN-10 1119772613, ISBN-13 978-1119772613, 2021. | | | | | | |

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| Knowledge Based Systems | | | | | | |
| Course Code: | |  | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Develop** knowledge-based systems using various techniques and tools. | | | | 2 | C-6 |
| CLO-2 | **Analyze**, design, and implement knowledge-based systems to solve real-world problems. | | | | 4 | C-4 |
| CLO-3 | **Evaluate** the performance and limitations of knowledge-based systems for specific applications. | | | | 4 | C-5 |
| Course Contents: | | | | | | |
| The course on Knowledge-Based Systems aims to introduce students to the fundamental concepts and techniques used in the design, development, and implementation of knowledge-based systems. The course covers the following topics: Introduction to knowledge-based systems and expert systems. Knowledge representation techniques, such as rules, frames, and semantic networks. Inference mechanisms, including forward and backward chaining, fuzzy logic, and Bayesian networks. Knowledge acquisition and knowledge engineering. Reasoning with uncertainty and managing inconsistent knowledge. Applications of knowledge-based systems in areas such as medicine, finance, and engineering. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. The Knowledge Gap 1st Edition by Natalie Wexler, ISBN-10 0735213569, ISBN-13 978-0735213562, 2020. 2. Artificial Intelligence for Improved Patient Outcomes 1st Edition by DANIEL W. BYRNE, ISBN-10 1975197933, ISBN-13 978-1975197933, 2023. | | | | | | |

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| Mobile Application Development | | | | | | |
| Course Code: | |  | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Develop** mobile applications using industry-standard development tools and frameworks. | | | | 2 | C-2 |
| CLO-2 | **Design** and implement user-friendly interfaces for mobile applications. | | | | 3 | C-5 |
| CLO-3 | **Test** and **deploy** mobile applications across different platforms and devices. | | | | 4 | C-2 |
| Course Contents: | | | | | | |
| The Mobile Application Development course is a comprehensive program that equips students with the knowledge and skills necessary to develop mobile applications for iOS and Android platforms. Spanning 10 weeks, the course covers the fundamental principles of mobile app development, including programming languages, development environments, user interface design, and application deployment. Students will gain proficiency in creating user-friendly and functional mobile applications, exploring data storage techniques, integrating external APIs and services, and mastering the processes of testing, debugging, and optimizing mobile apps. By the end of the course, students will have developed a portfolio of diverse mobile applications that showcase their abilities in mobile app development. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Clean Mobile Architecture 1st Edition by Petros Efthymiou, ISBN-10 6188600707, and ISBN-13 978-6188600706, 2022. 2. Mobile Development with .NET 2nd Edition by Can Bilgin, ISBN-101800204698, ISBN-13978-1800204690, 2021. | | | | | | |

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| Web Technologies | | | | | | |
| Course Code: | |  | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Design** and develop responsive and user-friendly websites using HTML, CSS, and JavaScript. | | | | 2 | C-5 |
| CLO-2 | **Implement** effective navigation and information architecture for websites. | | | | 3 | C-3 |
| CLO-3 | **Optimize** websites for performance, accessibility, and search engine visibility. | | | | 4 | C-2 |
| Course Contents: | | | | | | |
| It covers various aspects of web development, starting with an introduction to web technologies and standards. Students learn HTML and CSS fundamentals, including the structure of web pages, semantic elements, and styling using CSS. The course also delves into JavaScript programming, covering concepts like DOM manipulation and event handling. Students explore front-end development frameworks such as Bootstrap or Foundation, learning how to build responsive and interactive websites using these tools. Additional topics may include web design principles, accessibility considerations, web optimization techniques, and the basics of server-side technologies like PHP or Node.js. Practical exercises, projects, and assignments may be included to provide hands-on experience in developing functional and visually appealing websites. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Front-End Back-End Development with HTML, CSS, JavaScript, jQuery, PHP, and MySQL 1st Edition by Jon Duckett, ISBN-101119813093, ISBN-13978-1119813095, 2022. 2. Responsive Web Design with HTML5 and CSS 4th Edition by Ben Frain, ISBN-10180324271X, ISBN-13978-1803242712, 2022. 3. Web Development with Blazor 2nd Edition by Jimmy Engstrom, Jeff Fritz, ISBN-101803241497, ISBN-13978-1803241494, 2023. | | | | | | |

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| Multivariable Calculus | | | | | | |
| Course Code: | | MT1401 | **Pre-requisite:** | Applied Calculus and Analytical Geometry | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Comprehend** the basic concepts and techniques of differential and integral calculus of functions of several variables. | | | | 1 | C-2 |
| CLO-2 | **Apply** the knowledge of different transforms to solve relevant problems. | | | | 2 | C-3 |
| CLO-3 | **Analyze** the given problems and apply integrals to compute physical quantities like area/volume. | | | | 3 | C-4 |
| Course Contents: | | | | | | |
| Functions of Several Variables and Partial Differentiation, Relative changes, differentials, local and absolute extrema and saddle points, Multiple Integrals, Line and Surface Integrals. Green’s and Stoke’s Theorem. Fourier Series: periodic functions, Functions of any period P-2L, Even & odd functions, Half Range expansions, Fourier Transform; Laplace Transform, Z-Transform. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Calculus with Multiple Variables Essential Skills 1st Edition by Chris McMullen, ISBN-10 1941691374, ISBN-13 978-1941691373, 2021. 2. An Illustrative Guide to Multivariable and Vector Calculus 1st Edition by Stanley J. Miklavcic, ISBN-10 3030334589, ISBN-13 978-3030334581, 2020. 3. Multivariable Calculus 9th Edition by James Stewart, Daniel K. Clegg, Saleem Watson, ISBN-10 0357042921, ISBN-13 978-0357042922, 2020. | | | | | | |

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| Linear Algebra | | | | | | |
| Course Code: | | MT1402 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Interpret** the fundamental concepts of linear algebra, vector equations and linear transformations. | | | | 1 | C-2 |
| CLO-2 | **Apply** the basic knowledge of vector spaces, eigen value and eigen vectors to solve the critical problems of Linear Algebra. | | | | 2 | C-3 |
| CLO-3 | **Solve** systems of linear equations appearing in different engineering applications. | | | | 3 | C-3 |
| Course Contents: | | | | | | |
| Algebra of linear transformations and matrices. determinants, rank, systems of equations, vector spaces, orthogonal transformations, linear dependence, linear Independence and bases, eigenvalues and eigenvectors, characteristic equations, Inner product space and quadratic forms, Applications of linear systems. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Introduction to Linear Algebra 6th Edition by Gilbert Strang, ISBN-10 1733146679, ISBN-13 978-1733146678, 2023. 2. Linear Algebra: Theory, Intuition, Code Latest Edition by Mike X Cohen, ISBN-10 9083136604, ISBN-13 978-9083136608, 2021. 3. Linear Algebra 5th Edition by Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, ISBN-13 978-0136745495, 2022. | | | | | | |

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| Probability & Statistics | | | | | | |
| Course Code: | | MT2403 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Explain** basic understanding of probability and statistics. | | | | 1 | C-2 |
| CLO-2 | **Demonstrate** an ability to use descriptive techniques to describe the statistical data. | | | | 2 | C-2 |
| CLO-3 | **Apply** inferential statistical methods to solve problems. | | | | 3 | C-3 |
| CLO-4 | **Analyze** and investigate any given data distribution. | | | | 3 | C-4 |
| Course Contents: | | | | | | |
| Introduction to Statistics and Data Analysis, Statistical Inference, Samples, Populations, and the Role of Probability. Sampling Procedures. Discrete and Continuous Data. Statistical Modeling. Types of Statistical Studies. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes’ Rule. Random Variables and Probability Distributions. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev’s Theorem. Discrete Probability Distributions. Continuous Probability Distributions. Fundamental Sampling Distributions and Data Descriptions: Random Sampling, Sampling Distributions, Means and the Central Limit Theorem. Sampling Distribution of S2, t-Distribution, F-Quantile and Probability Plots. Single Sample & One- and Two- Sample Estimation Problems and Tests of Hypotheses. The Use of P-Values for Decision Making in Testing Hypotheses (Single Sample & One- and Two-Sample Tests), Linear Regression and Correlation. Least Squares and the Fitted Model, Multiple Linear Regression and Certain, Nonlinear Regression Models, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Introduction to Statistics 2020 Edition by Jim Frost, ISBN-10 1735431109, ISBN-13 978-1735431109, 2020. 2. Probability and Statistics Fourth Edition by Morris DeGroot and Mark Schervish, ISBN-10 0134995473, ISBN-13 978-0134995472, 2018. 3. Introduction to Probability and Statistics 15th Edition by William Mendenhall, Robert J. Beaver, Barbara M. Beaver, ISBN-10 1337554421, ISBN-13 978-1337554428, 2019. | | | | | | |

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| Technical & Business Writing | | | | | | |
| Course Code: | | EW4404 | **Pre-requisite:** | Communication Skills | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Demonstrate** an appropriate communication style to different types of audiences in an ethically responsible manner. | | | | 9 | A-2 |
| CLO-2 | **Demonstrate** competence in producing technical documents. | | | | 7 | A-3 |
| CLO-3 | **Work** on a standard word processing software along with a referencing tool for writing technical reports. | | | | 5 | P-4 |
| CLO-4 | **Present** topics using modern presentation skills and demonstrate a thorough understanding of verbal and non-verbal communication. | | | | 7 | A-3 |
| Course Contents: | | | | | | |
| Overview of technical reporting, use of library and information gathering, administering questionnaires, reviewing the gathered information; Technical exposition; topical arrangement, exemplification, definition, classification and division, casual analysis, effective exposition, technical narration, description and argumentation, persuasive strategy, Organizing information and generation solution: brainstorming, organizing material, construction of the formal outline, outlining conventions, electronic communication, generation solutions. Polishing style: paragraphs, listening sentence structure, clarity, length and order, pomposity, empty words, pompous vocabulary, document design: document structure, preamble, summaries, abstracts, table of contents, footnotes, glossaries, cross- referencing, plagiarism, citation and bibliography, glossaries, index, appendices, typesetting systems, creating the professional report; elements, mechanical elements and graphical elements. Reports: Proposals, progress reports, Leaflets, brochures, handbooks, magazines articles, research papers, feasibility reports, project reports, technical research reports, manuals and documentation, thesis. Electronic documents, Linear verses hierarchical structure documents. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Technical Writing for Business People 1st Edition by Carrie Marshall, ISBN-10 1780174462, ISBN-13 978-1780174464, 2018. 2. The Insider's Guide to Technical Writing 2nd Edition by Krista Van Laan and Joann T Hackos, ISBN-10 1937434788, ISBN-13 978-1937434786, 2022. 3. Business and Technical Writing Sixth Edition by Jeffrey Jablonski, ISBN-10 1465289283, ISBN-13 978-1465289285, 2016. | | | | | | |

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| Social Sciences (Example: Introduction to Marketing) | | | | | | |
| Course Code: | | SS1501 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Explain** the basic concepts and theories of marketing. | | | | 1 | C-1 |
| CLO-2 | **Analyze** and evaluate the marketing environment and consumer behavior. | | | | 2 | C-2 |
| CLO-3 | **Marketing** strategies to real-world situations and make informed decisions. | | | | 3 | C-3 |
| Course Contents: | | | | | | |
| Introduction to Marketing is a course that provides an overview of the principles and practices of marketing. The course covers topics such as the marketing mix, market research, segmentation, targeting and positioning, branding, advertising, sales promotion, pricing, and distribution channels. Students will also learn about consumer behavior, marketing ethics, and the role of marketing in society. The course may include case studies, group projects, and assignments that require students to develop marketing strategies for different products or services. By the end of the course, students will have a solid foundation in marketing concepts and be able to apply them to real-world business problems. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Principles of Marketing 18th edition by Gary Armstrong, Philip Kotler, ISBN-13 978-9352865611, 2021. 2. Principles of Marketing 17th Edition by Gary Armstrong, ISBN-10 013449251X, ISBN-13 978-0134492513, 2017. 3. Marketing Management, Global Edition by Philip Kotler and Kevin Keller, ISBN-10 1292404817, ISBN-13 978-1292404813, 2021. | | | | | | |
| Social Sciences (Example: Financial Accounting) | | | | | | |
| Course Code: | | SS1502 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Understand** and analyze financial statements to make informed decisions. | | | | 4 | C-2 |
| CLO-2 | **Apply** the accounting concepts and principles to record business transactions. | | | | 2 | C-1 |
| CLO-3 | **Analyze** and evaluate financial information for decision-making purposes. | | | | 5 | C-3 |
| Course Contents: | | | | | | |
| This course introduces the fundamentals of financial accounting, focusing on the preparation, analysis, and interpretation of financial statements. Students will learn the basic accounting cycle, including journal entries, adjusting entries, and closing entries. The course covers the principles of accrual accounting and the measurement and reporting of assets, liabilities, and equity. It also introduces the analysis and interpretation of financial statements, including the use of financial ratios to evaluate a company's performance. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Financial Accounting Latest Edition by Dr. S.K. Singh, ISBN-13 978-9351678649, 2020. 2. Financial Accounting Essentials You Always Wanted To Know 4th Edition by Vibrant Publishers and Kalpesh Ashar, ISBN-10 1949395286, ISBN-13 978-1949395280, 2019. 3. Financial Accounting Theory and Analysis 14th Edition by Myrtle W. Clark, Jack M. Cathey, Richard G. Schroeder, ISBN-10 1119577772, ISBN-13 978-1119577775, 2022. | | | | | | |

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| Application of Information & Communication Technology | | | | | | |
| Course Code: | | GE1601 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Identify** and describe various communication protocols and their applications in different networking scenarios. | | | | 2 | C-1 |
| CLO-2 | **Evaluate** the role of information technology in business operations and propose strategies for effective technology adoption. | | | | 4 | C-3 |
| CLO-3 | **Apply** different software tools for data visualization and analysis to support decision-making processes. | | | | 6 | C-3 |
| Course Contents: | | | | | | |
| The course "Application of Information & Communication Technology" is designed to introduce students to the basic concepts of information and communication technology (ICT) and how it is applied in different fields. The course covers topics such as computer hardware and software, operating systems, word processing, spreadsheets, databases, internet, email, and social media. Students will learn how to use various software applications and tools to solve real-world problems and enhance their productivity. Additionally, the course will provide an overview of the ethical and social implications of ICT and its impact on society. By the end of the course, students will have gained a foundational understanding of ICT and its practical applications. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Progress in Information Geometry 1st Edition by Frank Nielsen, ISBN-13 978-3030654580, 2021. 2. Computers Made Easy Second Edition by James Bernstein, ISBN-13 979-8608506109, 2020. 3. Information and Communication Technologies in Education, Research, and Industrial Applications 1st Edition by Vadim Ermolayev, Mari Carmen Suárez-Figueroa, Vitaliy Yakovyna, & 3 more, ISBN-10 303013928X, ISBN-13 978-3030139285, 2019. | | | | | | |

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| Functional English | | | | | | |
| Course Code: | | GE1602 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Understand** and use basic English grammar and vocabulary. | | | | 1 | C-1 |
| CLO-2 | **Write** clear and concise emails and business correspondence. | | | | 2 | C-2 |
| CLO-3 | **Develop** effective speaking and presentation skills for professional settings. | | | | 3 | C-3 |
| Course Contents: | | | | | | |
| Paragraph and Essay Writing, Descriptive Essays; Sentence Errors, Persuasive Writing; How to give presentations, Sentence Errors; Oral Presentations, Comparison and Contrast Essays, Dialogue Writing, Short Story Writing, Review Writing, Narrative Essays, Letter Writing. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. A Systemic Functional Grammar of English: A Simple Introduction 1st Edition, Kindle Edition by David Banks, ISBN-13 978-1138605954, 2019. 2. Learn English Through Stories 1st Edition by Donald Wells, ISBN-13 979-8709118409, 2021. 3. Concise Functional English Grammar 2020: English Grammar 1st Edition by Ricardo Fernandes Marques, ISBN-13 979-8651489015, 2020. | | | | | | |

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| Expository Writing | | | | | | |
| Course Code: | | GE1603 | **Pre-requisite:** | Functional English | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Compose** clear and effective written communication with a focus on audience and purpose. | | | | 1 | C-1 |
| CLO-2 | **Analyze** and evaluate different types of texts for their rhetorical strategies and techniques. | | | | 2 | C-2 |
| CLO-3 | **Synthesize** research from a variety of sources and incorporate it effectively into written arguments. | | | | 3 | C-3 |
| Course Contents: | | | | | | |
| Principles of writing good English, understanding the composition process: writing clearly; words, sentence and paragraphs; Comprehension and expression; Use of grammar and punctuation. Process of writing, observing, audience collecting, composing, drafting and revising, persuasive writing, reading skills, listening skills and comprehension, skills for taking notes in class, skills for exams; Business communications; planning messages, writing concise but with impact. Letter formats, mechanics of business, letter writing, letters, memo and applications, summaries, proposals, writing resumes, styles and formats, oral communications, verbal and non-verbal communication, conducting meetings, small group communication, taking minutes. Presentation skills; presentation strategies, defining the objective, scope and audience of the presentation, material gathering material organization strategies, time management, opening and concluding, use of audio-visual aids, delivery and presentation. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. "The Elements of Style" 4th Edition by William Strunk Jr. and E.B. White, ISBN-13 978-1599632193, 2018. 2. Expository Writing Latest Edtion by Mervin James Curl, ISBN-10 935534211X, ISBN-13 978-9355342119, 2021. 3. Expository Thoughts on the Gospel of Matthew Updated Edition by J. C. Ryle, R. Clark, ISBN-10 1622458621, ISBN-13 978-1622458622, 2022. | | | | | | |

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| Quantitative Reasoning – 1 (Discrete Structures) | | | | | | |
| Course Code: | | GE1604 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Describe** the key concepts of Discrete Structures such as Logic, arguments, sets, Permutations, Relations, Graphs, and Trees etc. | | | | 2 | C-2 |
| CLO-2 | **Apply** formal logic proofs and/or informal, but rigorous, logical reasoning to real problems, such as predicting the behavior of software or solving problems such as puzzles. | | | | 2 | C-3 |
| CLO-3 | **Apply** discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography. | | | | 2 | C-3 |
| CLO-4 | **Differentiate** various discrete structures and their relevance within the context of computer science, in the areas of data structures and algorithms, in particular. | | | | 2 | C-4 |
| Course Contents: | | | | | | |
| Mathematical reasoning, propositional and predicate logic, rules of inference, proof by induction, proof by contraposition, proof by contradiction, proof by implication, set theory, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings, function composition, inverse functions, recursive functions, Number Theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations. Algorithms, Searching and Sorting Algorithms, elements of graph theory, planar graphs, graph coloring, Graph Algorithms, euler graph, Hamiltonian path, rooted trees, traversals. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Discrete Mathematics and Its Applications Eighth Edition by Kenneth Rosen, ISBN-10 1260091996, ISBN-13 978-1260091991, 2018. 2. Practical Discrete Mathematics Latest Edition by Ryan T. White, Archana Tikayat Ray, ISBN-10 1838983147, ISBN-13 978-1838983147, 2021. | | | | | | |

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| Quantitative Reasoning – 2 (Calculus and Analytical Geometry) | | | | | | |
| Course Code: | | GE1605 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Describe** real value functions of one and more variables. | | | | 1 | C-1 |
| CLO-2 | **Apply** the concepts of limits and continuity to solve problems in differential calculus. | | | | 3 | C-3 |
| CLO-3 | **Solve** applied problems by applying concepts of Integration. | | | | 3 | C-3 |
| Course Contents: | | | | | | |
| Limits and Continuity; Introduction to functions, Introduction to limits, Techniques of funding limits, Indeterminate forms of limits, Continuous and discontinuous functions and their applications, Differential calculus; Concept and idea of differentiation, Geometrical and Physical meaning of derivatives, Rules of differentiation, Techniques of differentiation, Rates of change, Tangents and Normal lines, Chain rule, implicit differentiation, linear approximation, Applications of differentiation; Extreme value functions, Mean value theorems, Maxima and Minima of a function for single-variable, Concavity, Integral calculus; Concept and idea of Integration, Indefinite Integrals, Techniques of integration, Riemann sums and Definite Integrals, Applications of definite integrals, Improper integral, Applications of Integration; Area under the curve, Analytical Geometry; Straight lines in R3, Equations for planes. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Essential Calculus Skills Latest Edition by Chris McMullen, ISBN-10 1941691242, ISBN-13 978-1941691243, 2018. 2. Informal Introduction to Stochastic Calculus with Applications 2nd Edition by Ovidiu Calin, ISBN-10 9811247099, ISBN-13 978-9811247095, 2021. 3. INTEGRALS (Modular system) 1st Edition by Jeffrey Collins, ISBN-13 979-8502505314, 2021. | | | | | | |

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| Islamic Studies | | | | | | |
| Course Code: | | GE2606 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Demonstrate** the understanding of fundamental human rights and relation with non-Muslims through discussion on related issues. | | | | 9 | C-2 |
| CLO-2 | **Demonstrate** knowledge of Islamic civilization and moral values. | | | | 10 | C-2 |
| Course Contents: | | | | | | |
| Basic Themes of Quran, Introduction to Sciences of Hadith, Introduction to Islamic Jurisprudence, Primary & Secondary Sources of Islamic Law, Makken & Madnian life of the Prophet, Islamic Economic System, Political theories, Social System of Islam. Definition of Akhlaq.The Most Important Characters mentioned in the Holy Qur’an and Sunnah, SIDQ (Truthfulness) Generosity Tawakkaul(trust on Allah)Patience Taqua (piety). Haqooq ul ibad in the light of Quran & Hadith - the important characteristic of Islamic Society. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Principles of Islamic Studies Latest Edition by Harun Verstaen, ISBN-13 979-8360629962, 2022. 2. Weekend Learning Islamic Studies Level 1 (Revised and Enlarged Edition) by Mansur Ahmad and Husain A. Nuri, ISBN-10 1936569574, ISBN-13 978-1936569571, 2018. | | | | | | |

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| Ideology and Constitution of Pakistan | | | | | | |
| Course Code: | | GE4607 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Demonstrate** the understanding of political and constitutional system of Pakistan. | | | | 8 | C-2 |
| CLO-2 | **Understand** the social, moral, and cultural values system of  Pakistan. | | | | 9 | C-2 |
| CLO-3 | **Analyze** the contemporary problems faced by Pakistan (social, human resource, economic development, food safety / water resources) | | | | 8 | C-4 |
| Course Contents: | | | | | | |
| Historical background of Pakistan: Muslim society in Indo-Pakistan, the movement led by the societies, the downfall of Islamic society, the establishment of British Raj- Causes and consequences. Political evolution of Muslims in the twentieth century: Sir Syed Ahmed Khan; Muslim League; Nehru; Allama Iqbal: Independence Movement; Lahore Resolution; Pakistan culture and society, Constitutional and Administrative issues, Pakistan and its geo- political dimension, Pakistan and International Affairs, Pakistan and the challenges ahead. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Ideology of Pakistan Islam in South Asia 2nd Edition by Sharif Mujahid, ISBN-10 9694082234, ISBN-13 978-9694082233, 2009. 2. Pakistan: Ideology, Constitution, Laws, Foreign Policy Edition 2 by Samin Khan, ISBN-10 9694082234, 2007. | | | | | | |

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| Social Sciences (Example: Introduction to Management) | | | | | | |
| Course Code: | | GE2608 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Understanding** principles of management. | | | | 2 | C-1 |
| CLO-2 | **Developing** leadership and decision-making skills. | | | | 4 | C-2 |
| CLO-3 | **Knowledge** of organizational behavior and human resource management. | | | | 3 | C-3 |
| Course Contents: | | | | | | |
| Introduction to Management: concept, nature, and purpose, Evolution of Management Thought: classical, behavioral, and modern approaches, Functions of Management: planning, organizing, staffing, directing, and controlling, Decision Making and Problem Solving, Leadership and Motivation, Communication in Management, Human Resource Management, Marketing Management, Financial Management, Operations Management, Contemporary Issues in Management. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Principles of Management New Edition by David S Bright, Anastasia H Cortes, ISBN-10 1680922882, ISBN-13 978-1680922882, 2019. 2. Management 14th Edition by Richard L. Daft, ISBN-10 0357139755, ISBN-13 978-0357139752, 2021. 3. Principles of Management Essentials You Always Wanted To Know Second Edition by Vibrant Publishers, Callie Daum, ISBN-10 1949395669, and ISBN-13 978-1949395662, 2020. | | | | | | |

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| Art & Humanities (Professional Practices) | | | | | | |
| Course Code: | | GE4610 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Identify** the content of religious, national, or international law dealing with professional ethics | | | | 8 | A-2 |
| CLO-2 | **Apply** the knowledge of ethics in their personal and professional life. | | | | 9 | A-3 |
| CLO-3 | **Gain** the ability to enhance key factors of interpersonal relations, to follow and implement the acquired knowledge of ethical skills in given situations by controlling his/her temperament. | | | | 10 | A-4 |
| Course Contents: | | | | | | |
| Historical, social, and economic context of Computing (software engineering, Computer Science, Information Technology); Definitions of Computing (software engineering, Computer Science, Information Technology) subject areas and professional activities; professional societies; professional ethics; professional competency and life-long learning; uses, misuses, and risks of software; information security and privacy; business practices and the economics of software; intellectual property and software law (cyber law); social responsibilities, software related contracts, Software house organization. Intellectual Property Rights, The Framework of Employee Relations Law and Changing Management Practices, Human Resource Management and IT, Health and Safety at Work, Software Liability, Liability and Practice, Computer Misuse and the Criminal Law, Regulation and Control of Personal Information. Overview of the British Computer Society Code of Conduct, IEEE Code of Ethics, ACM Code of Ethics and Professional Conduct, ACM/IEEE Software Engineering Code of Ethics and Professional Practice. Accountability and Auditing, Social Application of Ethics. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Professional Issues in Software Engineering 3rd Edition by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, CRC Press, ISBN-10: 0748409513, 2020. 2. Applied Professional Ethics New Edition by Gregory R. Beabout, University Press of America, ISBN-10: 0819193747, 2019. | | | | | | |

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| Civics and Community Engagement | | | | | | |
| Course Code: | | GE4611 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Identify** and analyze the roles of citizens in civic engagement and community problem-solving. | | | | 3 | C-2 |
| CLO-2 | **Develop** strategies for community building and conflict resolution using civic engagement. | | | | 5 | C-2 |
| CLO-3 | **Evaluate** the impact of civic and community engagement on personal and social development. | | | | 6 | C-2 |
| Course Contents: | | | | | | |
| Civics and Community Engagement might cover topics such as civic responsibility, government structures and processes, citizen participation, and community development. It may also involve practical experiences such as community service or internships. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Civic Engagement in Communities of Color Latest Edition by Kristen E. Duncan, Wayne Journell, ISBN-10 0807768561, ISBN-13 978-0807768563, 2023. 2. Civic Engagement and Leadership: Edition II by Dr. Tekemia Dorsey, Beloved Joshua Simons, ISBN-10 1958785148, ISBN-13 978-1958785140, 2022. 3. Community Participation and Civic Engagement in the Digital Era: Localizing Sustainable Development New Edition by Mudit Kumar Singh, ISBN-10 1802622926, ISBN-13 978-1802622928, 2022. | | | | | | |

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| Entrepreneurship | | | | | | |
| Course Code: | | GE4612 | **Pre-requisite:** | None | | |
| Credit Hours: | | 3+0 |
| Course Learning Outcomes (CLOs): PLO BT Level | | | | | | |
| CLO-1 | **Create** a business plan for a new venture. | | | | 2 | C-2 |
| CLO-2 | **Identify** and evaluate opportunities for starting a new business. | | | | 1 | C-2 |
| CLO-3 | **Analyze** the financial aspects of a new venture, including revenue streams and costs. | | | | 3 | C-2 |
| Course Contents: | | | | | | |
| Introduction to entrepreneurship and its importance in economic growth, Ideation, opportunity recognition, and evaluation, Business planning and feasibility analysis  Marketing and sales strategies, Financial management, including budgeting and forecasting, Legal and regulatory considerations for starting a business, Innovation, intellectual property, and product development, Leadership and management skills for entrepreneurs, Networking, partnerships, and collaborations, Social entrepreneurship and sustainable business practices. | | | | | | |
| Teaching Methodology: | | | | | | |
| Lectures, Written Assignments, Semester Project, Presentations | | | | | | |
| Course Assessment: | | | | | | |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam | | | | | | |
| Reference Materials: | | | | | | |
| 1. Entrepreneurship: Theory, Process, Practice 12th Edition by Donald F. Kuratko, ISBN-10 0357899504, ISBN-13 978-0357899502, 2023. 2. Entrepreneurial Mindset: Mastering Personal Development for Business Success Kindle Edition by Christina Hoffmann, ISBN-13 978-0357899624, 2023. 3. Entrepreneurship: The Practice and Mindset 2nd Edition by Heidi M. Neck, Christopher P. Neck , Emma L. Murray, ISBN-10 1544354622, ISBN-13 978-1544354620, 2020. | | | | | | |

# Quality Assessment Criteria

An assessment measures the student’s knowledge, skills, and attitudes according to well-defined Course Learning Outcomes (CLO’s) and Program Learning Outcomes (PLO’s) in a course. Therefore, the development of credible quality assessment criteria will become imperative to improve the quality of education. The department must assess its overall performance periodically using quality criteria. The following are the main features of good quality assessment criteria.

# Validity

Validity means all the CLO’s and PLO’s in a course are being assessed effectively and efficiently according to the mapping of CLO’s and PLOs with the course content defined in a course outline of a subject. Each course must consist of a minimum of three CLO’s to capture the whole scope of the different domain levels of the subject as described in Bloom’s Taxonomy. Instructors should create answer models and rubrics when developing the assessment.

# Reliability

The CLO’s and PLO’s should be assessed frequently in a course so that the adequate evaluation measurements can be recorded on each CLO. This will help instructors to take remedial actions to improve the assessment in the future.

# Effectivity

Effectivity measures the alignment of course assessments, CLO’s, PLO’s, and objectives with each other. This will help students to remain focused on the course objectives.

# Transparency

Assessments should be evaluated without any bias and according to the well-defined rubrics/detail marks distribution of each question in the solved samples such as quizzes, assignments, midterm, and final term exams. Afterwards, students have the right to review their exams or assessments, so it is clear how their final grade came to be and also so they can receive feedback on their performance.

# Feasibility

The instructors should spend suitable time to deliver lectures on each CLO. The instructors should discuss paper pattern, weightage of each evaluation instrument and grade evaluation criteria openly. The students should be given ample time to prepare and solve the assignments, quizzes, midterm, and final term exams.

# Academic Ethics

The instructors should develop an environment in which students should work/give exams with proper ethics without any unfair means such as cheating and plagiarizing any document. If the students take help from other materials, they should properly cite that work.

**Validity**

**Assessment of all CLO's/PLO's**

**Mapping of the assessments of CLO's and PLO's with the course content**

**Minimum 3 CLO's**

**Solved samples and rubrics**

**Reliability**

**Frequent assessment of each CLO's**

**Minimum two times each CLO should be assessed**

**Discussion of assessment pattern with other resource persons**

**Effectivity**

**Course alignment strategy**

**Transparency**

**Evaluation according to the well-defined rubrics/detaiil marks distribution**

**Evaluation review**

**Feasibility**

**Reservation of ample time to deliver lecture on the course contents of each CLO**

**Discussion of paper pattern**

**Weightage criteria of each evaluation instrument**

**Considerable time for the preparation and solution of assessments**

**Ethics**

**Avoidance of unfair means**

**Plagiarism check on assignments/case study/academic documents**

**Figure 1: Characteristics of credible Quality Assessment Criteria**

# Criteria Considerations for the Quality Assessment

Teachers should consider the following criteria, which is described in the below table to achieve high quality assessments.

|  |  |
| --- | --- |
| **Criteria Considerations** | **Yes/No** |
| **Validity** | |
| 1. Did all the CLO’s and PLO’s assess in a course? |  |
| 1. Did the assessment of each CLO belong to its relative course content as described in the course outline? |  |
| 1. Did the course contain at least 3 CLO’s? |  |
| 1. Did all the assessments and tasks have solved models? |  |
| 1. Did all the solved models properly documented? |  |
| 1. Did all the well-defined rubrics and clear marking schemes developed to assess the CLO’s/PLO’s? |  |
| 1. Did all the assessments carefully developed so that the assessment should not assess irrelevant content? |  |
| **Reliability** | |
| 1. Did each CLO assess multiple times in a course? |  |
| 1. Did the assessment patterns discuss with the other resource persons before taking the assessments. |  |
| 1. In case, if any student gets low marks in one CLO assessment in one evaluation and in the other evaluation of same CLO, he gets good marks, did the instructor give proper remarks and describe remedial actions taken by the instructor to improve the quality of education? |  |
| 1. Did the teacher use second accessor to increase the reliability of an assessment? |  |
| **Effectivity** | |
| 1. Did the teacher use proper verbs of Bloom’s taxonomy in the assessments such as quizzes, assignments, midterm, final term etc. as mentioned in a course outline? |  |
| 1. Did all the assessments align with the described domain levels in a course outline? |  |
| 1. Did the assessments cover all the domain and thinking levels such as cognitive, affective, and psychomotor domains as described in a course outline? |  |
| **Transparency** | |
| 1. Did the teacher describe detail marks distribution of each question in an assessment? |  |
| 1. Did the solved samples of the assessments with the detail marks distribution share with the students and fully documented? |  |
| 1. Did the students give the right to review their assessments? |  |
| **Feasibility** | |
| 1. Did the teacher spend enough time on the course content of each CLO? |  |
| 1. Did the teacher present a complete pattern of the assessments before the students? |  |
| 1. Did the teacher grade the students on the described weightage criteria of the assessments as mentioned in a course outline? |  |
| 1. Did the teacher give ample time to solve the assessments? |  |
| **Ethics** |  |
| 1. Did the teacher provide an ethical environment, spacious classrooms and take suitable measures to avoid unfair means such as cheating etc.? |  |
| 1. Did the teacher check the plagiarism of the submitted documents?   OR Did the teacher take the measures to check that the work is original? |  |
| 1. In case the student takes help from other materials, did the teacher check that the literature from the other material is properly cited? |  |

**Mechanisms for CQI**

**Corrective Actions with assessment data and levels according to NCEAC**

***Table 1: Examples of Corrective Actions with assessment data and levels***

|  |  |  |
| --- | --- | --- |
| **Level of Corrective Action** | **Assessment Data** | **Corrective Actions Required**  **(Examples)** |
| Program Level | Program PLO Evaluation  PEO evaluation  Industry Input | Curriculum Modified  Mission Revised  Core/ Elective Courses Updated  PLOs Revised  PEOs Revised |
| Course Level | Course PLO Assessment  Course CLO Assessment  Course file  Course Review Report  Student Course Feedback  Batch Advisor Feedback | Course Contents  Pre-Requisite Of Course  CLO  Learning Level  Targeted PLO |
| Student Level | Student Grades Record  Student GPA and CGPA  Student Internship Data  Student FYP Assessment  Feedback of Advisors on Individual Students | Individual meeting session with Advisor  Arranging specially designed tutorials  Re-appearing in a specific course |

**CQI Based on CLO Attainment**

***Table 2: KPIs for CLOs***

|  |  |  |
| --- | --- | --- |
| **CLOs** | **KPI** | **Measurement Tool** |
| All CLOs defined for a particular course | 1. CLO attainment of all students in each section is greater than **40%** 2. More than 50% of the students have attainment greater than **40%** in each CLO | All assessment tools mapped to CLOs, as documented in the course outline |



**Figure 2: CQI based Hierarchy for CLO Attainment**

**CQI Based on PLO Attainment**

***Table 3: KPIs for PLOs***

|  |  |  |
| --- | --- | --- |
| **PLOs** | **KPI** | **Measurement Tool** |
| PLOs 1 – 10 | PLO attainment of each student is greater than 50%  PLO attainment of the cohort is greater than 50% | Direct assessment through CLO to PLO mapping of all courses. Also, Indirect assessment through the resource persons of Cohort subjects and survey conducted by AI QEC |



**Figure 3: Remedial action for PLO attainment**

**PLO specific Course List**

A graduating student who will not be able to obtain 50% score in any PLO attainment, he will be assessed from the following courses to complete CQI process.

|  |  |  |
| --- | --- | --- |
| **PLOs** | **Course List** | **Course Code** |
| PLO 1 | Programming Fundamentals | CC1101 |
| PLO 2 | Object oriented Programming | CC1102 |
| PLO 3 | Programming for AI | AC2201 |
| PLO 4 | Artificial Neural Network & Deep Learning | AC3203 |
| PLO 5 | Knowledge Representation & Reasoning | AC3204 |
| PLO 6 | Artificial Neural Network & Deep Learning | AC3203 |
| PLO 7 | Computer Vision | AC3205 |
| PLO 8 | Machine Learning | AC2202 |
| PLO 9 | Computer Vision | AC3205 |
| PLO 10 | Knowledge Representation & Reasoning | AC3204 |

***Table 4: KPIs and measurements tools for assessments of PEOs***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Program Educational Objectives** | **How measured** | **When measured** | **Improvement identified** | **Performance Indicator** | **Improvement made** |
| 1 | Employer Survey,  Alumni Survey, MOM of IAB | After the Graduation | Industrial problem identification.  Working in collaboration with industry and research organizations. | More than 50% of the total responses secure an average of 45% or more for Q1 through Q6 | Industrial reports included, emphasize on engineering entrepreneurship; projects in collaboration for local and international research organizations. |
| 2 | Employer Survey,  Alumni Survey, MOM of IAB | After the Graduation | Assessment failure (whole or CLO based) | More than 50% of the total responses secure an average of 45% or more for Q7 through Q9 | CLO based improvements and successful completion of courses |
| 3 | Employer Survey,  Alumni Survey, MOM of IAB | After the Graduation | Project evaluations | More than 50% of the total responses secure an average of 45% or more for Q10 through Q12 | Clearance of results |

**Design of Alumni Survey and Employer Survey :( Questions and Rubrics are in progress)**

Diagram

Description automatically generated

***Figure 4: Remedial Action for PEO Attainment.***

### Analysis of Alumni and Employer Survey

Departmental IAB conducts both of these surveys. IAB also gives its own feedback and evaluation with the same rubrics.

**Supporting Documents and Folders for the Program Assessment Criteria**

The following supporting documents must be collected to evaluate the program assessment.

1. Course Description folder.
2. CQI folder.
3. CLO/PLO Transcript folder
4. PEOs assessment folder.

**Course Description Folder**

Course Description file consists of the following documents:

1. CLO based Course Outline.
2. CQI form.
3. PLO sheets.
4. CLO sheets.
5. Course Result sheet.
6. Attendance sheet.
7. CLO based Quizzes.
8. CLO based midterm question paper.
9. CLO based final term question paper.
10. Solved samples of the quizzes with proper marks distribution.
11. Solved samples of the midterm paper with proper marks distribution.
12. Solved samples of the final paper with proper marks distribution.
13. 3 samples of each assessment (Good, Average, Worst) with plagiarism report if required.
14. Course Completion Report.

**CQI remedial folder**

CQI folder consists of the signed CQI remedial forms from the Resource Person and Chairman of the department of all the courses offered in the previous semesters to modify the courses in the next coming semesters.

**CLO/PLO Transcript folder**

CLO/PLO transcript folder consists of all the CLO’s/PLO’s transcripts of each semester**.**

**PEOs Assessment folder**

PEOs assessment folder consists of the Alumni surveys, Employer surveys, Departmental IAB feedback and their rubrics to enhance the quality of PEOs in the future.