




**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

**Distribution:**

- Chairman, Department of Computer Science
- Controller of Examinations
- Director Academics

**C.C:**

- Dean, Faculty of Computing & Information Technology
- Director, QEC
- Additional Registrar (Affiliation & Registration)
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File

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MEMORANDUM

TO : THE SECRETARY  
FROM : THE DIRECTOR  
SUBJECT: [Illegible]

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**Curriculum**  
*of*  
**BS Artificial Intelligence**  
*for*  
**Main Campus**



Issues

- 1. CPE is not a pattern.
- 2. Why Division course not taken?
- 3. How many courses are there?
- 4. How many courses are there in BS?
- 5. How many courses are there in BS?

Total Credit Hours  
Total credit hours = 120  
CPE = 30  
LD = 15  
INT = 0  
Projects = 6  
Major = 77

*H. F. G.*  
Chairman  
Department of Computer Science  
University of Sargodha

**Department of Computer Science**  
**University of Sargodha**  
**(Applicable from Fall 2024)**

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## Underlying Principles of Artificial Intelligence Degree Programs

Curriculum plays an important role within education as it outlines the planned and structured learning experiences that an academic program provides. For an effective academic program, the curriculum must meet the needs of the stakeholders and face the emerging challenges. The Department of Computer Science (UOS) realizes the rapidly changing needs of today's knowledge intensive technology driven complex work places and the changing patterns of 21<sup>st</sup> century universities' education which have removed the identity of place, the identity of time, the identity of the scholarly community, and the identity of the student community. To meet these challenges, the Department has revised the existing curriculum. The curriculum is based on following underlying principles:

- i. The curriculum should be a broad based and provides students with the flexibility to work across many disciplines & professions.
- ii. The curriculum should prepare graduates to succeed in a rapidly changing field.
- iii. The curriculum should provide guidance for the expected level of mastery of topics by graduates.
- iv. Should provide realistic, adoptable recommendations that provide guidance and flexibility, allowing curricular designs that are innovative and track recent developments in the field.
- v. The curriculum contents should be relevant and compatible with a variety of institutions.
- vi. The size of the essential knowledge must be managed.
- vii. The curriculum should identify the fundamental skills and knowledge that all graduates should possess.
- viii. The curriculum should provide the greatest flexibility in organizing topics into courses and curricula.

The curriculum has developed using top-down curriculum development approach. It has adopted a balanced and multidisciplinary approach and presents a blend of study areas which spreads across the boundaries of fundamental knowledge of traditional disciplines to advanced knowledge of the emerging disciplines. Body of knowledge (BOK) of AI program covers knowledge areas which are required for the program's accreditation from the Accreditation Council and knowledge area which are required for professional certification and professional development.

It is universally accepted that each profession needs both a specific skill set and an appropriate mindset. Developing an appropriate mindset of the prospective computing graduates requires a body of knowledge which enriches students' experiences, thoughts, beliefs, assumptions, and attitudes about the special characteristics of that specific domain. Therefore, the course contents and related practical experiences are designed to meet the professional requirements of the respective domain. For this the revised curriculum mainly focuses on following six (6) key areas:

- i. Knowledge: Theoretical learning of concepts and principles regarding a particular subject(s).
- ii. Skills: Capability of using learnt knowledge and applying it according to the context
- iii. Competencies: The ability to do things satisfactory- not necessarily outstandingly or even well, but rather to a minimum level of acceptable performance.
- iv. Expertise: Level of proficiency and innovative ways of applying learnt knowledge. (Competitive edge)
- v. Dispositions: Habits of mind or tendencies to respond to certain situations in certain ways.

The role of dispositions in computing education is very important. For example, having the disposition to be a programmer is much better than just having programming skills.

vi. Values: Moral, ethical and professional practices.

To strengthen the curriculum further, specialization tracks have also been integrated within the curriculum's BOK. These specialization tracks are designed according to what the industry is looking for in an employee and the learning interests of students. Furthermore, life skills including desired dispositions, soft skills, public speaking, critical thinking & reasoning, 21st Century

literacies, personal attributes, entrepreneurship, attitude towards lifelong learning, professional practices and other social skills have not considered discrete items, rather threaded into the entire fabric of the curriculum.

## **Curriculum for BS Artificial Intelligence Program**

### **BSAI Program's Rationale**

Artificial Intelligence is an approach to make a computer, a robot, or a product to think how smart human think. AI is a study of how human brain think, learn, decide and work, when it tries to solve problems. And finally to output the intelligent software systems. The aim of AI is to improve computer functions which are related to human knowledge, for example, reasoning, learning, and problem-solving.

The objectives of AI research are reasoning, knowledge representation, planning, learning, natural language processing, realization, and ability to move and manipulate objects. There are long-term goals in the general intelligence sector.

Recent developments in computer hardware, software and communication technologies have offered exciting new opportunities and challenges for creation of innovative learning environments for Artificial Intelligence 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 workplaces. The key rationale behind the BS Artificial Intelligence 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.

### **Program's Aims & Objectives**

BSAI Program is committed to create, expand, disseminate and teach the artificial intelligence body of knowledge through academics, applications and research which positively impact society locally, nationally, and internationally.

BSAI program aims to develop students' critical professional thinking and intuition. The program's curriculum provides a balanced mixture of learning experiences to make the graduates capable of sound professional decisions. As a result, the successful graduates will be able to assume responsible positions in business, government, and education at the research, development, and

planning levels. The program also provides an excellent foundation for further formal learning and training. The program is also expected to provide environments to put into practice, the principles and techniques learnt during implementation of the program's curriculum. 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 Computer Science.
- The program should encourage students to develop and use abstract models in addition to apply respective technology in practical situations.
- The program should promote students' special communication skills both orally and in writing. They must be able to produce well-organized reports/presentations/projects, which clearly delineate objectives, methods of solution, results, and conclusions for a complex task.
- 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.

### **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

  
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- 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

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>			

*[Handwritten Signature]*  
 Chairman  
 Department of Computer Science  
 University of Singapore

## 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) ).

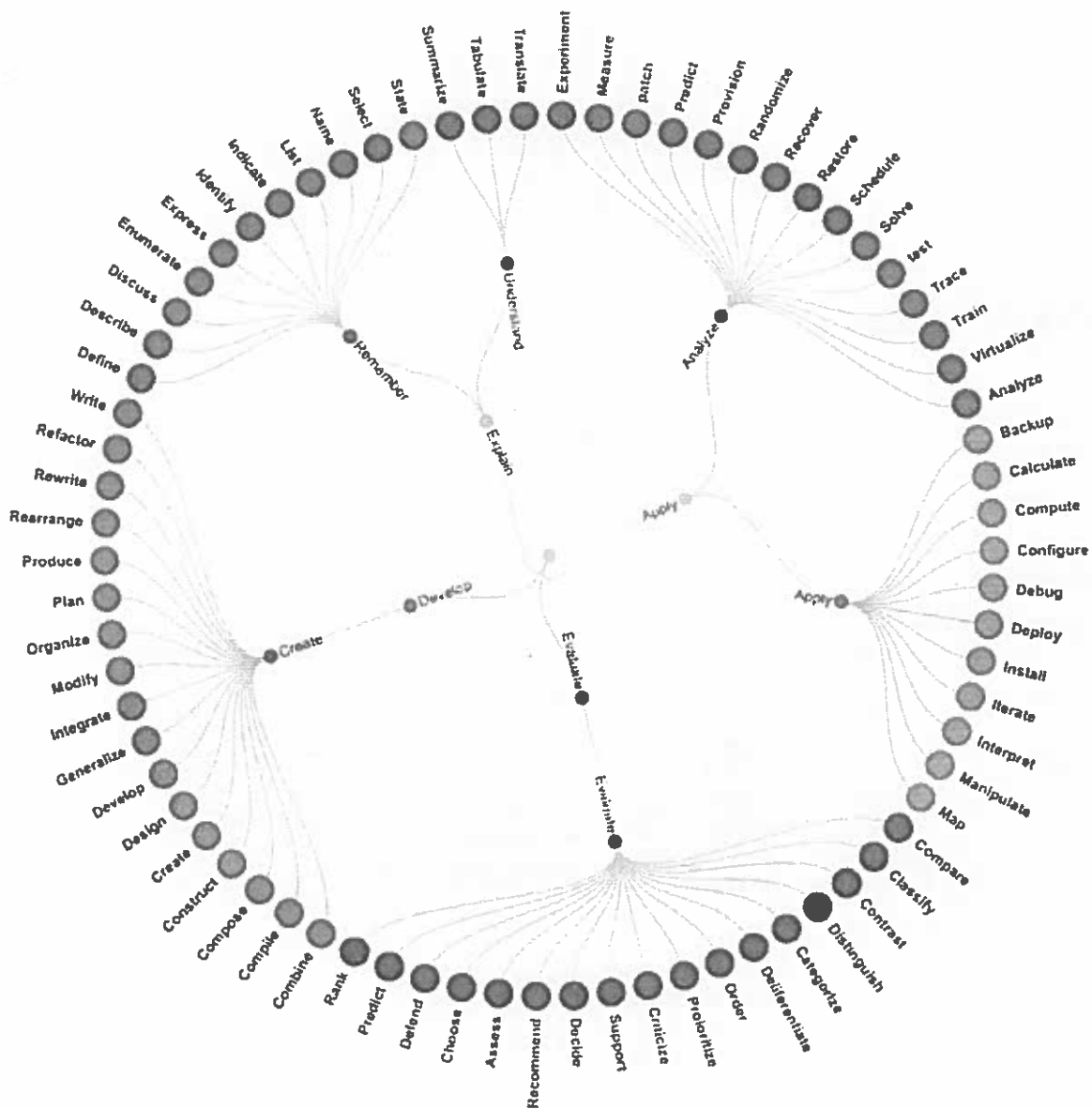
S#	Program Learning Outcomes (PLOs)	Computing Professional Graduate
1	Academic Education	To prepare graduates as computing professionals
2	Knowledge for Solving Computing Problems	Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain 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	Explain: define, describe, discuss, enumerate, express, identify, indicate, list, name, select, state, summarize, tabulate, translate
Understand	
Apply	Apply: 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  Evaluate: analyze, compare, classify, contrast, distinguish, categorize, differentiate, discriminate, order, prioritize, criticize, support, decide, recommend, assess, choose, defend, predict, rank
Analyze	
Evaluate	
Create	Develop: 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 Artificial Intelligence 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 AI domain or proceed to further or higher education or training.

### Program's Structure

The BS (AI) program gives the students an in-depth knowledge they need to transform large and complex scenarios into actionable decisions. The program and its curriculum focuses on how complex inputs — such as knowledge, vision, language and huge databases — can be used to make

decisions to enhance human capabilities. The curriculum of the BS (AI) program includes coursework in computing, mathematics, automated reasoning, statistics, computational modeling, introduction to classical artificial intelligence languages and case studies, knowledge representation and reasoning, artificial neural networks, machine learning, natural language processing, vision and symbolic computation. The program also encourages students to take courses in ethics and social responsibility, with the opportunity to participate in long term projects in which artificial intelligence can be applied to solve problems that can change the world for the better — in areas like agriculture, defense, healthcare, governance, transportation, e-commerce, finance and education. The proposed areas which are required to be covered to complete the degree. Covered areas consist of core courses (compulsory), foundation courses, general courses and electives.

### **Degree Requirement**

Minimum credit hours shall be 130 for BS Artificial Intelligence program.

### **Duration**

The program shall comprise minimum Eight (8) Semesters/Terms spread over Four (4) calendar years with two Semesters/Terms a year as per rules of the University.

### **Eligibility Criteria**

HSSC (Part-I) with least 50% Marks with one of the following combinations:

- I. Pre-Engineering
- II. Pre-Medical (Admitted candidates has to pass 6-credit hours courses of mathematics in first two semesters.)
- III. General Science
  - a) Math, Stat, Phy
  - b) Math, Stat, Eco
  - c) Math, Stat, Comp
  - d) Math, Phy, Comp
  - e) Math, Eco, Comp
- IV. A-Level (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.

  
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## Distribution of Courses

Followings are the distribution of total credit hours:

BS Artificial Intelligence			
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>

## Mapping of BS Artificial Intelligence Program

Mapping of BSAI Program on the Generic Structure:						
Sr. No	Sem. No	Code	Pre- Reqs	Course Title	Dom	Cr. Hr. (Cont Hr)
<b>Computing Core (46/130) 14 Courses</b>						
1	1	CMPC-5201		Programming Fundamentals	Core	4 (3-3)
2	2	CMPC-5202	CMPC-5201	Object Oriented Programming	Core	4 (3-3)
3	2	CMPC-5203		Database Systems	Core	4 (3-3)
4	2	CMPC-5204		Digital Logic Design	Core	3 (2-3)
5	3	CMPC-5205	CMPC-5202	Data Structures	Core	4 (3-3)
6	3	CMPC-5206		Information Security	Core	3 (2-3)
7	3	CMPC-5207		Artificial Intelligence	Core	3 (2-3)
8	3	CMPC-5208		Computer Networks	Core	3 (2-3)
9	3	CMPC-5101		Software Engineering	Core	3 (3-0)
10	4	CMPC-5209	CMPC-5204	Computer Organization & Assembly Language	Core	3 (2-3)


11	5	CMPC-6201		Operating Systems	Core	3 (2-3)
12	7	CMPC-6101	CMPC-5205	Analysis of Algorithms	Core	3 (3-0)
13	7	CMPC-6702		Final Year Project – I	Core	2 (0-6)
14	8	CMPC-6703	CMPC-6702	Final Year Project - II	Core	4 (0-12)

**Domain Core (18/130) 6 Courses**

Sr. No	Sem. No.	Code	Pre-Reqs	Course Title	Domain	Cr Hr (Cont Hr)
1	4	AIDC-4101		Programming for Artificial Intelligence	Domain Core	3 (2-3)
2	4	AIDC-4102		Machine Learning	Domain Core	3 (2-3)
3	5	AIDC-5101		Artificial Neural Networks & Deep Learning	Domain Core	3 (2-3)
4	5	AIDC-5102		Knowledge Representation & Reasoning	Domain Core	3 (2-3)
5	6	AIDC-6101		Computer Vision	Domain Core	3 (2-3)
6	6	ITDC-6204		Parallel & Distributed Computing	Domain Core	3 (2-3)

**Domain Elective (21/130) 7 Courses**

Sr. N.	Sem. No	Code	Pre-Reqs	Course Title	Domain	Cr Hr (Cont Hr)
1	5/6/7	AIDE-5201		Natural Language Processing	Domain Elective	3 (2-3)
2	5/6/7	AIDE-5202		Speech Processing	Domain Elective	3 (2-3)
3	5/6/7	AIDE-6201		Data Mining	Domain Elective	3 (2-3)
4	5/6/7	AIDE-6202		Advanced Statistics	Domain Elective	3 (2-3)
5	5/6/7	AIDE-6203		Reinforcement Learning	Domain Elective	3 (2-3)
6	5/6/7	CSDC-5101		Theory of Automata	Domain Elective	3 (3-0)
7	5/6/7	CSDC-6201		HCI & Computer Graphics	Domain Elective	3 (2-3)
8	5/6/7	AIDE-6204		Fuzzy Systems	Domain Elective	3 (2-3)
9	5/6/7	AIDE-6205		Swarm Intelligence	Domain Elective	3 (2-3)
10	5/6/7	AIDE-6206		Agent Based Modeling	Domain Elective	3 (2-3)
11	5/6/7	AIDE-6207		Knowledge Based Systems	Domain Elective	3 (2-3)

  
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Preliminary Courses – (For Pre-Medical Students Non-Credit Hour Courses) Students have to pass these courses in first and second semester.						
Sr. N.	Sem. No	Code	Pre- Reqs	Course Title	Domain	Cr Hr (Cont Hr)
1	1	URCM-5107	-	Mathematics I		Non-Crd hr
2	2	URCM-5108	URCM-5107	Mathematics II		Non-Crd hr

Mathematics & Supporting Courses (12/130) 4 Courses						
Sr. N.	Sem. No	Code	Pre- Reqs	Course Title	Domain	Cr Hr (Cont Hr)
1	2	MATH-5101	URCQ-5102	Multivariable Calculus	MATH	3 (3-0)
2	2	MATH-5102	URCQ-5102	Linear Algebra	MATH	3 (3-0)
3	3	MATH-5103		Probability & Statistics	MATH	3 (3-0)
4	1	ENGL-6101	URCE-5118	Technical & Business Writing	ENGL	3 (3-0)

Elective Supporting Courses (Social Science) (3/130) 1 Course						
Sr. N.	Sem. No	Code	Pre- Reqs	Course Title	Domain	Cr Hr (Cont Hr)
1	1	BUSB-6101		Introduction to Marketing	Social Science	3 (3-0)
2	1	BUSB-6102		Human Resource Management	Social Science	3 (3-0)
3	3	BUSB-6103	-	Financial Accounting	Social Science	3 (3-0)
4	4	BUSB-6104	-	International Relations	Social Science	3 (3-0)

General Education Requirement as per HEC UG Education Policy (30/130) 12 Courses						
Sr. N.	Sem. No	Code	Pre- Reqs	Course Title	Domain	Cr Hr (Cont Hr)
1	1	URCS-5123		Application of Information & Communication Technologies	GER	3 (2-3)
2	1	URCE-5118		Functional English	GER	3 (3-0)
3	2	URCE-5119	URCE-5118	Expository Writing	GER	3 (3-0)
4	1	URCQ-5101		Quantitative Reasoning – 1 (Discrete Structures)	GER	3 (3-0)
5	1	URCQ-5102		Quantitative Reasoning – 2 (Calculus and Analytic Geometry)	GER	3 (3-0)
6	4	URCI-5105		Islamic Studies / Ethics (for non-Muslims)	GER	2 (2-0)
7	8	URCI-5122		Ideology and Constitution of Pakistan	GER	2 (2-0)
8	4	URCA-5101		Introduction to Management	GER	2 (2-0)
9	4	URCW-5201		Natural Sciences (Applied Physics)	GER	3 (2-3)
10	8	URCS-6101		Arts & Humanities (Professional Practices)	GER	2 (2-0)
11	8	URCC-5125		Civics and Community Engagement	GER	2 (2-0)
12	7	URCE-5124		Entrepreneurship	GER	2 (2-0)

13		URCQ-5111		Translation of Holy Quran-I	GER	0 (1-0)
14		URCQ-5111		Translation of Holy Quran-II	GER	0 (1-0)
15		URCQ-5111		Translation of Holy Quran-III	GER	0 (1-0)
16		URCQ-5111		Translation of Holy Quran-IV	GER	0 (1-0)

## Course Coding Scheme

Course Level	
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
CSCC	Computer Science Core
AICC	Artificial Intelligence Core
AIEC	Artificial Intelligence Elective
URCI	General Science
MATH	
ENGL	
URCC	
URCQ	
URCS	
URCE	
URCA	
URCF	
URCW	
URCT	

  
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## Scheme of Studies for BS Artificial Intelligence Program

Sr.#	Code	Pre-Reqs	Course Title	Domain	Cr Hrs (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-5123		Discrete Structures	GER	3 (3-0)
4	URCQ-5122		Calculus and Analytic Geometry	GER	3 (3-0)
5	URCE-5118		Functional English	GER	3 (3-0)
ID-6	BUSB-6101		Elective Supporting Course (e.g. Introduction to Marketing)	SS	3 (3-0)
				<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)
ID-10	MATH-5101	URCQ-5102	Multivariable Calculus	MATH	3 (3-0)
11	MATH-5102	URCQ-5102	Linear Algebra	MATH	3 (3-0)
	URCQ-5111		Translation of Holy Quran-I	GER	NC
				<b>Total Cr Hrs</b>	<b>17 (14-9)</b>
<b>Semester 3</b>					
12	CMPC-5205	CMPC-5202	Data Structures	Core	4 (3-3)
13	CMPC-5209	CMPC-5204	Computer Organization & Assembly Language	Core	3 (2-3)
14	CMPC-5207		Artificial Intelligence	Core	3 (2-3)
15	CMPC-5208		Computer Networks	Core	3 (2-3)
16	CMPC-5101		Software Engineering	Core	3 (3-0)
ID-17	MATH-5103		Probability & Statistics	MATH	3 (3-0)
				<b>Total Cr Hrs</b>	<b>19 (15-12)</b>
<b>Semester 4</b>					
18	CMPC-5206		Information Security	Core	3 (2-3)
19	AIDC-4101		Programming for Artificial Intelligence	Domain Core	3 (2-3)
20	AIDC-4102		Machine Learning	Domain Core	3 (2-3)
21	URCW-5201		Applied Physics	GER	3 (2-3)
22	URCE-5119		Expository Writing	GER	3 (3-0)
23	URCI-5105		Islamic Studies	GER	2 (2-0)
24	URCQ-5111		Translation of Holy Quran-II	GER	0 (1-0)
				<b>Total Cr Hrs</b>	<b>17 (13-12)</b>

Semester 5					
25	CMPC-6201		Operating Systems	Core	3 (2-3)
26	AIDC-5101		Artificial Neural Networks & Deep Learning	Domain Core	3 (2-3)
27	AIDC-5102		Knowledge Representation & Reasoning	Domain Core	3 (2-3)
28	xxxx-yyyy		Domain Elective 1	Domain Elective	3 (2-3)
29	xxxx-yyyy		Domain Elective 2	Domain Elective	3 (2-3)
30	URCA-5118		Social Science (E.g. Introduction to Management)	GER	2 (2-0)
				<b>Total Cr Hrs</b>	<b>17 (12-15)</b>
Semester 6					
31	AIDC-6101		Computer Vision	Domain Core	3 (2-3)
32	ITDC-6204		Parallel & Distributed Computing	Domain Core	3 (2-3)
33	xxxx-yyyy		Domain Elective 3	Domain Elective	3 (2-3)
34	xxxx-yyyy		Domain Elective 4	Domain Elective	3 (2-3)
35	xxxx-yyyy		Domain Elective 5	Domain Elective	3 (2-3)
36	xxxx-yyyy		Domain Elective 6	Domain Elective	3 (2-3)
37	URCQ-5111		Translation of Holy Quran-III	GER	0 (1-0)
				<b>Total Cr Hrs</b>	<b>18 (12-18)</b>
Semester 7					
38	CMPC-6702		Final Year Project – I	Core	2 (0-6)
39	CMPC-6101	CMPC-5205	Analysis of Algorithms	Core	3 (3-0)
40	xxxx-yyyy		Domain Elective 7	Domain Elective	3 (2-3)
41	ENGL-6101	URCE-5118	Technical & Business Writing	EN	3 (3-0)
42	URCE-5124		Entrepreneurship	GER	2 (2-0)
				<b>Total Cr Hrs</b>	<b>13 (10-9)</b>
Semester 8					
43	CMPC-6703	CMPC-6702	Final Year Project – II	Core	4 (0-12)
44	URCI-5122		Ideology and Constitution of Pakistan	GER	2 (2-0)
45	URCF-5114		Arts and Humanities (E.g. Professional Practices)	GER	2 (2-0)
46	URCC-5125		Civics and Community Engagement	GER	2 (2-0)
47	URCQ-5111		Translation of Holy Quran-IV	GER	NC
				<b>Total Cr Hrs</b>	<b>10 (6-12)</b>

  
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## Course Contents of Computing Core

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 a 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>		

## 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

  
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CMPC-5205 Data Structures		
<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.		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
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>		

CMPC-5204 Digital Logic Design		
<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.		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
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>		
<ol style="list-style-type: none"> <li>1. Digital Fundamentals by Floyd, Global Edition.</li> <li>2. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e</li> <li>3. DIGITAL DESIGN, GLOBAL EDITION, 6th/e by M. Morris Mano and Michael Ciletti</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 computer systems: Information is bits + context, programs are translated by other programs into different forms, it pays to understand how compilation systems work, processors read and interpret instructions stored in memory, caches matter, storage devices form a hierarchy, the operating system manages the hardware, systems communicate with other systems using networks; Representing and manipulating information: information storage, integer representations, integer arithmetic, floating point; Machine-level representation of programs: a historical perspective, program encodings, data formats, accessing information, arithmetic and logical operations, control, procedures, array allocation and access, heterogeneous data structures, putting it together: understanding pointers, life in the real world: using the gdb debugger, out-of-bounds memory references and buffer overflow, x86-64: extending ia32 to 64 bits, machine-level representations of floating-point programs; Processor architecture: the Y86 instruction set architecture, logic design and the Hardware Control Language (HCL), sequential Y86 implementations, general principles of pipelining, pipelined Y86 implementations

### 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. Computer System Architecture, M. Morris Mano, 3rd Edition,
3. Assembly Language Programming for Intel- Computer, Fifth Edition
4. Computer Systems: A Programmer's Perspective, 3rd Edition (CS:APP3e), Randal E. Bryant and David R.O' Hallaron, Carnegie Mellon University
5. Robert Britton, MIPS Assembly Language Programming, 1st Edition

## CMPC-6201 Operating Systems

**Credit Hours:** 3 (2-3)  
**Contact Hours:** 2-3  
**Pre-requisites:** Data Structures

### Course Introduction:

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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)

### Course Outline:

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

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

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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## CMPC-5203 Database Systems

<b>Credit Hours:</b>	4 (3-3)
<b>Contact Hours:</b>	3-3
<b>Pre-requisites:</b>	None

### Course Introduction:

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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)

### Course Outline:

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.

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

1. Fundamentals of Database Management Systems, Mark L. Gillenson, 3rd Edition, 2023
2. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg, 2019
3. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, 2013
4. Database System Concepts, 6th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan, 2019
5. Database Management Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke, 2002

## 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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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

  
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## CMPC-5208 Computer Networks

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

### Course Introduction:

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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)

### Course Outline:

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.

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

1. Computer Networking: A Top-Down Approach Featuring the Internet, 6th edition by James F. Kurose and Keith W. Ross
2. Computer Networks, 5th Edition by Andrew S. Tanenbaum
3. Data and Computer Communications, 10th Edition by William Stallings
4. Data Communication and Computer Networks, 5th Edition by Behrouz A. Forouzan

CMPC-5101 Software Engineering		
<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.		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
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>1. Software Engineering, Sommerville I., 10th Edition, Pearson Inc., 2014</li> <li>2. 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-6101 Analysis of Algorithms

<b>Credit Hours:</b>	3 (3-0)
<b>Contact Hours:</b>	3-0
<b>Pre-requisites:</b>	Data Structures

### Course Introduction:

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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	

### Course Outline:

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.

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

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

CMPC-5207 Artificial Intelligence		
<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.		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
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>		



ITDC-6204 Parallel and Distributed Computing		
<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>		
The Parallel and Distributed Computing course explores advanced computing paradigms, covering parallel processing and distributed systems. Participants gain expertise in designing and optimizing algorithms for parallel execution, addressing challenges in distributed computing environments.		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
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>		

CMPC-6702 Final Year Project-I		
<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.		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
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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**CMPC-6703 Final Year Project-II**

<b>Credit Hours:</b>	4 (0-12)
<b>Contact Hours:</b>	0-12
<b>Pre-requisites:</b>	Final Year Project-I

**Course Introduction:**

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)

**Course Outline:**

1. Database Design
2. Interface Design
3. Initial Prototype
4. Implementation
5. Testing

## Artificial Intelligence Domain Core Courses

<b>AIDC-4101 Programming for Artificial Intelligence</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	Artificial Intelligence	
<b>Course Introduction:</b>		
<p>This course aims to introduce standard programming practices and to help develop programming skills necessary for designing and implementing Artificial Intelligence systems. The course introduces classical as well as modern state of the art programming language for Artificial Intelligence (Lisp, Prolog, Python, and R), and builds up the necessary programming background for the main courses like Machine Learning, Artificial Neural Networks &amp; Deep Learning, Natural Language Processing, and Speech Processing. This course will help the students of Artificial Intelligence develop the programming acumen and style. The ultimate aim of this course is to help students in using the AI programming languages to solve problems of interest to them.</p>		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	Understand the fundamental constructs of Lisp, Prolog, and Python programming languages.	C2 (Understand)
CLO-2	Comprehend the fundamental constructs of programming languages for data analysis and representation.	C2 (Understand)
CLO-3	Understand and apply the Object-oriented concepts in the programming languages.	C2 (Understand)
CLO-4	Apply various libraries for plotting, interpreting and analyzing data in Python.	C3 (Apply)
<b>Course Outline:</b>		
<p>The first objective of the course is to introduce and then build the proficiency of students in different AI programming languages. The basics include IDE for the languages, variables, expressions, operands and operators, loops, control structures, debugging, error messages, functions, strings, lists, object-oriented constructs and basic graphics in the languages. Special emphasis is given to writing production quality clean code in the programming language. Once the classical programming languages are properly introduced, the course should introduce some libraries necessary for interpreting, analyzing and plotting numerical data in Python (e.g., NumPy, Matplotlib, Anaconda and Pandas for Python) and give examples of each library using simple use cases and small case studies.</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. AI and Machine Learning for Coders: A Programmer's Guide to Artificial Intelligence, Laurence Moroney, 1st Edition, 2023</li> <li>2. Russell, S. and Norvig, P. "Artificial Intelligence. A Modern Approach", 3rd ed, Prentice Hall, Inc., 2015.</li> <li>3. Norvig, P., "Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp", Morgan Kaufman Publishers, Inc., 1992.</li> <li>4. Luger, G.F. and Stubblefield, W.A., "AI algorithms, data structures, and idioms in Prolog, Lisp, and</li> </ol>		

Java”, Pearson Addison-Wesley. 2009.

5. Severance, C.R., 2016. “Python for everybody: Exploring data using Python 3.” CreateSpace Independent Publ Platform.
6. Miller, B.N., Ranum, D.L. and Anderson, J., 2019. “Python programming in context.” Jones & Bartlett Pub.
7. McKinney, W., 2012. “Python for data analysis: Data wrangling with Pandas, NumPy, and IPython.” O’Reilly Media, Inc.

**Reference Book:**

8. Joshi, P., 2017. “Artificial intelligence with python.” Packt Publishing Ltd.
9. Janert, P.K., 2010. “Data analysis with open source tools: a hands-on guide for programmers and data scientists.” O’Reilly Media, Inc.

## 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 Boltzman Machines; Deep Recurrent Neural Networks (BPTT, LSTM, etc.); GPU programming for deep learning CuDNN; Generative adversarial networks (GANs); Sparse coding and auto-encoders; Data augmentation, elastic distortions, data normalization; Mitigating overfitting with dropout, batch normalization, dropconnect; Novel architectures, ResNet, GoogleNet, etc

### 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.

## AIDC-6101 Computer Vision

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

### Course Introduction:

With a single glance a human interprets the entire scene. How many objects are present in the scene and where they are located. Which person is present in the scene. What will happen next. However, computers lack this capability. We have seen only face detectors so far working in our mobile phones? What is the challenge in understanding the 3D scene, i.e., the identity, the location and the size of the objects present in the scene. In this course we will introduce the basic concepts related to 3D scene modelling from single view and multiple views.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understanding the single view geometry concepts	C2 (Understand)
CLO-2	Understanding the multiple view geometry concepts	C2 (Understand)
CLO-3	Apply concepts of CV for solving real world problems	C3 (Apply)

### Course Outline:

Introduction to Computer Vision (Problems faced, History and Modern Advancements). Image Processing, Image filtering, Image pyramids and Fourier transform, Hough transform. Camera models, Setting up a camera model from parameters, Camera looking at a plane, Relationship of plane and horizon line, Rotation about camera center. Concatenation, Decomposition and Estimation of transformation from point correspondences, Points and planes in 2D/3D, Transformations in 2D/3D, Rotations in 2D/3D. Edge detection, corner detection. Feature descriptors and matching (HoG features, SIFT, SURF). Applications of Computer Vision Traditional Methods: Image Stitching: Making a bigger picture from smaller pictures Single View Geometry: Converting a single image into a 3D model. Applications of CV using Deep Learning: Image Detection (Localization, Historical Techniques, RCNN, FRCNN, YOLO, Retina), Image Segmentation (UNet, SegNet, MaskRCNN), Image Generation (GANN)

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

#### Text Book:

1. Szeliski, R. (2022). *Computer vision: algorithms and applications*. Springer Nature.

#### Reference Book:

1. Hartley, R., & Zisserman, A. (2003). *Multiple view geometry in computer vision*. Cambridge university press.
2. Forsyth, D. A., & Ponce, J. (2002). *Computer vision: a modern approach*. prentice hall professional technical reference.
3. Gonzalez, R. C. (2009). *Digital image processing*. Pearson education India.

AIDC-5102 Knowledge Representation and Reasoning		
<b>Credit Hours:</b>	3 (3-0)	
<b>Contact Hours:</b>	3-0	
<b>Pre-requisites:</b>	Artificial Intelligence	
<b>Course Introduction:</b>		
<p>Knowledge representation is one of the fundamental areas of Artificial Intelligence. It is the study of how knowledge about the world can be represented and manipulated in an automated way to enable agents to make intelligent decisions. This course will provide an overview of existing knowledge representation frameworks developed within AI including but not limited to propositional and first-order logic, ontologies, planning, reasoning and decision making under uncertainty. The assignments component of the course would provide hands-on experience of software like Prolog, Protégé, probabilistic reasoning APIs and tools to support complex decision making. It is expected that after completing this course, students will understand (a) the foundations of Knowledge Representation &amp; Reasoning and (b) which tools and techniques are appropriate for which tasks.</p>		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the fundamentals of knowledge representation and reasoning in deterministic situations	C2 (Understand)
CLO-2	Understand the challenges in representing knowledge and reasoning under uncertainty	C2 (Understand)
CLO-3	Analyze different situations and apply appropriate knowledge representation frameworks	C4 (Analyze)
CLO-4	Development of hybrid approaches by synergizing the existing framework to solve complex decision-making problems.	C4 (Analyze)
<b>Course Outline:</b>		
<p>Propositional Logic, First-order Logic, Horn Clauses, Description Logic, Reasoning using Description Logic, Forward and Backward Chaining in Inference Engines, Semantic Networks, Ontologies and Ontology Languages, Logical Agents, Planning, Rule-based Knowledge Representation, Reasoning Under Uncertainty, Bayesian Networks Representation, Inference in Bayesian Networks, Fuzzy Logic, Inference using Fuzzy Rules, Markov Models, Commonsense Reasoning, Explainable AI. Reference Materials:</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach (3rd Ed.) (2015)</li> <li>2. David Poole and Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, 2nd Ed, 2017</li> <li>3. Ronald Brachman and Hector Levesque. Knowledge Representation and Reasoning, 2004</li> </ol>		

AIDC-4102 Machine Learning		
<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.		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
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		

## Artificial Intelligence Domain Elective Courses

AIDE-5201 Natural Language Processing		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	Artificial Neural Networks & Deep Learning	
<b>Course Introduction:</b>		
Natural Language Processing (NLP) is the application of computational techniques to the analysis and synthesis of natural language and speech. This course is an introduction to NLP with prior programming experience in Python.		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand techniques for information retrieval, language translation, and text classification. Understand the advantages of using standard corpora.	C2 (Understand)
CLO-2	Identify examples of current corpora for a variety of NLP tasks.	C2 (Understand)
CLO-3	Understand and contrast deterministic and stochastic grammars, providing examples to show the adequacy of each	C2 (Understand)
CLO-4	Solve classic and stochastic algorithms for parsing natural language.	C3 (Apply)
<b>Course Outline:</b>		
Introduction & History of NLP, Parsing algorithms, Basic Text Processing, Minimum Edit Distance, Language Modeling, Spelling Correction, Text Classification, Deterministic and stochastic grammars, CFGs, Representing meaning /Semantics, Semantic roles, Semantics and Vector models, Sentiment Analysis, Temporal representations, Corpus-based methods, N-grams and HMMs, Smoothing and backoff, POS tagging and morphology, Information retrieval, Vector space model, Precision and recall, Information extraction, Relation Extraction (dependency, constituency grammar), Language translation, Text classification, categorization, Bag of words model, Question and Answering, Text Summarization		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>Hastie, T. and Tibshirani R. "The Elements of Statistical Learning ", Corr. 9th printing latest edition; Springer</li> <li>Bishop, C.M. (2008) "Pattern Recognition and Machine Learning latest edition" ; Springer-Verlag New York.</li> </ol>		

  
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## AIDE-5202 Speech Processing

**Credit Hours:** 3(2-3)  
**Contact Hours:** 2-3  
**Pre-requisites:** -

### Course Introduction:

- 1.
- 2.
- 3.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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.	DE 2
CLO-2	Focus on understanding of key algorithms including the noisy channel model, Hidden Markov Models (HMMs), GMM (Gaussian Mixture Model) acoustic models,	DE 2
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).	DE 2

### Course Outline:

1. Overview of Course, Intro to Probability Theory, and ASR Background: N-gram Language Modeling J+M New Chapter 4: N-grams
2. TTS: Background (part of speech tagging, machine learning, classification, NLP) and Text Normalization J+M New Chapter 7: Phonetics, J+M New Chapter 8 Speech Synthesis, pages 1-10, J+M New Chapter 5 Word Classes and Part-of-Speech Tagging, pages 1-36, but skip section 5.6, Optional Advanced Reading: Chapter 4 "Text Segmentation and Organisation" from Taylor, Paul. 2007. Chapter 5 "Text Decoding" from Taylor, Paul. 2007.
3. TTS: Grapheme-to-phoneme, Prosody (Intonation, Boundaries, and Duration) and the Festival software J+M New Chapter 8, pages 10-25, Read sections 1, 2, 3, 4, 5, and 6.1 and 6.1.1 from Alan Black's lecture notes on TTS and Festival. , Festival manual (used as Festival's scripting language): Introduction to Scheme for C Programmers, from Cal Tech. Optional Advanced Reading: Chapter 6 "Prosody Prediction from Text" from Taylor, Paul. 2007.
4. TTS: Waveform Synthesis (Diphone and Unit Selection Synthesis) J+M New Chapter 8, pages 25-end Optional Advanced Reading: Chapter 16 "Unit Selection Synthesis" from Taylor, Paul. 2007. Optional Advanced Reading: Optional: Section 7 from Alan Black's lecture notes on TTS and Festival. Optional Advanced Reading: The rest of Section 6 of Alan Black's lecture notes
5. ASR: Noisy Channel Model, Bayes, HMMs, Forward, Viterbi J+M New Chapter 6: Hidden Markov Models, pages 1-20 J+M New Chapter 9: Automatic Speech Recognition, pages 1-12
6. ASR: Feature Extraction and Acoustic Modeling, Evaluation J+M New Chapter 9: Automatic Speech Recognition pages 12-31, 31-45 J+M New Chapter 10: Speech Recognition:

Advanced Topics pages 11-16

7. ASR: Learning (Baum-Welch) and Disfluencies J+M New Chapter 9: Automatic Speech Recognition 46-52 , J+M New Chapter 10: Speech Recognition: Advanced Topics pages 1-11

**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. Some papers from the literature



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AIDE-5203 Deep Learning		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	Artificial Neural Networks and Deep Learning	
<b>Course Introduction:</b>		
<p>Deep neural networks have achieved state of the art performance on several compute vision and speech recognition benchmarks. Deep learning algorithms extract layered high and low- level features from raw data. With increasing non-line hidden layers, the discriminative power of the network improves. This course builds on the fundamentals of Neural networks and artificial intelligence and covers advanced topics in neural networks, convolutional and recurrent network structures, deep unsupervised and reinforcement learning. It also embeds applications of these algorithms to several real-world problem in computer vision, speech recognition, natural language processing, game theory, etc.</p>		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Apply deep learning algorithms to real-world problems	C3 (Apply)
CLO-2	Analyze results from deep learning to select appropriate solutions	C4 (Analyze)
CLO-3	Code the novel neural network architectures from scratch and evaluating the performance on application specific standard benchmarks	C3 (Apply)
<b>Course Outline:</b>		
<p>Basics of deep learning, learning networks, Shallow vs. Deep learning etc.; Machine learning theory – training and test sets, evaluation, etc. Theory of Generalization; Multi-layer perceptrons, error back-propagation; Deep convolutional networks, Computational complexity of feed forward and deep convolutional neural networks; Unsupervised deep learning including auto-encoders; Deep belief networks; Restricted Boltzman Machines; Deep Recurrent Neural Networks (BPTT, LSTM, etc.); GPU programming for deep learning CuDNN; Generative adversarial networks (GANs); Sparse coding and auto-encoders; Data augmentation, elastic distortions, data normalization; Mitigating overfitting with dropout, batch normalization, dropconnect; Novel architectures, ResNet, GoogleNet, etc</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville ( <a href="http://www.deeplearningbook.org/">http://www.deeplearningbook.org/</a>)</li> <li>2. Deep learning with python by Francoise Chollet, ISBN-10: 9781617294433, 2017</li> </ol>		

**CSDC-5101 Theory of Automata & Formal Languages**

**Credit Hours:** 3 (3-0)  
**Contact Hours:** 3-0  
**Pre-requisites:** -

**Course Introduction:**

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain and manipulate the different concepts in automata theory and formal languages such as formal proofs, automata, regular expressions, Turing machines etc.	C2 (Understand)
CLO-2	Prove properties of languages, grammars and automata with rigorously formal mathematical methods	C2 (Understand)
CLO-3	Design of automata, RE and CFG	C3 (Apply)
CLO-4	Transform between equivalent NFAs, DFAs and REs	C3 (Apply)
CLO-5	Define Turing machines performing simple tasks	C2 (Understand)
CLO-6	Differentiate and manipulate formal descriptions of languages, automata and grammars with focus on regular and context-free languages, finite automata and regular expressions.	C3 (Apply)

**Course Outline:**

Finite State Models: Language definitions preliminaries, Regular expressions/Regular languages, Finite automata (FAs), Transition graphs (TGs), NFAs, Kleene's theorem, Transducers (automata with output), Pumping lemma and non-regular language Grammars and PDA: CFGs, Derivations, derivation trees and ambiguity, Simplifying CFLs, Normal form grammars and parsing, Decidability, Context sensitive languages, grammars and linear bounded automata (LBA), Chomsky's hierarchy of grammars Turing Machines Theory: Turing machines, Post machine, Variations on TM, TM encoding, Universal Turing Machine, Defining Computers by TMs.

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

1. Introduction to computer theory, Daniel I. A. Cohen, 2nd Edition
2. Automata, Computability and Complexity: Theory and Applications, by Elaine Rich, 2011
3. An Introduction to Formal Languages and Automata, by Peter Linz, 4th edition, Jones & Bartlett Publishers, 2006
4. Theory of Automata, Formal Languages and Computation, by S. P. Eugene, Kavier, 2005, New Age Publishers

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AIDE-6201 Data Mining		
<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.</p> <p>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 Data Pre-processing and Summary Statistics.</li> <li>• Introduce the concepts of Frequent Item Set Generation, Associations and Correlations measures.</li> <li>• Introduce the concepts of Classification, Prediction, and Clustering algorithms. 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>		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
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 unsupervised models and algorithms with respect to their accuracy	C4 (Analyze)
<b>Course Outline:</b>		
<p>Introduction to data mining and basic concepts, Pre-Processing Techniques &amp; 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 &amp; anomaly detection, Web and Social Network Mining, Data Mining Trends and Research Frontiers. Implementing concepts using Python</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Jiawei Han &amp; Micheline Kamber, Jian Pei . Data Mining: Concepts and Techniques, 3rd Edition.</li> <li>2. Pang-Ning Tan, Michael Steinbach, and Vipin Kumar . Introduction to Data Mining. Latest Edition</li> <li>3. Charu C. Aggarwal. Data Mining: The Textbook Latest Edition</li> <li>4. D. Hand, H. Mannila, P. Smyth. Principles of Data Mining. MIT Press Latest Edition.</li> </ol>		

## AIDE-5202 Speech Processing

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

### Course Introduction:

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

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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.	DE 2
CLO-2	Focus on understanding of key algorithms including the noisy channel model, Hidden Markov Models (HMMs), GMM (Gaussian Mixture Model) acoustic models,	DE 2
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).	DE 2

### Course Outline:

Overview of Course, Intro to Probability Theory, and ASR Background: N-gram Language Modeling J+M New Chapter 4: N-grams TTS: Background (part of speech tagging, machine learning, classification, NLP) and Text Normalization J+M New Chapter 7: Phonetics, J+M New Chapter 8 Speech Synthesis, pages 1-10, J+M New Chapter 5 Word Classes and Part-of-Speech Tagging, pages 1-36, but skip section 5.6, Optional Advanced Reading: Chapter 4 "Text Segmentation and Organisation" from Taylor, Paul. 2007. Chapter 5 "Text Decoding" from Taylor, Paul. 2007. TTS: Grapheme-to-phoneme, Prosody (Intonation, Boundaries, and Duration) and the Festival software J+M New Chapter 8, pages 10-25, Read sections 1, 2, 3, 4, 5, and 6.1 and 6.1.1 from Alan Black's lecture notes on TTS and Festival., Festival manual (used as Festival's scripting language): Introduction to Scheme for C Programmers, from Cal Tech. Optional Advanced Reading: Chapter 6 "Prosody Prediction from Text" from Taylor, Paul. 2007. TTS: Waveform Synthesis (Diphone and Unit Selection Synthesis) J+M New Chapter 8, pages 25-end Optional Advanced Reading: Chapter 16 "Unit Selection Synthesis" from Taylor, Paul. 2007. Optional Advanced Reading: Section 7 from Alan Black's lecture notes on TTS and Festival. Optional Advanced Reading: The rest of Section 6 of Alan Black's lecture notes ASR: Noisy Channel Model, Bayes, HMMs, Forward, Viterbi J+M New Chapter 6: Hidden Markov Models, pages 1-20 J+M New Chapter 9: Automatic Speech Recognition, pages 1-12 ASR: Feature Extraction and Acoustic Modeling, Evaluation J+M New Chapter 9: Automatic Speech Recognition pages 12-31, 31-45 J+M New Chapter 10: Speech Recognition: Advanced Topics pages 11-16 ASR: Learning (Baum-Welch) and Disfluencies J+M New Chapter 9: Automatic Speech Recognition 46-52, J+M New Chapter 10: Speech Recognition: Advanced Topics pages 1-11

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

1. The new edition of Jurafsky and Martin. 2007. Speech and Language Processing.
2. Selected chapters from Taylor, Paul. 2007. Text-to-Speech Synthesis
3. Some papers from the literature.

<b>AIDE-6202 Advance Statistics</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	-	
<b>Course Introduction:</b>		
At the end of the course the students will be able to: Domain		
<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	DE 1
CLO-2	Apply Statistical techniques in real life problems.	DE 3
CLO-3	Apply Statistical techniques in real life problems.	DE 2
CLO-4	Apply basic data science statistical techniques by using SPSS on real world datasets.	DE 3
<b>Course Outline:</b>		
<p>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.</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Discovering Statistics Using IBM SPSS Statistics, Andy Field, 1st Edition, 2024</li> <li>2. Probability and Statistics for Computer Scientists, 3rd Edition, Michael Baron. 2019</li> <li>3. Probability for Computer Scientists, online Edition, David Forsyth, 2017</li> </ol>		

AIDE-6203 Reinforcement Learning		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	-	
<b>Course Introduction:</b>		
CLO No.	Course Learning Outcomes	Bloom Taxonomy
	At the end of the course the students will be able to:	Domain
CLO-1	Learn key concepts of Reinforcement Learning, underlying classic and modern algorithms in RL. You will be introduced to statistical learning techniques where an agent explicitly takes actions and interacts with the world.	DE 2
CLO-2	In this course, you will learn about several algorithms that can learn near optimal policies based on trial and error interaction with the environment---learning from the agent's own experience. Learning from actual experience is striking because it requires no prior knowledge of the environment's dynamics, yet can still attain optimal behavior. We will cover intuitively simple but powerful Monte Carlo methods, and temporal difference learning methods including Q-learning.	DE 2
CLO-3	We will wrap up this course investigating how we can get the best of both worlds: algorithms that can combine model-based planning (similar to dynamic programming) and temporal difference updates to radically accelerate learning.	DE 2
<b>Course Outline:</b>		
<p>Intro to Course.  The K-Armed Bandit Problem  Markov Decision Processes  Value Functions &amp; Bellman Equations  Dynamic Programming  Sample Based Learning Methods  Monte Carlo Methods for Prediction &amp; Control  Temporal Difference Learning Methods for Prediction  Temporal Difference Learning Methods for Control  Planning, Learning, &amp; Acting.  Prediction and Control with Function Approximation.  On-policy Prediction with Approximation.  Construction Features for Prediction.  Control with Approximation.  Policy Gradient.</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. MIT press, latest edition.</li> <li>Link: <a href="https://www.coursera.org/specializations/reinforcement-learning">https://www.coursera.org/specializations/reinforcement-learning</a>.</li> </ol>		

## CSDC-6201 HCI & Computer Graphics

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

### Course Introduction:

CLO No.	Course Learning Outcomes	Bloom Taxonomy
	At the end of the course the students will be able to:	Domain
CLO-1	Explain context of HCI and different measures for evaluation	DE 2
CLO-2	Apply the principles of good design for people from the	DE 3
CLO-3	Perspective of age and disabilities	DE 4
CLO-4	Analyze techniques for user centered design for a medium sized software.	DE 5

### Course Outline:

The human: Input–output channels, Human memory, Thinking, Emotion, Individual differences, Psychology and the design of interactive systems

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

Using toolkits, User interface management systems, Evaluation techniques

Universal design, User support, Task analysis

Modeling rich interaction, 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*.

**AIDE-6204 Fuzzy Systems**

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

**Course Introduction:**

CLO No.	Course Learning Outcomes	Bloom Taxonomy
	At the end of the course the students will be able to:	Domain
CLO-1	Fuzzy Logic is an important area having multiple applications in Computing. The course will introduce students with key concepts of Fuzzy Logic.	DE 2


**Course Outline:**

- Introduction to Fuzzy Logic.
- Fuzzy Set Theory
- Fuzzy Arithmetic
- Fuzzy Relations
- Possibility Theory
- Fuzzy Inference
- Approximate Reasoning
- Fuzzy Logic in Databases
- Information Retrieval with Fuzzy Logic
- Fuzzy Intelligent Agents
- Fuzzy Clusters
- Fuzzy Hierarchical Control
- Automotive Applications
- Computer Network Applications
- Medical Applications
- Fuzzy Decision Trees
- Knowledge Engineering and Data Mining

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

1. Timothy Ross, "Fuzzy Logic with Engineering Applications", John Wiley and Sons, Latest Edition.
2. A First Course in Fuzzy Logic by Hung T. Nguyen and Elbert A. Walker, Chapman and Hall/CRC; Latest Edition
3. Introduction to the Basic Principles of Fuzzy Set Theory and some of its Applications Communication and Cognition, Gent, Latest Edition.

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## AIDE-6205 Swarm Intelligence

**Credit Hours:** 3 (2-3)  
**Contact Hours:** 2-3  
**Pre-requisites:** -

### Course Introduction:

CLO No.	Course Learning Outcomes	Bloom Taxonomy
	At the end of the course the students will be able to:	Domain
CLO-1	Learn up-to-date efficient variants of different meta heuristics together with their potential applications and develop their interest in both research and development.	DE 2

### Course Outline:

Introduction to swarm intelligence and key principles (e.g., self-organization, stigmergy), natural and artificial examples, computational and embedded SI. Foraging, trail laying/following mechanisms. Open-space, multi-source foraging experiments: biological data and microscopic models.

From real to virtual ants: Ant System (AS), the first combinatorial optimization algorithm based on ant trail/following principles. Application to a classical operational research problem: the Travel Salesman Problem (TSP). From AS to Ant Colony Optimization (ACO). Ant-based algorithms (ABC, Ant-Net) applied to routing in telecommunication networks. Definitive assignment of course projects.

Introduction to mobile robotics: basic hardware and software concepts centered around the differential drive vehicle used in the course (e-Puck). Introduction to control architecture for mobile robots with special focus on reactive control architectures.

Introduction to unsupervised multi-agent machine-learning techniques for automatic design and optimization: terminology and classification, Genetic Algorithms (GA) and Particle Swarm optimization (PSO). Comparison between both techniques in theory and practice.

Application of machine-learning techniques to automatic control design and optimization in single-robot and multi-robot experiments. Specific issues for automatic control design and optimization in collective systems (e.g., credit assignment problems, noise resistance).

Collective movements in natural societies; focus on flocking phenomena. Collective movements in artificial systems: Reynolds' virtual agents (Boids) and experiments with multi-robot systems (flocking, formation).

Multi-level modeling of self-organized robotic systems: microscopic and macroscopic models; Markov formalism; linear and nonlinear micro-to-macro mapping, model analysis.

Combined modeling and machine-learning methods for control optimization. Diversity and specialization metrics.

Division of labor and task-allocation mechanisms, part I: threshold-based algorithms.

Division of labor and task-allocation mechanisms, part II: market-based algorithms and comparisons between threshold-based and market-based algorithms. A short tutorial on sensor networks, networked robotic systems and their relation with Swarm Intelligence.


Aggregation and segregation. Social insects, data clustering algorithms, and collective robotics experiments.

Distributed structure building in natural and artificial systems.

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

1. Andries Engelbrecht, Computational Intelligence: An Introduction, Latest Edition . Wiley.
2. E. Bonabeau, M. Dorigo, and G. Theraulaz, (1999). Swarm Intelligence: From Natural to Artificial Systems, Latest Edition. Oxford University Press.

<b>AIDE-6206 Agent Based Modeling</b>		
<b>Credit Hours:</b>	3 (2-3)	
<b>Contact Hours:</b>	2-3	
<b>Pre-requisites:</b>	-	
<b>Course Introduction:</b>		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
	At the end of the course the students will be able to:	<b>Domain</b>
CLO-1	Learn what agent based modeling is by covering range of methodological and theoretical issues.	DE 2
CLO-2	To explain the specifics of building agent based models, reviewing available software platforms and showing how one can build an agent based model using one of these.	DE 1
<b>Course Outline:</b>		
<p>Introduction to agent based modeling.  Introduction to Net Logo.  Complexity in Social Worlds.  Net Logo Commands. Net Logo Procedures.  Model properties (Why agent-based objects?, Agents, environments, and timescales).  Biological systems: fireflies, flocking, slime mold, bees, ants (flocking behavior slime mold).  Biological systems: predator/prey, debugging (Verification and validation).  Social systems: segregation, Schelling, Micro motives and Macro behavior.  A self-forming neighborhood model. Cellular automata.  Critical phenomena. Sand piles.  Current research topics in Agent Based Modeling.</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
1. Agent-Based Models, Nigel Gilbert, SAGE Publications, 2008		

  
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## AIDE-6207 Knowledge Based Systems

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

### Course Introduction:

CLO No.	Course Learning Outcomes	Bloom Taxonomy
	At the end of the course the students will be able to:	Domain
CLO-1	Understand various mechanisms and systems used to represent knowledge, methodologies for knowledge engineering will also be studied	DE 2
CLO-2	Understand Adaptive Computing which includes the use of artificial neural networks and genetic algorithms.	DE 2
CLO-3	Learn methodological and project management approaches will also be discussed in the course to develop knowledge based systems.	DE 2

### Course Outline:

Basic concepts, Definition of AI; Background and past achievements, Overview of application areas, Problems and problem solving State space search.  
 Production rules, Logic, Heuristic search techniques.  
 Generate and test; Hill climbing, Search reduction strategies  
 Representation models, Predicate logic; rules; Semantic nets; Frames; Conceptual graphs, Scripts.  
 Fuzziness and uncertainty Security considerations, Fuzzy logic.  
 Statistical techniques for determining probability Methodologies for developing knowledge based systems.  
 The KBS Development Life Cycle, Knowledge acquisition/elicitation  
 Management of KBS projects, Prototyping; Implementation; Development environments  
 Neural networks, Architectures; Hopfield network; Multi-layer perception  
 Feedforward; Backpropagation, Genetic algorithms, Basic concepts; Population; Chromosomes; Operators.  
 Schemata; Coding, Rule induction, Basic concepts; Decision trees/rule sets  
 Expert systems, Natural language processing.  
 Machine vision and robotics  
 Data mining and intelligent business support, Internet based application

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

1. Jackson, P. (1998). Introduction to expert systems. Addison-Wesley Longman Publishing Co., Inc..
2. Goldberg D. E.,(1989). Genetic Algorithms in Search, Optimisation and Machine Learning. AddisonWesley.
3. Michalski, Bratko, Kubat, (1999). Machine Learning and Data Mining. Wiley.
4. A Bradford,(2000). Knowledge Engineering and Management: The Common KADS Methodology. MIT Press.

## CSDE-6505 Introduction to Large Language Models

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

### Course Introduction:

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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)

### Course Outline:

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).

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

1. Quick Start Guide to Large Language Models: Strategies and Best Practices for Using ChatGPT and Other LLMs by Ozdemir, Sinan. Addison-Wesley Professional.
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.
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.

## DSDE-5102 Database Administration and Management

**Credit Hours:** 04 (3-1)  
**Contact Hours:** 3-3  
**Pre-requisites:** 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

<p>Reference Materials (or use any other standard and latest books):</p>
<ol style="list-style-type: none"> <li>1. DBA Essentials for 21c: Installing Oracle Database 21c on OCI Compute (English Edition), by Divit Gupta, 1st Edition, 2023</li> <li>2. Oracle Database 19c DBA By Examples: Installation and Administration by Ravinder Gupta 1st Edition, 2021</li> <li>3. <a href="https://docs.oracle.com/en/database/oracle/oracle-database/21/admin/index.html">https://docs.oracle.com/en/database/oracle/oracle-database/21/admin/index.html</a></li> <li>4. <a href="https://www.udemy.com/course/oracle-database-course/">https://www.udemy.com/course/oracle-database-course/</a></li> </ol>

### Preliminary Courses for Pre-Medical Students

<p>URCM-5107 Mathematics I</p>	
<p><b>Credit Hours:</b></p>	<p>Non-Credit Hour</p>
<p><b>Contact Hours:</b></p>	<p>3</p>
<p><b>Pre-requisites:</b></p>	<p>None</p>
<p><b>Course Content:</b></p> <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>	
<p><b>Reference Materials:</b></p> <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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## URCM-5108 Mathematics II

<b>Credit Hours:</b>	Non-Credit Hour
<b>Contact Hours:</b>	3
<b>Pre-requisites:</b>	None

### Course Content:

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.

### Reference Materials:

1. Thomas, G. B., & Finney, A. R. (2005). *Calculus*. Reading: Addison-Wesley.
2. Anton, H., Bevens. I., & Davis, S. (2005). *Calculus: A new horizon* (8th ed.). New York: John Wiley.
3. Stewart, J. (1995). *Calculus* (3rd ed.). Pacific Grove, California: Brooks/Cole.
4. Swokowski, E. W. (1983). *Calculus and analytic geometry*. Boston: PWS-Kent Company.
5. Thomas, G. B., & Finney, A. R. (2005). *Calculus* (11th ed.), Reading: Addison-Wesley.

## 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>		

**MATH-5102 Linear Algebra**

<b>Credit Hours:</b>	3 (3-0)
<b>Contact Hours:</b>	3
<b>Pre-requisites:</b>	Calculus and Analytical Geometry

**Course Introduction:**

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)

**Course Outline:**

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.

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

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.

## MATH-5103 Probability and Statistics

<b>Credit Hours:</b>	3 (3-0)
<b>Contact Hours:</b>	3
<b>Pre-requisites:</b>	None

### Course Introduction:

To provide fundamentals of solution for system of linear equations, operations on system of equations, matrix properties, solutions and study of their properties.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Develops students fundamental skills of solving ordinary differential equations, and developing differential equations for real-world problems	C2(Understand)

### Course Outline:

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.

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

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

## ENGL-6101 Technical & Business Writing

<b>Credit Hours:</b>	3 (3-0)
<b>Contact Hours:</b>	3
<b>Pre-requisites:</b>	Functional English

### Course Introduction:

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	-	-

### Course Outline:

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.

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

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.

## 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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 Department of Computer Science  
 University of Jodhpur

**BUSB-6102 Human Resource Management**

**Credit Hours:** 3 (3-0)  
**Contact Hours:** 3  
**Pre-requisites:** None

**Course Introduction:**

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	-	-

**Course Outline:**

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.

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

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]
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

## General Education Courses

### URCA-5123 Application of Information & Communication Technologies

<b>Credit Hours:</b>	3 (3-0)
<b>Contact Hours:</b>	3
<b>Pre-requisites:</b>	None

#### Course Introduction:

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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)

#### Course Outline:


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 (Dumb, 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.

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

1. Charles S. Parker, Understanding Computers: Today and Tomorrow, Course Technology, 25 Thomson Place, Boston, Massachusetts 02210, 15th Edition." (2007). USA
2. Livesley, Robert Kenneth. An introduction to automatic digital computers. Cambridge University Press, 2017.
3. Zawacki-Richter, Olaf, and Colin Latchem. "Exploring four decades of research in Computers & Education." Computers & Education 122 (2018): 136-152.
4. Sinha, Pradeep K., and Priti Sinha. Computer fundamentals. BPB publications, 2010.
5. Goel, Anita. Computer fundamentals. Pearson Education India, 2010.

<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>		
<p>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.</p>		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	-	-
<b>Course Outline:</b>		
<p>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.</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Practical Business English, Collen Vawdrey, 1993, ISBN = 0256192740</li> <li>2. Effective Communication Skills: The Foundations for Change, John Nielsen, 2008, ISBN = 1453506748</li> <li>3. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.</li> <li>4. A Textbook of English Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000</li> </ol>		

<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>		
<p>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.</p>		
<b>CLO No.</b>	<b>Course Learning Outcomes</b>	<b>Bloom Taxonomy</b>
CLO-1	-	-
<b>Course Outline:</b>		
<p>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.</p>		
<b>Reference Materials (or use any other standard and latest books):</b>		
<ol style="list-style-type: none"> <li>1. Practical Business English, Collen Vawdrey, 1993, ISBN = 0256192740</li> <li>2. Effective Communication Skills: The Foundations for Change, John Nielsen, 2008, ISBN = 1453506748</li> <li>3. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.</li> <li>4. A Textbook Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000</li> </ol>		

  
 Chairman  
 Department of  
 University of Jammu

## URCQ-5123 Discrete Structures

<b>Credit Hours:</b>	3 (3-0)
<b>Contact Hours:</b>	3
<b>Pre-requisites:</b>	-

### Course Introduction:

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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)

### Course Outline:

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.

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

1. Schaum's Outline of Discrete Mathematics, Fourth Edition, 2021
2. Discrete Mathematics and Its Applications, 8th edition by Kenneth H. Rosen, 2018
3. Discrete Mathematics with Applications, 5th Edition by Susanna S. Epp, 2019
4. Discrete Mathematics, 7th edition by Richard Johnsonbaugh, 2007

URCQ-5102 Calculus and Analytic Geometry		
<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 <sup>3</sup> , 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>		

  
 Chairman  
 Department of *Mathematics* Science  
 University of *Madagascar* Antananarivo

## URCI-5105 Islamic Studies

**Credit Hours:** 2 (2-0)  
**Contact Hours:** 2  
**Pre-requisites:** -

### Course Introduction:

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 *Haqooq ul Ibad* (Bandon Kay Haqooq) in Islam. What is The rights of people in Islamic Point of View. Islamic point of view about other religions.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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.	

### Course Outline:

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.

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

1. Introduction to Islam by Dr Hamidullah, Papular Library Publishers Lahore
2. Principles of Islamic Jurisprudence by Ahmad Hassan, Islamic Research Institute, IIUI
3. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services

## URCI-5122 Ideology and Constitution of Pakistan

**Credit Hours:** 2 (2-0)  
**Contact Hours:** 2  
**Pre-requisites:** -

### Course Introduction:

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

- to develop vision of Historical Perspective, Government, Politics, Contemporary Pakistan, ideological background of Pakistan.
- To study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.


CLO No.	Course Learning Outcomes	Bloom Taxonomy
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	

### Course Outline:

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.

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

1. The Emergence of Pakistan, Chaudary M., 1967
2. The making of Pakistan, Aziz. 1976
3. A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988

  
Chairman  
Department of Computer Science  
University of Sindh

## URCA-5101 Introduction to Management

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

### Course Introduction:

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	

### Course Outline:

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.

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

1. Management by Robbins, S.P. & Coulter, Mary, Prentice Hall; 10th Edition (November 3, 2008). ISBN-10: 0132090716
2. Fundamentals of Management by Robbins, S.P. & DeCenzo, David A, Prentice Hall; 7<sup>th</sup> Edition (January 13, 2010). ISBN-13: 978-0132090711
3. Human Resource Management by David A. DeCenzo and Stephen P. Robbins. Wiley; 7th Edition (October 10, 2001). ISBN-10: 0471397857

## URCW-5201 Applied Physics

**Credit Hours:** 3 (2-3)  
**Contact Hours:** 2-3  
**Pre-requisites:** 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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	

### 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.

## URCF-6101 Professional Practices

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

### Course Introduction:

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	-

### Course Outline:

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.

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

1. Boddington, P. (2023). AI ethics: a textbook. Springer Nature.
2. Professional Issues in Software Engineering by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, CRC Press; 3rd Edition (2000). ISBN-10: 0748409513
3. Computer Ethics by Deborah G. Johnson, Pearson; 4th Edition (January 3, 2009). ISBN-10: 0131112414
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
5. Applied Professional Ethics by Gregory R. Beabout, University Press of America (1993).
6. Noorman, M., & Johnson, D. G. (2014). Negotiating autonomy and responsibility in military robots. *Ethics and Information Technology*, 16(1), 51-62.

## 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.

*[Handwritten Signature]*  
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 Department of Social Science  
 University of Sargodha

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*.
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

## URCE-5124 Entrepreneurship

**Credit Hours:** 2 (2-0)  
**Contact Hours:** 2  
**Pre-requisites:** None

### Course Introduction:

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
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)

### Course Outline:

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.

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

1. Entrepreneurship by Robert Hisrich, Michael Peters and Dean Shepherd, McGrawHill/Irwin; 9th Edition (September 27, 2012). ISBN-10: 0078029198
2. Entrepreneurship: Ideas in Action by Cynthia L. Greene, South-Western Educational Pub; 5th Edition (January 6, 2011). ISBN-10: 0538496894
3. Entrepreneurship by William D. Bygrave and Andrew Zacharakis, Wiley; 2nd Edition (October 12, 2010). ISBN-10: 0470450371
4. Entrepreneurship: Theory, Process, and Practice by Donald F. Kuratko, South-Western College Pub; 8th Edition (November 14, 2008). ISBN-10: 0324590911
5. Entrepreneurship: Successfully Launching New Ventures by Bruce R. Barringer and Duane Ireland, Prentice Hall; 4th Edition (October 27, 2011)

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>		

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

Credit Hours:	Non-Credit
Contact Hours:	-
Pre-requisites:	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۔





- النساء (٢٣٤، ٣٨، ٨٨، ٢١٤، ١١٤، ٣١٤، ٥٢، ١٨، ١٨، ٣١٤، ٢٢، ٣٨، ٥٨، ١٢، ١٥، ٥٨)
- المائدة (٢٢، ١٢، ٣٤، ٢، ٤٥، ٢٤)
- النحل (١٢، ٢٨٤، ٣١٤، ٣٤٤، ١٢، ٢٨٤، ٢٨٤)
- الرعد (٢٨، ١٨، ٥٨، ٨٨، ٢)
- الاعراف (٤٣، ٢٢، ٤٢، ٢٥٤، ١٥، ١٨، ٥٥٤، ٢٢٤، ٢٢، ٤٢)
- القصص (٥٢، ٥٢)
- فصلت (٥٢)
- الانعام (٨٣، ١١، ١١، ١١٤، ١٣٤، ٢٢٤، ١٢٤)
- النمل (١٢، ٢٥)
- الحج (١٣، ٢٢، ١٢، ٢٢، ١١)
- الحجرات (٢، ٤٤، ٢، ٤٤، ٣، ٨٤، ٣٤، ١٤)
- الاحزاب (٣٨، ١٢، ٢٢، ٢٢، ٨٢، ٢٢، ٢٢، ٢٢، ٥٨، ٢٢)
- الحشر (٢)
- طه (٨١)
- الانعام (٥٢٤، ٤٥٤، ٢٤٤، ٤٢٤، ٢٢، ١٨٤)
- ق (٥٢)
- الانفال (١٨، ٢٥، ٤٢)
- الفتح (٢٤)
- يونس (١٤، ٢٤، ٨٤، ٢٢، ٨٨، ٨٨)
- الفرقان (٣٢، ٤٨، ١٢، ٣٢)
- النور (٣٨، ٢، ٥، ١٢، ٤٢، ٣٢، ٣٢، ٤٢، ٤٢، ٨٨)
- لقمان (٢، ٣٢، ٢٤، ٨٢، ٢٤)
- الاسراء (١٣، ١٣، ١٤٤، ٢، ١٢)
- المزمّل (٢٤)
- المدثر (٢، ٥)
- المدثر (٥١)
- فاطر (٨٣)
- الفتح (٢٨)
- البلد (١٤)
- الزمر (٢، ١٤)
- الحجر (٣٢)
- النجم (٤٢)
- الرحمن (١٢)
- هود (٢، ٨١٤، ٣)
- الكهف (٨، ٢٢)
- الشورى (١٢)
- غافر (٢٨، ١٨)
- الحديد (١٨، ١٨)
- مريم (٢٢)
- النازعات (٤٥)
- التوبه (٢٢، ٥٢، ١١)
- الهمزه (٤)

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

<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 familiarize the students with commandments of trade and inheritance mentioned in the Quranic text (with the help of Urdu translation).	-
CLO-2	To introduce the students to scientific facts and miracles of the Holy Quran and Quranic stress on deep study of Allah's explored universe.	-
CLO-3	To motivate the students for reading and exploring the last Holy Book revealed by Almighty Allah.	-
CLO-4	Through memorization students will develop their relation with last revelation.	-

### Course Outline:

تجارت اور وراثت:  
مال کی تقسیم، نادان کا مال، عوام الناس کا مال، عورتوں کا مال، یتیموں کا مال، کفار کا مال، جائز مال، معاہدے، ربن، قرض

سائنسی حقائق:  
تخلیق کائنات، اجرام فلکی، شجر و حجر، زمین و آسمان کے اسرار، ہوائیں اور طوفان، بہائم اور مویشی، حشرات الارض، پہاڑ اور سمندر

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

منتخب آیات مع ترجمہ و تجوید

- البقرہ (۲۸، ۲۸، ۳۲۸، ۲۸، ۳۱۸، ۲۸، ۳۲۸، ۱۱۶، ۳۲۸، ۲۸، ۳۲۸، ۲۸)
- ۳۱۸، ۸۲۸، ۸۲۸، ۵۱۸، ۴۱۸، ۳۲، ۱۱۶، ۳۲۸، ۲۱۸، ۲۱۸، ۲۸، ۲۸، ۳۸۸، ۱۸، ۲۸
- ۲۸، ۳۳۸، ۵۲۸، ۲۲۸، ۵۲۸، ۵۲۸، ۱۲، ۱۲، ۵۲۸، ۱۳، ۱۳، ۱۳، ۲۸، ۲۸، ۲۸، ۲۸
- (۸۲، ۳۲)
- آل عمران (۱۴۴، ۵۳۲، ۱۳۲، ۱۲۴، ۱۸، ۲۳)
- النساء (۲۸، ۸، ۲۸، ۴۲۴)
- المائدہ (۲۲، ۳۲، ۳۱، ۲۲، ۱۲)
- التوبہ (۲۲، ۵۸، ۲۲، ۵۸، ۵۸، ۱۲، ۵)
- الاعراف (۸۱۴، ۳۲۴، ۱۲، ۲۳، ۳۲۴، ۱۲، ۱۵، ۳۳۴، ۲۱۴، ۲۲۴)
- الرعد (۱۴، ۵)
- الطور (۵۵)

- الانعام (٢٣، ٢٥٤، ٤٥٤، ٣٢، ٢٣)
- الانفال (٤٥، ٢٣، ٢٨)
- الكهف (٤٣، ٢١٤، ١٥، ٨٣، ٣٥، ١٤، ٣٥)
- الجاثية (٣)
- فاطر (٣٤، ٨٤، ١٨)
- العنكبوت (٤٥، ٣٢، ١٨)
- الروم (١٣)
- الاسراء (٢٢، ١١)
- الرعد (٨)
- السبا (١٤، ٣، ٨٨)
- يونس (٢٢، ٤١٤، ٥٨، ٥٨، ٣، ٨٨)
- يوسف (٥٤، ٥٢)
- الفرقان (٣٣، ٨٢)
- لقمان (٢٤، ٢٨)
- طه (٣٣، ٥٤٤)
- النحل (٣١، ٤٤، ٤٢، ٢٥، ٢١، ٢٢، ٢٢، ٣٤٤، ٢، ٢)
- النمل (٥٢، ٥٢، ٢٢، ١٢، ٨٢، ٢٤، ١٤، ٢٤)
- السجده (١٨)
- الحديد (٢)
- هود (٢، ٣٥)
- يسين (٤٥، ١٣)
- الروم (٢٣، ٢٣، ١٣، ٢٤، ٥٨، ٢٥)
- فصلت (٢٣، ٢٣)
- الحج (٤٢، ٣٢، ٨٨، ٣١)
- الحجر (٨٨، ٢٤)
- الانبياء (٤٣، ١٣، ١٥)
- الزاريات (١٥)
- الزلزله (٤)
- القصص (٢١، ٢١، ١٢، ٤٢، ٨٢)
- النور (١٣، ٨٨، ٨٨، ١٥، ٣٥، ٣٥)
- الجمعة (٤٤، ٨٢، ١٤، ٤٤، ٣)
- القمر (١)
- الواقعه (٢٢)
- الفاطر (٣٤، ١٨)
- الملك (٢٤)
- الصف (١٤)
- الجن (٣٤)
- الشورى (٢٨)
- الزخرف (٤٤)
- الفيل (٤)