Curriculum, Course Syllabi, and Model Study Plan

For Program

BS Cyber Security

To Be Offered at University of the Punjab, Lahore & Sub-Campuses

Department of Data Science

BoS Meeting: 23.5.2025

Faculty of Computing & Information Technology (FCIT)

BoF Meeting: 26.5.2025

Version: 1.0.2

University of the Punjab, Lahore.

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Admission Eligibility Criteria

Years of Study completed:	12
Study Program/Subject:	Minimum 50% marks in Intermediate/12 years schooling/A- Level (HSSC) or Equivalent with Mathematics are required for admission in BS Cyber Security. (Equivalency certificate by IBCC will be required in case of education from some other country or system.) **or** • F.Sc. Pre-medical or equivalent in a relevant discipline[1].
Percentage/CGPA	50% marks required with the exception of DAE where 60% marks are required for admission.
Entry Test (if applicable) with minimum requirement:	Typically, the Department of Data Science will conduct an entry test to select students as per number of available seats.

1. Students with pre-medical are also eligible. However, they must have to pass deficiency courses of Mathematics of 6 credit hours in first two semesters.

   Deficiency:

   "Students with pre-medical, must have to pass deficiency courses of Mathematics of 6 credit hours in first two semesters."

CURRICULUM

OF

UNDERGRADUATE DEGREE PROGRAMS

COMPUTING DISCIPLINES

(Revised 2023)

HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

3.1 Essential Requirements for the Computing Degree:

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

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

- Minimum 50% marks in Intermediate/12 years schooling/A- Level (HSSC) or Equivalent with Mathematics are required for admission in all BS Computing Programs other than BS Computing Engineering.
  **Equivalency certificate by IBCC will be required in case of education from some other country or system.*
- Minimum 60% marks in Intermediate/12 years schooling/A- Level (HSSC) or Equivalent with Mathematics are required for admission in BS Computer Engineering Program.
- The students who have not studied Mathematics at intermediate level have to pass deficiency courses of Mathematics (06 credits) in first two semesters.
- At minimum 130 credit hours are required for award of BS degrees in any computing discipline mentioned in this document.
- The minimum duration for completion of BS Computing degrees is four years. The HEC allows maximum period of seven years to complete BS degree requirements.
- A minimum 2.0 CGPA (Cumulative Grade Point Average) on a scale of 4.0 is required for award of BS Computing Degree.
- The students after successful completion of 04 semesters in BS Computing Programs may exit with Associate Degree in Computing subject to completion of all requirements for the award of associate degree, i.e., Credit Hours, CGPA, and compulsory courses.

1 BS Cyber Security

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

1.1 Program Objectives

Program Educational Objectives (POs) for Bachelor of Studies in Cyber Security (BS CySec): **PO(1):** Graduates will demonstrate advanced expertise in Cyber Security, possessing in- depth knowledge of cybersecurity principles, technologies, and best practices.
PO(2): Graduates will exhibit proficiency in practical skills related to threat detection, incident response, and secure systems development.
PO(3): Graduates will embody ethical principles and values essential for responsible cybersecurity practice and global cybersecurity initiatives.

1.2 Graduate Attributes

1	Academic Education	Completion of an accredited program (BS CySec) of study designed to prepare graduates as computing professionals
2	Knowledge for Solving Computing Problems	Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements
3	Problem Analysis	Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines

4	Design/ Development of Solutions	Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations
5	Modern Tool Usage	Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations
6	Individual and Team Work	Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings
7	Communication	Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions
8	Computing Professionalism and Society	Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice
9	Ethics	Understand and commit to professional ethics, responsibilities, and norms of professional computing practice
10	Life-long Learning	Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional

Mapping BS-Cyber Security POs to GA's

BS Cyber Security			
Graduate Attributes (GA's)	**PO (1)**	**PO (2)**	**PO (3)**
GA-1 Academic Education	✓		
GA-2 Knowledge for Solving Computing Problems	✓		
GA-3 Problem Analysis	✓		
GA-4 Design/Development of Solutions	✓	✓	
GA-5 Modern Tool Usage	✓	✓	
GA-6 Individual and Teamwork		✓	
GA-7 Communication		✓	✓
GA-8 Computing Professionalism and Society			✓
GA-9 Ethics			✓
GA-10 Life-long Learning			✓

Areas Covered in the BS Cyber Security

Group Code	Couse Group	HEC	PU
CC	Computing Core	46 (14)	46 (14)
DC	Domain Core	18 (6)	18 (6)
DE	Domain Elective	21 (7)	21 (7)
MS	Mathematics & Supporting Courses	12 (4)	12 (4)
ES	Elective Supporting Courses	3 (1)	3 (1)
GE	General Education Requirement	30 (12)	32 (13)
--	Quran Translation	0	4(8)
	Total	**130 (44)**	**136 (53)**

Computing Core (CC) Courses

Total Credit hours: 46 (14)

Course Title	Cr Hrs	Lab
Programming Fundamentals	3	1
Object Oriented Programming	3	1
Database Systems	3	1
Digital Logic Design	2	1
Data Structures	3	1
Information Security	2	1
Artificial Intelligence	2	1
Computer Networks	2	1
Software Engineering	3	0
Computer Organization and Assembly Language	2	1
Operating Systems	2	1
Analysis of Algorithms	3	0
Final Year Project-1	0	2
Final Year Project-2	0	4
Total	**30**	**16**

Domain Core (DC) Courses

Total Credit hours: 18 (6)

Course Title	Cr Hrs	Lab
Cyber Security	2	1
Information Assurance	2	1
Network Security	2	1

Secure Software Design and Development	2	1
Digital Forensics	2	1
Parallel & Distributed Computing	2	1
Total	**12**	6

Mathematics and Supporting (MS) Courses

Total Credit hours: 12 (4)

Course Title	**Cr Hrs**	**Lab**
Multivariable Calculus	3	0
Linear Algebra	3	0
Probability and Statistics	3	0
Technical and Business Writing	3	0
Total	**12**	**0**

General Education Requirement (GE) Courses

Total Credit hours: 30 (12)

Course Title	**Cr Hrs**	**Lab**
Applications of Information and Communication Technologies	2	1
Functional English	3	0
Expository Writing	3	0
Discrete Structures	3	0
Calculus and Analytic Geometry	3	0
Islamic Studies/University Equivalent	2	0
Pakistan Studies	2	0
Ideology and Constitution of Pakistan	2	0
Social Science Elective	2	0

Applied Physics	2	1
Professional Practices	2	0
Civic and Community Engagement	2	0
Entrepreneurship	2	0
Total	**30**	**2**

Elective Supporting (ES) Courses

Total Credit hours: 3 (1)

Course Title	**Cr Hrs**	**Lab**
Introduction to Marketing	3	0
Financial Accounting	3	0
Total	**3**	**0**

Quran Translation (QT) Courses

Total Credit hours: 4(8)

Course Title	**Cr Hrs**	**Lab**
Quran Translation 1	0.5	
Quran Translation 2	0.5	
Quran Translation 3	0.5	
Quran Translation 4	0.5	
Quran Translation 5	0.5	

Quran Translation 6	0.5	
Quran Translation 7	0.5	
Quran Translation 8	0.5	
Total	**4**	

Domain Elective (DE) Courses

Total Credit hours: 21 (7)

Course Title	Cr Hrs	Lab
Cyber Security Elective I	2	1
Cyber Security Elective II	2	1
Cyber Security Elective III	2	1
Cyber Security Elective IV	2	1
Cyber Security Elective V	2	1
Cyber Security Elective VI	2	1
Cyber Security Elective VII	2	1
Total	**14**	**7**

List of Cyber Security Elective Courses

Sr #	Course Title	CrHrs	Lab
1	Vulnerability Assessment & Reverse Engineering	3	
2	Basic Electronics	3	
3	Hardware Security	3	
4	Malware Analysis	3	
5	Wireless and Mobile Security	3	
6	Theory of Automata	3	
7	HCI & Computer Graphics	3	
8	Penetration Testing	3	
9	Computer Architecture	3	
10	Advanced Digital Logic Design	3	
11	Embedded Systems	3	
12	Cyber Law & Cyber Crime (Cyber Warfare)	3	
13	Control System Security	3	
14	Web Engineering	3	
15	Software Construction and Development	3	
16	Natural Language Processing	3	
17	Machine Learning	3	
18	Computer Vision	3	
19	Deep Learning	3	
20	Open-Source Intelligence	3	
21	System Programing	3	
22	DevSecOps	3	
23	Software Security Compliance	3	
24	Cybersecurity Compliance Frameworks	3	
25	Software Security Audit	3	
26	Generative /Agentic AI	3	

Note: New courses may be added to the list with the approval of the Chairman Department of Data Science, University of the Punjab, Lahore.

Scheme of Study for BS Cyber Security

Semester I					
Sr #	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-001	Quran Translation I	--		0.5
2	MD-001	Math Deficiency I	--		0
3	GE-190	Functional English	GE		3 (3-0)
4	GE-168	Ideology and Constitution of Pakistan	GE		2 (2-0)
5	GE-160	Applications of Information and Communication Technologies	GE		3 (2-1)
6	GE-163	Islamic Studies	GE		2 (2-0)
7	CC-112	Programming Fundamentals	CC		3 (3-0)
8	CC-112-L	Programming Fundamentals Lab	CC		1 (0-1)
		Total Semester Load			**16.5 (14.5-2)**
Semester II					
Sr #	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-002	Quran Translation II	--		0.5
2	MD-002	Math Deficiency II	--		0
3	GE-169	Applied Physics	GE		3 (2-1)
4	MS-251	Probability and Statistics	MS		3 (3-0)
5	GE-199	Expository Writing	GE		3 (3-0)
6	CC-110	Digital Logic Design	CC		2 (2-0)
7	CC-110-L	Digital Logic Design Lab	CC		1 (0-1)
8	CC-211	Object Oriented Programming	CC	Programming Fundamentals	3 (3-0)
9	CC-211-L	Object Oriented Programming Lab	CC	Programming Fundamentals	1 (0-1)
		Total Semester Load			**16.5 (13.5-3)**
Semester III					
Sr #	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-003	Quran Translation III	HQ		0.5
2	GE-162	Calculus and Analytic Geometry	GE		3 (3-0)
3	CC-210	Computer Organization and Assembly Language	CC	Digital Logic Design	3 (2-1)
4	GE-167	Discrete Structures	GE		3 (3-0)
5	CC-213	Data Structures	CC	Object-Oriented Programming	3 (3-0)
6	CC-213-L	Data Structures Lab	CC	Object-Oriented Programming	1 (0-1)

7	DC-221	Introduction to Cyber Security	DC		3 (2-1)
8	MS-252	Linear Algebra	MS		3 (3-0)
			Total Semester Load		**19.5 (16.5-3)**
Semester IV					
Sr #	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-004	Quran Translation IV	HQ		0.5
2	MS-253	Multivariable Calculus	MS	Calculus and Analytical Geometry	3 (3-0)
3	DC-222	Information Assurance	DC	-	3 (2-1)
4	CC-215	Database Systems	CC		3 (3-0)
5	CC-215-L	Database Systems Lab	CC		1 (0-1)
6	CC-310	Artificial Intelligence	CC	Object Oriented Programming	3 (2-1)
7	CC-214	Computer Networks	CC		3 (2-1)
8	CC-308	Information Security	CC		3 (2-1)
			Total Semester Load		**19.5 (14.5-5)**
Semester V					
Sr #	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-005	Quran Translation V	HQ		0.5
2	CC-311	Operating Systems	CC	Data Structures	3 (2-1)
3	GE-363	Civics and Community Engagement	GE		2 (2-0)
4	CC-313	Analysis of Algorithms	CC	Data Structures	3 (3-0)
5	DC-321	Secure Software Design and Development	DC	Cyber Security	3 (2-1)
6	DE-323	Web Technologies	DE	Object Oriented Programming	3 (2-1)
7	DC-322	Digital Forensics	DC	Cyber Security	3 (2-1)
			Total Semester Load		**17.5 (13.5-4)**
Semester VI					
Sr #	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-006	Quran Translation VI	HQ		0.5
2	ES-392	Introduction to Marketing	UE		3 (3-0)
3	DC-223	Network Security	DC	Cyber Security	3 (2-1)
4	CC-303	Software Engineering	CC		3 (3-0)
5	DE-321	Penetration Testing	DE		3 (2-1)
6	DE-322	Vulnerability Assessment & Reverse Engineering	DE		3 (2-1)
7	DE-335	Computer Architecture	DE		3 (2-1)
			Total Semester Load		**18.5 (14.5-4)**

Semester VII					
Sr #	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-007	Quran Translation VII	HQ		0.5
2	MS-254	Technical and Business Writing	MS		3 (3-0)
3	GE-362	Entrepreneurship	GE		2 (2-0)
4	DE-333	Theory of Automata and Formal Languages	DE		3 (2-1)
5	DE-421	Cyber Law & Cyber Crime (Cyber Warfare)	DE		3 (2-1)
6	DE-324	Software Construction and Development	DE	Object Oriented Programming	3 (2-1)
7	CC-401	Final Year Project-1	CC		2 (0-2)
		Total Semester Load			**16.5 (11.5-5)**
Semester VIII					
Sr #	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-008	Quran Translation VIII	HQ		0.5
2	GE-161	Pakistan Studies	GE		2 (2-0)
3	ES-492	Introduction to Management	GE		2 (2-0)
4	DC-409	Parallel and Distributed Computing	DC	Operating Systems	3 (2-1)
5	GE-402	Professional Practices	GE		2 (2-0)
6	CC-402	Final Year Project-2	CC	FYP-1	4 (0-4)
		Total Semester Load			**13.5 (8.5–5)**

Course Outlines

Course outlines are attached in Annex A

ITEM No. 2

Current work (if any).

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The cases related to the current work is placed before the Board of Studies of Data Science for consideration and approval.

1. **To recommend the syllabi for Deficiency Courses of Mathematics of Six (06) credit hours, for students of Intermediate (Pre-Medical) for Cyber Security at PU Department of Data Science, PU Gujranwala Campus, PU Jhelum Campus and Affiliated Colleges.**

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The case is placed before the Board of Studies of Data Science for consideration and approval.

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Program	BS Cyber Security
Course Code	MS-001
Course Title	Math Deficiency - I
Credit Hours	3
Course Category	Mathematics and Science Foundation
Pre-requisites	**Courses**
Syllabus	Defining Set, various types of set representation and operations, Relation and function, Graphical transformation of one and two dimensional functions, Properties of functions, composition and inverses of functions, domain and range of the functions, Maximum and minimum values of functions, increasing and decreasing functions, zeros and intercept of functions, piecewise functions, continuity and Discontinuity of functions, Polynomials and rational functions, Polynomial long division and Synthetic division, Solution of rational functions, Absolute valued function, properties of absolute valued functions, Asymptotes (Horizontal, vertical and oblique), Exponential functions and their properties, Logs functions and their properties, Systems of Two Equations and Two Unknowns, Systems of Three Equations and Three Unknowns, Matrix Algebra (Add, subtract and multiply matrices), Row Operations and Row Echelon Forms, Augmented Matrices, Determinant of Matrices (2 x 2 and higher order matrices), Cramer's Rule, Inverse Matrices, Series and Sequences, Trigonometry, Angles in Radians and Degrees, Right Triangle Trigonometry, Law of Cosines & Sines, Area of Triangle, Graphs of Other Trigonometric Functions , Graphs of Inverse Trigonometric Functions, Basic Trigonometric Identities (Pythagorean, Sum and Difference, Double, Half, and Power Reducing), Trigonometric Equations, General Form of a Conic, Parabolas, Circles, Ellipses, Hyperbolas, Degenerate Conics, Polar and Parametric Equations, Polar and Rectangular Coordinates.
Books	• Textbook of Algebra and Trigonometry Class XI is published by Punjab Textbook Board (PTB) Lahore, Pakistan. • Calculus and Analytic Geometry, MATHEMATICS 12 (Mathematics FSc Part 2 or HSSC-II), Punjab Text Book Board Lahore, Pakistan
Recommended	• Gilbert, S. S., B. C. Andy and B. Andrew, B. 2005. Linear Algebra and Its Applications. 4th Ed. Thomson Brooks/Cole, Belmont, CA, USA. • Chung, S. K. 2014. Understanding basic calculus. Create Space Independent Publishing Platform, 173-175. • Howard, Anton, Irl Bivens, Stephen Davis, Calculus, 10th Ed,2011, John Wiley & Sons, Inc. (1318 Pages)

Assessment		**Sessional**	**Mid-Term**	**Final Term**	**Total**
Criteria	**% Marks**	25	35	40	100

Program	BS Cyber Security
Course Code	MS-002
Course Title	Math Deficiency - II
Credit Hours	3
Course Category	Mathematics and Science Foundation
Pre-requisites	**Courses**
Syllabus	Complex Numbers, Arithmetic with Complex Numbers (Add, subtract, multiply and divide complex numbers), Trigonometric Polar Form of Complex Numbers, De Moivre's Theorem and nth Roots, Recursion, Arithmetic and Geometric Sequences, Sigma Notation, Arithmetic Series, Geometric Series (Sum infinite and finite geometric series and categorize geometric series), Counting with Permutations and Combinations, Basic Probability, Binomial Theorem, Limit Notation, Graphs to Find Limits, Tables to Find Limits, Substitution to Find Limits, Rationalization to Find Limits, One Sided Limits and Continuity, Instantaneous Rate of Change, Tangent Lines and Rates of Change, The Derivative Function, Introduction to Techniques of Differentiation, The Product and Quotient Rules, Derivatives of Trigonometric Functions, The Chain Rule, Derivatives of Logarithmic Functions, Derivatives of Exponential and Inverse Trigonometric Functions, Increase, Decrease, and Concavity, Relative Extrema, Absolute Maxima and Minima, An Overview of the Area Problem, Area Under a Curve, The Indefinite Integral, Integration by Substitution, The Definition of Area as a Limit; Sigma Notation, The Definite Integral.
Books	• Textbook of Algebra and Trigonometry Class XI is published by Punjab Textbook Board (PTB) Lahore, Pakistan. • Calculus and Analytic Geometry, MATHEMATICS 12 (Mathematics FSc Part 2 or HSSC-II), Punjab Text Book Board Lahore
Recommended	• Mark J. Christensen, Computing for Calculus, 1st Edition, Academic Press, (1st January 1981), 240pages, ISBN: 9781483271088. • Lay, L. D. 2015. Probability and Statistics for Engineering and the Sciences, 9th Ed. Cengage Learning, Boston, MA, USA. • Howard, Anton, Irl Bivens, Stephen Davis, Calculus, 10th Ed, 2011, John Wiley & Sons, Inc. (1318 Pages) • Online Material: www.mathworld.com

Assessment		**Sessional**	**Mid-Term**	**Final Term**	**Total**
Criteria	**% Marks**	25	35	40	100

2. To recommend the syllabi for mandatory Quran translation course for BS Cyber Security at PU Department of Data Science, PU Gujranwala Campus, PU Jhelum Campus and Affiliated Colleges. ……

The case is placed before the Board of Studies of Data Science for consideration and approval.

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CENTRE FOR QUR'ĀN AND SUNNAH
University of the Punjab, Quaid-e-Azam Campus, Lahore
director.cqs@pu.edu.pk

Ref. No. 012 /CQS Date: 23-11-2020

بسم اللہ الرحمٰن الرحیم

محترم رجسٹرار
پنجاب یونیورسٹی لاہور

عنوان: **رپورٹ برائے تدریس ترجمہ قرآن**

السلام علیکم ورحمۃ اللہ وبرکاتہٗ!

دفتر رجسٹرار کی جانب سے طلب کی گئی معلومات برائے تدریس ترجمہ قرآن (بی ایس آنرز سمسٹر اول، تعلیمی سال خزاں ۲۰۲۰) ارسال خدمت ہیں۔ جن کی تفصیل درج ذیل ہے۔۔

ا۔ Centre For Quran and Sunnah (مرکز القرآن والسنۃ) کی ویب سائٹ تخلیقی مراحل میں ہے۔ جسے cqs.edu.pk پر ملاحظہ کیا جاسکتا ہے۔ ویب سائٹ کی تکمیل کے بعد اسے پنجاب یونیورسٹی کی ویب سائٹ کے ساتھ لنک کر دیا جائے گا۔

۲۔ تدریس ترجمہ قرآن کمیٹی کے مختلف اجلاس ہوئے جن کی سربراہی محترم پرووائس چانسلر نے فرمائی اور درج ذیل فیصلے کیے گئے۔

کریڈٹ آورز (Credit Hours) کی تقسیم:

یونیورسٹی نوٹیفیکیشن کی روشنی میں بی ایس (آنرز) کے لیے سالانہ ایک کریڈٹ آور (Credit Hour) کو لیب ورک کریڈٹ آور کے مساوی قرار دیا گیا ہے۔ اور اس طرح **ہر سمسٹر میں ہفتہ وار تین کلاسیں پڑھائی جائیں گی۔**

پہلا، تیسرا، پانچواں اور ساتواں سمسٹر نان کریڈٹ آور (Non Credit Hour) تصور کیا جائے گا۔ جبکہ دوسرا، چوتھا، چھٹا اور آٹھواں سمسٹر (ہر سمسٹر) ایک کریڈٹ آور کے مساوی ہوگا۔

ان سمسٹرز میں نمبروں کی تقسیم درج ذیل ہے:

مڈ ٹرم: 35 نمبر فائنل ٹرم: 40 نمبر

زبانی امتحان (Viva): 20 نمبر Viva کے لیے تین ممتحنین مقرر کیے جائیں گے۔

حاضری (Attendance): 5 نمبر

اساتذہ کا انتخاب:

i. پنجاب یونیورسٹی کے جملہ تدریسی شعبہ جات میں پہلے سے اسلامیات لازمی اور عربی کا کورس پڑھانے والے اساتذہ جو ایم فل اسلامیات/ایم فل عربی ہیں سے استفادہ کیا جائے گا اور انہیں ترجمہ پڑھانے والے اساتذہ کی فہرست میں شامل کیا جائے گا۔

ii. تعلیمی سال کے آغاز سے قبل اساتذہ کا "مرکز القرآن والسنۃ" کے زیر اہتمام ورکشاپ/تربیتی کورس کرایا جائے گا۔

CENTRE FOR QUR'ĀN AND SUNNAH
University of the Punjab, Quaid-e-Azam Campus, Lahore
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Ref. No. _____/CQS Date: _____

نصاب:

الف-بی ایس آنرز:

سال اول: سمسٹر-I سورۃ الفاتحۃ تا سورۃ آل عمران۔

سمسٹر-II سورۃ النساء تا سورۃ الأنعام۔

سال دوم: سمسٹر-III سورۃ الأعراف تا سورۃ یونس۔

سمسٹر-IV سورۃ ھود تا سورۃ الکھف۔

سال سوم: سمسٹر-V سورۃ مریم تا سورۃ الفرقان

سمسٹر-VI سورۃ الشعراء تا سورۃ ص

سال چہارم: سمسٹر-VII سورۃ الزمر تا سورۃ ق

سمسٹر-VIII سورۃ الذاریات تا سورۃ الناس۔

ب-ایم اے/ایم ایس سی: بی ایس آنرز کے سال سوم اور چہارم کا نصاب

ج-ایم فل: سورۃ المؤمنون، سورۃ الأحزاب اور سورۃ الحشر کا ترجمہ

د-پی ایچ ڈی: سورۃ النور، سورۃ الفرقان اور سورۃ الحجرات

نوٹ: i. ایم اے، ایم فل اور پی ایچ ڈی کا کورس ایک کریڈٹ آور (Credit Hour) پر مشتمل ہوگا۔

ii. بی ایس آنرز کے پہلے دو سال کا نصاب ADP میں پڑھایا جائے گا۔

پہلے اور دوسرے سمسٹر کے لیے اسباق کی منصوبہ بندی (Lesson Plan) ترتیب دیا جس کی کاپی لف ہے۔

مڈٹرم امتحان اور فائنل ٹرم امتحان کے لیے نمونے کا پرچہ (Sample Assessment Paper) ترتیب دیا، کاپی لف ہے۔

تدریسِ ترجمۂ قرآن کورس، بی ایس آنرز کے پہلے سمسٹر سے آٹھویں سمسٹر کے لیے مندرجہ ذیل کورس کوڈز ترتیب دیے ہیں۔

سال اول: سمسٹر-I	تدریسِ ترجمۂ قرآن	HQ-001
سمسٹر-II	تدریسِ ترجمۂ قرآن	HQ-002
سال دوم: سمسٹر-III	تدریسِ ترجمۂ قرآن	HQ-003
سمسٹر-IV	تدریسِ ترجمۂ قرآن	HQ-004
سال سوم: سمسٹر-V	تدریسِ ترجمۂ قرآن	HQ-005
سمسٹر-VI	تدریسِ ترجمۂ قرآن	HQ-006
سال چہارم: سمسٹر-VII	تدریسِ ترجمۂ قرآن	HQ-007
سمسٹر-VIII	تدریسِ ترجمۂ قرآن	HQ-008

CENTRE FOR QUR'ĀN AND SUNNAH
University of the Punjab, Quaid-e-Azam Campus, Lahore
director.cqs@pu.edu.pk

Ref. No. _____/CQS Date: _____

شارٹ کورس برائے اساتذہ وملازمین :

پنجاب یونیورسٹی اساتذہ اور ملازمین کے لیے "سینٹر فار قرآن اینڈ سنہ "کے زیر اہتمام ترجمۂ قرآن کا شارٹ کورس (Short Course) کرایا جائے گا۔

۳۔ پہلے اور دوسرے سمسٹر کے لیے ورک بک ترتیب دی گئی ہے جو طلبا کو مہیا کی جائے گی۔

۴۔ تدریس ترجمہ قرآن کے لیے حاضری رجسٹر/ڈیلی پراگریس رپورٹ بھی ترتیب دی جارہی ہے جس میں حاضری کے ساتھ ساتھ طالبعلم کا مڈٹرم امتحان، فائنل ٹرم امتحان اور زبانی امتحان کا ریکارڈ بھی محفوظ کیا جائے گا۔

۵۔ مرکز القرآن والسنۃ کے زیر اہتمام سال بھر میں انعقاد پذیر ہونے والے پروگراموں کا کیلنڈر ترتیب دیا گیا ہے۔

۲۳نومبر ۲۰۲۰

اللہ ہمارا حامی و ناصر ہو

والسلام

پروفیسر ڈاکٹر حارث مبین
ڈائریکٹر
مرکز القرآن والسنۃ
0301-7913405
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3. Pakistan Studies course to be included in the F23 and onward in the already approved curriculum as approved by HEC.

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The case is placed before the Board of Studies of Data Science for consideration and approval.

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Annex A

BS in Cyber Security

Department of Data Science

Faculty of Computing and Information Technology
University of the Punjab, Lahore

BS in Cyber Security

Program Title: BS Cyber Security

Department: Department of Data Science (DDS)

Faculty: Faculty of Computing and Information Technology

1. Department Mission:

The mission of the Department for BS Cyber Security is to equip students with comprehensive knowledge, practical skills, and ethical grounding in the field of Cyber Security. We aim to develop professionals capable of safeguarding digital assets, securing critical infrastructures, and responding to emerging cyber threats. Our graduates will serve the community and the nation with integrity, responsibility, and innovation, becoming a source of pride for the Institute and for Pakistan.

2. Introduction:

Cyber Security is the study of principles, technologies, and practices designed to protect systems, networks, and data from cyber threats. It is a scientific and practical discipline focused on the identification, prevention, detection, and response to cyber-attacks. Cyber Security encompasses the systematic study of the confidentiality, integrity, and availability of information, as well as the mechanisms that support secure communication, data protection, digital forensics, and risk management in both public and private sectors

3. Program Introduction:

The Cyber Security program in the Department of Data Science has been designed to prepare students in all aspects of securing digital systems, networks, and data—from threat modeling and risk assessment to implementing defense mechanisms, conducting penetration testing, and responding to cyber incidents. The curriculum integrates the Engineering, Technological, and Scientific foundations of information security with practical skills in cyber defense, cryptography, secure software development, and digital forensics. Graduating students are equipped with the expertise and ethical mindset required to meet the growing demands of both local and international job markets in the ever-evolving field of Cyber Security.

4. Program Objectives

The BS Cyber Security program at the Department of Cyber Security, University of the Punjab, Lahore, aims to train students in modern cyber security practices that not only prepare them for advanced studies but also enable them to become vital assets in industries where digital protection and secure computing are critical.

By the time of graduation, the students develop an ability to:

- Identify, analyze, and mitigate cyber threats using contemporary tools, techniques, and methodologies.
- Design, implement, and manage secure computing environments, networks, and systems that meet organizational and user requirements.
- Investigate and respond to security breaches through skills in ethical hacking, digital forensics, and incident handling.
- Understand legal, ethical, and professional responsibilities in the domain of cyber security, including data privacy and compliance.
- Collaborate effectively in multidisciplinary teams, manage cyber security projects, and adapt to emerging technologies and threats through continuous learning.
- Apply entrepreneurial thinking and innovative problem-solving to address national and global cyber security challenges and contribute as future leaders in the field.

5. Market Need / Rationale of the Program

In today's digitally interconnected world, the proliferation of technologies such as 5G, the Internet of Things (IoT), and cloud computing has exponentially increased the surface area vulnerable to cyber threats. As organizations and individuals become more reliant on digital platforms, the imperative to safeguard data, infrastructure, and privacy has never been more critical.

Global Trends Highlighting the Demand for Cyber Security Professionals

- **Escalating Cyber Threats**: The frequency and sophistication of cyber-attacks are on the rise, targeting sectors ranging from finance to healthcare. This surge necessitates a robust cybersecurity workforce capable of anticipating and mitigating threats.
- **Workforce Shortage**: According to Cybersecurity Ventures, there are approximately 3.5 million unfilled cybersecurity positions globally in 2025, underscoring a significant talent gap in the industry.

- **Rapid Job Growth**: The U.S. Bureau of Labor Statistics projects a 33% growth in employment for information security analysts from 2023 to 2033, a rate much faster than the average for all occupations.
- **Integration of AI in Cybersecurity**: The advent of artificial intelligence introduces both opportunities and challenges in cybersecurity. While AI can enhance threat detection, it also presents new vulnerabilities, requiring professionals adept in AI-centric security measures.

National Imperatives and Educational Response

Recognizing the strategic importance of cybersecurity, Pakistan has initiated several measures:

- **National Cyber Security Policy**: The Government of Pakistan has articulated a comprehensive policy framework aimed at protecting national digital assets and fostering a secure cyber environment.
- **Academic Initiatives**: In response to the growing demand, numerous Pakistani universities have launched BS Cyber Security programs. Notable institutions include:
    - COMSATS Institute of Information Technology
    - National University of Sciences and Technology (NUST)
    - Information Technology University (ITU)
    - University of Engineering and Technology (UET) Lahore
    - University of Management and Technology (UMT)
    - Superior University
    - DHA Suffa University
    - Iqra University
    - University of Central Punjab (UCP)
    - University of Wah
    - Islamia University of Bahawalpur
    - Bahria University
    - Sir Syed University of Engineering and Technology
    - Lahore University of Management Sciences (LUMS)
    - University of Peshawar
    - Shaheed Zulfiqar Ali Bhutto Institute of Science and Technology (SZABIST)
    - Mehran University of Engineering and Technology
    - Riphah International University
    - Ghulam Ishaq Khan Institute of Engineering Sciences and Technology (GIKI)

- Hamdard University
- University of Science and Technology, Bannu
- University of Engineering and Technology, Taxila
- National University of Computer and Emerging Sciences (FAST)
- Quaid-i-Azam University
- NED University of Engineering and Technology
- Karachi Institute of Economics and Technology

These programs aim to cultivate a skilled workforce capable of addressing both national and global cybersecurity challenges.

Career Prospects and Industry Demand

Graduates of BS Cyber Security programs are poised to enter a dynamic job market with roles such as:

- Information Security Analyst
- Cybersecurity Consultant
- Network Security Engineer
- Penetration Tester
- Security Software Developer
- Digital Forensics Analyst
- Chief Information Security Officer (CISO)

Industries ranging from banking, healthcare, defense, to e-commerce are actively seeking cybersecurity professionals to protect sensitive data and ensure compliance with regulatory standards.

In light of these factors, the establishment and expansion of BS Cyber Security programs are not only timely but essential. They serve to bridge the talent gap, bolster national security, and position graduates at the forefront of a critical and ever-evolving field.

6. Admission Eligibility Criteria

- Years of Study completed: 12 Years

- Study Program/Subject: Intermediate with Mathematics or equivalent, F.Sc. Pre-medical or equivalent in a relevant discipline.
- Percentage/CGPA: 50% marks required with the exception of DAE where 60% marks are required for admission.
- Entry Test (if applicable) with minimum requirement: Typically, the Department of Data Science will conduct an entry test to select students as per number of available seats.
- Student with pre-medical are also eligible. However, they must have to pass deficiency courses of Mathematics of 6 credit hours in first two semesters.

7. Duration of the Program

- Four-year program spread over 8 semesters (two semesters per year)

8. Assessment Standards

Sr. #	Elements	Weightage	Details
1.	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2.	Formative Assessment	25%	It is continuous assessment. It may include: classroom participation, attendance, assignments and presentations, homework, course projects, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Letter Grades should be included.

Percentage Marks	Letter Grade	Grade Points
85 and Above	A	4.00
80-84	A-	3.70
75-79	B+	3.30
70-74	B	3.00
65-69	B-	2.70
61-64	C+	2.30
58-60	C	2.00
55-57	C-	1.70
50-54	D	1.00
Below 50	F	0.00

5. Categorization of Courses as per HEC Recommendation and Difference

***Note**: Basics courses represent Math and Science Foundation course as per HEC/NCEAC approved curriculum.*

CC = Computing Core, DC = Domain Core, MS = Math and Science Foundation, GE = General Education, UE = University Elective, DE = Domain Elective

Semester	Courses	Category (Credit Hours)								
		Core Courses		Basic Courses		Major Electives (DS Elective)	Minor Electives (DS Supporting)	Any Other		Semester Load
		CC	DC	MS	GE			UE	MD	
1	5+1	3			8	3				**14**
2	5+1	4		3	5		4			**16+1**
3	5+1	8		6				3		**17**
4	5+1	4	3	3			8			**18+1**
5	6+1	7	3			3	3	2		**18**
6	5+1	4	9			3				**16+1**
7	6+1	2	3		3	3	3	3		**17**
8	6+1	7			5	3		4		**19+1**
PU	**43+8**	39	18	12	19	15	18	12	0	132+4
HEC Guidelines	**42**	**39**	**18**	**12**	**19**	**12**	**18**	**12**		**130**
Difference (HEC &) PU	**1+8**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**2+4**

**Core: Compulsory, Basic: Foundation, Major Electives: Professional Minor Electives: Specialization*

Note: The course/column heads are customizable according to nature and level of the program.

**** These Math courses will be as Non-Credit courses with only Pass/Fail grade assigned to the students so that overall credit will not affect.***

6. Scheme of Studies / Semester-wise workload

Semester I					
Sr#	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-001	Quran Translation I	--		0.5
2	MD-001	Math Definciency I	--		0
3	GE-190	Functional English	GE		3 (3-0)
4	GE-168	Ideology and Constitution of Pakistan	GE		2 (2-0)
5	GE-160	Applications of Information and Communication Technologies	GE		3 (2-1)
6	GE-163	Islamic Studies	GE		2 (2-0)
7	CC-112	Programming Fundamentals	CC		3 (3-0)
8	CC-112-L	Programming Fundamentals Lab	CC		1 (0-1)
Semester II					
Sr#	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-002	Quran Translation II	--		0.5
2	MD-002	Math Definciency II	--		0
3	GE-169	Applied Physics	GE		3 (2-1)
4	MS-251	Probability and Statistics	MS		3 (3-0)
5	GE-199	Expository Writing	GE		3 (3-0)
6	CC-110	Digital Logic Design	CC		2 (2-0)
7	CC-110-L	Digital Logic Design Lab	CC		1 (0-1)
8	CC-211	Object Oriented Programming	CC	Programming Fundamentals	3 (3-0)
9	CC-211-L	Object Oriented Programming Lab	CC	Programming Fundamentals	1 (0-1)
Semester III					
Sr#	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-003	Quran Translation III	HQ		0.5
2	GE-162	Calculus and Analytic Geometry	GE		3 (3-0)
3	CC-210	Computer Organization and Assembly Language	CC	Digital Logic Design	3 (2-1)
4	GE-167	Discrete Structures	GE		3 (3-0)
5	CC-213	Data Structures	CC	Object-Oriented Programming	3 (3-0)
6	CC-213-L	Data Structures Lab	CC	Object-Oriented Programming	1 (0-1)
7	DC-221	Cyber Security	DC		3 (2-1)
8	MS-252	Linear Algebra	MS		3 (3-0)
Semester IV					
Sr#	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-004	Quran Translation IV	HQ		0.5

2	MS-253	Multivariable Calculus	MS	Calculus and Analytical Geometry	3 (3-0)
3	DC-222	Information Assurance	DC	-	3 (2-1)
4	CC-215	Database Systems	CC		3 (3-0)
5	CC-215-L	Database Systems Lab	CC		1 (0-1)
6	CC-310	Artificial Intelligence	CC	Object Oriented Programming	3 (2-1)
7	CC-214	Computer Networks	CC		3 (2-1)
8	CC-308	Information Security	CC		3 (2-1)
Semester V					
Sr#	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-005	Quran Translation V	HQ		0.5
2	CC-311	Operating Systems	CC	Data Structures	3 (2-1)
3	GE-363	Civics and Community Engagement	GE		2 (2-0)
4	CC-313	Analysis of Algorithms	CC	Data Structures	3 (3-0)
5	DC-321	Secure Software Design and Development	DC	Cyber Security	3 (2-1)
6	DE-323	Web Technologies	DE	Object Oriented Programming	3 (2-1)
7	DC-322	Digital Forensics	DC	Cyber Security	3 (2-1)
Semester VI					
Sr#	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-006	Quran Translation VI	HQ		0.5
2	ES-392	Introduction to Marketing	UE		3 (3-0)
3	DC-223	Network Security	DC	Cyber Security	3 (2-1)
4	CC-303	Software Engineering	CC		3 (3-0)
5	DE-321	Penetration Testing	DE		3 (2-1)
6	DE-322	Vulnerability Assessment & Reverse Engineering	DE		3 (2-1)
7	DE-335	Computer Architecture	DE		3 (2-1)
Semester VII					
Sr#	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**
1	HQ-007	Quran Translation VII	HQ		0.5
2	MS-254	Technical and Business Writing	MS		3 (3-0)
3	GE-362	Entrepreneurship	GE		2 (2-0)
4	DE-333	Theory of Automata and Formal Languages	DE		3 (2-1)
5	DE-421	Cyber Law & Cyber Crime (Cyber Warfare)	DE		3 (2-1)
6	DE-324	Software Construction and Development	DE	Object Oriented Programming	3 (2-1)
7	CC-401	Final Year Project-1	CC		2 (0-2)
Semester VIII					
Sr#	**Code**	**Course Title**	**Type**	**Prerequisite**	**Credit hours**

50	HQ-008	Quran Translation VIII	HQ		0.5
51	GE-161	Pakistan Studies	GE		2 (2-0)
52	ES-492	Introduction to Management	GE		2 (2-0)
53	DC-409	Parallel and Distributed Computing	DC	Operating Systems	3 (2-1)
54	GE-402	Professional Practices	GE		2 (2-0)
55	CC-402	Final Year Project-2	CC	FYP-1	4 (0-4)

Research Thesis / Project /Internship

Final Year Project (6 credit hours, Semester 7 and 8)

Award of Degree

Degree awarding criteria stating:

CGPA percentage required to Qualify: 2.0

Thesis /Project/Internship: Final Year Project Required

7. NOC from Professional Councils (if applicable)

Not applicable

8. Faculty Strength

Degree	Area/Specialization	Total
PhD	1. Prof. Dr. Muhammad Kamran Malik, Natural Language Processing, AI & Data Science 2. Prof. Dr. Muhammad Adnan Abid, Information Retrieval, AI & Data Science 3. Dr. Shahid Manzoor. Bioinformatics, Comparative Genomics, Genome Assembly and Annotation, Metagenomics, Biological Databases, Co-relation network analysis, Microbiom analysis, Proteomic, Transcriptomic and Metabolic Pathway analysis. 4. Dr. Muhammad Nadeem Majeed. Communication & Networks, Cyber Security, AI & Data Sceince 5. Dr. Faisal Bukhari. Computer Vision, Image Processing, Machine Learning, and Statistics 6. Dr. Muhammad Khurram Shahzad. Business Process Management and Natural Language Processing 7. Dr. Waheed Iqbal. Cloud Computing, Distributed Systems, Machine Learning	12

	8. Dr. Muhammad Arif Butt. Cyber Security, OS Kernel and device driver development, Fuzzification of OS Kernel Modules 9. Dr. Muhammad Idrees. Programming, Data Structures, Algorithms, Databases, Computer Vision and Image Processing, Data Science 10. Dr. Muhammad Ali. Machine Learning, Image Processing, Computer Vision 11. Dr. Zubair Nawaz. Analysis of Algorithms, Advanced Algorithms, High Performance Computing 12. Dr. Muhammad Abdullah. Cloud Computing, Scalable Applications, Machine Learning	
MS/MPhil	1. Theory of Formal Languages and Automata, Design and Implementation of Compilers 2. Digital Logic and Design, Microprocessors	2
Total		**14**

9. Present Student Teacher Ratio in the Department

14 Faculty members with 350 BS students

10. Assessment and Examination

The course outline has following elements:

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

BS in Cyber Security Course Outlines

This section provides detailed Course Outline for all courses from all areas of BS Cyber Security, including the course title, course code, credit hours split, pre-requisite, course introduction, course learning outcomes, and Reference material.

1.1 BS Cyber Security Computing Core (46/133) 14 Courses

Course Name: **Programming Fundamentals**
Course Code: CC-112
Course Area: Computing Core
Credit Hours: 4 (3-3)
Contact Hours: 3-3
Pre-requisites: None

Course Introduction

This course provides fundamental concepts of programming to freshmen. The courses is pre- requisite to many other courses; therefore, students are strongly advised to cover all contents and try to achieve CLOs to the maximum possible level. The course may be taught as language independent. Further, it is up to the university to choose any language for the practical/Lab purpose but that must be latest and market oriented.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Understand basic problem solving steps and logic Constructs	C2 (Understand)
CLO 2	Apply basic programing concepts	C3 (Apply)
CLO 3	Design and implement algorithms to solve real world problems	C6 (Create)

Course Outline

Introduction to Programming and Importance for a CS Graduate, Basics of Programming and Software Development, C++ Development Environment and Basic Program Construction, Header Files and Library Files, Variables and Data Types, Operators (Arithmetic, Logical, Increment, Decrement) and Precedence, Type Conversion, Input and Output Statements in C++, IF Statement, IF -ELSE Statement, ELSE-IF Statement, Conditional Operator Switch Statement, GOTO Statement, Arrays, One Dimensional and Two Dimensional Arrays, FOR Loop, Nested FOR loops, Loops with Arrays, WHILE Loop, DO-WHILE Loop, Break Statement, Continue Statement, Functions and its Importance, Parts of Functions, Passing Arguments to Functions, Returning Values from Functions, Inline Functions, Default Arguments, Recursion, Strings, String Manipulation

Functions, Structures and its Importance, Declaring Structures and Structures Variables, Accessing Structures Members, Nested Structures, Passing Structures Function, Enumerations, Array of Structures, Pointers and its Importance, Pointers and Arrays, Pointers and Function (Call by Value and Call by Reference), Pointers and Strings, File Handling in C++, Reading from a File, Writing to a File.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Deitel, Paul, and Harvey Deitel. C++ How to Program. Latest Edition., Prentice Hall,
2. Lafore, Robert. Object-Oriented Programming in C++. Latest Edition., Sams,
3. Sahay, S. Object Oriented Programming with C++. 1st Edition., Oxford University Press, 2012.
4. Kanetkar, Yashavant. Basic Programming in C++. BPB Publications, Latest Edition.

Course Name: **Object Oriented Programming**
Course Code: CC-211
Course Area: Computing Core
Credit Hours: 4 (3-3)
Contact Hours: 3-3
Pre-requisites: Programming Fundamentals

Course Introduction

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

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Understand principles of object oriented paradigm	C2 (Understand)
CLO 2	Identify the objects & their relationships to build object oriented solution	C4 (Analyze)
CLO 3	Model a solution for a given problem using object oriented principles	C3 (Apply)
CLO 4	Examine an object oriented solution	C5 (Evaluate)

Course Outline

Object Oriented Programming (OOP) and its Significance as a Modeling Technique. Comparison of Structured Programming and OOP, Classes and Objects in C++, Abstraction, New User Defined Data Types, Creating Objects from Classes, Accessing Member, Access Specifiers, Member Functions, Defining Member Functions, Constructors and Properties, Default Constructor, Constructor Overloading, Copy Constructor, Deep Copy, Shallow Copy, Destructors, "this" Pointer, Constant Member Function, Static Variables, Accessing Static Data Member, Static Member Function, Comparison of Global Variables and Static Variable, Arrays of Objects, Pointer to Objects Templates, Function Templates, Class Templates, Data Encapsulation and Abstraction, Importance of Data Encapsulation and Abstraction, Correctly Using the Access Modifiers, Friend Functions, Composition, Aggregation, Operator Overloading, Overloading Assignment Operator, Friend Function and Operator Overloading, Unary Operators Overloading, Inheritance and Importance, Inheritance in C++, Comparison of Overloading and Overriding, Hierarchy of Inheritance, Types of Inheritance, Private Inheritance, Protected Inheritance Multiple Inheritance Problem in Multiple Inheritance, Polymorphism and Importance, Virtual Functions, Static Binding, Dynamic Binding, Abstract

Classes and Concrete Classes, Virtual Destructors, Virtual Functions and Pure Virtual Functions, Virtual Functions Usage, Dynamic Dispatch, Namespaces and Using Namespaces, Memory Management and Importance, Memory Areas(Heap, Stack), Use of new Operator, malloc() and calloc() Functions Calls, Exception Handling.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Deitel, Paul, and Harvey Deitel. C++ How to Program. 10th Edition., Prentice Hall, 2016.
2. Lafore, Robert. Object-Oriented Programming in C++. 4th Edition., Sams, 2002.
3. Sahay, S. Object Oriented Programming with C++. 1st Edition., Oxford University Press, 2012.
4. Kanetkar, Yashavant. Basic Programming in C++. 1st Edition., BPB Publications, 2004.

Course Name: **Digital Logic Design**
Course Code: CC-110
Course Area: Computing Core
Credit Hours: 3(2-3)
Contact Hours: 2-3
Pre-requisites: None

Course Introduction

The course introduces the concept of digital logic, gates and the digital circuits. Further, it focuses on the design and analysis combinational and sequential circuits. It also serves to familiarize the student with the logic design of basic computer hardware components.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Acquire knowledge related to the concepts, tools and - techniques for the design of digital electronic circuits	C1 (Remember)
CLO 2	Demonstrate the skills to design and analyze both - combinational and sequential circuits using a variety of techniques	C3 (Apply)
CLO 3	Apply the acquired knowledge to simulate and implement small-scale digital circuits	C3 (Apply)
CLO 4	Understand the relationship between abstract logic characterizations and practical electrical implementations.	C2 (Understand)

Course Outline

Introduction to Numbering Systems, Conversion and Complements, Binary Arithmetic, Boolean Algebra, Boolean Functions, Standard and Canonical Forms of Boolean, Functions, Logic Gates, Implementation of Boolean Functions with AND, OR, and Not Gates. Simplification of Boolean Functions by Algebraic Manipulation, Map and Tabulation Methods, Boolean Function Implementation with NAND and NOR Gates. Combinational Logic Design and Analysis, Adders, Subtractions, Code Converters. Combinational Logic with MSI and LSI, Binary Parallel Adder, Decimal Adder, BCD Adder, Magnitude Comparator, Decoders, De-multiplexers, Encoders, Multiplexers, ROMs, PLAs and its Implementations. Sequential Logic, Introduction to Latches, Flip Flops, Types of Flip-Flops, Registers, Counters, Timing Sequence and Memory Unit. Asynchronous Sequential Logic, Digital Integrated Circuits, RTL and DTL Circuits, MOS, CMOS. Digital Logic Simulator as Logic Gate Simulator, Multimedia Logic.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Morris, M. M. Digital Logic and Computer Design. 5th Edition., Pearson Education India, 2009.
2. Floyd, Thomas L. Digital Computer Electronics. 9th Edition., Pearson Education India, 2011.
3. Floyd, Thomas L. Digital Fundamentals. 11th Edition., Pearson, 2011.

Course Name: **Data Structures**
Course Code: CC-213
Course Area: Computing Core
Credit Hours: 4 (3-1)
Contact Hours: 3-3
Pre-requisites: Object Oriented Programming

Course Introduction

The course is designed to teach students structures and schemes, which allow them to write programmer to efficiently manipulate, store, and retrieve data. Students are exposed to the concepts of time and space complexity of computer programs.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Implement various data structures and their algorithms and apply them in implementing simple applications	C3 (Apply)
CLO 2	Analyze simple algorithms and determine their complexities.	C4 (Analyze)
CLO 3	Apply the knowledge of data structure to other application domains.	C3 (Apply)
CLO 4	Design new data structures and algorithms to solve problems.	C6 (Create)

Course Outline

Introduction and Overview, Abstract Data Type, Arrays, Stacks(Push and Pop), Infix, Postfix and Prefix, Basic Operations, Queues(Insertion, Deletion, De-queues), Heap, Lists, Linked Lists, Searching(Binary and Sequential), Sorting, Sorting and Hashing, Recursion, Trees, Linked Lists Implementation, Binary Trees, B-Trees, Trees Traversal, Basic Operations, Traversals Sets, Graph, Representation of Directed and Undirected Graphs, Traversals, Minimum Cost Spanning Tree, Complexity(Space and Time).

Reference Material

The following is the recommended list of books (or their latest editions):

1. Weiss, Mark A. Data Structures and Algorithm Analysis in Java. 3rd Edition., Pearson, 2014.
2. Carrano, Frank M., and Timothy M. Henry. Data Structures and Abstractions with Java. 5th Edition., Pearson, 2017.
3. Drozdek, Adam. Data Structures and Algorithms in C++. 4th Edition., Cengage Learning, 2018.
4. Weiss, Mark Allen. Data Structures and Algorithm Analysis in C++. 4th Edition., Pearson, 2014.

Lewis, John, and Joseph Chase. Java Software Structures: Designing and Using Data Structures. 4th Edition., Pearson, 2014.

Course Name: **Database Systems**
Course Code: CC-215
Course Area: Computing Core
Credit Hours: 4 (3-1)
Contact Hours: 3-3
Pre-requisites: None

Course Introduction

The course aims to introduce basic database concepts, different data models, data storage and retrieval techniques and database design techniques. The course primarily focuses on relational data model and DBMS concepts

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Explain fundamental database concepts.	C1 (Remember)
CLO 2	Design conceptual, logical and physical database schemas using different data models.	C3 (Apply)
CLO 3	Identify functional dependencies and resolve database anomalies by normalizing database tables.	C4 (Analyze)
CLO 4	Use Structured Query Language (SQL) for database definition and manipulation in any DBMS	C3 (Apply)

Course Outline

Basic database concepts, Database approach vs. file based system, database architecture, three level schema architecture, data independence, relational data model, attributes, schemas, tuples, domains, relation instances, keys of relations, integrity constraints, relational algebra, selection, projection, Cartesian product, types of joins, normalization, functional dependencies, normal forms, entity relationship model, entity sets, attributes, relationship, entity-relationship diagrams, Structured Query Language (SQL), Joins and subqueries in SQL, Grouping and aggregation in SQL, concurrency control, database backup and recovery, indexes, NoSQL systems

Reference Material

The following is the recommended list of books (or their latest editions):

1. Connolly, Thomas, and Carolyn Begg. Database Systems: A Practical Approach to Design, Implementation, and Management. 6th Edition., Pearson, 2015.
2. Garcia-Molina, Hector, Jeffrey D. Ullman, and Jennifer Widom. Database Systems: The Complete Book. 2nd Edition., Pearson, 2008.
3. Silberschatz, Avi, Henry Korth, and S. Sudarshan. Database System Concepts. 6th Edition., McGraw-Hill Education, 2019.
4. Ramakrishnan, Raghu, and Johannes Gehrke. Database Management Systems. 3rd Edition., McGraw-Hill Education, 2008.

Course Name: **Information Security**
Course Code: CC-308
Course Area: Computing Core
Credit Hours: 3 (2-1)
Contact Hours: 2-3
Pre-requisites: None

Course Introduction

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

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Explain key concepts of information security such as design principles, cryptography, risk management, and ethics	C1 (Remember)
CLO 2	Discuss legal, ethical, and professional issues in information security	C2 (Understand)
CLO 3	Apply various security and risk management tools for achieving information security and privacy	C3 (Apply)
CLO 4	Identify appropriate techniques to tackle and solve problems in the discipline of information security	C4 (Analyze)

Course Outline

Information security foundations, security design principles; security mechanisms, symmetric and asymmetric cryptography, encryption, hash functions, digital signatures, key management, authentication and access control; software security, vulnerabilities and protections, malware, database security; network security, firewalls, intrusion detection; security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics in information security, privacy and anonymity of data.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Stallings, William. Computer Security: Principles and Practice. 3rd Edition., Pearson, 2017.
2. Whitman, Michael E., and Herbert J. Mattord. Principles of Information Security. 6th Edition., Cengage Learning, 2021.
3. Gollmann, Dieter. Computer Security. 3rd Edition., Wiley, 2016.
4. Easttom, William. Computer Security Fundamentals. 3rd Edition., Pearson, 2020.

Course Name: **Artificial Intelligence**
Course Code: CC-310
Course Area: Computing Core
Credit Hours: 3 (2-1)
Contact Hours: 2-3
Pre-requisites: Object Oriented Programming

Course Introduction

Artificial Intelligence has emerged as one of the most significant and promising areas of computing. This course focuses on the foundations of AI and its basic techniques like Symbolic manipulations, Pattern Matching, Knowledge Representation, Decision Making and Appreciating the differences between Knowledge, Data and Code. AI programming language Python has been proposed for the practical work of this course.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Understand the fundamental constructs of Python programming language.	C2 (Understand)
CLO 2	Understand key concepts in the field of artificial intelligence	C2 (Understand)
CLO 3	Implement artificial intelligence techniques and case studies	C3 (Apply)

Course Outline

An Introduction to Artificial Intelligence and its applications towards Knowledge Based Systems; Introduction to Reasoning and Knowledge Representation, Problem Solving by Searching (Informed searching, Uninformed searching, Heuristics, Local searching, Minmax algorithm, Alpha beta pruning, Game-playing); Case Studies: General Problem Solver, Eliza, Student, Macsyma; Learning from examples; ANN and Natural Language Processing; Recent trends in AI and applications of AI algorithms. Python programming language will be used to explore and illustrate various issues and techniques in Artificial Intelligence

Reference Material

The following is the recommended list of books (or their latest editions):

1. Russell, Stuart, and Peter Norvig. Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall, 2015.
2. Norvig, Peter. Paradigms of Artificial Intelligence Programming: Case Studies in Common Lisp. Morgan Kaufmann, 1992.
3. Joshi, Pratap. Artificial Intelligence with Python. Packt Publishing, 2017.
4. Miller, Bruce N., David L. Ranum, and Jessica Anderson. Python Programming in Context. 1st Edition. Jones & Bartlett Learning, 2019.

Course Name: **Computer Networks**
Course Code: CC-214
Course Area: Computing Core
Credit Hours: 3 (2-1)
Contact Hours: 2-3
Pre-requisites: None

Course Introduction

This course introduces the basic concept of computer network to the students. Network layers, Network models (OSI, TCP/IP) and protocol standards are part of the course.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Describe the key terminologies and technologies of computer networks	C1 (Remember)
CLO 2	Explain the services and functions provided by each layer in the Internet protocol stack.	C4 (Analyze)
CLO 3	Identify various internetworking devices and protocols and their functions in a networking	C2 (Understand)
CLO 4	Analyze working and performance of key technologies, algorithms and protocols	C4 (Analyze)

Course Outline

Networking Concepts, Topologies: Bus, Star, Ring, Tree, Mesh, Need of Networks, Peer-to-Peer networks, Client- Server Networks, Hybrid Networks, Network Models, TCP/IP Model, OSI Model, Data Link Layer, Error Detection/Correction & Control Techniques, Error Control Techniques, Stop and Wait ARQ, Go-Back-N ARQ, Selective-Reject ARQ, High Level Data Link Control Protocols (HDLC, Stop & Wait, Sliding Window, Access Techniques, Random Access techniques, Aloha, Slotted Aloha, CSMA, CSMA/CD, Controlled Access Techniques, Reservation, Token Passing , Internetworking Devices, Hubs, Switches, Routers. NICs, Switching Techniques, Circuit and Packet Switching, Message Switching, Structure of a Switch, LAN Architectures, Wired LANs, IEEE Standards, Ethernet, Fast and Gigabit Ethernet, Logical Addressing, IPv4 and IPv6 Addressing and Packet Structure, Transition from IPv4 to IPv6, ICMPv6, IGMP, Forwarding and Routing, Unicast and Multicast Routing Protocols, UDP, TCP and SCTP Protocols, Fundamentals of DNS, FTP, SMTP, WWW, HTTP and SNMP Protocols.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Stallings, William. Data and Computer Communications. 8th Edition., Prentice Hall, 2007.
2. Forouzan, Behrouz A. Data Communications and Networking. 4th Edition., McGraw-Hill, 2007.
3. Tanenbaum, Andrew S. Computer Networks. 4th Edition., Prentice Hall, 2003.

Forouzan, Behrouz A., and Firouz Mosharraf. Computer Networks: A Top-Down Approach. McGraw-Hill, 2012.

Course Name: **Software Engineering**
Course Area: Computing Core
Course Code: CC-303
Credit Hours: 3 (3-0)
Contact Hours: 3-0
Pre-requisites: None

Course Introduction

The students will be provided with a more concise description of state-of-the-art software process models and application of software engineering concepts as used in a professional software development environment. This course covers advanced theoretical concepts in software engineering and provides extensive hands-on experience in dealing with various issues of software development. It involves a semester-long group software development project. Emphasis will be placed on agile software development methodologies for team development, quality assessment, and knowledge management in software engineering.

CLO No.	Course Learning Outcome	Bloom's Taxonomy Domain Level
CLO-1	Understand various software engineering processes and activates	C 2 (Understand)
CLO-2	Apply the system modeling techniques to model a medium size software system	C 3 (Apply)
CLO-3	Apply software quality assurance and testing principles to medium size software systems	C3 (Apply)

Course Outline

Professional software development, Software engineering practices, Software process structure, Traditional software process models, Agile software development, Agile process models(XP, Scrum), Agile development practices, Requirements engineering process, Functional and non-functional requirements, Model driven engineering, UML diagrams: Context models, Interaction models, Structural models, behavioral models, , Architectural design, Detailed design and implementation, , Design patterns, Coding standards, Software testing and quality assurance, Software deployment, maintenance, evolution, Overview of project management(Introduction to MS Project or related tool) Introduction to software development, environment (Concepts of Build, Continuous Integration/Continuous delivery, Configuration management (GitHub, GitLab, etc).

Reference Material
The following is the recommended list of books (or their latest editions):

1. Sommerville, Ian. Engineering Software Products: An Introduction to Modern Software Engineering. United Kingdom, Pearson, 2020
2. Mall, Rajib. Fundamentals of Software Engineering, Fourth Edition. Phi Learning, 2018.
3. Martin, Robert C. Clean Code. Pearson Education, 2009.
4. Stephens, Rod. Beginning Software Engineering. John Wiley and Sons,
5.Amuthabala, K., et al. Agile Software Development - An Overview. MileStone Research Publications, 2023

Course Name: **Computer Organization and Assembly Language**
Course Code: CC-210
Course Area: Computing Core
Credit Hours: 3 (2-1)
Contact Hours: 2-3
Pre-requisites: Digital Logic Design

Course Introduction

The main objective of this course is to 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.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Acquire the basic knowledge of computer organization computer architecture and assembly language	C1 (Remember)
CLO 2	Understand the concepts of basic computer organization, architecture, and assembly language techniques	C2 (Understand)
CLO 3	Solve the problems related to computer organization and assembly language	C3 (Apply)

Course Outline

Introduction to computer systems: Information is bits + context, programs are translated by other programs into different forms, it pays to understand how compilation systems work, processors read and interpret instructions stored in memory, caches matter, storage devices form a hierarchy, the operating system manages the hardware, systems communicate with other systems using networks; Representing and manipulating information: information storage, integer representations, integer arithmetic, floating point; Machine-level representation of programs: a historical perspective, program encodings, data formats, accessing information, arithmetic and logical operations, control, procedures, array allocation and access, heterogeneous data structures, putting it together: understanding pointers, life in the real world: using the gdb debugger, out of-bounds memory references and buffer overflow, x86-64: extending ia32 to 64 bits, machine-level representations of floating-point programs; Processor architecture: the Y86 instruction set architecture, logic design and the Hardware Control Language (HCL), sequential Y86 implementations, general principles of pipelining, pipelined Y86 implementations

Reference Material

The following is the recommended list of books (or their latest editions):

1. Patterson, David A., and John L. Hennessy. Computer organization and Design. 5th Edition. Morgan Kaufmann, 2013.
2. Mano, M. Morris. Computer system architecture. 3rd Edition. Prentice-Hall, Inc., 1993.
3. Duntemann, Jeff. Assembly language step-by-step: Programming with Linux. 3rd Edition. John Wiley & Sons, 2011.
4. Bryant, Randal E., and David Richard O'Hallaron. Computer systems: a programmer's perspective. 3rd Edition. Prentice Hall, 2016.
5. Britton, Robert. MIPS assembly language programming. 2003.

Course Name: **Operating Systems**
Course Code: CC-311
Course Area: Computing Core
Credit Hours: 3 (2-1)
Contact Hours: 2-3
Pre-requisites: Data Structures

Course Introduction

To help students gain a general understanding of the principles and concepts governing the functions of operating systems and acquaint students with the layered approach that makes design, implementation and operation of the complex OS possible.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Understand the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems.	C2 (Understand)
CLO 2	Analyze and evaluate the algorithms of the core functions of the Operating Systems and explain the major performance issues with regard to the core functions.	C4 (Analyze)
CLO 3	Demonstrate the knowledge in applying system software and tools available in modern operating systems.	C3 (Apply)

Course Outline

Introduction & Overview, Computer Organization, Interrupts, Components of Operating System, Processes & PCB, Process Creation, Process Management, Processes, Process States, Process State Models, Inter-Process Communication, Process Scheduling, Threads, Synchronization Issues, Busy Waiting Algorithm &Bakery Algorithm, TSL & Priority Inversion, Semaphores, Classical Synchronization Problems, Dead Locks, Deadlock Detection, Deadlock recovery, Deadlock Avoidance, Deadlock Prevention, Memory management, Real Memory Organization and Management, Virtual Memory Organization: Paging, Segmentation, Virtual Memory Management: Placement, Replacement, and Fetch Strategies Input Output Management, File System.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Abraham, Silberschatz, Gagne Greg, and Galvin Peter Baer. Operating System Concepts, 10th Edition. 2018.
2. Tanenbaum, Andrew. Modern operating systems, 5th.Edition. Pearson Education, Inc, 2023.
3. Ritchie, Colin. Operating Systems, 3rd Edition. Continuum, 2000.

Course Name: **Analysis of Algorithms**
Course Code: CC-313
Course Area: Computing Core
Credit Hours: 3 (3-0)
Contact Hours: 3-0
Pre-requisites: Data Structures

Course Introduction

Detailed study of the basic notions of the design of algorithms and the underlying data structures. Several measures of complexity are introduced. Emphasis on the structure, complexity, and efficiency of algorithms.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	To provide a Comprehensive study of Computer Algorithms	C2 (Understand)
CLO 2	To discuss the solutions for classical problems and their complexity	C4 (Analyze)
CLO 3	To provide in depth coverage to Analysis and Design of new Algorithms.	C3 (Apply)
CLO 4	Graph algorithms, including single source and all-pairs shortest paths, and at least one minimum spanning tree algorithm	C1 (Remember)

Course Outline

Introduction; role of algorithms in computing, Analysis on nature of input and size of input Asymptotic notations; Big-O, Big Ω, Big Θ, little-o, little-ω, Sorting Algorithm analysis, loop invariants, Recursion and recurrence relations; Algorithm Design Techniques, Brute Force Approach, Divide-and-conquer approach; Merge, Quick Sort, Greedy approach;

Dynamic programming; Elements of Dynamic Programming, Search trees; Heaps; Hashing; Graph algorithms, shortest paths, sparse graphs, String matching; Introduction to complexity classes

Reference Material

The following is the recommended list of books (or their latest editions):

1. Cormen, Thomas H., et al. Introduction to algorithms. 4th Edition. MIT press, 2022.
2. Kleinberg, Jon, and Eva Tardos. Algorithm design. Pearson Education India, 2013/2014
3. Sedgewick, R., and K. Wayne. Algorithms 4th Edition, 2021.Acessoem, 2023.

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Course Name: **Final Year Project – I**
Course Code: CC-401
Course Area: Computing Core
Credit Hours: 2 (0-2)
Contact Hours: **0**-6
Pre-requisites: None
Course Introduction

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Analysis and Design of FYP	C6 (Create)

Course Outline

Analysis and Design of FYP

Course Name: **Final Year Project – II**
Course Code: CC-402
Credit Hours: 4 (0-4)
Contact Hours: 0 - 12
Pre-requisites: Final Year Project – I
Course Introduction

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Thesis and complete FYP submission	C6 (Create)

Course Outline

Thesis and complete FYP submission

1.2 BS Cyber Security Domain Core (18/133) 6 Courses

This Cyber Security **Domain Core** area consists of 6 courses, comprising 18 credit hours, as outlined below:

Course Name:	**Introduction to Cyber Security**
Course Code:	DC-221
Credit Hours:	3 (2-1)
Contact Hours:	2-3
Pre-requisites:	Information Security

Course Introduction

This course provides students an introduction to common cyber security threats, vulnerabilities, and risks related to web applications, networks, software and mobile applications. The course provides basic concepts and terminology used in the information and cyber security fields. Moreover, it will also enable students to differentiate between the various forms of malware and how they affect computers and networks.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	To be able to identify computer system threats	C2 (Understand)
CLO-2	To be able to identify Malware attacks, and understand the stages of attack and payloads.	C2 (Understand)
CLO-3	Implement various cryptographic techniques and simulate attack scenarios	C3 (Apply)

Course Outline

Introduction to Cyber, Introduction to Cyber security; Networks and the Internet; cyber threat landscape; understanding security; information security Principles (Confidentiality, Integrity, Availability); Information Security Terminology; Who are the attackers; Advanced Persistent Threat (APT); Malware, types of malware; Attacks using malware; Malware Attack Lifecycle: Stages of Attack; Social engineering attacks; types of payload; Industrial Espionage in Cyberspace; Basic cryptography; Web application attacks; Database security; Cyber kill chain; Privacy and anonymity; Network security; Software security; Mobile device security; Mobile app security; Cyber Terrorism and Information Warfare; Introduction to Digital Forensics; Digital Forensics Categories.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Easttom, Chuck. Computer Security Fundamentals. 4th ed., Pearson, 2019.
2. Ciampa, Mark. CompTIA Security+ Guide to Network Security Fundamentals. 5th ed., Cengage Learning, 2018.
3. Pfleeger, Charles P., et al. Security in Computing. 5th ed., Prentice Hall, 2015.

Course Name: **Information Assurance**
Course Code: DC-222
Credit Hours: 3 (2-1)
Contact Hours: 2-3
Pre-requisites: None

Course Introduction

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

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	Apply security governance principles; organizational processes; developing and implementing a documented security policy.	C3 (Apply)
CLO-2	Understand and apply risk management concepts	C2 (Understand)
CLO-3	To understand the business, legal, and technical knowledge needed to secure vital government and business assets.	C2 (Understand)

Course Outline

Introduction to (IS) Information System (Concept, Design, Functions, Architecture, Components and applications of IS); Secure System Planning and Administration; Information Security Policies and Procedures; Asset Management; Organizational and Human Security; Cyber Security Management Concepts; NIST Cyber Security Framework; Enterprise Roles and Structures; Strategic Planning; Security Plans and Policies; Contingency Planning; Laws; Laws and Regulatory Requirements; Security Standards and Controls, Risk Management Process, NIST Risk Management Framework, Security Metrics and Key Performance Indicators (KPIs); Physical Security and Environmental Events; Contingency Planning; Security Education, ISO 27001 Compliance, Training, and Awareness. Introduction to Fintech IS standards and Risk Management.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Whitman, Michael E., and Herbert J. Mattord. Principles of Information Security. 6th ed., Cengage Learning, 2017. Print.
2. Stewart, James M., Mike Chapple, and Darril Gibson. CISSP Study Guide. 7th ed., Sybex, 2021. Print.
3. Boyce, Joseph, and Daniel Jennings. Information Assurance: Managing Organizational IT Security Risks. Elsevier, 2002. Print.
4. Blyth, Andrew, and Gerald L. Kovacich. Information Assurance: Security in the Information Environment. 2nd ed., Springer, 2006. Print.

Course Name: **Network Security**
Course Code: DC-223
Credit Hours: 3 (2-1)
Contact Hours: 2-3
Pre-requisites: Introduction to Cyber Security

Course Introduction

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

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	To be able to understand network security threats and methods for security networks	C2 (Understand)
CLO-2	To be able to secure wired networks by deploying various methods	C3 (Apply)
CLO-3	To be able to secure wireless networks by deploying various methods	C3 (Apply)

Course Outline

Introduction to network security, Networking Concepts and Protocols, Network Threats and Vulnerabilities, Network Security Planning and Policy, Access Control, Defense against Network Attacks, DOS and DDOS detection and prevention, Firewalls, Intrusion Detection and Prevention Systems, Antivirus Filtering, Naming and DNS Security, DNSSEC, IP security, Secure Sockets Layer, VPN, Packet Sniffing and spoofing, Honeypot, Ethernet Security, Wireless Security, Wireless Attacks, Wireless LAN Security with 802.11i, Wireless Security Protocols, Wireless Intrusion Detection, Physical access and Security, Tor Network, Network Forensics. Defense against Network Attacks, Security Architecture of autonomous vehicles, Security requirements of autonomous vehicles.

Reference Material

The following is the recommended list of books (or their latest editions):

1. McNab, Chris. Network Security Assessment: Know Your Network. 4th ed., O'Reilly Media, 2018. Print.
2. Boyle, Randall J. Corporate Computer Security. 3rd ed., Auerbach Publications, 2008. Print.
3. Chandra, Praphul. Bulletproof Wireless Security: Wi-Fi, Bluetooth, and RFID Hacks and Countermeasures. Wiley, 2006. Print.
4. Stallings, William. Network Security Essentials: Applications and Standards. 9th ed., Pearson, 2021. Print.
5. Stallings, William. Cryptography and Network Security: Principles and Practices. 8th ed., Pearson, 2021. Print.

Course Name:	**Secure Software Design and Development**
Course Code:	DC-321
Credit Hours:	3 (2-1)
Contact Hours:	2-3
Pre-requisites:	Introduction to Cyber Security

Course Introduction

The module aims 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. The course details the software security activities that need to be incorporated throughout the software development lifecycle. It provides comprehensive coverage that includes the people, processes, and technology components of software, networks, and host defenses.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	A good comprehension of software security standards, models, processes and best practices that need to be incorporated throughout the software development lifecycle.	C2 (Understand)
CLO-2	Identify insecure programming patterns and the ability to replace them with secure alternatives.	C2 (Understand)
CLO-3	Know tools for software security analysis and testing, and the ability to use them in practice and understand their capabilities and limitations.	C3 (Apply)

Course Outline

Secure software concepts; System issues; System properties; Software Project Time Management; Software Project Costing; Software Quality Assurance; Security Concepts in the SDLC; Risk management; Security standards (e.g., coding standards, NIST standards, Federal Information Processing Standards); Best practices (e.g., OWASP development guide, OWASP code review guide, OWASP testing guide); Security methodologies (e.g., Socratic Methodology, Operationally Critical Threat, Asset, and Vulnerability Evaluation, STRIDE and DREAD, Open Source Security Testing Methodology Manual); Security frameworks (e.g., Zachman Framework, Control Objectives for Information and Related Technology, Sherwood Applied Business Security Architecture (SABSA)); Regulations- Privacy and Compliance; Security Models (e.g., BLP Confidentiality Model, Clark and Wilson Model (Access Triple Model)); Trusted Computing; Secure Software Requirements (Sources for Security Requirements, Types of Security Requirements); Secure Software Design (Design consideration, Information Technology Security Principles and Secure Design, Designing Secure Design Principles); Design Processes; Secure Software Implementation/Coding; Software Development Methodologies; Common Software Vulnerabilities and Controls; Defensive Coding Practices—Concepts and Techniques; Code Vulnerabilities and Avoiding Polymorphic Malware Attacks: Buffer overflow, Format string bug,

Code vulnerabilities SQL Injection, Cross-site Scripting, Cross-site Request Forgery, Session management, Replication of vulnerabilities and exploitation; Secure Software Testing; Security Testing Methodologies; Software Security Testing; Software Acceptance; Legal Protection Mechanisms; Software Deployment- Operations- Maintenance and Disposal, Introduction to SCADA Security.

Reference Material

The following is the recommended list of books (or their latest editions):

1. (ISC)² Guide to the CSSLP CBK. 2nd ed., (ISC)² Press, 2013.
2. McGraw, Gary. Software Security: Building Security In. 1st ed., Addison-Wesley Professional,. 2006

Course Name:	**Digital Forensics**
Course Code:	DC-322
Credit Hours:	3 (2-1)
Contact Hours:	2-3
Pre-requisites:	Introduction to Cyber Security

Course Introduction

This course is an introduction to computer forensics and investigation. It provides an understanding of how to conduct investigations to correctly gather, analyze and present digital evidence to different audiences. It also outlines the tools to locate and analyze digital evidence on a variety of devices, how to keep up to date with changing technologies, and laws and regulations in digital forensics.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	To develop knowledge about forensic law, standards, regulations and ethical values	C2 (Understand)
CLO-2	To be able to conduct digital forensics for multiple platforms and applications by various tools	C3 (Apply)
CLO-3	To be able to generate reports based on digital forensic tools for security systems and platforms	C3 (Apply)

Course Outline

An introduction to Digital Forensics; use of digital forensics; Key technical concepts; Challenges in Digital Forensics ; The Difference between Computer Experts and Digital Forensics Experts; Investigative Process Methodologies ; Education, Training, and Awareness; Laws, Standards, and Regulations; Ethics and Professional Conduct; Digital Evidence Management; Collecting evidence; Antiforensics; Network forensics; Mobile and Embedded Forensics; Cloud forensics; Internet Forensics; social media forensics; Investigation Methods for Collecting Digital Evidence; Digital Forensic Readiness; Digital forensics tools; Discovery of Computers and Storage Media; Discovery of Audio/ Video Evidence; Data Visualization; Data Sources; Graphing and Charting; Analyzing Data; Data Distributions; Analysis Scenarios; Data Visualization Tools, Legal and ethical issues in digital forensic.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Sammons, John. The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics. 2nd ed., Syngress, 2012. Print.
2. Nelson, Bill, et al. Digital Forensics and Incident Response: Incident Response Techniques and Procedures to Respond to Modern Cyber Threats. 2nd ed., Academic Press, 2018. Print.
3. Kävrestad, Joakim. Guide to Digital Forensics: A Concise and Practical Introduction. Latest ed., CRC Press. 2017. Print

Course Name:	**Parallel and Distributed Computing**
Course Code:	DC-409
Credit Hours:	3 (2-1)
Contact Hours:	2-3
Pre-requisites:	Object Oriented Programming, Operating Systems

Course Introduction

In this course student will learn about parallel and distributed computers. They will be able to write portable programs for parallel or distributed architectures using Message-Passing Interface (MPI) library with analytical modeling and performance of parallel programs. They can also analyze complex problems with shared memory programming with OpenMP.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Learn about parallel and distributed computers.	C1 (Remember)
CLO 2	Coding programs for parallel or distributed architectures using Message-Passing Interface (MPI) library	C3 (Apply)
CLO 3	Analyze complex problems with shared memory programming with openMP.	C4 (Analyze)

Course Outline

Asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, synchronization, and tools (Cuda, Swift, Globus, Condor, Amazon AWS, OpenStack, Cilk, gdb, threads, MPICH, OpenMP, Hadoop, FUSE).

Reference Material

The following is the recommended list of books (or their latest editions):

1. Tanenbaum, Andrew S., and Maarten Van Steen. Distributed Systems: Principles and Paradigms. 2nd ed., Prentice Hall, 2007.

2. Hwang, Kai, Jack Dongarra, and Geoffrey C. Fox. Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet. 1st ed., Morgan Kaufmann, 2012.

3.3 BS Cyber Security Domain Elective (21/133) 7 Courses

This BS CySec Domain Electives has 7 courses comprising 21 credit hours, as outlined

Course Name: Vulnerability Assessment & Reverse Engineering
Course Code: DE-322
Credit Hours: 3 (2-1)
Contact Hours: 2-3
Pre-requisites: Introduction to Cyber Security

Course Introduction

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

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	Basic Understanding of Hacking and Ethical Hacking.	C2 (Understand)
CLO-2	Apply techniques for vulnerability assessment and penetration testing.	C3 (Apply)
CLO-3	Understand Software vulnerabilities, Network vulnerabilities, Types of Malware and its Analysis.	C2 (Understand)

Course Outline

Understanding the need for security assessments; Classifying vulnerabilities; Software vulnerabilities; Network vulnerabilities; Vulnerability assessment versus penetration testing; Vulnerability Assessment Tools; Vulnerability management Regulatory compliance; Calculating ROIs; Application review process; Pre-assessment; Code navigation; Codeauditing tactics; Memory corruption; understanding issues in programming languages; Steps in Reverse engineering, Common tools used for Reverse engineering; Binary Obfuscation techniques; Understanding core assembly concepts to perform malicious code analysis, Identifying key assembly logic structures with a disassembler, Malware analysis Types of malware analysis; Malware Taxonomy; Static analysis; Dynamic analysis; Malware Inspection; Malware analysis tools; Sandboxing and virtualization, Introduction to threat intelligence platform.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Anton, Philip S. Finding and Fixing Vulnerabilities in Information Systems: The Vulnerability Assessment and Mitigation Methodology. Addison-Wesley Professional, 2002.
2. Dowd, Mark. The Art of Software Security Assessment: Identifying and Preventing Software Vulnerabilities. Addison-Wesley Professional, 2005.
3. Eilam, Eldad. Reversing: Secrets of Reverse Engineering. 3rd ed., Wiley, 2014.
4. Sikorski, Michael. Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software. 2nd ed., No Starch Press, 2015.

Course Name: **Introduction to Computer Electronics**

Course Code:

Credit Hours: 3 (2-3)
Contact Hours: 2-3
Pre-requisites: None

Course Introduction

This course introduces the fundamental concepts and principles of computer electronics, covering both analog and digital circuits. Students will learn about electronic components, circuit analysis, and the practical applications of electronics. The course includes theoretical lessons and hands-on laboratory exercises.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	Understand the basic principles of computer electronics and circuit theory and identify and understand the functions of various electronic components.	C2 (Understand)
CLO-2	Develop skills in analyzing and designing simple computer electronic circuits and gain practical experience through laboratory experiments.	C2 (Understand) C3 (Apply)
CLO-3	Apply computer electronic principles to real-world problems and projects.	

Course Outline

Introduction to Computer Electronics, Overview of electronics and its applications History and evolution of electronic technology, Introduction to electronic components and circuits, Electrical Quantities and Ohm's Law, Voltage, current, resistance, and power, Ohm's Law and its applications, Series and parallel circuits, Practical exercises with resistors Circuit Analysis Techniques, Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL), Thevenin's and Norton's Theorems Mesh and nodal analysis, Solving circuit problems, Capacitors and Inductors, Introduction to capacitors and inductors, Capacitance and inductance in AC and DC circuits, Series and parallel combinations, Time constants and transient response, AC Circuits and Signal Analysis, Introduction to alternating current (AC), Sinusoidal waveforms and phasors, Impedance and reactance, Frequency response and resonance, Diodes and Rectifiers, Semiconductor materials and PN junctions, Diode characteristics and types, Rectifier circuits: half-wave, full-wave, and bridge rectifiers, Clipping and clamping circuits, Transistors and Amplifiers, Bipolar Junction Transistors (BJTs) and Field-Effect Transistors (FETs), Transistor biasing and operation modes, Small-signal amplifiers, Amplifier configurations: common emitter, common collector, and common base Operational Amplifiers, Introduction to operational amplifiers (op-amps), Ideal op-amp characteristics, Basic op-amp circuits: inverting, non-inverting, summing, and differential amplifiers, Practical applications of op-amps, Digital Electronics Basics, Introduction to digital logic and binary numbers, Logic gates: AND, OR, NOT, NAND, NOR, XOR, and XNOR, Boolean algebra and simplification techniques, Combinational logic circuits, Sequential Logic Circuits, Flip-flops: SR, JK, D, and T flip-flops, Counters and shift registers, Timing diagrams and clock signals, Memory elements and storage

devices, Integrated Circuits and Microcontrollers, Overview of integrated circuits (ICs), Types of ICs and their applications, Introduction to microcontrollers, Basic programming and interfacing with peripherals, Power Electronics, Power supply basics, Voltage regulators and DC-DC converters, Introduction to inverters and motor control, Practical applications in power management, Sensors and Actuators, Types of sensors: temperature, light, motion, and pressure, Interfacing sensors with electronic circuits, Actuators: relays, motors, and solenoids

Reference Material

The following is the recommended list of books (or their latest editions):

1. Boylestad, Robert L., and Louis Nashelsky. Electronic Devices and Circuit Theory. 11th ed., Pearson, 2013.
2. Alexander, Charles K., and Matthew N. O. Sadiku. Fundamentals of Electric Circuits. 6th ed., McGraw-Hill Education, 2016.
3. Horowitz, Paul, and Winfield Hill. The Art of Electronics. 3rd ed., Cambridge University Press, 2015.
4. Evans, Alvis J., and David E. Evans. Basic Electronics: Principles and Techniques. 1st ed., Delmar Cengage Learning, 2007.

Course Name: **Cryptography**
Course Code:
Credit Hours: 3 (3-0)
Contact Hours: 3
Pre-requisites: None

Course Introduction

This course provides fundamental concepts of the cryptographic techniques and protocols. It also provides insight as to how cryptography can be used to secure data over a public network.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	Understand basic working of cryptography and cryptanalysis	C2 (Understand)
CLO-2	Learn mathematical concepts applied to new cryptographic algorithms.	C3 (Apply)
CLO-3	Analyze different cryptographic methods.	C4 (Analyze)

Course Outline

Introduction and Motivation, Cryptography and Cryptanalysis, Classical Encryption Methods, Number theory, Modular Arithmetic, Block Cipher, DES, Finite Fields, Private Key Encryption Methods, AES, Triple DES, RC4, Key Management, Confidentiality using Symmetric Keys, Prime Numbers, Primality Test, Public Key Encryption Methods, RSA, Discrete Logarithm Problem, ElGamal Cryptosystem, Hash Functions, Digital Signatures, Authentication Protocols, Elliptic Curve Cryptography, NP-Hard Problems, Algebraic Cryptography, an overview.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Stallings, William. Cryptography and Network Security: Principles and Practice. 8th ed., Pearson, Hoboken, NJ, 2017.
2. Hoffstein, Jeffrey, Jill Pipher, and Joseph H. Silverman. An Introduction to Mathematical Cryptography. Springer, New York, NY, 2014.
3. Menezes, Alfred J., Paul C. Van Oorschot, and Scott A. Vanstone. Handbook of Applied Cryptography. CRC Press, Boca Raton, FL, 2020.
4. Schneier, Bruce. Applied Cryptography: Protocols, Algorithms, and Source Code in C. 2nd ed., Wiley, New York, NY, 1996.

Course Name: **Malware Analysis**
Course Code:
Credit Hours: 3(2-3)
Contact Hours: 2-3
Pre-requisites: Programming Fundamentals, Operating Systems

Course Introduction This course provides fundamental concepts of malware analysis. The primary objective of this course is to understand the working of malware. In addition to detect and eliminate Malware. This course will help in learning to analyze and identify the suspect binary, its characteristics and functionalities in a safe environment.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand basic working of Malware	C2 (Understand)
CLO-2	Learn how to eliminate different types of Malwares	C3 (Apply)
CLO-3	Analyze Malware characteristics an functionalities	C4 (Analyze)

Course Outline

Introduction to Malware Analysis, Malware and its Types, Importance of Malware Analysis, Goals of Malware Analysis, Static Analysis, Dynamic Analysis, Assembly Lang. and Disassembly Primer, Disassembly Using IDA, Debugging Malicious Binaries, Malware Functionalities and Persistence, Code Injection and Hooking, Malware Obfuscation Techniques, Hunting Malware Using Memory Forensics, Detecting Advanced Malware Using Memory Forensics, Ethical and Legal Considerations, Tools and Environments for Malware Analysis

Reference Material

The following is the recommended list of books (or their latest editions):

1. Monnappa K. A. Learning Malware Analysis, Publisher(s): Packt Publishing, 2018.
2. Michael Sikorski, Andrew Honig. Practical Malware Analysis. Publisher(s): No Starch Press. 2012.

Course Name: **Wireless and Mobile Security**
Course Code:
Credit Hours: 3 (2-3)
Contact Hours: 2-3
Pre-requisites: Introduction to Cyber Security

Course Introduction

Wireless and mobile security involves protecting wireless networks, mobile devices, and their applications from various security threats. A comprehensive course on wireless and mobile security covers a wide range of topics, from basic concepts to advanced security measures.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	Identify and describe the various security threats, vulnerabilities, and attacks wireless and mobile communication systems	C2 (Understand)
CLO-2	Apply cryptographic techniques to secure wireless and mobile communications	C3 (Apply)
CLO-3	Evaluate and implement security protocols for wireless networks	C3 (Apply)

Course Outline

Introduction to Wireless and Mobile Security, Importance and challenges of securing wireless networks and mobile devices, Types of wireless networks (Wi-Fi, Bluetooth, NFC, cellular), Common threats and vulnerabilities in wireless and mobile environments, Basics of wireless communication, Wireless network architecture and protocols (IEEE 802.11 standards), Wireless encryption methods (WEP, WPA, WPA2, WPA3), Authentication and access control in wireless networks, Wi-Fi Security, Understanding Wi-Fi security protocols, Wi-Fi attack techniques (e.g., eavesdropping, DE authentication attacks), Defenses against Wi-Fi attacks, Bluetooth protocol and security features, Common Bluetooth attacks (e.g., Bluejacking, Bluesnarfing), Security measures for Bluetooth communication, Overview of other wireless technologies (NFC, Zigbee, etc.) and their security issues, Mobile operating systems (iOS, Android, Windows), Security features of mobile operating systems, Common mobile threats (e.g., malware, phishing, rooting/jailbreaking), Mobile device management (MDM) and security policies, Mobile Application Security, Secure mobile application development practices, Common mobile app vulnerabilities (e.g., insecure data storage, improper authentication), Static and dynamic analysis of mobile applications, Tools for mobile app security testing (e.g., OWASP Mobile Security Testing Guide, MobSF), Mobile Payment and Banking Security, Overview of mobile payment systems (e.g., NFC payments, mobile wallets), Security mechanisms in mobile payment applications, Threats to mobile banking and payment systems, Best practices for securing mobile financial transactions, Network sniffing and packet analysis, Man-in-the-Middle (MitM) attacks on wireless networks, Rogue access points and evil twin attacks, Cellular Network Security, Security features and vulnerabilities in cellular networks, SIM card security, Threats to cellular communication and countermeasures, Bring Your Own Device Security, Securing personal

devices in a corporate network, Data leakage prevention and endpoint security, Emerging Trends and Future Directions, Security considerations for 5G networks, Advances in wireless security technologies, Future trends in mobile security, Intelligent Transport System (ITS) security, VANETs Security.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Rappaport, Theodore S. Wireless Communications: Principles and Practice. 7th ed., Pearson, Hoboken, NJ, 2021.
2. Nichols, Randall K., and Panos C. Lekkas. Wireless Security: Models, Threats, and Solutions. 2nd ed., Auerbach Publications, Boca Raton, FL, 2014.
3. Boudriga, Noureddine. Wireless Security and Cryptography: Specifications and Implementations. Wiley, Hoboken, NJ, 2010.

Course Name: **Theory of Automata and Formal Langauages**
Course Code: DE-333

Course Area: Domain Electives
Credit Hours: 3 (3-0)
Contact Hours: 3-0
Pre-requisites: None

Course Introduction

The course introduces some fundamental concepts in automata theory and formal languages including grammar, finite automaton, regular expressions, formal language, pushdown automaton, and Turing machine. Not only do they form basic models of computation, they are also the foundation of many branches of computer science, e.g. compilers, software engineering, concurrent systems.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Explain the different concepts in automata theory and formal languages	C2 (Understand)
CLO 2	Determine solution to simple automata problems.	C4 (Analyze)
CLO 3	Apply their understanding of key notions through complex problem solving	C3 (Apply)

Course Outline

Introduction to Language: Language as a set, string, string terminologies, alphabet, operations on languages (Union, Concatenation, Kleene Closure), Language Representation: Recursive Definition, Regular Expression (Basic Regular Expressions, Complex Regular Expressions using notational short hands), Grammars, Automata Introduction: What is Automata? Types of Automata, Parts of Automata, Determinism, Finite Automata (FA): Definition of FA, Elements of FA, Nondeterministic Finite Automata (NFA), Deterministic Finite Automata (DFA), Working of FA, Regular Expression to NFA conversion, NFA to DFA conversion, Minimization of number of states in a DFA, DFA coding in C language, Kleene's Theorem: Transition Graph (TG), Generalized Transition Graph (GTG), Statement and Proof of Kleene's Theorem, Finite Automata With output: Moore Machine, Mealy Machine, Moore=Mealy, Context Free Grammars: Definition, Derivation, Problems in Context Free Grammars (Ambiguity, Left Recursion, Common Prefixes), Methods for removal of these problems, Chomsky Normal Form (CNF), Pushdown Automata (PDA): Definition of PDA, Elements of PDA, Creation of PDA i.e. CFG=FA, Touring Machines: Definition of Turing Machines, Elements of Turing Machines, Creation of Turing Machines, Pumping Lemma.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Hopcroft, John E., Jeffery D. Ullman, and Rajeev Motwani. Introduction to Automata Theory, Languages, and Computation. 3rd ed., Pearson Education, 2013.
2. Rich, Elaine A. Automata, Computability and Complexity: Theory and Applications. Pearson, 2013.
3. Cohen, Daniel I. A. Introduction to Computer Theory. 2nd ed., Wiley, 1996

Course Name: **Human Computer Interaction**
Course Code:
Course Area: Domain Electives
Credit Hours: 3(2 -1)
Contact Hours: 2-3
Pre-requisites:

Course Introduction

This course is designed to provide students with a comprehensive introduction to the field of Human Computer Interaction (HCI). This course aims to impart foundational knowledge in order to design useful interactive system based on the needs and the context of the use of the interactive systems. The course covers topics about the design process and the design principles that should be considered while designing interactive systems that would provide good a user experience. This course helps to understand the concept of evaluating designs and prototypes using different evaluation techniques with assistance of experts and users.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Capabilities of humans and computers that can be utilized while designing interactive systems.	C1 (Remember)
CLO 2	Understand the process of interaction and causes of problems during interactions.	C2 (Understand)
CLO 3	Understand the process of designing interactive systems.	C2 (Understand)
CLO 4	Awareness and application of design principles for improved user experience.	C3 (Apply)

Course Outline

Introduction to the field of HCI, The Human Factor, The Computer Factor, The Interaction, Models of Interaction, Interaction Paradigms, Interaction Design Basics and the design process, Personas, Scenarios Introduction to Wireframes and Prototypes, Design Principles, Principles to Support Usability, Principles of Learnability, Flexibility and Robustness, Shneiderman's Eight golden rules, Nielsen's heuristics, Introduction to Evaluation, Evaluation Techniques, Experts Evaluations, Cognitive walkthrough, Heuristic evaluation, Evaluating through user participation, Laboratory Evaluation, Field Evaluation, Observational techniques, Query techniques, and Think-Aloud techniques, Usability Testing, Contemporary topics and issues, Conducting Experimental, Understanding and the process of A/B Testing.

Reference Material

The following is the recommended list of books (or their latest editions):

1. A. Dix, J. Finlay, G. Abowd and R. Beale. Human Computer Interaction, Third Edition, Prentice Hall, (LATEST EDITION)
2. J. Preece, Y. Rogers, H. Sharp. Interaction Design: Beyond Human-Computer Interaction, 6th Edition, Wiley, 2023

Course Name: **Penetration Testing**
Course Code: DE-321
Credit Hours: 3 (2-1)
Contact Hours: 2-3
Pre-requisites: Introduction to Cyber Security

Course Introduction

Penetration testing, often referred to as ethical hacking, involves a comprehensive approach to evaluating the security of an information system by simulating an attack from malicious outsiders (external testing) and malicious insiders (internal testing).

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	Define and explain the goals and methodologies of penetration testing	C2 (Understand)
CLO-2	Identify and comply with relevant laws, regulations, and professional standards	C2 (Understand)
CLO-3	Analyze and prioritize vulnerabilities based on potential impact and exploitability.	C3 (Apply)

Course Outline

Introduction to Penetration Testing, Definition and objectives, Differences between penetration testing and vulnerability assessments, Legal and ethical considerations, Types of penetration testing (black-box, white-box, gray-box), Reconnaissance and Information Gathering, Passive vs. active reconnaissance, Open Source Intelligence (OSINT) gathering, Tools for information gathering (e.g., Maltego, Recon-ng), Footprinting and enumeration, Scanning and Enumeration, Network scanning techniques (e.g., ping sweeps, port scanning), Vulnerability scanning (e.g., Nessus, OpenVAS), Service enumeration, Identifying live hosts and open ports, Exploitation, Common vulnerabilities and exploits (e.g., SQL injection, buffer overflows), Exploitation frameworks (e.g., Metasploit), Manual exploitation techniques, Post-exploitation strategies, Web Application Penetration Testing, Understanding web technologies, Common web application vulnerabilities (e.g., OWASP Top Ten), Tools for web application testing (e.g., Burp Suite, OWASP ZAP), Techniques for exploiting web vulnerabilities, Network protocols and their vulnerabilities, Wireless network security and attacks, Man-in-the-Middle (MitM) attacks, Network sniffing and traffic analysis, Social Engineering, Psychology of social , engineering attacks, Defense strategies against social engineering. Password Attacks, Password cracking techniques (e.g., brute force, dictionary attacks), Tools for password attacks (e.g., John the Ripper, Hashcat), Password policies and best practices, Wireless network standards and encryption, Wireless attack tools (e.g., Aircrack-ng, Kismet), Wireless network penetration testing methodology, Writing penetration testing reports, Documenting findings and recommendations, Exploiting IoT (Internet of Things) devices, Mobile application security testing, Cloud security and penetration testing, Advanced persistent threats (APTs) and their tactics, Overview of essential tools (e.g. Wireshark), Automation in penetration testing, Understanding laws and regulations related to penetration testing, Real-world scenarios and case studies.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Stuttard, Dafydd, and Marcus Pinto. The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws. 2nd ed., Wiley, 2011.
2. Allsopp, Wil. Advanced Penetration Testing: Hacking the World's Most Secure Networks. Wiley, 2017.
3. McNab, Chris. Network Security Assessment: Know Your Network. 3rd ed., O'Reilly Media, 2016.

Course Name: **Computer Architecture**
Course Code: DE-335
Course Area: Domain Electives
Credit Hours: 3 (2-1)
Contact Hours: 2-3
Pre-requisites:

Course Introduction

This course covers the basics of modern computer organization and architectures, emphasis on understanding interaction between computer hardware and software at various levels. Students will learn concepts of technology, performance evaluation, instruction set design, ALU, data path and control unit design of processors and pipelining for performance enhancement.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain L
CLO-1	Understand the organization of modern computing systems - microprocessor organization and architecture.	C2 (Understand)
CLO-2	Understand pipelined processor organization & hazards, memory hierarchy & storage devices & multiprocessors.	C2 (Understand)
CLO-3	Perform performance analysis and evaluation.	C4 (Analyze)
CLO-4	Apply ALU & control unit implementations, memory hierarchy and multiprocessors.	C3 (Apply)

Course Outline

Computer Architecture and Importance for Computer Science Graduates, Instruction Set Architectures(ISA), Complex Instruction Set Computing (CISC), Reduced Instruction Set Computing (RISC), Operations of the Computer Hardware, Assembly Language, Registers, Data and Instruction Representation, Different Types of Instructions, Loops and IF Statements in Assembly, Supporting Procedures/Functions in Computer Hardware, Supporting Different Data Types in Hardware, Immediate and Addresses in Instructions, Compiling and Linking Processes to Convert a C/Java Program into Assembly and Converting that into Machine Code, Review of Number Systems, Signed and Unsigned Data Types, Arithmetic Operations (Subtraction, Multiplication, Division) in Hardware, Float Data Types and Arithmetic Operations on Float, Evaluating Performance of a System, Latency, Response Time, and Throughput, CPU Execution Time, Calculating CPU Execution Time for a Program, Benchmarks and Amdahl's Law, Processor Design, Building a 32-bit ALU, Processor Data path, Designing a Processor to Execute Instructions and Include Control Unit, Pipelining and Hazards in Pipelining and Solutions, Memory Hierarchy, Caches, Measuring and Improving Cache Performance, Direct Mapped Cache, Fully Associative Caches and Cache Optimizations, Virtual Memory, Virtual Machines. Storage and other I/O topics, Multiprocessors, Multi-cores and Clusters.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Patterson, David A., and John L. Hennessy. Computer Organization and Design: The Hardware/Software Interface. Morgan Kaufmann, 2013.
2. Hennessy, John L., and David A. Patterson. Computer Architecture: A Quantitative Approach. Morgan Kaufmann, 2012.

Course Name: **Advanced Digital Logic Design**

Course Code:
Credit Hours: 3 (2-3)
Contact Hours: 2-3
Pre-requisites: Digital Logic Design

Course Introduction

This course deals with the advanced concepts and techniques in digital logic design. Building on the foundational knowledge of basic digital logic, this course covers topics such as sequential circuit design, programmable logic devices, hardware description languages, and digital system design. The course includes both theoretical lessons and practical laboratory exercises to equip students with the skills needed to design and implement complex digital systems.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	Understand advanced principles of digital logic design. Develop skills in designing complex combinational and sequential circuits.	C2 (Understand)
CLO-2	Gain proficiency in using hardware description languages (HDLs) like VHDL and Verilog.	C2(Understand)
CLO-3	Learn to design and implement digital systems using programmable logic devices (PLDs) and field-programmable gate arrays (FPGAs).	C3 (Apply)

Course Outline

Review of Basic Digital Logic, Overview of fundamental digital logic concepts
Boolean algebra and logic simplification techniques, Basic combinational and sequential circuit design, Advanced Combinational Circuit Design Multiplexers, demultiplexers, encoders, and decoders Arithmetic circuits: adders, subtractors, multipliers, and dividers Designing with combinational building blocks, Sequential Circuit Design Latches and flip- flops: SR, JK, D, and T flip-flops Synchronous and asynchronous sequential circuits, State machines: Moore and Mealy models, State Machine Design, State diagram and state table representation, State minimization techniques, Implementation of state machines using flip- flops, Programmable Logic Devices, Introduction to programmable logic devices (PLDs), Types of PLDs: PALs, GALs, CPLDs, and FPGAs, Programming and configuring PLDs, Hardware Description Languages (HDLs), Overview of VHDL and Verilog, Basic syntax and constructs of HDLs, Writing simple HDL modules and testbenches, Combinational Logic Design Using HDLs, Describing combinational circuits in VHDL and Verilog, Behavioral and structural modeling, Simulation and testing of combinational circuits, Sequential Logic Design Using HDLs, Describing sequential circuits in VHDL and Verilog, State machines and process blocks, Simulation and testing of sequential circuits, Design Verification and Testing, Importance of design verification, Testbenches and simulation techniques, Timing analysis and constraints, FPGA Design Flow, Overview of FPGA design flow, Synthesis, place, and route processes, FPGA configuration and bitstream generation, Advanced Topics in Digital Design, Design for testability (DFT), Fault modeling and fault simulation, Power optimization and low- power design techniques, High-Level Synthesis and Design Automation, Introduction to high- level synthesis (HLS), Design automation tools and methodologies, Benefits and challenges of HLS, Digital System Design and Integration,

Integration of digital subsystems, Interfacing with peripherals and external devices, System-level design and partitioning.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Harris, David, and Sarah Harris. Digital Design and Computer Architecture. 2nd ed., Morgan Kaufmann, 2012.
2. Wakerly, John F. Digital Design: Principles and Practices. 4th ed., Pearson, 2005.
3. Ciletti, Michael D. Advanced Digital Design with the Verilog HDL. 2nd ed., Pearson, 2010.
4. Digital design software tools (e.g., Xilinx Vivado, Altera Quartus)
5. Lab kit with basic electronic components and FPGA development board

Course Name: Embedded Systems
Course Code:
Credit Hours: 3 (2-1)
Contact Hours: 2-3
Pre-requisites: None

Course Introduction
This course provides an in-depth understanding of embedded systems, focusing on their design, implementation, and application. Students will learn about the hardware and software components of embedded systems, real-time operating systems, and the development of embedded software.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	Understand the fundamental concepts of embedded systems and their applications.	C2 (Understand)
CLO-2	Design and implement embedded systems using appropriate hardware and software tools.	C3 (Apply)
CLO-3	Analyze the performance and constraints of embedded systems.	C4 (Analyze)
CLO-4	Develop real-time embedded systems with an understanding of the real-time operating systems (RTOS).	C5 (Evaluate)

Course Outline

Introduction to Embedded Systems, Definition and characteristics of embedded systems, Applications and examples of embedded systems, Overview of embedded system design process, Microcontrollers vs. microprocessors, System on Chip (SoC), Embedded hardware components (sensors, actuators, etc.), Introduction to microcontrollers (e.g., ARM Cortex, AVR, PIC), Architecture and programming of microcontrollers, Peripherals and interfacing (GPIO, ADC, Timers, UART, SPI, I2C), Basics of embedded C programming, Interrupt handling, Input/Output programming, Embedded software development tools and environment, Concepts of real-time systems, RTOS fundamentals, Task scheduling, context switching, and inter-task communication, RTOS examples (FreeRTOS, VxWorks), Hardware/software co-design, Embedded system development lifecycle, Prototyping and debugging techniques, Case studies of embedded system design, Serial communication protocols (UART, SPI, I2C), Wireless communication protocols (Bluetooth, Zigbee, Wi-Fi), Networking in embedded systems, Code optimization techniques, Power management in embedded systems, Memory management, Security challenges in embedded systems, Embedded Linux, Internet of Things (IoT), Machine learning in embedded systems.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Wolf, Wayne. Computers as Components: Principles of Embedded Computing System Design. 3rd ed., Morgan Kaufmann, 2012.

2. Barr, Michael, and Anthony Massa. Programming Embedded Systems: With C and GNU Development Tools. 2nd ed., O'Reilly Media, 2006.
3. Noergaard, Tammy. Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers. 2nd ed., Newnes, 2012.
4. Yiu, Joseph. The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors. 3rd ed., Newnes, 2015.

Course Name: **Cyber Law and Cyber Crimes**
Course Code: DE-421

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

Course Introduction

The course will explore different types of internet-related crime; study relevant computing and network technologies, especially where used either in the commission or detection or prevention of cybercrime; analyze policing, legal, electronic, and other measures designed to combat cybercrime and considers their main strengths and weaknesses; and assess recent sociological and socio-legal theories of cyberspace and apply these theories to the specific field of cybercrime. Topics covered include offenders' use of the internet, computer 'hacking'; media piracy; the ways in which children might be better protected whilst online and cyber security along with current and previous cyber laws in Pakistan and surrounding areas.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	Identify the crimes committed in cyber world and their implications	C2 (Understand)
CLO-2	Understanding how the crimes are done and progresses in time to know the future possibilities	C2 (Understand)
CLO-3	Explore the fundamentals to protect himself and other against such crimes and create a general awareness towards secured environment	C3 (Apply)

Course Outline

Cyber law principles and its significance in the digital age, legal frameworks and regulations, cybercrime classification and analysis, digital rights and responsibilities, cybercrime investigation and forensics, cybersecurity policies and compliance, cybersecurity and intellectual property, emerging issues in cyber law and cybersecurity, cybersecurity incident response and legal remedies, and a capstone project or case studies, Types of Cybercrime: Illegal Access, Data Interference, Computer- related Fraud etc. - Privacy Laws: National and International Regulations - Ethical Issues: Computer-related Forgery, Misuse of Devices, System Interference, Cyber laws in Pakistan ETO 2002, PECCO 2007 and PECA 2016, Middle East Cyber Laws, EU commission Law.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Cyber Law, Privacy and Security: Concepts, Methodologies, Tools, and Applications. Edited by Information Resources Management Association, IGI Global, 2019. DOI: 10.4018/978-1-5225-8897-9.
2. Wagner, Abraham, and Nicholas Rostow. Cybersecurity and Cyberlaw. Publisher, Carolina Academic Press 2020. Print.

Course Name: **Control System Security**

Course Code:

Credit Hours: 3 (2-3)
Contact Hours: 2-3
Pre-requisites: Information Security

Course Introduction

The main goal of the course is to introduce the students to safety and security aspects of modern control systems arising due to their digital and networked implementation. The main course body consists of basic concepts, approaches to and methods of modeling, analysis, and detection of faults and attacks in control systems.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	Identify the basic principles of safety and security in safety- and mission-critical control systems	C2 (Understand)
CLO-2	Explain the control performance under different fault models	C2 (Understand)
CLO-3	Evaluate the risk of different threat scenarios, and the effectiveness of safety and security mechanisms, in a real process	C3 (Apply)

Course Outline

Mathematical description of linear systems in continuous and discrete time in the presence of communication networks, faults, and attacks. Networked control systems. Sampled-data systems. Control performance monitoring. Fault detection and isolation though model-based and data-driven methods. Cyber-security in control systems and typical attack examples and scenarios. Safety and security risk management. Security mechanisms. Safety and security in networked control systems. Control performance monitoring and control under fault. Fault detection and isolation. Cyber-attacks and security mechanisms in control systems.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Ishii, Hideaki, and Quanyan Zhu. Security and Resilience of Control Systems: Theory and Applications. Springer, 2022.
2. Reiger, Craig, et al. Industrial Control Systems Security and Resiliency: Practice and Theory. Springer, 2019.

Course Name: **Cyber Physical Systems**
Course Code:
Credit Hours: 3 (2-3)
Contact Hours: 2-3
Pre-requisites:

Course Introduction

This course introduces students with the fundamentals of cyber physical system. The students will be introduced about different algorithm, protocols for adaptive and secure cyber physical systems.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	Define the algorithms, protocols for adaptive and secure cyber-physical systems	C2 (Understand)
CLO-2	Identify different attacks and vulnerabilities in the context of networked cyber-physical systems using a unified framework	C2 (Understand)
CLO-3	Provide a security analysis for a given system in terms of how vulnerable the system is to different types of attack	C3 (Apply)

Course Outline

This course provides an introduction to security issues relating to various cyber-physical. The goal is to expose students to fundamental security primitives specific to cyber-physical systems and to apply them to a broad range of current and future security challenges. Students will work with various tools and techniques used by hackers to compromise computer systems, smart technologies, IoT devices, embedded systems or otherwise interfere with normal operations. This course will offer insights from cutting edge applied research about the strategies and techniques that can be implemented to protect against cyber-attacks.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Hussain, Omar Khadeer, et al. Cyber Security for Cyber Physical Systems, Springer, 2022.
2. Song, Houbing, et al. Security and Privacy in Cyber-Physical Systems: Foundations, Principles, and Applications, Wiley, 2019.

Course Name: **Open-Source Intelligence**
Course Code:
Credit Hours: 3 (2-3)
Contact Hours: 2-3
Pre-requisites:

Course Introduction

This course offers an in-depth exploration of Panoramic OSINT (Open Source Intelligence), focusing on advanced methods and tools used to gather, analyze, and interpret publicly available information across a wide range of platforms. Students will learn to apply OSINT techniques in specialized areas such as counter-terrorism, dark web investigations, cryptocurrency tracking, and social media monitoring. The course is designed to provide practical skills for real-world applications, equipping students to respond to emerging threats in cybersecurity, law enforcement, and intelligence sectors.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	Understand and explain the principles and significance of OSINT in modern intelligence and cybersecurity operations.	C2 (Understand)
CLO-2	Utilize a variety of tools and techniques to collect and analyze data from open sources, including social media, the Dark Web, and cryptocurrency networks.	C2 (Understand)
CLO-3	Apply OSINT methodologies in specialized areas such as counter-terrorism and crisis management	C3 (Apply)

Course Outline

Definition and scope of OSINT, Historical development and significance, Legal and ethical considerations in OSINT, OSINT collection frameworks (e.g., Maltego, Recon-ng), Data mining and scraping techniques, Analysis and visualization of OSINT data, Identifying terrorist networks and activities online, Monitoring extremist content on the surface web, Case studies on successful counter-terrorism operations using OSINT, Introduction to the Dark Web: TOR, I2P, and other anonymous networks, Tools for navigating and monitoring Dark Web activities, Fundamentals of blockchain and cryptocurrency, Tracking transactions on the blockchain, Techniques for monitoring social media platforms, Analyzing social media behavior for threat detection, Sentiment analysis and trend identification, Using OSINT in emergency situations, Automated OSINT using AI and machine learning, Ethical dilemmas in OSINT investigations

Reference Material

The following is the recommended list of books (or their latest editions):

1. Bazzell, Michael. Open Source Intelligence Techniques: Resources for Searching and Analyzing Online Information, 8th ed., 2021.
2. Steele, Robert David. The Open-Source Everything Manifesto: Transparency, Truth,

and Trust, 2012.
3. Rid, Thomas, and Ben Buchanan. Cyber War Will Not Take Place, Oxford University Press, 2015.
4. "OSINT Framework." OSINT Framework, (link unavailable).
5. "Bellingcat's Guide to OSINT." Bellingcat, (link unavailable).

Course Name: **Advanced Programming**
Course Code:
Credit Hours: 3 (2-3)
Contact Hours: 2-3
Pre-requisites: Object-Oriented Programming

Course Introduction

This course comprises of advanced programming topics in the Java programming Language. This course builds on the earlier programming offered on Object Oriented Programming. Advanced concepts of program design, implementation and testing will be introduced within a framework of object-oriented programming using the Java programming language.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain	Level
CLO-1	Understand basic OOP and advanced programming concepts using Java programming language	C	2(Understand)
CLO-2	Design, implement and test multi-threaded, database oriented and network and distributed applications and event driven GUIs	C	3 (Apply)
CLO-3	Understand Java for functional programming	C	2 (Understand)
CLO-4	Create innovative and robust mobile applications that will be valuable addition to their programming portfolio	C	6 (Create)

Course Outline

Java Platform, Java Virtual Machine and Portability, Classes and Object Creation in Java, OOP Concepts in Java, Data Encapsulation and Abstraction, Inheritance and Polymorphism, Abstract Classes and Interfaces in Java, Java Packages, Inner Classes and Usage, Accessing Private Members, Java Collections and Generics , Exception Handling and Importance, Throwing and Catching Exceptions, try-catch-finally Blocks, Threads and Importance, Creating Threads, Starting Threads, Seep, Join, Priority, Daemon Threads, Thread Synchronization and Importance, Sharing Objects Between Threads and Race Conditions, Synchronized Methods and Synchronized Blocks, wait(), notify(), notifyall(), Explicit Locks for Synchronization, features in the Java Concurrent Package, Reading and Writing String Values from a File, Preserving Object State using Serialization, Network Programming, Java Sockets and the java.net package, TCP Based Programming, UDP Based Programming, Sending Objects Over the Network Using Serialization, Java Remote Method Invocation (RMI), Graphical User Interfaces (GUIs), Event Driven Programming and using it with GUIs, Java Database Connectivity (JDBC),Functional Programming and Importance, Lambdas, Data Streams in Java.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Deitel, Paul J, and Harvey M Deitel. Java : How to Program. New York, Pearson, 2019.
2. Schildt, Herbert. Java: A Beginner's Guide, Ninth Edition, 9th Edition. New York, McGraw-Hill, 2022.
3. Schildt, Herbert. Java: The Complete Reference, Twelfth Edition. McGraw Hill Professional, 2021.

3.4 Mathematics and Supporting Courses

This area of the Mathematics and Supporting Courses consists of 4 courses, totaling 12 credit hours, as outlined below:

Course Name: **Probability and Statistics**
Course Code: MS-251
Course Area: Mathematics & Supporting Courses
Credit Hours: 3 (3-0)
Contact Hours: 3-0
Pre-requisites: None

Course Introduction

Probability & Statistics will provide the foundations of basic statistical measures like, Measures of Central Tendency, Sets and Probability, Random Variables and Probability Distribution, Sampling Theory, Statistical Inference and different types of regressions.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Measures of Central Tendency and Variation.	C1 (Remember)
CLO 2	The concept of a Sets, probability, Random Variables and Probability Distribution	C2 (Understand)
CLO 3	Statistical Inference, Regression and Correlation	C4 (Analyze)

Course Outline

Introduction to Statistics and Data Analysis, Statistical Inference, Samples, Populations, and the Role of Probability. Sampling Procedures. Discrete and Continuous Data. Statistical Modeling. Types of Statistical Studies. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes' Rule. Random Variables and Probability Distributions. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem. Discrete Probability Distributions. Continuous Probability Distributions. Fundamental Sampling Distributions and Data Descriptions: Random Sampling, Sampling Distributions, Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of S2, t-Distribution, FQuantile and Probability Plots. Single Sample & One- and Two-Sample Estimation Problems. Single Sample & One- and Two-Sample Tests of Hypotheses. The Use of PValues for Decision Making in Testing Hypotheses (Single Sample & One- and TwoSample Tests), Linear Regression and Correlation. Least Squares and the Fitted Model, Multiple Linear Regression and Certain, Nonlinear Regression Models, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Walpole, Ronald E., Raymond H. Myers, Raymond H. Myers, Raymond H. Myers, Probability and statistics for engineers and scientists. 9th Edition., Pearson, 2011.
2. Hayter, Anthony J. "Probability and statistics for engineers and scientists. 4th Edition., Cengage Learning 2012.
3. Spiegel, Murray R., R. Alu Srinivasan, and John J. Schiller. Schaum's outline of probability and statistics, 4th Edition., McGraw Hill, 2012.
4. Haigh, John. Probability: A very short introduction. Vol. 310. Oxford University Press, 2012.

Course Name:	**Multivariate Calculus**
Course Code:	MS-253
Course Area:	Mathematics & Supporting Courses
Credit Hours:	3 (3-0)
Contact Hours:	3-0
Pre-requisites:	Calculus and Analytic Geometry

Course Introduction

In this course the students will be equipped with the knowledge of complex variables and transforms which they can use as a tool to solve the practical problems in engineering and technology

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Understand Multivariable Functions	C2 (Understand)
CLO 2	Compute Multivariable Integrals	C5 (Evaluate)
CLO 3	Analyze Vector Fields and Line Integrals	C4 (Analyze)

Course Outline

Calculus of parametric curves, polar coordinates, coordinates and vectors in three-dimensions, dot and cross products, lines and planes in three-dimensions, conic sections and quadratic surfaces, parametric curves in three-dimensions, functions of two and three variables, partial derivatives, tangent planes and differentiability, the chain rule, the gradient and directional derivatives, maxima and minima, Lagrange multipliers, double integrals over rectangles and general regions, double integrals in polar coordinates, applications of double integrals, surface area as double integral, triple integral, cylindrical and spherical coordinates, vector fields and line integrals, Greens theorem, divergence and curl, Stokes theorem, divergence theorem.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Stewart, James, Daniel K. Clegg, Saleem Watson, Multivariable Calculus, 9th Edition., Centage Learning, 2012.
2. Briggs, William, Lyle Cochran, Bernard Gillett, Eric Schulz, Multivariable Calculus, 3rd Edition., Pearson, 2018.
3. Dineen, Seán. Multivariate calculus and geometry, 3rd Edition., Springer-Verlag London, 2014.

Course Name: **Linear Algebra**
Course Code: MS-252
Course Area: Mathematics & Supporting Courses
Credit Hours: 3 (3-0)
Contact Hours: 3-0
Pre-requisites: Calculus and Analytical Geometry

Course Introduction

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

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Algebra of linear transformations and matrices	C2 (Understand)
CLO 2	Systems of Equations	C1 (Remember)
CLO 3	Eigenvalues and Eigenvectors	C3 (Apply)

Course Outline

Introduction to Vectors. Solving Linear Equations. Elimination Factorization. Vector Spaces and Subspaces. Orthogonality. Determinants. Eigen values, and Eigenvectors. Linear Transformations. Linear Transformation, Applications of Matrices in Engineering. Graphs and Networks, Marko Matrices, Population, and Economics. Linear Programming. Fourier Series. Applied Linear Algebra for Functions, Applied Linear Algebra for Statistics and Probability, Computer Graphics. Numerical Applied Linear Algebra. Complex Vectors and Matrices. Discrete Transforms and Simple Applications. Cosine Transform, The Discrete Fourier Transform. Simplification and Factorization of the DFT. Matrix. Fast Fourier Transforms. The Discrete Time Fourier Transform.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Strang, Gilbert. Introduction to Applied Linear Algebra. 5th Edition., Wellesley-Cambridge Press, 2022.
2. Poole, David. Applied Linear Algebra: A modern introduction. 4th Edition., Cengage Learning, 2015.
3. Kolman, Bernard, and David Hill. Elementary Applied Linear Algebra with Applications. 9th Edition., Pearson, 2014.
4. Strang, Gilbert, and Betsy Coonley. Applied Linear Algebra and Its Applications. 4th Edition., Brooks/Cole, 2005
5. Anton, Howard, Irl Bivens, and Chris Davis. Elementary Applied Linear Algebra: Applications Version. 12th Edition., Wiley, 2020.

Course Name: **Technical and Business Writing**
Course Code: MS-254
Course Area: General Education
Credit Hours: 3(3-0)
Contact Hours: 3-0
Pre-requisites:

Course Introduction

This course focuses on professional writing, covering essential documents for decision-making and action in the workplace, such as proposals, reports, instructions, policies, emails, letters, and product descriptions. It includes practice in both individual and collaborative writing processes to create clear, ethical, and effective documents.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Organizing information and generating solution	C2 (Understand)
CLO 2	Designing document with best layout and structure	C3 (Apply)
CLO 3	creating the professional report	C6 (Create)

Course Outline

Overview of technical reporting, use of library and information gathering, administering questionnaires, reviewing the gathered information; Technical exposition; topical arrangement, exemplification, definition, classification and division, casual analysis, effective exposition, technical narration, description and argumentation, persuasive strategy, Organizing information and generation solution: brainstorming, organizing material, construction of the formal outline, outlining conventions, electronic communication, generation solutions. Polishing style: paragraphs, listening sentence structure, clarity, length and order, pomposity, empty words, pompous vocabulary, document design: document structure, preamble, summaries, abstracts, table of contents, footnotes, glossaries, cross-referencing, plagiarism, citation and bibliography, glossaries, index, appendices, typesetting systems, creating the professional report; elements, mechanical elements and graphical elements. Reports: Proposals, progress reports, Leaflets, brochures, handbooks, magazines articles, research papers, feasibility reports, project reports, technical research reports, manuals and documentation, thesis. Electronic documents, Linear verses hierarchical structure documents.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Zobel, Justin. Writing for Computer Science. 3rd Edition., Springer London, 2014.
2. Hardesty, Ray E. Technical and Business Writing for Working Professionals. Xlibris, 2011.
3. Brown, Bill Wesley. Successful Technical Writing: Documentation for Business and Industry. 2nd Edition., Goodheart-Willcox, 2000

3.5 BS CySec Elective Supporting Courses

This CySec Elective Supporting area consists of 1 course, comprising 3 credit hours, as outlined below:

Course Name:	**Computation in MATLAB**
Course Code:	
Course Area:	Mathematics & Supporting Courses
Credit Hours:	3(2-3)
Contact Hours:	2-3
Pre-requisites:	Programming Fundamentals

Course Introduction

The course introduces programming and problem solving Using MATLAB. It emphasizes the systematic development of algorithms and programs. Basic or even no programming experience is necessary.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Fluent in the use of procedural statements—assignments, conditional statements, loops, function calls—and arrays	C1 (Remember)
CLO 2	Working familiarity with graphics tools in MATLAB	C3 (Apply)
CLO 3	Knowledge of basic vector computation	C2 (Understand)

Course Outline

Introduction to MATLAB Windows, Built-in Functions, Arrays, Matrices, Script Files, Plots, Functions and Function Files, Loops, Selection Statements, Polynomials, Curve Fitting and Interpolation.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Lipsman, Ronald L., et al. A Guide to MATLAB: For Beginners and Experienced Users. 3rd Edition., Cambridge University Press, 2014.
2. Etter, Delores M., David C. Kuncicky, and Douglas W. Hull. Introduction to MATLAB. 4th Edition., Pearson, 2018.
3. Moore, Holly. MATLAB for Engineers. 4th Edition., Pearson, 2022.

3.6 General Education Courses

This BS CySec General Education area consists of 12 courses, comprising 33 credit hours, as outlined below:

Course Name: Applications of Information and Communication Technologies
Course Code: GE-160
Course Area: General Education
Credit Hours: 3 (2-1)
Contact Hours: 2-3
Pre-requisites: None

Course Introduction

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 and Future Trends in ICT.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	To understand the fundamental concepts and components of ICT	C2 (Understand)
CLO 2	To develop practical skills in using ICT tools and software.	C6 (Create)
CLO 3	To learn about emerging trends and technologies in the ICT field.	C3 (Apply)

Course Outline

Brief history of Computer, Four Stages of History, Computer Elements, Processor, Memory, Hardware, Software, Application Software its uses and Limitations, System Software its Importance and its Types, Types of Computer, Introduction to CBIS (Computer Based Information System), Methods of Input and Processing, Class2. Organizing Computer Facility, Centralized Computing Facility, Distributed Computing Facility, Decentralized Computing Facility, Input Devices. Keyboard and its Types, Terminal (Dump, Smart, Intelligent), Dedicated Data Entry, SDA (Source Data Automation), Pointing Devices, Voice Input, Output Devices. Soft- Hard Copies, Monitors and its Types, Printers and its Types, Plotters, Computer Virus and its Forms, Storage Units, Primary and Secondary Memories, RAM and its Types, Cache, Hard Disks, Working of Hard Disk, Diskettes, RAID, Optical Disk Storages (DVD, CD ROM), Magnetic Types, Backup System, Data Communications, Data Communication Model, Data Transmission, Digital and Analog Transmission, Modems, Asynchronous and Synchronous Transmission, Simplex. Half Duplex, Full Duplex Transmission, Communications, Medias (Cables, Wireless), Protocols, Network Topologies (Star, Bus, Ring), LAN, LAN, Internet, A Brief History, Birthplace of ARPA Net, Web Link, Browser, Internet Services provider and Online Services Providers, Function and Features of Browser, Search Engines, Common Services available on Internet, Introduction to MS Word, MS Excel, MS PowerPoint.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Shelly, Gary B., and Misty E. Vermaat. Discovering Computers: Digital Technology, Data, and Devices. 17th Edition., Cengage Learning, 2022.
2. Sinha, P.K. Computer Fundamentals. 8th Edition., BPB Publications, 2020.
3. Williams, Brian K. Using Information Technology: A Practical Introduction to Computers & Communications. 11th Edition., McGraw-Hill Education, 2015.
4. O'Leary, Timothy J., and Linda I. O'Leary. Computing Essentials 2024. 29th Edition., McGraw-Hill Education, 2023.

Course Name: **Functional English**
Course Code: GE-190
Course Area: General Education
Credit Hours: 3 (3-0)
Contact Hours: 3-0
Pre-requisites: None

Course Introduction

This is first course in English to the Bachelor of Studies students and covers all the fundamental concept of English composition and comprehension. The course is designed in such a way that students can use this knowledge to further enhance their language skills in English. The course aims at enhancing students' skill and competence in communicating their ideas in writing and speaking in English language. It will primarily focus on four areas of language to help the students achieve proficiency in language use, develop skills in listening comprehension, improve reading efficiency, use the conventions of standard written English with skill and assertion, build-up vocabulary, and clearly and accurately reproduce specific data. It will illustrate the force and effectiveness of simple and direct English.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Essay Writing and Sentence Errors	C1 (Remember)
CLO 2	Deliver Oral Presentations	C3 (Apply)
CLO 3	Narration and Reviewing	C5 (Evaluate)

Course Outline

Paragraph and Essay Writing, Descriptive Essays; Sentence Errors, Persuasive Writing; How to give presentations and Errors; Oral Presentations, Comparison and Contrast Essays, Dialogue Writing, Short Story Writing, Review Writing, Narrative Essays, Letter Writing

Reference Material

The following is the recommended list of books (or their latest editions):

1. Langan, John. College writing skills with readings. 5th Edition. New York (2001).
2. Khattak, Arif. A Textbook of English Prose and Structure. GIKI Institute, 2000.
3. Bloor, Thomas, and Meriel Bloor. The functional analysis of English: A Hallidayan approach. 3rd Edition. Routledge, 2013.
4. Klammer, Thomas P. Analyzing English Grammar, 4th Edition. Pearson Education India, 2004.

Course Name: **Expository Writing**
Course Code: GE-199
Course Area: General Education
Credit Hours: 3(3-0)
Contact Hours: 3-0
Pre-requisites:

Course Introduction

The course introduces students to the communications so they can effectively communicate their message. The course also covers how to make an effective presentation both written and verbal. Various modern techniques of communication and presentation skills are covered in this course. Further the course aims to enhance students' linguistic command, so they could communicate effectively in diversified socio-cultural situations; create larger stretches of interactive text in speech and writing; and identify and repair any instances of potential communication break-up.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Principles of writing good English, understanding the composition process	C1 (Remember)
CLO 2	Process of writing, observing, audience collecting, composing, drafting and revising	C2 (Understand)
CLO 3	Presentation skills and presentation strategies,	C3 (Apply)

Course Outline

Principles of writing good English, understanding the composition process: writing clearly; words, sentence and paragraphs; Comprehension and expression; Use of grammar and punctuation. Process of writing, observing, audience collecting, composing, drafting and revising, persuasive writing, reading skills, listening skills and comprehension, skills for taking notes in class, skills for exams; Business communications; planning messages, writing concise but with impact. Letter formats, mechanics of business, letter writing, letters, memo and applications, summaries, proposals, writing resumes, styles and formats, oral communications, verbal and non-verbal communication, conducting meetings, small group communication, taking minutes.

Presentation skills; presentation strategies, defining the objective, scope and audience of the presentation, material gathering material organization strategies, time management, opening and concluding, use of audio-visual aids, delivery and presentation

Reference Material

The following is the recommended list of books (or their latest editions):

1. Vawdrey, Colleen, Ted D. Stoddard, and R. DerMont Bell. Practical Business English. Richard d Irwin,1993.
2. Nielsen, John. Effective Communication Skills: The Foundations for Change. Xlibris Corporation, 2008.
3. Langan, John. College writing skills with readings. 5th Edition. McGraw-Hill Education. 2001

Course Name: **Discrete Structures**
Course Code: GE-167
Course Area: General Education
Credit Hours: 3(3-0)
Contact Hours: 3-0
Pre-requisites: None

Course Introduction

Introduces the foundations of discrete mathematics as they apply to Computer Science, focusing on providing a solid theoretical foundation for further work. Further, this course aims to develop understanding and appreciation of the finite nature inherent in most Computer Science problems and structures through study of combinatorial reasoning, abstract algebra, iterative procedures, predicate calculus, tree and graph structures. In this course more emphasis shall be given to statistical and probabilistic formulation with respect to computing aspects.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Understand the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs and Trees etc.	C2 (Understand)
CLO 2	Apply formal logic proofs and/or informal, but rigorous, logical reasoning to real problems, such as predicting the behavior of software or solving problems such as puzzles.	C3 (Apply)
CLO 3	Design and implement algorithms to solve real world problems	C6 (Create)
CLO 4	Differentiate various discrete structures and their relevance within the context of computer science, in the areas of data structures and algorithms, in particular	C4 (Analyze)

Course Outline

Mathematical reasoning, propositional and predicate logic, rules of inference, proof by induction, proof by contraposition, proof by contradiction, proof by implication, set theory, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings, function composition, inverse functions, recursive functions, Number Theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations. Algorithms, Searching and Sorting Algorithms, elements of graph theory, planar graphs, graph coloring, Graph Algorithms, Euler graph, Hamiltonian path, rooted trees, traversals.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Rosen, Kenneth H. Discrete Mathematics and Its Applications. 7th Edition., McGraw-Hill Education, 2012.
2. Epp, Susanna S. Discrete Mathematics with Applications. 4th Edition., Cengage Learning, 2010.
3. Johnsonbaugh, Richard. Discrete Mathematics. 7th Edition., Pearson, 2018.
4. Kolman, Bernard, Robert Busby, and Sharon Ross. Discrete Mathematical Structures. 4th Edition., Pearson, 2014.
5. Grimaldi, Ralph P. Discrete and Combinatorial Mathematics: An Applied Introduction. Pearson, 2016.
6. Grassmann, Winifred. Logic and Discrete Mathematics: A Computer Science Perspective. Springer, 2007.

Course Name: **Calculus and Analytic Geometry**
Course Code: GE-162
Course Area: Mathematics & Supporting Courses
Credit Hours: 3 (3-0)
Contact Hours: 3-0
Pre-requisites: None

Course Introduction
To provide foundation and basic ground for calculus and analytical geometry background.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Techniques of funding limits, Indeterminate forms of limits, Continuous and discontinuous functions and their applications	C1 (Remember)
CLO 2	Differentiation, Geometrical and Physical meaning of derivatives	C2 (Understand)
CLO 3	Concept and idea of Integration	C2 (Understand)
CLO 4	Applications of Integration; Area under the curve, Analytical Geometry	C3 (Apply)

Course Outline

Limits and Continuity; Introduction to functions, Introduction to limits, Techniques of funding limits, Indeterminate forms of limits, Continuous and discontinuous functions and their applications, Differential calculus; Concept and idea of differentiation, Geometrical and Physical meaning of derivatives, Rules of differentiation, Techniques of differentiation, Rates of change, Tangents and Normals lines, Chain rule, implicit differentiation, linear approximation, Applications of differentiation; Extreme value functions, Mean value theorems, Maxima and Minima of a function for single-variable, Concavity, Integral calculus; Concept and idea of Integration, Indefinite Integrals, Techniques of integration, Riemann sums and Definite Integrals, Applications of definite integrals, Improper integral, Applications of Integration; Area under the curve, Analytical Geometry; Straight lines in R3, Equations for planes.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Thomas, George B., and Ross L. Finney. Calculus and Analytic Geometry. 10th ed., Addison Wesley, 1995.
2. Swokowski, Earl W. Calculus and Analytical Geometry. 6th ed., Brooks/Cole Publishers, 1994.
3. Anton, Howard, Irl Bivens, and Stephen Davis. Calculus. 10th ed., Wiley, 2012.
4. Anton, Howard. Calculus with Analytic Geometry: Student Solution Manual. 5th ed., Wiley, 1995.

Course Name: **Islamic Studies**
Course Code: GE-163
Course Area: General Education
Credit Hours: 3 (3-0)
Contact Hours: 3-0
Pre-requisites: None

Course Introduction

This course will provide the foundational information of Islamic values and implementation of those values in different parts of life.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Introduction to Quranic studies	C1 (Remember)
CLO 2	Seerat of Prophet (SAW) and Introduction to Sunnah	C2 (Understand)
CLO 3	Political System of Islam and Islamic Economic System	C3 (Apply)

Course Outline

Basic Themes of Quran, Introduction to Sciences of Hadith, Introduction to Islamic Jurisprudence, Primary & Secondary Sources of Islamic Law, Makken & Madnian life of the Prophet, Islamic Economic System, Political theories, Social System of Islam. Definition of Akhlaq.The Most Important Characters mentioned in the Holy Qur'an and Sunnah, SIDQ (Truthfulness)Generosity Tawakkaul(trust on Allah)Patience Taqua (piety). Haqooq ul ibad in the light of Quran & Hadith - the important characteristic of Islamic Society.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Hamidullah, Dr. Introduction to Islam. Popular Library Publishers, Lahore.
2. Hassan, Ahmad. Principles of Islamic Jurisprudence. Islamic Research Institute, International Islamic University Islamabad.
3. Waliullah, Mir. Muslim Jurisprudence and the Quranic Law of Crimes. Islamic Books Services.

Course Name:	**Civics and Community Engagement**
Course Code:	GE-363
Credit Hours:	2 (2-0)
Contact Hours:	2-0
Pre-requisites:	None

Course Introduction

This course is designed to provide students with fundamental knowledge about civics, citizenship, and community engagement. In this course, the students will learn about the essentials of civil society, government, civic responsibilities, inclusivity, and effective ways to participate in shaping the society which will help them apply theoretical knowledge to the real-world situations to make a positive impact on their communities.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Demonstrate fundamental understanding of civics, government, citizenship and civil society.	C2 (Understand)
CLO 2	Understand the concept of community and recognize the significance of community engagement for individuals and groups..	C2 (Understand)
CLO 3	Recognize the importance of diversity and inclusivity for societal harmony and peaceful co-existence..	C4 (Analyze)

Course Outline

Concepts of civics, citizenship, and civic engagement, Foundations of modern society and citizenship, Types of citizenship: active, participatory, digital, etc. Structure and functions of government in Pakistan. The relationship between democracy and civil society., Right to vote and importance of political participation and representation. Overview of fundamental rights and liberties of citizens under Constitution of Pakistan 1973. Civic responsibilities and duties. Ethical considerations in civic engagement (accountability, non-violence, peaceful dialogue, civility, etc.) Concept, nature and characteristics of community. Community development and social cohesion. Approaches to effective community engagement. Case studies of successful community driven initiatives. Public discourse and public opinion. Role of advocacy in addressing social issues. Social action movements. The use of digital platforms for civic engagement. Cyber ethics and responsible use of social media. Digital divides and disparities (access, usage, socioeconomic, geographic, etc.) and their impacts on citizenship. Understanding diversity in society (ethnic, cultural, economic, political etc.). Youth, women and minorities' engagement in social development. Addressing social inequalities and injustices in Pakistan. Promoting inclusive citizenship and equal rights for societal harmony and peaceful co-existence. As part of the overall learning requirements, the course may have one or a combination of the following practical activities: Students can collect and share stories from community members. This could be done through oral histories, interviews, or multimedia presentations that capture the lived experiences and perspectives of diverse individuals. Students can organize a community event or workshop that addresses a specific issue or fosters community interaction. This could be a health fair, environmental cleanup, cultural festival, or educational workshop. Students can collaborate with a local nonprofit organization or community group. They can actively contribute by volunteering their time and skills to address a particular community need, such as tutoring, mentoring, or supporting vulnerable populations. Students can organize a cultural exchange event that celebrates the

diversity within the community. This could include food tastings, performances, and presentations that promote cross-cultural understanding.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Remy, R. C. (2005). Civics Today: Citizenship, Economics, & You. United States: Glencoe/McGraw-Hill.
2. Kymlicka, W. (2000). Citizenship in diverse societies. Oxford University Press.
3. Youniss, J., & Levine, P. (2009). Engaging Young People in Civic Life: Vanderbilt University Press.
4. Mattson, K. (2024). Digital citizenship in action: empowering students to engage in online communities. International Society for Technology in Education.
5. Kronick, R. F. (2018). Community Engagement: Principles, Strategies and Practices. United States: Nova Science Publishers, Incorporated.

Course Name:	**Entrepreneurship**
Course Code:	GE-362
Course Area:	General Education
Credit Hours:	2 (2-0)
Contact Hours:	2-0
Pre-requisites:	None

Course Introduction

This course is designed for anyone looking to start their own business, whether as a main income or a side job, including freelancers, contractors, consultants, and gig economy workers. It focuses on three key areas: the traits and skills that make entrepreneurs successful, how to generate and expand business ideas, and how to ensure these ideas are profitable. These elements will help both current and future entrepreneurs develop and grow their businesses.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO 1	Understand the traits, skills, attitudes and drive necessary to be a successful entrepreneur	C2 (Understand)
CLO 2	Develop personal growth plans to address weaknesses and capitalize on strengths in order to increase their potential to succeed in small business.	C3 (Apply)
CLO 3	Understand the needs of target markets related to potential viable business idea.	C2 (Understand)
CLO 4	Match potential viable idea to personal assessment profile.	C4 (Analyze)

Course Outline

Entrepreneurship and the Entrepreneurial Mind-Set. Entrepreneurial Intentions and Corporate Entrepreneurship. Entrepreneurial Strategy. Generating and Exploiting New Entries. Creativity and the Business Idea. Identifying and Analyzing Domestic and International Opportunities. Intellectual Property and Other Legal Issues for the Entrepreneur. The Business Plan. Creating and Starting the Venture. The Marketing Plan. The Organizational Plan. The Financial Plan. Sources of Capital. Informal Risk.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Hisrich, Robert D., Michael P. Peters, and Dean A. Shepherd. Entrepreneurship. 9th Edition., McGraw-Hill/Irwin, 2012.
2. Greene, Christopher L. Entrepreneurship: Ideas in Action. 5th Edition., South-Western Educational Pub, 2011.
3. Bygrave, William D., and Andrew Zacharakis. Entrepreneurship. 2nd Edition., Wiley, 2010.
4. Kuratko, Donald F. Entrepreneurship: Theory, Process, and Practice. 8th Edition., South- Western College Pub, 2008.
5. Barringer, Bruce R., and R. Duane Ireland. Entrepreneurship: Successfully Launching New Ventures. 4th Edition., Prentice Hall, 2011.

3.7 Arts & Humanities Course

Course Name: **Professional Practices**
Course Code: GE-402
Course Area: General Education
Credit Hours: 3 (3-0)
Contact Hours: 3-0
Pre-requisites: None

Course Introduction

A Computing graduate as professional has some responsibilities with respect to the society. This course develops student understanding about historical, social, economic, ethical, and professional issues related to the discipline of Computing. It identifies key sources for information and opinion about professionalism and ethics. Students analyze, evaluate, assess ethical & professional computing case studies.

CLO No.	Course Learning Outcomes	Bloom's Taxonomy Domain Level
CLO-1	Understand the concepts of key, ethical, managerial and legal issues typically encountered by an IT professional.	C2 (Understand)
CLO-2	Identify, access and critically review appropriate and relevant literature drawn from academic, technical, legal, professional business sources.	C3 (Apply)
CLO-3	Evaluate and critically reflect upon self-presentation.	C5 (Evaluate)

Course Outline

Historical, social, and economic context of Computing (software engineering, Computer Science, Information Technology); Definitions of Computing (software engineering, Computer Science, Information Technology) subject areas and professional activities; professional societies; professional ethics; professional competency and life-long learning; uses, misuses, and risks of software; information security and privacy; business practices and the economics of software; intellectual property and software law (cyber law); social responsibilities, software related contracts, Software house organization. Intellectual Property Rights, The Framework of Employee Relations Law and Changing Management Practices, Human Resource Management and IT, Health and Safety at Work, Software Liability, Liability and Practice, Computer Misuse and the Criminal Law, Regulation and Control of Personal Information. Overview of the British Computer Society Code of Conduct, IEEE Code of Ethics, ACM Code of Ethics and Professional Conduct, ACM/IEEE Software Engineering Code of Ethics and Professional Practice. Accountability and Auditing, Social Application of Ethics.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Bott, Frank, Allison Coleman, Jack Eaton, and Diane Rowland. Professional Issues in Software Engineering. 3rd Edition., CRC Press, 2000.
2. Johnson, Deborah G. Computer Ethics. 4th Edition., Pearson, 2009.
3. Bott, Frank. Professional Issues in Information Technology. 2nd Edition., BCS Learning & Development Limited, 2014.
4. Baase, Sara. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet. 3rd Edition., Prentice Hall, 2008.
5. Beabout, Gregory R. Applied Professional Ethics. University Press of America, 1993.

3.8 Natural Sciences Course

Course Name: **Applied Physics**
Course Code: GE-169
Course Area: General Education
Credit Hours: 3 (2-1)
Contact Hours: 2-3
Pre-requisites: None

Course Introduction

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

CLO No.	Course Learning Outcomes	Bloom's Taxonomy	
		Domain	Level

Course Outline

Electric force and its applications and related problems, conservation of charge, charge quantization, Electric fields due to point charge and lines of force. Ring of charge, Disk of charge, A point charge in an electric field, Dipole in a n electric field, The flux of vector field, The flux of electric field, Gauss' Law, Application of Gauss' Law, Spherically symmetric charge distribution, A charge isolated conductor, Electric potential energy, Electric potentials, Calculating the potential from the field and related problem Potential due to point and continuous charge distribution, Potential due to dipole, equipotential surfaces, Calculating the field from the potential, Electric current, Current density, Resistance, Resistivity and conductivity, Ohm's law and its applications, The Hall effect, The magnetic force on a current, The Biot- Savart law, Line of B, Two parallel conductors, Amperes' s Law, Solenoid, Toroids, Faraday's experiments, Faraday's Law of Induction, Lenz's law, Motional emf, Induced electric field, Induced electric fields, The basic equation of electromagnetism, Induced Magnetic field, The displacement current, Reflection and Refraction of light waves, Total internal reflection, Two source interference, Double Slit interference, related problems, Interference from thin films, Diffraction and the wave theory, related problems, Single-Slit Diffraction, related problems, Polarization of electromagnetic waves, Polarizing sheets, related problems.

Reference Material

The following is the recommended list of books (or their latest editions):

1. Halliday, David, Robert Resnick, and Jearl Walker. Fundamentals of physics. John Wiley & Sons, 2013.
2. Garcia, Narciso, and Arthur Damask. Physics for computer science students: with emphasis on atomic and semiconductor physics. Springer Science & Business Media, 2012.

Program	BS Cyber Security
Course Code	UE406
Course Title	Foreign Language/Arabic Language
Credit Hours	3
Course Category	
Pre-requisites	None
Syllabus	الاسم ، الفعل، الحرف،الضمائر متصلہ،المرکب الاضافی،المرکب التوصیفی،الضمائر المنفصلۃ،حروف الجر،الجملہ الاسمیۃ، الجملۃ الفعلیہ، المذکر والمونث، الواحد الجمع،الفعل الماضی،الفعل المضارع،الفعل المضعف،الضمائر المتصلۃبالافعال،الفعل الصحیح،الفعل المعتل، لاحادیث النبویۃ، الاناشید المختارۃ، القصص،حروف الہجا،المخارج الحروف،پہلے سپیارے کا ترجمہ مع الفاظ کی تشریح بلحاظ قواعد
Books Recommended	• "اللسان العربی" • عربی کا معلم ، حصہ اول، دوم • تسہیل الصرف • تسہیل النہو • القراۃ الراشدہ • القراۃ الرشیدہ

Checklist for a New Academic Program

Parameters	
1. Department Mission and Introduction	☐
2. Program Introduction	☐
3. Program Alignment with University Mission	☐
4. Program Objectives	☐
5. Market Need/ Rationale	☐
6. Admission Eligibility Criteria	☐
7. Duration of the Program	☐
8. Assessment Criteria	☐
9. Courses Categorization as per HEC Recommendation	☐
10. Curriculum Difference	☐
11. Study Scheme / Semester-wise Workload	☐
12. Award of Degree	☐
13. Faculty Strength	☐
14. NOC from Professional Councils (if applicable)	☐

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Program Coordinator
Chairperson

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