

# **Course Catalog – Computer Science**

## **Department Mission**

The Department will become a leader in computer science and related domains by building a strong teaching and research environment to train and transform young men and women into responsible and successful professionals who can proactively engaged themselves for the betterment of the society.

## **Department Vision**

The Department will become a leader in computer science and related domains by building a strong teaching and research environment to train and transform young men and women into responsible and successful professionals who can proactively engaged themselves for the betterment of the society.

## **Program Educational Objectives**

Graduates of the undergraduate program in Computer Science are expected to attain the following objectives within a few years of graduation:

- Succeed in their chosen profession by applying computational and analytical approaches of computer science to solve real life problems.
- Successfully engage in life-long learning in cross-disciplinary domains such as bioinformatics, business analytics etc.
- Exhibit high professional ethical standards to become productive leaders in society.
- Successfully launch themselves as young entrepreneurs enabling a knowledge based economy

## **Program Outcomes**

The program must enable students to attain, by the time of graduation:

- An ability to apply knowledge of computing and mathematics appropriate to the program's student outcomes and to the discipline
- An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
- An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
- An ability to function effectively on teams to accomplish a common goal
- An understanding of professional, ethical, legal, security and social issues and responsibilities
- An ability to communicate effectively with a range of audiences

- An ability to analyze the local and global impact of computing on individuals, organizations, and society
- Recognition of the need for and an ability to engage in continuing professional development
- An ability to use current techniques, skills, and tools necessary for computing practice
- An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices CS.
- An ability to apply design and development principles in the construction of software systems of varying complexity CS.

## **Bachelor of Science in Computer Science**

### *Courses with their prerequisite requirement(s)*

Serial #	Course Name	Credit Hour	Semester	Pre-Requisite
1	Technical & Business Writing	3	2	English Composition & Comprehension
2	Digital Logic Design (DLD)	4	3	Applied Physics
3	Multivariate Calculus	3	2	Calculus & Analytical Geometry
4	Object Oriented Programming (OOP)	4	2	Programming Fundamentals
5	Microprocessor & Assembly Language	4	6	Digital Logic Design
6	Theory of Automata	3	6	Discrete Structures
8	Data Structures & Algorithms	4	3	OOP
9	Numerical Computing	3	5	Calculus & Analytical Geometry
10	Operating Systems (OS)	4	5	Data Structures & Algorithms
12	Compiler Construction	3	8	Theory of Automata
13	Database Systems	4	3	Data Structure and Algorithms
15	Artificial Intelligence	3	6	Data Structures & Algorithms

16	Computer Architecture & Organization	3	6	Digital Logic & Design
17	Software Engineering	3	4	OOP
18	Mobile Application Development	3	7	OOP
19	Differential Equations	3	6	Calculus & Analytical Geometry
23	Design & Analysis of Algorithms	3	4	Data Structures & Algorithms
24	Data Mining	3	7	Artificial Intelligence & Database Systems

## *Course Breakdown*

### **BSCS PROGRAM**

#### **General Education Courses**

<b>Serial No.</b>	<b>Course Name</b>	<b>Course Code</b>	<b>Course Credit Hours</b>	<b>Pre requisite</b>
1	English Composition & Comprehension	HUM-1011	3(3+0)	-
2	Islamic Studies	HUM-1012	2(2+0)	-
3	Introduction to Computing (ITC)	CS-1031	4(3+1)	-
4	Technical & Business Writing	HUM-2014	3(3+0)	
5	Pakistan Studies	HUM-1015	2(2+0)	-
6	Communication & Presentation Skills	HUM-3016	3(3+0)	-
7	Professional Practices	CS-4084	3(3+0)	-
<b>Total Credit Hours</b>			<b>20</b>	

#### **University Elective Courses**

<b>Serial No.</b>	<b>Course Name</b>	<b>Course Code</b>	<b>Course Credit Hours</b>	<b>Pre requisite</b>
1	Fundamentals of Financial Accounting	MGT-1013	3(3+0)	-
2	Introduction to Management	MGT-3018	3(3+0)	-
3	Entrepreneurship	MGT-3019	3(3+0)	Introduction to computing
4	Chinese Language	HUM-2017	3(3+0)	-
<b>Total Credit Hours</b>			<b>12</b>	

### Computer Science Supporting Courses

Serial No.	Course Name	Course Code	Course Credit Hours	Pre requisite
1	Multivariate Calculus	MTH-3022	3(3+0)	Calculus & Analytical Geometry
2	Numerical Computing	MTH-3025	3(3+0)	Calculus & Analytical Geometry
3	Theory of Programming Languages	CS-4064	3(3+0)	Theory of Automata
4	Differential Equations	MTH-3026	3(3+0)	-
<b>Total</b>			<b>12</b>	

### Computing Core Courses

Serial No.	Course Name	Course Code	Course Credit Hours	Pre requisite
1	Programming Fundamentals (PF)	CS-2032	4(3+1)	Introduction to computing
2	Discrete Structures	MTH-2022	3(3+0)	-
3	Data Communication & Networks (DCN)	CS-3052	4(3+1)	-
4	Object Oriented Programming (OOP)	CS-3033	4(3+1)	Programming fundamentals
5	Data Structures & Algorithms (DSA)	CS-3061	4(3+1)	OOP

6	Operating Systems (OS)	CS-3051	4(3+1)	Programming fundamentals
7	Database Systems	CS-3042	4(3+1)	Programming fundamentals
8	Intro. to Information Security	CS-3055	3(3+0)	Introduction to Computing
9	Software Engineering	CS-3081	3(3+0)	Programming fundamentals
10	Final year project-I	CS-4000	3(3+0)	-
11	Final year project-II	CS-4001	3(3+0)	-
<b>Total Credit Hours</b>			<b>39</b>	

### Computer Science Elective Courses

Serial No.	Course Name	Course Code	Course Credit Hours	Pre requisite
1	IS/Bio/DS Specialization 1	IS/Bio/DS	3(3+0)	Web design & development
2	IS/Bio/DS Specialization 2	IS/Bio/DS	3(3+0)	IS/Bio/DS Specialization 1
3	IS/Bio/DS Specialization 3	IS/Bio/DS	3(3+0)	Design & Analysis of Algorithms
4	IS/Bio/DS Specialization 4	IS/Bio/DS	3(3+0)	IS/Bio/DS Specialization 1
5	IS/Bio/DS Specialization 5	IS/Bio/DS	3(3+0)	IS/Bio/DS Specialization 1
6	Project Management	CS-3086	3(3+0)	Database systems
<b>Total Credit Hours</b>			<b>18</b>	

### Computer Science Core Courses

<b>Serial No.</b>	<b>Course Name</b>	<b>Course Code</b>	<b>Course Credit Hours</b>	<b>Pre requisite</b>
1	Digital Logic Design	CS-2072	4(3+1)	Applied Physics
2	Microprocessor & Assembly Language	CS-3073	4(3+1)	DLD
3	Theory of Automata	CS-4063	3(3+0)	-
4	Compiler Construction	CS-4065	3(3+0)	Theory of automata
5	Artificial Intelligence	CS-3091	3(3+0)	-
6	Computer Architecture & Organization	CS-3074	4(3+1)	Microprocessor & Assembly Language
7	Design and Analysis of Algorithms	CS-3062	3(3+0)	Data structures & Algorithms
<b>Total Credit Hours</b>			<b>24</b>	

## Description of Terms:

Term	Meaning
GEC	General Education Course
UEC	University Elective Course
CSSC	Computer Science Supporting Course
CCC	Computing Core Course
CSEC	Computer Science Elective Course
CSCC	Computer Science Core Course

**Structure of BSCS Program** (Between 124 – 136 Credit Hours are required for UG Degree)

**At least 134 credit hours are required for BSCS Degree.**

Serial Number	Category	Credit Hours	
1	Computing Courses		39
	Core Courses	39	
2	Computer Science Courses		54
	Computer Science Core Courses	24	
	Computer Science Supporting Courses	12	
	Computer Science Elective Courses	18	
3	General Education Courses	20	20
4	University Elective Courses	12	12
5	Math & Science Foundation courses	12	12
	<b>Total Credit Hours</b>		<b>137</b>



## **LIST OF OPTIONAL COURSES**

1	System Analysis and Design	3 (3+0)
2	Wireless networks	3(2+1)
3	Mobile Networks	3 (3+0)
4	Expert Systems	3 (3+0)
5	Distributed Computing	3(2+1)
6	Cloud Computing	3 (3+0)
7	Professional Issues in IT	3 (3+0)
8	Search Engine Optimization	3 (3+0)
9	Digital Signal Processing	3 (3+0)
10	Computer Graphics	3(2+1)
11	Game Development	3 (2+1)
12	Digital Image Processing	3(2+1)
13	Natural Language Processing	3 (3+0)
14	Formal Methods for Software Engineering	3 (3+0)
15	Artificial Neural Network	3(2+1)
16	Embedded Systems (Micro controllers)	3 (2+1)
17	Data Warehousing	3(2+1)
18	Network Security	3 (2+1)
19	Simulation Modeling	3 (2+1)
20	Computer Vision	3 (3+0)

## BSCS Scheme of Study

Degree Program	Semester	Course Offered
	First	English Composition & Comprehension
		Fundamental of Financial Accounting (University Elective)
		Programming Fundamentals
		Calculus & Analytical Geometry
		Islamic Studies
		Introduction to Computing
	Second	Applied Physics
		Technical & Business Writing
		Multivariate Calculus
		Pakistan Studies
		Object Oriented Programming
		Discrete Structures
	Third	Communication & Presentation Skills
		Probability & Statistics
		Digital Logic Design
		Database Systems
		Data Structure and Algorithms
	Fourth	Microprocessor and Assembly Language
		IS/Bio/DS Specialization 1 (CS Elective)
		Software Engineering
		Linear Algebra
Data Communications & Networks		
Design & Analysis of Algorithm		

BS Computer Sciences	Fifth	Numerical Computing
		Operating Systems
		IS/Bio/DS Specialization 2 (CS Elective)
		Artificial Intelligence
		Intro. to Management (University Elective)
		Chinese Language (University Elective)
	Sixth	Microprocessor & Assembly language
		Computer Architecture and Organization
		IS/Bio/DS Specialization 3 (CS Elective)
		Differential Equations
		Theory of Automata
	Seventh	Mobile Application Development (CS Elective)
		Entrepreneurship University Elective
		IS/Bio/DS Specialization 4 (CS Elective)
		Theory of Programming languages
		Project Management (University Elective)
		Final Year Project Part 1
	8th	Final Year Project Part 2
Compiler Construction		
IS/Bio/DS Specialization 5 (CS Elective)		
Professional Practices		

### Semester 1

<b>Serial #</b>	<b>Course Name</b>	<b>Credit Hours</b>	<b>Course Code</b>
1	English Composition & Comprehension	3(3+0)	HUM-1011
2	Fundamental of Financial Accounting (University Elective)	3(3+0)	MGT-1013
3	Programming Fundamentals	4(3+1)	CS-2032
4	Calculus & Analytical Geometry	3(3+0)	MTH-2021
5	Islamic Studies	2(2+0)	HUM-1012
6	Introduction to Computing	3(3+0)	CS-1031
<b>Semester Subtotal</b>		<b>18</b>	

### **Semester 2**

<b>Serial #</b>	<b>Course Name</b>	<b>Credit Hours</b>	<b>Course Code</b>
1	Applied Physics	3(3+0)	EE-2071
2	Technical & Business Writing	3(3+0)	HUM-2014
3	Multivariate Calculus	3(3+0)	MTH-3022
4	Pakistan Studies	2(2+0)	HUM-1015
5	Object Oriented Programming	4(3+1)	CS-3033
6	Discrete Structures	3(3+0)	MTH-2022
<b>Semester Subtotal</b>		<b>18</b>	

### **Semester 3**

<b>Serial #</b>	<b>Course Name</b>	<b>Credit Hours</b>	<b>Course Code</b>
-----------------	--------------------	---------------------	--------------------

1	Communication & Presentation Skills	3(3+0)	HUM-3016
2	Probability & Statistics	3(3+0)	MTH-3041
3	Digital Logic Design	4(3+1)	CS-2072
4	Database Systems	4(3+1)	CS-3042
5	Data Structure & Algorithms	4(3+1)	CS-3061
<b>Semester Subtotal</b>		<b>18</b>	

### Semester 4

Serial #	Course Name	Credit Hours	Course Code
1	IS/Bio/DS Specialization 1 (CS Elective)	3(3+0)	IS/BIO/DS
2	Software Engineering	3(3+0)	CS-3081
3	Linear Algebra	3(3+0)	MTH-3024
4	Data Communications & Networks	4(3+1)	CS-3052
5	Design & Analysis of Algorithm	3(3+0)	CS-3062
<b>Semester Subtotal</b>		<b>16</b>	

### Semester 5

Serial #	Course Name	Credit Hours	Course Code
1	Numerical Computing	3(3+0)	MTH-3025
2	Operating Systems	4(3+1)	CS-3051
3	IS/Bio/DS Specialization 2 (CS Elective)	3(3+0)	IS/BIO/DS
4	Artificial Intelligence	3(3+0)	CS-3091
5	Intro. to Management (University Elective)	3(3+0)	MGT-3018
5	Chinese Language (University Elective)	3(3+0)	CS-582

<b>Semester Subtotal</b>	<b>19</b>	
--------------------------	-----------	--

### Semester 6

Serial #	Course Name	Credit Hours	Course Code
1	Microprocessor & Assembly language	3(2+1)	CS-3073
3	Computer Architecture and Organization	3(3+0)	CS-3074
4	IS/Bio/DS Specialization 3 (CS Elective)	3(3+0)	IS/BIO/DS
5	Differential Equations	3(3+0)	MTH-3026
6	Theory of Automata	3(3+0)	CS-4063
<b>Semester Subtotal</b>		<b>17</b>	

### Semester 7

Serial #	Course Name	Credit Hours	Course Code
1	Mobile Application Development (CS Elective)	3(2+1)	CS-3036
2	Entrepreneurship University Elective	3(3+0)	MGT-3019
3	IS/Bio/DS Specialization 4 (CS Elective)	3(3+0)	IS/BIO/DS
4	Theory of Programming languages	3(3+0)	CS-4064
5	Project Management (University Elective)	3(3+0)	CS-3086
6	Final Year Project Part 1	3(3+0)	CS-4000
<b>Semester Subtotal</b>		<b>18</b>	

### Semester 8

Serial #	Course Name	Credit Hours	Course Code
----------	-------------	--------------	-------------

1	Final Year Project Part 2	3(3+0)	CS-4001
2	Compiler Construction	3(3+0)	CS-4065
3	IS/Bio/DS Specialization 5 (CS Elective)	3(2+1)	IS/BIO/DS
4	Professional Practices	3(3+0)	CS-4084
<b>Semester Subtotal</b>		<b>12</b>	

Total Credit Hours = 18+18+18+16+19+17+18+12 = **136**

**Computer Science – Elective Courses Not limited to the list below**

Computer Graphics 3 (2+1)

Digital Image Processing 3 (2+1)

Digital Signal Processing 3 (3+0)

Computer Vision 3 (3+0)

Distributed Computing 3 (2+1)

Data and Network Security 3 (3+0)

Wireless Networks 3 (2+1)

Social Computing 3 (3+0)

Mobile Application and Development 3 (2+1)

Web Design and Development 3 (2+1)

Data Warehousing 3 (2+1)

Expert Systems 3 (3+0)

Artificial Neural Network 3 (3+0)

Fuzzy Logic 3 (3+0)

Web Engineering 3 (3+0)

Fundamentals of Data Mining 3 (3+0)

Computational Intelligence 3 (3+0)

Multi Agent Systems 3 (3+0)

Natural Language Processing 3 (3+0)  
Game Development 3 (2+1)  
Logical Paradigms of Computing 3 (3+0)  
Formal Methods for Software Engineering 3 (3+0)

### **University Elective Courses**

Financial Accounting 3 (3+0)  
Financial Management 3 (3+0)  
Human Resource Management 3 (3+0)  
Marketing 3 (3+0)  
Economics 3 (3+0)  
Psychology 3 (3+0)  
International Relations 3 (3+0)  
Foreign/Regional Language (French, German, Sindhi, Punjabi, Urdu etc.) 3 (3+0)  
Philosophy 3 (3+0)

### **BSCS specializations**

#### **a) Courses for BSCS with specialization in Data Science**

1. Introduction to Data Science: 3(3+0)
2. Big Data Concept & Techniques: 3(3+0)
3. Big Data Analytics (3 credit hours): 3(3+0)
4. Data Mining (3 credit hours): 3(3+0)
5. Machine Learning: 3(3+0)

#### **b) Courses for BSCS with specialization in Information Security**

1. Introduction to Information Security: 3(3+0)
2. Cryptography and Network Security: 3(3+0)
3. Computer System Security: 3(3+0)
4. Web Security: 3(3+0)
5. Information Security Goals, Strategies and Policies: 3(3+0)

#### **c) Courses for BSCS with specialization in Bioinformatics**

1. General Biology (Genomics/Biochemistry/ Biotechnology): 3 (3+0)
2. Bioinformatics I (Introduction to Bioinformatics): 3 (2+1)
3. Molecular and General Genetics: 3 (3+0)



4. Bioinformatics II: 3 (2+1)
5. Ethical and Legal Issues in Biology: 3 (3+0)

## **Description of Courses**

### **Semester 1**

#### **CS-1031: Introduction to Computing (3+1) 4**

**Pre requisite: N/A**

Computer uses in modern society. Emphasis on uses in non-scientific disciplines. Includes word processing, spreadsheets, web-page creation, elementary programming, basic computer organization, the Internet, the uses of computers and their influence on society.

**Text:** Introduction to Computers 6th International Edition, Peter, N. McGraw-Hill.

Using Information Technology: A Practical Introduction to Computer & Communications, 6th Edition. Williams, S. McGraw-Hills.

Computers, Communications & information: A user's introduction, Sarah, E. Hutchinson. Stacey, C. Swayer.

Fundamentals of Information Technology, Alexis L Mathewsleon Leon Press.

#### **MTH-2021: Calculus and Analytical Geometry (3+0) 3**

**Pre requisite: N/A**

This course is devoted to the study of elementary analytic geometry, functions, limits, continuity, derivatives, antiderivatives, and definite integrals.

**Text:** Calculus and Analytical Geometry, Swokowski Olinick. Pence. 1994. 6<sup>th</sup> edition. Brooks/Cole Publishers.

Calculus and Analytical Geometry 10th edition. Thomas, F. John Wiley and Sons

#### **MGT-1013: Fundamentals of Financial Accounting / University Elective (3+0) 3**

**Pre requisite: N/A**

This course is an introduction to the basic concepts and standards underlying financial accounting systems. Several important concepts will be studied in detail, including: revenue recognition, inventory, long-lived assets, present value, and long term liabilities. The course emphasizes the construction of the basic financial accounting statements - the income statement, balance sheet, and cash flow statement - as well as their interpretation.

**Text:** Financial Accounting: An Introduction to Concepts, Methods, and Uses by Clyde P. Stickney, Roman L. Weil

Financial Accounting: Tools for Business Decision Making by Paul D. Kimmel, Jerry J. Weygandt, Donald E. Kieso

#### **CS-2032: Programming Fundamentals (3+1) 4**

**Pre requisite: CS-1031**

A hands-on introduction to computation, through programming and problem solving

**Text:** C How to Program, Paul Deitel and Harvey Deitel, Prentice Hall; 7<sup>th</sup> edition (March 4, 2012)

Programming in C, Stephen G. Kochan, Addison-Wesley Professional; 4th edition (September 25, 2013). ISBN-10: 0321776410.

### **HUM-1011: English Composition & Comprehension (3+0) 3**

**Pre requisite: N/A**

The Basic English Program course prepares students to cope with university education. It mainly aims at bridging the gap between school and university education. The English Program consists of a number of competencies: reading, writing, listening, speaking, vocabulary, grammar, critical thinking skills, and self-learning. A multimedia component of the program is also available to reinforce the language skills and to support independent learning.

**Text:** John E. Warriner. Warriner's English Grammar and Composition.

Handouts

### **HUM-1012: Islamic Studies (2+0) 2**

**Pre requisite: N/A**

This course enables learners to develop an understanding of the importance of the major beliefs of Islam, and of the early history of the Islamic community. As a result, learners develop their knowledge and understanding of the main elements of Islamic faith and history, evaluating the meaning and importance of these elements in the lives and thoughts of Muslims.

**Text:** Hameed ullah Muhammad, "Emergence of Islam", IRI, Islamabad.

Hameed ullah Muhammad, "Muslim Conduct of State".

Hameed ullah Muhammad, 'Introduction to Islam.

## **Semester 2**

### **EE-2071: Applied Physics (3+0) 3**

**Pre requisite: N/A**

This initial course introduces the concepts and fundamentals of Electronic devices. Topics include passive components, diode and transistor fundamentals and applications, characteristics and applications of optoelectronic devices. This course introduces features and classifications of Transducers. It also provides the idea about Digital fundamentals and communication systems

**Text:** University Physics, Freedman. Young. 10th and higher editions.

College Physics, Resnick. Halliday. Krane. 6th and higher editions

### **MTH-3022: Multivariable Calculus (3+0) 3**

**Pre requisite: MTH-2021**

This course takes calculus from the two dimensional world of single variable functions into the three dimensional world, and beyond, of multivariable functions. Topics include the following: vector geometry and the analytic geometry of lines, planes and surfaces; calculus of curves in two or three dimensions, including arc length and curvature; calculus of scalar-valued functions of several variables, including the gradient, directional derivatives and the Chain Rule; Lagrange multipliers and optimization problems; double integrals in rectangular and polar coordinates; triple integrals in rectangular, cylindrical and spherical coordinates; calculus of vector fields including line integrals, curl and divergence, fundamental theorem for line integrals and Green's theorem.

**Text:** Multivariable Calculus, 6th edition James, Stewart 2007 Cengage Learning publishers

Multivariable Calculus, 5th edition Howard, A. Albert, H. 1995, John Wiley.

**HUM-1015: Pakistan Studies (2+0) 2**

**Pre requisite:** N/A

This course aims to introduce students to the history of the region comprising Pakistan, provide an overview of contending perspectives on the origins of the country, and examine its politics, society and culture. The course, furthermore, looks at some contemporary developmental issues facing the country.

**Text:** The Emergence of Pakistan, Chaudary M., 1967

The making of Pakistan, Aziz. 1976

**CS-2022: Discrete Structures (3+0) 3**

The purpose of this course is to understand and use (abstract) discrete structures that are backbones of computer science. In particular, this class is meant to introduce logic, proofs, sets, relations, functions, counting, and probability, with an emphasis on applications in computer science.

**Text:** Multi-agent systems: an introduction to distributed artificial intelligence. Steven J. Ferber. Addison-Wesley, 1999.

Multiagent systems: a modern approach to distributed artificial intelligence. G. Weiss. The MIT Press, 1999.

**CS-3033: Object Oriented Programming (3+1) 4**

**Pre requisite:** CS-2032

This subject introduces object-oriented programming. The student learns to build reusable objects, encapsulate data and logic within a class, inherit one class from another and implement polymorphism. This subject uses the C++ programming language exclusively and establishes a foundation for learning system analysis and design and more advanced concepts as implemented in languages such as C++, Java, C# and Objective-C.

**Text:** C++: How to Programme, Deitel and Deitel, 5/e, Pearson.

Object Oriented Programming in C++, 3rd Edition, Robert Lafore

**HUM-2014: Technical & Business Writing (3+0) 3**

**Pre-requisite:** 1011

This course involves the study and practice of writing in professional settings. This class focuses on documents necessary to make decisions and take action on the job such as letters and memorandums, reports, proposals, e-mail, and other documents

**Text:** Blake, Gary and Robert W. Bly. The Elements of Technical Writing. Advice on style, using examples from technical writing.

Burnett, Rebecca E. Technical Communication.

Advanced textbook showing how written documents contribute to organizational effectiveness. Covering abstracts, manuals, instructions, report, letters, etc.

## Semester 3

### **HUM-3016: Communication & Presentation Skills (3+0) 3**

**Pre requisite:** N/A

This course provides students with the knowledge and skills to communicate professionally on many levels including writing; speaking; conducting meetings; giving presentations and interpersonal dialogues; and using electronic media.

**Text:** Practical Business English, Collen Vawdrey, 1993, ISBN = 0256192740

Effective Communication Skills: The Foundations for Change, John Nielsen, 2008, ISBN = 1453506748

### **CS-2072: Digital Logic and Design (3+1) 4**

**Pre requisite:** CS-2071

This course provides a modern introduction to logic design and the basic building blocks used in digital systems, in particular digital computers. It starts with a discussion of combinational logic: logic gates, minimization techniques, arithmetic circuits, and modern logic devices such as field programmable logic gates. The second part of the course deals with sequential circuits: flip-flops, synthesis of sequential circuits, and case studies, including counters, registers, and random access memories. State machines will then be discussed and illustrated through case studies of more complex systems using programmable logic devices. Different representations including truth table, logic gate, timing diagram, switch representation, and state diagram will be discussed.

**Text:** Digital Fundamentals by Floyd, 11/e.

Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e.

### **MTH-3041: Probability and Statistics (3+0) 3**

**Pre requisite:** N/A

This course provides an elementary introduction to probability and statistics with applications. Topics include: basic combinatorics, random variables, probability distributions, Bayesian inference, hypothesis testing, confidence intervals, and linear regression.

**Text:** Probability & Statistics for Engineers & Scientists Ronald, W. Myers, Y.2008", 8th edition. Prentice Hall Publisher.

Probability and Statistics for Engineering and the Sciences Lay, L. Devore. 2003. Duxbury Publishers.

### **CS-3061: Data Structures and Algorithms (3+1) 4**

#### **Pre requisite: CS-3033**

The course emphasizes the design, implementation, and analysis of common data structures and algorithms. The goal is to teach how data structures provide the necessary data abstraction for the development of large software systems and their central role in software engineering. Data structures covered include sets, linked lists, stacks, queues, hash tables, trees, heaps, and graphs. Students are introduced to algorithms for searching, sorting, and data structure manipulation and learn the techniques to analyze program efficiency. Programming using recursion and dynamic data structures are covered.

**Text:** Data Structures and Algorithm Analysis, Mark Allen Weiss, Florida International University, Addison-Wesley (latest Edition)

Data Structures: Abstraction and Design Using Java, Koffman and Wolfgang, Wiley; 2nd Edition (or latest Edition), 2010

### **CS-3042: Database Systems (3+1) 4**

#### **Pre requisite: CS-1031**

This course covers mostly relational database systems. First, students will learn how to effectively design and create relational databases, and how to use them via the SQL query and manipulation language. Next, the internals of relational database systems will be studied including how the relational database systems store data, optimize and execute SQL queries, and process transactions. Finally, this course will briefly discuss advanced, non-relational issues, such as object-oriented and XML data models, data integration, and data mining.

**Text:** Database Systems, A Practical Approach to Design, Implementation, and Management, 4th Edition, Thomas Connolly, Carolyn Begg, Addison Wesley, 2005

Fundamentals of Database Systems by R. Elmasri and S. Navathe. 6<sup>th</sup> Edition, Addison-Wesley (2010). ISBN-10: 0136086209

## **Semester 4**

### **CS-3081: Software Engineering (3+0) 3**

#### **Pre requisite: CS-1031**

Requirements, specification, design, implementation, testing, and verification of large software systems. Study and use of software engineering methodologies. Team programming.

**Text:** Software Engineering 8E by Ian Sommerville, Addison Wesley; 8th Edition (2006). ISBN-10: 0321313798

Software Engineering: A Practitioner's Approach by Roger S. Pressman, McGraw-Hill Science/Engineering/Math; 7th Edition (2009). ISBN-10: 0073375977.

### **MTH-3024: Linear Algebra (3+0) 3**

#### **Pre requisite: N/A**

Students explore the following topics: systems of linear equations, matrix arithmetic, determinants, real vector spaces, linear transformations, eigenvalues, eigenvectors, and diagonalization.

**Text:** Elementary Linear Algebra with Applications 9th edition Bernard, K. David, H. 2007. Prentice Hall PTR.

Strang's Linear Algebra and Its Applications, 4th edition. Gilbert, S. Strang, B. Coonley. Andy, B. Andrew, B. 2005. Brooks/Cole.

### **CS: IS/Bio/DS Specialization-1 / CS Elective (3+0) 3**

### **CS-3062: Design and Analysis of Algorithms (3+0) 3**

#### **Pre requisite: CS-3061**

Techniques for designing efficient algorithms, analyzing their complexity and applying these algorithms to a broad range of application settings. Methods for recognizing and dealing with hard problems are studied. Review of design and analysis techniques; advanced data structures; graph algorithms (network flows, matching, min-cut); NP-completeness, randomization and approximation algorithms; special topics (string matching, computational geometry or number theoretic algorithms).

**Text:** Introduction to Algorithms, T. H. Cormen, C. E. Leiserson, and R. L. Rivest, MIT Press, McGraw-Hill, 3rd Edition, New York, NY, 2010.

Algorithms in C++; Robert Sedgewick

### **CS-3052: Data Communication and Networks (3+1) 4**

#### **Pre requisite: N/A**

Overview of computer networks, TCP/IP protocol suite, computer-networking applications and protocols, transport-layer protocols, network architectures, Internet Protocol (IP), routing, link-layer protocols, local area and wireless networks, medium access control, physical aspects of data transmission, and network-performance analysis.

**Text:** Data Communications and Networking, by Behrouz A. Forouzan, 5<sup>th</sup> edition, 2013.

Data and Computer Communications by William Stallings 9th Edition 2011.

## **Semester 5**

### **MTH-3025: Numerical Computing (3+0) 3**

#### **Pre requisite: MTH-121**

This is an introductory numerical analysis course. We study numerical methods to solve linear and nonlinear equations, to interpolate and approximate data, and methods for numerical integration and differentiation.

**Text:** Numerical Methods in Scientific Computing by Germund, D. Åke, B  
Numerical Analysis by Gerald.

### **CS-3051: Operating Systems (3+1) 4**

#### **Pre requisite: CS-1031**

This course involves basic concepts of operating systems and system programming. Processes and inter-process communication/synchronization; virtual memory, program loading and linking; file and I/O subsystems; utility programs, including device control, memory management and addressing, interrupts, synchronization, security

**Text:** Operating System Concepts, 9th Edition, Silberschatz A., Peterson, J. L., & Galvin P. C. 2012.

Modern Operating Systems, 3rd Edition, Tanenbaum A. S., 2008.

### **MGT-3018: Introduction to Management / University Elective (3+0) 3**

#### **Pre requisite: N/A**

This course introduces students to the roles and functions of managers. The content includes an introduction to organizations and the need for and nature of management. It examines the evolution of management theory, organizational environments, and corporate social responsibility and ethics. The course also includes a detailed investigation of the four functions of management: planning and decision making, organizing, leading and motivating, and controlling

**Text:** Ricky W. Griffin. Fundamental of Management. 3rd ed. Texas and A. M. University

### **CS: IS/Bio/DS Specialization-2 / CS Elective (3+0) 3**

#### **HUM-2017: Chinese Language / University Elective (3+0) 3**

**Pre-requisite:** Nil

This beginner's course is designed for students who desire to study Chinese systematically. The course uses video-based material to introduce the language in real-life settings. Pinyin and simplified characters are used. Accurate pronunciation, tones, and grammatical expressions are the main focuses for this semester.

#### **CS-3091: Artificial Intelligence (2+1) 3**

**Pre requisite:** N/A

This course in Artificial Intelligence (AI) is designed to expose the student to both the breadth and depth of the subject. Topics include problem solving, knowledge and reasoning, acting logically, uncertain knowledge and reasoning, learning, and communicating, perceiving and acting.

**Text:** Artificial Intelligence Illuminated by Ben Coppin, 1st edition, Jones & Bartlett Learning, 2004.

Artificial Intelligence: A Modern Approach by Stuart Jonathan Russell, Peter Norvig  
Prentice Hall, 2010.

## **Semester 6**

#### **CS-3073: Microprocessor and Assembly Language (3+1) 4**

**Pre requisite:** EE-2071

introduce the organization of computer systems and usage of assembly language for optimization and control. Emphasis should be given to expose the low-level logic employed for problem solving while using assembly language as a tool. At the end of the course the students should be capable of writing moderately complex assembly language subroutines and interfacing them to any high level language.

**Text:** The Intel Microprocessor 8th ed, Barry B Brey.

Assembly Language for Intel-based Computers, 6th Ed Irvine.

#### **CS-3074: Computer Architecture and Organization (3+0) 3**

**Pre requisite:** CS-2072

This course will introduce students to the fundamental concepts underlying modern computer organization and architecture. Main objective of the course is to familiarize students about hardware design including logic design, basic structure and behavior of the various functional modules of the computer and how they interact to provide the processing needs of the user. It will cover machine level representation of data, instruction sets, computer arithmetic, CPU structure and functions, memory system organization and architecture, system input/output, multiprocessors, and digital logic. The emphasis is on studying and analyzing fundamental issues in architecture design and their impact on performance.

**Text:** Computer Architecture: A Quantitative Approach by Hennessy & Patterson, Morgan & Kauffman Series (2006) 4th Edition.

Computer Organization & Design: The Hardware/Software Interface by Patterson & Hennessy, Morgan & Kauffman Series (2008) 4th Edition

### **CS: IS/Bio/DS Specialization-3 / CS Elective (3+0) 3**

#### **MTH-3026: Differential Equations (3+0) 3**

**Pre requisite:** MTH-121

Applications of calculus and linear algebra to the solution of ordinary differential equations.

**Text:** A First Course in Differential Equation Zill. Prindle. Weber. Schmidt.1996. Brooks/Cole Publishing. Differential Equations with Boundary-Value Problems, Dennis. G. Zill, Michael, R. Cullen. 1996, Brooks/Cole Publishing.

**CS-4063: Theory of Automata (3+0) 3**

**Pre requisite:** N/A

The course deals with time and space complexity classes. Reductions, completeness, and the role of randomness. Logic and undecidability.

**Text:** Artificial Intelligence: Structures and Strategies for Complex Problem Solving: International Edition by George F. Luger, 6th edition: Pearson Education, 2008.

Artificial Intelligence: A Modern Approach, by Stuart Jonathan Russell, Peter Norvig, John F. Canny, 3rd Edition, Prentice Hall.

## Semester 7

**CS-3036: Mobile Application and Development / CS Elective (2+1) 3**

**Pre requisite:** CS-3033

Students learn how to develop applications for mobile devices, including smartphones and tablets. Students are introduced to the survey of current mobile platforms, mobile application development environments, mobile device input methods, as well as developing applications for two popular mobile platforms. Students will design and build a variety of Apps throughout the course to reinforce learning and to develop real competency with great emphasis on development of android applications.

**Text:** Android Wireless Application Development, third edition, Lauren Darcey, Shane Conder, Addison Wesley, 2012, ISBN 0321813839.

Mobile Design and Development: Practical concepts and techniques for creating mobile sites and web apps, by Brian Fling Publisher: O'Reilly Media, 2009.

**CS-4000: Final year Project-I (3+0) 3**

**Pre requisites:** N/A

This is the final capstone component for the undergraduate thesis in the area of interest related to computer sciences. Students will complete their faculty-supervised thesis research, write up and submit their theses, and give a final oral presentation on their thesis work.

**CS: IS/Bio/DS Specialization-4 / CS Elective (3+0) 3**

**MGT-3019: Entrepreneurship / University Elective (3+0) 3**

**Pre requisite:** CS-1031

The E-Commerce Entrepreneurship course introduces students to the online world of business, retail, and commerce. The class will equip students with the skills necessary to launch a successful e-commerce venture while addressing common challenges and pitfalls.

**Text:** Managing E-commerce in Business by J. Botha, C. H. Bothma, Pieter Geldenhuys Juta and Company Ltd, 27-Feb-2008.

E-Commerce: An Introduction by Amir Manzoor, Lambert Academic Publishing.

**CS-3086: Project Management / University Elective (3+0) 3**

**Pre-requisite:** CS-3081



Students will study the software project planning, cost estimation and scheduling, project management tools, factors influencing productivity and success. Students will also learn productivity metrics, analysis of options and risks, software process standards and process implementation, software contracts and intellectual property and approaches to maintenance and long term software development.

**Text:** Bob Hughes & Mike Cotterell, "Software Project Management" Fourth Edition, McGraw-Hill, 2005

Andrew Stellman & Jennifer Greene, Applied Software Project Management, O'Reilly Media, 2005

### **CS-4064: Theory of Programming languages (3+0) 3**

#### **Pre-requisite:**

The purpose of this course is to provide a broad vision of Programming Languages and their comparison. The student will develop knowledge on different aspects of the area which will allow him/her to perform critical evaluation of languages and their constructs. We will also study the impact of different computer architectures and other consideration on the design of a programming language and ultimately the way we think and write programs. The course will cover major programming paradigms including Logic Programming, Functional Programming, and Object-Oriented Programming. We will also study syntax, semantics, data structures and constructs of several programming languages. In addition, it will cover advanced topics such as how languages handle exceptions and how they deal with concurrency. Finally we will look at some of the new programming paradigms and language efforts underway to support these paradigms.

**Text:** Concepts of Programming Languages, Robert W. Sebesta, 10th edition, 2012  
Scott, Michael L., Programming Language Pragmatics, 2nd edition, 2006

## **Semester 8**

### **CS-4065: Compiler Construction (3+0) 3**

#### **Pre requisites: CS-4063**

This module introduces topics include compiler design, lexical analysis, parsing, symbol tables, declaration and storage management, code generation, and optimization techniques.

**Text:** Compilers: Principles, Techniques, and Tools By Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, Contributor Jeffrey D. Ullman, Addison-Wesley Pub. Co., 2nd edition, 2006 Original from the University of Michigan.

Modern Compiler Design, by Dick Grune, Henri E. Bal, Cerial J. H. Jacobs, Koen G. Langendoen, John Wiley, 2000.

### **CS-4001: Final Year Project-II (3+0) 3**

#### **Pre requisites: N/A**

This is the final capstone component for the undergraduate thesis in the area of interest related to computer sciences. Students will complete their faculty-supervised thesis research, write up and submit their theses, and give a final oral presentation on their thesis work.

### **CS: IS/Bio/DS Specialization-5 / CS Elective (3+0) 3**

#### **CS-4084: Professional Practices (3+0) 3**

**Pre-requisite:** Nil

This course examines the underlying assumptions, values, experiences, skills, forms of knowledge and broader contexts that impact on and inform students' professional practice approach. Using case studies as a starting point, students will explore some of the key issues of contemporary workplaces. Students will be required to draw on theoretical perspectives and ideas from contemporary research as well as insights generated through critical reflection, online discussions and collaborative problem-solving. This course introduces the various communication options available in a business context so that students can make appropriate choices in the workplace. Students will gain confidence in their ability to communicate by practicing and receiving feedback on business communication skills. Through this critical enquiry process, it is expected that students will further develop their understandings of their own practices and change and develop aspects of these practices. It has a particular emphasis on building professional knowledge of working in a business environment and developing work ready skills in the areas of written and oral communication, intercultural communication, client service, problem solving and self-management. Students will develop strategies to communicate these abilities through career communication, including career documents and interviews. Opportunities for improving academic and workplace language proficiency are embedded in the course.

**Text:** PROFESSIONAL PRACTICE by Jiddu Krishnamurti and S.V. RAVINDRA.

#### **University Elective Courses:**

#### **UEC/MGT-486: Management Information Systems (3+0) 3**

**Pre requisite:** CS-131

The Role of Information Systems in Business Today, Perspectives on Information Systems, Business Processes and Information Systems, Types of Business Information Systems, Systems for Collaboration and Team Work, the Information Systems Function in Business, Organizations and Information Systems, How Information Systems Impact Organizations and Business Firms, Using Information Systems to Achieve Competitive Advantage, Understanding

Ethical and Social Issues Related to Systems, Ethics in an Information Society, the Moral Dimensions of Information Systems. IT Infrastructure and Emerging Technologies: Foundations of Business Intelligence, Telecommunications, the Internet and Wireless Technology, Securing Information Systems, Enterprise Systems, Supply Chain Management

Systems, Customer Relationship Management Systems, Enterprise Applications: New Opportunities and Challenges, E-Commerce: Digital Markets, Digital Goods, Managing Knowledge, Decision Making and Information Systems, Business Intelligence in the Enterprise, Managing Global Systems.

**Text:** Management Information System by Hitesh Gupta, 2012

Management Information Systems by S. SADAGOPAN PHI Learning, 01-Jan-1997

### **Information Security Specialization Course Offerings:**

#### **CS-3055: Intro. to Information Security (3+0) 3**

This course provides an overview of information security. It is designed to help students with prior computer and programming knowledge to understand this important priority in society today. The technical content of the course gives a broad overview of essential concepts and methods for providing and evaluating security in information processing systems (operating systems and applications, networks, protocols, and so on). In addition to its technical content, the course touches on the importance of management and administration, the place information security holds in overall business risk, social issues such as individual privacy, and the role of public policy.

**Text:** Principles of Information Security 3rd E by Michael E. Whitman and Herbert J. Mattord

#### **CS-5057: Cryptography and Network Security (3+0) 3**

The course covers theory and practice of computer security, focusing in particular on the security aspects of the web and Internet. It surveys cryptographic tools used to provide security, such as shared key encryption (DES, 3DES, RC-4/5/6, etc.); public key encryption, key exchange, and digital signature (Diffie-Hellmann, RSA, DSS, etc.). The module also reviews how these tools are utilized in the internet protocols and applications such as SSL/TLS, IPSEC, Kerberos, PGP, S/MIME, SET, and others (including wireless). System security issues, such as viruses, intrusion, and firewalls are also included in course content.

**Text:** Cryptography and Network Security by William Stalling 6th Edition, 2012

Principles of Information Security 3rd E by Michael E. Whitman and Herbert J. Mattord

#### **CS-5056: Digital Forensics: (3+0) 3**

This course will provide a foundation in the field of Computer Forensics. The student will learn how to obtain and analyze digital information for possible use as evidence in civil, criminal or administrative cases. Course content includes setup and use of an investigator's laboratory, computer investigations using digital evidence controls, processing crime and incident scenes, performing data acquisition, computer forensic analysis, e-mail investigations, image file recovery, investigative report writing, and expert witness testimony.

**Text:** Digital Forensics with Open Source Tools by C. Altheide & H. Carvey , Syngress, 2011. ISBN: 9781597495868.

Computer Forensics and Cyber Crime: An Introduction (3rd Edition) by Marjie T. Britz, 2013.

Incident Response & Computer Forensics, Third Edition by Jason Luttgens, Matthew Pepe, and Kevin Mandia, Publisher: McGraw-Hill Education; 3rd edition (August, 2014)

#### **CS-4058: Web Security (3+0) 3**

The course deals with client-side (browser) vulnerabilities associated with browsing the web, system penetration, information breach and identity threat. Encrypting data stream using SSL, Confidentiality and Integrity of data using third party transaction protocols e.g. SET, PCI DSS Standard, Server-side security:

CGI security, server configuration, access control, operating system security, malicious e-mails, web scripts, cookies, web bugs spyware, rogue AV etc.

**Text:** The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws by Dafydd Stuttard, Marcus Pinto

Web Services Security by Mark O'Neil

### **CS-3059: Information Security Goals, Strategies and Policies (3+0) 3**

This course enlightens and discusses business and management aspects of information security: Legal and regulatory aspects; strategic planning process; security policies, policy designing and management process for a secure information systems environment.

**Text:** Security Program and Policies: Principles and Practices, 2nd Edition by Sari Greene  
Strategic Information Security by John Wylder

### **Data Science Specializations Course Offerings:**

#### **CS-3044: Introduction to Data Science (3 + 0) 3**

This course will introduce students to the rapidly growing field of data science and equip them with some of its basic principles and tools as well as its general mindset. Students will learn concepts, techniques and tools they need to deal with various facets of data science practice, including data collection and integration, exploratory data analysis, predictive modeling, descriptive modeling, data product creation, evaluation, and effective communication. The focus in the treatment of these topics will be on breadth, rather than depth, and emphasis will be placed on integration and synthesis of concepts and their application to solving problems. To make the learning contextual, real datasets from a variety of disciplines will be used.

**Text:** Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014.

#### **CS-4045: Big Data Concept & Techniques (3 + 0) 3**

This course focuses on the methods that do work, introducing all the techniques and concepts involved in capturing, storing, manipulating, and analyzing big data, including data mining and predictive analytics. Course also includes big data's relationship to data science, statistics, and programming; its uses in marketing, scientific research, and tools like Amazon's recommendation engine; and the ethical issues that lie behind its use.

**Text:** Big Data Concepts, Theories, and Applications edited by Shui Yu, Song Guo, Springer  
Data Smart: Using Data Science to Transform Information into Insight, by J. W. Foreman

#### **CS-5046: Big Data Analytics (3 + 0) 3**

##### **Pre-req.: CS-4045**

This course provides the fundamental knowledge to equip students being able to handle challenges related to big data. The course discusses the overview applications, market trend, the fundamental platforms, such as Hadoop, Spark, and other tools, e.g., Linked Big Data, several data storage methods and how to upload, distribute, and process them including HDFS, HBase, KV stores, document database, and graph database, different ways of handling analytics algorithms on different platforms, visualization issues and mobile issues on Big Data Analytics and fundamental knowledge on Big Data Analytics to handle various real-world challenges.

**Text:** Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data 1st Edition by EMC Education Services

Lean Analytics: Use Data to Build a Better Startup Faster, by A. Croll and B. Yoskovitz

#### **CS-4047: Data Mining (3+0) 3**

**Pre requisites:** CS-2042

Data Mining studies algorithms and computational paradigms that allow computers to find patterns and regularities in databases, perform prediction and forecasting, and generally improve their performance through interaction with data. It is currently regarded as the key element of a more general process called Knowledge Discovery that deals with extracting useful knowledge from raw data. The knowledge discovery process includes data selection, cleaning, coding, using different statistical and machine learning techniques, and visualization of the generated structures. The course will cover all these issues and will illustrate the whole process by examples. Special emphasis will be given to the Machine Learning methods as they provide the real knowledge discovery tools. Important related technologies, as data warehousing and on-line analytical processing (OLAP) will be also discussed.

**Text:** Data Mining: Concepts and Techniques, 3rd Edition Jiawei Han, Micheline Kamber, Jian Pei; 2011  
Data Mining: Concepts, Models, Methods, and Algorithms, 2nd Edition, Mehmed Kantatardzic, 2011

### **CS-3093: Machine Learning (3 + 0) 3**

#### **Pre requisites: CS-3091**

This course provides a broad introduction to machine learning, datamining, and statistical pattern recognition. Topics include supervised learning (parametric/non-parametric algorithms, support vector machines, kernels, neural networks), unsupervised learning (clustering, dimensionality reduction, recommender systems, deep learning), best practices in machine learning (bias/variance theory; innovation process in machine learning and AI). The course will also draw from numerous case studies and applications, so that students also learn how to apply learning algorithms to building smart robots (perception, control), text understanding (web search, anti-spam), computer vision, medical informatics, audio, database mining, and other areas.

**Text:** Bishop, C. (2006). Pattern Recognition and Machine Learning. Berlin: Springer-Verlag  
The Elements of Statistical Learning by Hastie, Tibshirani, and Friedman

### **Bioinformatics Course Offerings:**

#### **CS-3101: General Biology (3+0) 3**

##### **Pre-requisite: Nil**

The course is designed/offered to train the next generation of computer professionals and researchers to gain basic knowledge of Biology. This preliminary knowledge will help them build a foundation in the interdisciplinary field of Bioinformatics/Computational Biology required to design and implement novel methods and tools to provide a better understanding of biological systems with the integration of Computer Science. The main objective is to provide students with significant comprehension of Biology from which they can understand the relevance of advanced courses of Bioinformatics.

**Text:** Campbell and Mitchell, "Biology: Concepts and connections", Wesley Longman Inc. New York.

Star C., "Biology Concepts and Applications", Thomson.

#### **CS-3103: Bioinformatics-I (2+1) 3**

##### **Pre-requisite: CS-3101**

Introduces bioinformatics concepts and practice. Students will gain practical experience with bioinformatics tools and develop basic skills in the collection and presentation of bioinformatics data. Retrieval and analysis of electronic information are essential for today's research environment. This course explores the theory and practice of biological database searching and analysis. In particular, students are introduced to integrated systems where a variety of data sources are connected through World Wide Web access. Information retrieval and interpretation are discussed, and many practical examples in a computer laboratory setting enable students to improve their data mining skills. Methods included in the course are searching the biomedical literature, sequence homology searching, multiple alignment and several genome analytical methods.

**Text:** Arthur M. Lesk, "Introduction to Bioinformatics", Oxford University Press.

Ignacimuthu SJ, "Basic Bioinformatics", Narosa Publishing House.

#### **CS-4102: Molecular Biology & General Genetics (3+0) 3**

##### **Pre-requisite: CS-3101**

This course provides a comprehensive overview of the key concepts in molecular biology and genetics. Topics to be covered include nucleic acid structure and function, DNA replication, transcription, translation, chromosome structure, gene expression in prokaryotes and eukaryotes, method in recombinant DNA technology. This course provides the basic principles of inheritance and students will gain experience in variety of techniques used in gene analysis.

**Text:** Robert Weaver, "Molecular Biology", McGraw Hill.

Gardner, "Principles of Genetics", John Wiley and Sons.

### **CS-4104: Bioinformatics-II (2+1) 3**

**Pre-requisite:** CS-3101, CS-4102

This course is designed to develop understanding of gene and protein at structural level using computational tools. Several large-scale DNA sequencing efforts have resulted in megabase amounts of DNA sequences being deposited in public databases. As such, the sequences are of less use than those sequences that are fully annotated. Assigning annotations, such as exon boundaries, repeat regions, and other biologically relevant information, accurately in the feature tables of these sequences requires a significant amount of human intervention. This course instructs students on computer analytical methods for gene identification, promoter analysis, and introductory gene expression analysis using software methods. Additionally, students are introduced to comparative genomics and proteomic analysis methods. Students will become proficient in annotating large genomic DNA sequences.

**Text:**

David Mount, "Bioinformatics: Sequence and Genome analysis", Cold Spring Harbour Laboratories.

P. Rastogi and N. Mendiritta, "Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery", Prentice-Hall of India Pvt.Ltd.

### **CS-3105: Ethical & Legal Issues in Biology (3+0) 3**

**Pre-requisite:** Nil

This course introduces the ethical and legal aspects related to biological practices and products. Students in this course analyze and discuss traditional philosophical theories regarding the nature of the moral good. They then apply these theories to critical issues and selected cases involving experiments with human subjects, organ transplantation, in vitro fertilization, the use of animals in research, the collection and publication of research data, peer review, conflicts of interest, and other topics of current concern. This course provides an overview of the important ethical, legal and regulatory issues that are critical to bioinformatics. The course shares current trends and essential elements of ethics, legal issues and regulations in a way that allows for an appreciation of how each influences the others. Students will examine core ethical values that guide the practice of science.

**Text:** Katina Strauch and Bruce Strauch, "Legal and Ethical Issues in Acquisitions", Routledge.

Tom Forester and Perry Morrison, "Computer Ethics: Cautionary Tales and Ethical Dilemmas in Computing", The MIT Press.



## **List of Elective Courses**

### **Computer Graphics: (2+1) 3**

Graphics hardware. Fundamental algorithms. Applications of graphics. Interactive graphics programming — graph plotting, windows and clipping, and segmentation. Programming raster display systems, Differential Line Algorithm, panning and zooming. Raster algorithms and software — Scan Converting lines, characters and circles. Scaling, Rotation, Translation, Region filling and clipping. Two and three dimensional imaging geometry (Perspective projection and Orthogonal projection) and transformations.

Curve and surface design, rendering, shading, color and animation.

**Text:** Fundamentals of Computer Graphics: 2nd Edition by Peter Shirley A. K. Peters, 2005

Computer Graphics, Principles and Practice, J. D. Foley, A. van Dam, S. K. Feiner and J. F. Hughes, Addison-Wesley ISBN: 0-201-12110-7.

### **Digital Image Processing (2+1) 3**

Elements of digital image processing, Image model, Sampling and quantization, Relationships between pixels, Image Enhancement: Enhancement by point processing, Spatial filtering, Enhancement in the frequency domain, Color Image Processing, image Segmentation: Discontinuity detection, Edge linking and boundary detection, Thresh holding, Region oriented segmentation, Use of motion for segmentation, Image Registration: Introduction to image registration, Techniques of image registration, Representation and Description: Boundary description, Regional description, Morphological Image Processing: Dilation and Erosion, Opening and Closing, Some basic morphological algorithms, Extensions to gray level images, Image Transforms: Discrete Fourier Transform, Discrete Cosine Transform, Haar Transform, Hadamard Transform

**Text:** Digital Image Processing, R. C. Gonzalez & R. E. Woods, 3rd edition, Prentice Hall, 2008, ISBN 9780131687288.

Digital Image Processing (3rd Edition) by Rafael C. Gonzalez, Prentice Hall; 3rd edition (2007)

### **Computer Vision (3+0) 3**

Concepts behind computer-based recognition and extraction of features from raster images. applications of vision systems and their limitations. Overview of early, intermediate and high level vision, Segmentation: region splitting and merging; quad tree structures for segmentation; mean and variance pyramids; computing the first and second derivatives of images using the Sobel and Laplacian operators; grouping edge points into straight lines by means of the Hough transform; limitations of the Hough transform; parameterization of conic sections. Perceptual grouping: failure of the Hough transform; perceptual criteria; improved Hough transform with perceptual features; grouping line segments into curves. 3D vision, Triangulation principle, Stereoscopy.

**Text:** Computer Vision: A Modern Approach 2nd ed, By David Forsyth, Jean Ponce, Prentice Hall, 2011.

Computer Vision, by Linda G. Shapiro, George C. Stockman, Prentice Hall, 2001.

### **Distributed Computing (3+0) 3**

Introduction to Parallel and Distributed Systems, Software Architectures: Threads and Shared memory, Processes and Message passing, Distributed Shared Memory (DSM), Distributed Shared Data (DSD). System Models, Networking and Internetworking, Communication Models and Abstractions (Message passing, stream-oriented communications, remote procedure calls, remote method invocation), Naming in Distributed Systems, Concurrency and Synchronization, Process Synchronization, Distributed Transaction and Concurrency Control, Distributed Data Replication, Security and Access Control, Overview of Web Services, Cloud Computing.

**Text:** Distributed Systems: Principles and Paradigms, Andrew S. Tanenbaum and Maarten van Steen. Prentice-Hall, 2002.

Distributed Systems: Concepts and Design by 4th edition, George Coulouris, Jean Dollimore and Tim Kindberg. Addison-Wesley, 200537

### **Social Computing (3+0) 3**

The topics covered in this course will reflect the latest research and development activities in social networking e.g., Service architectures for social networks; Common APIs for popular architectures (Facebook, Open Social, etc.); Open ID and Shibboleth; Linked Data for social networks (FOAF, SKOS, etc); Social network properties and analysis methodologies; Social network interoperability; Social network topologies and ecosystems. Social networks in e-learning, enterprise and media; Identity, privacy and ownership in social networks; Aspects of recommendation engines and information retrieval in social networks; Sentiment classification, opinion extraction, social knowledge acquisition, social group identification and clustering, outlier detection.

**Text:** Opinion Mining and Sentiment Analysis (Foundations and Trends(R) in Information Retrieval by Bo Pang Lillian Lee.

Introduction to Social Network Theory by Kadushin, Charles. (Feb 17, 2004).

### **Data Warehousing (3+0) 3**

This course provides an introduction to data warehouse design. Topics in data modeling, database design and database access are reviewed. Issues in data warehouse planning, design, implementation, and administration are discussed in a seminar format. The role of data warehouse in supporting Decision Support Systems (DSS) is also reviewed.

**Text:** Data Warehousing Fundamentals, 2nd Edition, Paulraj Ponniah, 2010, John Wiley & Sons Inc., NY.

Building the Data Warehouse, 4th Edition, W. H. Inmon, 2005, John Wiley & Sons Inc., NY.

### **Expert Systems (3+0) 3**

In this course the students will learn the methodology used to transfer the knowledge of a human expert into an intelligent program that can be used to solve problems or give advice.

**Text:** Expert Systems: Principles and Programming, Joseph C. Giarratano, Gary D. Riley, 4th Edition, Course Technology, 2004, ISBN: 0534384471.

Jess in Action: Java Rule-Based Systems, Ernest Friedman-Hill, Manning Publications, July 2003, ISBN: 1930110898.

### **Artificial Neural Networks (ANN) (2+1) 3**

This course will cover basic neural network architectures and learning algorithms, for applications in pattern recognition, image processing, and computer vision. Three forms of learning will be introduced (i.e., supervised, unsupervised and reinforcement learning) and applications of these will be discussed. The students will have a chance to try out several of these models on practical problems.

**Text:** Neural Network Design, Martin T. Hagan, Howard B. Demuth, Mark H. Beale, ISBN: 0-9717321-0-8

### **Web Engineering (2+1) 3**

Web Engineering introduces a structured methodology utilized in software engineering to Web development projects. The course addresses the concepts, methods, technologies, and techniques of developing Web sites that collect, organize and expose information resources. Topics covered include requirements engineering for Web applications, design methods and technologies, interface design, usability of web applications, accessibility, testing, metrics, operation and maintenance of Web applications, security, and project management. Specific technologies covered in this course include client-side (HTML, JavaScript, and CSS) and server-side (ASP.NET).

### **Formal Methods in Software Engineering (3+0) 3**

This course presents some formal notations that are commonly used for the description of computation and of computing systems, for the specification of software and for mathematically rigorous arguments about program properties.

The following areas of study that constitute the backbone of the course are; Predicate calculus and natural deduction, inductive definitions of data types as a basis for recursive functions and structural induction, formal language theory (particularly regular expressions, finite state machines and context free grammars), specification languages, propositional programming language semantics, partial correctness and proofs of termination.

**Text:** Software Reliability Methods, Doron A. Peled, 2001 Springer-Verlag.

Logic in Computer Science Modelling and Reasoning about Systems 2<sup>nd</sup> Edition Michael Huth, Imperial College of Science, Technology and Medicine, London Mark Ryan, University of Birmingham, 2004.

Principles of Model Checking, Christel Baier and Joost-Pieter Katoen MIT Press, 2008.