# **COMSATS** University Islamabad

Registrar Secretariat, Academic Unit (PS)

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No. CUI-Reg/Notif- 4759 /21/3434

December 17, 2021

### NOTIFICATION

## Scheme of Studies of Bachelor of Science in Cyber Security BS (CYS)

Academic Council in its 32<sup>nd</sup> meeting held on October 06, 2021, on the recommendation of 28<sup>th</sup> meeting of Board of Faculty of Information Sciences & Technology, approved revised Scheme of Studies of Bachelor of Science in Cyber Security BS (CYS) effective from Spring 2022 at CUI System:

### Nomenclature: Bachelor of Science in Cyber Security BS (CYS)

1.	Minimum Duration:	04 Years
2.	Minimum No. of Semesters:	08

3. Cours	e Work	(Min No. of Courses)	(Min No. of Credit Hours)
a)	General Education	07	21
b)	University Electives	04	12
c)	Mathematics & Science Foundation	04	12
d)	Computing Core	11	39
e)	Computer Science Core	05	18
f)	Cyber Security Core (Domain Core)	06	18
g)	Cyber Security Electives (Domain Electives)	04	12
Minim	um No. of Courses Required:	41	
Minim	um No of Credit Hours Required:		132

**Note:** Regulations relating to Undergraduate Degree Programs approved by the Competent Authority and amended from time to time shall be applicable.

Maniba Nasir

Additional Registrar

### Encl: (Total 31 pages including this page)

### **Distribution:**

- 1. All Campus Directors, CUI
- 2. Dean, Faculty of Information Sciences and Technology, CUI
- 3. Controller of Examinations, CUI
- 4. Chairperson, Department of Computer Science, CUI
- 5. Incharge QEC/CU Online, PS
- 6. All HoDs/Incharge of Academics/Examinations Sections, CUI Campuses
- 7. Internal distributions, Registrar Office (Academic Unit), CUI

Cc:

- 1. PS to Rector CUI
- 1. PS to Registrar CUI

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### **General Education**

Subject/Knowledge Area	Credit Hours	Contact Hours
Introduction to Info. & Comm. Technologies	3(2-1)	2-3
English Composition & Comprehension	3(3-0)	3-0
Communication & Presentation Skills	3(3-0)	3-0
Technical & Business Writing	3(3-0)	3-0
Islamic Studies/ Ethics	3(3-0)	3-0
Pakistan Studies	3(3-0)	3-0
Professional Practices	3(3-0)	3-0

## **University Elective**

Subject/Knowledge Area	Credit Hours	Contact Hours
Foreign Language	3(3-0)	3-0
Management Related	3(3-0)	3-0
Social Science Related	3(3-0)	3-0
Economy Related	3(3-0)	3-0

### Mathematics and Science Foundation

Subject/Knowledge Area	Credit Hours	Contact Hours
Calculus & Analytic Geometry	3(3-0)	3-0
Linear Algebra	3(3-0)	3-0
Probability & Statistics	3(3-0)	3-0
Differential Equations	3(3-0)	3-0

### **Computing Core**

Subject/Knowledge Area	Credit Hours	Contact Hours	
Programming Fundamentals	4(3-1)	3-3	
Discrete Structures	3(3-0)	3-0	
Object Oriented Programming	4(3-1)	3-3	
Database Systems	4(3-1)	3-3	
Data Structures & Algorithms	4(3-1)	3-3	
Information Security	3(3-0)	3-0	
Computer Networks	4(3-1)	3-3	
Operating Systems	4(3-1)	3-3	
Software Engineering	3(3-0)	3-0	
Final Year Project – I	2(0-2)	0-6	
Final Year Project – II	4(0-4)	0-12	

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### **Computer Science Core**

Subject/Knowledge Area	Credit Hours	Contact Hours
Artificial Intelligence	4(3-1)	3-3
Digital Logic Design	4(3-1)	3-3
Analysis of Algorithms	3(3-0)	3-0
Computer Organization & Assembly Language	4(3-1)	3-3
Parallel & Distributed Computing	3(2-1)	2-3

### Cyber Security Core (Domain Core)

Subject/Knowledge Area	Credit Hours	Contact Hours
Introduction to Cyber Security	3(3-0)	3-0
Digital Forensics	3(2-1)	2-3
Information Assurance	3(3-0)	3-0
Network Security	3(2-1)	2-3
Secure Software Design and Development	3(2-1)	2-3
Vulnerability Assessment & Reverse Engineering	3(2-1)	2-3

## Cyber Security Electives (Domain Electives)

Subject/Knowledge Area	Credit Hours	Contact Hours
Basic Electronics	3(2-1)	2-3
Hardware Security	3(3-0)	3-0
Malware Analysis	3(3-0)	3-0
Wireless and Mobile Security	3(3-0)	3-0
Penetration Testing	3(2-1)	2-3
Computer Architecture	3(3-0)	3-0
Advance Digital Logic Design	3(3-0)	3-0
Cyber Warfare	3(3-0)	3-0
Control System Security	3(3-0)	3-0
Cryptanalysis	3(3-0)	3-0
Embedded Systems	3(2-1)	2-3
Embedded Systems Security	3(2-1)	2-3

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Course	Course Title	Credit	Pre-requisite(s)
Code		Hours	
CSC101	Introduction to ICT	3(2,1)	-
HUM100	English Comprehension and Composition	3(3,0)	-
HUM103	Communication Skills	3(3,0)	HUM100
HUM102	Report Writing Skills	3(3,0)	HUM100
HUM110	Islamic Studies **	3(3,0)	
HUM111	Pakistan Studies	3(3,0)	-
CYC410	Professional Practices for Cyber Security	3(3,0)	-

\*\*Non-Muslim students can opt for HUM114 Ethics 3(3,0) course in lieu of HUM110 Islamic Studies, if they intend to.

### University Electives (Any 4 courses)

Course	Course Title	Credit	Pre-requisite(s)
Code		Hours	110 requisite(s)
MGT100	Introduction to Business	3(3,0)	
MGT101	Introduction to Management	3(3,0)	-
MGT131	Financial Accounting	3(3,0)	- 10 M
MGT210	Fundamentals of Marketing	3(3,0)	-
MGT350	Human Resource Management	3(3,0)	-
MGT513	New Product Development	3(3,0)	-
ECO300	Engineering Economics	3(3,0)	-
ECO400	Business Economics	3(3,0)	-
ECO403	Managerial Economics	3(3,0)	-
ECO111	Principles of Microeconomics	3(3,0)	
ECO484	Project Planning and Monitoring	3(3,0)	-
HUM220	Introduction to Psychology	3(3,0)	-
HUM221	International Relations	3(3,0)	-
HUM320	Introduction to Sociology	3(3,0)	-
HUM430	French	3(3,0)	- Andrewski - Maria
HUM431	German	3(3,0)	-
HUM432	Arabic	3(3,0)	
HUM433	Persian	3(3,0)	-
HUM434	Chinese	3(3,0)	•
HUM435	Japanese	3(3,0)	

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### Mathematics & Science Foundation Courses

Course Code	Course Title	Credit Hours	Pre-requisite(s)
MTH104	Calculus and Analytic Geometry	3(3,0)	-
MTH262	Statistics and Probability Theory	3(3,0)	-
MTH242	Differential Equations	3(3,0)	MTH104
MTH231	Linear Algebra	3(3,0)	-

### **Computing Core Courses**

Course	Course Title	Credit	Pro-requisite(s)
Code		Hours	rie-requisite(s)
CSC103	Programming Fundamentals	4(3,1)	-
CSC102	Discrete Structures	3(3,0)	
CSC241	Object Oriented Programming	4(3,1)	CSC103
CSC211	Data Structures and Algorithms	4(3,1)	CSC103
CSC323	Principles of Operating Systems	4(3,1)	CSC211
CSC270	Database Systems	4(3,1)	CSC211
CSC291	Software Engineering Concepts	3(3,0)	-
CSC340	Computer Networks	4(3,1)	-
CSC432	Information Security	3(3,0)	-
CYC498	Final Year Project – I*	2(0,2)	CSC291, HUM102
CYC499	Final Year Project – II	4(0,4)	CYC498

\* Final Year Project – I must be graded independently.

### **Computer Science Core Courses**

Course Code	Course Title	Credit Hours	Pre-requisite(s)
EEE241	Digital Logic Design	4(3,1)	
CSC301	Design and Analysis of Algorithms	3(3,0)	CSC211
CSC325	Computer Organization & Assembly Language	4(3,1)	
CSC334	Parallel and Distributed Computing	3(2,1)	CSC323
CSC462	Artificial Intelligence	4(3,1)	CSC102

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## **Cyber Security Core Courses**

Course Code	Course Title	Credit Hours	Pre-requisite(s)
CYC205	Introduction to Cyber Security	3(3,0)	-
CYC303	Digital Forensics	3(2,1)	
CYC307	Information Assurance	3(3,0)	-
CYC365	Network Security	3(2,1)	CSC340
CYC386	Secure Software Design and Development	3(2,1)	-
CYC390	Vulnerability Assessment & Reverse Engineering	3(2,1)	

### Cyber Security Elective Courses (Any 4 Courses)

Course	Course	Credit	Pre-requisite(s)
CYC312	Cyber Threat Intelligence	3(3,0)	-
CYC466	Malware Analysis	3(3,0)	-
CYC467	Wireless and Mobile Security	3(3,0)	-
CYC378	Penetration Testing	3(2,1)	-
EEE440	Computer Architecture	3(3,0)	EEE241
CYC468	Hardware Security	3(3,0)	-
CYC469	Cyber Warfare	3(3,0)	-
CYC471	Control System Security	3(3,0)	-
CYC332	Cryptanalysis	3(3,0)	-
CYC470	Embedded Systems	3(2,1)	-
CYC473	Embedded Systems Security	3(2,1)	-
CYC475	Topics in Cyber Security	3(3,0)	-
EEE231	Electronics I	4(3,1)	-
CSC303	Mobile Application Development	3(2,1)	CSC241
CSC336	Web Technologies	3(2,1)	CSC241
CSC337	Advanced Web Technologies	3(2,1)	CSC336
CSC412	Visual Programming	3(2,1)	CSC241
CSC417	E-Commerce and Digital Marketing	3(2,1)	-
CSC418	DevOps for Cloud Computing	3(2,1)	-
CSC335	Game Design	3(3,0)	-
CSC353	Computer Graphics	3(2,1)	MTH231
CSC356	Human Computer Interaction	3(2,1)	-
CSC495	Game Development	4(3,1)	CSC241
CSC496	Game Engine Development	3(2,1)	CSC495

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## Tentative Study Plan for BS (CYS)

Below is a tentative eight semester study plan of course offerings. A campus may change the offerings depending upon their available resources.

	Semester – 1				
S#	Course Code	Course Title	Credit Hours	Pre-requisite(s)	
1	CSC101	Introduction to ICT	3(2, 1)		
2	HUM100	English Comprehension and Composition	3(3, 0)		
3	HUM110	Islamic Studies	3(3, 0)		
4	HUM111	Pakistan Studies	3(3, 0)		
5	MTH100	Mathematics I*	3(3, 0)		
6		University Electives 1/4			

		Semester – 2		
S#	Course Code	Course Title	Credit Hours	Pre-requisite(s)
1	CSC103	Programming Fundamentals	4(3, 1)	
2	HUM102	Report Writing Skills	3(3, 0)	HUM100
3	EEE241	Digital Logic Design	4(3, 1)	
4	CSC102	Discrete Structures	3(3, 0)	
5	MTH101	Calculus I*	3(3, 0)	
6	CSC291	Software Engineering Concepts	3(3, 0)	

	Semester – 3				
S#	Course Code	Course Title	Credit Hours	Pre-requisite(s)	
1	CSC241	Object Oriented Programming	4(3, 1)	CSC103	
2	HUM103	Communication Skills	3(3, 0)	HUM100	
3	MTH231	Linear Algebra	3(3, 0)		
4	MTH104	Calculus and Analytic Geometry	3(3, 0)		
5	CYC205	Introduction to Cyber Security	3(3, 0)		

	Semester – 4			
S#	Course Code	Course Title	Credit Hours	Pre-requisite(s)
1	CSC211	Data Structures and Algorithms	4(3, 1)	CSC103
2	CSC340	Computer Networks	4(3, 1)	
3	CSC325	Computer Organization and Assembly Language	4(3, 1)	
4	MTH242	Differential Equations	3(3, 0)	MTH104
5		University Electives 2/4		

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	Semester – 5				
S#	Course Code	Course Title	Credit Hours	Pre-requisite(s)	
1	CSC270	Database Systems	4(3, 1)	CSC211	
2	CSC323	Principles of Operating Systems	4(3, 1)	CSC211	
3	CYC410	Professional Practices for Cyber Security	3(3, 0)		
4	MTH262	Statistics and Probability Theory	3(3, 0)		
5	CYC303	Digital Forensics	3(2, 1)		
6		Cyber Security Elective Courses 1/4			

	Semester – 6			
S#	Course Code	Course Title	Credit Hours	Pre-requisite(s)
1	CSC462	Artificial Intelligence	4(3, 1)	CSC102
2	CSC301	Design and Analysis of Algorithms	3(3, 0)	CSC211
3	CSC334	Parallel and Distributed Computing	3(2, 1)	CSC323
4	CYC365	Network Security	3(2, 1)	CSC340
5	CYC307	Information Assurance	3(3, 0)	
6		Cyber Security Elective Courses 2/4		

	Semester – 7				
S#	Course Code	Course Title	Credit Hours	Pre-requisite(s)	
1	CSC432	Information Security	3(3, 0)		
2	CYC386	Secure Software Design and Development	3(2, 1)		
3	CYC498	Final Year Project-I	2(0, 2)	CSC291, HUM102	
4	CYC390	Vulnerability Assessment & Reverse Engineering	3(2, 1)		
5	101 - 58 - 11	Cyber Security Elective Courses 3/4			

		Semester – 8		
S#	Course Code	Course Title	Credit Hours	Pre-requisite(s)
1	CYC499	Final Year Project-II	4(0, 4)	CYC498
2		University Electives 3/4		
3		University Electives 4/4		
4		Cyber Security Elective Courses 4/4		

\* Non-Credit course. Students with Pre-Medical background must have to pass deficiency courses of Mathematics (MTH100 and MTH101) of 6 credit hours within one year.

### **General Education Courses**

Pre-Requisite: None

Course Code: CSC101 Course Title: Introduction to ICT Credit Hours: 3(2, 1)

### **Course Objectives:**

- To provide basic understanding of information and communication technologies (ICTs);
- To discuss the four main functions of computer hardware: input, processing, output, and storage;
- To describe major hardware components and processor architecture;
- To explain the communications and networking terminology further include Internet operations and its uses;
- To describe the major operating system functions and demonstrate usage of operating system services;
- To discuss fundamental concepts of programming using Python;
- To demonstrate basic coding, testing and debugging Python programs;
- To discuss databases and e-commerce concepts;

### **Course Contents:**

This course covers the basics of Information and Communications Technologies. Topics include: Overview of ICT; Computing Models; Computer Systems & Components; Number Systems & Computer Codes; System & Application Software; Introduction to Databases & Information Systems; Computer Networks & Internet; Security; Future trends in ICT; Problem Solving Concepts; Program Development Lifecycle; Introduction to Python;

- 1. Understanding Computers: Today and Tomorrow, Comprehensive, Deborah Morley, Charles S. Parker, Cengage Learning, 2017.
- 2. Python Basics: A Practical Introduction to Python 3, David Amos, Dan Bader, Joanna Jablonski, and Fletcher Heisler, Real Python, 2021
- 3. Foundations of Computer Science, Behrouz Forouzan, McGraw-Hill, 2017.
- 4. Starting Out with Python, Tony Gaddis, Addison-Wesley, 2016.
- 5. Problem Solving & Programming, Maureen Sprankle, Jim Hubbard, Prentice Hall, 2012.

**Course Title:** Professional Practices for Cyber Security **Credit Hours:** 3(3, 0)

### **Course Objectives:**

- To develop an understanding of the basic cultural, social, legal, and ethical issues inherent in the discipline of computing;
- To highlight the usage and significance of professional ethics;
- To discuss the intellectual property and privacy rights;
- To communicate and evaluate formal documents;
- To explain the consequences of computing on individuals, organizations, and society.

### **Course Contents:**

Confidentially; Ethical Standards related to Cyber Security; Legal, ethical and Professional issues in cyber/information security; Privacy and Intellectual Property laws for cyber security; Ethical frameworks for cyber security; Modern ethical challenges for Cyber Security; Cyber Security issues effecting industry; Sociological and Criminological Perspectives on Hacking, Cyber-Stalking, Cyber-Bullying, and Online Harassment, Perspectives on Internet Governance, Policing and Governing the Internet, Surveillance and Dataveillance, Cyberlaw, Cyber laws and Digital freedom.

- 1. Ethics in Information Technology, Reynolds, G., Cengage, 2019.
- 2. Ethical and Social Issues in Information Age, Kizza, J. M., Springer, 2016.
- 3. Hands-On Ethical Hacking and Network Defense, Michael T. Simpson, 2010.
- 4. Cybercrime: Law Enforcement, Security and Surveillance in the Information Age "Tom Douglas, Douglas Thomas, Brian Loader", 2013.
- 5. Investigating Cybercrime Sara L. Latta, Enslow Publishing, 2017.

### **Computing Core Courses**

**Course Code:** CSC211 **Course Title:** Discrete Structures **Credit Hours:** 3(3, 0)

### Pre-Requisite: None

### **Course Objectives:**

- To teach important discrete data structures such as sets, relations, functions, graph and trees;
- To introduce a formal system (propositional and predicate logic) on which mathematical reasoning is based;
- To thoroughly train in the construction and understanding of mathematical proofs;
- To exercise common mathematical arguments and proof strategies;
- To develop the ability to see a problem from a mathematical perspective.



### **Course Contents:**

This course introduces mathematical structures necessary for the development of program logic. It covers the following topics: Set Theory; Propositional & First Order Logic; Rules of Inference; Mathematical Proofs; Counting & Probability; Graphs & Tree Structures; and Discrete Probability.

- 1. Discrete Mathematics and Its Applications, Rosen, K. H., McGraw Hill, 2018.
- 2. Discrete Mathematics with Applications, Susanna S.E., Cengage Learning, 2019.
- 3. Discrete Mathematics, John, D., Pearson, 2017.

**Course Title:** Programming Fundamentals **Credit Hours:** 4(3, 1)

### **Course Objectives:**

- To introduce various programming language paradigms;
- To develop the skills to analyze, design, test and translate problems into computer programs;
- To present the fundamental programming concepts, including basic type system;
- To demonstrate basic coding, testing and debugging techniques;
- To provide an implementation of the concepts.

### **Course Contents:**

This course emphasis the basic concepts used in programming. The topics include: Computer Programming; Basic Syntax & Semantics of a Higher-Level Language; Conditional & Iterative Control Structures; Functions & Parameter Passing; Recursion; Arrays; String Processing; Exception Handling; Refactoring; Debugging; Modern Programming Environments; Testing Fundamentals; and File I/O

- 1. Java How to Program, Deitel, P. & Deitel, H., Prentice Hall, 2019.
- 2. Java: The Complete Reference, Herbert Schildt, Prentice Hall, 2018.
- Introduction to Java Programming and Data Structures, Comprehensive Version, Y.D.Liang, Pearson, 2017.
- 4. Java: Programming Basics for Absolute Beginners, Nathan Clark, CreateSpace Independent Publishing Platform, 2017.

**Course Title:** Object Oriented Programming **Credit Hours:** 4(3, 1)

### **Course Objectives:**

- To introduce the object-oriented programming paradigm;
- To teach in depth the philosophy of object-oriented design and concepts of encapsulation, abstraction, inheritance and polymorphism;
- To develop understanding of sub typing and generic types;
- To explain the usage of library components;
- To develop code that responds to exception conditions raised during execution;
- To develop understanding of event handlers for use in reactive systems, such as GUIs;
- To demonstrate implementation of the concepts.

### **Course Contents:**

This course emphasizes the concepts of object-oriented techniques used in developing computerbased system. The topics include: Overview of Object-Oriented Programming; Classes & its Concepts; Problem Solving in Object Oriented Paradigm; Inheritance; Polymorphism; Library Components; Object Oriented Concepts of File Handling; Swing Classes; Events & Event Handlers; and Canonical Uses.

- 1. Introduction to Java Programming and Data Structures, Comprehensive Version, Y. Liang, Y. Daniel Liang, Pearson, 2019.
- 2. Concise Guide to Object-Oriented Programming, Kingsley Sage, Springer, 2019.
- 3. Absolute Java, Savitch, W. & Mock, K., Pearson, 2016.

## Course Code: CSC270 Course Title: Database Systems Credit Hours: 4(3, 1)

### **Course Objectives:**

- To understand the fundamental concepts necessary for designing and implementing database systems and database applications;
- To introduce relational and NoSQL database concepts with emphasis on both theoretical and practical learning;
- To apply knowledge of the SQL language and implementing components of relational and NoSQL database systems (DBMS);
- To provide a practical exposure to database programming techniques;
- To create database instances in the cloud for both relational and NoSQL database systems such as MySQL, SQL Server, Amazon Redshift, Google BigQuery and MongoDB.

### **Course Contents:**

This course introduces the fundamental concepts of database systems. Topics include: Introduction to Databases & Information Systems; Evolution of Database Systems; Components; Architecture; Functions; Relational Model; Relational Algebra; Relational Calculus; Data Modeling; Relational Data Model; Relational Algebra & Calculus; Integrity Constraints; Conceptual Models; Entity-Relationship (E-R) Model; Enhanced E-R Model; Mapping Conceptual Schema to Relational Schema; Functional Dependency & Normalization; Structured Query Language (SQL); Views; Materialized Views; Non-Relational/No SQL Databases; MongoDB as NoSQL Database; Document Model; and Transaction Management.

- 1. Database systems: A Practical Approach to Design, Implementation, And Management, Thomas Connoll y, Carolyn Begg, Pearson, 2015.
- MongoDB: The Definitive Guide, Shannon Bradshaw, Eoin Brazil, Kristina Chodorow, O'Reilly Media, 2019.
- 3. Fundamentals of Database Systems, Elmasri, R, Navathe, Pearson, 2016.

## Course Code: CSC340 Course Title: Computer Networks Credit Hours: 4(3, 1)

### **Course Objectives:**

- To discuss the network components, services and technologies;
- To describe the layered architecture of network protocols (e.g. TCP/IP) and explains core functions of each layer including addressing, routing, internetworking, switching, multiplexing, error and flow control, medium access and coding, Wireless and mobile networks;
- To discuss threats to network security and design of secure networks;
- To develop an understanding with the implementation of fundamental concepts of networking.

### **Course Contents:**

This course introduces the concepts of computer networks along with communication standards and protocols. Topics include: Introduction; Physical Components; Internet Backbones; Layered Architecture; Application Layer Services & Protocols; Transport Layer Services; Transport Layer Protocols; Network Layer; The Internet Protocol; Routing Algorithms; Link Layer; Error Detection Techniques; MAC Protocols; Physical Layer; Transmission Impairment; Wireless & Mobile Networks; Cellular Networks; and Security in Computer Networks.

- 1. Computer Networking: A Top-Down Approach, James F. Kurose, Keith Ross Pearson, 2021.
- Data Communications and Networking with TCP/IP Protocol Suite, Behrouz A. Forouzan, McGraw-Hill, 2021

**Course Title:** Information Security **Credit Hours:** 3(3, 0)

### **Course Objectives:**

- To Provide familiarity with prevalent network and distributed system attacks, defenses against them, and forensics to investigate the aftermath;
- To develop an understanding of cryptography, how it has evolved, and some key encryption techniques used today;
- To develop an understanding of security policies (such as authentication, integrity and confidentiality), as well as protocols to implement such policies in the form of message exchanges.

### **Course Contents:**

This course introduces applications the concepts and of information security. Topics include: Information Security Overview; Threats & Attacks; Legal & Professional Issues; Security Analysis; Security Technology; Cryptography; Confidentiality; Planning; Risk Authentication Models; Operational Security; and Implementation & Maintenance.

- 1. Principles of Information Security, Michael E., Whitman & Mattord, H. J., Cengage Learning, 2017.
- 2. Security in Computing, Pfleeger, C.P., Pfleeger, S.L. & Margulies, J., Prentice Hall, 2015.
- 3. Introduction to Computer Security, Goodrich, M., & Tamassia, R., Pearson, 2021.

**Course Title:** Data Structures and Algorithms **Credit Hours:** 4(3, 1)

### **Course Objectives:**

- To discuss the issues of time complexity and examine various algorithms from this perspective;
- To introduce the concept and usage of data structures through abstract data structures, including linked lists, stacks, queues, priority queue, trees, and graphs;
- To implement above data structures and their applications;
- To develop an understanding of recursion as they apply to trees and graphs;
- To introduce the concept of memory management and garbage collection.

### **Course Contents:**

This course provides fundamental knowledge of data organization. The topics include: Overview of Data Structures; Static & Dynamic List; Stack; Queue; Tree & its Algorithms; Graph & its Algorithms; Sorting; Searching; Hashing; and Time Complexity of an Algorithm.

- 1. A Common-Sense Guide to Data Structures and Algorithms, Jay Wengrow, Pragmatic Bookshelf, 2020.
- 2. Data Structures and Algorithm Analysis in C++, Mark Allen Weiss, Addison-Wesley, 2014.

**Course Title:** Principles of Operating Systems **Credit Hours:** 4(3, 1)

### **Course Objectives:**

- To discuss the services provided by, and the design of an operating system;
- To explain the structure and organization of the file system and memory management;
- To discuss what a process is and how processes are synchronized and scheduled as well as how access to system resources is managed;
- To present the use of system calls for managing processes, memory and the file system;
- To explain the data structures and algorithms used to implement an OS;
- To explain security and protection issues in computer systems;
- To use C and UNIX commands to develop various system programs under Linux to make use of OS concepts related to process synchronization, shared memory, mailboxes, file systems, etc.

### **Course Contents:**

This course introduces the services and functions performed by operating system for smooth and accurate system operations. Topics include: Operating Systems Overview; Device Organization & System Operations; Operating Systems Principles; Process Management; Process Synchronization; Deadlocks; Multiprocessor Issues; Memory Management; Storage Management; and Security & Protection.

- 1. Operating System Concepts, Silberschatz & Galvin, Addison-Wesley, 2021.
- 2. Modern Operating Systems, Tanenbaum, A. S., Prentice Hall, 2014.
- 3. Operating Systems: Internals and Design Principles, Stallings, W., Pearson, 2017.

**Course Title:** Software Engineering Concepts **Credit Hours:** 3(3, 0)

### **Course Objectives:**

Course Code: CSC291

- To introduce the different software process models by illustrating its phases;
- To develop awareness of using different tools and environment supported in software engineering;
- To develop basic understanding of requirement engineering to gather requirements for developing a system;
- To create design of a system by understanding its core concepts;
- To construct the system by understanding different coding techniques;
- To introduce the concepts of verification and validation.

### **Course Contents:**

This course introduces the different software process models by illustrating its phases and principles of software engineering. Topics include Overview of Software Engineering; Software Process Models; Requirement Engineering Concepts; Software Design; Design Modeling; Software Quality Engineering; Software Project Management; Software Maintenance and Software Evolution.

- Software Engineering: A Practitioner's Approach, Roger S. Pressman & Bruce R. Maxim, McGraw-Hill, 2020.
- 2. Engineering Software Products: An Introduction to Modern Software Engineering, Ian Sommerville, Pearson Education Limited, 2021.
- 3. Software Engineering, Ian Sommerville, Pearson Education Limited, 2016.
- 4. Software Engineering with UML, Bhuyan Unhelkar, CRC Press, 2018.

**Course Code:** CYC498 **Course Title:** Final Year Project-I **Credit Hours:** 2(0, 2)

#### **Course Objectives:**

- To learn, how to design and model a project in cyber security;
- To employ the knowledge gained from courses throughout the program such as network security, secure software design and development, vulnerability assessment & reverse engineering to design project in domain of cyber security;
- To develop the project plan, software requirement specification document and software design document for data science projects;
- To enhance communication, presentation and writing skills.

#### **Course Contents:**

This course is designed as final year project, which requires students to demonstrate design of cyber security project and presentation skills at levels which are commensurate with professional practices. It is desirable that students apply their knowledge of cyber security throughout the courses such as introduction to cyber security, digital forensics, information assurance, network security, secure software design and development, vulnerability assessment & reverse engineering and artificial intelligence to a real-world data science problem from conception to completion. In this part of the project, students shall design a system in the area of cyber security including a proper project plan, software requirement specification document and software design document with some initial implementation.

### **Recommended Books:**

Books will be recommended by the faculty member supervising the capstone project

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**Course Code:** CYC499 **Course Title:** Final Year Project-II **Credit Hours:** 4(0, 4)

### **Course Objectives:**

- To implement the design produced in CYC498 along with testing and evaluation of a complex realworld project in the area of cyber security;
- To enhance presentation, communication and technical writing skills;
- To establish the ability to become an effective team player.

### **Course Contents:**

The final year project is a prominent element of the Cyber Security degree program and is central to the development of student professional competencies. This is the second part of a two-semester, final year project. Student teams employ the knowledge gained from courses throughout the program such as introduction to cyber security, digital forensics, information assurance, network security; secure software design and development, vulnerability assessment & reverse engineering to a real-world problem in domain of cyber security from conception to completion. In this part of the project, students implement the design they produced in CYC498, test their code, and evaluate their final product.

### **Recommended Books:**

Books will be recommended by the faculty member supervising the capstone project

### **Computer Science Core Courses**

**Course Codes:** CSC325 **Course Title:** Computer Organization & Assembly Language **Credit Hours:** 4(3, 1)

### **Course Objectives:**

- To explain the basic characteristics of a microprocessor and its applications;
- To present the basic architecture of the IA-32 processor;
- To provide a comprehensive understanding of 80X86 instruction set;
- To develop an understanding of the basic steps of assembling, linking and executing an assembly program;
- To solve a given problem by writing programs in assembly language.

### **Course Contents:**

This course covers the concepts of computer organization along with programming in Assembly language. Topics include: Preliminary Concepts of Computer Organization; Von Neumann Architecture; IA-32 Microprocessors Organization; Modes of the processors; Non-Von Neumann Architectures; Pipelined vs. Non-Pipelined Systems; Parallel Processing; CISC vs. RISC Processors; Instructions Set Design & Formats; Addressing Modes; Memory System Organization & Architecture; Utilization of Memory Systems in Programming; IO Fundamentals; Data Transfer methods; CPU Performance Calculation; and Assembly Language Programming.

### **Recommended Books:**

- 1. Assembly Language for x86 Processors, Irvine, K.R., Pearson, 2020.
- 2. Computer Organization and Architecture, William S., Pearson, 2019.
- 3. Essentials of Computer Organization and Architecture, Null L., Jones and Bartlett, 2019.

Pre-Requisite: EEE241

**Course Code:** CSC462 **Course Title:** Artificial Intelligence **Credit Hours:** 4(3, 1)

### **Course Objectives:**

- To describe the fundamentals of Artificial Intelligence;
- To implement an appropriate uninformed/informed search algorithm for a problem and characterize its time and space complexity;
- To translate natural language sentences (e.g. English) into logic statements;
- To convert logic statements into a clause form and apply resolution to a set of logic statements to answer a query;
- To explain the basic machine learning tasks and techniques.

### **Course Contents:**

This course gives a broad overview of the fundamental theories and techniques of Artificial Intelligence. Topics include: Overview of Artificial Intelligence; Agents & Environments; Problem-Solving; Adversarial Search; Constraint Satisfaction Problems; Knowledge Representation & Reasoning; Uncertainty; and Automated Planning.

- 1. Artificial Intelligence: A Modern Approach, Russell, S., and Norvig, P., Pearson, 2020.
- 2. Artificial Intelligence Basics: A Non-Technical Introduction, Taulli, T., Apress, 2019

**Course Title:** Design and Analysis of Algorithms **Credit Hours:** 3(3, 0)

### **Course Objectives:**

- To develop an ability to analyze the asymptotic performance of algorithms;
- To discuss rigorous correctness proofs for algorithms;
- To explain the major algorithms and data structures;
- To apply important algorithmic design paradigms and methods of analysis;
- To highlight the significance of NP complete problems.

### **Course Contents:**

This course is designed to provide knowledge of the principles and techniques used in the design and analysis of algorithms. Topics cover: Overview of Algorithm; Proving Correctness of Algorithms; Asymptotic Notations; Solving Recurrence Relations; Sorting & Order Statistics; Brute Force Algorithms & their Analysis; Divide and Conquer; Dynamic Programming; Greedy Algorithms; Graph; and Basic Computability.

- 1. Introduction to the Design and Analysis of Algorithms, Levitin, A., Pearson, 2017.
- Introduction to Algorithms, Cormen, T. H., Leiserson, C.E., Rivest, R.L. & Stein, C., MIT Press, 2019.



**Course Title:** Parallel and Distributed Computing **Credit Hours:** 3(2, 1)

#### **Course Objectives:**

- To explain the fundamental concepts of parallel and distributed computing along with its benefits and limitations;
- To provide an understanding of basic concepts of parallel and distributed systems paradigms: Grid Computing, Cloud Computing, cluster and Peer-to-Peer Computing;
- To develop an understanding of the application of parallel and distributed algorithms in problem solving;
- To provide hands-on experience of distributed and parallel programming paradigms using open MPI.

### **Course Contents:**

This course covers the basic concepts and applications of parallel & distributed computing. Topics include: Distributed Systems; Parallel Computing; Virtual Machines & Virtualization; Parallel Algorithms & Patterns; OpenMP; GPU Concepts & Architectures; and GPU Programming Model.

- 1. Parallel and High-Performance Computing, Robey, R., Zamora, Y., Manning, 2021.
- 2. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Hwang, K., Fox, C. G., Dongarra, J. J., Morgan Kaufmann, 2011.
- 3. Distributed Systems: Concepts and Design, Coulouris, G., Dollimore, J. & Kindberg, Addison-Wesley, Pearson, 2011.

### Cyber Security Core Courses

**Course Code:** CYC205 **Course Title:** Introduction to Cyber Security **Credit Hours:** 3(3, 0)

## **Course Objectives:**

- To provides students an introduction to common cyber security threats, vulnerabilities, and risks related to web applications, networks, software and mobile applications;
- To provides basic concepts and terminology used in the information and cyber security fields;
- To enable students to differentiate between the various forms of malware and how they affect computers and networks.

### **Course Contents:**

This course provides an overview of cyber security. Topics include: Introduction to Cyber Security; Network Security; Types of Network Attacks; Application Security; Mobile Security; Data Security; Infrastructure Security; Defense Against Cyber Attack; Management of Cyber Security; Cyber Investigators; Cyber Security & Industrial Control Systems; Legal Framework for Cyber Security; and Cyber Security & Automation.

### **Recommended Books:**

- 1. Introduction to Cyber Security: Guide to the World of Cyber Security, Shinde, A., Notion Press, 2021.
- 2. Cyber Security, Padallan, J. O., Packt, 2019.
- 3. Cyber security for Beginners, Meeuwisse, R., Cyber Simplicity Ltd, 2017.
- 4. cyber security Essentials, Brooks, C. J., Grow, C., Craig, P., Short, D., John Wiley & Sons, 2018.

Pre-Requisite: None

**Course Code:** CYC303 **Course Title:** Digital Forensics **Credit Hours:** 3(2, 1)

### **Course Objectives:**

- To describe the fundamentals and importance of digital forensics;
- To teach different techniques and procedures that enables them to perform a digital investigation;
- To conduct a digital investigation in an organized and systematic way;
- To apply open-source forensics tools to perform digital investigation.

### **Course Contents:**

This course provides an overview of digital forensics and its related issues. The topics include: Introduction to Digital Forensics; Digital Forensic Approaches; Forensic Lab Environment Preparation; Computer Forensics; Internet & E-Mail Examinations; Mobile Forensics; Cloud Computing & Digital Forensics; Law Enforcement Incident Response; Report Writing & Presentation; Social Media Forensics; Social Engineering Forensics; and Anti-Forensics.

- 1. Digital Forensics Explained, Greg Gogolin, CRC Press, 2021.
- 2. Digital Forensics, A. Flaglien, I. M. Sunde, A. Dilijonaite, J. Hamm, J. P. Sandvik, P.Bjelland, K. Franke, S. Axelsson, John Wiley & Sons, Ltd, 2017.
- 3. The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics, John Sammons, Syngress, 2014.
- 4. Hacking Exposed Computer Forensics Secrets & Solutions, A. Philipp, D. Cowen, C. Davis, McGraw-Hill Education, 2009.

## Course Code: CYC365 Course Title: Network Security Credit Hours: 3(2, 1)

### **Course Objectives:**

- To develop core competencies in the fields of Network security and offer the opportunity of learning the current network security landscape;
- To understanding current threats and vulnerabilities and examining ways of developing effective countermeasures;
- To provides a brief overview to network forensics for analyzing network traffic for the purposes of information gathering, legal evidence, or intrusion detection.

### **Course Contents:**

This course introduces the security issues faced by computer networks along with techniques to guardagainstthem.Topics include: Network Security Issues; OSISecurityArchitecture; Threats & Vulnerabilities; Cryptography; AccessControl; Transport-LayerSecurity; WirelessNetworkSecurity; EmailSecurity; IPDetection; Firewalls; and Security Management.

- 1. Network Security Essentials: Applications and Standards, William Stallings, Pearson, 2016.
- 2. Network Security, Firewalls, and VPNS, by J. Michael Stewart, Denise Kinsey, Jones & Bartlett Learning, 2020.
- 3. Principles of Computer Security: CompTIA Security+ and Beyond by Wm.A. Conklin et al., McGraw Hill, 2018.

## Course Title: Secure Software Design and Development

Credit Hours: 3(2, 1)

### **Course Objectives:**

- To develop core competencies in the fields of Secure Software Concepts, Secure Software Requirements, Secure Software Design, Secure Software Implementation/Coding, and Secure Software Testing;
- To describe the software security activities that needs to be incorporated throughout the software development lifecycle;
- To provides comprehensive coverage that includes the people, processes, and technology components of software, networks, and host defenses.

### **Course Contents:**

This course introduces the development methodologies for developing secure software. Topics include: Secure Software Concepts; Secure Software Development Methodologies; Secure SDLC; Secure Software Requirements; Secure Software Design; Architecture; Risk Management; Secure Software Implementation; Defensive Programming; Secure Software Testing; Securing DevOps; AppSec Process; and Applications.

- Secure, Resilient, and Agile Software Development, Mark S. Merkow, CISSP, CISM, CSSLP, CRC Press, 2019.
- 2. Secure Software Design, Theodor Richardson, Charles N Thies, Packt, 2012.
- Software Security Engineering: A Guide for Project Managers, Julia H. Allen, Sean J. BarnumRobert J. Ellison, Gary McGraw, Nancy R. Mead, Pearson Education, 2008.

## **Course Code:** CYC307 **Course Title:** Information Assurance **Credit Hours:** 3(3, 0)

### **Course Objective:**

• To understand the role and interaction of policies, laws, procedures, management issues, and technical issues in protecting information resources.

### **Course Contents:**

The purpose of this course is to provide the concepts and techniques for information assurance in an organization. The topics include: Information Assurance Basics; Information Assurance Planning Process; Risk Mitigation Process; Information Assurance Detection and Recovery Process; and Application of Information Assurance.



- 1. Information Assurance Handbook: Effective Computer Security and Risk Management Strategies, Corey Schou, Steven Hernandez, McGraw-Hill Education, 2014.
- 2. Information Assurance: Surviving in the Information Environment, Andrew Blyth, Gerald L. Kovacich, Springer, 2014.



## Course Code: CYC390 Course Title: Vulnerability Assessment & Reverse Engineering Credit Hours: 3(2, 1)

### **Course Objectives:**

- To develop core competencies in the field of vulnerability assessment covering software, networks and Web applications;
- To covers reverse engineering techniques to analyze software, exploit targets, and defend against security threats like malware and viruses.

### **Course Contents:**

The objective of this course is to introduce the concepts of Vulnerability Assessment & Reverse Engineering. Topics include: Vulnerability Management Governance; Significance of Security Assessments; Enumeration & Vulnerability Assessment; Network Access; Privilege Escalation; Vulnerability Scoring & Threat Modeling; Steps in Reverse Engineering; Reverse Engineering Tools; Binary Obfuscation Techniques; Assembly Logic Structures with a Disassembler; Malware Analysis; and Sandboxing & Virtualization.

### **Recommended Books:**

- 1. Network Vulnerability Assessment, Sagar Rahalkar, Packt, 2018.
- Practical Reverse Engineering: x86, x64, ARM, Windows Kernel, Reversing Tools, and Obfuscation, Bruce Dang, Alexandre Gazet, Wiley, 2014.

Pre-Requisite: None