




**NOTIFICATION**

On the recommendations of Academic Council made in its 21<sup>st</sup> (2/2024) meeting held on 07.06.2024, the Syndicate in its 67<sup>th</sup> (3/2024) meeting held on 12.07.2024 approved the curricula of following programs for implementation w.e.f. Fall 2024:

- i. BS in Data Science (Annex-'A')
- ii. BS in Artificial Intelligence (Annex-'B')

  
(WAQAR AHMAD)  
Additional Registrar (General)

No. SU/Acad/24/774

Dated: 03.10.2024

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Annex - A

Curriculum  
of  
BS Data Science  
for  
Main Campus



Department of Computer Science  
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(Applicable from Fall-2024)

*H. Farid*  
Chairman  
Department of Computer Science  
University of Sargodha

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## Underlying Principles of BS Data Science Degree Programs

Computing (a nucleus of all activities including technical, academic, professional and development practices relating to computers) provides a wide range of choices on how an individual might focus his or her professional life. This document provides an overview of the different kinds of degree programs in Computing that are currently available and for which curriculum standards are now available. It is believed that this report may be an essential source for university faculty, administrators, students, parents and professionals who need to be aware of Computing as a broad based discipline that crosses the boundaries between science, engineering, and professional practice. In reality, computing consists of several disciplines. Various questions are naturally critical including: what are the different kinds of Computing degree programs or how are they similar and how are they different? The variety of degree programs in Computing presents prospective students, educators, and administrators with important choices where they may focus their efforts.

The following sections of the report also provide a complete detail of the proposed curricula pertaining to the Data Science BS program. All details regarding the scheme of study, course content with CLOs, and overall structure of the degree programs are presented in this document. Computing is a dynamic field and accordingly a good care has been taken to design a flexible structure that will maintain currency with the latest scientific and technological advancements in the field. Moreover, it seems that Computing is a discipline that incorporates scientific, engineering, and creative features. A reasonable emphasis has been given to formal scientific and engineering areas to enhance the level of formalization in the degree programs. Technology can play an important role in the implementation of Computing programs. As a result, all programs are structured on essential dimensions including scientific knowledge, technology, and design skills.



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## Curriculum for BS Data Science Program

### BSDS Program's Rationale

Data science is the study of extracting useful information from data using advanced analytical tools and scientific concepts for business decision-making, strategic planning, and other purposes. It's becoming increasingly important for businesses. Data science provides organizations with insights that help them enhance operational efficiency, find new business prospects, and improve marketing and sales initiatives, among other things. They can, in the end, give you a competitive advantage over your competitors.

Recent developments in computer hardware, software and communication technologies have offered new exciting opportunities and challenges for creation of innovative learning environments for Data Science and its curricula design. The challenge of getting all newly emerging technologies incorporated into the curriculum is becoming pivotal for the effectiveness of curricula. There is a need for curricula structures that are really able to meet the challenges of 21<sup>st</sup> century knowledge driven complex work places. The key rationale behind the BS Data Science program is to prepare a curriculum that provide integration of all components and the foundations that allow accessing all of the new knowledge and technology to fulfill the vision of future.

Data engineering, statistics, programming, social engineering, data warehousing, machine learning, and natural language processing are all used to create data science concepts and procedures. Data mining, large data analysis, data extraction, and data retrieval are some of the most common approaches employed.

There are various advantages to data science. Data science aids organizations in making faster and better decisions, identifying and refining target audiences, and more.

### Program's Aims & Objectives

Data Science program aims to develop students' programming abilities, proficiency with statistical analysis of data, build and access data-based models, executional of statistical analysis and data management skills. Moreover, students will be able to utilize data science concepts and methods to solve real world problems. Students can design more complex algorithms involving more complex data structures, and can implement their solutions in multiple languages. Students can also compare the performance of multiple methods and models, recognize the connections between how the data were collected and the scope of conclusions from the resulting analysis, and articulate the limitations and abuses of formal inference and modeling. Students have multiple strategies for constructing models and can use different measures of model fit and performance to assess models. Students can design their own statistical analyses and implement them with advanced statistical programming tools. Some of the key objectives of the program are listed below:

- The program should provide a broad understanding of the field through introducing concepts, theory, techniques, and through intensive education/training in focused areas of Data Science.
- The program should enhance student's ability to identify the characteristics of datasets and compare the trivial data and big data for various applications. Students can integrate data from disparate sources, can transform data from one format to another, and can program data management in relational databases.
- The program should encourage students to design and implement machine learning techniques

and computing environment to solve real world problems.

- The program should develop abilities in students to prepare a wider range of visual and numerical data summaries and carry out basic inferential procedures using Data Science techniques.
- The program should provide formal foundations for higher learning and education.
- The program should be dynamic and flexible enough to maintain its body of knowledge in line with the latest scientific and technological developments in the field.
- The program should provide professional orientation to prepare students for industry in the data science.


## Curricula Consideration

During the revision of the Computing Curricula two major guidelines have been considered (ACM and Seoul Accord). However, in some cases the main focus of these guidelines is mostly traditional Artificial Intelligence programs.

## Association of Computing Machinery (ACM) - Guidelines

Association of Computing Machinery (ACM), USA is the largest body in the world for computer scientists. Its membership is spread over the entire globe. It has a pool of highly reputed professionals which meet after a few years to assess the directions being taken by the computing discipline. In view of its assessment, it identifies knowledge areas and also their relative importance in the years to come. Thus, ACM shows the path to follow to the computing academia and professionals all over the world. Computing curricula are designed keeping in view following identified knowledge areas of ACM [ref # ACM 2013 curriculum report]. It has been tried to reasonably cover all knowledge areas without compromising the flexibility needed for a national model curriculum. The mapping of these key knowledge areas with the courses are given in the table below.

- AL - Algorithms and Complexity
- AR - Architecture and Organization
- CN - Computational Science
- DS - Discrete Structures
- GV - Graphics and Visual Computing
- HCI - Human-Computer Interaction
- IAS - Information Assurance and Security
- IM - Information Management
- IS - Intelligent Systems
- NC - Networking and Communications
- OS - Operating Systems
- PBD - Platform-based Development
- PD - Parallel and Distributed Computing
- PL - Programming Languages
- SDF - Software Development Fundamentals
- SE - Software Engineering
- SF - Systems Fundamentals
- SP - Social Issues and Professional Issues

  
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The following knowledge areas have been addressed with the major computing courses.

### Knowledge Areas in ACM CS 2013 Curriculum

#	Knowledge Area	CS 2013		ACM 2013 Subjects Taught in Various Universities	NCEAC Revised 2023 Subjects in Core
		Tier-1	Tier-2		
1	AL-Algorithms and Complexity	19	9	Algorithms; Algorithms and Data Structures; Algorithm Design and Analysis	Data structures, Analysis of Algorithms, Theory of Automata
2	AR-Architecture and Organization	0	16	Intro to Computer Architecture; DLD; Computer Engineering	DLD, Computer Org & Assembly Language, Computer Architecture
3	CN-Computational Science	1	0	eScience; Modeling and Simulation; Computer Graphics	HCI & Computer Graphics; (Elective: Numerical Analysis)
4	DS-Discrete Structures	37	4	Discrete Mathematics; Mathematical Foundations of CS; Probability for CS; Discrete Structures 1; Discrete Str 2	Discrete Structures, Probability & Statistics
5	GV-Graphics and Visualization	2	1	Computer Graphics; Computer Graphics	HCI & Computer Graphics; (Elective: Computer Graphics)
6	HCI-Human-Computer Interaction	4	4	Human Computer Interaction	HCI & Computer Graphics
7	IAS-Information Assurance and Security	3	6	Computer Systems Security	Information Security; (Elective: Cyber Security)
8	IM-Information Management	1	9	Database Systems	Database Systems; Adv Database Management Sys
9	IS-Intelligent Systems	0	10	Artificial Intelligence Programming; Artificial Intelligence	Artificial Intelligence
10	NC-Networking and Communication	3	7	Introduction to Computer Networking; Computer Networks	Computer Networks
11	OS-Operating Systems	4	11	Operating Systems	Operating Systems

12	PBD-Platform-based Development	0	0		(Electives: Web Technology {ASP, Javascript}, Visual Prog {C#}, Mobile App Dev {React/Flutter/Kotlin/Swift})
13	PD-Parallel and Distributed Computing	5	10	Parallel Programming Principle and Practice;	Parallel & Distributed Computing
14	PL-Programming Languages	8	20	Introduction to Compilers; Compilers; Introduction to Programming; Programming Languages	Programming Fundamentals, OOP, Compiler Construction
15	SDF-Software Development Fundamentals	43	0	Java Programming I; Introduction to Program Design; Introduction to Programming; OOP	Programming Fundamental, Object Oriented Programming, Data Structures
16	SE-Software Engineering	6	22	Software Engineering	Software Engineering
17	SF-Systems Fundamentals	18	9	Computer Systems and Networks; Great Ideas in Computer Architecture; System Programming	DLD, Computer Networks, Computer Architecture
18	SP-Social Issues and Professional Practice	11	5	Ethics in Technology; Technology Consulting in the Community	Professional Practices
	<b>Total Core Hours</b>	<b>165</b>	<b>143</b>		
		<b>308</b>			

  
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### Outcome Based Education (OBE) System and Seoul Accord:

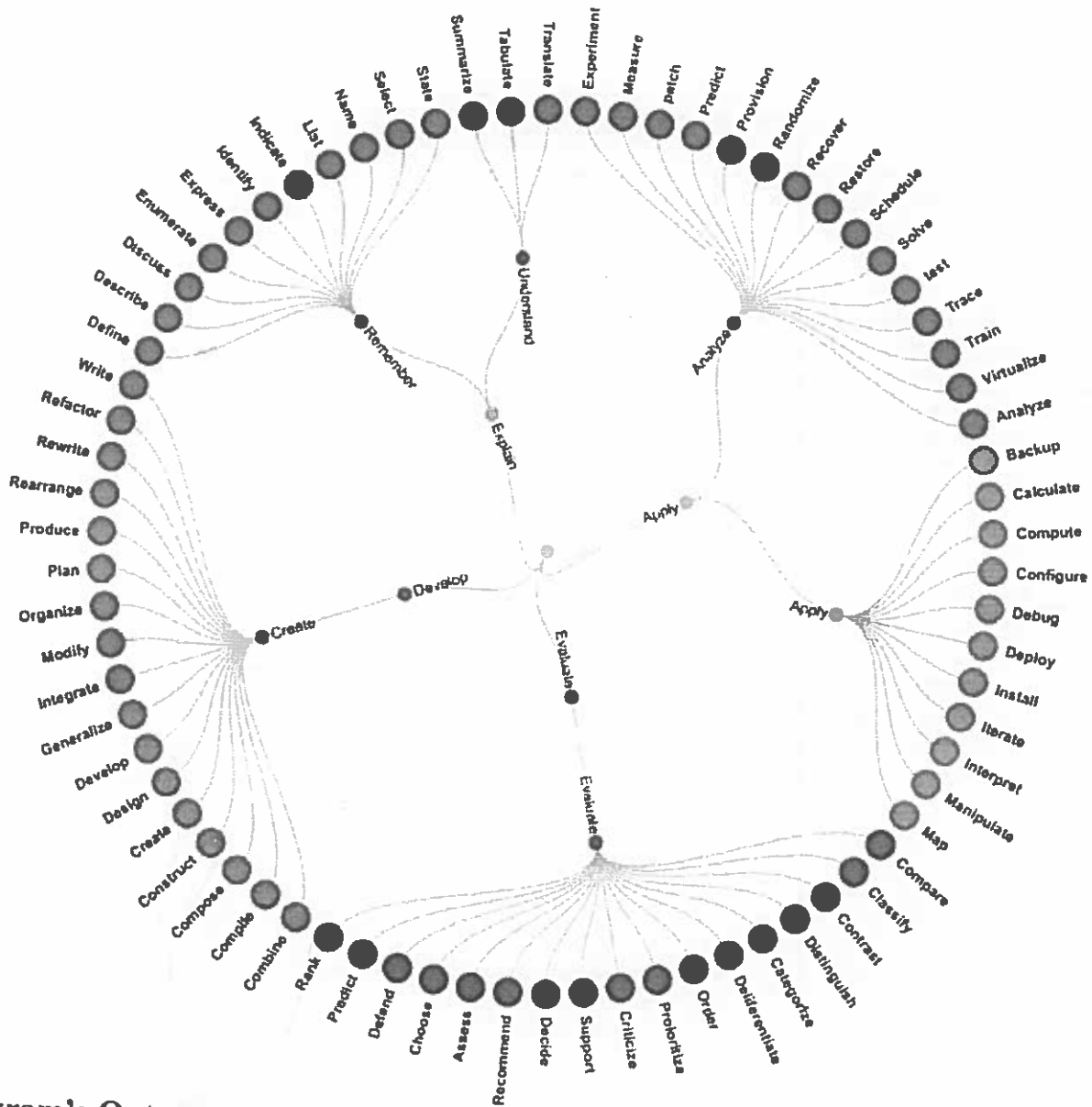
Keeping in view the latest transformation from knowledge-based education philosophy to Outcome based education (OBE) system, the OBE model based on Seoul Accord has also been considered. Computing programs prepare students to attain educational objectives by ensuring that students demonstrate achievement of the following outcomes (derived from Graduate Attributes define by Seoul Accord [www.seoulaccord.org](http://www.seoulaccord.org) ).

S#	Program Learning Outcomes (PLOs)	Computing Professional Graduate
1	Academic Education	To prepare graduates as computing professionals
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.
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.
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.
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.
6	Individual and Team Work	Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.
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.
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
9	Ethics	Understand and commit to professional ethics, responsibilities, and norms of professional computing practice
10	Life-long Learning	Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional

## Bloom's Taxonomy

Revised Bloom's Taxonomy	Skill level with applicable verbs
Remember	<b>Explain:</b> define, describe, discuss, enumerate, express, identify, indicate, list, name, select, state, summarize, tabulate, translate
Understand	
Apply	<b>Apply:</b> backup, calculate, compute, configure, debug, deploy, experiment, install, iterate, interpret, manipulate, map, measure, patch, predict, provision, randomize, recover, restore, schedule, solve, test, trace, train, virtualize
Analyze	<b>Evaluate:</b> analyze, compare, classify, contrast, distinguish, categorize, differentiate, discriminate, order, prioritize, criticize, support, decide, recommend, assess, choose, defend, predict, rank
Evaluate	
Create	<b>Develop:</b> combine, compile, compose, construct, create, design, develop, generalize, integrate, modify, organize, plan, produce, rearrange, rewrite, refactor, write

  
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**Program's Outcome**

The program will produce Data Science experts of great character, competence, vision and drive equipped with up-to-date knowledge, marketable skills, valuable competencies, unique expertise, globally compatible dispositions and culturally and professionally acceptable values to take on appropriate professional roles in computer science domain or proceed to further or higher education or training.

**Program's Structure**

BS (Data Science) has a dual emphasis on basic principles of statistics and computer science, with foundational training in statistical and mathematical aspects of data analysis. This program develops foundation on broad computer science principles, including algorithms, data structures, data management and machine learning. This program will prepare graduates for a career in data analysis, combining foundational statistical concepts with computational principles from computer science.

## Degree Requirement

Minimum credit hours shall be 130 for BS Data Science program.

## Duration

The program shall comprise of minimum eight semesters/terms spread over four calendar years with two semesters/terms a year as per the rules of the University.

## Eligibility Criteria

The minimum requirements for admission in a bachelor degree program in Computer Science is at least 50% marks in Intermediate (HSSC) examination with one of the following combinations:

- i. Pre-Engineering
- ii. Pre-Medical (Admitted candidates have to pass 6-credit hours courses of mathematics in first two semesters.)
- iii. General Science
  - a. Mathematics, Statistics, Physics
  - b. Mathematics, Statistics, Economics
  - c. Mathematics, Statistics, Computer
  - d. Mathematics, Physics, Computer
  - e. Mathematics, Economics, Computer
- iv. A-Levels (with equivalence of mentioned above by IBCC) with at-least 50% obtained marks

## Assessment & Evaluation

University's semester and examination rules & regulations shall be followed for assessment & evaluation.

## Distribution of Courses

The distribution of total credit hours for BSDS is given as follows:

BS Data Science			
Category	Major Areas	Credit Hours	Courses
General education	General Education Requirement	30	12
Major courses	Computing core	46	14
	Domain core	18	06
	Domain elective	21	07
Interdisciplinary courses	Mathematics & supporting	12	04
	Elective supporting	03	01
		<b>130</b>	<b>44</b>

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## Mapping of BS Data Science Program on the Generic Structure

Computing Core Courses – 46 Credit Hours (14 Courses)					
Sr. #	Sem #	Code	Pre- Reqs	Course Title	CH (Cont Hr)
1	1	CMPC-5201		Programming Fundamentals	4 (3-3)
2	2	CMPC-5202	CMPC-5201	Object Oriented Programming	4 (3-3)
3	2	CMPC-5203		Database Systems	4 (3-3)
4	2	CMPC-5204		Digital Logic Design	3 (2-3)
5	3	CMPC-5205	CMPC-5202	Data Structures	4 (3-3)
6	3	CMPC-5206		Information Security	3 (2-3)
7	3	CMPC-5207		Artificial Intelligence	3 (2-3)
8	3	CMPC-5208		Computer Networks	3 (2-3)
9	3	CMPC-5101		Software Engineering	3 (3-0)
10	4	CMPC-5209	CMPC-5204	Computer Organization & Assembly Language	3 (2-3)
11	5	CMPC-6201		Operating Systems	3 (2-3)
12	7	CMPC-6101	CMPC-5205	Analysis of Algorithms	3 (3-0)
13	7	CMPC-6702		Final Year Project – I	2 (0-6)
14	8	CMPC-6703	CMPC-6702	Final Year Project – II	4 (0-12)

Domain Core – 18 Credit Hours (6 Courses)					
Sr #	Sem #	Code	Pre-Req	Course Title	CH (Cont Hr)
1	4	DSDC-5201		Introduction to Data Science	3 (2-3)
2	4	DSDC-5202		Advanced Statistics	3 (2-3)
3	5	DSDC-6201		Data Mining	3 (2-3)
4	5	DSDC-6202		Data Visualization	3 (2-3)
5	6	DSDC-6203		Data Warehousing & Business Intelligence	3 (2-3)
6	6	ITDC-6204		Parallel & Distributed Computing	3 (2-3)

Domain Elective – 21 Credit Hours (7 Courses)					
Sr #	Sem #	Code	Pre-Req	Course Title	CH (Cont Hr)
1	5/6/7	CSDC-5102		Advanced Database Management Systems	3 (2-3)
2	5/6/7	DSDE-6201		Big Data Analytics	3 (2-3)
3	5/6/7	AIDC-4102		Machine Learning	3 (2-3)
4	5/6/7	AIDC-5101		Artificial Neural Networks & Deep Learning	3 (2-3)
5	5/6/7	DSDE-6202		Business Process Analysis	3 (2-3)
6	5/6/7	CSDC-5101		Theory of Automata	3 (2-3)
7	5/6/7	CSDC-6201		HCI & Computer Graphics	3 (2-3)
8	5/6/7	DSDE-6203		Platforms & Architectures for Data Science	3 (2-3)
9	5/6/7	DSDE-6204		Text Mining	3 (2-3)

10	5/6/7	DSDE-6205		Topics in Data Science	3 (2-3)
11	5/6/7	AIDE-5202		Speech Processing	3 (2-3)
12	5/6/7	DSDE-6206		Enterprise Application Development	3 (2-3)
13	5/6/7	DSDE-6207		Cloud Computing	3 (2-3)
14	5/6/7	DSDE-6208		Web System and Technology	3 (2-3)
15	5/6/7	CSDE-6202		Mobile Application Development I	3 (2-3)
16	5/6/7	CSDE-6505		Introduction to Large Language Models	3 (2-3)

**Preliminary Courses for Pre-Medical Students – Non-Credit Hour (4 Courses)**

Sr#	Sem#	Code	Pre-Req	Course Title	CH (Cont Hr)
1	1	URCM-5107		Mathematics I	0 (3-0)
2	2	URCM-5108	URCM-5107	Mathematics II	0 (3-0)

**Mathematics & Supporting Courses – 12 Credit Hours (4 Courses)**

Sr#	Sem#	Code	Pre-Req	Course Title	CH (Cont Hr)
1	1	MATH-5101	URCQ-5102	Multivariable Calculus	3 (3-0)
2	1	MATH-5102	URCQ-5102	Linear Algebra	3 (3-0)
3	1	MATH-5103		Probability & Statistics	3 (3-0)
4	1	ENGL-6101	URCE-5118	Technical & Business Writing	3 (3-0)

**Elective Supporting Courses (Social Science) – 3 Credit Hours (1 Course)**

Sr#	Sem#	Code	Pre-Req	Course Title	CH (Cont Hr)
1	1	BUSB-6101		Introduction to Marketing	3 (3-0)
2	1	BUSB-6102		Human Resource Management	3 (3-0)

**General Education Requirement – 30 Credit Hours (12 Courses)**

Sr#	Sem#	Code	Pre-Req	Course Title	CH (Cont Hr)
1	1	URCS-5123		Application of Information & Communication Technologies	3 (2-3)
2	1	URCE-5118		Functional English	3 (3-0)
3	2	URCE-5119	URCE-5118	Expository Writing	3 (3-0)
4	1	URCQ-5101		Discrete Structures	3 (3-0)
5	1	URCQ-5102		Calculus and Analytic Geometry	3 (3-0)
6	4	URCI-5105		Islamic Studies/ Ethics (for non-muslims)	2 (2-0)
7	8	URCI-5122		Ideology and Constitution of Pakistan	2 (2-0)
8	4	URCA-5101		Introduction to Management	2 (2-0)
9	4	URCW-5201		Applied Physics	3 (2-3)
10	8	URCS-6101		Professional Practices	2 (2-0)

11	8	URCC-5125		Civics and Community Engagement	2 (2-0)
12	7	URCE-5124		Entrepreneurship	2 (2-0)
13	2	URCQ-5111		Translation of Holy Quran-I	0 (1-0)
14	4	URCQ-5111		Translation of Holy Quran-II	0 (1-0)
15	6	URCQ-5111		Translation of Holy Quran-III	0 (1-0)
16	8	URCQ-5111		Translation of Holy Quran-IV	0 (1-0)

### Course Coding Scheme

Level	Course Type
5	Foundation, Core Level 1 Courses
5	Foundation, Core Level 1 Courses
6	Core Level 2 + Specialization Level 1
6	Specialization Level 2
Code	Discipline
CMPC	Computing Core
CSDC	Computer Science Domain Core
CSDE	Computer Science Domain Elective
ITDC	Information Technology Domain Core
ITDE	Information Technology Domain Elective
SEDC	Software Engineering Domain Core
SEDE	Software Engineering Domain Elective
AIDC	Artificial Intelligence Domain Core
AIDE	Artificial Intelligence Domain Elective
DSDC	Data Science Domain Core
DSDE	Data Science Domain Elective
URCI	General Science
MATH	
ENGL	
URCC	
URCQ	
URCS	
URCE	
URCA	
URCF	

## Scheme of Studies for BS Data Science Program

(130 Credit Hours)

#	Code	Pre-Reqs	Course Title	Domain	Cr hr (Cont hr)
<b>Semester 1</b>					
1	CMPC-5201		Programming Fundamentals	Core	4 (3-3)
2	URCS-5123		Application of Information & Communication Technologies	GER	3 (2-3)
3	URCQ-5101		Discrete Structures	GER	3 (3-0)
4	URCQ-5102		Calculus and Analytic Geometry	GER	3 (3-0)
5	URCE-5118		Functional English	GER	3 (3-0)
6	BUSB-6101		Introduction to Marketing	SS	3 (3-0)
	URCM-5107		Mathematics I*	PRE	0(1-0)
				<b>Total Cr Hrs</b>	<b>19 (17-6)</b>
<b>Semester 2</b>					
7	CMPC-5202	CMPC-5201	Object Oriented Programming	Core	4 (3-3)
8	CMPC-5203		Database Systems	Core	4 (3-3)
9	CMPC-5204		Digital Logic Design	Core	3 (2-3)
10	MATH-5101		Multivariable Calculus	Maths	3 (3-0)
11	MATH-5102		Linear Algebra	Maths	3 (3-0)
	URCM-5108		Mathematics II*	PRE	0(1-0)
12	URCQ-5111		Translation of Holy Quran-I	GER	0
				<b>Total Cr Hrs</b>	<b>17 (14-9)</b>
<b>Semester 3</b>					
13	CMPC-5205	CMPC-5202	Data Structures	Core	4 (3-3)
14	CMPC-5209	CMPC-5204	Computer Organization & Assembly Language	Core	3 (2-3)
15	CMPC-5207		Artificial Intelligence	Core	3 (2-3)
16	CMPC-5208		Computer Networks	Core	3 (2-3)
17	CMPC-5101		Software Engineering	Core	3 (3-0)
18	MATH-5103		Probability & Statistics	Maths	3 (3-0)
				<b>Total Cr Hrs</b>	<b>19 (15-12)</b>
<b>Semester 4</b>					
19	CMPC-5206		Information Security	Core	3 (2-3)
20	DSDC-5201		Introduction to Data Science	Domain Core	3 (2-3)
21	DSDC-5202		Advanced Statistics	Domain Core	3 (2-3)
22	URCW-5201		Applied Physics	GER	3 (2-3)
23	URCE-5119	URCE-5118	Expository Writing	GER	3 (3-0)
24	URCI-5105		Islamic Studies	GER	2 (2-0)
25	URCQ-5111		Translation of Holy Quran-II	GER	0
				<b>Total Cr Hrs</b>	<b>17 (13-12)</b>

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Semester 5					
26	CMPC-6201		Operating Systems	Core	3 (2-3)
27	DSDC-6201		Data Mining	Domain Core	3 (2-3)
28	DSDC-6202		Data Visualization	Domain Core	3 (2-3)
29	yyyy-xxxx		Domain Elective 1	Domain Elective	3 (2-3)
30	yyyy-xxxx		Domain Elective 2	Domain Elective	3 (2-3)
31	URCA-5101		Introduction to Management	GER	2 (2-0)
				<b>Total Cr Hrs</b>	<b>17 (12-15)</b>
Semester 6					
32	DSDC-6203		Data Warehousing & Business Intelligence	Domain Core	3 (2-3)
33	ITDC-6204		Parallel & Distributed Computing	Domain Core	3 (2-3)
34	yyyy-xxxx		Domain Elective 3	Domain Elective	3 (2-3)
35	yyyy-xxxx		Domain Elective 4	Domain Elective	3 (2-3)
36	yyyy-xxxx		Domain Elective 5	Domain Elective	3 (2-3)
37	yyyy-xxxx		Domain Elective 6	Domain Elective	3 (2-3)
38	URCO-5111		Translation of Holy Quran-III	GER	0
				<b>Total Cr Hrs</b>	<b>18 (12-18)</b>
Semester 7					
39	CMPC-6702		Final Year Project - I	<del>X</del> Core	2 (0-6)
40	CMPC-6101	CMPC-5205	Analysis of Algorithms	Core	3 (3-0)
41	yyyy-xxxx		Domain Elective 7	Domain Elective	3 (2-3)
42	TD ENGL-6101	URCE-5118	Technical & Business Writing	EN	3 (3-0)
43	URCE-5124		Entrepreneurship	GER	2 (2-0)
				<b>Total Cr Hrs</b>	<b>13 (08-9)</b>
Semester 8					
44	CMPC-6703	CMPC-6702	Final Year Project - II	<del>X</del> Core	4 (0-12)
45	URCI-5122		Ideology and Constitution of Pakistan	GER	2 (2-0)
46	URCF-5118		Professional Practices	GER	2 (2-0)
47	URCC-5125		Civics and Community Engagement	GER	2 (2-0)
48	URCO-5111		Translation of Holy Quran-IV	GER	0
				<b>Total Cr Hrs</b>	<b>10 (6-12)</b>

\* Only offered to Pre-Medical Students.

## Computing Core Courses

CMPC-5201 Programming Fundamentals		
<b>Credit Hours:</b>	4 (3-3)	
<b>Contact Hours:</b>	3-3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
<p>This course provides fundamental concepts of programming to freshmen. The course is prerequisite to many other courses, therefore, students are strongly advised to cover all contents and try to achieve CLOs to the maximum possible level. The course may be taught as language independent. Further, it is up to the university to choose any language for the practical/Lab purpose but that must be latest and market oriented.</p>		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand basic problem solving steps and logic constructs	C2 (Understand)
CLO-2	Apply basic programming concepts	C3 (Apply)
CLO-3	Design and implement algorithms to solve real world problems	C3 (Solve)
<b>Course Outline:</b>		
<p>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, multidimensional 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.</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Starting Out with Programming Logic and Design: latest edition by Tony Gaddis.</li> <li>2. The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie.</li> <li>3. Object Oriented Programming in C++ latest edition by Robert Lafore.</li> <li>4. C++ How to Program latest Edition by Paul Deitel and Harvey Deitel</li> <li>5. Problem Solving and Program Design in C++, latest Edition by Jeri R. Hanly &amp; Elliot B. Koffman.</li> </ol>		

  
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## CMPC-5202 Object Oriented Programming

<b>Credit Hours:</b>	4 (3-3)
<b>Contact Hours:</b>	3-3
<b>Pre-requisites:</b>	Programming Fundamentals

### Course Introduction:

The course aims to focus on object-oriented concepts, analysis and software development. The basic concept of OOP is covered in this course.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand principles of object-oriented paradigm.	C2 (Understand)
CLO-2	Identify the objects & their relationships to build object-oriented solution	C3 (Apply)
CLO-3	Model a solution for a given problem using object-oriented principles	C3 (Solve)
CLO-4	Examine an object-oriented solution	C4 (Examine)

### Course Outline:

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.

### Reference Materials (or use any other standard and latest books):

1. Java How to Program, Early Objects: 11th Edition by Paul Deitel, Harvey Deitel
2. Beginning Java 2, latest Edition by Ivor Horton
3. An Introduction to Object Oriented Programming with Java, latest Edition by C. Thomas Wu
4. Starting Out with C++ from Control Structures to Objects, latest Edition, Tony Gaddis
5. C++ How to Program, latest Edition, Deitel & Deitel.
6. Object Oriented Programming in C++, latest Edition by Robert Lafore

<b>CMPC-5203 Database Systems</b>		
<b>Credit Hours:</b>	4 (3-3)	
<b>Contact Hours:</b>	3-3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
The course aims to introduce basic database concepts, different data models, data storage and retrieval techniques and database design techniques. The course primarily focuses on relational data model and DBMS concepts.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Explain fundamental database concepts.	C2 (Explain)
CLO-2	Design conceptual, logical and physical database schemas using different data models.	C5 (Design)
CLO-3	Identify functional dependencies and resolve database anomalies by normalizing database tables.	C2 (Identify)
CLO-4	Use Structured Query Language (SQL) for database definition and manipulation in any DBMS	C4 (Use)
<b>Course Outline:</b>		
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 subqueries in SQL, Grouping and aggregation in SQL, concurrency control, database backup and recovery, indexes, NoSQL systems.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Fundamentals of Database Management Systems, Mark L. Gillenson, 3rd Edition, 2023</li> <li>2. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg, 2019</li> <li>3. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, 2013</li> <li>4. Database System Concepts, 6th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan, 2019</li> <li>5. Database Management Systems, 3rd Edition by Raghuram Ramakrishnan, Johannes Gehrke, 2002</li> </ol>		

  
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<b>CMPC-5204 Digital Logic Design</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
The course introduces the concept of digital logic, gates and the digital circuits. Further, it focuses on the design and analysis combinational and sequential circuits. It also serves to familiarize the student with the logic design of basic computer hardware components.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Acquire knowledge related to the concepts, tools and techniques for the design of digital electronic circuits	-
CLO-2	Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques	-
CLO-3	Apply the acquired knowledge to simulate and implement small-scale digital circuits	-
CLO-4	Understand the relationship between abstract logic characterizations and practical electrical implementations.	-
<b>Course Outline:</b>		
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.		
<b>Reference Materials (or use any other standard and latest books):</b>		
1. Digital Fundamentals by Floyd, Global Edition. 2. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e 3. DIGITAL DESIGN, GLOBAL EDITION, 6th/e by M. Morris Mano and Michael Ciletti		

<b>CMPC-5205 Data Structures</b>		
<b>Credit Hours:</b>	4 (3-3)	
<b>Contact Hours:</b>	3-3	
<b>Pre-requisites:</b>	Programming Fundamentals	
<b>Course Introduction:</b>		
The course is designed to teach students structures and schemes, which allow them to write programmer to efficiently manipulate, store, and retrieve data. Students are exposed to the concepts of time and space complexity of computer programs.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Implement various data structures and their algorithms and apply them in implementing simple applications	C3 (Apply)
CLO-2	Analyze simple algorithms and determine their complexities.	C5 (Analyze)
CLO-3	Apply the knowledge of data structure to other application domains.	C3 (Apply)
CLO-4	Design new data structures and algorithms to solve problems.	C6 (Design)
<b>Course Outline:</b>		
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, dequeuer, 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.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Data Structures and Algorithm Analysis in Java latest Edition by Mark A. Weiss</li> <li>2. Data Structures and Abstractions with Java Latest Eidition by Frank M. Carrano &amp; Timothy M. Henry</li> <li>3. Data Structures and Algorithms in C++ 4th Edition by by Adam Drozdek</li> <li>4. Data Structures and Algorithm Analysis in C++ Latest Edition by Mark Allen Weiss Java Software Structures: Designing and Using Data Structures by John Lewis and Joseph Chase</li> </ol>		

  
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**CMPC-5206 Information Security**

<b>Credit Hours:</b>	3 (2-3)
<b>Contact Hours:</b>	2-3
<b>Pre-requisites:</b>	None

**Course Introduction:**

This course provides a broad overview of the threats to the security of information systems, the responsibilities and basic tools for information security, and the levels of training and expertise needed in organizations to reach and maintain a state of acceptable security. It covers concepts and applications of system and data security. Areas of particular focus include secure network design, implementation and transition issues, and techniques for responding to security breaches.

<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Explain key concepts of information security such as design principles, cryptography, risk management, and ethics	C2 (Explain)
CLO-2	Discuss legal, ethical, and professional issues in information security	A2 (Discuss)
CLO-3	Apply various security and risk management tools for achieving information security and privacy	C3 (Apply)
CLO-4	Identify appropriate techniques to tackle and solve problems in the discipline of information security	C4 (Identify)

**Course Outline:**

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.

**Reference Materials (or use any other standard and latest books):**

1. Computer Security: Principles and Practice, 3rd edition by William Stallings
2. Principles of Information Security, 6th edition by M. Whitman and H. Mattord
3. Computer Security, 3rd edition by Dieter Gollmann
4. Computer Security Fundamentals, 3rd edition by William Easttom
5. CISSP, 7th edition, Shon Harris

<b>CMPC-5207 Artificial Intelligence</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	Object Oriented Programming	
<b>Course Introduction:</b>		
Artificial Intelligence has emerged as one of the most significant and promising areas of computing. This course focuses on the foundations of AI and its basic techniques like Symbolic manipulations, Pattern Matching, Knowledge Representation, Decision Making and Appreciating the differences between Knowledge, Data and Code. AI programming language Python has been proposed for the practical work of this course.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Understand the fundamental constructs of Python programming language.	C2 (Understand)
CLO-2	Understand key concepts in the field of artificial intelligence	C2 (Understand)
CLO-3	Implement artificial intelligence techniques and case studies	C3 (Apply)
<b>Course Outline:</b>		
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, Minmax 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.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Russell, S. and Norvig, P. "Artificial Intelligence. A Modern Approach", 3rd ed, Prentice Hall, Inc., 2020.</li> <li>2. Norvig, P., "Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp", Morgan Kaufman Publishers, Inc., latest edition.</li> <li>3. Luger, G.F. and Stubblefield, W.A., "AI algorithms, data structures, and idioms in Prolog, Lisp, and Java", Pearson Addison-Wesley. 2019.</li> <li>4. Severance, C.R., 2016. "Python for everybody: Exploring data using Python 3." CreateSpace Independent Publ Platform.</li> <li>5. Miller, B.N., Ranum, D.L. and Anderson, J., 2019. "Python programming in context." Jones &amp; Bartlett Pub.</li> <li>6. Joshi, P., 2022. "Artificial intelligence with python." Packt Publishing Ltd.</li> </ol>		

  
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<b>CMPC-5208 Computer Networks</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
This course introduces the basic concept of computer network to the students. Network layers, Network models (OSI, TCP/IP) and protocol standards are part of the course.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Describe the key terminologies and technologies of computer networks	C2 (Describe)
CLO-2	Explain the services and functions provided by each layer in the Internet protocol stack.	C2 (Explain)
CLO-3	Identify various internetworking devices and protocols and their functions in a networking	C4 (Identify)
CLO-4	Analyze working and performance of key technologies, algorithms and protocols	C4 (Analyze)
CLO-5	Build Computer Network on various Topologies	P3 (Build)
<b>Course Outline:</b>		
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.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Computer Networking: A Top-Down Approach Featuring the Internet, 6th edition by James F. Kurose and Keith W. Ross</li> <li>2. Computer Networks, 5th Edition by Andrew S. Tanenbaum</li> <li>3. Data and Computer Communications, 10th Edition by William Stallings</li> <li>4. Data Communication and Computer Networks, 5th Edition by Behrouz A. Forouzan</li> </ol>		

<b>CMPC-5101 Software Engineering</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3-0	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
This course provides students with a foundational understanding of the principles, methodologies, and practices essential for designing, developing, and maintaining software systems. Emphasis is placed on the entire software development life cycle, covering requirements analysis, system design, quality assurance and testing.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Describe various software engineering processes and activates	C1 (Describe)
CLO-2	Apply the system modeling techniques to model a medium size software systems	C3 (Apply)
CLO-3	Apply software quality assurance and testing principles to medium size software systems	C4 (Apply)
CLO-4	Discuss key principles and common methods for software project management such as scheduling, size estimation, cost estimation and risk analysis	C2 (Discuss)
<b>Course Outline:</b>		
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		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Modern Software Engineering: Doing What Works to Build Better Software Faster, David Farley, 1st Edition, 2022</li> <li>2. Software Engineering, Sommerville I., 10th Edition, Pearson Inc., 2014</li> <li>3. Software Engineering, A Practitioner's Approach, Pressman R. S. &amp; Maxim B. R., 8th Edition, McGraw-Hill, 2015.</li> </ol>		

  
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## CMPC-5209 Computer Organization & Assembly Language

<b>Credit Hours:</b>	3 (2-3)
<b>Contact Hours:</b>	2-3
<b>Pre-requisites:</b>	Digital Logic Design

### Course Introduction:

This course helps students understanding the architecture and design principles of modern computing systems. They will explore the essentials of assembly language programming, understanding how low-level instructions contribute to the functioning of CPUs. They will also gain a profound understanding of hardware-software interactions, setting the foundation for advanced studies in computer science and programming.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understanding the basics of computer organization with emphasis on the lower level abstraction of a computer system	C1 (Memorize)
CLO-2	Understand the digital logic, instruction set	C2 (Understand)
CLO-3	Familiarity with assembly language programming.	C2 (Understand)


### Course Outline:

Introduction to Microprocessor Architecture: Microprocessor Bus Structure -Addressing, Data and Control, Registers and Flags. Addressing Modes. Introduction to Assembly Language, 80x86 families; program layout. Data Definitions, Basic Instructions. Unsigned Arithmetic; Logic and Bit Operations. Modules; Separate Assembly; Argument Passing Libraries; Combining Assembly and C Code. String Instructions; Arrays. Macros; Structures. Floating Point Instruction. Bit MS-DOS. BIOS Disk Accessing. BIOS Keyboard/Video/Graphics. Interrupts; TSR Programs. Accessing I/O Ports; 8253 Timer

### Reference Materials (or use any other standard and latest books):

1. Introduction to Computer Organization: An Under the Hood Look at Hardware and x86-64 Assembly, 1st Edition, 2022
2. Assembly Language for x86 Processors by Kip R. Irvine, Prentice Hall; 6th Edition (March 7, 2010). ISBN-10: 013602212X
3. The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications by Walter A. Triebel & Avtar Singh, Prentice Hall; 4th Edition (September 8, 2002). ISBN-10: 0130930814.
4. Lab Manual to Accompany - The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications by Walter A. Triebel & Avtar Singh, Pearson; 4th Edition (2003). ASIN: B000Q652KQ
5. Principles of Computer Organization and Assembly Language by Patrick Juola, Prentice Hall; 1st Edition (January 11, 2011). ASIN: B009TGBI1Q
6. The Art of Assembly Language by Randall Hyde, No Starch Press; 2nd Edition (March 22, 2010). ISBN-10: 1593272073.

<b>CMPC-6201 Operating Systems</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	Data Structures	
<b>Course Introduction:</b>		
To help students gain a general understanding of the principles and concepts governing the functions of operating systems and acquaint students with the layered approach that makes design, implementation and operation of the complex OS possible.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Understand the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems	C2 (Understand)
CLO-2	Analyze and evaluate the algorithms of the core functions of the Operating Systems and explain the major performance issues with regard to the core functions	C5 (Evaluate)
CLO-3	Demonstrate the knowledge in applying system software and tools available in modern operating systems.	C3 (Demonstrate)
<b>Course Outline:</b>		
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		
<b>Reference Materials (or use any other standard and latest books):</b>		
1. Modern Operating Systems, 5th edition by Andrew S. Tanenbaum, 2022		
2. Operating Systems: Three Easy Pieces, by Remzi H Arpaci-Dusseau and Andrea C Arpaci-Dusseau, 1st Edition, 2018		
3. Operating Systems Concepts, 9th edition by Abraham Silberschatz, 2012		
4. Operating Systems, Internals and Design Principles, 9th edition by William Stallings, 2017		

  
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<b>CMPC-6101 Analysis of Algorithms</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3-0	
<b>Pre-requisites:</b>	Data Structures	
<b>Course Introduction:</b>		
Detailed study of the basic notions of the design of algorithms and the underlying data structures. Several measures of complexity are introduced. Emphasis on the structure, complexity, and efficiency of algorithms.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Explain what is meant by “best”, “expected”, and “worst” case behavior of an algorithm	
CLO-2	Identify the characteristics of data and/or other conditions or assumptions that lead to different behaviors.	
CLO-3	Determine informally the time and space complexity of simple algorithms	
CLO-4	List and contrast standard complexity classes	
CLO-5	Use big O, Omega, Theta notation formally to give asymptotic upper bounds on time and space complexity of algorithms	
CLO-6	Use of the strategies(brute-force, greedy, divide-andconquer, and dynamic programming) to solve an appropriate problem	
CLO-7	Solve problems using graph algorithms, including single source and all-pairs shortest paths, and at least one minimum spanning tree algorithm	
CLO-8	Trace and/or implement a string-matching algorithm	
<b>Course Outline:</b>		
Introduction; role of algorithms in computing, Analysis on nature of input and size of input Asymptotic notations; Big-O, Big $\Omega$ , Big $\Theta$ , little-o, little- $\omega$ , 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.		
<b>Reference Materials (or use any other standard and latest books):</b>		
1. Introduction to Algorithms (3rd edition) by Thomas H. Corman, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein		
2. Algorithm Design, (1st edition, 2013/2014), Jon Kleinberg, Eva Tardos,		
3. Algorithms, (4th edition, 2011), Robert Sedgewick, Kevin Wayne		

<b>CMPC-6702 Final Year Project-I</b>		
<b>Credit Hours:</b>	2 (0-6)	
<b>Contact Hours:</b>	0-6	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
This course marks a crucial phase in the undergraduate program, providing students with a unique opportunity for hands-on research and/or project development.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Undertake problem identification, formulation and solution.	C2 (Understand)
CLO-2	Define project scope and set milestones.	C3 (Apply)
CLO-3	Attain proficiency in creating comprehensive project documentation.	C3 (Apply)
CLO-4	Cultivate effective teamwork and collaboration skills, fostering ability to work with team members towards shared objectives.	-
<b>Course Outline:</b>		
<ol style="list-style-type: none"> <li>1. Project Proposal</li> <li>2. Introduction Software Requirement Specification</li> <li>3. Software Function Specification</li> <li>4. Design Documentation</li> </ol>		

  
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<b>CMPC-6703 Final Year Project-II</b>		
<b>Credit Hours:</b>	4 (0-12)	
<b>Contact Hours:</b>	0-12	
<b>Pre-requisites:</b>	Final Year Project-I	
<b>Course Introduction:</b>		
Final Year Project-II represents the culmination of the undergraduate program, where students bring their projects to completion. Students engage in refining their projects, addressing challenges, and contributing to the existing body of knowledge in their chosen fields.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Develop, implement, and test solutions to real world problems.	C3 (Apply)
<b>Course Outline:</b>		
<ol style="list-style-type: none"> <li>1. Database Design</li> <li>2. Interface Design</li> <li>3. Initial Prototype</li> <li>4. Implementation</li> <li>5. Testing</li> </ol>		

## Domain Core Courses

<b>DSDC-5201 Introduction to Data Science</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
Data Science is the study of the generalizable extraction of knowledge from data. Being a data scientist requires an integrated skill set spanning mathematics, statistics, machine learning, databases and other branches of computer science along with a good understanding of the craft of problem formulation to engineer effective solutions. The aim of this course is to: Introduce students to this rapidly growing field and equip them with some of its basic principles and tools as well as its general mindset. Explain the significance of exploratory data analysis in data science. Identify common approaches used for Feature Generation as well as Feature Selection, and finally discuss the Ethical and Privacy issues. Programming language Python has been proposed for the practical work of this course.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Describe what Data Science is and the skill sets needed to be a data scientist.	C2 (Understand)
CLO-2	Apply EDA and the Data Science process in a case study.	C3 (Apply)
CLO-3	Comprehend the fundamental constructs of Python programming language.	C2 (Understand)
CLO-4	Apply basic machine learning algorithms to solve real world problems of moderate complexity.	C3 (Apply)

**Course Outline:**

Introduction: What is Data Science? Big Data and Data Science hype, Datafication, Current landscape of perspectives, Skill sets needed; Statistical Inference: Populations and samples, Statistical modeling, probability distributions, fitting a model, Intro to Python; Exploratory Data Analysis and the Data Science Process; Basic Machine Learning Algorithms: Linear Regression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes; Feature Generation and Feature Selection; Dimensionality Reduction: Singular Value Decomposition, Principal Component Analysis; Mining Social-Network Graphs: Social networks as graphs, Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs, Neighborhood properties in graphs; Data Visualization: Basic principles, ideas and tools for data visualization; Data Science and Ethical Issues: Discussions on privacy, security, ethics, Next-generation data scientists.

**Reference Materials (or use any other standard and latest books):**

1. Foundations of data science, Blum, A., Hopcroft, J., & Kannan, R., Vorabversion eines Lehrbuchs, 2016.
2. An Introduction to Data Science, Jeffrey S. Saltz, Jeffrey M. Stanton, SAGE Publications, 2017.
3. Python for everybody: Exploring data using Python 3, Severance, C.R., CreateSpace Independent Pub Platform. 2016.
1. Doing Data Science, Straight Talk from the Frontline, Cathy O'Neil and Rachel Schutt, O'Reilly. 2014.
2. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, John Wiley & Sons, 2015.

  
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<b>DSDC-5202 Advance Statistics</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3-0	
<b>Pre-requisites:</b>	Probability and Statistics	
<b>Course Introduction:</b>		
Statistical methods are used for analysis of different datasets for forecasting the values, predicting the unknowns, relating the variables for getting deeper insights and relating data differences with real world complexities. Data Science extracts knowledge from data on the basis of hidden patterns which can be made explicit by incorporating the statistical algorithms in it. This course is designed to prepare students on statistical techniques with a purview of artificial intelligence and data science.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Describe what part of statistics is meant for data scientist and what the applications of statistics in data science are.	C1 (Knowledge)
CLO-2	Apply Statistical techniques in real life problems.	C3(Apply)
CLO-3	Analyze, Correlate, Forecast data by using different statistical techniques	C2 (Understand)
CLO-4	Apply basic data science statistical techniques by using SPSS on real world datasets.	C3 (Apply)
<b>Course Outline:</b>		
Introduction to Statistics, Use of Statistics in Data Science, Experimental Design, Statistical Techniques for Forecasting, Interpolation/ Extrapolation, Introduction to Probability, Conditional Probability, Prior and Posterior Probability, Random number generation (RNG), Techniques for RNG, Correlation analysis, Chi Square Dependency tests, Diversity Index, Data Distributions Multivariate Distributions, Error estimation, Confidence Intervals, Linear transformations, Gradient Descent and Coordinate Descent, Likelihood inference, Revision of linear regression and likelihood inference, Fitting algorithms for nonlinear models and related diagnostics, Generalized linear model; exponential families; variance and link functions, Proportion and binary responses; logistic regression, Count data and Poisson responses; log-linear models, Overdispersion and quasi-likelihood; estimating functions, Mixed models, random effects, generalized additive models and penalized regression; Introduction to SPSS, Probability/ Correlation analysis/ Dependency tests/ Regression in SPSS.		
<b>Reference Materials (or use any other standard and latest books):</b>		
1. Discovering Statistics Using IBM SPSS Statistics, Andy Field, 1st Edition, 2024		
2. Probability and Statistics for Computer Scientists, 3rd Edition, Michael Baron.2019		
3. Probability for Computer Scientists, online Edition, David Forsyth ,2017		

<b>DSDC-6201 Data Mining</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	Advance Statistics, Introduction to Data Science	
<b>Course Introduction:</b>		
<p>Data Mining has emerged at the confluence of artificial intelligence, statistics, and databases as a technique for automatically discovering hidden patterns in large datasets. The main purpose of this course is the ability to analyze and construct knowledge from data. The aims of this course are to:</p> <ul style="list-style-type: none"> <li>• Expand on the student's understanding and awareness of the concepts of data mining basics, techniques, and application.</li> <li>• Introduce the concepts of <i>Data Pre-processing and Summary Statistics</i>.</li> <li>• Introduce the concepts of <i>Frequent Item Set Generation, Associations and Correlations measures</i>.</li> <li>• Introduce the concepts of <i>Classification, Prediction, and Clustering algorithms</i>. Build on the programming and problem-solving skills developed in previous subjects studied by the student, to achieve an understanding of the development of Classification, Prediction, and Clustering applications.</li> </ul>		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Apply preprocessing techniques on any given raw data.	C3 (Apply)
CLO-2	Select and apply proper data mining algorithm to discover interesting patterns	C3 (Apply)
CLO-3	Analyze and extract patterns to solve problems and point out how to deploy solution	C4 (Analyze)
CLO-4	Evaluate systematically supervised, semi supervised and	C4 (Analyze)
<b>Course Outline:</b>		
Introduction to data mining and basic concepts, Pre-Processing Techniques & Summary Statistics, Association Rule mining using Apriori Algorithm and Frequent Pattern Trees, Introduction to Classification Types, Supervised Classification (Decision trees, Naïve Bae Classification, K-Nearest Neighbors, Support Vector Machines etc.), Unsupervised Classification (K Means, K Median, Hieratical and Divisive Clustering, Kohonan Self Organizing maps), outlier & anomaly detection, Web and Social Network Mining, Data Mining Trends and Research Frontiers. Implementing concepts using Python		
<b>Reference Materials (or use any other standard and latest books):</b>		
1.	Jiawei Han & Micheline Kamber, Jian Pei . Data Mining: Concepts and Techniques, 3rd Edition.	
2.	Pang-Ning Tan, Michael Steinbach, and Vipin Kumar . Introduction to Data Mining. Latest Edition	
3.	Charu C. Aggarwal. Data Mining: The Textbook Latest Edition	
4.	D. Hand, H. Mannila, P. Smyth. Principles of Data Mining. MIT Press Latest Edition.	

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<b>DSDC-6202 Data Visualization</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	Data Warehousing & Business Intelligence	
<b>Course Introduction:</b>		
Data Visualization is a process of obtaining detailed insights hidden in the data. It is a necessary component in the pipeline of any data science project. This course teaches skills specifically in terms of how to effectively present the data and findings. Further, this course provides hands on skills using R for data exploration and visualization.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Provides knowledge about importance, necessity, and justification of performing exploratory data analysis and visualization	C2 (Understand)
CLO-2	Introduce various type of charts along with their alternatives solution to show same data from versatile aspects.	C2 (Understand)
CLO-3	Improving the competency of the students to analyze different problems and select the most appropriate solution.	C3 (Apply)
CLO-4	Use of R, various recent tools, and technologies to develop hands-on skills for exploratory data analysis and visualization.	C3 (Apply)
<b>Course Outline:</b>		
Introduction of Exploratory Data Analysis and Visualization, Building Blocks and Basic Operations; Types of Exploratory Graphs, single and multi-dimensional summaries, five number summary, box plots, histogram, bar plot and others; Distributions, their representation using histograms, outliers, variance; Probability Mass Functions and their visualization; Cumulative distribution functions, percentile-based statistics, random numbers; Modelling distributions, exponential, normal, lognormal, pareto; Probability density functions, kernel density estimation; Relationship between variables, scatter plots, correlation, covariance; Estimation and Hypothesis Testing; Clustering using K-means and Hierarchical; Time series and survival analysis; Implementing concepts with R (or similar language)		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Yau, N. (2024). <i>Visualize this: the FlowingData guide to design, visualization, and statistics</i>. John Wiley &amp; Sons.</li> <li>2. Peng, R. (2016). <i>Exploratory data analysis with R</i>. Lulu. com.</li> <li>3. Chen, M., Hauser, H., Rheingans, P., &amp; Scheuermann, G. (Eds.). (2020). <i>Foundations of data visualization</i> (pp. 225-241). Cham, Switzerland: Springer International Publishing.</li> </ol>		

<b>DSDC-6203 Data Warehousing &amp; Business Intelligence</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
<p>Gives an overview about importance &amp; significance of Data Warehousing (DWH) and Business Intelligence (BI). Discusses the main concepts and solutions for DWH and BI. The key concepts underpinning the logical design, physical design and implementation of data warehouses are appraised. Data collection, data extraction, cleansing, transformation and loading methods are considered along with query optimization techniques. Differentiation between OLAP &amp; OLTP. Data Warehousing supports information processing by providing a solid platform of integrated, historical, and consistent data for performing enterprise- wide data analysis.</p>		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Demonstrate an appreciation of the role that Data Warehouses and Business Intelligence play in enhancing the decision-making process.	C2 (Understand)
CLO-2	Demonstrate an understanding of the fundamental concepts of the Star and the Snowflake Schema; learn how to design the schema of a DW based on these two models.	C2 (Understand)
CLO-3	Understand the architecture of DW Systems and be able to specify the advantages and potential problem areas	C3 (Apply)
CLO-4	Use Analytic SQL to aggregate, analyze and report, and model data.	C3 (Apply)
<b>Course Outline:</b>		
<p>Introduction to Data Warehouse and Business Intelligence; Necessities and essentials of Business Intelligence; DW Life Cycle and Basic Architecture; DW Architecture in SQL Server; Logical Model; Indexes; Physical Model; Optimizations; OLAP Operations, Queries and Query Optimization; Building the DW; Data visualization and reporting based on Data warehouse using SSAS and Tableau; Data visualization and reporting based on Cube; Reports and Dashboard management on PowerBI; Dashboard Enrichment; Business Intelligence Tools.</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. W. H. Inmon, "Building the Data Warehouse", Wiley-India Edition.</li> <li>2. Ralph Kimball, "The Data Warehouse Toolkit – Practical Techniques for Building Dimensional Data Warehouse," John Wiley &amp; Sons, Inc.</li> <li>3. Matteo Golfarelli, Stefano Rizzi, "Data Warehouse Design - Modern Principles and Methodologies", McGraw Hill Publisher</li> </ol>		

<b>ITDC-6204 Parallel and Distributed Computing</b>	
<b>Credit Hours:</b>	3 (2-3)
<b>Contact Hours:</b>	2-3
<b>Pre-requisites:</b>	Object Oriented Programming, Operating Systems
<b>Course Introduction:</b>	
<p>The Parallel and Distributed Computing course explores advanced computing paradigms,</p>	

covering parallel processing and distributed systems. Participants gain expertise in designing and optimizing algorithms for parallel execution, addressing challenges in distributed computing environments.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Learn about parallel and distributed computers.	C2 (Understand)
CLO-2	Write portable programs for parallel or distributed architectures using Message-Passing Interface (MPI) library	C3 (Apply)
CLO-3	Analyze complex problems with shared memory programming with openMP.	C4 (Analyze)
<b>Course Outline:</b>		
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).		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. An Introduction to Parallel Programming, P. S. Pacheco and M. Malensek, Morgan Kaufmann, 2nd Edition.2021</li> <li>2. Parallel And Distributed Computing,Ajit Singh, Kindle Edition,2021</li> <li>3. Distributed Systems: Principles and Paradigms, A. S. Tanenbaum and M. V. Steen, Prentice Hall, 4th Edition, 2008</li> </ol>		


## Data Science Elective Courses

<b>CSDC-5102 Advanced Database Management System</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	Database Systems	
<b>Course Introduction:</b>		
Advanced Database Management Systems is an extension to "Database Systems" course. The aim of the course is to enhance the previous knowledge of database systems by deepening the understanding of the theoretical and practical aspects of the database technologies, and showing the need for distributed database technology to tackle deficiencies of the centralized database systems. Moreover, it focuses to introduce the basic principles and implementation techniques of distributed database systems, and expose emerging research issues in database systems and application development.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Understanding advance data models, technologies and approaches for building distributed database systems.	C2 (Understand)
CLO-2	Applying the models and approaches in order to become enabled to select and apply appropriate methods for a particular case	C3 (Apply)
CLO-3	To develop a database solution for a given scenario/ challenging problem in the domain of distributed database systems.	C3 (Apply)
<b>Course Outline:</b>		
Introduction to advance data models such as object relational, object oriented. File organizations concepts, Transactional processing and Concurrency control techniques, Recovery techniques, Query processing and optimization, Database Programming (PL/SQL, T-SQL or similar technology), Integrity and security, Database Administration (Role management, managing database access, views), Physical database design and tuning, Distributed database systems, Emerging research trends in database systems, MONGO DB, NO SQL (or similar technologies)		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg</li> <li>2. Database Management Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke</li> <li>3. Database System Concepts, 6th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan.</li> <li>4. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom</li> </ol>		

  
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<b>DSDE-6201 Big Data Analytics</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
The course objective is to develop understanding about the core concept of Big Data, why Big Data requires a different programming paradigm and mindset, and what are the various programming approaches used, what type of data can be processed.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Understand the fundamental concepts of Big Data and its programming paradigm.	C2 (Understand)
CLO-2	Hadoop/MapReduce Programming, Framework, and Ecosystem	C3 (Apply)
CLO-3	Apache Spark Programming	C3 (Apply)
<b>Course Outline:</b>		
Introduction and Overview of Big Data Systems; Platforms for Big Data, Hadoop as a Platform, Hadoop Distributed File Systems (HDFS), MapReduce Framework, Resource Management in the cluster (YARN), Apache Scala Basic, Apache Scala Advances, Resilient Distributed Datasets (RDD), Apache Spark, Apache Spark SQL, Data analytics on Hadoop Spark, Machine learning on Hadoop / Spark, Spark Streaming, Other Components of Hadoop Ecosystem		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. White, Tom. "Hadoop: The definitive guide." O'Reilly Media, Inc., 2012.</li> <li>2. Karau, Holden, Andy Konwinski, Patrick Wendell, and Matei Zaharia. "Learning spark: lightning-fast big data analysis." O'Reilly Media, Inc., 2015.</li> <li>3. Miner, Donald, and Adam Shook. "MapReduce design patterns: building effective algorithms and analytics for Hadoop and other systems." O'Reilly Media, Inc., 2012.</li> </ol>		

<b>AIDC-4102 Machine Learning</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	Artificial Intelligence	
<b>Course Introduction:</b>		
Machine learning is one of the fastest growing areas of computer science, with far-reaching applications. The aim of this course is to:		
a) Present the basic machine learning concepts;		
b) Present a range of machine learning algorithms along with their strengths and weaknesses;		
c) Apply machine learning algorithms to solve problems of moderate complexity.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Describe basic machine learning concepts, theories and applications.	C1 (Knowledge)
CLO-2	Apply supervised learning techniques to solve classification problems of moderate complexity.	C3 (Apply)
CLO-3	Apply unsupervised learning techniques to solve clustering problems of moderate complexity	C3 (Apply)
CLO-4	Apply reinforcement learning algorithms to environments with complex dynamics.	C3 (Apply)
CLO-5	Develop a reasonable size project using suitable machine learning technique	C6 (Design)
<b>Course Outline:</b>		
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 Agglomerative Clustering, k-means partitional clustering; Self-Organizing Maps (SOM) k-Nearest-neighbor algorithm; Semi- supervised learning with EM using labeled and unlabeled 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.		
<b>Reference Materials (or use any other standard and latest books):</b>		
1. Machine Learning, Tom, M., McGraw Hill, 1997.		
2. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, MIT Press, 2012		

  
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## AIDC-5101 Artificial Neural Networks & Deep Learning

<b>Credit Hours:</b>	3 (2-3)
<b>Contact Hours:</b>	2-3
<b>Pre-requisites:</b>	Programming for Artificial Intelligence

### Course Introduction:

This course will introduce Artificial Neural Networks and Deep Learning. ANN's basic architecture and how they mimic the human brain using simple mathematical models. Many of the important concepts and techniques around brain computing and the major types of ANN will also be introduced. Emphasis is made on the mathematical models, understanding learning laws, selecting activation functions and how to train the networks to solve classification problems. Deep neural networks have achieved state of the art performance on several computer vision and speech recognition benchmarks. This course will further build on the fundamentals of Neural networks and artificial intelligence and will introduce advanced topics in neural networks, convolutional and recurrent network structures, deep unsupervised and reinforcement learning.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the fundamentals of neural networks in AI	C2 (Understand)
CLO-2	Explain how simple ANNs can be designed	C2 (Understand)
CLO-3	Apply ANN for classification Problems	C3 (Apply)
CLO-4	Apply deep learning algorithms to real-world problems	C3 (Apply)
CLO-5	Analyze results from deep learning to select appropriate solutions	

### Course Outline:

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 Boltzmann 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

### Reference Materials (or use any other standard and latest books):

1. Chollet, F. (2021). *Deep learning with Python*. Simon and Schuster.
2. Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep learning*. MIT press.
3. Graupe, D. (2016). *Deep learning neural networks: design and case studies*. World Scientific Publishing Company.
4. Anderson, J. A. (1995). *An introduction to neural networks*. MIT press.
5. Hassoun, M. H. (1995). *Fundamentals of artificial neural networks*. MIT press.

<b>DSDE-6202 Business Process Analysis</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
The Business Analysis Process course will give you a foundational understanding of the process of business analysis and will introduce you to a framework that can be used within a variety of industries and organizations. You'll see how an analyst assesses a business problem, prepares business requirements, and implements a solution.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Understand the key Terms and concepts in Business Process Management.	C2 (Understand)
CLO-2	Learn about the major methodologies and techniques for implementing BPM.	C2 (Understand)
CLO-3	Learn what a BPM management and process-centric organization is and how it works.	C2 (Understand)
CLO-4	Understand the metrics and measurements critical to managing processes	C3 (Apply)
CLO-5	Learn how to identify critical processes.	C3 (Apply)
<b>Course Outline:</b>		
Introduction: Motivation and Definitions, Business Process Lifecycle, Classification of Business Processes, Goals, Structure, and Organization. Evolution of Enterprise Systems Architectures: Traditional Application Development, Enterprise Applications and their Integration, Enterprise Modeling and Process Orientation, Workflow Management, Enterprise Services Computing. Business Process Modeling: Foundation, Conceptual Model and Terminology, Abstraction Concepts, From Business Functions to Business Processes, Activity Models and Activity Instances, Process Models and Process Instances, Process Interactions, Modeling Process Data, Modeling Organization, Modeling Operation, Business Process Flexibility, Architecture of Process Execution Environments. Process Orchestrations: Control Flow Patterns, Petri Nets, Event-driven Process Chains, Workflow Nets, Graph-Based Workflow Language, Business Process Model and Notation. Process Choreographies: Motivation and Terminology, Development Phases, Process Choreography Design, Process Choreography Implementation, Service Interaction Patterns, Choreography Modeling in BPMN. Properties of Business Processes: Data Dependencies, Object Lifecycle Conformance, Structural Soundness, Soundness, Relaxed Soundness, Weak Soundness, Lazy Soundness, Soundness Criteria Overview. Business Process Management Architectures: Workflow Management Architectures, Flexible Workflow Management, Web Services and their Composition, Advanced Service Composition, Data-Driven Processes: Case Handling. Business Process Management Methodology: Dependencies between Processes, Methodology Overview, Phases in Detail.		
<b>Reference Materials (or use any other standard and latest books):</b>		
1. Business Process Management: Concepts, Languages, Architectures by Mathias Weske		

- Springer; 2nd Edition (May 3, 2012). ISBN-10: 3642286151.
2. Business Process Management Common Body of Knowledge by Yvonne LedererAntonucci, et. al., CreateSpace Independent Publishing Platform (March 8, 2009). ISBN-10: 1442105666
3. Process Management: A Guide for the Design of Business Processes by Jörg Becker, Martin Kugeler and Michael Rosemann, Springer; 2nd Edition (January 21, 2011). ISBN-10: 3642151892
4. Business Process Management, Second Edition: Practical Guidelines to Successful Implementations by John Jeston and Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561
5. Process Management: Practical Guidelines to Successful Implementation by T.S. Malik, Global India Publications Pvt Ltd; 1st Edition (December 31, 2009). ISBN-10: 9380228368
6. Business Process Management: Practical Guidelines to Successful Implementations by John Jeston & Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561
7. BPMN Method and Style with BPMN Implementer's Guide: A structured approach for business process modeling and implementation using BPMN 2.0 by Bruce Silver, Cody-Cassidy Press (October 17, 2011). ISBN-10: 0982368119
8. Workflow Modeling: Tools for Process Improvement and Application Development by Alec Sharp and Patrick McDermott, Artech House; 2nd Edition (October 31, 2008). ISBN-10: 1596931922
9. Process Analysis and Improvement: Tools and Techniques by Seppanen, Marvic S., Kumar, Sameer & Chandra, Charu (2005). McGraw-Hill
10. Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals (The MK/OMG Press) by Paul Harmon and Business Process Trends, Morgan Kaufmann; 2nd Edition (July 27, 2007). ISBN-10: 0123741521

<b>CSDC-5101 Theory of Automata</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	- None	
<b>Course Introduction:</b>		
This course helps the students delving into the theoretical foundations of computation and automata theory. It uncovers the principles behind formal languages, regular expressions, finite automata, and Turing machines, gaining insights into the theoretical underpinnings of computer science.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Fundamental concepts of automata theory and formal languages to form basic models of computation which provide foundation of many branches of computer science, e.g. compilers, software engineering, concurrent systems.	C1 (Knowledge)
<b>Course Outline:</b>		
Introduction to Automata: The Methods and the Madness, Introduction to Formal Proof, Inductive Proofs, the Central Concepts of Automata Theory. Finite Automata: Introduction of Finite Automata, Deterministic Finite Automata, Nondeterministic Finite Automata, Finite Automata with Epsilon Transitions. Regular Expressions and Languages, Regular Expressions, Finite Automata and Regular Expressions, Applications of Regular Expressions, Algebraic Laws for Regular Expressions. Properties of Regular Languages, Proving Languages Not to Be Regular, Closure Properties of Regular Languages, Decision Properties of Regular Languages, Equivalence and Minimization of Automata. Context-Free Grammars and Languages: Context-Free Grammars, Parse Trees, Applications of Context-Free Grammars, Ambiguity in Grammars and Languages. Pushdown Automata: Definition of the Pushdown Automaton, the Languages of a PDA, Equivalence of PDAs and CFGs, Deterministic Pushdown Automata. Properties of Context-Free Languages: Normal Forms for Context-Free Grammars, The Pumping Lemma for Context-Free Languages, Closure Properties of Context-Free Languages, Decision Properties of CFLs. Introduction to Turing Machines: Problems That Computers Cannot Solve, The Turing Machine, Programming Techniques for Turing Machines, Extensions to the Basic Turing Machine, Restricted Turing Machines, Turing Machines and Computers. Un-decidability: A Language That Is Not Recursively Enumerable, Un-decidable Problem That Is RE, Un-decidable Problems About Turing Machines, Posts Correspondence Problem, Other Un-decidable Problems. Intractable Problems: The Classes P and NP, an NP-Complete Problem, A Restricted Satisfiability Problem.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Introduction to Automata Theory, Languages, and Computation by J. Hopcroft, R. Motwani, and J. Ullman, 3rd Edition, 2006, Addison-Wesley.</li> <li>2. An Introduction to Formal Language and Automata by Peter Linz, Jones &amp; Bartlett Pub; 4th Edition (2006). ISBN-10: 0763737984</li> <li>3. Automata and Formal Languages: An Introduction by Dean Kelley, Prentice Hall (1995). ISBN-10: 0134977777</li> </ol>		

## CSDC-6201 HCI & Computer Graphics

<b>Credit Hours:</b>	3 (2-3)
<b>Contact Hours:</b>	2-3
<b>Pre-requisites:</b>	None

### Course Introduction:

The course concerns interaction between humans (the users) and computers. The course is used in UI design, rendering, geometric objects, animation, and many more.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain context of HCI and different measures for evaluation.	C2 (Understand)
CLO-2	Apply the principles of good design	C3 (Apply)
CLO-3	Perspective of age and disabilities.	C4 (Analyze)

### Course Outline:

The human: Input–output channels, Human memory, Thinking, Emotion, Individual differences, Psychology and the design of interactive systems. The computer: Text entry devices, Positioning, pointing and drawing, display devices, Devices for virtual reality and 3D interaction, Physical controls, sensors and special devices, Paper: printing and scanning, Memory, Processing and networks. The interaction: Models of interaction, Frameworks and HCI, Ergonomics, Interaction styles, Elements of the WIMP interface, Interactivity, The context of the interaction, Experience, engagement and fun. Interaction design basics: What is design? The process of design, User focus, Scenarios, Navigation design, Screen design and layout, Iteration and prototyping. HCI in the software process: The software life cycle, Usability engineering, Iterative design and prototyping, Design rationale. Design rules: Principles to support usability, Standards, Guidelines, Golden rules and heuristics, HCI patterns. Implementation support: Elements of windowing systems, Programming the application. Using toolkits, User interface management systems. Evaluation techniques: What is evaluation? Goals of evaluation, Evaluation through expert analysis, Evaluation through user participation, choosing an evaluation method. Universal design: Universal design principles, Multi-modal interaction, Designing for diversity. User support: Requirements of user support, Approaches to user support, Adaptive help systems, designing user support systems. Task analysis: Differences between task analysis and other techniques, Task decomposition, Knowledge-based analysis, Entity–relationship-based techniques, Sources of information and data collection, Uses of task analysis. Dialog notations and design: What is dialog? Dialog design notations, Diagrammatic notations, Textual dialog notations, Dialog semantics, Dialog analysis and design. Models of the system: Standard formalisms, Interaction models, Continuous behavior. Modeling rich interaction: Introduction, Status–event analysis, Rich contexts, Low intention and sensor-based interaction. Groupware: Groupware systems, Computer-mediated communication, Meeting and decision support systems, Shared applications and artifacts, Frameworks for groupware, implementing synchronous groupware. Ubiquitous computing and augmented realities: Ubiquitous computing applications research, Virtual and augmented reality, Information and data visualization. Hypertext, multimedia and the World Wide Web: Understanding hypertext, Finding things, Web technology and issues, Static web content, Dynamic web content.

### Reference Materials (or use any other standard and latest books):

1. Kunigk, J., Buss, I., Wilkinson, P., & George, L. (2018). *Architecting modern data platforms: a guide to enterprise hadoop at scale*. O'Reilly Media.
2. Marcus, A. (2015). HCI and user-experience design. *Human–Computer Interaction Series*, 265-269.
3. Grudin, J. (2006). The GUI shock: computer graphics and human-computer interaction. *Interactions*, 13(2), 46-ff.
4. Jacko, J. A. (Ed.). (2012). *Human computer interaction handbook: Fundamentals, evolving technologies, and emerging applications*.

<b>DSDE-6203 Platforms &amp; Architectures for Data Science</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	None.	
<b>Course Introduction:</b>		
A data science platform is a set of tools, technologies, and processes that enable data scientists to perform advanced analytics on large datasets. It typically includes data storage, data processing, machine learning, and visualization capabilities. Building a data science platform involves integrating these components into a cohesive architecture that enables efficient and effective data science workflows		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Understand and gain material about how to operate clusters and successfully integrating Hadoop clusters into an enterprise context.	C2 (Understand)
<b>Course Outline:</b>		
Big data technology premier, Infrastructure, Cluster, Compute and storage, Networking, Organizational challenges, Datacenter consideration, Platform, Provisioning cluster, Platform validation, Security, Integration with management providers, Accessing and interacting with clusters, High availability, Backup and Disaster recovery, Taking Hadoop to cloud, Basics of virtualization for Hadoop, Solutions for Private clouds, Solutions in the public cloud, Automated provisioning		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Kunigk, Jan, et al. Architecting modern data platforms: a guide to enterprise hadoop at scale. O'Reilly Media, 2018</li> <li>2. Architecting Data and Machine Learning Platforms: Enable Analytics and AI-Driven Innovation in the Cloud, by Marco Tranquillin, 1st Edition, 2023</li> </ol>		

  
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**DSDE-6204 Text Mining**

<b>Credit Hours:</b>	3 (2-3)
<b>Contact Hours:</b>	2-3
<b>Pre-requisites:</b>	None.

**Course Introduction:**

This course will cover the major techniques for mining and analyzing text data to discover interesting patterns, extract useful knowledge, and support decision making, with an emphasis on statistical approaches that can be generally applied to arbitrary text data in any natural language with no or minimum human effort.

<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	To compare and contrast methods for sentence segmentation, tokenization, part-of-speech tagging, syntactic parsing and semantic representation	C2 (Understand)
CLO-2	To apply techniques such as named entity recognition, entity linking, relation and event extraction to extract information from text, while leveraging resources such as lexical and semantic resources (e.g., Framenet, Vernet, WordNet), and terminological repositories	C2 (Understand)
CLO-3	To design and customize text annotation workflows, taking into consideration various annotation formats	C3 (Apply)
CLO-4	To explain how text mining supports the development of semantic search systems	C4 (Analyze)
CLO-5	To explain the distributional hypothesis, and to compare with each other (1) count-based and (2) compositional distributional semantics models	C4 (Analyze)

**Course Outline:**

Introduction, Natural language processing, Document representation, Text categorization, Text clustering, Topic modelling, Document summarization, Social media and network analysis, Sentiment analysis, Text visualization.

**Reference Materials (or use any other standard and latest books):**

1. Feldman, R., & Sanger, J. (2007). *The text mining handbook: advanced approaches in analyzing unstructured data*. Cambridge university press.
2. Ehrmann, M. (2017). *Linked Lexical Knowledge Bases Foundations and Applications*.
3. Martin, J. H. (2009). *Speech and language processing: An introduction to natural language processing, computational linguistics, and speech recognition*. Pearson/Prentice Hall.
4. Manning, C. D., Raghavan, P., & Schütze, H. (2008). *Introduction to information retrieval*. Cambridge university press.
5. Gazit, Lior, and Meysam Ghaffari. *Mastering NLP from Foundations to LLMs: Apply advanced rule-based techniques to LLMs and solve real-world business problems using Python*. Packt Publishing Ltd, 2024.

<b>DSDE-6205 Topics in Data Science</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	None.	
<b>Course Introduction:</b>		
A data science platform is a set of tools, technologies, and processes that enable data scientists to perform advanced analytics on large datasets. It typically includes data storage, data processing, machine learning, and visualization capabilities. Building a data science platform involves integrating these components into a cohesive architecture that enables efficient and effective data science workflows		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Appreciate the computational challenges associated with data analysis and use some techniques developed to meet these challenges.	CLO-1
<b>Course Outline:</b>		
Numerical optimization: algorithms to find the minimizer of convex function e.g. gradient descent, Newton and quasi-Newton methods. Rates of convergence and computational costs associated with these algorithms in general and / or specific settings. Streaming algorithms: algorithms to process massive streams of data. Hashing, sketching and randomization. Probabilistic counting, counting distinct elements, count-min sketch. Deep Learning for Natural Language Processing, introduction to the theory and practice of deep NNs with focus on the applications in natural language processing (NLP). Neural network architectures such as convolutional NNs, recurrent NNs, attention mechanisms, transformers, sequence-to-sequence learning and (time-permitting) generative adversarial networks and variational autoencoder. key concepts of artificial NNs, such as activation functions, layers, weights and gradient descent for fitting a NN; Decision Trees and Random Forests. Model comparison and selection, Scientific validity in the context of the data analytics workflow, Basic model-agnostic assessment of supervised/predictive models, Performance quantification of models. Predictive model validation in R/mlr and python/sklearn Julia/MLJ. Statistical formulation of the supervised learning setting, Bias-variance trade-off, cross-validation and re-sampling estimators, Estimators of the generalization loss and the loss 's variance, Hypothesis testing for pairwise and portmanteau model comparison, Meta-strategies for automated model improvement, Interaction of model tuning and model validation workflows. Introduction to the theory and practice of artificial NNs for supervised learning, building up from simple single layer feed-forward networks to complex multi-layer 'deep' architectures. We will cover some theory such as universal approximation theorems, as well as practicalities like training and regularization. Convolutional Nns. Advanced component: recurrent NNs and unsupervised NNs. Reinforcement Learning: Reinforcement Learning, this topic will introduce the field of RL and standard agent-environment framework, covering Bellman's equations, dynamic programming, Monte Carlo and Temporal-Difference learning. Advanced Component: eligibility traces, function approximation		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Hastie, T., Tibshirani, R., Friedman, J. H., &amp; Friedman, J. H. (2009). <i>The elements of statistical learning: data mining, inference, and prediction</i> (Vol. 2, pp. 1-758). New York: springer.</li> <li>2. Bishop, C. M., &amp; Nasrabadi, N. M. (2006). <i>Pattern recognition and machine learning</i> (Vol. 4, No. 4, p. 738). New York: springer. Bratanic, T. (2024).</li> <li>3. <i>Graph Algorithms for Data Science: With Examples in Neo4j</i>. Simon and Schuster.</li> <li>4. Igual, L., &amp; Seguí, S. (2024). Introduction to data science. In <i>Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications</i> (pp. 1-4). Cham: Springer International Publishing.</li> </ol>		

**AIDE-5202 Speech Processing**

<b>Credit Hours:</b>	3 (2-3)
<b>Contact Hours:</b>	2-3
<b>Pre-requisites:</b>	None

**Course Introduction:**

This course emphasizes processing of the human speech waveform, primarily using digital techniques. Theory of speech production and speech perception as related to signals in time and frequency-domains is covered, as well as the measurement of model parameters, short-time Fourier spectrum, and linear predictor coefficients. Speech coding, recognition, speech synthesis, and speaker identification are discussed.

<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	This course is an introduction to automatic speech recognition, speech synthesis, and dialogue systems, from the computer science and linguistics (rather than EE) perspective.	C2 (Understand)
CLO-2	Focus on understanding of key algorithms including the noisy channel model, Hidden Markov Models (HMMs), GMM (Gaussian Mixture Model) acoustic models,	C2 (Understand)
CLO-3	A* and Viterbi decoding, N-gram language modeling, unit selection synthesis, dialogue architectures, and the role of linguistic knowledge (esp. phonetics, intonation, pronunciation variation, disfluencies, emotion).	C2 (Understand)


**Course Outline:**

Fundamentals of speech production; speech analysis: pitch and period extraction, formant estimation, voiced - unvoiced decision, Linear prediction, Inverse filtering; Auditory modelling, auditory masking; Speech enhancement; Clustering, Gaussian mixture modelling, hidden Markov modelling, Implementation of speech and speaker recognition systems.

**Reference Materials (or use any other standard and latest books):**

1. Speech and Language Processing An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, James Martin, 2nd Edition, 2014
2. The new edition of Jurafsky and Martin. 2007. Speech and Language Processing.
3. Selected chapters from Taylor, Paul. 2007. Text-to-Speech Synthesis
4. Quatieri, T. F. (2002). Discrete-Time Speech Signal Processing, Prentice-Hall, New Jersey.
5. Rabiner, L. R., and Juang, B.-H. (1993). Fundamentals of Speech Recognition, Prentice-Hall, New Jersey.
6. Mitra, S. K. (2010). Digital Signal Processing: A Computer-Based Approach, McGraw-Hill.

<b>DSDE-6206 Enterprise Application Development</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
This course explores advanced application development techniques in a large enterprise-wide setting using Microsoft technologies.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Understand the concepts and standards related to the discipline of E-Commerce.	C2 (Understand)
CLO-2	Analyze complex real world problems found in E-Commerce.	C3 (Apply)
<b>Course Outline:</b>		
Object-Oriented Programming Review, Software Architectures Overview, Application and Page Framework, Asp. Net Server Control and Client Side Scripts, Manipulating Pages and Server Control With JavaScript, Client-Side callback, Web Server Control, Validation Server Control, Master Pages, Theme and Skins, Data Binding & Data Management with ADO.Net, Basic Of XML, XML Reader and XML Writer, Xml Document and Xpath Document, HTML and CSS Design with Asp.Net, ASP.Net AJAX Control, Building and Consuming Services, XML Services, Protocol for Web Services, ADO. Net Data Services, Security and Configuration, Application Deployment and Distribution.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Galloway, J., Haack, P., Wilson, B., &amp; Allen, K. S. (2012). Professional ASP. NET MVC 4. John Wiley &amp; Sons.</li> <li>2. Beginning ASP.NET 4.5.1: in C# and VB (Wrox Programmer to Programmer) 1st Edition) by Imar Spaanjaars (March 24, 2014. ISBN-13: 978-1118846773</li> <li>3. Beginning ASP.NET 4.5 in C# by Matthew MacDonald, Apress; 1st Edition (August 29, 2012). ISBN-10:1430242515.</li> <li>4. Gaylord, J. N., Wenz, C., Rastogi, P., Miranda, T., &amp; Hanselman, S. (2013). Professional Asp. net 4.5 in C# and VB. John Wiley &amp; Sons.</li> </ol>		

  
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<b>DSDE-6207 Cloud Computing</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
This course gives an introduction to cloud computing and related techniques, issues, ecosystem and case studies. Students will become familiar with cloud services and their techniques through labs and the term project		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Understand about fundamental concepts of distributed computing, how these techniques work inside today's most widely-used cloud computing systems.	C1(Knowledge)
CLO-2	Understanding the basic principles of cloud deployment and Service models.	C2 (Understand)
CLO-3	Deployment of service models of Cloud through simulator/Vmware/Openstack etc.	C2 (Understand)
<b>Course Outline:</b>		
Overview of Distributed Computing, Emergence of Cloud Computing, Global Nature of the Cloud, Cloud-Based Service Offerings, Grid Computing, Reliability of Cloud Model, Benefits of Cloud Model, Legal Issues, Key Characteristics of Cloud Computing, Challenges for the Cloud. The Evolution of Cloud Computing. Web Services Delivered from the Cloud: Communication-as-a-Service (CaaS), Infrastructure-as-a-Service, Monitoring-as-a-Service (MaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS). Building Cloud Networks. Virtualization. Federation, Presence, Identity, and Privacy in the Cloud. Security in the Cloud. Common Standards in Cloud Computing. End-User Access to Cloud Computing. Mobile Internet Devices and the Cloud.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Cloud Computing: Concepts, Technology, Security, and Architecture (The Pearson Digital Enterprise Series from Thomas Erl),3rd Edition, 2023</li> <li>2. Cloud Computing Implementation, Management, and Security by John W. Rittinghouse and James F. Ransome, Taylor and Francis Group, LLC (2010). ISBN 978-1-4398-0680-7</li> <li>3. Distributed Computing: Principles and Applications Book by Mei-Ling L. Liu. ISBN-13: 978-0201796445</li> <li>4. Internet of Things: Principles and Paradigms,book by rajkumar buyya and Amir vahid DastjerDi(Eds.), publisher: Morgan kaufmann, ISBN: 978-0-12-805395-9</li> <li>5. <a href="https://arxiv.org/abs/1601.02752">https://arxiv.org/abs/1601.02752</a></li> <li>6. <a href="https://www.vmware.com/pdf/virtualization.pdf">https://www.vmware.com/pdf/virtualization.pdf</a></li> <li>7. <a href="https://www.vmware.com/pdf/virtualization_considerations.pdf">https://www.vmware.com/pdf/virtualization_considerations.pdf</a></li> <li>8. <a href="https://www.researchgate.net/publication/270581440_Cloud_Federation_characterization_and_conceptual_model">https://www.researchgate.net/publication/270581440_Cloud_Federation_characterization_and_conceptual_model</a></li> <li>9. <a href="https://xmpp.org/">https://xmpp.org/</a></li> <li>10. Architecting the Cloud: Design Decision for Cloud Computing Service Models (SAAS, PAAS and IAAS) Publisher: Wiley India Private Limited; 2014 edition, ISBN-10: 8126550333</li> </ol>		

<b>DSDE-6208 Web System and Technology</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
To introduce students with Web Systems and Technologies.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Have essential skills for website management	C1(Knowledge)
CLO-2	Demonstrate understanding of the basic Internet technology concepts	C3 (Apply)
CLO-3	Develop a prototype of interactive World Wide Web applications	C3 (Apply)
<b>Course Outline:</b>		
Overview of WWW, Web Pages, Web Sites, Web Applications, TCP/IP, TCP/IP Application, Services, Web Servers, WAMP Configuration. Introduction to HTTP, HTML & HTML5 Tags, and Dynamic Web Content.CSS and CSS3. Client Side Programming: JavaScript: Basics, Expressions and Control Flow, Functions, Objects, and Arrays, Accessing CSS from JavaScript. Form Handling. Server Side Programing: Programing in PHP. Introduction MySQL, MySQL Functions, Accessing MySQL via phpMyAdmin. Cookies, Sessions, and Authentication. Introduction to XML, Ajax, JQuery, Browsers and the DOM. Designing a Social Networking Site.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Learning PHP, MySQL, JavaScript, and CSS, A Step-by-Step Guide to Creating Dynamic Websites By Robin Nixon, O'Reilly Media; 6th Edition</li> <li>2. WEB TECHNOLOGIES A Computer Science Perspective Kindle Edition by Jeffrey C. Jackson, Prentice Hall; (September 06, 2022).</li> <li>3. Web Technologies by Uttam Kumar Roy, Oxford University Press, USA (June 13, 2011). ISBN-10: 0198066228</li> <li>4. Web Application Architecture: Principles, protocols and practices by Leon Shklar and Richard Rosen, Wiley; 2nd Edition (May 5, 2009). ISBN-10: 047051860X</li> </ol>		

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<b>CSDE-6202 Mobile Application Development I</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
Mobile Application Development I equips learners with fundamental skills to create responsive and feature-rich mobile applications. Explore key concepts in UI/UX design, programming, and mobile platforms, fostering proficiency in app development. Gain hands-on experience to launch their journey into the dynamic realm of mobile application creation.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Discuss different architectures & framework for Mobile Application development.	C1 (Knowledge)
CLO-2	Develop mobile applications using current software development environments.	C3 (Apply)
CLO-3	Compare the different performance tradeoffs in mobile application development.	C3 (Apply)
<b>Course Outline:</b>		
<p>What is Android? Obtaining the Required Tools, Installing and Configuring the Android SDK Manager, Creating Your First Android Application, Anatomy of an Android Application. The Big Picture, How to Get Started, Your First Android Project, A bit About Eclipse, Enhancing Your First Project. Understanding Activities, Linking Activities Using Intents, Fragments, Calling Built-In Applications Using Intents, Displaying Notifications. Understanding the Components of a Screen, Adapting to Display Orientation, Managing Changes to Screen Orientation, Utilizing the Action Bar, Creating the User Interface Programmatically, and Listening for UI Notifications. Using Basic Views, Using Picker Views, Using List View to Display Long Lists, Understanding Specialized Fragments. Using Image Views to Display Pictures, Using Menus with Views, Analog Clock and Digital Clock Views. Saving and Loading User Preferences, Persisting Data to Files, Creating and Using Databases. Sharing Data in Android, using a Content Provider, Creating Your Own Content Providers, Using the Content Provider. Sending SMS Messages Programmatically, Getting Feedback after Sending a Message, Sending SMS Messages Using Intent, Receiving SMS Messages, Sending E-mail. Displaying Maps, Getting Location Data, Monitoring a Location, Building a Location Tracker. Consuming Web Services Using HTTP, Accessing Web Services Using the Get Method, Consuming JSON Services, Sockets Programming. Creating Your Own Services, Establishing Communication between a Service and an Activity, Binding Activities to Services, Understanding Threading. Android games Development, Publishing Android Applications. Handling Telephone Calls, Fonts.</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>5. "Android Programming: The Big Nerd Ranch Guide" by Bill Phillips and Chris Stewart - A comprehensive guide for Android app development with hands-on examples and practical insights 2022, 5th Edition ISBN-10: 0137645546</li> <li>6. Professional Android application development, Reto Meier, Wrox Programmer to Programmer, 2012, 3rd Edition, ISBN-10: 1118102274.</li> <li>7. React Native in Action: Developing iOS and Android apps with JavaScript 1st Edition, Kindle Edition, 2019, ISBN-13 978-1617294051</li> <li>8. Flutter in Action by Eric Windmill, 2019, .ISBN-10: 1617296147</li> </ol>		

<b>CSDE-6505 Introduction to Large Language Models</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
The student will journey through the world of Large Language Models (LLMs) and discover how they are reshaping the AI landscape. You'll explore the factors fueling the LLM boom, such as the deep learning revolution, data availability, and computing power. This conceptual course will dig into LLMs and how they revolutionize businesses and everyday life with real-world examples, from finance to content creation.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Deepens your understanding of the end-to-end AI system architecture needed to design and deploy large language models	C2 (Understand)
CLO-2	Acquire the tools, skills, and strategies to successfully deploy LLMs	C3 (Apply)
CLO-3	Implement an LLM application of your own during a hands-on group project	C3 (Apply)
<b>Course Outline:</b>		
Overview of LLMs, Lifecycle of LLMs (pre-training, fine-tuning, and inference), LLM Hallucination & causes, LLM downstream tasks (Text classification, text similarity, search, question-answering, summarization, translation, and named entity recognition), Prompt engineering & optimization overview, Zero-shot and few-shot in-context learning, Fine-tune and evaluate models, Tradeoffs between various in-context learning approaches, Various types of embedding and their applications, Synthetic data generation, knowledge graph creation using LLM, Comparison of LLM models (GPT Turbo 3.5, GPT 4, Llama 2, Claude, BERT, Cohere, Lamda, Orca, Palm), HuggingFace Models, Integration Framework (LangChain), Data Framework (LlamaIndex).		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Quick Start Guide to Large Language Models: Strategies and Best Practices for Using ChatGPT and Other LLMs by Ozdemir, Sinan. Addison-Wesley Professional.</li> <li>2. Natural language understanding with Python: combine natural language technology, deep learning, and large language models to create human-like language comprehension in computer systems by Dahl, Deborah Anna.</li> <li>3. Modern Generative AI with ChatGPT and OpenAI models: leverage the capabilities of OpenAI's LLM for productivity and innovation with GPT3 and GPT4 by Alto, Valentina.</li> </ol>		

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## DSDE-5102 Database Administration and Management

<b>Credit Hours:</b>	04 (3-1)
<b>Contact Hours:</b>	3-3
<b>Pre-requisites:</b>	Database Systems

### Course Introduction:

The course will focus on the complexities of managing Oracle databases, gaining the expertise needed to administer intricate database systems effectively. From mastering Oracle Database Architecture fundamentals to advanced tasks like managing database instances, administering user access, and implementing multi tenancy.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the fundamental concepts of Oracle Database Administration, including Oracle Database Architecture, physical database files, memory structures, background processes, and Oracle Net Services configuration..	C2 (Understand)
CLO-2	Manage Oracle Database instances proficiently, including tasks such as starting and shutting down the database, working with initialization parameters, diagnosing problems, and utilizing the Data Dictionary for database administration tasks.	C3 (Apply)
CLO-3	Administer user access effectively by configuring user privileges, roles, and resource limitations. Understand multitenancy concepts in Oracle databases, including creating and managing pluggable databases (PDBs), data encryption, and managing tablespaces	C3 (Apply)

### Course Outline:


Oracle Database Administration, Oracle Database Architecture, Physical files of the DB, Memory Structures, Memory Management, Background Processes, How to install Oracle Database Software on the server without GUI ,How to access Oracle Database via sqlplus, sqlcl and SQL Developer, Managing Database Instance: Starting and Shutting down DB, working with initialization parameters, Diagnosing problems, working with Data Dictionary  
 Oracle Net Services, Administering User Access, Privileges & Roles, Resource Limitation  
 Multitenancy: Creating PDBs from SEED, Cloning PDBs, creating Refreshable Clones, Unplug/Plug PDBs, Transparent Data Encryption (TDE), Creating and Managing Tablespaces  
 Managing UNDO Data, Practicing different Backup and Recovery scenarios via RMAN, Moving Data: Data Pump, SQL Loader, Data Guard configuration, Applying the latest Database Patch, Database Upgrade from 19c to 21c

### Reference Materials (or use any other standard and latest books):

1. DBA Essentials for 21c: Installing Oracle Database 21c on OCI Compute (English Edition), by Divit Gupta, 1st Edition, 2023
2. Oracle Database 19c DBA By Examples: Installation and Administration by Ravinder Gupta 1st Edition, 2021
3. <https://docs.oracle.com/en/database/oracle/oracle-database/21/admin/index.html>
4. <https://www.udemy.com/course/oracle-database-course/>

## Preliminary Courses for Pre-Medical Students

URCM-5107 Mathematics I	
<b>Credit Hours:</b>	Non-Credit Hour
<b>Contact Hours:</b>	3
<b>Pre-requisites:</b>	None
<b>Course Content:</b>	
<p>The goal of Mathematics I is to prepare students for first-year Calculus. Helping students gain proficiency in their understanding and ability to utilize real-valued functions, the primary tool in Calculus, accomplishes this goal. Students are presented a broad set of 'function tools', including a general understanding of function properties together with a 'library' of commonly used functions. It is intended that students become skilled at recognizing the different families of functions and the primary properties that set each apart, are able to apply the general function properties to each type of function, and are able to use the special set of algebraic skills associated with each. Students are also expected to become adept in utilizing and interpreting the results from graphing calculators, as an important investigative tool.</p>	
<b>Reference Materials:</b>	
<ol style="list-style-type: none"> <li>1. Thomas, G. B., &amp; Finney, A. R. (2005). <i>Calculus</i>. Reading: Addison-Wesley.</li> <li>2. Anton, H., Bevens. I., &amp; Davis, S. (2005). <i>Calculus: A new horizon</i> (8th ed.). New York: John Wiley.</li> <li>3. Stewart, J. (1995). <i>Calculus</i> (3rd ed.). Pacific Grove, California: Brooks/Cole.</li> <li>4. Swokowski, E. W. (1983). <i>Calculus and analytic geometry</i>. Boston: PWS-Kent Company.</li> <li>5. Thomas, G. B., &amp; Finney, A. R. (2005). <i>Calculus</i> (11th ed.). Reading: Addison-Wesley.</li> </ol>	

  
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<b>URCM-5108 Mathematics II</b>	
<b>Credit Hours:</b>	Non-Credit Hour
<b>Contact Hours:</b>	3
<b>Pre-requisites:</b>	None
<b>Course Content:</b>	
<p>Calculus is the mathematical study of continuous change. It has two major branches, differential calculus and integral calculus. Both branches make use of the fundamental notions of convergence of infinite sequences and infinite series to a well-defined limit. Modern calculus is considered to have been developed in 17th century. A course in calculus is a gateway to other, more advanced courses in mathematics devoted to the study of functions and limits, broadly called mathematical analysis. Calculus is used in every branch of the physical sciences, actuarial science, computer science, medicine, demography, and in other fields. It allows one to go from rates of change to the total change or vice versa, and many times in studying a problem we know one and are trying to find the other. This course aims to provide students with the essential concepts of mathematics and how these can be employed for analyzing real data.</p>	
<b>Reference Materials:</b>	
<ol style="list-style-type: none"> <li>1. Thomas, G. B., &amp; Finney, A. R. (2005). <i>Calculus</i>. Reading: Addison-Wesley.</li> <li>2. Anton, H., Bevens. I., &amp; Davis, S. (2005). <i>Calculus: A new horizon</i> (8th ed.). New York: John Wiley.</li> <li>3. Stewart, J. (1995). <i>Calculus</i> (3rd ed.). Pacific Grove, California: Brooks/Cole.</li> <li>4. Swokowski, E. W. (1983). <i>Calculus and analytic geometry</i>. Boston: PWS-Kent Company.</li> <li>5. Thomas, G. B., &amp; Finney, A. R. (2005). <i>Calculus</i> (11th ed.), Reading: Addison-Wesley.</li> </ol>	

## Mathematics & Supporting Courses

<b>MATH-5101 Multivariable Calculus</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3	
<b>Pre-requisites:</b>	Calculus and Analytical Geometry	
<b>Course Introduction:</b>		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Develop the skills to have ground knowledge of multivariate calculus and appreciation for further computer science courses.	C2 (Understand)
<b>Course Outline:</b>		
<p>Multivariable Functions and Partial Derivatives: Functions of Several Variables. Limits and Continuity. Partial Derivatives. Differentiability, Linearization, and Differentials. The Chain Rule. Partial Derivatives with Constrained Variables. Directional Derivatives, Gradient Vectors, and Tangent Planes. Extreme Values and Saddle Points. Lagrange Multipliers. Taylor's Formula. Multiple Integrals: Double Integrals. Areas, Moments, and Centers of Mass. Double Integrals in Polar Form. Triple Integrals in Rectangular Coordinates. Masses and Moments in Three Dimensions. Triple Integrals in Cylindrical and Spherical Coordinates. Substitutions in Multiple Integrals. Laplace Transforms: Laplace Transform. Inverse Transform. Linearity. First Shifting Theorem (s-Shifting). Transforms of Derivatives and Integrals. ODEs. Unit Step Function (Heaviside Function). Second Shifting Theorem (t-Shifting). Short Impulses. Dirac's Delta Function. Partial Fractions. Convolution. Integral Equations. Differentiation and Integration of Transform. Systems of ODEs. Laplace Transform: General Formulas. Table of Laplace Transforms. Fourier Analysis: Fourier Series, Arbitrary Period. Even and Odd Function. Half-Rang Expansions. Forced Oscillations. Approximation by Trigonometric Polynomials. SturmLiouville Problems. Orthogonal Functions. Orthogonal Series. Generalized Fourier Series. Fourier Integral. Fourier Cosine and Sine Transforms. Fourier Transform. Power Series, Taylor Series: Sequences, Series, Convergence Tests. Power Series. Functions Given by Power Series. Taylor and Maclaurin Series. Laurent Series. Residue Integration: Laurent Series. Singularities and Zeros. Infinity. Residue Integration Method. Residue Integration of Real Integrals.</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Calculus &amp; Analytic Geometry by Thomas, Wiley; 10th Edition (August 16, 2011). ISBN-10: 0470458364</li> <li>2. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley; 10th Edition (August 16, 2011). ISBN-10: 0470458364</li> <li>3. Multivariable Calculus by James Stewart, Brooks Cole; 7th Edition (January 1, 2011). ISBN-10: 0538497874</li> <li>4. Multivariable Calculus by James Stewart 6th Edition, 2007, Cengage Learning publishers.</li> <li>5. Calculus and Analytical Geometry by Swokowski, Olinick and Pence, 6th Edition, 1994, Thomson Learning EMEA, Ltd.</li> <li>6. Elementary Multivariable Calculus by Bernard Kolman William F. Trench, 1971, Academic Press.</li> <li>7. Multivariable Calculus by Howard Anton, Albert Herr 5th Edition, 1995, John Wiley</li> </ol>		

<b>MATH-5102 Linear Algebra</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3	
<b>Pre-requisites:</b>	Calculus and Analytical Geometry	
<b>Course Introduction:</b>		
To provide fundamentals of solution for system of linear equations, operations on system of equations, matrix properties, solutions and study of their properties.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Develops students fundamental skills of solving ordinary differential equations, and developing differential equations for real-world problems	C2(Understand)
<b>Course Outline:</b>		
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.		
<b>Reference Materials (or use any other standard and latest books):</b>		
1. Introduction to Linear Algebra by Gilbert Strang, Wellesley Cambridge Press; latest Edition 2. Elementary Linear Algebra with Applications by Bernard Kolman, David Hill, latest Edition, Prentice Hall.		


<b>MATH-5103 Probability and Statistics</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
To provide fundamentals of solution for system of linear equations, operations on system of equations, matrix properties, solutions and study of their properties.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Develops students fundamental skills of solving ordinary differential equations, and developing differential equations for real-world problems	C2(Understand)
<b>Course Outline:</b>		
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, Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of $S^2$ , t-Distribution, F-Quantile and Probability Plots. Single Sample & One- and Two-Sample Estimation Problems. Single Sample & One- and Two-Sample 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.		
<b>Reference Materials (or use any other standard and latest books):</b>		
1. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, Pearson; 9th Edition (January 6, 2011). ISBN-10: 0321629116		
2. Probability and Statistics for Engineers and Scientists by Anthony J. Hayter, Duxbury Press; 3rd Edition (February 3, 2006), ISBN-10:0495107573		
3. Schaum's Outline of Probability and Statistics, by John Schiller, R. Alu Srinivasan and Murray Spiegel, McGraw-Hill; 3rd Edition (2008). ISBN-10:0071544259		

  
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<b>ENGL-6101 Technical &amp; Business Writing</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3	
<b>Pre-requisites:</b>	Functional English	
<b>Course Introduction:</b>		
<p>Students in the senior level needs good technical writing skills not only for writing project report but also useful for them to communicate their resume and get place in the market. This is a high level course which provide useful knowledge to the students for writing proposals etc. Further, the course aims at augmenting students' proficiency in technical writing in order to sensitize them to the dynamics, challenges, and needs of the modern world characterized by technologically advanced social, cultural, and corporate settings. It will focus on students' ability to effectively convey and exchange information in cross-cultural, international, and multinational milieu necessitated by the emergence of global society.</p>		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	-	-
<b>Course Outline:</b>		
<p>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, crossreferencing, 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.</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Technical Report Writing, by Pauley and Riordan, Houghton Mifflin Company, 8<sup>th</sup> Edition.</li> <li>2. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill.</li> </ol>		

## Elective Supporting Courses

<b>BUSB-6101 Introduction to Marketing</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	-	-
<b>Course Outline:</b>		
Defining Marketing and the Marketing Process, Marketing: Creating and Capturing, Customer Value, Company and Marketing Strategy: Partnering to Build Customer Relationships, Analyzing the Marketing Environment, Managing Marketing Information to Gain Customer Insights, Consumer Markets and Consumer Buyer Behavior, Customer-Driven Marketing Strategy: Creating Value for Target Customers, New Product Development and Product Life-Cycle Strategies, New Product Development and Product Life-Cycle Strategies, Pricing: Understanding and Capturing Customer Value, Pricing Strategies, Marketing Channels: Delivering Customer Value, Retailing and Wholesaling, Advertising and Public Relations		
<b>Reference Materials (or use any other standard and latest books):</b>		
1. Technical Report Writing, by Pauley and Riordan, Houghton Mifflin Company, 8 <sup>th</sup> Edition.		
2. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill.		

  
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<b>BUSB-6102 Human Resource Management</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	-	-
<b>Course Outline:</b>		
<p>Managing Human Resources. Understanding the External and Organizational Environments. Ensuring Fair Treatment and Legal Compliance. HR Planning for Alignment and Change. Using Job Analysis and Competency Modeling. Recruiting and Retaining Qualified Employees. Selecting Employees to Fit the Job and the Organization. Training and Developing a Competitive Workforce. Conducting Performance Management. Developing an Approach to Total Compensation. Using Performance-Based Pay to Achieve Strategic Objectives. Providing Benefits and Services for Employees' Well-Being. Risk Management, Employee Relations, and Risk Management, Health, Safety, and Employee Well-Being. Understanding Unionization and Collective Bargaining.</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<p>1. Managing Human Resources by Susan E. Jackson, Randall S. Schuler and Steve Werner, South-Western College Pub; 11th Edition (June 16, 2011). ISBN-10:1111580227 [TB]</p> <p>2. Management of Human Resources by Gary Dessler, CarolinRekar Munro and Nina D. Cole, Pearson Education Canada; 3rd Edition (February 28, 2010). ISBN-10:0321687140</p>		


## General Education Requirement Courses

<b>URCE-5118 Functional English</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
This is first course in English to the Bachelor of Science students and covers all the fundamental concept of English composition and comprehension. The course is designed in such a way that students can use this knowledge to further enhance their language skills in English. The course aims at enhancing students' skill and competence in communicating their ideas in writing and speaking in English language. It will primarily focus on four areas of language to help the students achieve proficiency in language use, develop skills in listening comprehension, improve reading efficiency, use the conventions of standard written English with skill and assertion, build-up vocabulary, and clearly and accurately reproduce specific data. It will illustrate the force and effectiveness of simple and direct English.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	-	-
<b>Course Outline:</b>		
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.		
<b>Reference Materials (or use any other standard and latest books):</b>		
1. Practical Business English, Collen Vawdrey, 1993, ISBN = 0256192740		
2. Effective Communication Skills: The Foundations for Change, John Nielsen, 2008, ISBN = 1453506748		
3. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.		
4. A Textbook of English Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000		

  
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<b>URCE-5119 Expository Writing</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3	
<b>Pre-requisites:</b>	Functional English	
<b>Course Introduction:</b>		
The course introduces students to the communications so they can effectively communicate their message. The course also covers how to make an effective presentation both written and verbal. Various modern techniques of communication and presentation skills are covered in this course. Further the course aims to enhance students' linguistic command, so they could communicate effectively in diversified socio-cultural situations; create larger stretches of interactive text in speech and writing; and identify and repair any instances of potential communication break-up.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	-	-
<b>Course Outline:</b>		
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.		
<b>Reference Materials (or use any other standard and latest books):</b>		
1. Practical Business English, Collen Vawdrey, 1993, ISBN = 0256192740		
2. Effective Communication Skills: The Foundations for Change, John Nielsen, 2008, ISBN = 1453506748		
3. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.		
4. A Textbook Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000		

<b>URCQ-5101 Discrete Structures</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3	
<b>Pre-requisites:</b>	-	
<b>Course Introduction:</b>		
Introduces the foundations of discrete mathematics as they apply to Computer Science, focusing on providing a solid theoretical foundation for further work. Further, this course aims to develop understanding and appreciation of the finite nature inherent in most Computer Science problems and structures through study of combinatorial reasoning, abstract algebra, iterative procedures, predicate calculus, tree and graph structures. In this course more emphasis shall be given to statistical and probabilistic formulation with respect to computing aspects.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Understand the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs and Trees etc.	C2 (understand)
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.	C3 (Apply)
CLO-3	Apply discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography.	C3 (Apply)
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	C4 (Differentiate)
<b>Course Outline:</b>		
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.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1.Schaum's Outline of Discrete Mathematics, Fourth Edition, 2021</li> <li>2. Discrete Mathematics and Its Applications, 8th edition by Kenneth H. Rosen, 2018</li> <li>3.Discrete Mathematics with Applications, 5th Edition by Susanna S. Epp, 2019</li> <li>4. Discrete Mathematics, 7th edition by Richard Johnson Baugh, 2007</li> </ol>		

  
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<b>URCI-5105 Islamic Studies</b>		
<b>Credit Hours:</b>	2 (2-0)	
<b>Contact Hours:</b>	2	
<b>Pre-requisites:</b>	-	
<b>Course Introduction:</b>		
To provide Basic information about Islamic Studies. To enhance understanding of the students regarding Islamic Civilization. History of Islam, understanding of the worship and its usefulness. The basic concept of Quran Pak: wisdom, patience, loyalty. The comparative analysis of Islam with other religions. The Concept and Value of <i>Haqooq ul Ibad</i> (Bandon Kay Haqooq) in Islam. What is The rights of people in Islamic Point of View. Islamic point of view about other religions.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	To further enhance the knowledge of Islam.	
CLO-2	To understand the basic concept of Islam and Quran Pak.	
CLO-3	To understand the concept of Haqooq ul ibad in the light of Quran.	
CLO-4	To know the importance of Islamic concept about other religions.	
<b>Course Outline:</b>		
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.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Introduction to Islam by Dr Hamidullah, Papular Library Publishers Lahore</li> <li>2. Principles of Islamic Jurisprudence by Ahmad Hassan, Islamic Research Institute, IIUI</li> <li>3. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services</li> </ol>		

<b>URCI-5122 Ideology and Constitution of Pakistan</b>		
<b>Credit Hours:</b>	2 (2-0)	
<b>Contact Hours:</b>	2	
<b>Pre-requisites:</b>	-	
<b>Course Introduction:</b>		
Pakistan studies is an important course at this university in which students study about their motherland. The following are the specific objective of the course		
<ul style="list-style-type: none"> <li>● to develop vision of Historical Perspective, Government, Politics, Contemporary Pakistan, ideological background of Pakistan.</li> <li>● To study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.</li> </ul>		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	To educate students about the history of Pakistan.	
CLO-2	To understand the basic concept of Islam and Quran Pak.	
CLO-3	To educate student Government and politics	
<b>Course Outline:</b>		
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 geopolitical dimension, Pakistan and International Affairs, Pakistan and the challenges ahead.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. The Emergence of Pakistan, Chaudary M., 1967</li> <li>2. The making of Pakistan, Aziz. 1976</li> <li>3. A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988</li> </ol>		

  
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<b>URCS-5123 Application of Information &amp; Communication Technologies</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
This is an introductory course in Computer Science designed for beginners. Apart from leading the participants through a whirlwind history of computing, the course also develops a feel for web programming through a series of lectures that help the students develop their own web page. Main objective of the course is to build an appreciation for the fundamental concepts in computing and to become familiar with popular PC productivity software.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Understand basics of computing technology	C1 (Knowledge)
CLO-2	Do number systems conversions and arithmetic	C2 (Understand)
CLO-3	Have knowledge of types of software	C2 (Understand)
CLO-4	Have knowledge of computing related technologies	C3 (Apply)
<b>Course Outline:</b>		
Brief history of Computer, Four Stages of History, Computer Elements, Processor, Memory, Hardware, Software, Application Software its uses and Limitations, System Software its Importance and its Types, Types of Computer (Super, Mainframe, Mini and Micro Computer), Introduction to CBIS (Computer Based Information System), Methods of Input and Processing, Class2. Organizing Computer Facility, Centralized Computing Facility, Distributed Computing Facility, Decentralized Computing Facility, Input Devices. Keyboard and its Types, Terminal (Dump, Smart, Intelligent), Dedicated Data Entry, SDA (Source Data Automation), Pointing Devices, Voice Input, Output Devices. Soft- Hard Copies, Monitors and its Types, Printers and its Types, Plotters, Computer Virus and its Forms, Storage Units, Primary and Secondary Memories, RAM and its Types, Cache, Hard Disks, Working of Hard Disk, Diskettes, RAID, Optical Disk Storages (DVD, CD ROM), Magnetic Types, Backup System, Data Communications, Data Communication Model, Data Transmission, Digital and Analog Transmission, Modems, Asynchronous and Synchronous Transmission, Simplex. Half Duplex, Full Duplex Transmission, Communications, Medias (Cables, Wireless), Protocols, Network Topologies (Star, Bus, Ring), LAN, LAN, Internet, A Brief History, Birthplace of ARPA Net, Web Link, Browser, Internet Services provider and Online Services Providers, Function and Features of Browser, Search Engines, Some Common Services available on Internet.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Charles S. Parker, Understanding Computers: Today and Tomorrow, Course Technology, 25 Thomson Place, Boston, Massachusetts 02210, 15th Edition." (2007).USA</li> <li>2. Livesley, Robert Kenneth. An introduction to automatic digital computers. Cambridge University Press, 2017.</li> <li>3. Zawacki-Richter, Olaf, and Colin Latchem. "Exploring four decades of research in Computers &amp; Education." Computers &amp; Education 122 (2018): 136-152.</li> <li>4. Sinha, Pradeep K., and Priti Sinha. Computer fundamentals. BPB publications, 2010.</li> <li>5. Goel, Anita. Computer fundamentals. Pearson Education India, 2010.</li> </ol>		

<b>URCS-6101 Professional Practices</b>		
<b>Credit Hours:</b>	2 (2-0)	
<b>Contact Hours:</b>	2	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
A Computing graduate as professional has some responsibilities with respect to the society. This course develops student understanding about historical, social, economic, ethical, and professional issues related to the discipline of Computing. It identifies key sources for information and opinion about professionalism and ethics. Students analyze, evaluate, and assess ethical and professional computing case studies.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
-	-	-
<b>Course Outline:</b>		
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.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Boddington, P. (2023). AI ethics: a textbook. Springer Nature.</li> <li>2. Professional Issues in Software Engineering by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, CRC Press; 3rd Edition (2000). ISBN-10: 0748409513</li> <li>3. Computer Ethics by Deborah G. Johnson, Pearson; 4th Edition (January 3, 2009). ISBN-10: 0131112414</li> <li>4. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet (3<sup>rd</sup> Edition) by Sara Baase, Prentice Hall; 3rd Edition (2008). ISBN-10: 0136008488</li> <li>5. Applied Professional Ethics by Gregory R. Beabout, University Press of America (1993).</li> <li>6. Noorman, M., &amp; Johnson, D. G. (2014). Negotiating autonomy and responsibility in military robots. <i>Ethics and Information Technology</i>, 16(1), 51-62.</li> </ol>		

  
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<b>URCQ-5102 Calculus and Analytic Geometry</b>		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3	
<b>Pre-requisites:</b>	-	
<b>Course Introduction:</b>		
To provide foundation and basic ground for calculus and analytical geometry background.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
-	-	
<b>Course Outline:</b>		
Limits and Continuity; Introduction to functions, Introduction to limits, Techniques of finding 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 Normals 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 $R^3$ , Equations for planes.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Calculus and Analytic Geometry by Kenneth W. Thomas.</li> <li>2. Calculus by Stewart, James.</li> <li>3. Calculus by Earl William Swokowski; Michael Olinick; Dennis Pence; Jeffery A. Cole</li> </ol>		

<b>URCA-5101 Introduction to Management</b>		
<b>Credit Hours:</b>	2 (2-0)	
<b>Contact Hours:</b>	2	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
Introduction to Marketing helps the students in exploring fundamental principles that drive successful business promotion and customer engagement. This course will delve into the core concepts of market research, product positioning, and strategic communication to provide a comprehensive foundation for understanding the ever-evolving world of marketing.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
-	-	
<b>Course Outline:</b>		
<p>Introduction to Managers and Management: What as Management and What Do Managers Do? Defining Management, Management Functions, Management Roles, Management Skills, History of Management. Organizational Culture and Environment: The Manager: Omnipotent or Symbolic? The Organization's Culture, The Environment - Defining Environment, The Specific Environment, The General Environment, Influence on Management Practice. Decision Making The Essence of Manager's Job: The Decision Making Process, The Rational Decision Maker, Decision Making Styles, Analyzing Decision Alternatives – Certainty, Risk, Uncertainty. Planning: The Foundations of Planning, The Definition of Planning, Purposes of Planning, Types of Plans, Contingency Factors on Planning, Objectives: The Foundation for Planning, Multiplicity of Objectives, Real Versus Stated Objectives, Traditional Objective Setting, Management by Objectives. Organization Structure and Design: Defining Organization Structure and Design, Building, The Vertical Dimension of Organizations, Building the Horizontal Dimension of Organizations, The Contingency Approach to Organization Design, Application of Organization Design. Motivation: Motivating Employees, What is Motivation? Contemporary Approaches to Motivation, Contemporary Issues in Motivation, From Theory to Practice: Suggestions for Motivating Employees. Leadership: Managers Verses Leaders, Trait Theories, Behavioural Theories, Contingency Theories, Emerging Approaches to Leadership, Contemporary Issues in Leadership. Communication: Communication and Interpersonal Skills, Understanding Communication, Communication Styles of Men And Women, Feedback Skills, Delegation Skills, Conflict Management Skills, Negotiation Skills. Controlling - Foundations of Control: What is Control? The Importance of Control, The Control Process, Types of Control, Qualities of Effective Control, The Dysfunctional Side of Control, Ethical Issues in Control; Controlling Tools and Techniques: Information Controls, Financial Controls, Operations Controls, Behavioral Controls. The Personnel Function: Terminology, Who Does Personnel Work? Staff Role of The Personnel Department Personnel (Human Resource) Functions. Job Design and Analysis: Job Design, Job Information and Personnel Management, Analyzing Jobs-Obtaining Job Information, Functional Job Analysis, Administration of The Job Analysis Program. Human Resource Planning: Reasons for Human Resource Planning, The Planning Process. Recruitment and Selections/Testing and Interview: Labour Market Considerations, Recruitment and Selection Policy Issues, The Employment Process, Sources of People, The Selection Process, The Selection Procedure, Testing: Interview. Miscellaneous: Union and Management, Compensation Administration, Health And Safety.</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Management by Robbins, S.P. &amp; Coulter, Mary, Prentice Hall; 10th Edition (November 3, 2008). ISBN-10: 0132090716</li> <li>2. Fundamentals of Management by Robbins, S.P. &amp; DeCenzo, David A, Prentice Hall; 7<sup>th</sup> Edition (January 13, 2010). ISBN-13: 978-0132090711</li> <li>3. Human Resource Management by David A. DeCenzo and Stephen P. Robbins. Wiley; 7<sup>th</sup> Edition (October 10, 2001). ISBN-10: 0471397857</li> </ol>		

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**URCW-5201 Applied Physics**

<b>Credit Hours:</b>	3 (2-3)
<b>Contact Hours:</b>	2-3
<b>Pre-requisites:</b>	None

**Course Introduction:**

The course introduces students with the basic concept of Physics and electronics. Students are also taught Physics laws and other associate topics to prepare them for the advanced level courses in this area. The focus of the course on electric force and its applications and related problems, conservation of charge, charge quantization, Electric fields due to point charge and lines of force and many other useful topics.

<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
-	-	

**Course Outline:**

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.

**Reference Materials (or use any other standard and latest books):**

1. Fundamentals of Physics (Extended), 10th edition, Resnick and Walker
2. Narciso Garcia, Arthur Damask, Steven Schwarz., "Physics for Computer Science Students", Springer Verlag, 1998.

## URCC-5125 Civics and Community Engagement

<b>Credit Hours:</b>	2 (2-0)
<b>Contact Hours:</b>	2
<b>Pre-requisites:</b>	None

### Course Introduction:

This course explores the foundations of civic responsibility, governance structures, and the vital role individuals play in shaping their communities. It provides knowledge and skills needed to actively engage in civic life, fostering a sense of responsibility and participation in building stronger, more inclusive societies.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the importance of civic participation, culture and cultural diversity, basic foundations of citizenship, group identities and the role of individuals in creating positive change within their communities.	C2 (Understand)
CLO-2	Develop students' knowledge, skills and attitudes necessary for active and responsible citizenship	C2 (Understand)

### Course Outline:

Introduction to Civics & Community Engagement (Overview of the course: Civics & Community Engagement, Definition and importance of civics, Key concepts in civics: citizenship, democracy, governance, and the rule of law, Rights and responsibilities of citizens, Citizenship and Community Engagement, Introduction to Active Citizenship: Overview of the Ideas, Concepts, Philosophy and Skills, Approaches and Methodology for Active Citizenship, Identity, Culture, and Social Harmony, Concept and Development of Identity, Group identities, Components of Culture, Cultural pluralism, Multiculturalism, Cultural Ethnocentrism, Cultural relativism, Understanding cultural diversity, Globalization and Culture, Social Harmony, Religious Diversity (Understanding and affirmation of similarities & differences), Understanding Socio-Political Polarization, Minorities, Social Inclusion, Affirmative actions, Multi-cultural society and inter-cultural dialogue, Inter-cultural dialogue (bridging the differences, promoting harmony), Promoting intergroup contact/ Dialogue, Significance of diversity and its impact, Importance and domains of Inter-cultural dialogue, ctive Citizen: Locally Active, Globally Connected, Importance of active citizenship at national and global level, Understanding community, Identification of resources (human, natural and others), Utilization of resources for development (community participation), Strategic planning, for development (community linkages and mobilization), Human rights, constitutionalism and citizen's responsibilities, Introduction to Human Rights, Human rights in constitution of Pakistan, Public duties and responsibilities, Constitutionalism and democratic process, Social Institutions, Social Groups, Formal Organizations and Bureaucracy, Types of groups, Group identities, Organizations, Bureaucracy, Weber's model of Bureaucracy, Role of political parties, interest groups and non-government organizations, Civic Engagement Strategies, Grassroots organizing and community mobilization, Advocacy and lobbying for policy change, Volunteerism and service-learning opportunity, Social issues/Problems of Pakistan

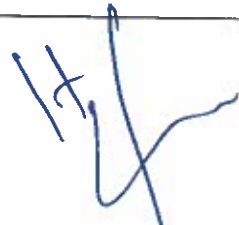
### Reference Materials (or use any other standard and latest books):

1. Kennedy, J. K., & Brunold, A. (2016). Regional context and Citizenship education in Asia and Europe. New Yourk: Routledge, Falmer.
2. Henslin, James M. (2018). Essentials of Sociology: A Down to Earth Approach (13<sup>th</sup> ed.) New York: Pearson Education
3. Macionis, J. J., & Gerber, M.L. (2020). Sociology. New York: Pearson Education
4. Glencoe McGraw-Hill. (n.d.). Civics Today: Citizenship, Economics, and Youth.

Handwritten signature and stamp of the Department of Social Science, University of Sindh.

5. Magleby, D. B., Light, P. C., & Nemacheck, C. L. (2020). *Government by the People* (16th ed.). Pearson.
6. Sirianni, C., & Friedland, L. (2005). *The Civic Renewal Movement: Community-Building and Democracy in the United States*. Kettering Foundation Press.
7. Bloemraad, I. (2006). *Becoming a Citizen: Incorporating Immigrants and Refugees in the United States and Canada*. University of California Press.
8. Kuyek, J. (2007). *Community Organizing: Theory and Practice*. Fernwood Publishing.
9. DeKieffer, D. E. (2010). *The Citizen's Guide to Lobbying Congress*. TheCapitol.Net.
10. Rybacki, K. C., & Rybacki, D. J. (2021). *Advocacy and Opposition: An Introduction to Argumentation* (8th ed.). Routledge.
11. Kretzmann, J. P., & McKnight, J. L. (1993). *Building Communities from the Inside Out: A Path Towards Finding and Mobilizing a Community's Assets*. ACTA Publications.
12. Patterson, T. E. (2005). *Engaging the Public: How Government and the Media Can Reinvigorate American Democracy*. Oxford University Press.
13. Love, N. S., & Mattern, M. (2005). *Doing Democracy: Activist Art and Cultural Politics*. SUNY Press

<b>URCE-5124: Entrepreneurship</b>		
<b>Credit Hours:</b>	2 (2-0)	
<b>Contact Hours:</b>	2	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
This course helps to ignite the student's passion for innovation and business leadership. Explore the essential principles of creating and managing a successful venture, from ideation to execution. Equip them with the entrepreneurial mindset and skills necessary to navigate the dynamic world of business and turn their ideas into reality.		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	The course gives students the tools necessary to think creatively, to plan out whether their idea is marketable to investors, guide them through the launch their own business, or to support an employer in launching and growing an entrepreneurial venture.	C2 (Understand)
<b>Course Outline:</b>		
Entrepreneurship and the Entrepreneurial Mind-Set, Entrepreneurial Intentions and Corporate Entrepreneurship. Entrepreneurial Strategy: Generating and Exploiting New Entries. Creativity and the Business Idea. Identifying and Analyzing Domestic and International Opportunities. Intellectual Property and Other Legal Issues for the Entrepreneur. The Business Plan: Creating and Starting the Venture. The Marketing Plan. The Organizational Plan. The Financial Plan. Sources of Capital. Informal Risk Capital, Venture Capital, and Going Public. Strategies for Growth and Managing the Implication of Growth. Succession Planning and Strategies for Harvesting and Ending the Venture.		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Entrepreneurship by Robert Hisrich, Michael Peters and Dean Shepherd, McGrawHill/Irwin; 9th Edition (September 27, 2012). ISBN-10: 0078029198</li> <li>2. Entrepreneurship: Ideas in Action by Cynthia L. Greene, South-Western Educational Pub; 5th Edition (January 6, 2011). ISBN-10: 0538496894</li> <li>3. Entrepreneurship by William D. Bygrave and Andrew Zacharakis, Wiley; 2nd Edition (October 12, 2010). ISBN-10: 0470450371</li> <li>4. Entrepreneurship: Theory, Process, and Practice by Donald F. Kuratko, South-Western College Pub; 8th Edition (November 14, 2008). ISBN-10: 0324590911</li> <li>5. Entrepreneurship: Successfully Launching New Ventures by Bruce R. Barringer and Duane Ireland, Prentice Hall; 4th Edition (October 27, 2011)</li> </ol>		

  
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 University of Sargodha



URCQ-5111: Translation of the Holy Quran - I		
<b>Credit Hours:</b>	Non-Credit	
<b>Contact Hours:</b>	-	
<b>Pre-requisites:</b>	None	
<b>Course Introduction:</b>		
This course is designed to develop the recitation skills in students.		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	To familiarize the students to keys and fundamentals of recitation of the holy Quran.	-
CLO-2	To develop the skill of the students of recitation the last revelation.	-
CLO-3	Students will learn the basic Arabic grammar in a practical way.	-
CLO-4	To develop an eagerness among the students to explore the last divine Book.	-
<b>Course Outline:</b>		
<p>تیسواں پارہ - ناظرہ مع تجوید  بنیادی عربی گرامر  اسم اور اسکے متعلقات : اسم فاعل ، مفعول ، تفضیل ، مبالغہ  فعل اور اسکی اقسام : ماضی ، مضارع ، امر ، نہی  حرف اور اسکی اقسام : حروف علت ، حروف جارہ ، مشبہ بالفعل  تیسویں پارے کی آخری بیس سورتیں ( حفظ مع ترجمہ )</p>		

  
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**URCQ-5111: Translation of the Holy Quran – II**

<b>Credit Hours:</b>	Non-Credit
<b>Contact Hours:</b>	-
<b>Pre-requisites:</b>	None

**Course Introduction:**

This course is designed to develop the recitation skills in students.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Students will come to know about the real nature, significance and relevance of the Islamic beliefs in light of the text of the Holy Quran.	-
CLO-2	Students will seek knowledge of translation and transliteration of the Holy Book Quran.	-
CLO-3	To familiarize the students with the concept of Ibādah (Its significance, scope and relevance) and its types in Islam.	-
CLO-4	Students will learn literal and idiomatic way of translation of the Holy Book.	-
CLO-5	Students will learn about the polytheism and its incompatibility in Islam highlighted by the Holy Quran.	-
CLO-6	To highlight the significance of learning through using all human faculties provided by the almighty Allah and familiarize the students about condemnation of ignorance mentioned in the Quranic text.	-
CLO-7	To develop Awareness among the students about rights and duties of different circles of society in the light of Holy Quran.	-
CLO-8	To introduce the students to Quranic Arabic grammar in practical manner.	-

**Course Outline:**

ایمانیات اور عبادات  
 اللہ پر ایمان، فرشتوں پر ایمان، رسولوں پر ایمان، آسمانی کتابوں پر ایمان، یوم آخرت پر ایمان،  
 تقدیر پر ایمان نماز، روزہ، زکوٰۃ، حج، جہاد،  
 معاشرے کے حقوق  
 خاندان کی تکوین، حق مہر، رضاعت و حمل، اولاد کو قتل کرنے کے ممانعت، شوہر کی نافرمانی،  
 طالق، بیوہ کی عدت کے احکام، نکاح کا پیغام بھیجنا، عورت کی وراثت (اس کے شوہر کی طرف  
 سے)، والدین کے حقوق، بیویوں اور اولاد کے بیچ عداوت، خاندان کے حقوق، مہمان کی عزت،  
 اجازت طلب کرنے کے اصول، مجلس کے آداب، تعاون اور بھائی چارہ، گروہ بندی، محبت،  
 لوگوں کے درمیان صلح، عفو و درگزر، غصہ پر قابو اور معاف کرنا، شعوب و قبائل، لوگوں کے  
 بیچ اختلافات، حمایت و نگہبانی۔

قرآنی عربی گرامر کے اصول اور انکے اطلاقات (متن قرآنی پر اطلاق سے توضیحات)

منتخب آیات مع ترجمہ و تجوید  
 • البقرہ (۱۱۷، ۲۳۸، ۴۵، ۱۱۸، ۲۷۸، ۱۷۷، ۴۵، ۳۴۷، ۱۵۸، ۷۱۸، ۴۲۸، ۵۳،

- ١١٨ ، ٢٢٧ ، ٢٣٧ ، ١١٧ ، ٢٤٨ ، ٤٢٨ ، ٢٨٧ ، ٨٢ ، ٢٢ ، ٣٤٨ ، ٢٨٧ ، ٤٢٨ ،  
 ٧٣٨ ، ٢٨٨ ، ٢٨٨ ، ١٣٨ ، ٢٨٨ ، ١٨٨ ، ٧٥٨ ، ٢٢٧ ، ٢٤٧ ، ٢٧٨ ، ٣٢٧ ، ٥٢٧  
 (٣٢ ، ١٢٧ ، ٨٢٧ ، ٣٣٨ ، ٥٢٧ ، ٨٢ ، ١٣٨ ، ٤٣٨ ، ١٣٨  
 النساء (٤٣ ، ٨٧ ، ٢١٧ ، ٢٣ ، ٢٢ ، ١٢ ، ٢٢ ، ٣٧ ، ١٢ ، ٢٢ ، ٢٣٧ ، ٢٤ ، ٨٢ ، ٤٢) •  
 ٧٢٧ ، ٤٣ ، ١٨ ، ٤٣ ، ٧٢٧ ، ٢٨٧ ، ٧٧ ، ٧٧ ، ٤٨ ، ٥٨ ، ٢١٧ ، ٥ ، ٧٧ ، ٥٣ ، ٢٨٧  
 (٧٢ ، ٢٨٧ ، ٥٤ ، ٢٥٧ ، ٢٧ ، ٧ ، ١٨ ، ٧ ، ٢  
 الانعام (٥٤ ، ٢٥ ، ٧٤٧ ، ١٣٧ ، ٥٧ ، ٨٢ ، ٨٨) •  
 آل عمران (٢٧ ، ٧ ، ٥٥٧ ، ٥٢ ، ٤٨٧ ، ٤٢ ، ٢٣ ، ١٢) •  
 المائدة (٤ ، ٨ ، ٨٢ ، ٢٣ ، ٢٧ ، ٨٢ ، ٨ ، ٥٤) •  
 الاعراف (٢٢٧ ، ٢٢٧ ، ٤٣) •  
 التوبة (٧١ ، ٢٧ ، ١٨) •  
 بود (٨٧) •  
 الزمر (٢) •  
 النور (٢٨ ، ١٢ ، ١٨ ، ٢٨ ، ٨٤ ، ٥٤) •  
 محمد (٣٣) •  
 انفال (١٨ ، ٨٢) •  
 الرعد (٣) •  
 الطلاق (٥) •  
 الحج (٤) •  
 ابراهيم (٣٨ ، ٥٥) •  
 الاسراء (٥٨ ، ٣٨) •  
 الاحقاف (٤٧) •  
 المومنون (١٨) •  
 العنكبوت (٢ ، ٤٨ ، ٢٥) •  
 النحل (٨٨) •  
 لقمان (٥٧ ، ٤٧ ، ٥) •  
 الاحزاب (٢٥ ، ١٤ ، ٢٣ ، ٤٣) •  
 الشعراء (١) •  
 الروم (٧٨) •  
 مريم (٥٧ ، ٢٨) •  
 المجادلة (٧٧ ، ٨٧) •



Chairman  
 Department of Molecular Science  
 University of Baghdad

### URCQ-5111: Translation of the Holy Quran – III

<b>Credit Hours:</b>	Non-Credit
<b>Contact Hours:</b>	-
<b>Pre-requisites:</b>	None

#### Course Introduction:

This course is designed to develop the recitation skills in students.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	To introduce ethics and highlight its importance, need and relevance for individual and collective life.	-
CLO-2	To illuminate the students with the Quranic norms of Morality i.e. truthfulness, patience, gratitude, modesty, forgiving, hospitality etc.	-
CLO-3	To familiarize the students with immoral values like falsify, arrogance, immodesty, extravagance, backbiting etc.	-
CLO-4	To inculcate ethical and moral values in our youth.	-
CLO-5	To develop a balanced dynamic and wholesome personality.	-
CLO-6	To introduce the students to Quranic Arabic grammar in practical manner.	-

#### Course Outline:

اخلاق (تعارف، ضرورت و اہمیت، اقسام، معنویت)  
اخلاق حسنہ:

برائی کو نیکی سے مٹانا، نیکی کے کاموں میں مسابقت، لوگوں کے درمیان صلح، عدل و انصاف، سچائی، ایثار، سلیم قلب، مہمان نوازی، لغویات سے اعراض، عاجزی و انکساری، نگاہ اور آواز کو پست رکھنا، چال میں میانہ روی، شرمگاہوں کی حفاظت، صبر، شکر، امور میں میانہ روی۔

اخلاق سنیہ:

ظلم اور زیادتی، غرور و تکبر، نفسانی خواہشات کی پیروی، بدگمانی، جھوٹ، چغلی اور تہمت، تمسخر اور شیخی خوری، لہو و لعب، برے ناموں سے پکارنا، احسان جتانہ اور تکلیف دینا، فضول خرچی اور حد سے بڑھنا، حسد اور تنگ دل، بے پردگی۔

قرآنی عربی گرامر کے اصول اور انکے اطلاقات  
(متن قرآنی پر اطلاق سے توضیحات)

منتخب آیات مع ترجمہ و تجوید

- البقرہ (۸۷۷، ۴۵۸، ۳۲، ۸۲۷، ۸۱۷، ۸۴۷، ۸۱۷، ۸۴، ۳۴۷، ۱۱۷، ۱۴۸، ۴۸۷، ۸۸۸، ۱۱، ۸۲۷، ۲۵۷، ۱۲۷، ۲۱۷، ۵۲۸، ۳۲۸، ۸۲۸، ۸۷۸، ۱۲، ۷۳۸، ۵۳، ۱۷، ۵۸۷، ۲۴۸، ۱۸، ۷۱، ۳۲، ۲۸۸، ۴۲۷، ۲۱)
- آل عمران (۵۴۷، ۵۷، ۵۸، ۴۲۷، ۸۳۷، ۲۵۷، ۵۳۷، ۴۵۷، ۱۷، ۱۱۸، ۴۸۷، ۳۳۷، ۵۱۷، ۵۱۷، ۲۸، ۲۱، ۷۵۷، ۱۵۷، ۲۴۷)
- النساء (۴۳۷، ۳۸، ۸۸، ۲۱۷، ۱۱۷، ۴۱۷، ۵۴، ۱۸، ۱۸، ۳۱۷، ۲۳، ۴۸، ۵۸، ۱۴، ۱۵، ۵۸)

- المائدة (٢٧، ٧٥، ٢، ٣٧، ٣٢، ١٤، ٢٤)
- النحل (٤٨٧، ٢٨٧، ١٣، ٣٧٧، ٤١٧، ٢٨٧، ١٢)
- الرعد (٢، ٨٨، ٥٨، ١٨، ٤٨)
- الاعراف (٧٢، ٤٢، ٢٢٧، ٥٥٧، ١٨، ٥، ١٥، ٢٥٧، ٧٤، ٢٢، ٧٣)
- القصص (٥٢، ٥٤)
- فصلت (٥٣)
- الانعام (١٢٧، ٤٤٧، ١٣٧، ١١، ١١، ٨٣)
- النمل (٢٥، ١٢)
- الحج (١١، ٢٢، ١٢، ٢٤، ١٣)
- الحجرات (١٧، ٤٧، ٨٧، ٣، ٧٧، ٢، ٧٧، ٢)
- الاحزاب (٤٣، ٥٨، ٤٣، ٢٤، ٤٤، ٨٤، ٢٤، ٢٤، ١٤، ٣٨)
- الحشر (٢)
- طه (٨١)
- الانعام (١٨٧، ٣٢، ٧٤٧، ٢٧٧، ٧٥٧، ٥٢٧)
- ق (٥٣)
- الانفال (٧٢، ٢٥، ١٨)
- الفتح (٤٧)
- يونس (٨٨، ٨٨، ٢٢، ٨٧، ٢٧، ١٧)
- الفرقان (٣٢، ١٢، ٧٨، ٣٢)
- النور (٨٨، ٧٣، ٧٢، ٣٣، ٣٣، ٧٣، ١٣، ٥، ٢، ٣٨)
- لقمان (٢٧، ٨٣، ٢٧، ٣٣، ٢)
- الاسراء (١٣، ٤، ١٧٧، ١٣)
- المزمل (٢٧)
- المدثر (٥، ٢)
- المدثر (٥١)
- فاطر (٨٣)
- الفتح (٢٨)
- البلد (١٧)
- الزمر (١٧، ٣)
- الحجر (٤٢)
- النجم (٧٣)
- الرحمن (١٢)
- هود (٣، ٨١٧، ٢)
- الكهف (٢٤، ٨)
- الشورى (١٣)
- غافر (١٨، ٢٨)
- الحديد (١٨، ١٨)
- مريم (٢٤)
- النازعات (٧٥)
- التوبه (١١، ٥٢، ٤٢)
- الهمزه (٧)





- فاطر (٣٧، ٨٧، ١٨)
- العنكبوت (٧٥، ٣٢، ١٨)
- الروم (١٤)
- الاسراء (٢٢، ١١)
- الرعد (٨)
- السبا (٨٨، ٣، ١٧)
- يونس (٨٨، ٤، ٥٨، ٥٨، ٧١٧، ٢٢)
- يوسف (٥٧، ٥٢)
- الفرقان (٣٤، ٨٢)
- لقمان (٢٧، ٢٨)
- طه (٣٤، ٥٧٧)
- النحل (٢، ٢، ٤٧٧، ٢٢، ٢٢، ٢١، ٢٥، ٧٢، ٧٧، ٤١)
- النمل (٢٧، ١٧، ٢٧، ٨٢، ١٢، ٢٢، ٥٢، ٥٢)
- السجده (١٨)
- الحديد (٢)
- هود (٢، ٣٥)
- يسين (٧٥، ١٣)
- الروم (٢٥، ٥٨، ٢٧، ١٤، ٢٣، ٢٣)
- فصلت (٢٣، ٢٣)
- الحج (٣١، ٨٨، ٤٢، ٧٢)
- الحجر (٨٨، ٢٧)
- الانبياء (١٥، ١٣، ٧٣)
- الزاريات (١٥)
- الزلزله (٧)
- القصص (٨٢، ٧٢، ١٢، ٢١، ٢١)
- النور (٣٥، ٤٥، ١٥، ٨٨، ٨٨، ١٣)
- الجمعه (٤، ٧٧، ١٧، ٨٢، ٧٧)
- القمر (١)
- الواقعه (٢٢)
- الفاطر (٣٧، ١٨)
- الملك (٢٧)
- الصف (١٧)
- الجن (٣٧)
- الشورى (٢٨)
- الزخرف (٧٧)
- الفيل (٧)

